

# **Microwave Digital Archive**

## **IEEE Microwave Theory and Techniques Society**

**1993-1994**

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# Welcome

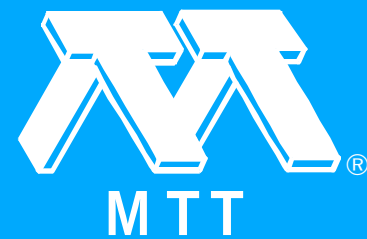
The Microwave Theory and Techniques Society of the IEEE has finished a complete archive of all reviewed and published material since 1953. Yearly updates of the published material will be compiled in the future. As digital media changes over the years, it will be necessary to update the format of the material, so this initial electronic release blazes a trail into the future.

The section "Getting Started" tells you how to optimize the Acrobat Reader Preferences to improve the readability of the document. If you need customer support before January 2001, call 831.657.2420 or 800.447.9100. If you find errors in the CD-ROM, e-mail a note to [c.jackson@ieee.org](mailto:c.jackson@ieee.org), or mail a comment to the current President of the MTT Society.

Remember that the quality of the old journals is not perfect, and that some photographs will not be as clear as Technicolor. Also, the optical character recognition is good, but not perfect, so some spelling errors will occur. None the less, you can copy and paste the material for your own uses and personal study.

All papers were electronic files or images scanned from hard copy and converted to Adobe Acrobat PDF file format for cross-platform access. Since some of the papers were scanned from hard copy, the viewing quality will vary with the size and quality of fonts used. Even though the viewing quality on your monitor may vary, all papers print clearly.

Thank You and Enjoy!



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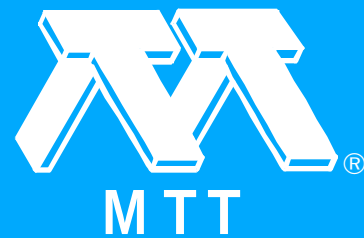
## ACKNOWLEDGMENTS

This CD- ROM was assembled from the electronic files provided to us by Adam Philippidis at IEEE headquarters and from scanned originals provided by Ted Saad. Many people have contributed to the entire CD-ROM Archival effort. Most notably, Ted Saad provided nearly all the hard copy material, and sacrificed his entire collection of journals for the project. He also wrote a number of the original articles. Another notable contributor, Roger Pollard convinced the Society that this was a worthwhile project. The team at Sony Electronic Publishing Services, and Adam Philippidis, at the IEEE Headquarters, have also provided substantial amounts of help in completing this archival project.

## REFERENCES

IEEE Catalog Number: JP-17-0-0-C-0

ISBN: 0-7803-9906-4



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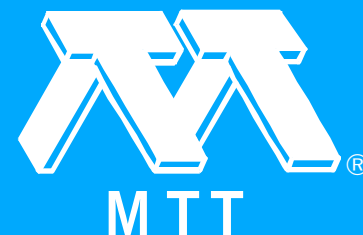
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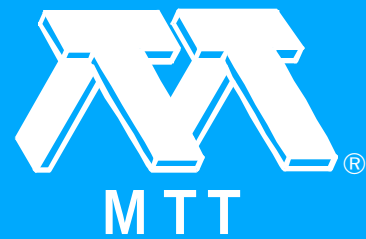




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## TRADEMARKS

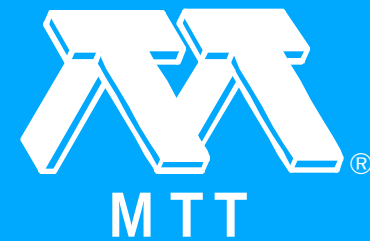
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# Getting Started



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## INTRODUCTION

This Electronic Guide file contains hypertext links to separate article files. Links are represented by colored text (e.g. a name or title); clicking on the text activates the link.

Before you start browsing and using the information on this CD-ROM, you will need to install Adobe Acrobat Reader + Search 3.0. If you already have Acrobat Reader installed on your system, make sure it is version 3.0 or higher and includes the Search plug-in.

In many instances, we refer to the “menu bar”, shown here for reference.

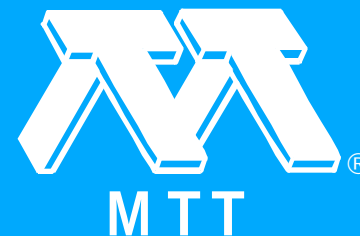


## ACROBAT PREFERENCES

To make viewing and searching easier, we recommend changing two default Acrobat Preferences (found under File > Preferences on the menu bar.)



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In the dialog box shown for **General** Preferences, turn OFF the “Open Cross-Document Links in Same Window” option; this will keep the Guide file open when you view article files and allows you to return to the same page in the Guide when you close an article.

In the dialog box shown for **Search** Preferences, turn ON the “Show Fields” option so that Title, Author, Keywords, and Subject fields are visible when specifying search criteria. If for some reason this preference option is not present on your system, check to see that you have the Search plug-in installed. The

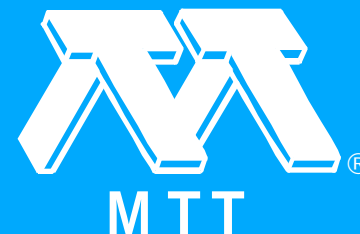
Search icon  will be present on the Acrobat Toolbar if the function is properly installed. Specifics of the Search function are described later in this section.

## EXITING AN ARTICLE

To exit an article after viewing, and return to the electronic guide, select File > Close from the menu bar. To switch between the article and the electronic guide or any other PDF file that is open, select “Window” and pick the open file you wish to return to.



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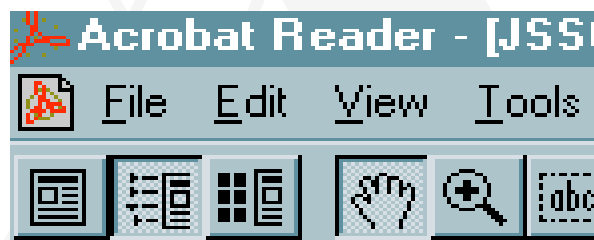
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## USING BOOKMARKS

In addition to links, you can navigate through the Electronic Guide using Bookmarks. If they are not already visible, choose View > Bookmarks and Page from the menu bar or press the “Display Page and Bookmarks” button on the tool bar. A panel opens on the left side of the screen displaying Bookmarks in a hierarchy.



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Each Bookmark corresponds to a page in the Guide. Click on the text in a Bookmark to go to that page.

Entries with lower level Bookmarks show an arrowhead, pointing down when subordinate Bookmarks are visible, pointing right when hidden. To view subordinate Bookmarks, click on the arrowhead. To hide them, click on the arrowhead again. Dragging the right margin of the bookmark panel resizes it.

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## PRINTING ARTICLES

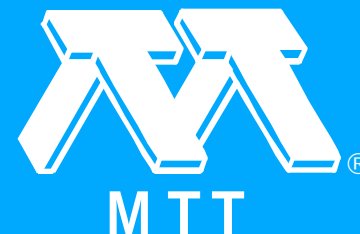
Articles may have text outside normal print-area defaults. We recommend selecting “Shrink to Fit” in the print menu (File > Print) to capture the complete image for your printout. This setting will become your new default.

## SELECTING GRAPHICS

To copy graphics to the Clipboard, choose Tools > Select Graphics from the menu bar. The cursor changes to the cross-hair icon.

Drag a rectangle around the graphic to select it. When you release the mouse button, the selected graphic is highlighted.

Choose Edit > Copy from the menu bar to copy the selected graphic to the Clipboard. To view the graphic, choose Window > Show Clipboard. The graphic is copied in the WMF (Windows), PICT (Macintosh), or XPIXMAP (UNIX) format. With UNIX, the graphic is pasted in the primary selection.



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## NAVIGATION BUTTONS

This Guide contains a variety of navigational aids to help you easily explore the contents.

### Section Map

The Electronic Guide is constructed in sections: e.g. Sessions, Authors, Getting Started. The current section is shown at the top of each page. The “path” to this section is shown at the right. Clicking these text buttons moves you to the start of that section.

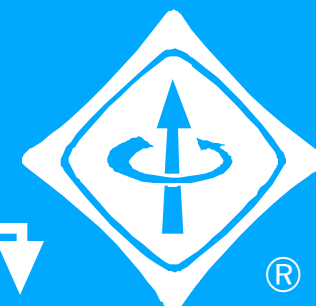
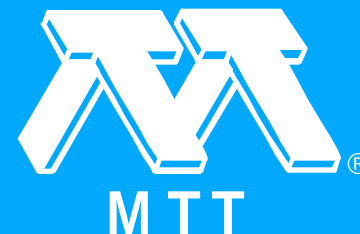
### Next Page button

Click to advance to the next page in the section.

### Previous Page button

Click to go back to the previous page in the section. The first and last pages of a section show only one button.

The Page Up and Page Down keys perform the same functions.

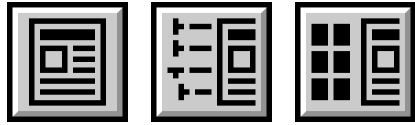


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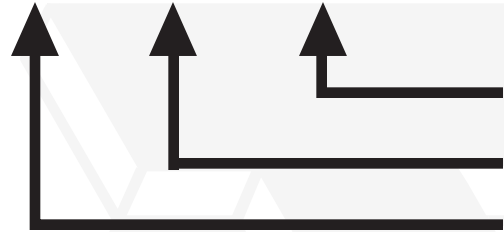


# Getting Started

## ACROBAT TOOLBAR



### View Modes



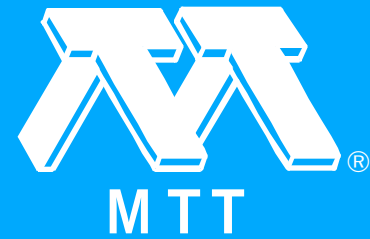
Display Thumbnails and Page  
Display Bookmarks and Page  
Display Page



### Zoom/Selection



Select Text  
Zoom In (Magnify)  
Move Page Image



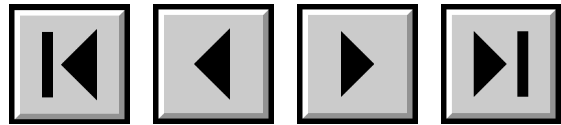
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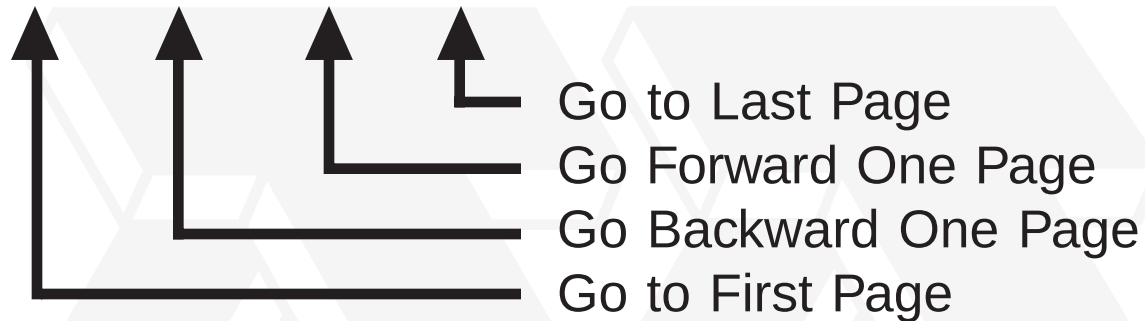


# Getting Started

## ACROBAT TOOLBAR (continued)



### Navigation

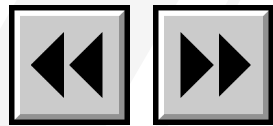


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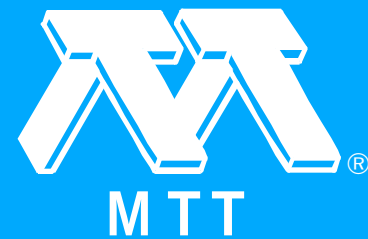


### History



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Previous (One Link)



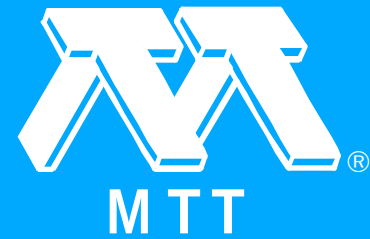
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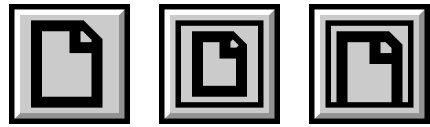
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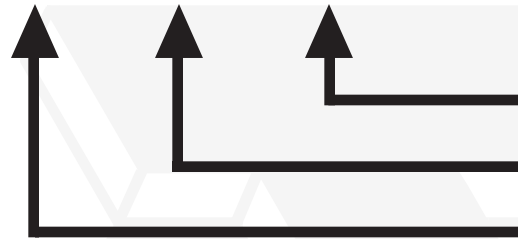
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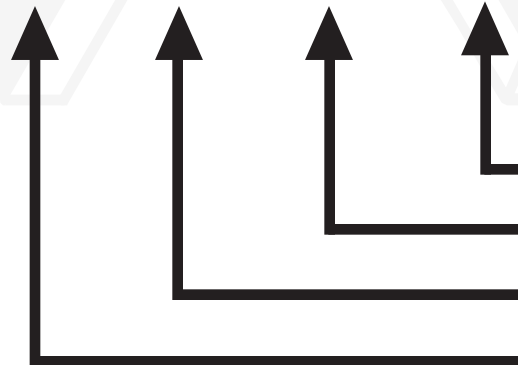
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Fit Page  
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Find/Search



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Previous Hit  
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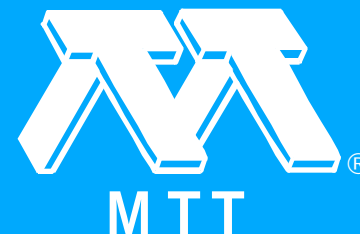
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## SEARCHING

Two types of searching are possible with Acrobat: Find and full-text Search. Choosing Find (from the Toolbar or Tools > Find) opens a dialog box. Type a search string in the field provided, check the appropriate options and press the “Find” button. Find searches linearly through the currently open Acrobat file (not necessarily the entire Electronic Guide) from the cursor forward.

Choosing the Search button or Search menu item (Tools > Search), selecting the Query item, opens a dialog box from which you can access the more powerful full-text search engine (if you installed Acrobat with the Search plug-in from this CD-ROM). Its dialog box is shown on the next page.

Typing a term in the text box at the top of the Search dialog box and pressing the “Search” button causes a full-text search of all words in the body of papers in the collection. Entering a term in one or more of the fixed fields (Title, Author, Subject or Keywords) will cause a search for hits in only those fields.



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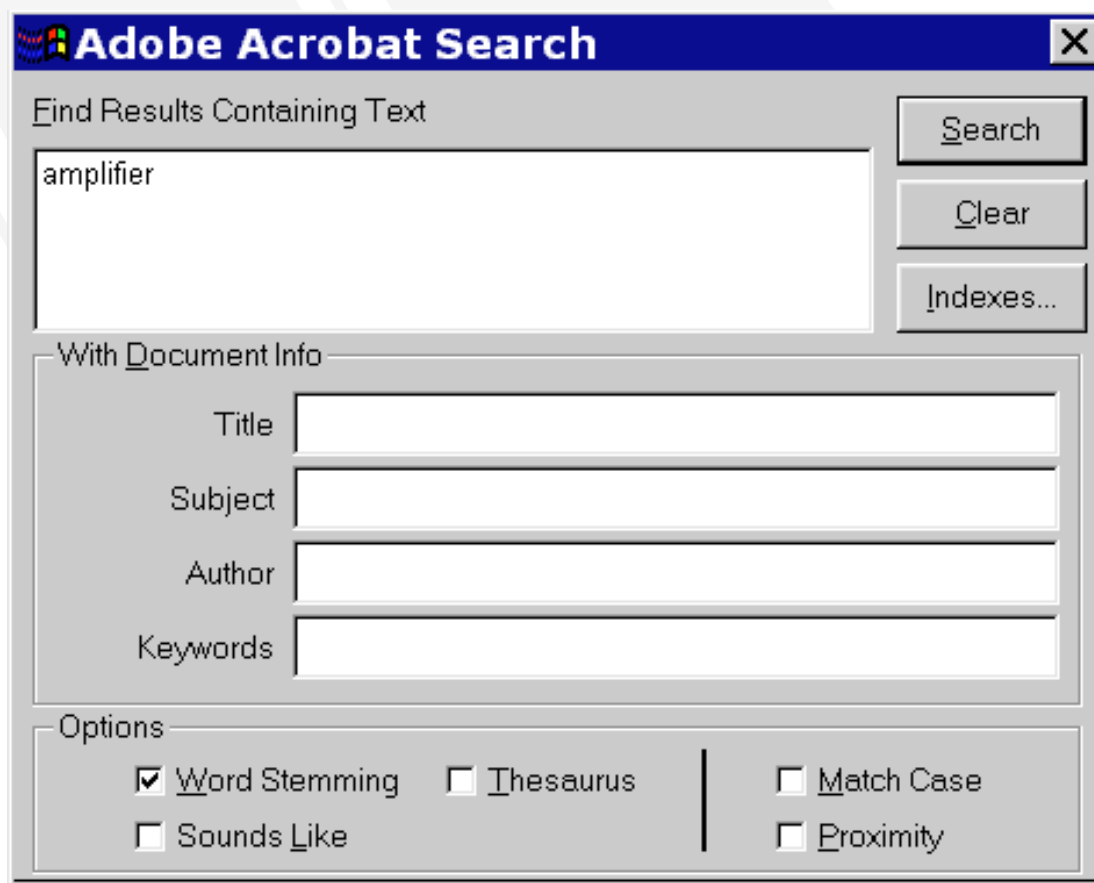
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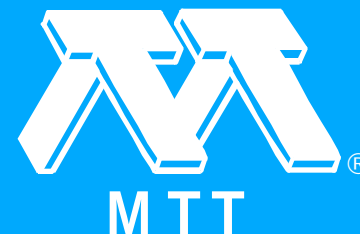
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If you are not finding files you think should show in the results list, Acrobat may not be attached to the correct index file. To check, press the “Indexes...” button for a list of available indexes. If this title is not listed, press the “Add...” button and look in the root directory of the CD-ROM for a file called “index.pdx”. Click on that file to add it to the list. If none exists, this title was not indexed.

See the Search Online Guide (on Help menu) for more complete instructions on selecting appropriate options, constructing boolean queries, etc.



The screenshot shows the 'Adobe Acrobat Search' dialog box. It has a title bar with the Adobe logo and the text 'Adobe Acrobat Search'. The main area is titled 'Find Results Containing Text' and contains a text input field with the word 'amplifier'. To the right of this field are three buttons: 'Search', 'Clear', and 'Indexes...'. Below the main input field is a section titled 'With Document Info' containing four labeled text input fields: 'Title', 'Subject', 'Author', and 'Keywords'. At the bottom is an 'Options' section with five checkboxes: 'Word Stemming' (checked), 'Thesaurus' (unchecked), 'Match Case' (unchecked), 'Sounds Like' (unchecked), and 'Proximity' (unchecked).



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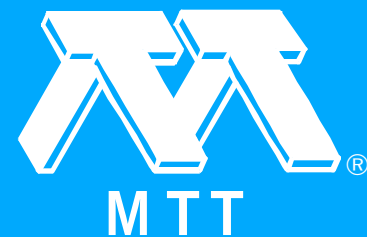
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# Issues by Publication

## 1993 Transactions on Microwave Theory and Techniques

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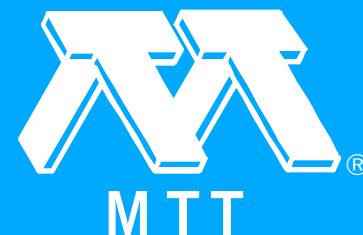


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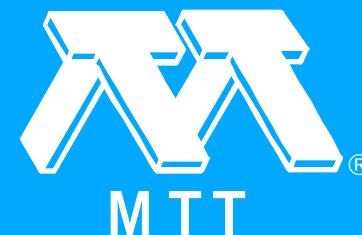


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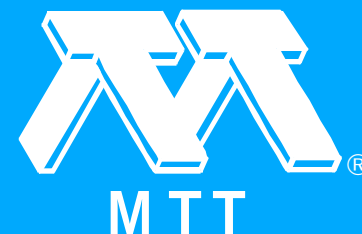
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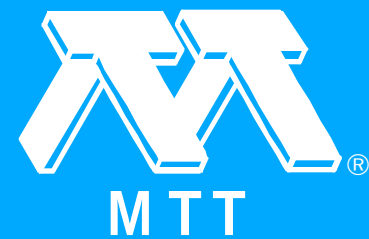
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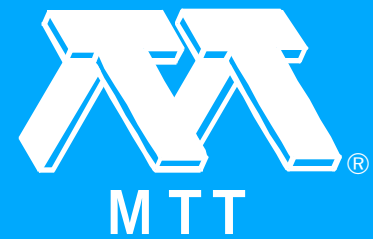
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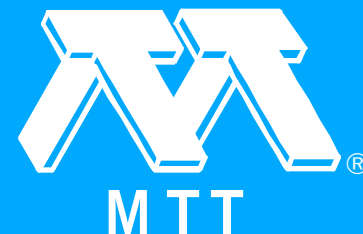


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- ☐ [Novel Schiffman Phase Shifters](#)
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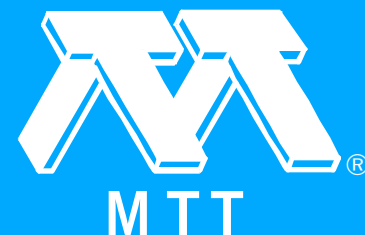
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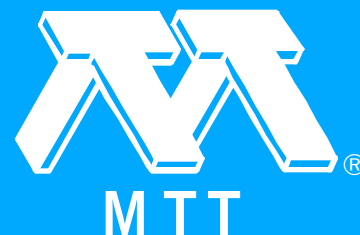
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- ❑ Analysis of Single and Coupled Microstrip Lines on Anisotropic Substrates Using Differential Matrix Operators and the Spectral-Domain Method
- ❑ Direct Analytical Solution for the Electric Field Distribution at the Conductor Surfaces of Coplanar Waveguides
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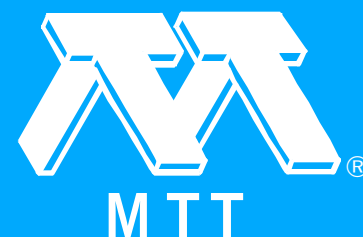
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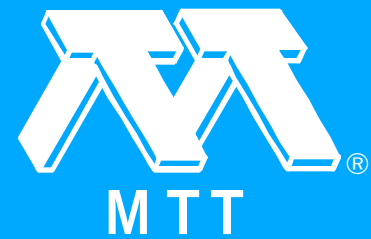
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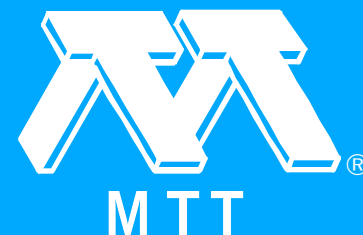


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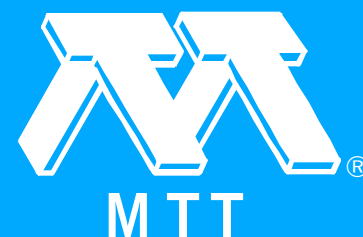
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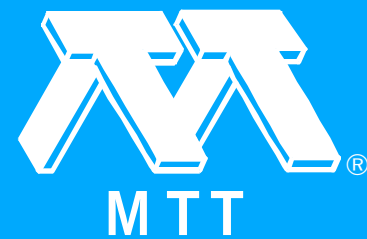
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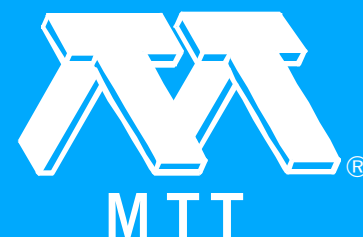
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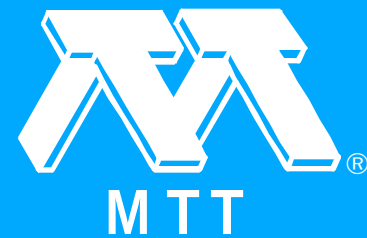
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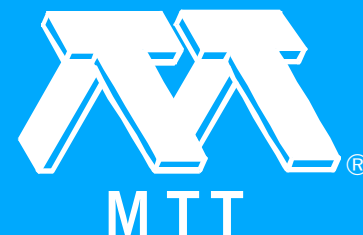


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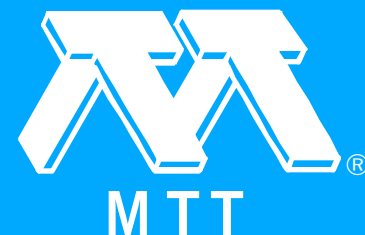
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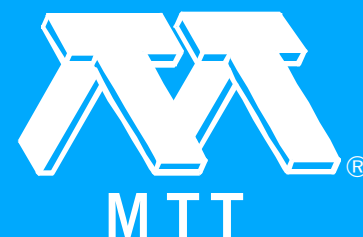
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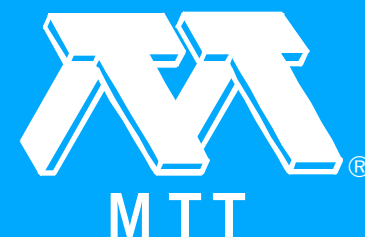
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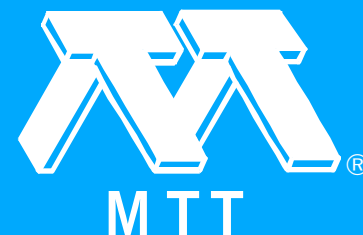


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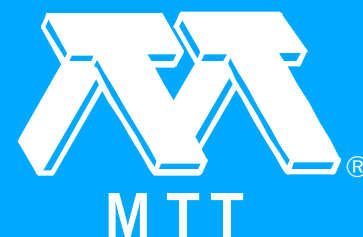
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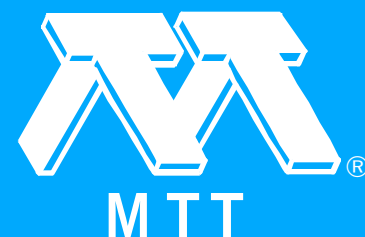
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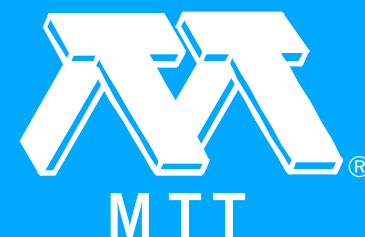
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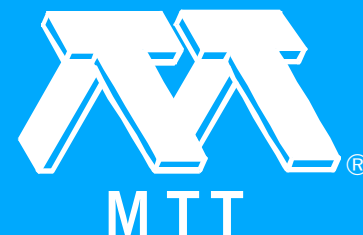
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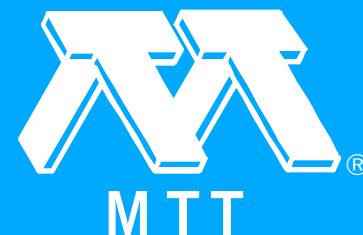


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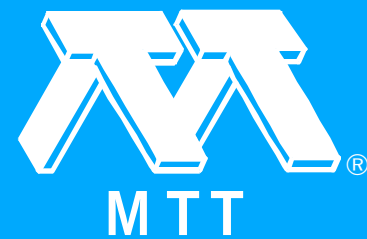
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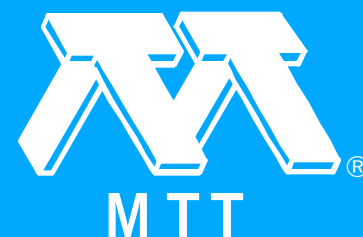
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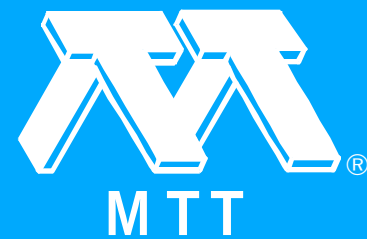
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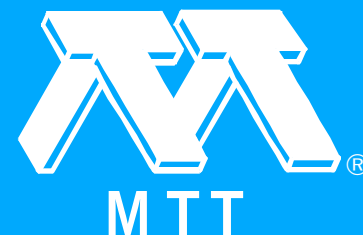
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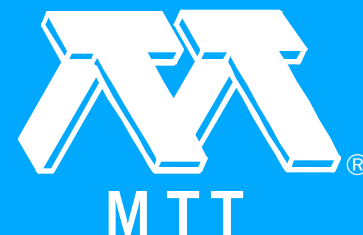


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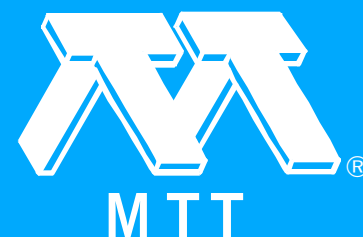
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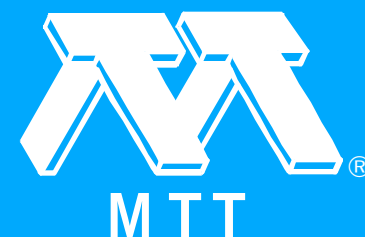
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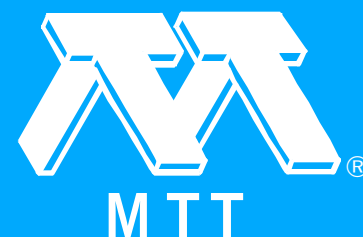
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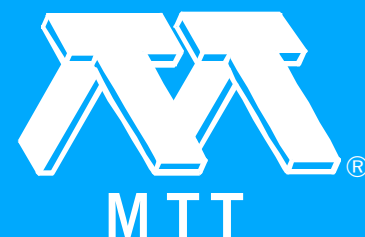
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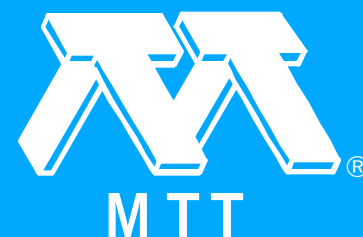
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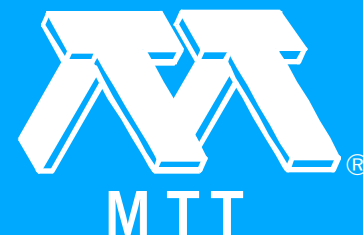
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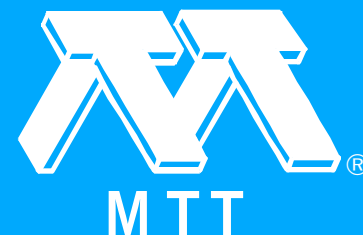


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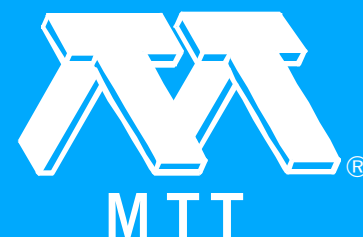
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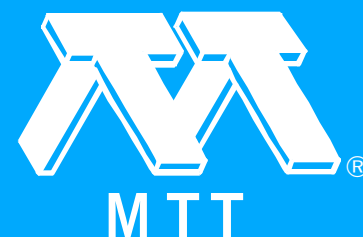
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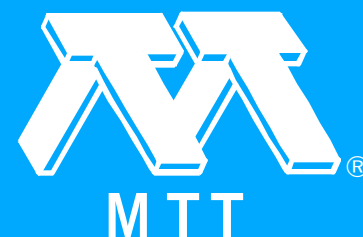
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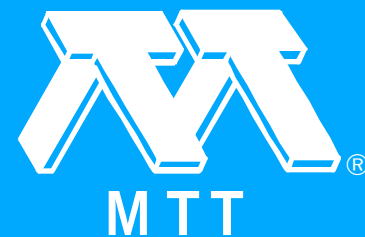
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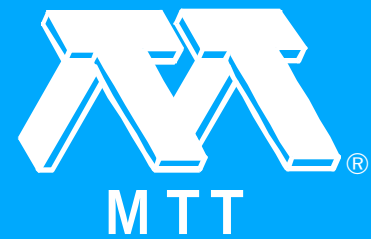
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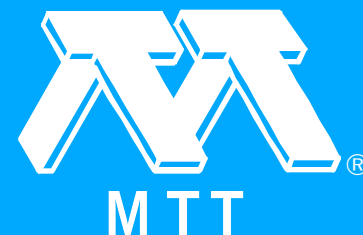


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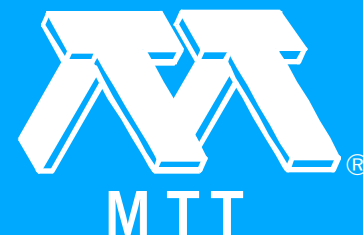
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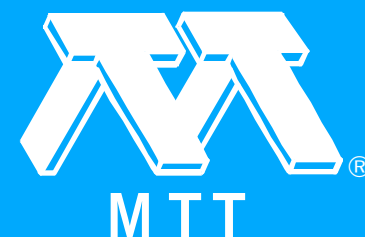
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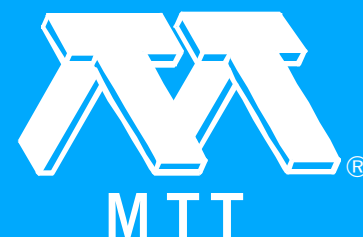
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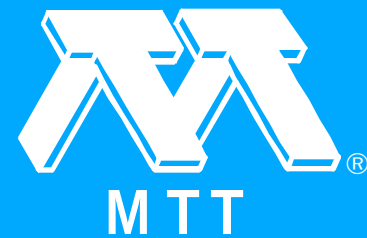
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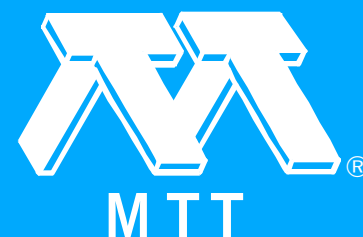


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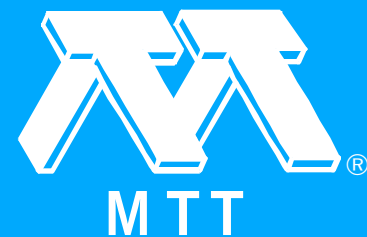
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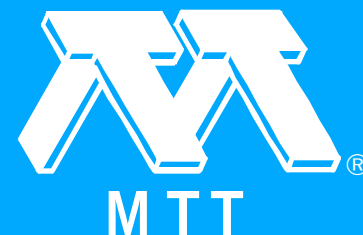
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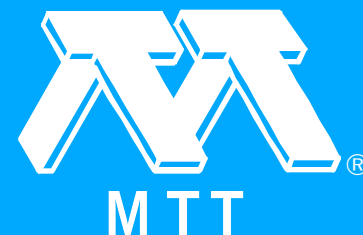


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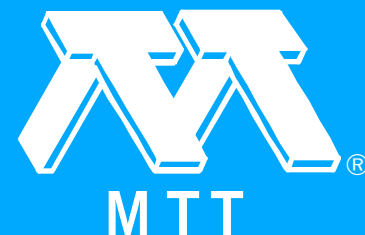
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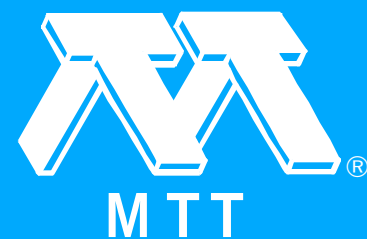
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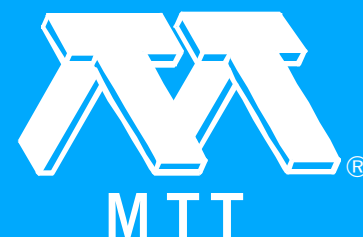
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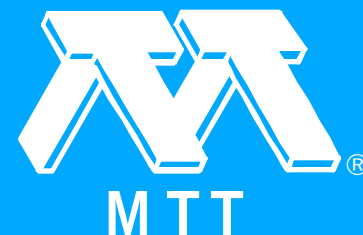
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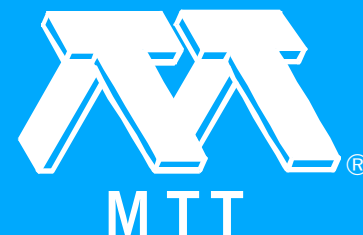


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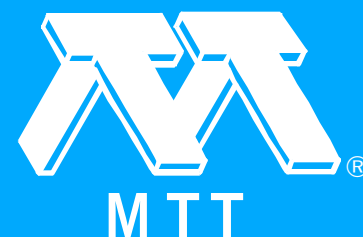
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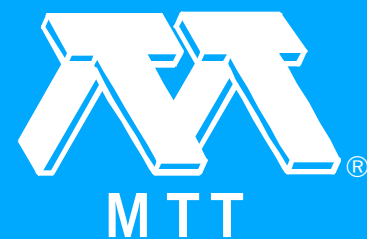
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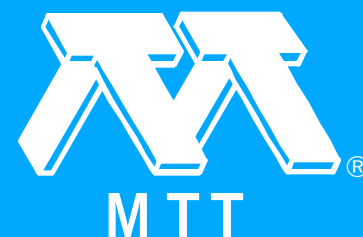
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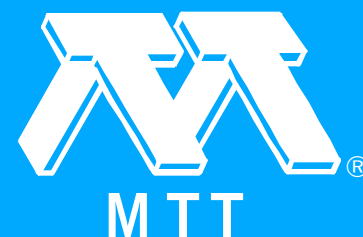
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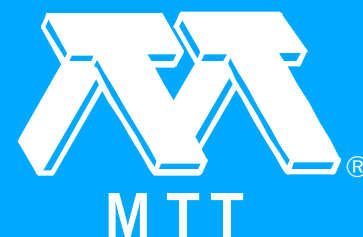
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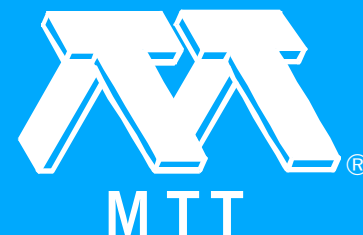
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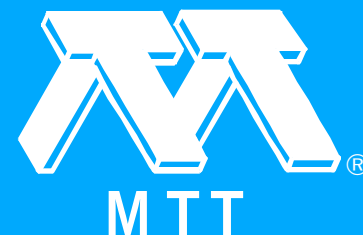


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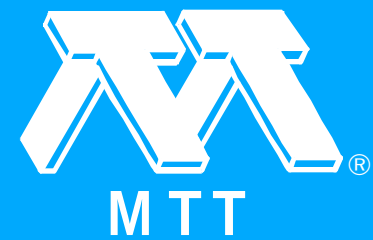
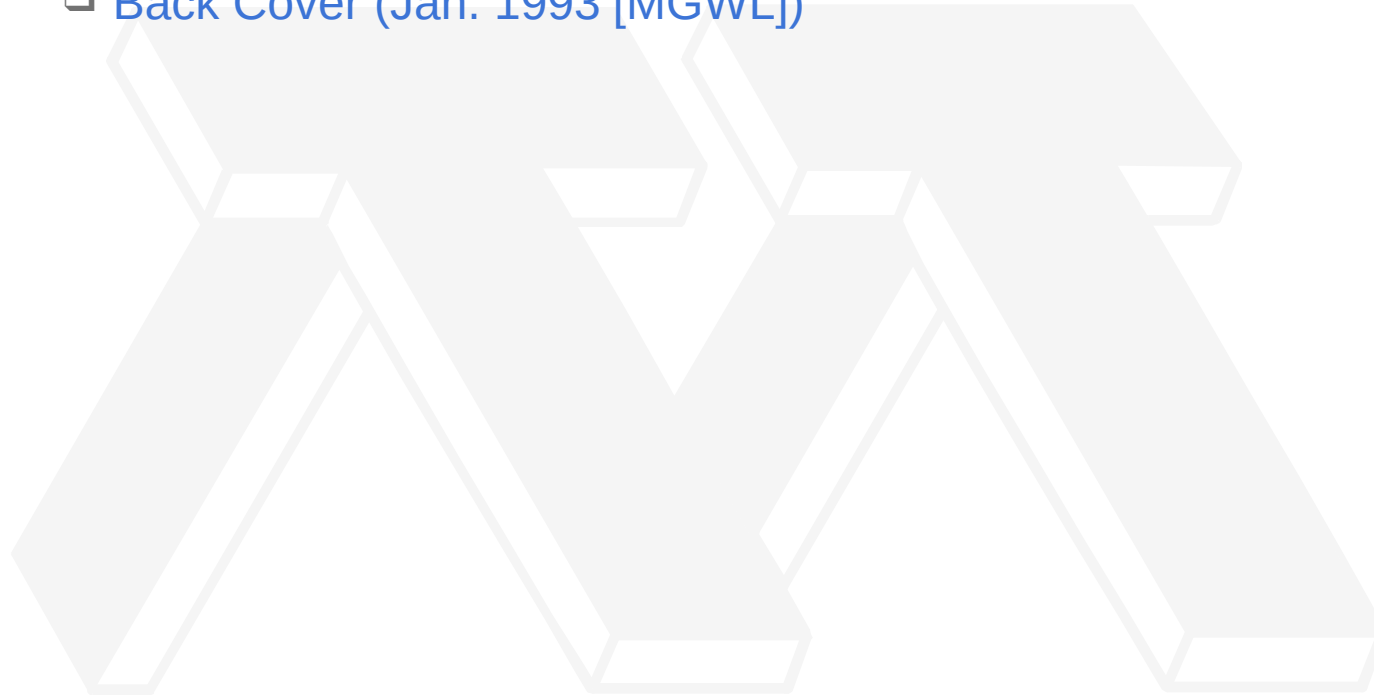
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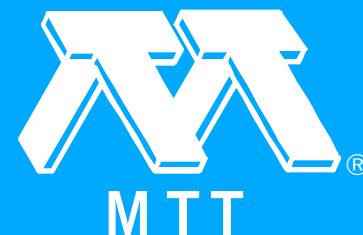


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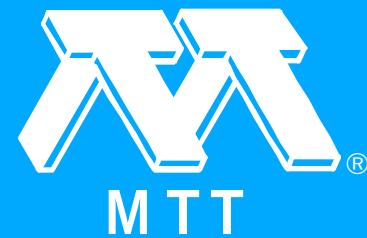
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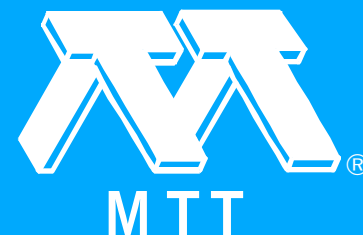
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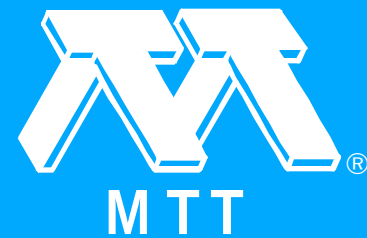
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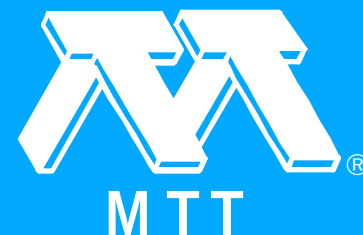
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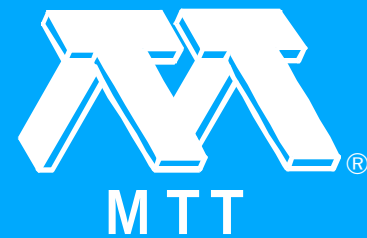
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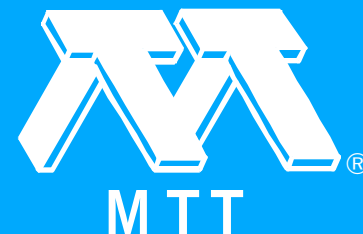
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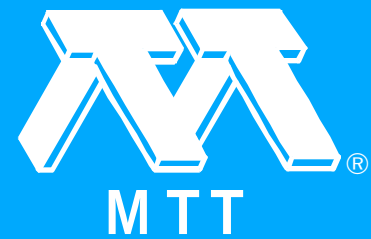
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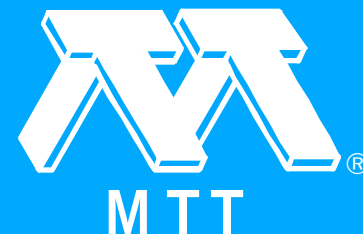


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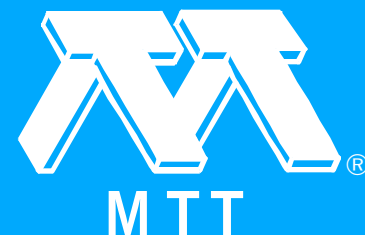
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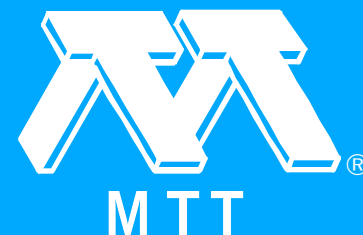


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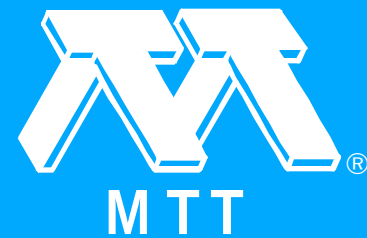
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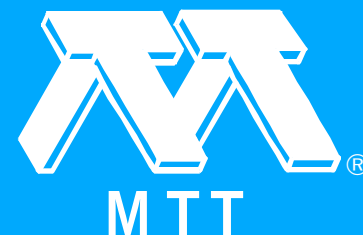


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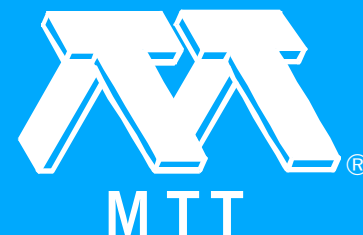
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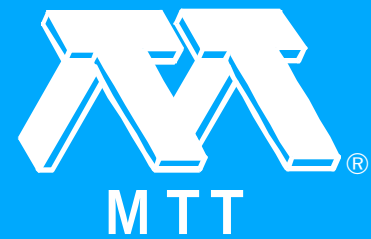
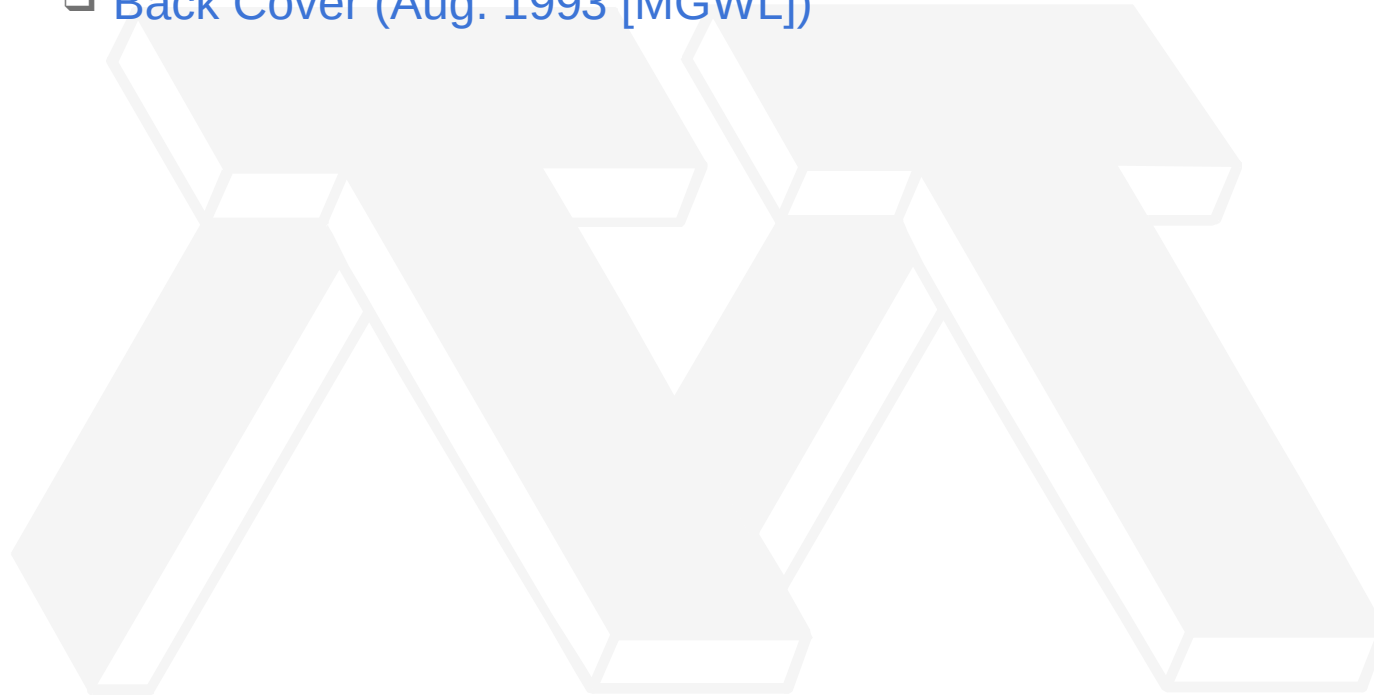
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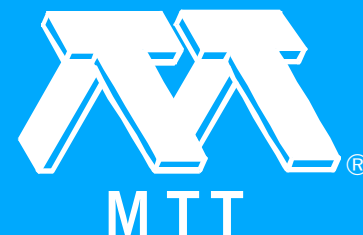


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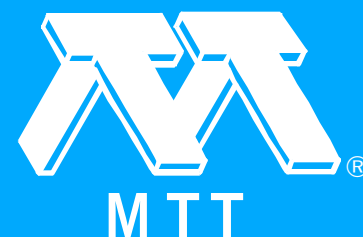
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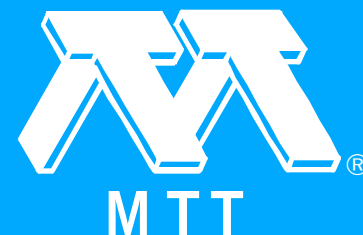
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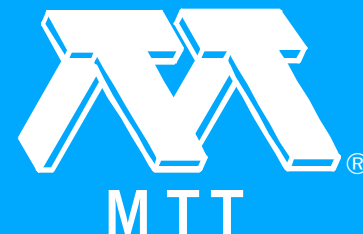


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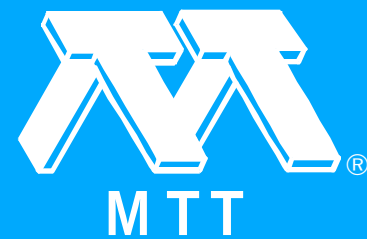
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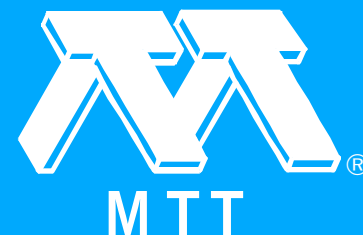


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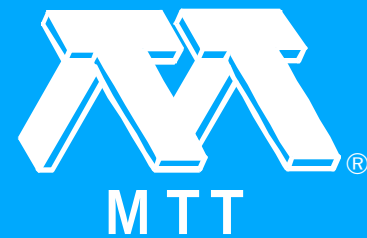
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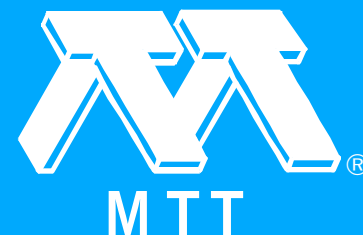


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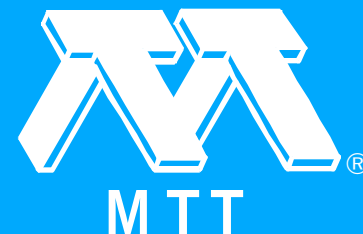
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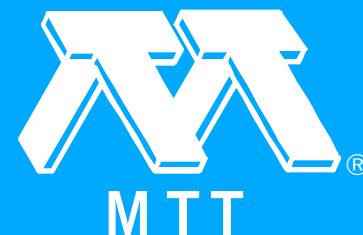


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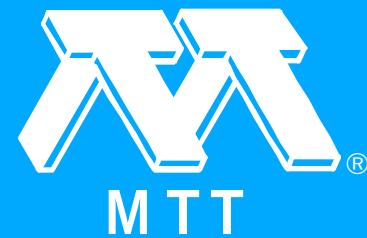
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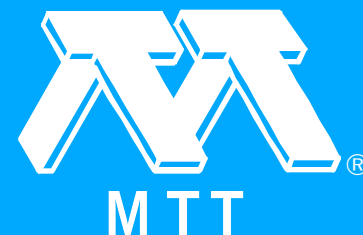


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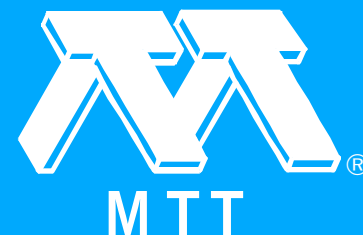


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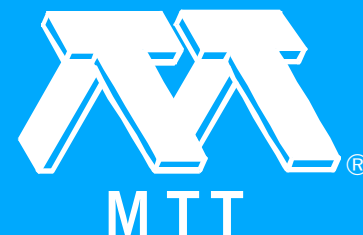
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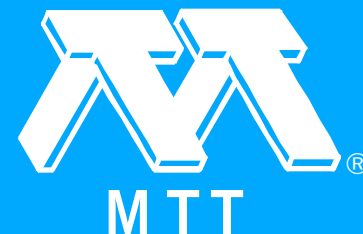


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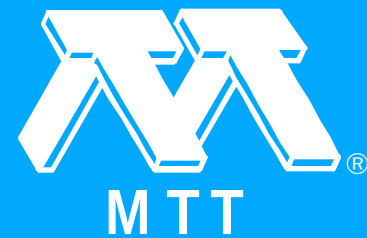
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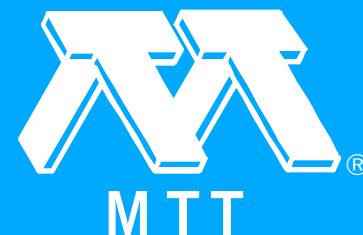


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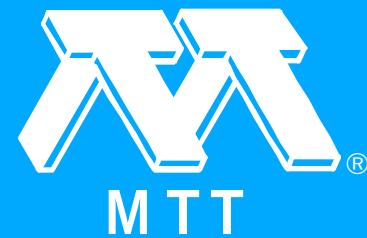
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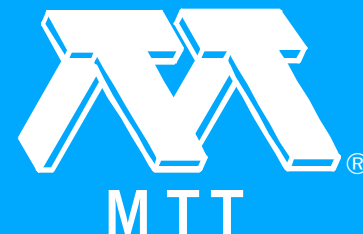


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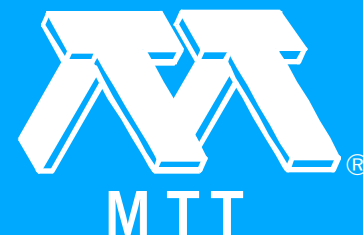
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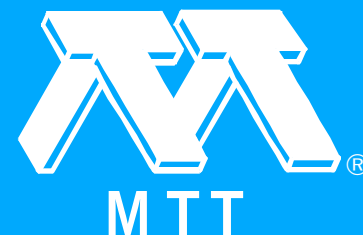
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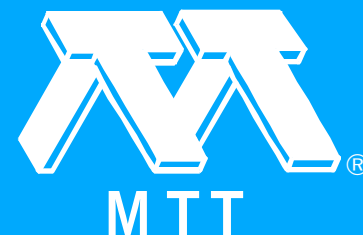
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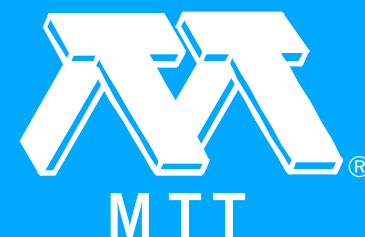
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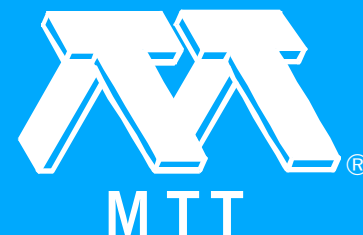


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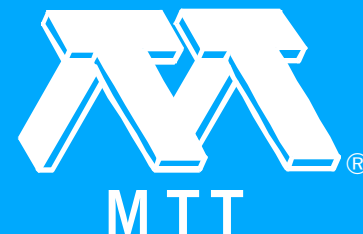
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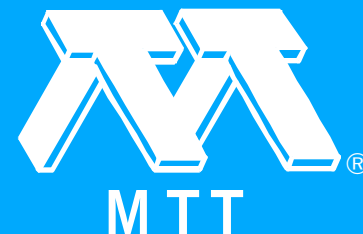


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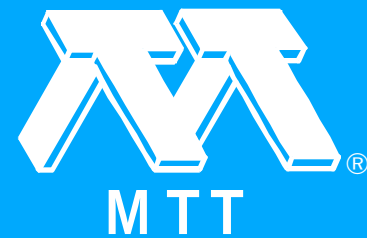
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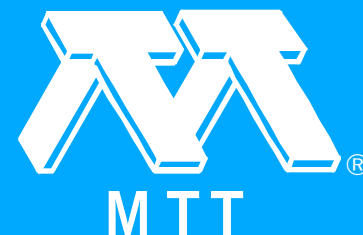
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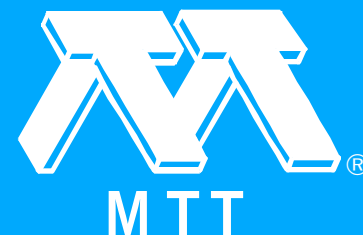
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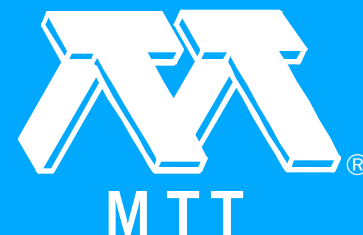


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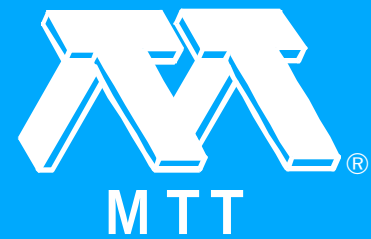
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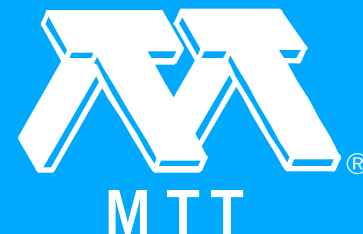


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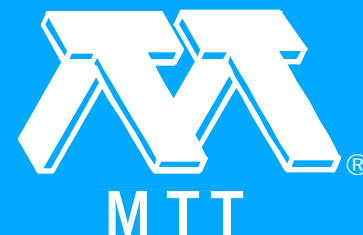
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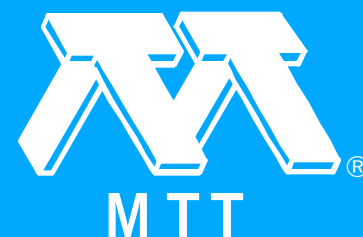
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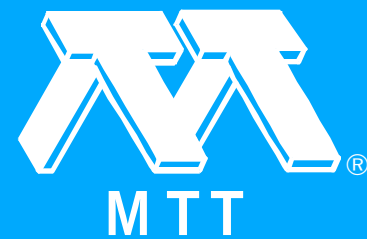
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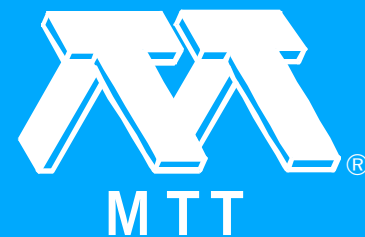
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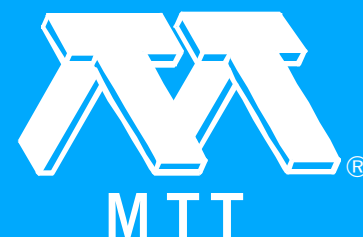
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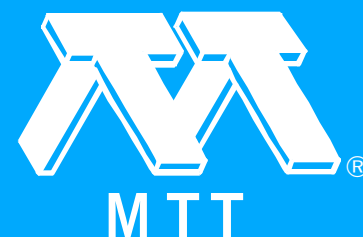
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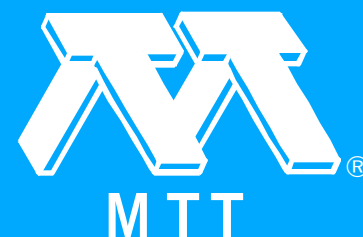
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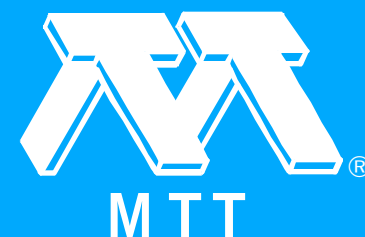
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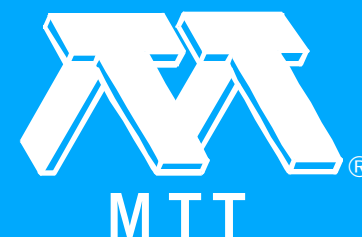
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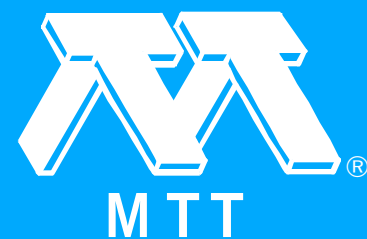
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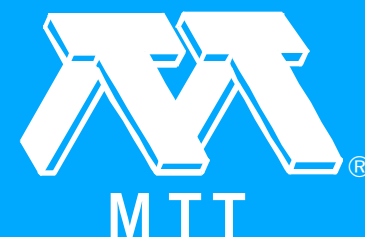
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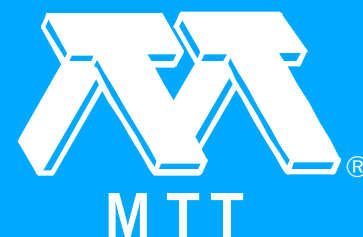
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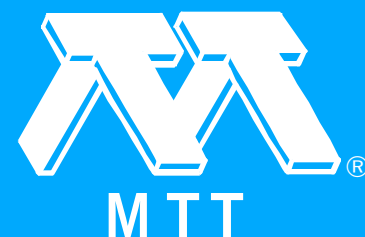
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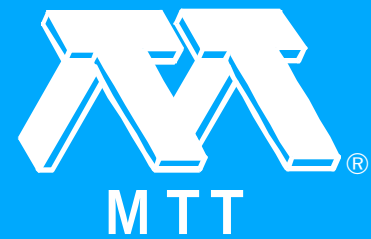
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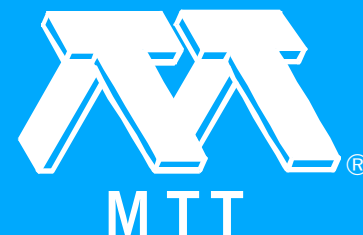


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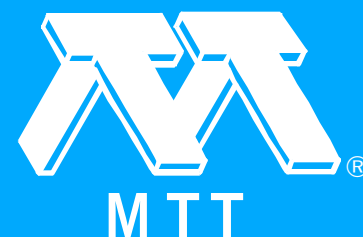
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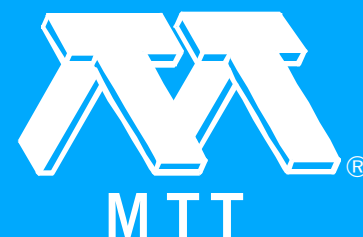
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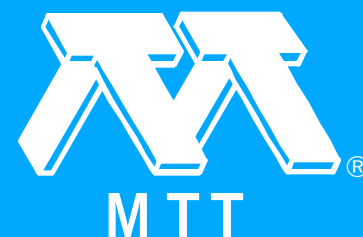
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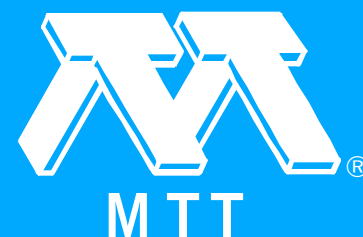
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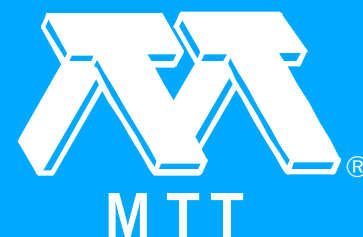
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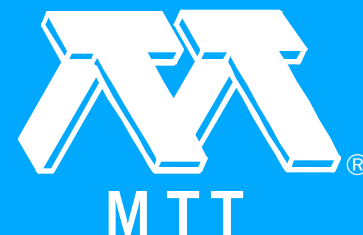
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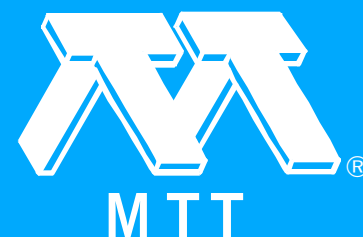
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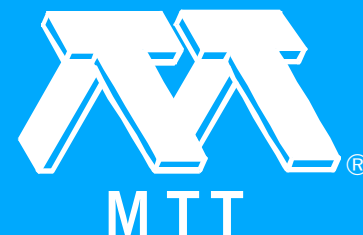
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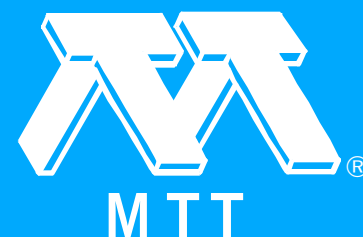
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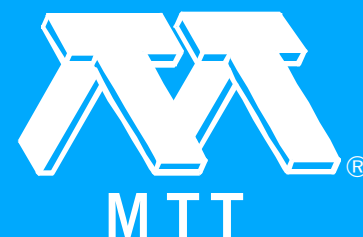
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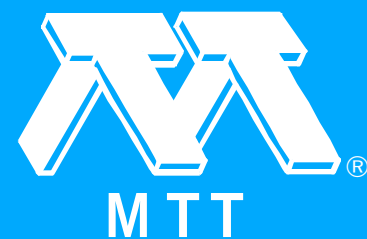
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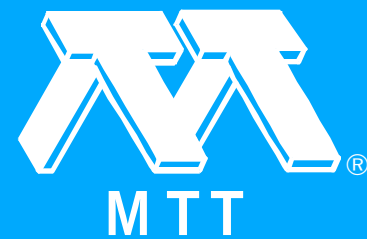
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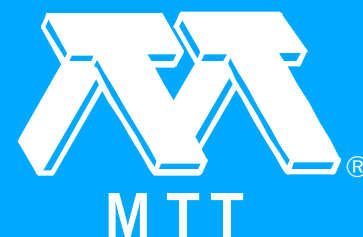
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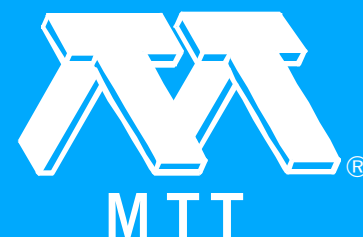
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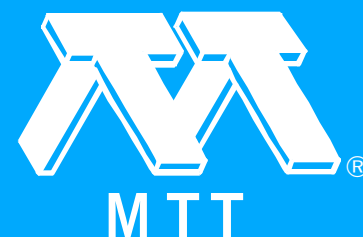
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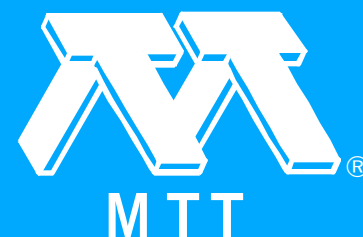
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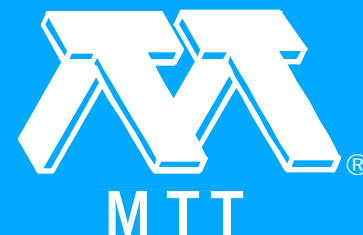
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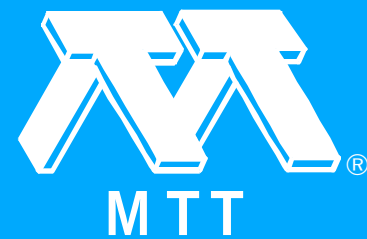
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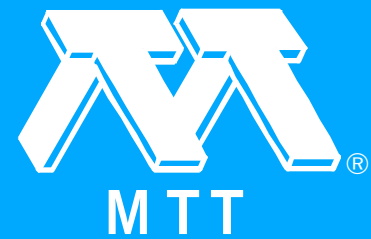
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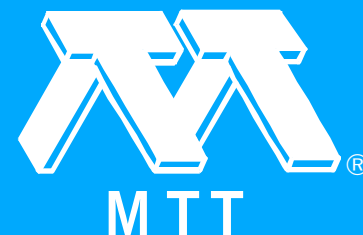


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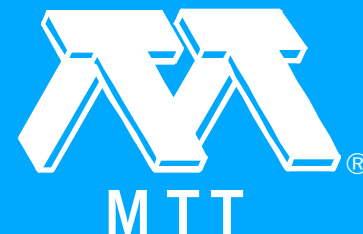
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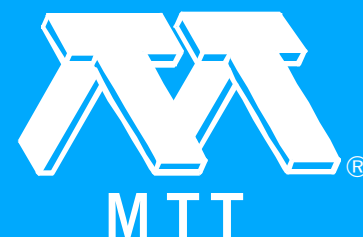
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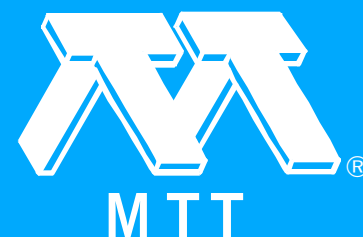
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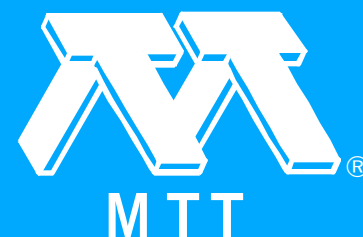
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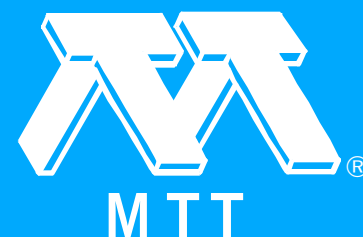
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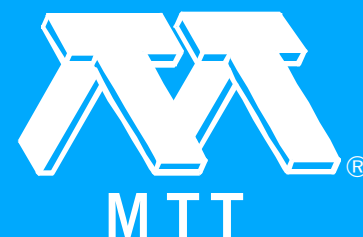
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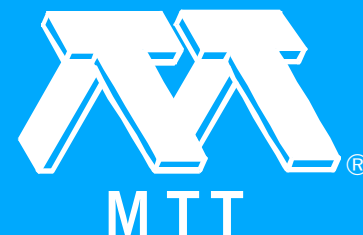
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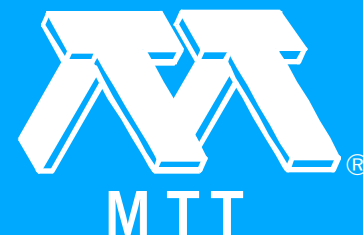
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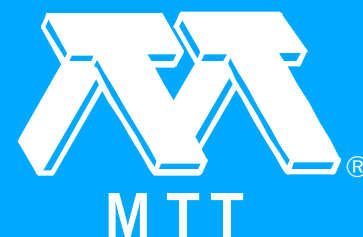
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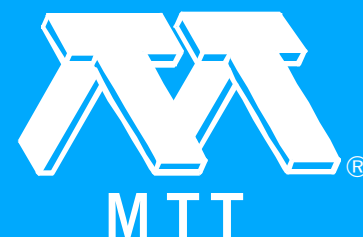
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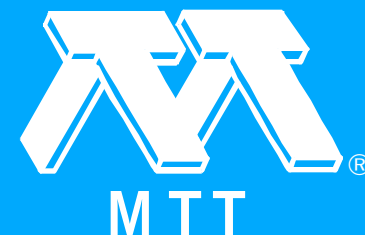
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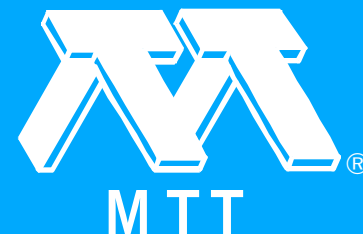
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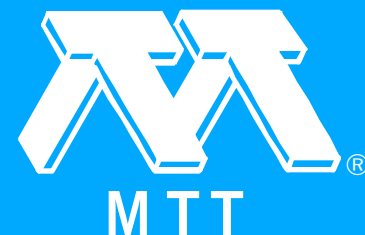
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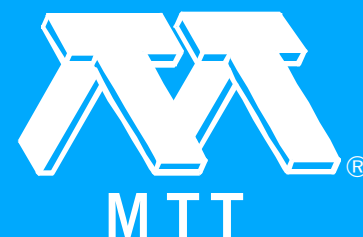
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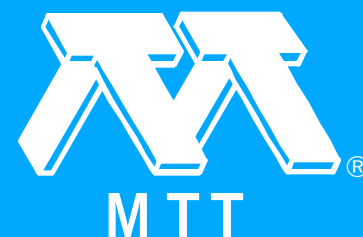
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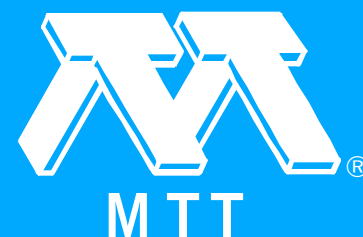
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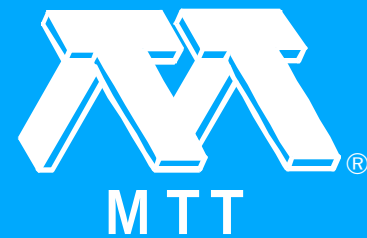
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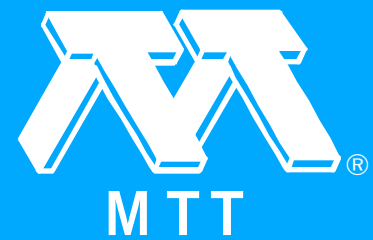
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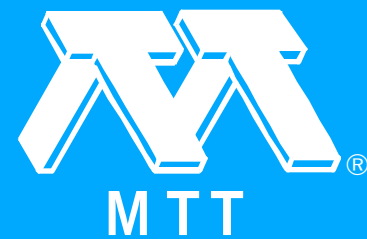
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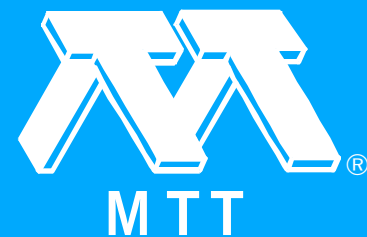
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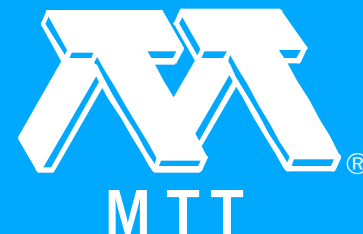
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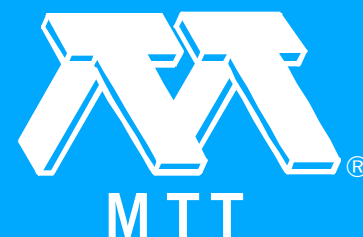
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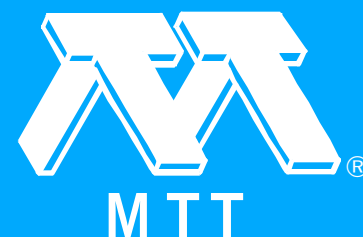
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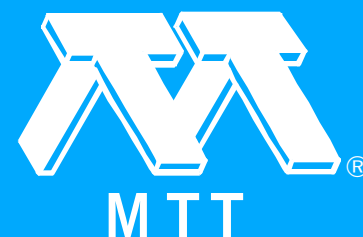
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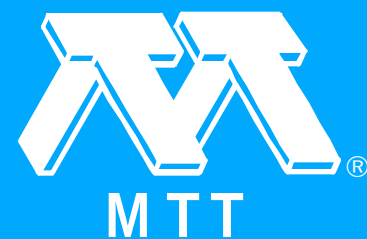
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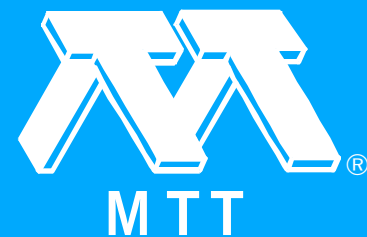
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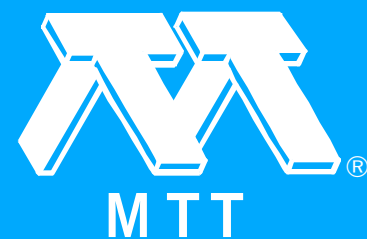
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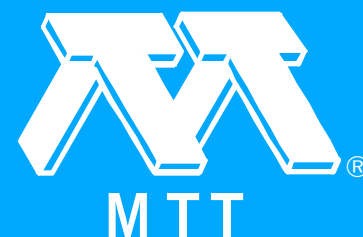
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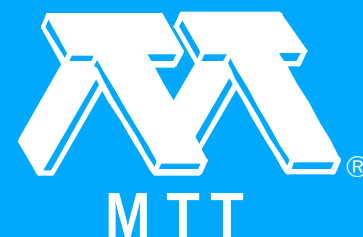
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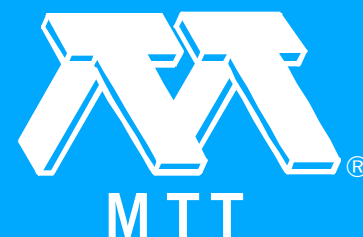
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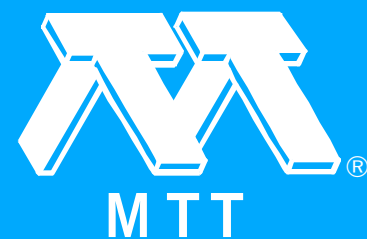
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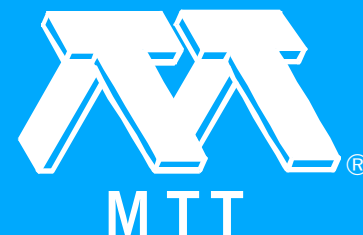
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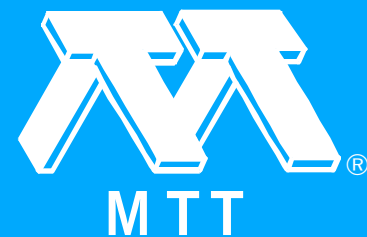
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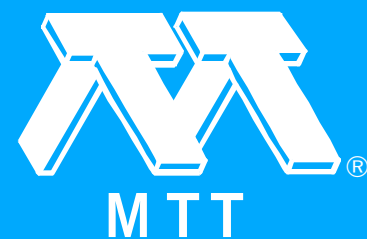
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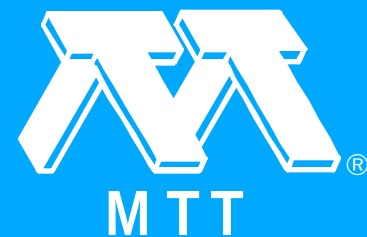
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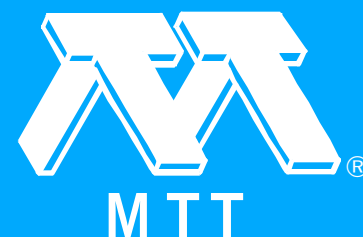
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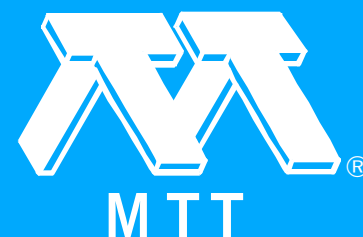
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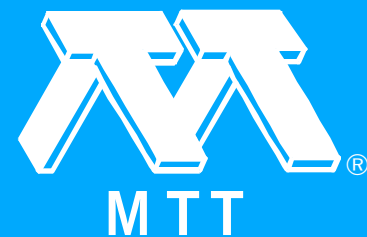
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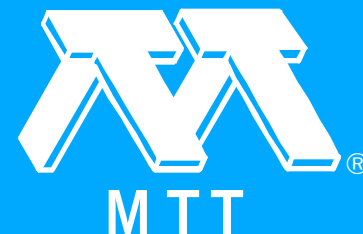
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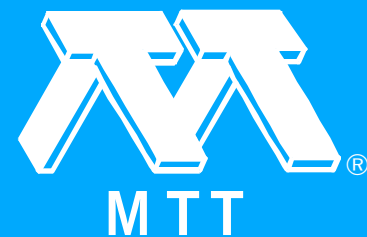
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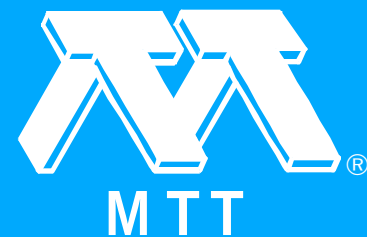
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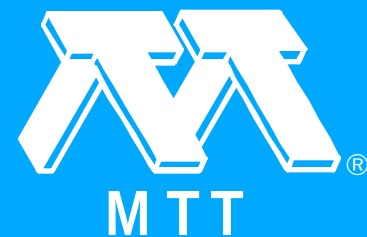
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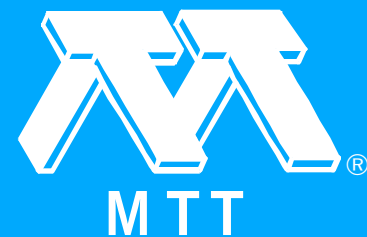
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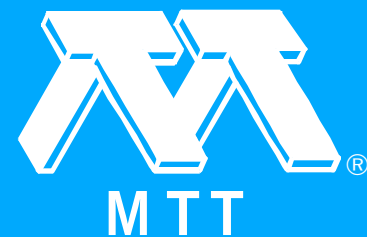
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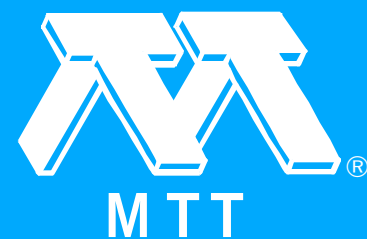
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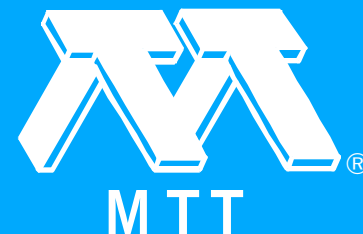
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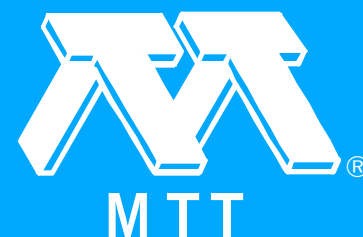
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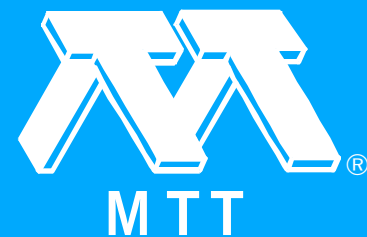
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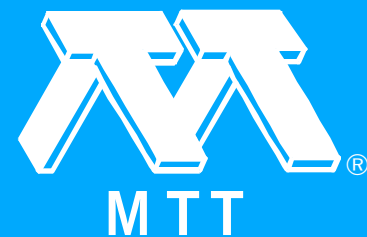
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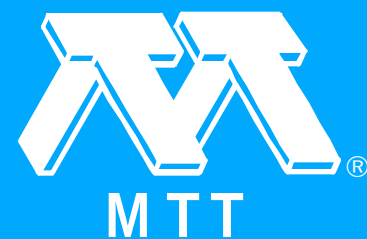
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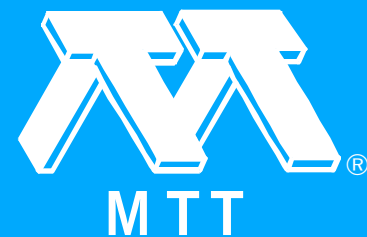
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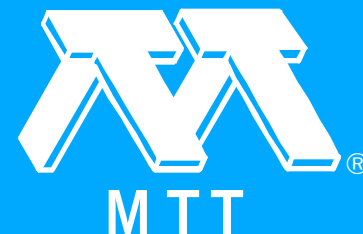
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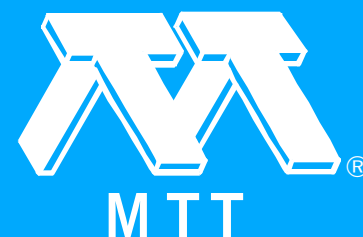
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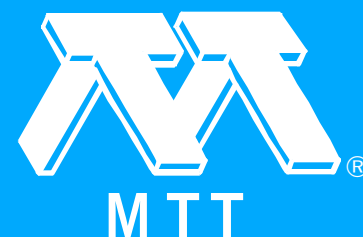
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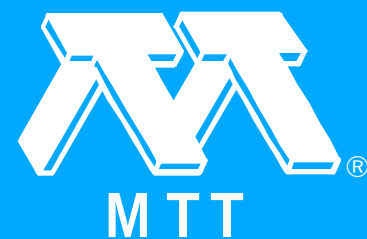
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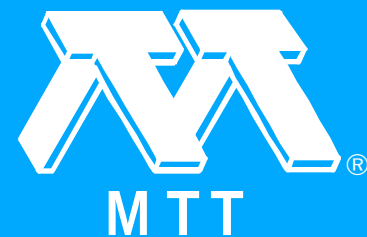
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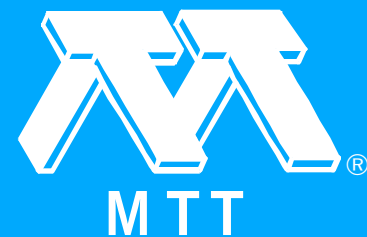
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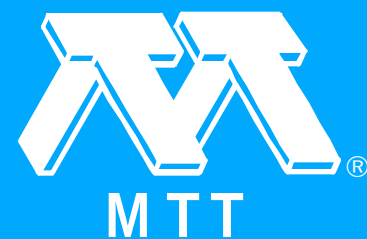
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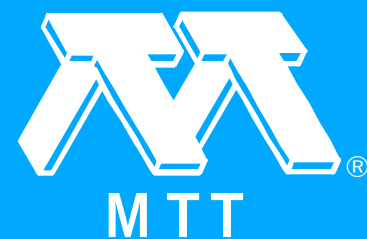
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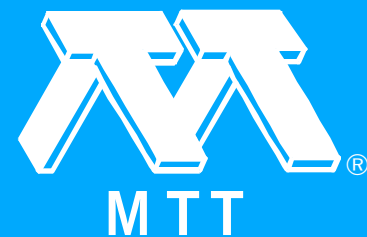
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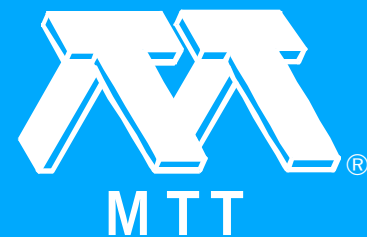
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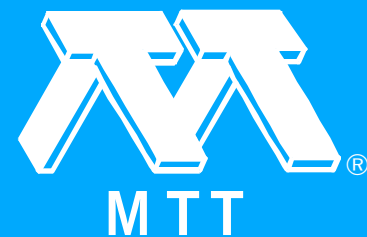
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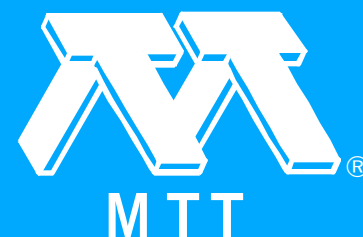
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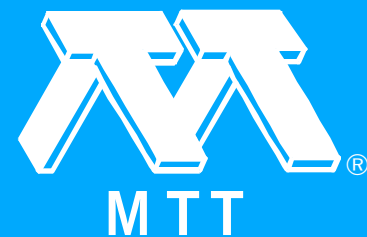
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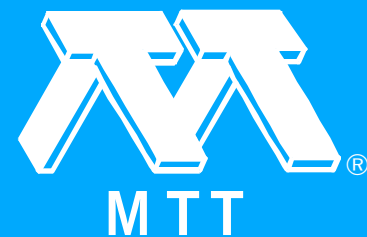
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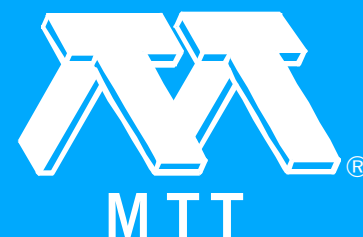
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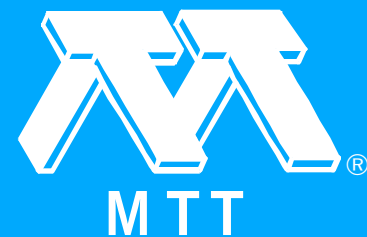
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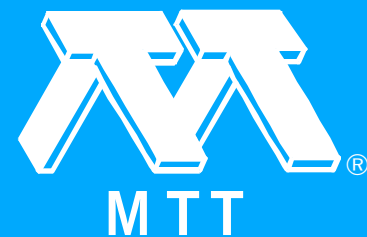
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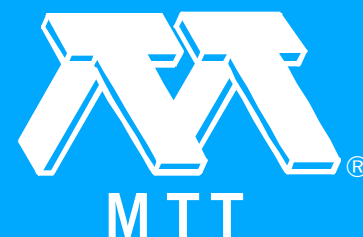
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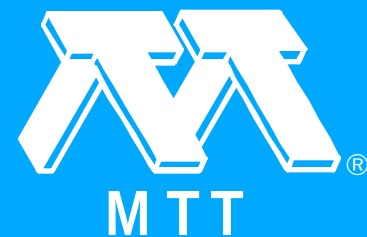
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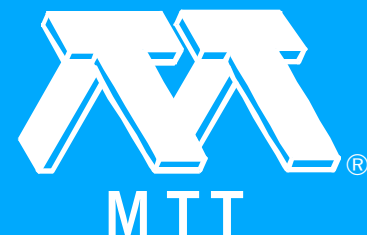
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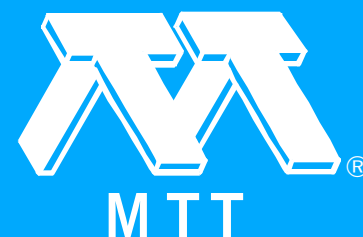
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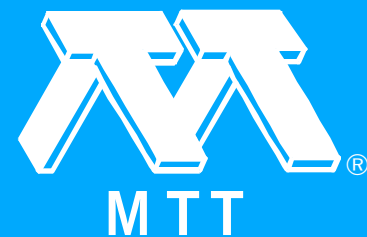
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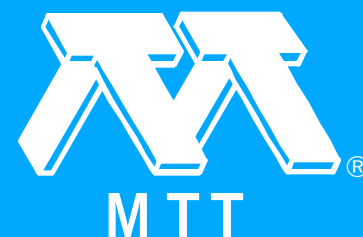
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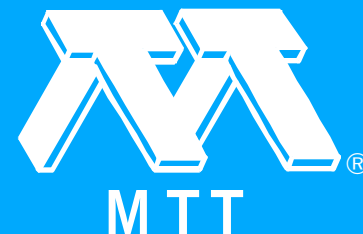
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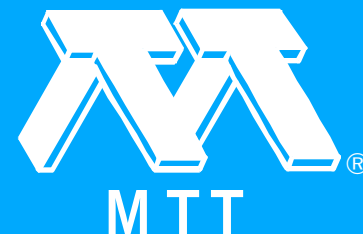
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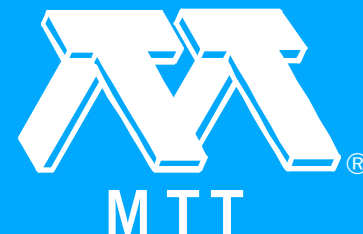
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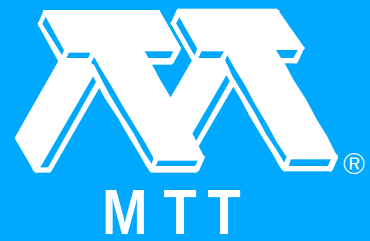
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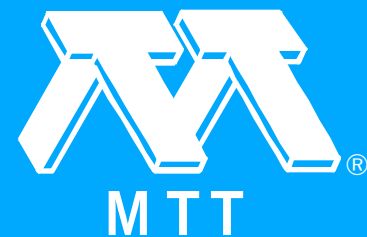
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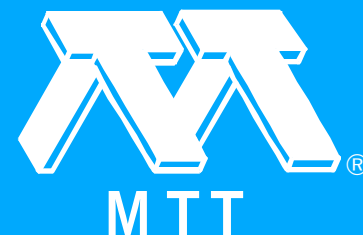
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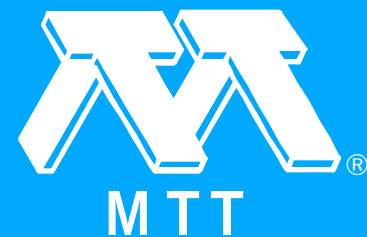
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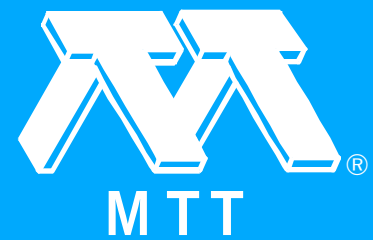
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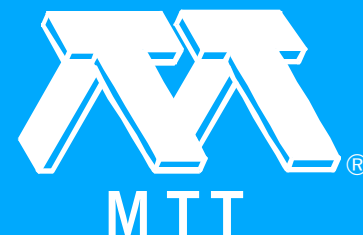
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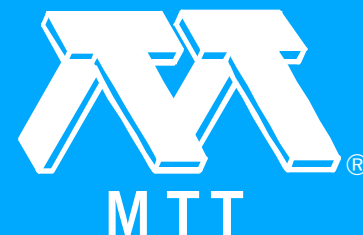
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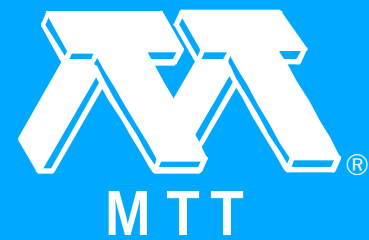
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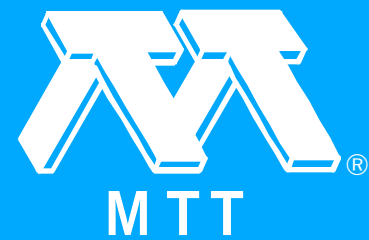
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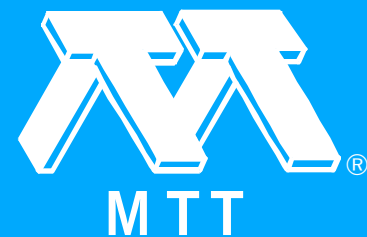
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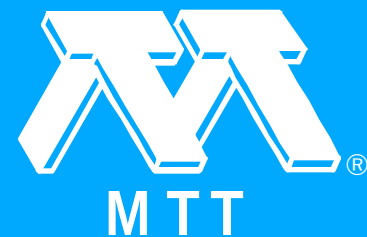
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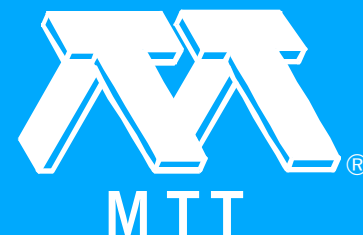
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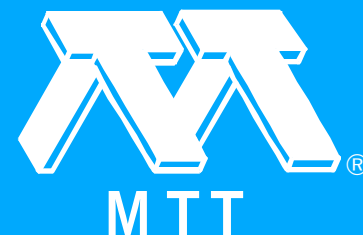
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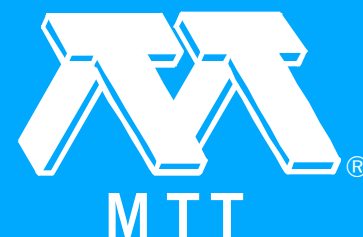
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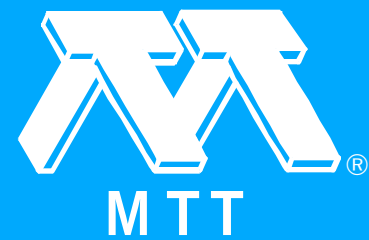
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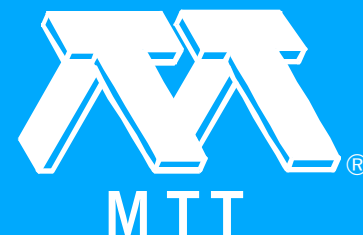
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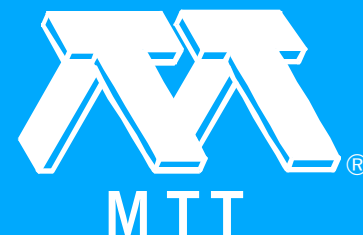
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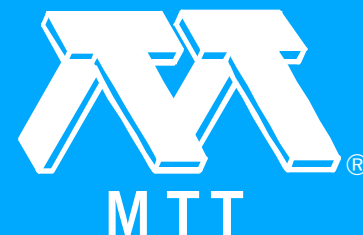
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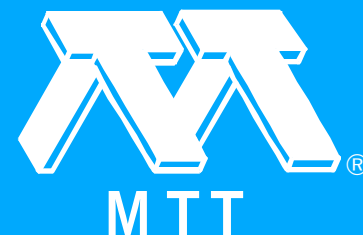
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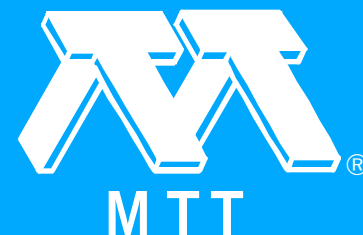
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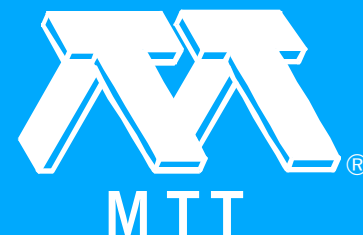
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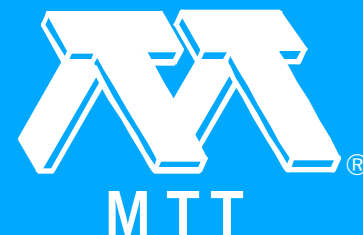
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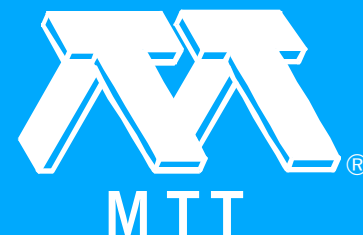
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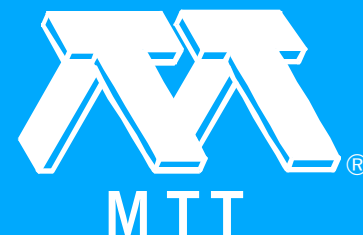
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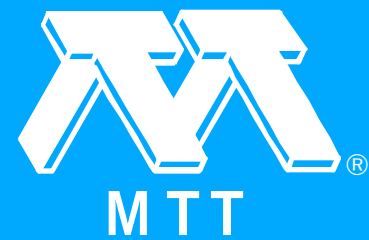
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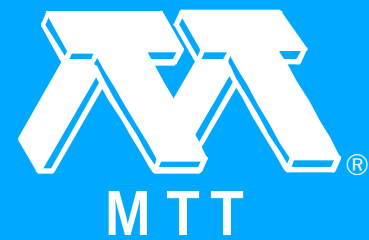
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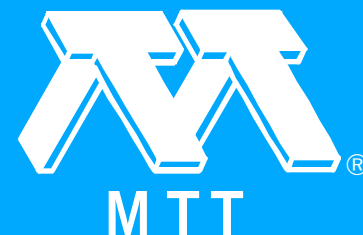
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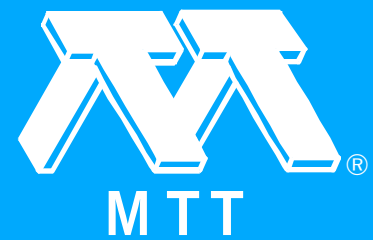
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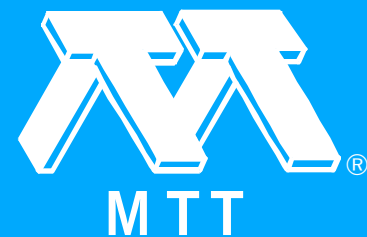
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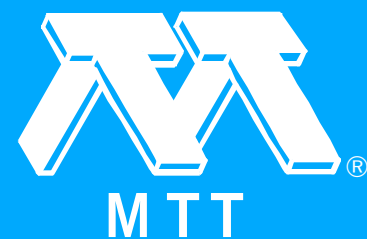
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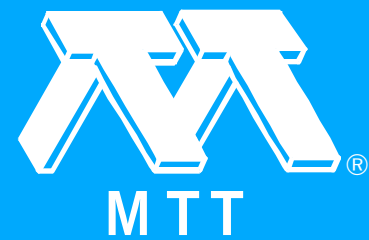
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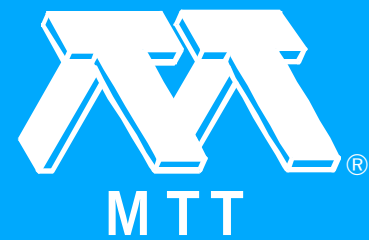
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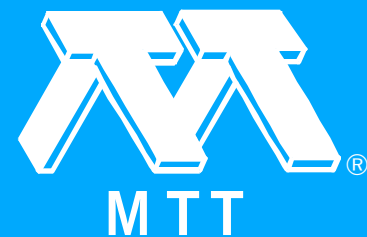
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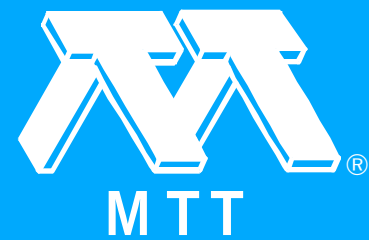
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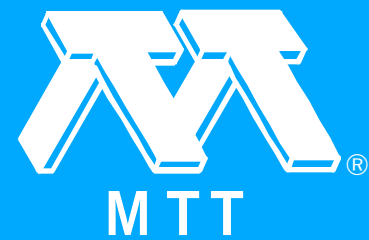
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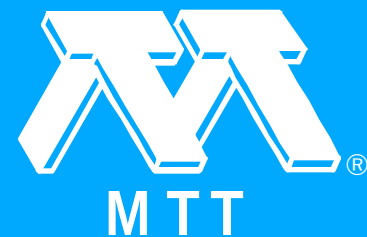
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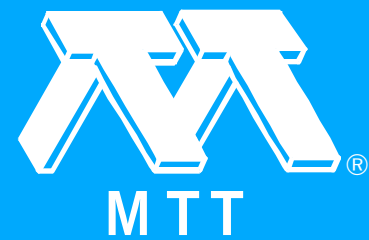
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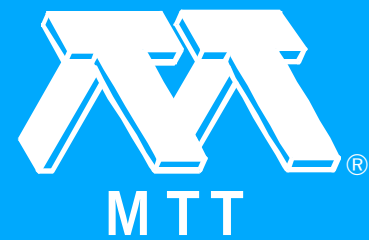
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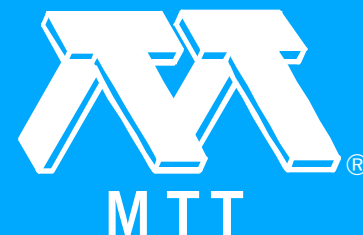
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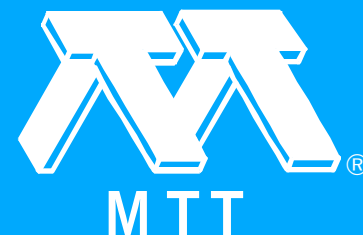
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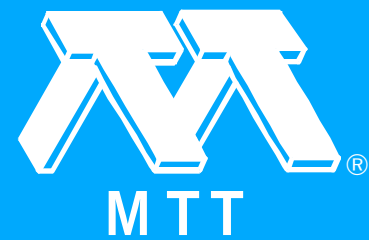
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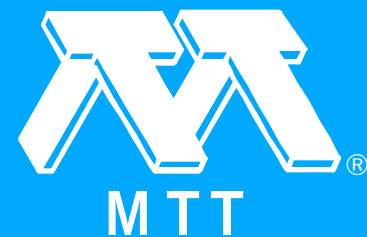
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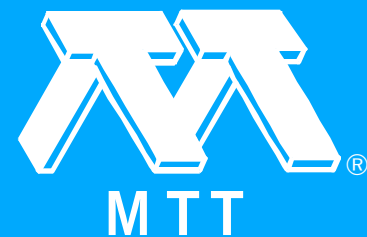
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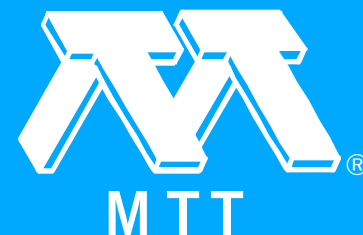
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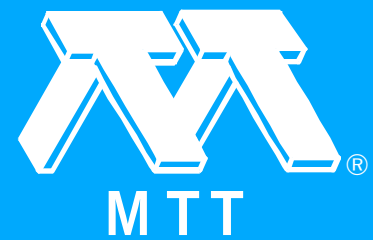
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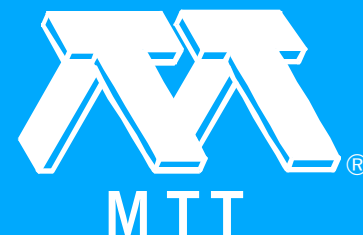
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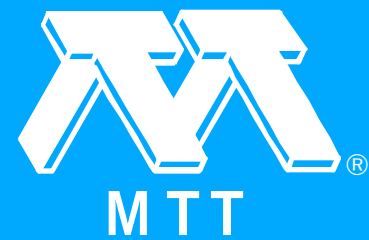
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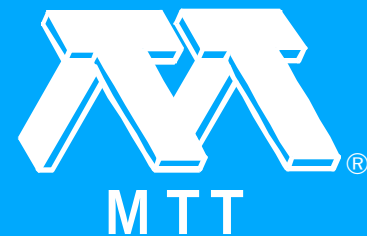
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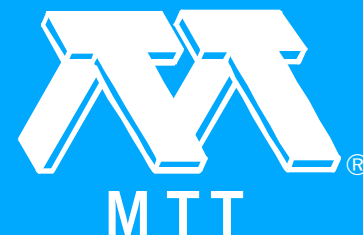
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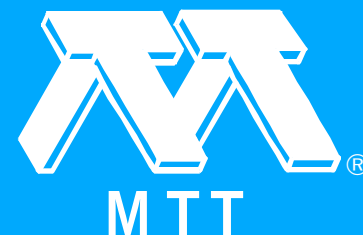


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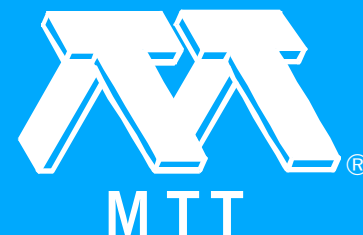
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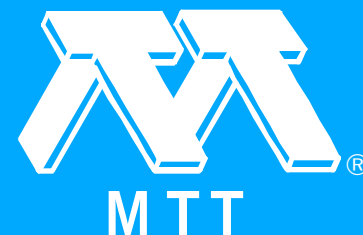
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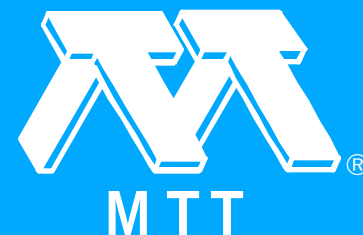
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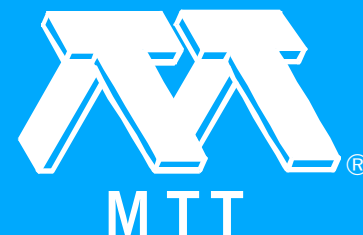
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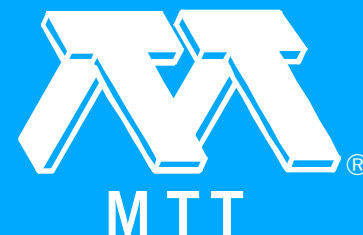
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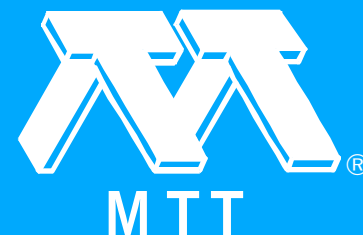
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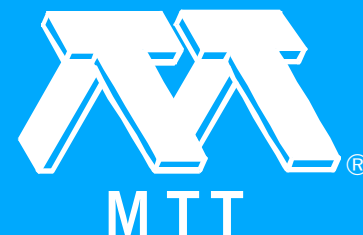
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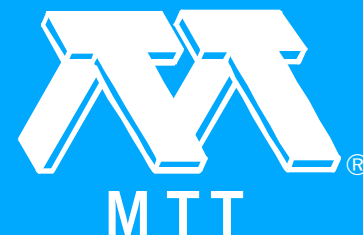
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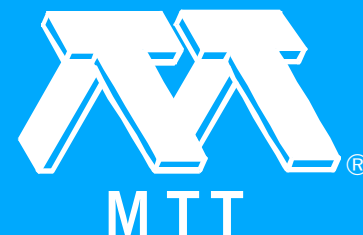
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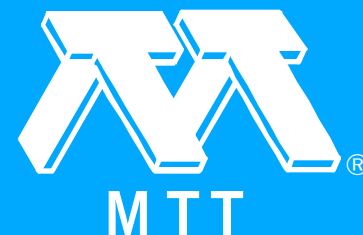
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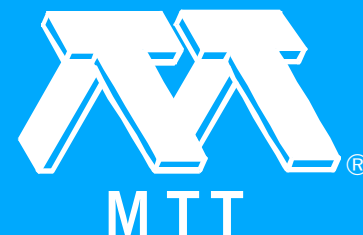
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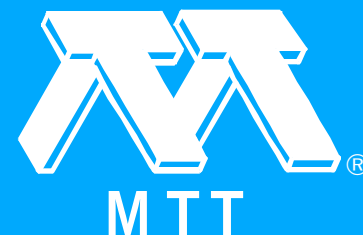
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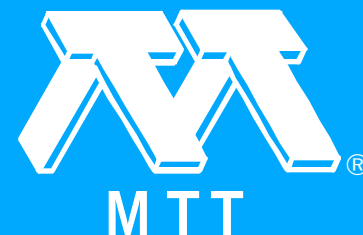
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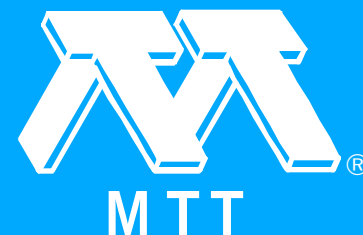
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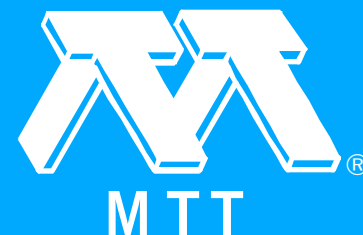
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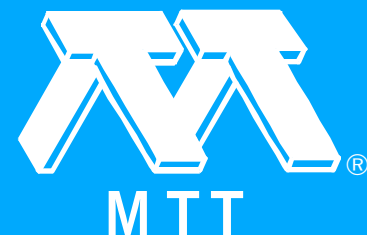
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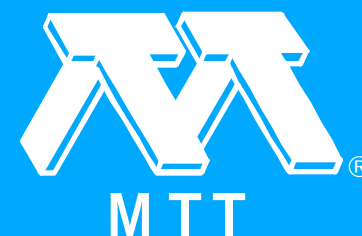
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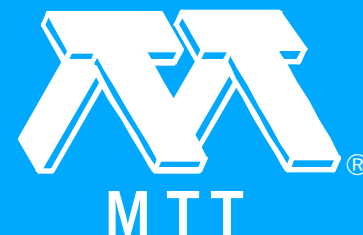
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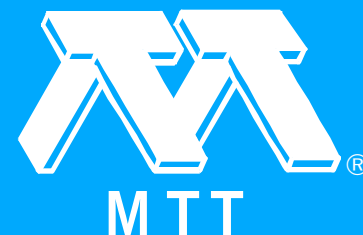
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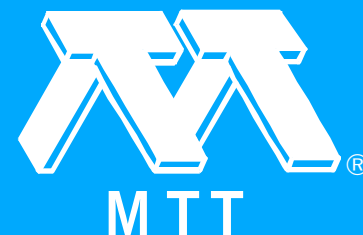
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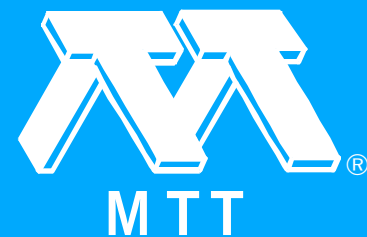
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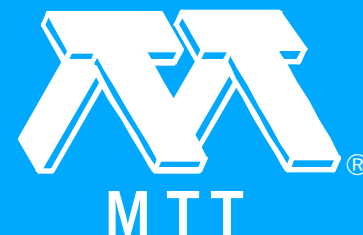
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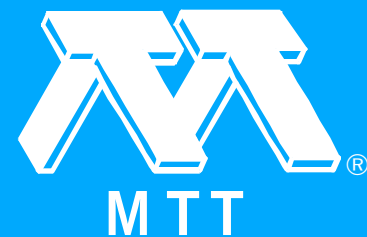
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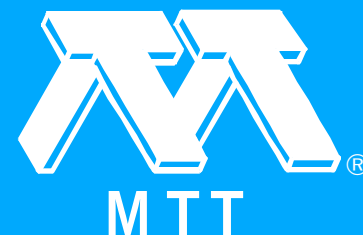
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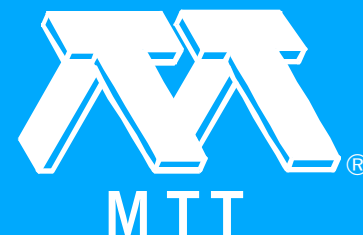
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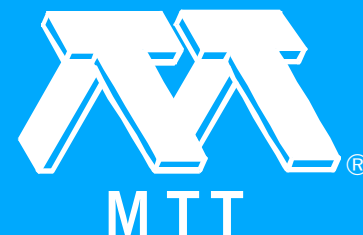
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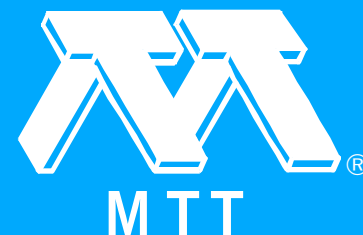
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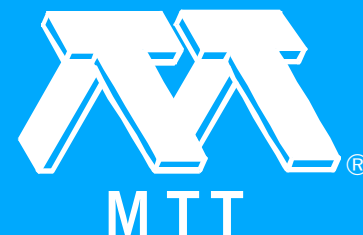
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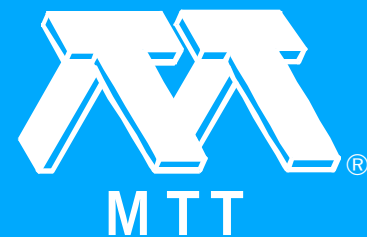
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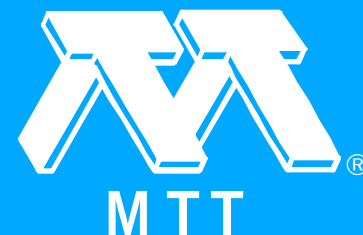
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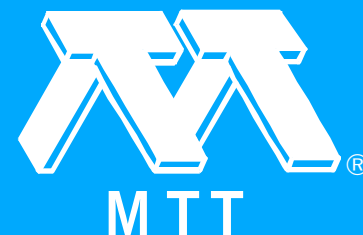
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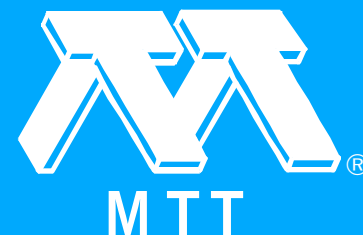
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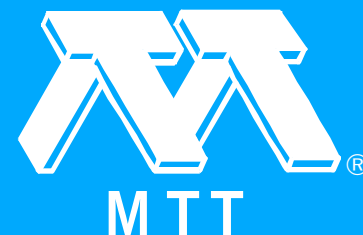
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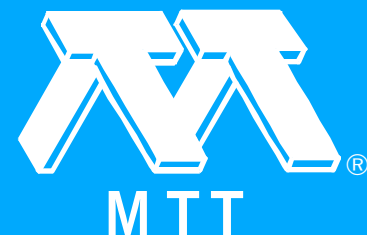
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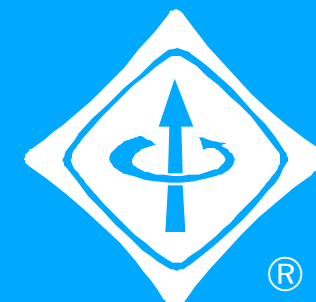
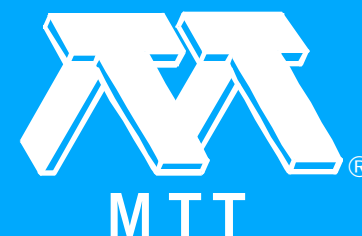
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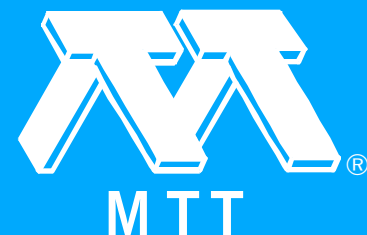
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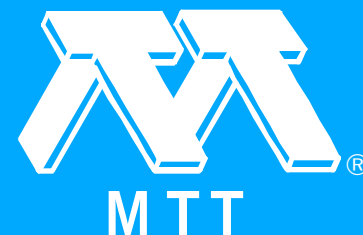
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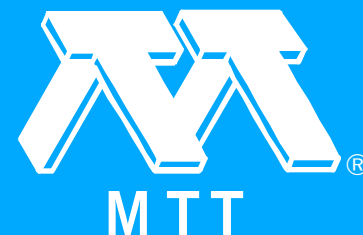
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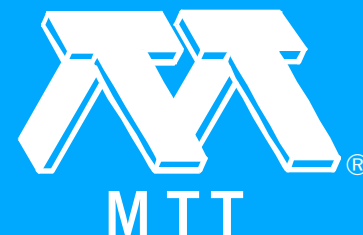
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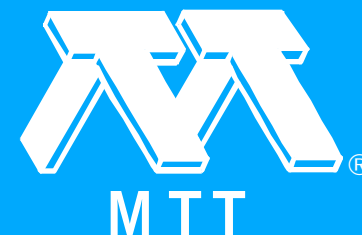
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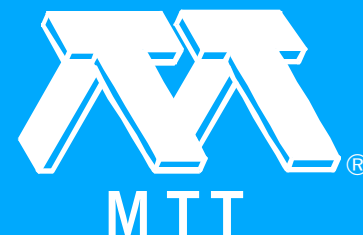
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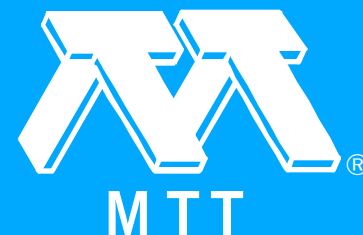
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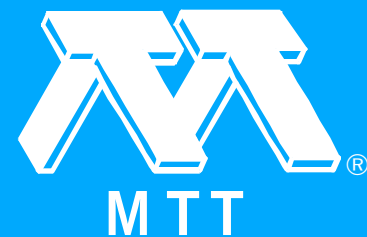
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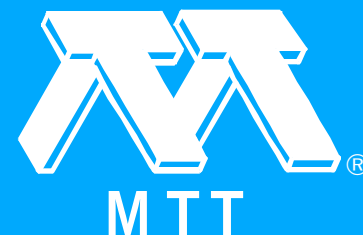
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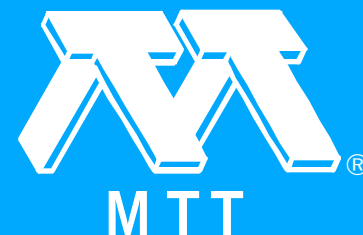
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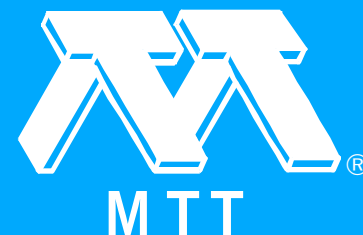
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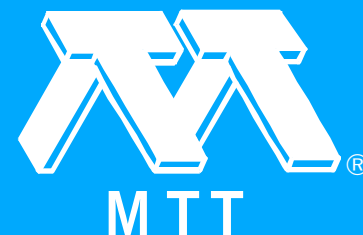
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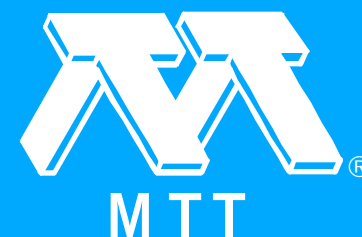
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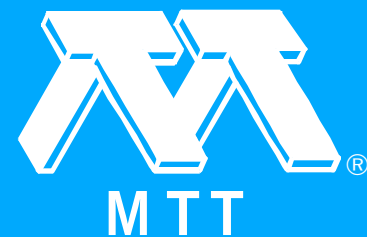
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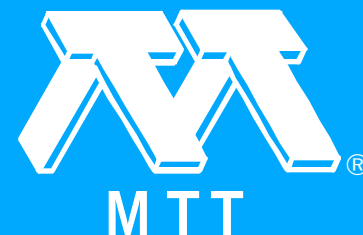
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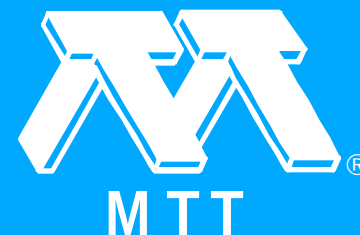
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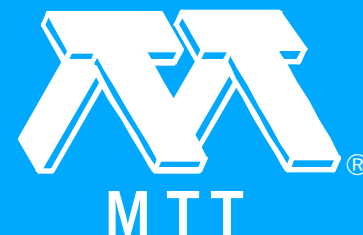
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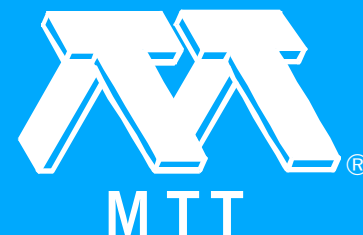
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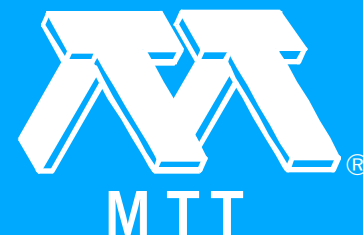
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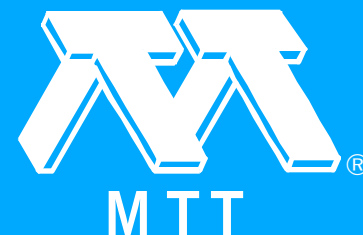
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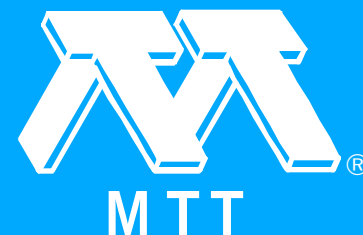
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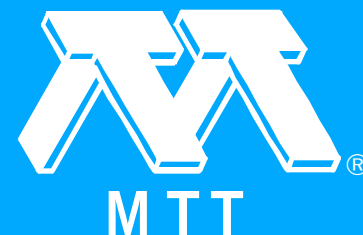
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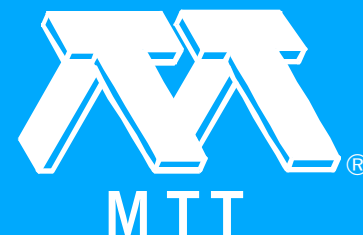
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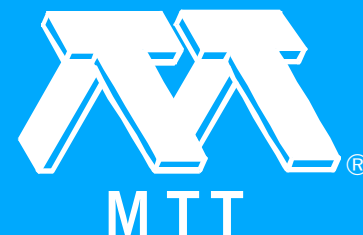


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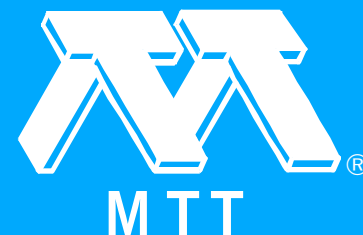
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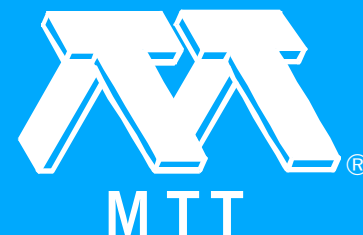
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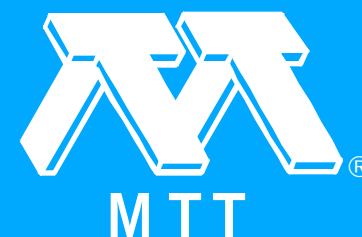
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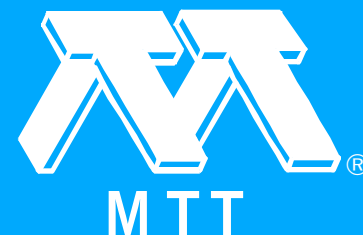
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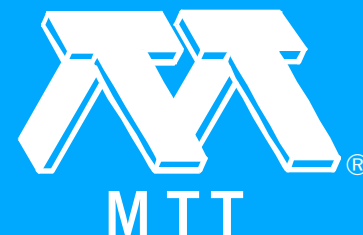
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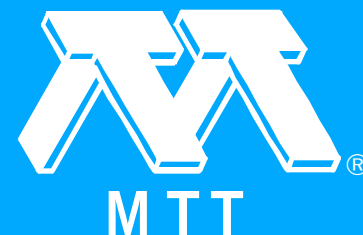
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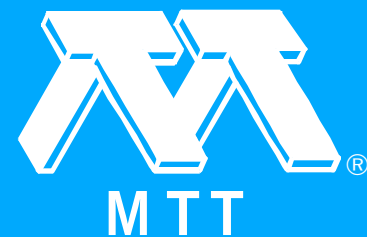
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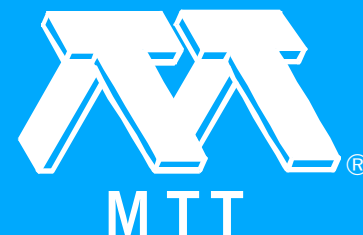
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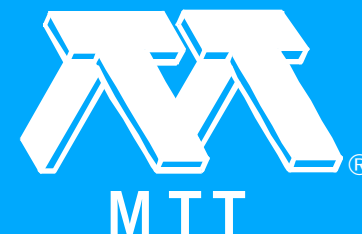
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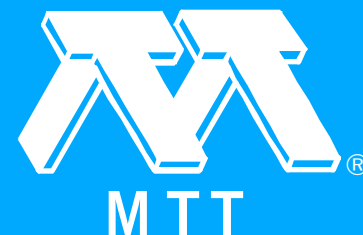
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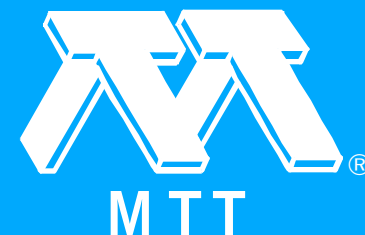
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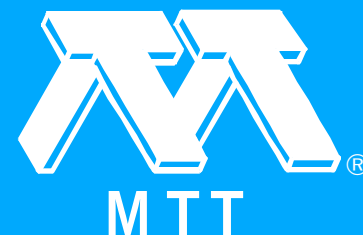
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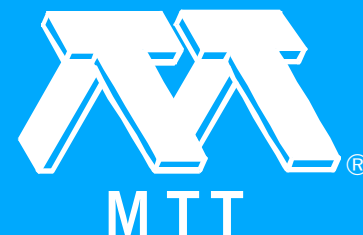
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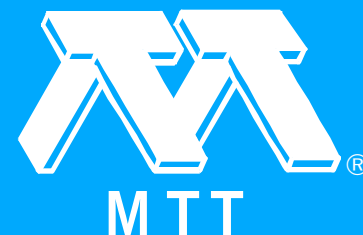
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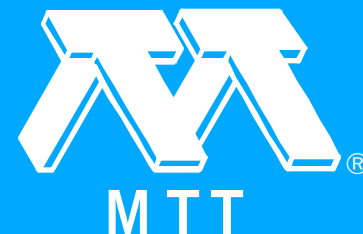
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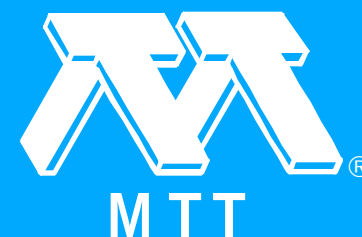
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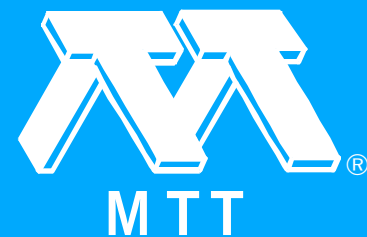
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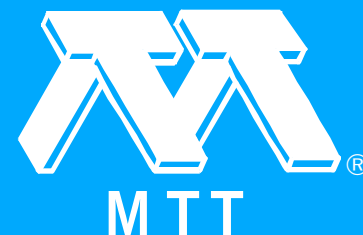
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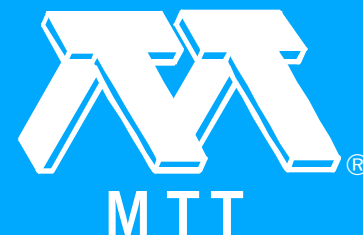
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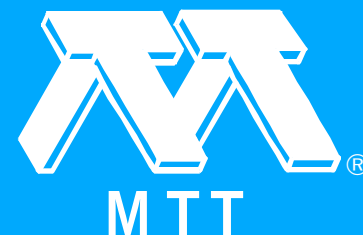


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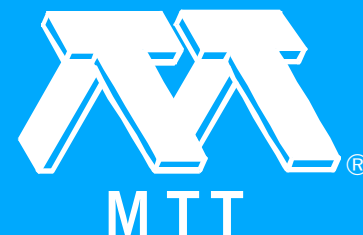
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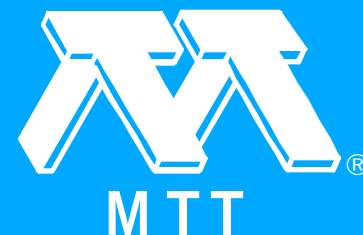
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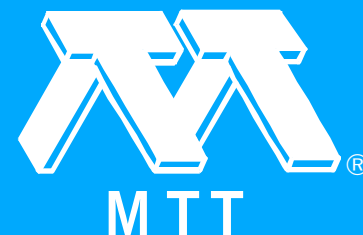


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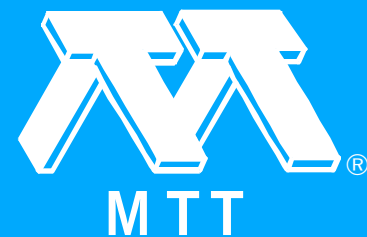
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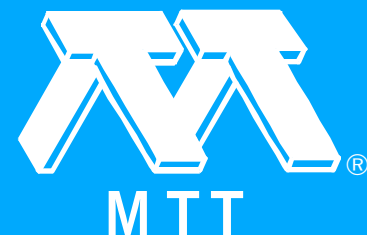
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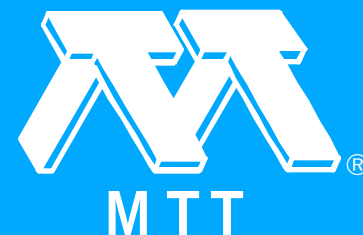
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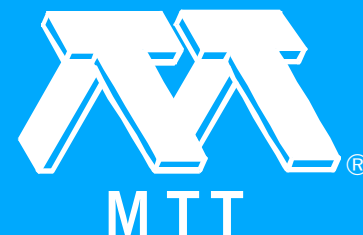
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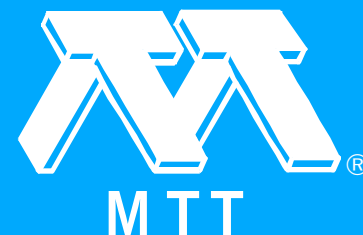
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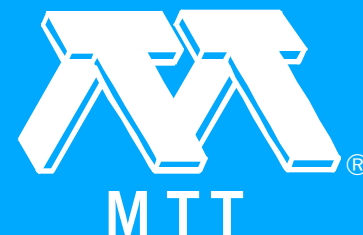
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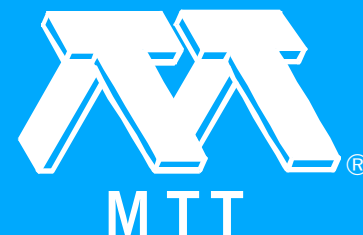
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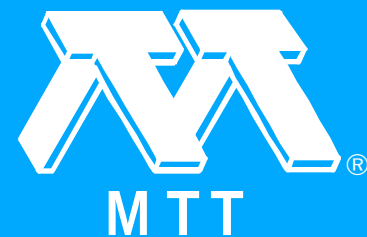
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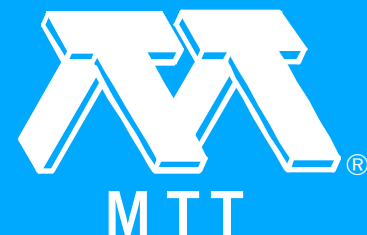
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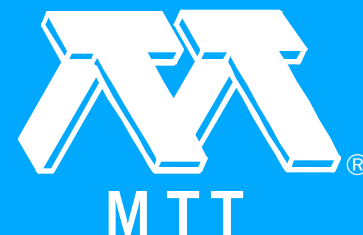


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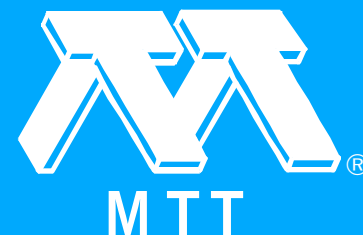
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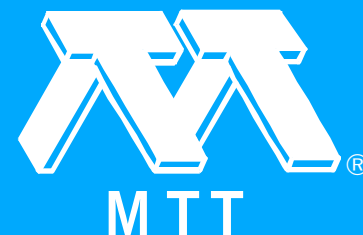


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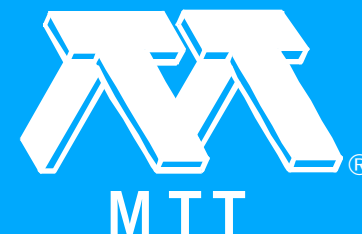
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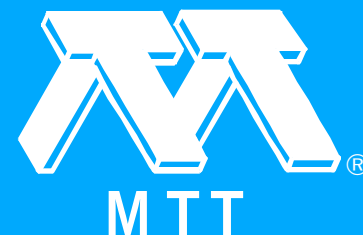


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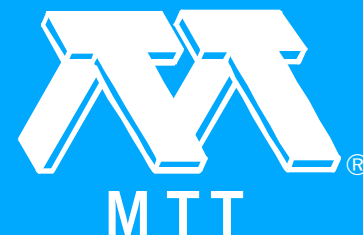
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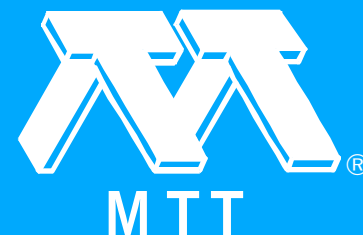
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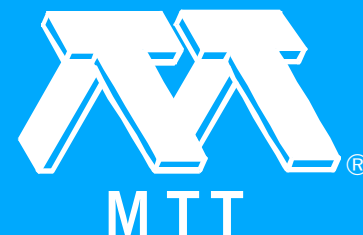
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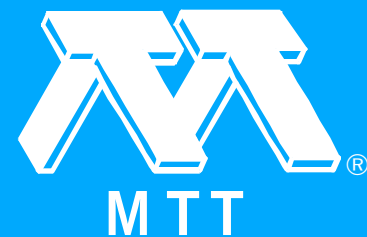
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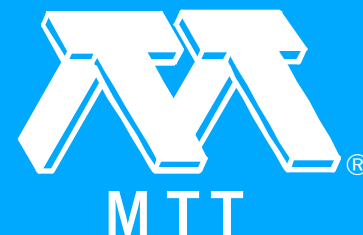
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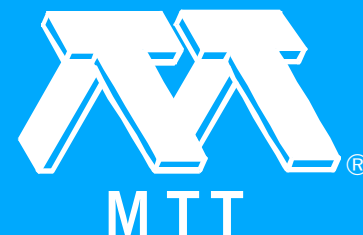
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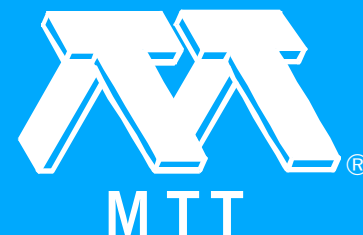
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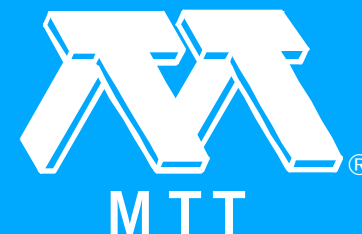
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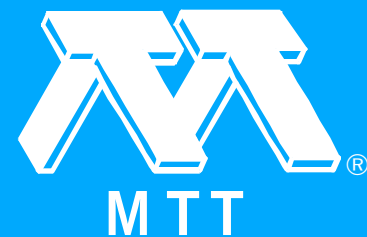
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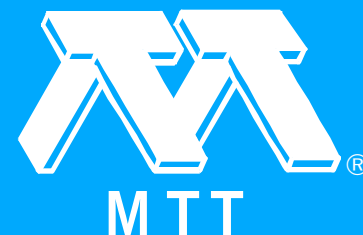
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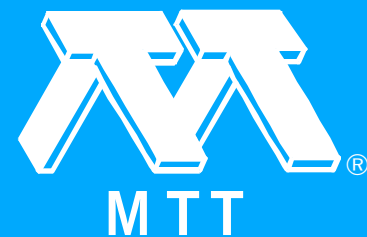
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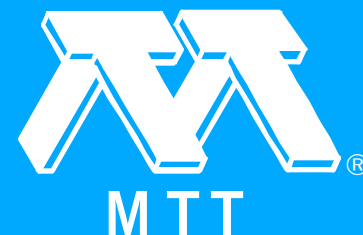
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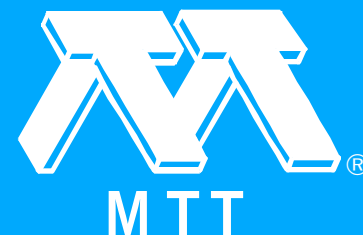
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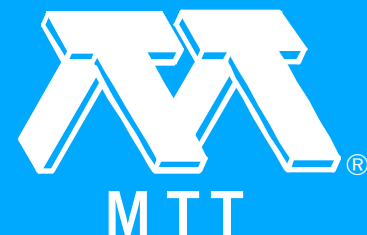
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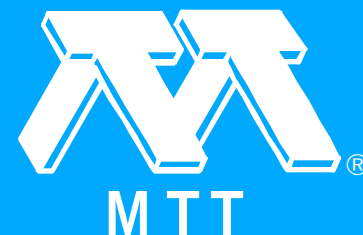
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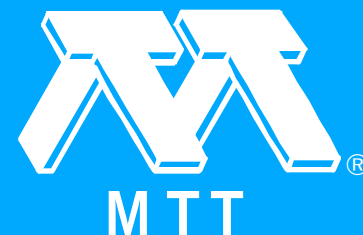
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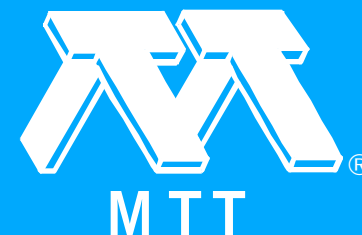
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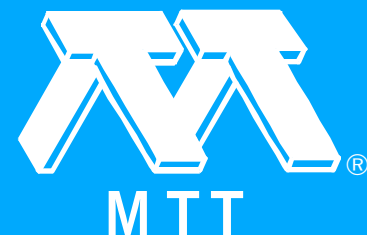
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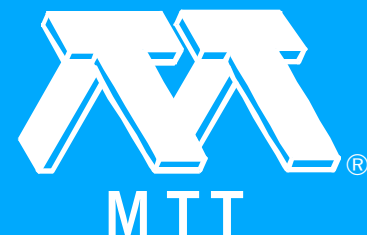
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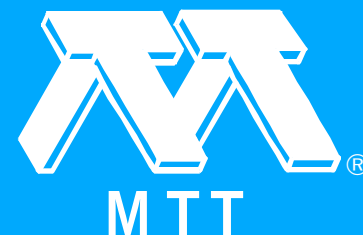


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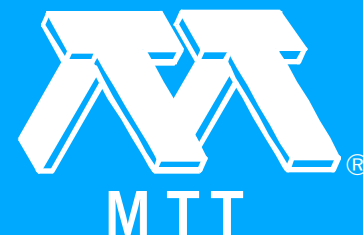
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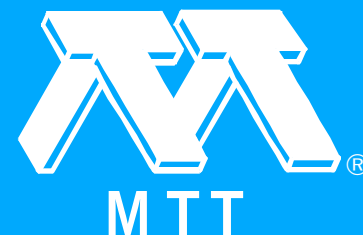
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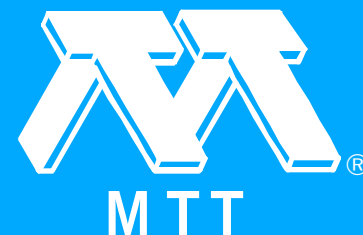
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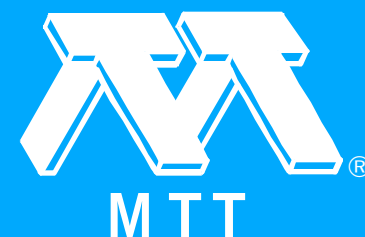
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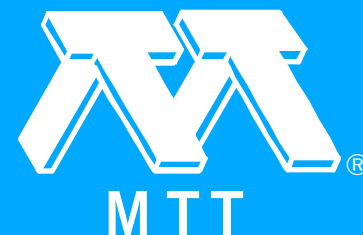
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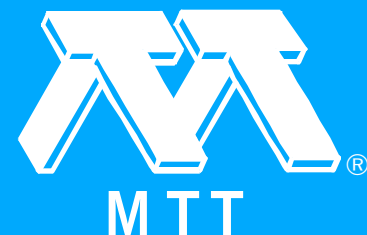
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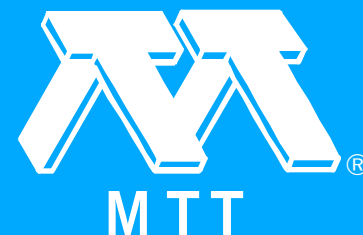
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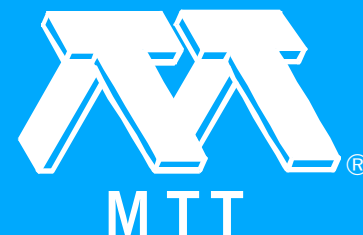
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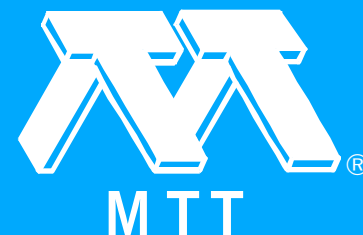
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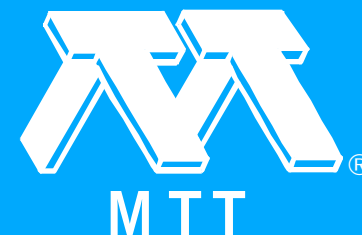
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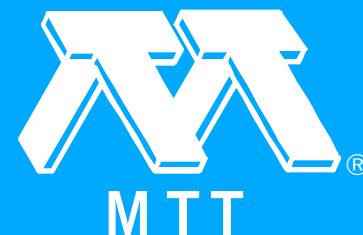


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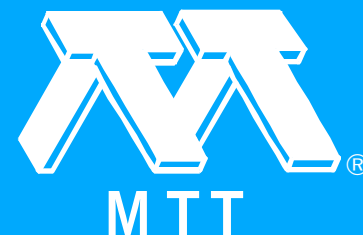
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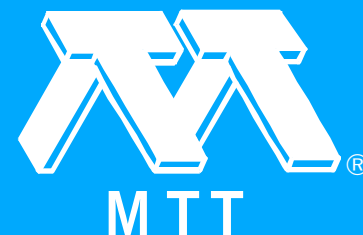
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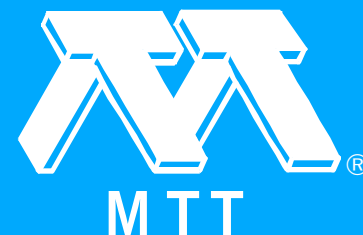
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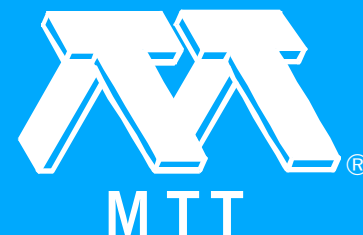


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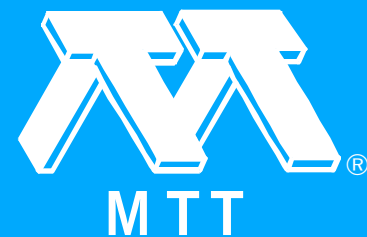
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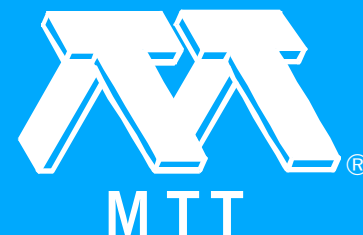
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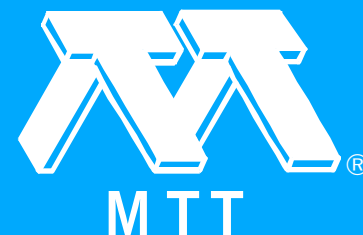
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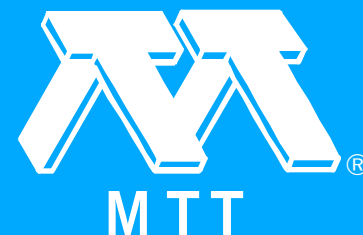
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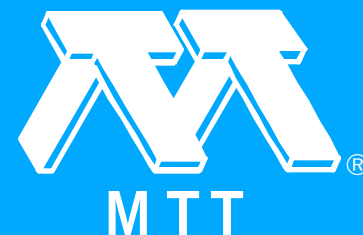
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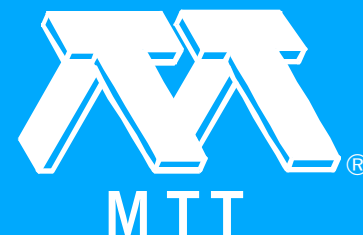
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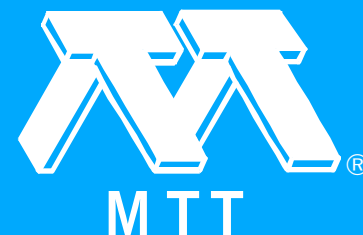
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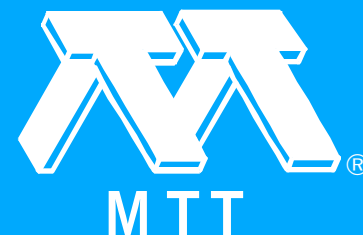
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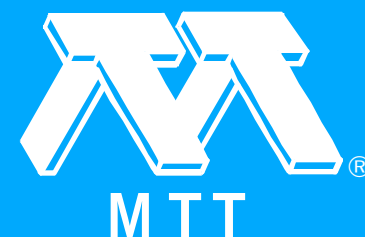
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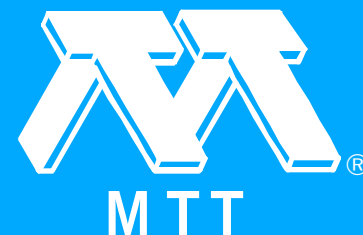
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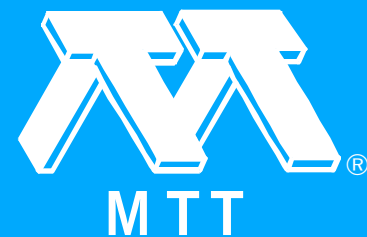
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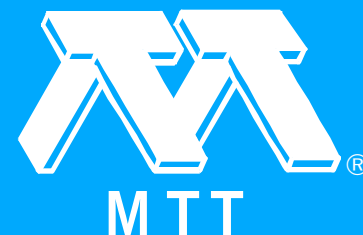
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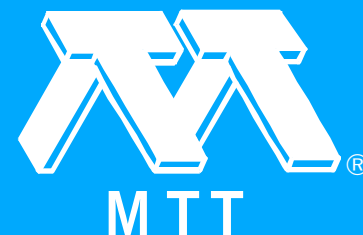
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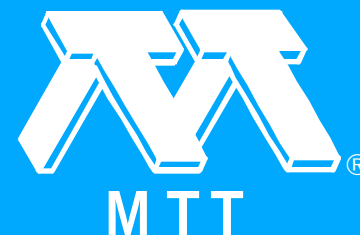
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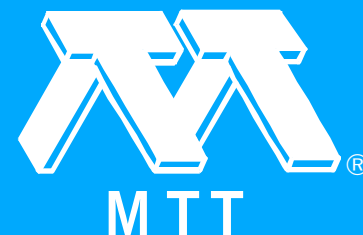


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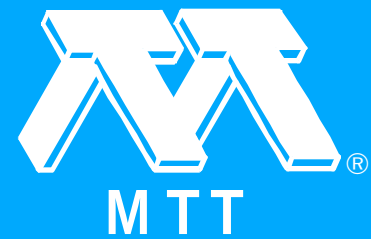


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## Experimental Characteristics and Performance Analysis of Monolithic InP-Based HEMT Mixers at W-Band

*Y. Kwon, D. Pavlidis, P. Marsh, G.-I. Ng and T.L. Brock. "Experimental Characteristics and Performance Analysis of Monolithic InP-Based HEMT Mixers at W-Band." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 1-8.*

Experimental characteristics of monolithic InAlAs/ InGaAs HEMT mixers are presented together with a theoretical analysis. Experiments at W-band show a maximum conversion gain of 0.9 dB with 2 dBm of LO power level. This is the first demonstration of a monolithic HEMT mixer with conversion gain at W-band. The conversion gain dependence on LO power, RF frequency and gate bias is measured and compared with the theoretical predictions. Good agreement between the theory and experiment could be found.



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## Novel Schiffman Phase Shifters

*J.L.R. Quirarte and J.P. Starski. "Novel Schiffman Phase Shifters." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 9-14.*

In a standard Schiffman phase shifter a coupled section and a uniform transmission line are used to give a differential phase shift. In order to achieve larger bandwidth it is necessary to use tight coupled sections which are difficult to realize. This paper shows how different configurations of coupled lines or parallel connected coupled lines can be used together with a uniform transmission line, another coupled lines or parallel connected coupled lines in order to obtain a differential phase shifter with loose coupled lines and the same performance as for the standard case. The measurements confirm the calculated results leading to a more realizable structure. Index Terms-Phase shifters, Schiffman sections, coupled transmission lines.



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*E.A. Gelvich, L.M. Borisov, Y.V. Zhary, A.D. Zakurdayev, A.S. Pobedonostsev and V.I. Poognin. "The New Generation of High-Power Multiple-Beam Klystrons." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 15-19.*

A number of drawbacks of single-beam transit klystrons (i.e., narrow band, high voltages, high weight) limit their use in some applications. Multiple-beam klystrons, operating in the fundamental resonator mode, offer the possibility of dramatic improvements in performance. This report describes the advantages of multiple-beam klystrons with regard to power supply voltages, weight and bandwidth. Characteristics of production prototypes are also presented.

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## Microwave Modeling of 2-D Active Grid Antenna Arrays

*A. Pance and M.J. Wengler. "Microwave Modeling of 2-D Active Grid Antenna Arrays." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 20-28.*

We present a new measurement technique for determining the broadband driving point impedance of large two-dimensional active grid arrays. The active array radiates a plane wave in the broadside direction when all elements are locked in phase. For analysis, the array is reduced to a single unit cell by exploiting the array symmetries. We determine the driving point impedance of the unit cell by using the Dielectric Waveguide Measurement method (DWM). The approximations of the method are discussed and the method is compared with other measurement techniques. We present results for four square arrays: dipole, bow-tie, double-Vee and slot array. We verify our measurement method by comparing it to the full-wave theory in the whole range. We show that the results for the dipole and the bow-tie arrays agree very well with the quasistatic theory and the results of others. We extend the quasistatic theory to the double-Vee array with excellent agreement and present a modified quasistatic circuit for the slot array. Finally, we show that all four antenna arrays can be represented by very simple circuits that use only transmission lines as circuit elements. We find that the bow-tie array represents the best choice for broadband operation.





## Analysis of a Wide Radiating Slot in the Ground Plane of a Microstrip Line

*M. Kahrizi, T.K. Sarkar and Z.A. Maricevic. "Analysis of a Wide Radiating Slot in the Ground Plane of a Microstrip Line." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 29-37.*

An analysis of a wide rectangular radiating slot excited by a microstrip line is described. Coupled integral equations are formulated to find the electric current distribution on the feed line and the electric field in the aperture. The solution is based on the method of moments and using the space domain Sommerfeld type Green's function. The information about the input impedance or reflection coefficient is extracted from the electric current distribution on the microstrip line utilizing the matrix pencil technique. The theoretical analysis is described and data are presented and compared with other theoretical and experimental results.





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## A Theoretical and Experimental Study of Coplanar Waveguide Shunt Stubs

*N.I. Dib, G.E. Ponchak and L.P.B. Katehi. "A Theoretical and Experimental Study of Coplanar Waveguide Shunt Stubs." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 38-44.*

A comprehensive theoretical and experimental study of straight and bent coplanar waveguide (CPW) shunt stubs is presented. In the theoretical analysis, the CPW is assumed to be inside a cavity, while, the experiments are performed on open structures. For the analysis of CPW discontinuities with air-bridges, a hybrid technique has been developed which has been validated through extensive theoretical and experimental comparisons. Throughout this study, the effect of the cavity resonances on the behavior of the stubs with and without air-bridges is investigated. In addition, the encountered radiation loss due to the discontinuities is evaluated experimentally.

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## Quasi-TEM Description of MMIC Coplanar Lines Including Conductor-Loss Effects

*W. Heinrich. "Quasi-TEM Description of MMIC Coplanar Lines Including Conductor-Loss Effects." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 45-52.*

A quasi-TEM model of MMIC coplanar structures is presented. The elements of the distributed equivalent circuit are calculated by closed-form approximations and hence can easily be implemented into CAD packages. The effects of non-ideal conductors are included as well as substrate loss and finite metallization thickness. The description holds for the entire quasi-TEM range, i.e., for typical MMIC geometries from DC to mm-wave frequencies. Validity of the model was checked by comparison to full-wave results. The errors for the effective dielectric constant and the characteristic impedance range below 5%, for the attenuation typical values of 5...10% are found (maximum: 20%).

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## Decoupling Between Two Conductor Microstrip Transmission Line

*S. He, A.Z. Elsherbeni and C.E. Smith. "Decoupling Between Two Conductor Microstrip Transmission Line." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 53-61.*

A numerical analysis of two-conductor transmission line with a rectangular notch in the dielectric between the strips is presented. Three media integral equations are derived and solved for the charge distributions. The decoupling between such two-conductor coupled microstrip transmission line is investigated for asymmetric conductors. It is found that the coupling between two conducting lines can be reduced significantly by removing dielectric material between the lines which has a rectangular shape. For best decoupling, the width should be as wide as possible between the conducting lines but the depth should have an optima somewhere in the base dielectric substrate.



## Equivalent Circuits for Multiconductor Microstrip Bend Discontinuities

*P.H. Harms and R. Mittra. "Equivalent Circuits for Multiconductor Microstrip Bend Discontinuities." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 62-69.*

With the increasing density of digital circuit layouts and faster pulse edges, microstrip discontinuities, e.g., bends, that were previously considered insignificant have now been shown to introduce noticeable signal degradation for short risetime pulses. In this paper, the T-equivalent circuit previously used for single-line microstrip bends is extended to the variable-angle, multiconductor microstrip bend. A brief overview is given of the excess-charge and current approaches which are employed to obtain the capacitance and inductance matrices for the equivalent circuit. These techniques effectively avoid the majority of numerical difficulties that occur in accounting for the infinite extent of the microstrip lines making up bends with arbitrary bend angles. In addition, to accurately accommodate the oblique bend angles without requiring many unknowns, the charge and current distributions are modeled with a combination of rectangular and triangular patches. Comparisons with previously published results from the technical literature and with experimental data are used to validate the excess capacitance and inductance computations. The excess capacitance and inductance matrices of several three-line bends are presented, and the three-line bend model is used in a simulation of a high-speed digital circuit to demonstrate the effect of the bend on digital pulse waveforms.





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## Analysis of Multiconductor Transmission Lines of Arbitrary Cross Section in Multilayered Uniaxial Media

*C.G. Hsu, R.F. Harrington, K.A. Michalski and D. Zheng. "Analysis of Multiconductor Transmission Lines of Arbitrary Cross Section in Multilayered Uniaxial Media." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 70-78.*

A mixed-potential electric field integral equation is formulated and applied in conjunction with the method of moments to analyze a transmission-line system consisting of multiple conducting strips of arbitrary cross section embedded in a stratified medium with or without top and/or bottom ground planes. Each layer of the medium is possibly uniaxially anisotropic, with its optical axis perpendicular to the dielectric interfaces. Computed dispersion curves and modal currents are presented and, when possible, are compared with data available in the literature.



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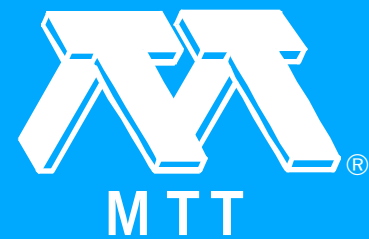
## Rigorous Analysis of the Propagation Characteristics of General Lossless and Lossy Multiconductor Transmission Lines in Multilayered Media

*F. Olyslager, D. De Zutter and K. Blomme. "Rigorous Analysis of the Propagation Characteristics of General Lossless and Lossy Multiconductor Transmission Lines in Multilayered Media." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 79-88.*

The frequency dependent propagation characteristics of lossless and lossy open coupled polygonal conductor transmission lines in a multilayered medium are determined based on a rigorous full-wave analysis. A boundary integral equation technique is used in conjunction with the method of moments. Losses in conductors and layers are included in an exact way without making use of a perturbation approach. Dispersion curves for the complex propagation constants and impedances are presented for a number of relevant examples and, where possible, compared with published data.

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## Numerical Analysis and Computer Simulation of Magnetostatic Wave Propagation in a YIG-Loaded Waveguide

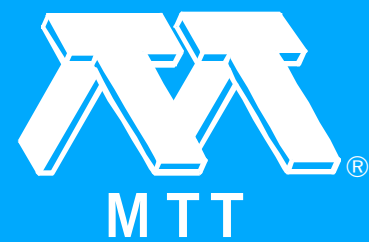
*M.M. Radmanesh, C.-M. Chu and G.I. Haddad. "Numerical Analysis and Computer Simulation of Magnetostatic Wave Propagation in a YIG-Loaded Waveguide." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 89-96.*

Magnetostatic Wave (MSW) propagation in a finite-width ferrite slab placed inside and along a rectangular wave-guide is investigated theoretically and numerically. Using the integral equation method, the general solution to the problem of wave propagation has been derived for the first time here in this paper. Thin-slab approximation made the derived solution more tractable and provided the dispersion relations in terms of an infinite determinant. From the presented results, it can be concluded that in order to obtain high value of group time delay over a large bandwidth thin, narrow slabs placed in the center of the guide must be used. On the other hand, to maximize the device bandwidth, thin slabs placed at the top or bottom of the guide are most appropriate.

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## Electromagnetic Scattering of Finite Strip Array on a Dielectric Slab

*C.-C. Lu and W.C. Chew. "Electromagnetic Scattering of Finite Strip Array on a Dielectric Slab." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 97-100.*

A fast recursive algorithm is used to compute the scattering properties of finite array of strip gratings on a dielectric slabs. This algorithm has a computational complexity of  $O(N \log^2 N)$  for one incident angle and  $O(N^2 \log N)$  for  $N$  incident angles. It uses plane wave basis for expanding the incident wave and the scattered wave. The scattered wave is expanded in terms of a Sommerfeld-type integral with spectral distribution along a vertical branch cut, rendering its expansion very efficient. To validate the scattering solution obtained using the recursive algorithm, comparisons with the method of moments are illustrated. The current distributions on the strips and scattering patterns are both presented. Since this algorithm has reduced computational complexity and is fast compared to other conventional methods, it can be used to analyze very large strip arrays. Scattering solution of a 50-wavelength wide strip is illustrated.

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## Full-Wave Analysis of a Two Slot Microstrip Filter Using a New Algorithm for Computation of the Spectral Integrals

*U.V. Gothelf and A. Ostergaard. "Full-Wave Analysis of a Two Slot Microstrip Filter Using a New Algorithm for Computation of the Spectral Integrals." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 101-108.*

An integral equation is formulated in the spectral domain for a two slot microstrip filter using the exact Green's function for the grounded dielectric substrate. Using a moment method (MM) procedure, the integral equation has been discretized. The elements of the impedance matrix and the excitation vector are given by two dimensional Sommerfeld type integrals in closed form. An efficient and accurate numerical integration scheme for computation of the elements is presented. The S parameters obtained from the MM procedure have been found to be in excellent agreement with measurements.



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## Resonant Frequency of Uncovered and Covered Rectangular Microstrip Patch Using Modified Wolff Model

*A.K. Verma and Z. Rostamy. "Resonant Frequency of Uncovered and Covered Rectangular Microstrip Patch Using Modified Wolff Model." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 109-116.*

A new model, called the Modified Wolff Model (MWM) is proposed to calculate the resonant frequency of a rectangular open microstrip patch, a patch with a dielectric superstrata and a patch inside a shielded enclosure. The model has also been applied to calculate resonant frequencies of higher order modes. Dependence of resonant frequency on the various parameters and its accuracy has been discussed using MWM. Results obtained from MWM follow very closely the results from various forms of fullwave analysis, and in almost all cases they are within 0.5% of published experimental results for the fundamental mode and within 1.7% for higher order modes. The method is computationally fast and efficient even on a desktop computer. The method could be used for other patches like circular, hexagonal and equilateral triangle.

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## Circular Polarization of the Magnetic Field in the WG Modes of Resonance of a Dielectric Disc at Microwave Frequencies

*I. Longo, P. Guillon and D. Cros. "Circular Polarization of the Magnetic Field in the WG Modes of Resonance of a Dielectric Disc at Microwave Frequencies." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 117-122.*

The circular polarization of the magnetic field of the Whispering-Gallery (WG) modes of resonance of a dielectric disc resonator has been tested in the evanescent-field region outside the dielectric material. Microwaves in the frequency range from 18 to 26.5 GHz (K-band) and the techniques of Electron Spin Resonance (ESR) have been used. The distribution of the electromagnetic fields was obtained with a finite element method and it was found in agreement with the experimental results.

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## Analysis of Single and Coupled Microstrip Lines on Anisotropic Substrates Using Differential Matrix Operators and the Spectral-Domain Method

*Y. Chen and B. Beker. "Analysis of Single and Coupled Microstrip Lines on Anisotropic Substrates Using Differential Matrix Operators and the Spectral-Domain Method." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 123-128.*

In this paper, a differential matrix operator technique is presented to simplify the formulation of boundary-value problems for open millimeter-wave integrated circuits (MIC's) which use anisotropic substrates. The spectral-domain method is applied to analyze the propagation characteristics of single and coupled microstrip lines printed on anisotropic substrates whose properties are described by both  $[\epsilon]$  and  $[\mu]$  tensors. In addition to considering the permittivity and permeability as a uniaxial or biaxial tensor, the effects of coordinate misalignment between the principal axes of  $[\epsilon]$  and those of the structure in the transverse plane are also included. It is shown that the misalignment in  $[\epsilon]$  and the presence of the  $[\mu]$  tensor has a significant effect on the dispersive properties of these two structures.

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## Direct Analytical Solution for the Electric Field Distribution at the Conductor Surfaces of Coplanar Waveguides

*M. Gillick, I.D. Robertson and J.S. Joshi. "Direct Analytical Solution for the Electric Field Distribution at the Conductor Surfaces of Coplanar Waveguides." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 129-135.*

A new analytical method of evaluating the electric field distribution across the conductor surfaces of coplanar waveguides (CPW's) is presented. Here, a series of conformal mappings are employed to transform the CPW's geometry and field distribution into a uniform image domain, to facilitate a direct field solution. The cumulative electric flux distribution across each conductor surface with the dielectric substrate is studied, and its effects on coupling and propagation modes are described. Direct solutions for the quasistatic normal electric field components are presented together with their graphical representations. Numerical computations show how the total electric flux terminating on the CPW's conductor surfaces varies in terms of the CPW's geometry and substrate parameters.

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## Dry Phantom Composed of Ceramics and Its Application to SAR Estimation

*T. Kobayashi, T. Nojima, K. Yamada and S. Uebayashi. "Dry Phantom Composed of Ceramics and Its Application to SAR Estimation." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 136-140.*

A dry phantom material having the same electric properties in the UHF band as biological tissues is developed. The new composite material is composed of microwave ceramic powder, graphite powder, and bonding resin. This material overcomes the various problems inherent in the conventional jelly phantom material, such as dehydration and deterioration due to invasion of bacteria or mold. This innovation of the phantom material makes it possible to accomplish highly reliable and precise estimation of specific absorption rate (SAR) in biological systems. Dry phantom models of spheres and human heads are fabricated. Experiments are performed to estimate the SAR of human heads exposed to microwave sources by using the thermography method. Since this material removes the necessity of the phantom shell indispensable with the conventional jelly material, the surface SAR distribution can be readily obtained.

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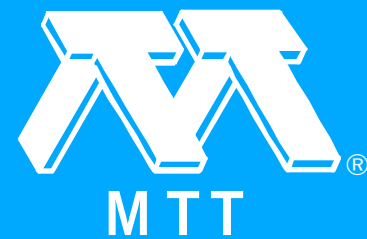


# Abstracts

## On the Use of Davidenko's Method in Complex Root Search (Short Papers)

*H.A.N. Hejase. "On the Use of Davidenko's Method in Complex Root Search (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 141-143.*

Davidenko's method has proved to be a powerful technique for solving a system of n-coupled nonlinear algebraic equations. It employs a Newton's method reduction to produce n-coupled first-order differential equations in a dummy variable. The advantage it offers over Newton's method and other traditional methods such as Muller's method is that it relaxes the restrictions that the initial guess has to be very close to the solution. Two examples involving the search for complex roots are presented. Davidenko's method seems to converge to the roots for all the arbitrary initial guesses considered while Muller's method appears to fail for some cases. This suggests the use of Davidenko's method as an alternative to Muller's method when the later fails to converge or is slowly convergent.



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## Mutual Coupling Between Two Small Circular Apertures in a Conducting Screen (Short Papers)

*S.V. Savov. "Mutual Coupling Between Two Small Circular Apertures in a Conducting Screen (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 143-146.*

With the use of the reaction integral and two-dimensional Fourier transform, an analytical expression for mutual coupling between two small circular apertures in a conducting screen, excited by normally incident plane electromagnetic wave, is obtained. Numerical examples for two different polarizations of the plane wave are investigated. The expression for the mutual admittance gives a correct value of the self admittance of a small aperture when the distance between the holes is equal to zero.

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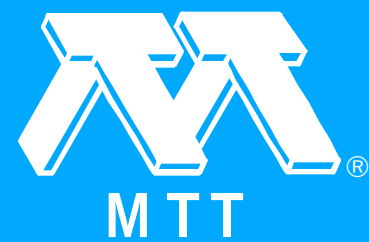
## Capacitance and Inductance Matrices of Coupled Lines from Modal Powers (Short Papers)

*S. Amari. "Capacitance and Inductance Matrices of Coupled Lines from Modal Powers (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 146-150.*

The capacitance and inductance matrices of a system of coupled lines are calculated from the modal powers. Knowledge of the propagation constants of the different modes, the eigencurrent matrix  $[M/\text{sub } I/]$  and the modal powers uniquely specify the two matrices. The present approach is tested both analytically and numerically.

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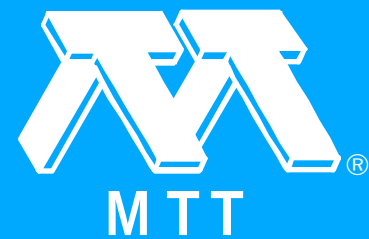
## Spectral Analysis Considerations Relevant to Radiation and Leaky Modes of Open-Boundary Microstrip Transmission Line (Short Papers)

*J.M. Grimm and D.P. Nyquist. "Spectral Analysis Considerations Relevant to Radiation and Leaky Modes of Open-Boundary Microstrip Transmission Line (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 150-153.*

The continuous radiation spectrum of open microstrip transmission line and its nonspectral leaky modes are conceptualized through a transform-domain integral-operator formulation and relevant spectral analysis. Two complex (transform-variable) wavenumber planes are implicated by Sommerfeld-integral representations of associated Green's functions and the necessary axial inverse transformation to the space domain. The radiation spectrum is identified with branch cuts in the axial wavenumber plane, which constrain the migration of branch-point singularities in the transverse wavenumber plane. Leaky-wave modes occur only when the branch cuts in the axial wavenumber plane are violated, allowing branch points in the transverse wavenumber plane to migrate across the (initial) real-axis integration path. The relation between spectral radiation modes, nonspectral leaky-wave modes and branch cuts in the axial wavenumber plane is discussed. The influence of branch cuts in the axial wavenumber plane upon the location of branch points in the transverse wavenumber plane is detailed, and a rationale is offered for the choice branch cuts in the latter plane. Although the formulation is developed specifically for the microstrip line, it is applicable more generally to a wide class of open conducting or dielectric waveguides. It is believed that the ideas presented here are new and significant, and provide perhaps the first general method for conceptualizing the continuous spectrum of practical open waveguides.

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## Characterizing the Cylindrical Via Discontinuity (Short Papers)

*P.H. Harms, J.-F. Lee and R. Mittra. "Characterizing the Cylindrical Via Discontinuity (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 153-156.*

Design of efficient electronic packaging for today's high-speed digital circuits and monolithic microwave integrated circuits requires accurate characterization of the electrical discontinuities that occur because they can significantly degrade the circuit performance by introducing various effects such as capacitive and inductive loading. However, discontinuities such as the cylindrical via are difficult to characterize because its relatively complicated geometry must be accurately modeled for good results. In this work, it is demonstrated that the nonorthogonal finite-difference time-domain (FDTD) technique can handle cylindrical via discontinuities without the use of an excessive number of unknowns as would be required with an equivalent orthogonal FDTD approach. Since the FDTD analysis is band limited in the frequency domain, the inaccurate, high-frequency components need to be removed before performing reliable transient analyses with the numerical results. The use of window filters to solve this problem is discussed, and a Hanning window is employed in a study of the transient response of an equivalent circuit for the via.

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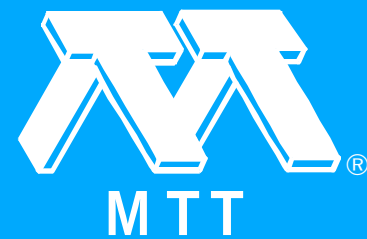


# Abstracts

## Slab Line Impedances Revisited (Short Papers)

*E. Costamagna, A. Fanni and M. Usai. "Slab Line Impedances Revisited (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 156-159.*

Accurate solutions for impedances and charge distributions in slab lines and rectangularly shielded lines are obtained by numerical inversion of the Schwarz=Christoffel (SC) conformal transformation. Circular inner conductors are considered, putting to the test the relatively simple numerical methods we have utilized, and results are successfully compared to the best data available from the literature. The method, besides supplying accurate global parameters, such as capacitances and impedances, is also shown to provide good evaluations for local charge densities. Equipotential and field lines can be easily derived, and accurate calculation of local field maps is shown possible, even from approximate geometries, when boundary conditions are not completely known.



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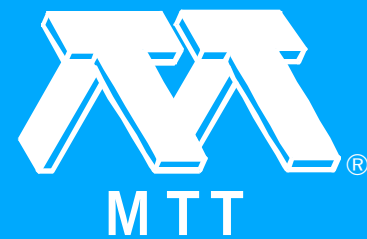


# Abstracts

## A Note on Experimental Determination of Small-Signal Equivalent Circuit of Millimeter-Wave FETs (Short Papers)

*A. Eskandarian and S. Weinreb. "A Note on Experimental Determination of Small-Signal Equivalent Circuit of Millimeter-Wave FETs (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 159-162.*

New expressions for determination of the parasitic inductances  $L_g$ ,  $L_d$ , and  $L_s$  in the small-signal equivalent circuit of high-frequency Field Effect Transistors (FET's) are derived, based on the "active/passive" (also known as "hot/cold") measurement technique developed in literature. These equations are required when the size of parasitic capacitances is such that their effect on the forward-biased gate measurement cannot be ignored, as has been the case with our millimeter-wave transistors. The method produces an equivalent circuit which has been used successfully for design of multi-stage amplifiers at 60 and 94 GHz.



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## Microstrip Quarter-Wave High Voltage DC Block (Short Papers)

*T.E. Koscica. "Microstrip Quarter-Wave High Voltage DC Block (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 162-164.*

A microstrip high voltage dc block is presented. Silicon rubber is used to insulate a quarter-wave coupler and the resulting effective dielectric constant and impedance are discussed. DC isolation up to 4500 V is achieved.

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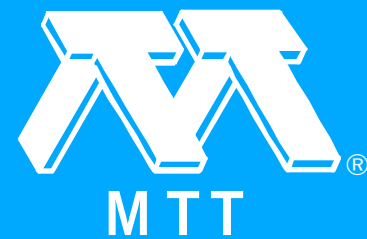


# Abstracts

## The Compressive Nature of Optical Detection in GaAs MESFETs and Possible Application as an RF Logarithmic Amplifier (Short Papers)

*A. Madjar, A. Paollela and P.R. Herczfeld. "The Compressive Nature of Optical Detection in GaAs MESFETs and Possible Application as an RF Logarithmic Amplifier (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 165-167.*

The photodetection mechanisms in GaAs MESFETs have been investigated by several researchers. Recently the authors have published an in-depth study of the MESFET as an optical detector under constant illumination involving both experimental and theoretical modelling. In this paper we discuss the compressive nature of that photodetection process. Experimental results involving constant illumination, modulated tight and pulsed illumination verify the theoretical conclusions. Finally we present a suggested structure of an RF logarithmic amplifier based on the above phenomenon.



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# Abstracts

## A New Finite-Difference Time-Domain Formulation and its Equivalence with the TLM Symmetrical Condensed Node (Comments and Authors' Reply)

*M. Celuch-Marcysiak, W.K. Gwarek, Z. Chen, M.M. Ney and W.J.R. Hoefer. "A New Finite-Difference Time-Domain Formulation and its Equivalence with the TLM Symmetrical Condensed Node (Comments and Authors' Reply)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 168-170.*

In [1] the authors present a new formulation of the finite-difference time-domain (FD-TD) method for Maxwell's equations. They compare this formulation (which we shall call "New FD-TD") with other existing FD-TD and TLM algorithms. They come to conclusions which can be summarized in the following statements:



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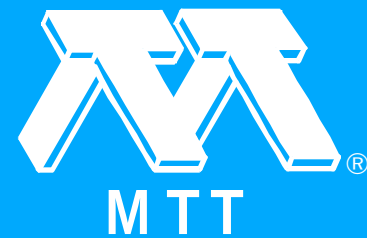


# Abstracts

## Josephson Effect Gain and Noise in SIS Mixers (Comments and Authors' Reply)

*D.G. Jablonski and M.J. Wengler. "Josephson Effect Gain and Noise in SIS Mixers (Comments and Authors' Reply)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 172-173.*

In their recent article, Wengler et al, report their observations and conclusions concerning the effects of Josephson currents on the microwave performance of superconductor-insulator-superconductor tunnel junction devices. I would like to caution that the authors seem poised to rediscover, the hard way, many lessons learned by researchers during the 1970s concerning the use of Josephson devices.



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# Abstracts

## An Analytic Algorithm for Unbalanced Stripline Impedance (Comments and Authors' Reply)

*E. Costamagna, A. Fanni and P. Robrish. "An Analytic Algorithm for Unbalanced Stripline Impedance (Comments and Authors' Reply)." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 173-174.*

Results obtained from numerical inversion of the Schwarz-Christoffel conformal transformation are utilized to discuss data derived from the subject paper and from the subsequent comments in [1].



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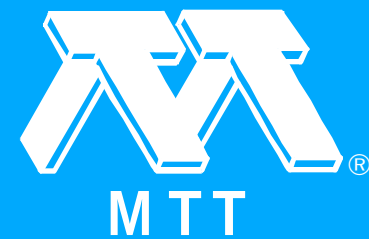
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## Call for Papers - Electrical Performance of Electronic Packaging (Jan. 1993 [T-MTT])

*"Call for Papers - Electrical Performance of Electronic Packaging (Jan. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 175-175.*



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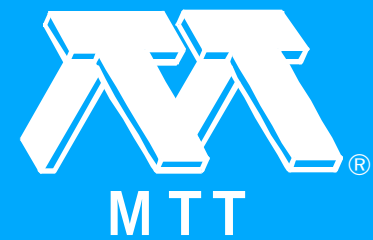
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## Information for Authors (Jan. 1993 [T-MTT])

*"Information for Authors (Jan. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 176-176.*



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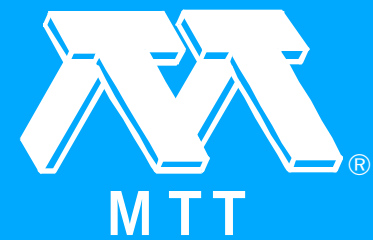
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## IEEE Order Plans (Advertisement) (Jan. 1993 [T-MTT])

*"IEEE Order Plans (Advertisement) (Jan. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 177-177.*



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## Emerging Technologies (Jan. 1993 [T-MTT])

*"Emerging Technologies (Jan. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 178-178.*



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## IEEE Copyright Form (Jan. 1993 [T-MTT])

*"IEEE Copyright Form (Jan. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.1 (Jan. 1993 [T-MTT]): 179-179.*



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*"Front Cover (Feb. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): b1-b1.*



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## Editorial (Feb. 1993 [T-MTT])

*S.A. Maas, D. Masse and T. Itoh. "Editorial (Feb. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 181-181.*

In the last few years the IEEE Microwave and Guided Wave Letters (MGWL), the IEEE Transactions on Microwave Theory and Techniques, and the IEEE MTT-S International Microwave Symposium Digest have experienced an increasing number of instances of unethical publication practices. The number of such incidents appears to be increasing, and thus has become a matter of great concern to the Editors of these journals and to the MTT Administrative Committee.

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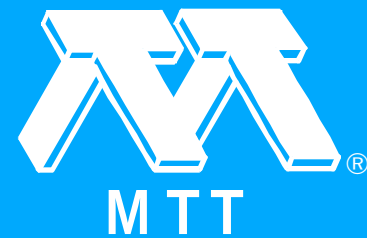


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## Editor's Note (Feb. 1993 [T-MTT])

*D. Masse. "Editor's Note (Feb. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 182-182.*

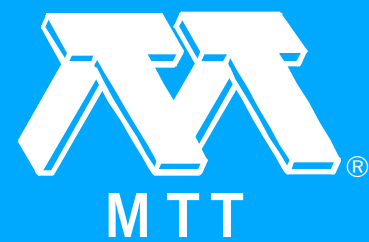
Starting with this issue of IEEE Transactions on microwave theory and techniques, the editorial board listing on the inside back cover will show only those reviewers who have been active during the past 12 months.



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## Large-Signal Characterization of Dual-Gate Field Effect Transistors Using Load-Pull Measurements

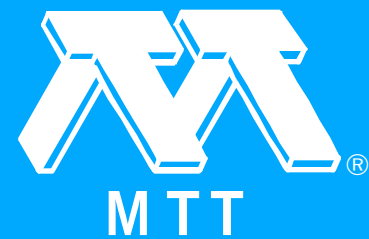
*D.M. Drury, D.C. Zimmerman and W.A. Davis. "Large-Signal Characterization of Dual-Gate Field Effect Transistors Using Load-Pull Measurements." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 183-189.*

A new automated injected signal load-pull measurement system has been designed to operate from 8 to 12 GHz, with a range of injected signal power extending to 4 W. The system has been shown to be as accurate as the HP8510 network analyzer. The large signal intrinsic drain to source resistance of an 1800  $\mu\text{m}$  dual gate FET was measured on the load-pull system, and subsequently a variable power amplifier was designed using the load-pull data. The amplifier output phase variation of the variable power amplifier was  $10^\circ$  when operating at 31.3 dBm.

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## Designing FET's for Broad Noise Circles

*B. Hughes. "Designing FET's for Broad Noise Circles." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 190-198.*

This paper shows that the keys to broader noise circles are a lower minimum noise figure and a small optimum generator reflection coefficient. There is an optimum FET width for the smallest generator reflection coefficient and the broadest noise circles. This was demonstrated with 0.25  $\mu\text{m}$  MODFET's. A FET of optimum width also has the lowest noise figure with a 50 ohm generator. An expression is derived showing that the optimum gate width is inversely proportional to frequency, and that the optimum width should be a weak function of gate length for FET's optimally scaled for gate length.

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## GaAs MESFET Characterization Using Least Squares Approximation by Rational Functions

*K. Nagatomo, Y. Daido, M. Shimizu and N. Okubo. "GaAs MESFET Characterization Using Least Squares Approximation by Rational Functions." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 199-205.*

We propose a new method to characterize active devices such as the FET by describing S-parameters with a set of rational functions of angular frequency. The set of rational functions is uniquely determined by only 27 coefficients, while the conventional method using tabulated S-parameters requires 8 times the number of sampling points (a typical case might require 404 data points in floating point notation). This drastically reduces the database size required to give adequate information for circuit design. We also describe a method for determining the equivalent circuit. Since the equivalent circuit is determined from the set of rational functions, no additional measurements are needed to determine extrinsic elements. In conventional methods, selection of initial values affects the final results. In our method, reliable initial values are extracted from the rational functions' coefficients. The calculated S-parameters of three GaAs MESFET's having different gate widths agree closely with those measured by wafer-probe.



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## Modeling and Analysis of Vias in Multilayered Integrated Circuits

*Q. Gu, Y.E. Yang and M.A. Tassoudji. "Modeling and Analysis of Vias in Multilayered Integrated Circuits." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 206-214.*

A method for modeling and analyzing vias in multi-layered integrated circuits is presented. The model of via structures is constructed based upon microwave network theory. The whole via structure is divided into cascaded subnetworks, including a vertical via passing through different layers and transitions from the microstrip line and/or striplines to the vertical via. The parameters of each subnetwork are obtained from electromagnetic field analysis. Numerical results in the frequency domain and the time domain are presented. Validation of the model has been carried out by both measurements and the FDTD modeling. Comparison to the measurements shows good agreement in the frequency range in which the components of experimental model are within specification, and the time domain simulation results also match well with the FDTD results.

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## K-Band Quasi-Planar Tapped Combline Filter and Diplexer

*W.-T. Lo and C.-K.C. Tzuang. "K-Band Quasi-Planar Tapped Combline Filter and Diplexer." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 215-223.*

The quasi-planar realizations of combline bandpass filter and diplexer using multiple coupled suspended substrate striplines (MCSSS's) have demonstrated good performance at K-band without any tuning. The N MCSSS's excite N zero-cutoff-frequency quasi-TEM modes. A new computer-aided filter design approach employing rigorous SDA (spectral-domain-approach) and 2N-port microwave circuit theory accounts for the effects of the N quasi-TEM modes, the couplings through non-adjacent MCSSS's, and cover height. Two 19.5 -to-20.5 GHz MCSSS's combline filters with different cover heights are built and tested to compare their filter characteristics. The reduction in cover height decreases the amount of non-adjacent couplings through MCSSS's and results in better filter stopband performance. Another 18.5-to-19 GHz and 20-to-20.5 GHz MCSSS's diplexer is also presented. All the measured results for the combline filters and diplexer agree well with the theoretic calculations.

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# Abstracts

## The Modeling, Analysis, and Design of Filter-Based Parametric Frequency Dividers

*G.R. Sloan. "The Modeling, Analysis, and Design of Filter-Based Parametric Frequency Dividers." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 224-228.*

This paper documents a technique for the design of filter-based parametric frequency dividers. The technique combines basic divider analysis with modern nonlinear simulation techniques. In essence, the procedure allows the completion of a successful design that is based on computer simulations, but requires little or no nonlinear optimization. Specifically, the paper investigates divider modeling, threshold, and efficiency, and presents a straight-forward design strategy.



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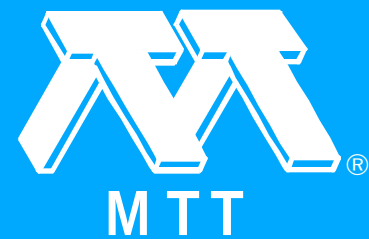
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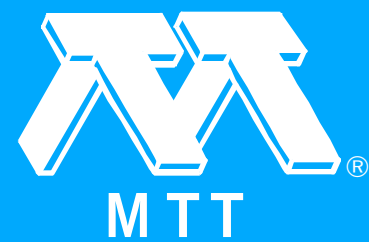
## Temperature Sensitivity of Coaxial Probe Complex Permittivity Measurements: Experimental Approach

*B.G. Colpitts. "Temperature Sensitivity of Coaxial Probe Complex Permittivity Measurements: Experimental Approach." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 229-233.*

An experimental investigation of the temperature sensitivity of the Teflon dielectric semi-rigid coaxial probe used in complex permittivity measurements is presented. Measurements are performed over the frequency range extending from 100 MHz to 26.5 GHz using 2.2 mm and 3.6 mm coaxial probes at a number of temperatures. An acute sensitivity of the probe-tip geometry to temperature is revealed along with its affect on measured complex permittivity. Measurements are further complicated by the nonlinear thermal phase response of the probe which results in hysteresis apparitions appearing in the measured complex permittivity during thermal cycling. The potential for removing these errors through temperature correction and the use of thermally stable probes is discussed.

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## On the Realization of Resistively Matched Three-Ports and the Ramp-Waveform Responses of Resistive, Signal-Split Three-Port Transmission-Line Networks

*I. Sakagami and A. Kaji. "On the Realization of Resistively Matched Three-Ports and the Ramp-Waveform Responses of Resistive, Signal-Split Three-Port Transmission-Line Networks." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 234-243.*

Three-port networks consisting of three transmission lines and three branching resistors at a junction, for the conditions of TEM wave propagation and lossless lines, are discussed. This discussion entails the following: 1) The matching conditions for the resistive three-port are modeled by scattering matrices. 2) As transmission lines of unequal length are used, the network transfer functions are derived for three different delay variables. These functions are obtained in a matrix form after their expansions with respect to these variables are derived. As a consequence, output waveforms can be calculated from the network transfer functions or their expansions. This method of expansion is superior to the conventionally used lattice diagram for analyzing high-speed logic circuits and designing their interconnections. 3) Three characteristics of output waveforms are discussed. 4) Ideal networks that furnish the same output waveforms as their inputs and practical networks that have parameters as close as possible to the ideal are described. 5) Examples of networks that keep the ringing of output waveforms within given tolerances, from the first arriving wave to the steady state, are presented. 6) Finally, this paper concludes with a discussion of power dissipation.



## Technique for Velocity-Matched Traveling-Wave Electrooptic Modulator in AlGaAs/GaAs

M.N. Khan, A. Gopinath, J.P.G. Bristow and J.P. Donnelly. "Technique for Velocity-Matched Traveling-Wave Electrooptic Modulator in AlGaAs/GaAs." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 244-249.

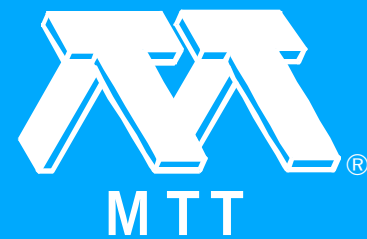
A new design for a velocity-matched traveling-wave directional-coupler intensity modulator in AlGaAs/GaAs is proposed. The proposed structure utilizes a thin coating of Ta<sub>2</sub>O<sub>5</sub> (which has a high dielectric constant at microwave frequencies and a low refractive index at optical frequencies) on the top of the modulator/electrode structure in order to achieve velocity matching between the optical wave and microwave signal. The addition of the Ta<sub>2</sub>O<sub>5</sub> film does not significantly affect the optical properties or voltage requirements of the modulator since the coating is thin ( $\sim 1000\text{\AA}$ ) and the refractive index at optical frequencies is low compared to that of AlGaAs/GaAs. The optical and RF characteristics of the proposed modulator are analyzed using the effective index and the finite difference methods. The optical bandwidth is calculated numerically taking into account both the anticipated velocity mismatches due to fabrication tolerances and the calculated frequency-dependent microwave losses. The predicted small-signal bandwidth, primarily limited by microwave losses, of a 3-mm-long direction coupler biased at a null point is greater than 45 GHz, and exceeds 100 GHz ( $\sim 50$  GHz electrical bandwidth) when biased in the linear region. This device is designed to operate at 830 nm with a maximum modulation voltage (full on/off modulation at low frequencies) of 5 V. The figure of merit of the proposed device is therefore at least 10 GHz/V when the electrical bandwidth of 50 GHz is used.

# Abstracts

## Ultra-Wideband Transient Microwave Scattering Measurements Using Optoelectronically Switched Antennas

*L. Carin and K. Agi. "Ultra-Wideband Transient Microwave Scattering Measurements Using Optoelectronically Switched Antennas." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 250-254.*

Ultra-wideband transient microwave scattering measurements are performed using optoelectronically switched planar antennas. The laser-based system produces freely propagating bursts of picosecond duration electromagnetic radiation, with a bandwidth extending from 5 to over 70 GHz. Measurements are presented for scattering from one and two conducting strips and from a conducting sphere. All measurements are compared to theoretical computations.



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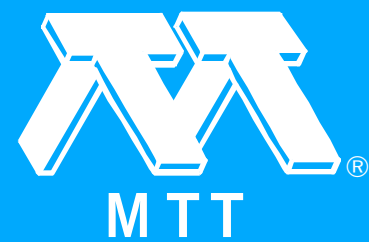
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## Nonlinear Response to Picosecond Pulse Excitations in Magneto-Dielectric Media

*H. How, C. Vittoria and K. Trott. "Nonlinear Response to Picosecond Pulse Excitations in Magneto-Dielectric Media." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 255-259.*

Nonlinear responses of magneto-dielectric thin layers to picosecond excitation have been calculated utilizing direct time-domain integration. Relaxations, hysteresis, and magnetic saturation phenomena associated with the response are therefore discussed in depth. The purpose of this calculation was to provide an analytical method by which physical properties of materials can be identified under picosecond-pulse excitation as well as to explore special cases of excitations in which picosecond pulses are efficiently absorbed. The calculations indicate that by examining the reflected waveform of the incident rectangular picosecond pulse the amount of magnetic hysteresis and saturation of the material may be estimated. It is shown that magnetic hysteresis will affect the shape of the trailing edge of the reflected signal, whereas the magnetic saturation effect can be identified from the slope of the reflected pulse step. Examples of designing effective picosecond-pulse screening structures have also been illustrated.

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## Improved Quasi-TEM Spectral Domain Analysis of Boxed Coplanar Multiconductor Microstrip Lines

*E. Drake, F. Medina and M. Horno. "Improved Quasi-TEM Spectral Domain Analysis of Boxed Coplanar Multiconductor Microstrip Lines." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 260-267.*

This paper presents a very efficient quasi-TEM analysis of multistrip transmission systems embedded in a layered medium. The number of conductors and substrates is arbitrary, and the whole structure is assumed to be enclosed in a rectangular set of boundary conditions. The analysis makes use of the Galerkin method in the spectral domain. Chebyshev polynomials with edge conditions are used as basis and test functions for the strips free charge distribution. This standard technique is considerably enhanced by means of two alternative procedures to accelerate the computation of the entries of the Galerkin matrix. Extremely accurate results for a multistrip system, including the charge distribution, can then be obtained on a PC computer in a short CPU time.

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# Abstracts

## Transient Analysis of Coupled, Tapered Transmission Lines with Arbitrary Nonlinear Terminations

*K.S. Oh and J.E. Schutt-Aine. "Transient Analysis of Coupled, Tapered Transmission Lines with Arbitrary Nonlinear Terminations." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 268-273.*

In this paper, a fast and efficient method to simulate the time-domain transient response of coupled, tapered transmission lines is presented. A time-domain scattering parameter formulation is used to derive the simple closed-form expression for the voltage variables for uniform lossless lines; then, this expression is applied to tapered lines by dividing the lines into many uniform sections. Computational efficiency and stability are achieved using recursive time-domain algorithms. The method that assumes a quasi-TEM mode of propagation is applicable to nonlinear terminations and inhomogeneous dielectric media. Memory requirement is minimized and is independent of the number of time steps. Simulation results when compared with experimental simulations indicated a good level of agreement.



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## Field Theoretical Treatment of H-Plane Waveguide Junctions with Anisotropic Medium

Y.-Y. Tsai and A.S. Omar. "Field Theoretical Treatment of H-Plane Waveguide Junctions with Anisotropic Medium." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 274-281.

A method based on the equivalence principle and cavity field expansions is presented to analyze a H-plane wave-guide junction with an anisotropic medium. Using the equivalence principle, magnetic surface currents are introduced at the imaginary boundaries chosen between the central region of the junction and the waveguides. The electric displacement  $D$  in the junction can be completely expressed in terms of a solenoidal set. On the other hand, the magnetic induction  $B$  in the junction must be expressed in terms of a solenoid set and an irrotational set. Continuing the tangential magnetic field at the imaginary boundaries leads to a matrix equation, the unknowns of which are the amplitudes of the scattered waveguide modes. Using this method, H-plane waveguide junctions with ferrite and composite ferrite posts are considered. The numerical results are compared with previously published experimental and theoretical results. Excellent agreement has been achieved.

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# Abstracts

## The Continuous Spectrum of the Inset Dielectric Guide and Its Application to Waveguide Transitions

*P.D. Sewell and T. Rozzi. "The Continuous Spectrum of the Inset Dielectric Guide and Its Application to Waveguide Transitions." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 282-289.*

The analysis of discontinuities in open waveguides, particularly strongly radiating discontinuities, requires a knowledge of the complete modal spectrum of the guide. The continuous spectrum of nonseparable open waveguides, a category which includes many useful high frequency structures, may be developed from a characteristic Green's function approach. This paper shall present as an example the continuous hybrid spectrum of the Inset Dielectric Guide (I.D.G.), a structure that shows promise for both propagation and antenna applications. As a verification, this spectrum has further been used to analyze strongly radiating rectangular waveguide to I.D.G. transitions, achieving a good correlation with experimental data.



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## Optimized Absorbing Boundary Conditions for the Analysis of Planar Circuits Using the Finite Difference Time Domain Method

*C.J. Railton, E.M. Daniel, D.-L. Paul and J.P. McGeehan. "Optimized Absorbing Boundary Conditions for the Analysis of Planar Circuits Using the Finite Difference Time Domain Method." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 290-297.*

The availability of effective numerical absorbing boundary conditions (ABCs) for use with the Finite Difference Time Domain (FDTD) method is essential for efficient application of the technique to microwave circuit analysis. Although many published results exist which have made use of various ABCs, little information concerning the optimum choice has been given. In this contribution, the suitability of available ABCs for planar circuit analysis is investigated and a new technique is presented whereby second order ABCs can be optimized for this type of problem.



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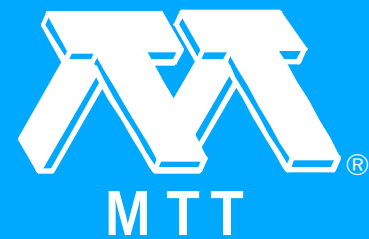
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## Finite Element Analysis of Inductive Strips in Unilateral Finline

*S.L. Foo and P.P. Silvester. "Finite Element Analysis of Inductive Strips in Unilateral Finline." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 298-304.*

A three-dimensional finite element method is used in conjunction with the boundary-marching algorithm to characterize inductive strips in unilateral finlines. For an idealized finline of zero fin thickness, without mounting groove effect, the results agree with those obtained by the hybrid-mode spectral-domain approach to within a few percent with only 98 elements. Field distributions for the dominant propagation mode in unilateral finlines are generated with the boundary-marching algorithm. The effect of metalization thickness, the influence of the mounting groove, and the effect of substrate bending on the discontinuity parameters are studied in detail.



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## Use of Redundant Testing Functions in Moment-Method Solutions for Block Models

*S. Caorsi, G.L. Gragnani and M. Pastorino. "Use of Redundant Testing Functions in Moment-Method Solutions for Block Models." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 305-310.*

An overconstrained version of the method of moments for SAR evaluation in biological bodies is presented. A number of testing functions larger than the one of basis functions is used in order to better constrain the solution near corners and edges. A rectangular system is obtained that is solved by means of a pseudoinversion algorithm. Comparisons with results reported in the literature are made, showing an enhancement of the MoM capabilities in SAR calculations, without a consistent increase in computational requirements.



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## Application of the FD-TD Method to the Analysis of Circuits Described by the Two-Dimensional Vector Wave Equation

*W.K. Gwarek, T. Morawski and C. Mroczkowski. "Application of the FD-TD Method to the Analysis of Circuits Described by the Two-Dimensional Vector Wave Equation." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 311-317.*

In the paper a class of microwave circuits described by a two-dimensional vector wave equation is defined. It is proposed to refer to them as vector two-dimensional or 2-DV circuits to distinguish them from circuits described by a two-dimensional scalar wave equation (typically referred to as 2-D circuits). It is shown that the 2-DV class contains some types of planar circuits filled with anisotropic medium, two-dimensional waveguide discontinuities and circular waveguide discontinuities. Calculation of dispersion characteristics of inhomogeneously filled hollow waveguides is an eigenvalue problem belonging to the 2-DV class. Application of the finite-difference time-domain (FD-TD) method to the analysis of 2-DV circuits is described. The efficiency of this method is shown by means of several examples of various kinds of circuits.

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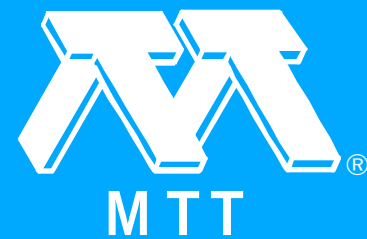


# Abstracts

## On the Application of the Wiener-Hopf Technique to Electrostatic Field Problems in Interdigital Transducers

*A.F. Molisch, A.R. Baghai-Wadji and C.O. Schiebl. "On the Application of the Wiener-Hopf Technique to Electrostatic Field Problems in Interdigital Transducers." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 318-324.*

Using the Wiener-Hopf-technique, we compute the electrostatic field distribution of interdigital transducers at the plane interface of two dielectric media sandwiched between two grounded metallic plates and neighbored by two grounded semi-infinite plates at the interface. To this end, we compute, for the first time, the associated Green's function, which already satisfies the boundary conditions at all the grounded plates. Consecutively, the Green's function is used to derive the elements of the charge-potential-interrelation matrix for various basis- and testing functions for a method-of-moments application. Examples demonstrate that the new method has considerable advantages with respect to accuracy and computer-memory requirements.



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## An Improved Floating-Random-Walk Algorithm for Solving the Multi-Dielectric Dirichlet Problem

*J.N. Jere and Y.L. Le Coz. "An Improved Floating-Random-Walk Algorithm for Solving the Multi-Dielectric Dirichlet Problem." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 325-329.*

An improved floating-random-walk algorithm for solving the multi-dielectric Dirichlet problem is outlined. The improvement is achieved by using statistically generated Green's functions that are calculated before hand and stored as look-up tables. These tables have been used to solve the multi-dielectric Dirichlet problem for an arbitrary two dimensional geometry. The improved algorithm is also compared with the conventional floating-random-walk algorithm and is found to be at least two times more efficient. Results are presented for two types of parallel plate geometries.

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## A Discussion of Rotating Wave Fields for Microwave Applications

*J.E. Velazco and P.H. Ceperley. "A Discussion of Rotating Wave Fields for Microwave Applications." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 330-335.*

Traveling wave and standing wave fields are central to microwave applications. This paper discusses a third category of fields: "rotating waves" which, while occasionally utilized in the past, are not commonly used or understood. Rotating waves are composed of a particular linear combination of standing waves, but have field profiles more similar to traveling waves. A rotating wave can be pictured as a frozen field rotating in space. An analysis is presented of rotating waves in cylindrical cavity resonators. The TM/sub 110/ rotating mode for a cylindrical resonator is discussed in some detail.



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## Stable Broadband Microwave Amplifier Design Using the Simplified Real Frequency Technique (Short Papers)

*W.-L. Jung and J.-H. Chiu. "Stable Broadband Microwave Amplifier Design Using the Simplified Real Frequency Technique (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 336-340.*

Yarman's simplified real frequency technique is modified to design a stability-guaranteed broadband microwave amplifier consisting of a potentially unstable transistor. The source and load terminations can be complex impedances. The stability is maintained by the conductance resulted from transforming the source and load terminations through the input and output matching circuits. The input and output matching circuits are derived concurrently, instead of sequentially. Repeating the design of an example from a previous paper shows that the transducer gain obtained by using this method is higher, with fewer matching circuit elements, than that by using Supercompact optimizers. And, with the same number of matching circuit elements, the transducer gain is slightly higher than that by using the dynamic CAD technique.



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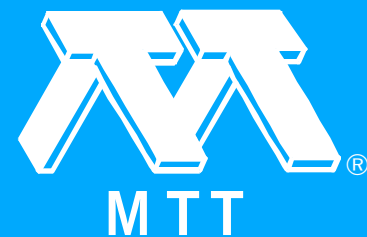


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## Extraction of Device Noise Sources from Measured Data Using Circuit Simulator Software (Short Papers)

*P.K. Ikalainen. "Extraction of Device Noise Sources from Measured Data Using Circuit Simulator Software (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 340-343.*

A procedure is presented for extracting the properties of device noise sources from experimental data. The extraction procedure can be implemented using commercially available circuit simulators. An example concerning a low-noise pseudomorphic HEMT shows that the two noise sources extracted from experimental data are largely uncorrelated provided that parasitic elements are de-embedded from the measurement and that the sources are extracted in H-parameter format.



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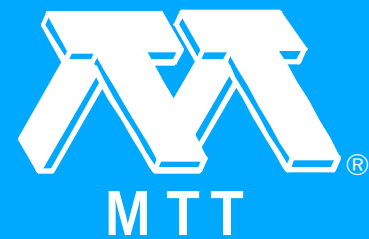
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## An Efficient Method for the Determination of Resonant Frequencies of Shielded Circular Disk and Ring Resonators (Short Papers)

*F. Tefiku and E. Yamashita. "An Efficient Method for the Determination of Resonant Frequencies of Shielded Circular Disk and Ring Resonators (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 343-346.*

This short paper describes an efficient method for the determination of resonant frequencies of shielded circular disks and annular ring resonators. Boundary integral equations are set up based on the Green's identity in the circular cylindrical coordinates, and are numerically solved by discretizing common boundary integral paths. The overall integration path is considerably shortened to reduce computation time by using simple eigen functions satisfying regular homogeneous boundary conditions as weighting functions instead of using Green's functions. Computational results for both circular disks and annular rings are presented and compared with other available numerical results for some cases. This method can be extended to treat thick conductors.

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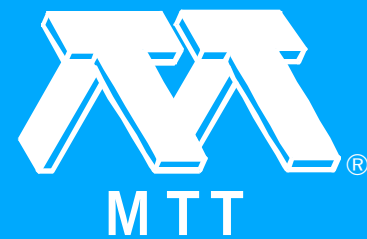


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## Design Analysis of Novel Coupling Structures for Multilayer MMIC's (Short Papers)

*M. Gillick, I.D. Robertson and J.S. Joshi. "Design Analysis of Novel Coupling Structures for Multilayer MMIC's (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 346-349.*

Novel monolithic multilayered coupling structures are presented and their performances analyzed. These structures have reduced current crowding at their conductor edges compared to coplanar type coupling structures, and are particularly suitable for integration with multi-dielectric MMIC's. This paper presents the closed-form analytical expressions for the coupler's even and odd mode impedances and coupling coefficients derived using conformal mapping techniques. These direct formulas have the advantage of being well suited for the computer aided design analysis of MMIC's without the need for lengthy numerical modelling techniques.



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## Rigorous Analysis of Iris Coupling Problem in Waveguide (Short Papers)

*R. Yang and A.S. Omar. "Rigorous Analysis of Iris Coupling Problem in Waveguide (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 349-352.*

In this short paper we present a new class of simple basis functions which explicitly take the edge conditions into consideration for solving waveguide iris coupling problem by using moment method. The good agreement between the results for some special cases for both parallel-plate waveguide and rectangular waveguide from the present work and that from previous publications demonstrate the correctness of the choice of the basis functions. Compared with previously published basis functions the basis functions introduced here are characterized by their simple form, generality and still with a similar fast convergence behavior.

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## Numerical Electromagnetic Inverse-Scattering Solutions for Two-Dimensional Infinite Dielectric Cylinders Buried in a Lossy Half-Space (Short Papers)

*S. Caorsi, G.L. Gagnani and M. Pastorino. "Numerical Electromagnetic Inverse-Scattering Solutions for Two-Dimensional Infinite Dielectric Cylinders Buried in a Lossy Half-Space (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 352-357.*

An approach to microwave imaging in a half-space geometry and for infinite dielectric cylinders buried in a lossy medium is proposed. The two-dimensional integral-equation for the inverse-scattering problem is discretized by the moment method. The resulting ill-conditioned system is solved by pseudoinversion. A multi-incidence process based on the invariance of the Green matrix to the incident field is described. Results of some numerical simulations, assuming a noisy environments, are reported and discussed.







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## Calculating Input Impedance of Electrically Small Insulated Antennas for Microwave Hyperthermia (Short Papers)

*P.S. Debicki and M.A. Astrahan. "Calculating Input Impedance of Electrically Small Insulated Antennas for Microwave Hyperthermia (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 357-360.*

Two analytical methods for approximating the input impedance of insulated monopole or dipole antennas embedded within an electrically dense medium have been reported in the literature. The methods differ by the applied degree of approximation in the solution of the integral equation for the current in the insulated conductor. These methods directly affect the calculation of the wavenumber and the characteristic impedance of an antenna treated as a lossy coaxial line. In the more complex approach the resulting formulas contain an additional term which improves the correlation with measured and numerically modeled results for electrically longer antennas. When applied to electrically small antennas (i.e.  $< 1/8$  wavelength in the medium), this term introduces a significant error into the calculation of the real part of the complex input impedance. Special care must be taken if these formulas are used to design multisectional antennas in order to avoid impedance mismatch. Two methods for correcting this error are presented.



# Abstracts

## Modeling of Planar Varactor Frequency Multiplier Devices with Blocking Barriers (Comments and Authors' Reply)

*R.J. Hwu, U. Lieneweg, T. Tolmunen, M.A. Frerking and J. Maserjian. "Modeling of Planar Varactor Frequency Multiplier Devices with Blocking Barriers (Comments and Authors' Reply)." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 361-362.*

I am compelled to write this comment in disagreement with some information in the paper "Modeling of Planar Varactor Frequency Multiplier Devices with Blocking Barriers" by Lieneweget et al. A precursor to that paper was published in the Proceedings of the Second International Symposium on Space Terahertz Technology. It appears to me that some conclusions drawn in this paper are the same as that which were discussed in my thesis (see UCLA thesis 1991). At that time, I raised my concern about the difference of the effective RC time constant between single and two back-to-back connected BIN (Barrier-Intrinsic-N/sup +/-) diodes based on high frequency measurement results I had obtained over a period of two years. I also provided an explanation in terms of the behavior of the effective series resistance and capacitance of the back-to-back connected diodes that was not experimentally verified...



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# Abstracts

## Optimum Noise Measure Terminations for Microwave Transistor Amplifiers (Comments and Authors' Reply)

*J.-C. Liu, S.-S. Bor, P.-C. Lu, D.K. Paul, P. Gardner and C.R. Poole. "Optimum Noise Measure Terminations for Microwave Transistor Amplifiers (Comments and Authors' Reply)." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 363-364.*

In the above paper, the authors have introduced a graphical method of obtaining circles of constant noise measure in the source reflection coefficient plane to achieve an optimal design of microwave transistor amplifiers.



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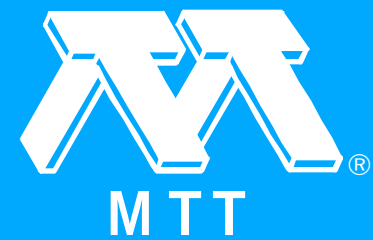
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## Information for Authors (Feb. 1993 [T-MTT])

*"Information for Authors (Feb. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 365-365.*



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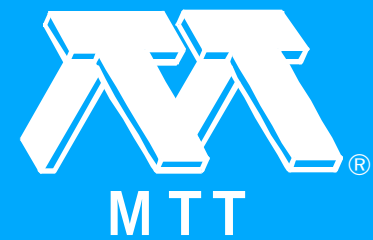
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## IEEE Order Plans (Advertisement) (Feb. 1993 [T-MTT])

*"IEEE Order Plans (Advertisement) (Feb. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 366-366.*



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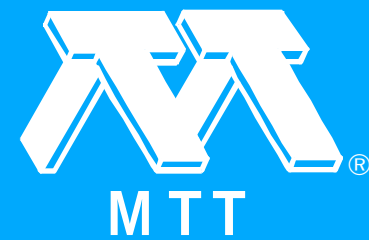
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## Ask IEEE (Advertisement) (Feb. 1993 [T-MTT])

*"Ask IEEE (Advertisement) (Feb. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 367-367.*



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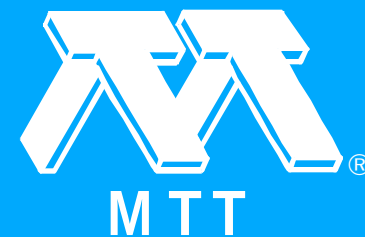
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## Emerging Technologies (Advertisement) (Feb. 1993 [T-MTT])

*"Emerging Technologies (Advertisement) (Feb. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): 368-368.*



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## Back Cover (Feb. 1993 [T-MTT])

*"Back Cover (Feb. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.2 (Feb. 1993 [T-MTT]): b1-b1.*



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## Front Cover (Mar. 1993 [T-MTT])

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*"Front Cover (Mar. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): f1-f1.*



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## Phase Noise in Cryogenic Microwave HEMT and MESFET Oscillators

*O. Llopis, R. Plana, H. Amine, L. Escotte and J. Graffeuil. "Phase Noise in Cryogenic Microwave HEMT and MESFET Oscillators." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 369-374.*

This paper addresses the influence of cooling on the phase noise of HEMT and MESFET oscillators. The initial measurements of the device dc characteristics and low frequency noise (0.1 kHz-100 kHz) under cooling give indications on the suitability of a given device for use in low phase noise cooled oscillators. Cooled pseudomorphic AlGaAs/GaInAs/GaAs HEMT's (PHEMT's) turn out to be particularly well-suited as they are free of collapse and they are free of g-r noise in the frequency range of interest. We report on 4 GHz oscillators operated at 110 K and featuring a phase noise below -100 dBc/Hz at 10 kHz from the carrier in spite of a very modest loaded Q (160). It is suggested that high temperature superconductor resonators could greatly enhance the spectral purity of PHEMT's oscillators.



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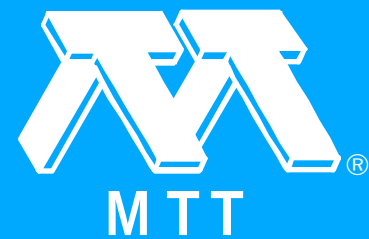
## A New Method for On Wafer Noise Measurement

*G. Dambrine, H. Happy, F. Danneville and A. Cappy. "A New Method for On Wafer Noise Measurement." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 375-381.*

A new method for measuring the noise parameters of MESFET's and HEMT's is presented. This new method is based on the fact that only three independent noise parameters are sufficient to fully describe the device noise performance. It is shown that two noise parameters ( $R_{n/}$  and  $|Y_{opt/I}|$ ) can be directly obtained from the frequency variation of the noise figure  $F_{50/}$  corresponding to a 50 ohm generator impedance. By using a theoretical relation between the intrinsic noise sources as additional data, the  $F_{50/}$  measurement only can provide the four noise parameters. A good agreement with more conventional techniques is obtained.

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## Evaluation of Noise Parameter Extraction Methods

*L. Escotte, R. Plana and J. Graffeuil. "Evaluation of Noise Parameter Extraction Methods." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 382-387.*

The influence of the algorithm used for noise parameter fitting on the accuracy of the microwave noise parameter measurements is investigated. Five different commonly used algorithms are compared by statistical analysis including instrument accuracy specifications. Some of these algorithms are found to be more efficient in terms of available accuracy and computer-time. The best predicted available accuracies reported between 4 and 20 GHz for each noise parameter compare well with observed accuracies on noise parameter measurements performed with a dedicated test-set on a noise standard made of a passive two-port. The accuracy on minimum noise figure is found to be 0.1 dB maximum.



## Unconditionally Stable Tracking Discriminator at 35 GHz

*B.N. Biswas, A.P. Sinha, P. Lahiri and D. Mondal. "Unconditionally Stable Tracking Discriminator at 35 GHz." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 388-394.*

A two-mode tuning method for injection locked oscillators at microwave frequencies has been presented. This technique allows one to modify the frequency response characteristics and stability boundary of an injection locked oscillator (ILO) in a favorable direction. Using this idea, a lock-in microwave discriminator has been proposed. The stability properties, tracking zone and other characteristics of the discriminator are presented based on both a mathematical analysis and experimental results.



## A Systematic Optimization Strategy for Microwave Device Modelling

*A.D. Patterson, V.F. Fusco, J.J. McKeown and J.A.C. Stewart. "A Systematic Optimization Strategy for Microwave Device Modelling." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 395-405.*

Small signal GaAs MESFET equivalent circuit models are typically very ill-conditioned since the error function most often used is sensitive to some combinations of the model components and extremely insensitive to other combinations. Consequently the convergence of the parameter estimation routines used is slow and there is a good deal of uncertainty associated with the optimized values of the insensitive components. In this work the degree of ill-conditioning in the equivalent circuit model is formally quantified using a systematically formulated principal components sensitivity analysis procedure. Using this procedure it is possible to estimate for the first time how reliable the component values are in the optimized model. On this basis the extraction of the MESFET equivalent circuit model is compared using electrical model components and physical model parameters. In addition a new optimization strategy is presented which improves the condition number of the model so that rapid convergence and accurate models are ensured. This technique transforms the axes of the model from the equivalent circuit components which are correlated to the uncorrelated principal component axes which can be systematically scaled to eliminate ill-conditioning. Using this technique it is possible to obtain accurate estimates of the insensitive model parameters such as the parasitic resistances without resorting to direct measurement techniques.





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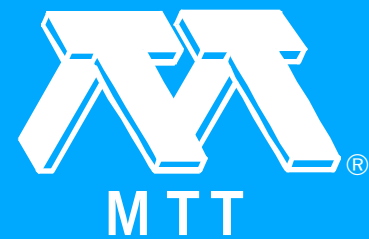
## The Use of Side Wall Images to Compute Package Effects in MoM Analysis of MMIC Circuits

*R.W. Jackson. "The Use of Side Wall Images to Compute Package Effects in MoM Analysis of MMIC Circuits." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 406-414.*

A novel formulation is presented for the method of moments solution of shielded, enclosed microstrip MMIC circuits. The technique involves first computing a circuit's mutual impedance characteristics with no lateral enclosure and then adding a correcting term resulting from the images introduced by lateral side walls. The method is especially useful for determining the impact of low Q package resonances in very large packages. Large lateral enclosure size does not degrade the efficiency of this technique. The importance of the TM/sub 0/ parallel plate mode in MMIC circuit coupling is emphasized.

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## Calibration Methods for Time Domain Network Analysis

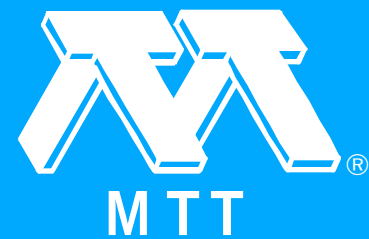
*L.A. Hayden and V.K. Tripathi. "Calibration Methods for Time Domain Network Analysis." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 415-420.*

Accurate calibration techniques for the characterization of general one-and two-port networks using Time Domain Reflection/Transmission (TDR/T) measurements are presented. Simple one-port open-short-match corrections formulated in reference are generalized for three arbitrary known loads and extended to the two-port case. Known general frequency-domain techniques are shown to be directly applicable to the time-domain measurements including the use of redundancy to reduce the number of required calibration standards. A time-domain thru-matchshort method similar to the well known TRL method is presented. Examples of the measured results for typical one- and two-port devices are included and compared with Vector Network Analyzer measurements to validate the Time Domain Network Analysis algorithms.

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## The Influence of Finite Conductor Thickness and Conductivity on Fundamental and Higher-Order Modes in Miniature Hybrid MIC's (MHMIC's) and MMIC's

*K. Wu, R. Vahldieck, J.L. Fikart and H. Minkus. "The Influence of Finite Conductor Thickness and Conductivity on Fundamental and Higher-Order Modes in Miniature Hybrid MIC's (MHMIC's) and MMIC's." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 421-430.*

This paper presents a rigorous analysis of the effect of finite metallization thickness and finite conductivity on the propagation characteristics of conductor-backed CPW on thin substrate. A self-consistent approach is used together with the method of lines (MoL) to determine the propagation constant, losses and field distribution of the fundamental and first two higher-order modes in CPW's with finite metallization thickness and lossy backmetallization. The method used is general and can be applied to miniature MIC's (MHMIC) and MMIC's including lossy semiconductor substrate. It is shown that the onset of higher order modes limits the usable frequency range of conductor backed CPW. The analysis includes also microstrip transmission lines on thin substrate material. It is demonstrated that a resistive strip embedded into the microstrip groundplane may potentially be useful in the design of integrated planar attenuators.



## Current Sheet Applicators for Clinical Microwave Hyperthermia

*M.K. Gopal and T.C. Cetas. "Current Sheet Applicators for Clinical Microwave Hyperthermia." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 431-437.*

Current sheet applicators (CSAS) are light-weight, small size applicators intended to be operated in array configurations. Their radiative fields are induced by RF currents in a conducting sheet embedded a few millimeters below the dielectric covered aperture surface. In arrays, these elements can be used over breast lesions, for superficial head tumors, torso regions and other curved body sites where conformity to body curvatures is necessary. Our clinical prototypes are tuned to 434 MHz and have a bandwidth of almost 20 MHz, which accommodates the tuning and coupling changes due to site differences of the body, body movement and tissue heterogeneities. The relative insensitivity of these units to air bubbles in bolus and scar tissues are attractive clinical features. The inherent linear polarization allows easy visualization of the superposition of electric field vectors of each element of an array, as well as provides deeper penetration on curved surfaces due to the electric field vector addition in the medium. In the case of a large breast tumor, depth of heating of over 4 cm was achieved along the central axis of a 2x2 coherent array. Experimental evaluation of these elements, leading up to their clinical implementation, is described in detail along with the results of a clinical example.



# Abstracts

## Measurement and Modelling of Radiative Coupling in Oscillator Arrays

*R.A. York and R.C. Compton. "Measurement and Modelling of Radiative Coupling in Oscillator Arrays." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 438-444.*

Arrays of coupled oscillators can be used for power-combining at microwave and millimeter-wave frequencies, and have been successfully demonstrated with a variety of devices. Such arrays have also recently been mode-locked for pulse generation, and can be configured for phase-shifterless beam-scanning. The nonlinear theory of coupled-oscillator phase dynamics depends crucially on the parameters describing the coupling between oscillators. Methods for experimental characterization of these parameters are described here, and simple models are developed which reproduce the measurements quite well. The models apply to radiative coupling and the effects of external reflectors which are sometimes used for stabilization. The theory is verified with a two-oscillator system.



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## Accurate Conductor Q-Factor Resonator Placed in an MIC of Dielectric Environment

*R.K. Mongia and P. Bhartia. "Accurate Conductor Q-Factor Resonator Placed in an MIC of Dielectric Environment." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 445-449.*

The unloaded Q-factor of a dielectric resonator is degraded due to conductor loss when it is placed in an MIC environment. In this paper, we report approximate but quite accurate closed form expressions for the Q-factor due to conductor loss. The results obtained are in good agreement with those of rigorous numerical methods. The effect of geometrical parameters on the useful tuning range of the structure is studied. Finally, an explicit relationship between the resonant frequency sensitivity factors and the conductor Q-factor is derived,





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## Origin and Avoidance of Spurious Solutions in the Transverse Resonance Method

*H. Aubert, B. Souny and H. Baudrand. "Origin and Avoidance of Spurious Solutions in the Transverse Resonance Method." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 450-456.*

In the context of transverse resonance method, a criterion is established for the choice of trial functions introduced in Galerkin's method: this criterion allows to avoid the appearance of spurious solutions in the whole region of a propagation diagram and guarantees, at the same time, a good precision for the true solutions.

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## Analysis of a CPW on Electric and Magnetic Biaxial Substrate

*G. Maze-Merceur, S. Tedjini and J.-L. Bonnefoy. "Analysis of a CPW on Electric and Magnetic Biaxial Substrate." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 457-461.*

This paper deals with a new formulation of the Spectral Domain Technique (SDT) for the analysis of the general case of uniaxial/biaxial, electric/magnetic anisotropic multilayer planar structures. As an illustration of the capabilities of this formulation we apply it to the analysis of shielded CPW structures. The dispersive properties of the fundamental and higher order modes in various cases of electric/magnetic anisotropy as well as the induction electric and magnetic lines are calculated. Such results, and particularly the induction lines, may be used to predict the behaviour of the studied structure as well as to point out its sensitive geometrical and electrical parameters. Some general rules will be discussed which lead to a better understanding of the effect of anisotropy.

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# Abstracts

## Field Theoretical Computer-Aided Design of Rectangular and Circular Iris Coupled Rectangular or Circular Waveguide Cavity Filters

*U. Papziner and F. Arndt. "Field Theoretical Computer-Aided Design of Rectangular and Circular Iris Coupled Rectangular or Circular Waveguide Cavity Filters." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 462-471.*

The rigorous CAD of a class of rectangular and circular waveguide cavity-filters is described which are coupled by rectangular and/or circular irises. The design theory is based on the full wave mode-matching method for three key-building block elements (asymmetric rectangular double-step, asymmetric rectangular-to-circular and circular-to-circular waveguide junction) associated with the generalized S-matrix technique for the composite structures. The waveguide filters may be arbitrarily composed of the key-building block elements and the rectangular or circular waveguide sections between them. Finite iris thicknesses, higher order mode interactions, as well as asymmetric structures are rigorously taken into account. The theory is verified by measurements.



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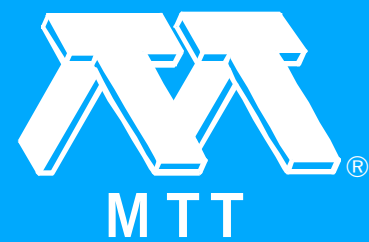
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## Full-Wave Analysis of Guiding Structures Using a 2-D Array of 3-D TLM Nodes

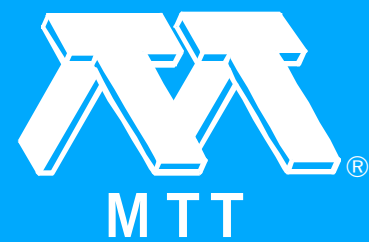
*H. Jin and R. Vahldieck. "Full-Wave Analysis of Guiding Structures Using a 2-D Array of 3-D TLM Nodes." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 472-477.*

This paper introduces a novel TLM approach to the full-wave analysis of guided wave structures. Instead of using real pulses as in the conventional TLM method, complex pulses are used in this new approach. Therefore a non-reciprocal phase shift in z-direction can be introduced which can be used to connect the z-arms in a 3-D node directly. As a result, the 3-D array of 3-D nodes, normally required in the TLM method to calculate the propagation and attenuation constant, is reduced to only one mesh unit in z-direction (2-D array of 3-D nodes). The propagation constant is determined by choosing a value and then calculating the frequency at which this value is valid from the Fourier Transform of the impulse response. Losses are found by computing the exponential decay of time harmonic solutions at the eigenfrequencies of the structure.

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## Full-Wave Boundary Integral Equation Method for Suspended Planar Transmission Lines with Pedestals and Finite Metallization Thickness

*L. Zhu and E. Yamashita. "Full-Wave Boundary Integral Equation Method for Suspended Planar Transmission Lines with Pedestals and Finite Metallization Thickness." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 478-483.*

A new boundary integral equation method is proposed for the full-wave analysis of suspended planar transmission lines with pedestals and/or finite metallization thickness. Coupled boundary integral equations are formulated on the equivalent magnetic currents only on the apertures of subregions using the Green's identity of the second kind. Because it is possible to take a large number of terms in the series expansion of Green's functions in each subregion independently from the order of resulting matrices, this approach can avoid the relative convergence problem. Numerical results of the present method on suspended coplanar waveguides are found to have a stable convergent property and to be in excellent agreement with other available theoretical results. Numerical data reveal the effects of conductor thickness and aperture width on the transmission properties of suspended planar transmission lines with pedestals.

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## Recurrence Modal Analysis for Multiple Waveguide Discontinuities and its Application to Circular Structures

*G.A. Gesell and I.R. Ciric. "Recurrence Modal Analysis for Multiple Waveguide Discontinuities and its Application to Circular Structures." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 484-490.*

A general formulation for the scattering from multiple waveguide discontinuities is presented. It is based on the modal analysis technique where the corresponding fields are expanded in terms of vector eigenfunctions and the boundary conditions are imposed at each junction. Analytic expressions for the global scattering matrices are derived using a recurrence procedure that requires substantially less computation than the traditional cascading techniques. The matrix equations are truncated in a manner that satisfies the conditions for a good overall convergence, which is illustrated for step-discontinuities in circular waveguides. Numerical results are presented for a thick iris in a circular waveguide and for iris matched dielectric window designs.

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# Abstracts

## Hybrid-Mode Analysis of Planar Transmission Lines with Arbitrary Metallization Cross Sections

Z. Ma, E. Yamashita and S. Xu. "Hybrid-Mode Analysis of Planar Transmission Lines with Arbitrary Metallization Cross Sections." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 491-497.

The problem of planar transmission lines of arbitrary metallization cross sections is solved by using the generalized transverse resonance technique combined with the mode-matching procedure. Analyses are carried out on the dispersion characteristics of microstrip lines, finlines and coplanar waveguides with trapezoidal strip cross sections. Numerical results verify the versatility and accuracy of this method, and show that the profiles of the metallizations in miniaturized MMIC guiding structures give marked effects on the transmission properties.



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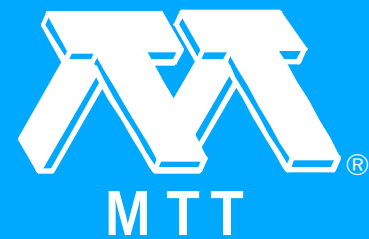
## Efficient Computation of the Periodic Green's Function in Layered Dielectric Media

*R.M. Shubair and Y.L. Chow. "Efficient Computation of the Periodic Green's Function in Layered Dielectric Media." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 498-502.*

This paper presents a novel technique for the efficient computation of the periodic Green's function in layered dielectric media. The technique is based upon expanding the spectral Green's function into a finite number of inverse-transformable complex exponential functions. This enables the use of Poisson's summation formula to express the periodic Green's function as a combined sum of spectral terms and spatial terms each set of which is rapidly convergent. Numerical results are obtained for the "on-plane" case, in which the direct summation of the series converges extremely slowly. Using the accelerated summation formula of this paper, a computation time reduction of 160 fold is obtained. The proposed technique is useful as it can be applied to a wide class of problems where periodic structures are to be modeled.

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## Choices of Expansion and Testing Functions for the Method of Moments Applied to a Class of Electromagnetic Problems

*M.I. Aksun and R. Mittra. "Choices of Expansion and Testing Functions for the Method of Moments Applied to a Class of Electromagnetic Problems." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 503-509.*

It is well known that the choice of expansion and testing functions plays an important role in determining the rate of convergence of the integrals associated with the moment method matrix, and that an improper choice can lead to erroneous results. The main objective of this paper is to critically examine this convergence issue and to provide criteria for the choice of these expansion and testing functions. The question of whether these functions need to satisfy the Holder condition is also investigated and the convergence behavior of the integrals involved in the spatial and spectral domain moment method is discussed for some representative expansion and testing functions.

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# Abstracts

## The Three-Dimensional Algorithm of Solving the Electric Field Integral Equation Using Face-Centered Node Points, Conjugate Gradient Method, and FFT

C.-C. Su. "The Three-Dimensional Algorithm of Solving the Electric Field Integral Equation Using Face-Centered Node Points, Conjugate Gradient Method, and FFT." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 510-515.

It has been known for a long time that the accuracy of solving the scattering by a dielectric body using the electric field integral equation (EFIE) is poor when the permittivity of the scatterer becomes large. Recently, such a trouble has been settled by using a procedure involving face-centered node points. Such a procedure is efficient, since it preserves the convolution property in the EFIE and, hence, the applicability of the fast Fourier transform. In this investigation we generalize this procedure to the three-dimensional and anisotropic case. The generalization is quite straight in both the formulation and the programming. A calculation for a scatterer with a relative permittivity of as high as 100 indicates that the proposed procedure converges quite rapidly, while the conventional approach fails to converge in using the conjugate gradient method.



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# Abstracts

## Analysis of a General Coaxial-Line/Radial-Line Region Junction (Short Papers)

*R.B. Keam and A.G. Williamson. "Analysis of a General Coaxial-Line/Radial-Line Region Junction (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 516-520.*

A general analysis of a coaxial line/radial-line region junction is presented for the case where the centre conductor is sheathed in a dielectric and extends the full width between two parallel metal plates. Expressions for the current distribution and the admittance of the junction are presented. Two example environments are considered, a rectangular waveguide and a base entrant cylindrical cavity, although the technique may be used for other environments. Comparison of theoretical and experimental results for these two cases show the theory to be very accurate.



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## A Rigorous Analysis of a Shielded Microstrip Asymmetric Step Discontinuity (Short Papers)

*C.N. Capsalis, N.K. Uzunoglu, C.P. Chronopoulos and Y.D. Sigourou. "A Rigorous Analysis of a Shielded Microstrip Asymmetric Step Discontinuity (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 520-523.*

In this paper microstrip asymmetric step discontinuities are analyzed using a mode-matching technique leading to the frequency-dependent characteristics of the structure. On both sides of the discontinuity the fields are expanded in terms of the normal even and odd hybrid modes of shielded microstrip lines, taking into account not only the propagating modes but also higher order even and odd modes, which are evanescent-type waves. The propagation constants of the even and odd hybrid modes are computed using a previously developed method. Then a mode-matching technique is applied in order to obtain the reflection and transmission coefficients of the discontinuity. Numerical results are also given for several asymmetric step discontinuities.

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## Semi-Discrete Finite Element Analysis of Zero-Thickness Inductive Strips in a Rectangular Waveguide (Short Papers)

*D. Crawford and M. Davidovitz. "Semi-Discrete Finite Element Analysis of Zero-Thickness Inductive Strips in a Rectangular Waveguide (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 523-527.*

A semi-discrete finite element method is applied to determine the network parameters for zero-thickness inductive discontinuities in a rectangular guide. The solution obtained is computationally efficient and is applicable under multi-mode conditions. Moreover, after obtaining the solution for a given geometry at a specific frequency, further frequency analysis for the same geometry requires only nominal additional recalculation. Convergence properties of the solution are studied and comparison with published data is carried out to verify the solution accuracy.

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# Abstracts

## Accurate and Efficient Computation of Dielectric Losses in Multi-Level, Multi-Conductor Microstrip for CAD Applications (Short Papers)

*J.P.K. Gilb and C.A. Balanis. "Accurate and Efficient Computation of Dielectric Losses in Multi-Level, Multi-Conductor Microstrip for CAD Applications (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 527-530.*

Accurate and efficient computation of dielectric losses in complex microstrip structures is important in the computer-aided design of microwave and millimeter-wave integrated circuits. The proposed approach can be used in lieu of lossy, full-wave solutions to provide accurate and efficient data for the CAD of multi-level, multi-conductor MIC and MMIC structures. This new application gives results that are as accurate as lossy full-wave techniques over a wide range of frequencies, including the dispersive region. In addition to providing accurate results, this method is up to three times faster, depending on the number and type of substrates or superstrates. Results are shown for various multi-conductor, multi-level structures which compare well with the lossy, full-wave approach and require significantly less computer time.



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# Abstracts

## Analysis of Nonlinear Termination Networks for Coupled Lossy and Dispersive Transmission Lines (Short Papers)

*G.W. Pan, G. Wang and B.K. Gilbert. "Analysis of Nonlinear Termination Networks for Coupled Lossy and Dispersive Transmission Lines (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 531-535.*

Based upon an algorithm described in a separate paper, multiple transmission lines with skin effect losses and dispersive characteristics were analyzed by the volume equivalent principle, and the scattering matrix  $[S(\omega)]$  and characteristic impedance matrix  $[Z_0(\omega)]$  of the transmission lines were obtained. The  $[S(\omega)]$  and  $[Z_0(\omega)]$  were then transformed by the inverse FFT into the time domain. The scattering matrix representation is multiplicative in nature, which leads to the time domain formulation as a set of convolution integrals. Instead of attempting to solve a set of coupled convolution integral equations by the multivariable Newton-Raphson method, which may occasionally be unstable, we generated a set of object functions and applied a multivariable optimization technique, referred to as the modified Levenberg-Marquardt algorithm, to attain the solutions. The new method, which is quite general, reduces to the special cases derived in many previous publications.



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## Complete Eigenvalue Analysis of Inhomogeneously Dielectric Loaded Two Conductor Guiding Structures (Short Papers)

*M.Z. Mohamed and J.M. Jarem. "Complete Eigenvalue Analysis of Inhomogeneously Dielectric Loaded Two Conductor Guiding Structures (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 536-539.*

A complete full-wave eigenvalue analysis is presented for inhomogeneously filled guiding structures that support TEM mode. The analysis is based on treating the transverse inhomogeneity of the filling dielectric as a polarization current that excites the corresponding empty guiding system. The problem is formulated to determine the quasi-TEM and higher order modes of the system. The mode propagation constants squared appear as eigenvalues of the problem, and the corresponding eigenvectors represent the expansion coefficients of the field modes. The strength of the formulation is verified by its application to the problem of the partially dielectric-filled parallel-plate waveguide. The results of the analysis are compared to the exact solution and a variational solution. The quasi-TEM mode variation versus permittivity and frequency variation is studied. The convergence and dispersion characteristics of the method are presented.

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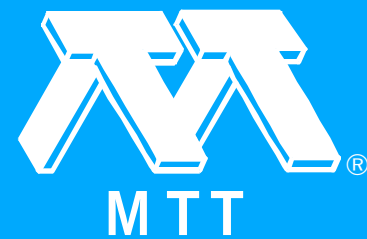


# Abstracts

## An Efficient Numerical Procedure Using the Shifted Power Method for Analyzing Dielectric Waveguides Without Inverting Matrices (Short Papers)

C.-C. Su. "An Efficient Numerical Procedure Using the Shifted Power Method for Analyzing Dielectric Waveguides Without Inverting Matrices (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 539-542.

A numerical procedure using the finite-difference scheme and the shifted power method is used to analyze the propagation characteristics of dielectric waveguides. The unique feature of this procedure is that in determining the eigenvalues corresponding to dominant modes no operation as costly as matrix inversion, such as Gaussian elimination, LU decomposition, or tridiagonalization, is invoked. So the proposed procedure is rather efficient in both memory space and computer time. Numerical results of a circular step-index fiber are presented for comparison. Due to its efficiency, the proposed procedure is capable of analyzing coupled waveguides.



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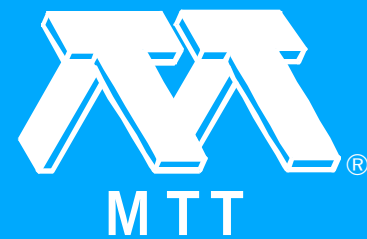


# Abstracts

## An Analytical Two-Dimensional Perturbation Method to Model Submicron GaAs MESFET's (Comments and Authors' Reply)

*N. Kukreja, R.S. Gupta, E. Donkor and F.C. Jain. "An Analytical Two-Dimensional Perturbation Method to Model Submicron GaAs MESFET's (Comments and Authors' Reply)." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 543-544.*

Using a two-dimensional perturbation method for GaAs MESFET's, the authors of the above paper, conclude that in the perturbed case, there is an increase in channel potential with channel position (along x-axis) by around 70 percent towards the drain end of the channel as compared to unperturbed case. However, their contention is contradicted by the relation in their paper which shows that at  $x = 0$  and  $x = L_g$ , the potential for the perturbed and unperturbed case is the same. Also, the model is valid till the linear regime and not in the saturation regime, as has been pointed out in the following text.



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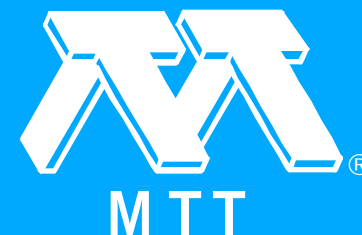
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# Abstracts

## Call for Papers - Filters and Passive Components (Mar. 1993 [T-MTT])

*"Call for Papers - Filters and Passive Components (Mar. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 546-546.*



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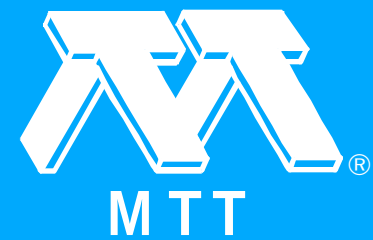
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# Abstracts

## Information for Authors (Mar. 1993 [T-MTT])

*"Information for Authors (Mar. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 547-547.*



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*"Ask IEEE (Advertisement) (Mar. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.3 (Mar. 1993 [T-MTT]): 548-548.*



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## Front Cover (Apr. 1993 [T-MTT])

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*"Front Cover (Apr. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): f1-f1.*



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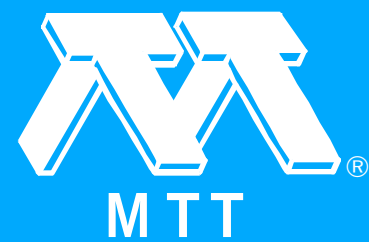
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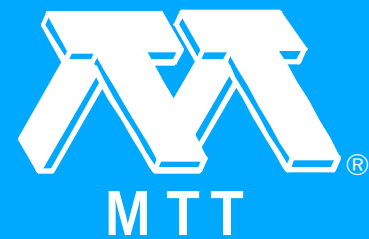
## New Approach to the Design and the Fabrication of THz Schottky Barrier Diodes

*A. Jelenski, A. Grub, V. Krozer and H.L. Hartnagel. "New Approach to the Design and the Fabrication of THz Schottky Barrier Diodes." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 549-557.*

GaAs Schottky barrier diodes with near-ideal electrical and noise characteristics for mixing applications in the THz frequency range are described. The conventional formulas describing these characteristics are valid only in a limited forward bias range, corresponding to currents much smaller than the operating currents under submillimeter mixing conditions. Therefore, generalized analytical expressions for the I-V and C-V characteristics of the metal-semiconductor junction in the full bias range are given. A new numerical diode model is presented which takes into account not only the phenomena occurring at the junction, such as current dependent recombination and drift/diffusion velocities, but also the variations of electron mobility and electron temperature in the undepleted epi-layer. A diode fabrication process based on the electrolytic pulse etching of GaAs in combination with an in situ platinum plating for the formation of the Schottky contacts is described. Schottky barrier diodes with a diameter of 1  $\mu\text{m}$  fabricated by this process have already shown excellent results in a 650 GHz waveguide mixer at room temperature. A DSB conversion loss of 7.5 dB and a DSB mixer noise temperature of less than 2000K have been obtained at an intermediate frequency of 4 GHz. The noise and I-V characteristics of Schottky diodes with a smaller diameter of 0.8  $\mu\text{m}$  are presented. The measured noise and I-V characteristics of these diodes show an excellent agreement with calculated values, confirming the validity of the proposed model.

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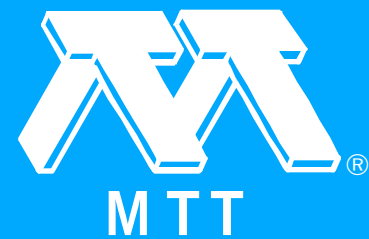
## An 86-106 GHz Quasi-Integrated Low Noise Schottky Receiver

*W.Y. Ali-Ahmad, W.L. Bishop, T.W. Crowe and G.M. Rebeiz. "An 86-106 GHz Quasi-Integrated Low Noise Schottky Receiver." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 558-564.*

An integrated planar receiver has been developed and tested over the 82-112 GHz bandwidth. The quasi-integrated antenna used in the receiver has a high gain, a high Gaussian coupling efficiency and a wide bandwidth. The novel mixer design consists of a planar GaAs Schottky diode placed at the feed of a dipole-probe suspended inside an integrated horn antenna. The diode uses an etched surface channel and a planar air bridge for reduced parasitic capacitance. At 92 GHz, the room temperature antenna-mixer exhibits a double sideband conversion loss and noise temperature of  $5.5 \pm 0.5$  dB and  $770 \text{ K} \pm 50 \text{ K}$ , respectively. The measured DSB conversion loss and noise temperature over a 20 GHz bandwidth (86 GHz-106 GHz) remain less than  $6.2 \text{ dB} \pm 0.5 \text{ dB}$  and  $1000 \text{ K} \pm 50 \text{ K}$ , respectively. The low cost of fabrication and simplicity of the design makes it ideal for millimeter- and submillimeter-wave receivers.

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## Cooled Schottky Varactor Frequency Multipliers at Submillimeter Wavelengths

*J.T. Louhi, A.V. Raisanen and N.R. Erickson. "Cooled Schottky Varactor Frequency Multipliers at Submillimeter Wavelengths." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 565-571.*

The efficiency of a Schottky varactor frequency multiplier at submillimeter wavelengths can be increased by cooling the diode. The main reason for better efficiency is the increased mobility of the free carriers. Because of that the series resistance decreases and the efficiency can be expected to increase as much as a few dB at low input power levels. At high output frequencies and at high power levels the efficiency of the multiplication is decreased by the current saturation, because the junction capacitance cannot be pumped effectively. When the diode is cooled the maximum current of the diode increases and much more output power can be expected. There are also slight changes in the I-V characteristic and in the diode junction capacitance, but they have a negligible effect on the efficiency of the multiplier. The theoretical maximum output power at near 1 THz is calculated to increase by about 10 dB from 50  $\mu$ W to 500  $\mu$ W, when the multiplier chain is cooled to 77 K. However, cooling to 77 K is not necessary, because considerable improvement in the efficiency may be achieved by cooling to 150 K, readily available in space by passive cooling.

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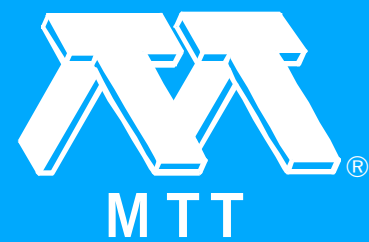
## Single Barrier Varactors for Submillimeter Wave Power Generation

*S.M. Nilsen, H. Gronqvist, H. Hjelmgren, A. Rydberg and E.L. Kollberg. "Single Barrier Varactors for Submillimeter Wave Power Generation." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 572-580.*

Theoretical work on Single Barrier Varactor (SBV) diodes indicates that the efficiency of a tripler with a SBV diode has a maximum for a considerably smaller capacitance variation than previously thought. SBV diodes based on GaAs, InGaAs and InAs have been fabricated, and their dc properties have been tested. Detailed modelling of the carrier transport properties of the SBV device is carried out in two steps. First, the semiconductor transport equations are solved simultaneously using a finite difference scheme in one dimension. Secondly, the calculated IV-, and CV characteristics are used by a multiplier simulator to calculate the optimum impedances, and output powers at the frequencies of interest. We have developed an analysis technique which complements the harmonic balance technique. Finally, simulations for a case study of a 750 GHz multiplier show that InAs diodes perform favorably compared to GaAs diodes.

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## Wide-Bandwidth Electron Bolometric Mixers: A 2DEG Prototype and Potential for Low-Noise THz Receivers

J.-X. Yang, F. Agahi, D. Dai, C.F. Musante, W. Grammer, K.M. Lau and K.S. Yngvesson.  
*"Wide-Bandwidth Electron Bolometric Mixers: A 2DEG Prototype and Potential for Low-Noise THz Receivers." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 581-589.*

This paper presents a new type of electron bolometric ("hot electron") mixer. We have demonstrated a three order of magnitude improvement in the bandwidth compared with previously known types of electron bolometric mixers, by using the two-dimensional electron gas (2DEG) medium at the hetero-interface between AlGaAs and GaAs. We have tested both in-house MOCVD-grown material, and MBE material, with similar results. The conversion loss ( $L_{\text{sub } c}$ ) at 94 GHz is presently 18 dB for a mixer operating at 20 K, and calculations indicate that  $L_{\text{sub } c}$  can be decreased to about 10 dB in future devices. Calculated and measured curves of  $L_{\text{sub } c}$  versus  $P_{\text{sub LO}}$ , and  $I_{\text{sub DC}}$ , respectively, agree well. We argue that there are several different configurations of electron bolometric mixers, which will all show wide bandwidth, and that these devices are likely to become important as low-noise THz receivers in the future.

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## Embedding Impedance Approximations in the Analysis of SIS Mixers

A.R. Kerr, S.-K. Pan and S. Withington. "Embedding Impedance Approximations in the Analysis of SIS Mixers." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 590-594.

Tucker's quantum theory of mixers is the basis for almost all analysis and design of SIS (Superconductor-Insulator-Superconductor) mixers. This paper examines the adequacy of three approximations to Tucker's theory: (i) the usual three-frequency approximation which assumes a sinusoidal LO voltage at the junction, and a short-circuit at all frequencies above the upper sideband, (ii) a five-frequency approximation which allows two LO voltage harmonics and five small-signal sidebands, and (iii) a quasi five-frequency approximation in which five small-signal sidebands are allowed, but the LO voltage is assumed sinusoidal. These are compared with a full harmonic-Newton solution of Tucker's equations, including eight LO harmonics and their corresponding sidebands, for realistic SIS mixer circuits. It is shown that the accuracy of the three approximations depends strongly on the value of  $\omega R / \hbar C$  for the SIS junctions used. For large  $\omega R / \hbar C$ , all three approximations approach the eight-harmonic solution. For  $\omega R / \hbar C$  values in the range 0.5 to 10, the range of most practical interest, the quasi five-frequency approximation is a considerable improvement over the three-frequency approximation, and should be suitable for much design work. For the realistic SIS mixers considered here, the five-frequency approximation gives results very close to those of the eight-harmonic solution.



# Abstracts

## A 200 GHz Tripler Using a Single Barrier Varactor

*D. Choudhury, M.A. Frerking and P.D. Batelaan. "A 200 GHz Tripler Using a Single Barrier Varactor." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 595-599.*

In this paper, we present results for a tripler to 200 GHz using a single barrier varactor (SBV). The performance of the tripler, over an output frequency range from 186 to 207 GHz, has been measured in a crossed waveguide mount. The theoretical performance of the device and the tripler mount have been calculated using large signal analysis. An overall efficiency of 2% was achieved with efficiency at the device of above 5%. A comparison of theoretical and measured results and a discussion of various losses in the mount and the varactor are presented.



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## Optimum Source Conductance for High Frequency Superconducting Quasiparticle Receivers

*Q. Ke and M.J. Feldman. "Optimum Source Conductance for High Frequency Superconducting Quasiparticle Receivers." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 600-604.*

We have used the quantum theory of mixing for extensive numerical calculations to determine the mixer source conductance  $G_{\text{sub } s/}$ , required to optimize a superconductor-insulator-superconductor (SIS) quasiparticle heterodyne receiver. The optimum  $G_{\text{sub } s/}$  matches an empirical formula which can be understood by a simple derivation. Previous work indicated that  $G_{\text{sub } s/}$  should vary inversely with frequency, and this implies that the critical current density of SIS junctions used for mixing should increase as frequency squared, a stringent constraint on the design of submillimeter SIS mixers. On the contrary, we find that  $G_{\text{sub } s/}$  is more weakly dependent upon frequency, and we discuss the implications for the design of submillimeter SIS mixers.



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## Evaluation of Integrated Tuning Elements with SIS Devices

*M.M.T.M. Dierichs, C.E. Honingh, R.A. Panhuyzen, B.J. Feenstra, A. Skalare, J.J. Wijnbergen, H.v.d. Stadt and T. de Graauw. "Evaluation of Integrated Tuning Elements with SIS Devices." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 605-608.*

The resonances of integrated tuning stubs in combination with SIS detectors are measured and calculated. The predicted resonances are compared with measurements of stubs integrated with Nb/Al/sub 2/O/sub 3/Nb junctions in a log-periodic antenna. Stubs of different lengths have been investigated on different substrates (on 200  $\mu\text{m}$  thick quartz and on a 7  $\mu\text{m}$  thick silicon membrane) and the results show a fairly good agreement with the model calculations. Quartz substrates showed resonances up to 640 GHz, while for silicon membranes stub resonances reach up to as 480 GHz. An observed resonance at 560 GHz is probably a substrate effect from the membrane. The gap frequency for all the samples is 670 GHz and no resonances are detected above this frequency. Up to the maximum detected frequency dispersion is found to be negligible.





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## A Planar Quasi-Optical SIS Receiver

*P.A. Stimson, R.J. Dengler, H.G. LeDuc, S.R. Cypher and P.H. Siegel. "A Planar Quasi-Optical SIS Receiver." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 609-615.*

A novel planar, quasi-optical SIS receiver operating at 230 GHz is described. The receiver consists of a 2 x 5 array of half wave dipole antennas with niobium-aluminum oxide-niobium SIS junctions on a quartz dielectric-filled parabola. The 1.4 GHz intermediate frequency is coupled from the mixer via coplanar strip transmission lines and 4:1 balun transformers. The receiver is operated at 4.2 K in a liquid helium immersion cryostat. We report here accurate measurements of the performance of single untuned array receiver elements. A mixer noise temperature of 89 K DSB, receiver noise temperature of 156 K DSB and conversion loss of 8 dB into a matched load have been obtained. This mixer noise temperature is approximately a factor of two larger than that of current state of the art waveguide mixers using untuned single junctions at the same frequency.

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## Performance of a Two-Junction Array SIS-Mixer Operating Around 345 GHz

*C.E. Honingh, G. de Lange, M.M.T.M. Dierichs, H.H.A. Schaeffer, T. de Graauw and T.M. Klapwijk. "Performance of a Two-Junction Array SIS-Mixer Operating Around 345 GHz." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 616-623.*

We have made a detailed study of the gain and noise of a SIS heterodyne receiver at 345 GHz. As mixing element we use an array of two Nb-Al/sub 2/O/ sub 3/-Nb SIS junctions in series. The array is operated in a waveguide mount with a backshort and an E-plane tuner. The best receiver noise temperature achieved is 140 K DSB. The embedding impedances were determined by fitting theory to the measured pumped curves. High-quality fits are obtained which constitute the first detailed test of the Tucker-theory at frequencies above 300 GHz. The impedances found by this method are in very good agreement with impedances measured in a scale model at 3.3 GHz. From these embedding impedances gain and noise of the mixer were calculated over a full bias range using the Tucker theory in the three-port low IF approximation. The calculated values are compared to mixer gain and noise as obtained from receiver measurements. The observed dependence of mixer gain and noise on bias voltage, pump power and embedding impedance is in good agreement with theory. However the absolute value of the measured gain is a factor  $.45 \pm 0.05$  lower than calculated. The measured mixer noise is approximately two quanta,  $38 \pm 10$  K, higher than calculated. These discrepancies appear to be independent of the bias parameters of the mixer.





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## A Traveling-Wave High Electron Mobility Transistor

*M.B. Anand, P.K. Ghosh, P.G. Kornreich and D.J. Nicholson. "A Traveling-Wave High Electron Mobility Transistor." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 624-631.*

A traveling-wave high electron mobility transistor (THEMT) is proposed. The proposed device is unique in that it includes an integral distributed load resistor and that it uses a high electron mobility transistor as the active device. A rigorous analysis of the device is carried out, using a small-signal equivalent circuit model for an incremental section of the device. Losses and reflected waves are not neglected, as has been done in other work. Treating the device as a 4-port network, closed-form expressions for S-parameters are derived, we believe for the first time. Theoretical calculations using equivalent circuit parameter values of a HEMT reported in the literature, show that the proposed device is capable of exponential increase in gain with device width. Power gain of more than 10 dB at 50 GHz and remarkably flat response in the frequency range 10 GHz to 100 GHz are shown to be achievable for a 1 mm wide device.

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## Approximate Approach to the Design of Shielded Dielectric Disk Resonators with Whispering-Gallery Modes

*E.N. Ivanov, D.G. Blair and V.I. Kalinichev. "Approximate Approach to the Design of Shielded Dielectric Disk Resonators with Whispering-Gallery Modes." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 632-638.*

An analytical method is presented for calculating the resonant frequency and the Q-factor of shielded dielectric disk resonators excited in whispering-gallery modes. The method is based on a single-mode representation of electromagnetic fields in partial regions of the resonator. For high order modes with high degree of energy concentration in the dielectric this method gives a good agreement with experimental results obtained for different sapphire disks at both room temperature and cryogenic temperatures.

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# Abstracts

## A Small Dielectric TEM Mode Resonator with a Crossing Slot and its Application to a Cellular Radio VCO

*T. Uwano. "A Small Dielectric TEM Mode Resonator with a Crossing Slot and its Application to a Cellular Radio VCO." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 639-646.*

A small TEM mode dielectric resonator which has a new feature with a crossing slot on the outer ground conductor plane is presented. The slot, functioning as a short-ended stub line serially inserted into the transmission line, can tune the resonant frequency down. The resonant frequency in a stripline resonator structure is rigorously analyzed by the method based on the Spectral Domain Approach, and hence the equivalent circuit is derived. This resonator is applied to a cellular radio VCO with a varactor connected across the slot. The performance of the VCO in the 900 MHz cellular band is described.



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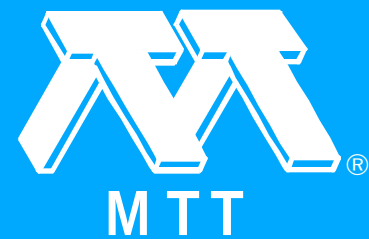
## Full-Wave Analysis of a Transversely Magnetized Ferrite Nonradiative Dielectric Waveguide

A.C. Cesar and R.F. Souza. "Full-Wave Analysis of a Transversely Magnetized Ferrite Nonradiative Dielectric Waveguide." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 647-651.

A full-wave analysis is applied to a nonradiative dielectric waveguide where the isotropic dielectric slab is replaced by a transversely magnetized ferrite. The characteristic equation is obtained and the corresponding effects are discussed. The above structure exhibits reciprocal propagation characteristics. Nonreciprocal effects are also possible with a proper dielectric loading. Several numerical results are presented in the form of dispersion curves and operational diagram, as function of several ferrite and guide parameters. Electronically tuned and nonreciprocal devices can be implemented using this simple structure.

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## Scattering Parameters Measurement of a Nonreciprocal Coupling Structure

*P. Kwan and C. Vittoria. "Scattering Parameters Measurement of a Nonreciprocal Coupling Structure." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 652-657.*

A novel ferrite image guide was designed and tested from 26.5 to 40 GHz. The nonreciprocal structure consisted of two dielectric image guides separated by a ferrite slab. M-type hexagonal ferrite was used with its C-axis oriented parallel and perpendicular to the direction of propagation. Electromagnetic scattering S -parameters of the device were measured for a nonuniform external biasing magnetic field applied parallel to the C-axis of the ferrite slab. Nonreciprocal effects were observed for all cases considered above. Our results implied applications for ferrite devices operating at millimeter wavelength frequencies, such as: isolators, filters, modulators, switches, phase shifter etc.

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## A Frequency-Dependent Finite-Difference Time-Domain Formulation for General Dispersive Media

*O.P. Gandhi, B.-Q. Gao and J.-Y. Chen. "A Frequency-Dependent Finite-Difference Time-Domain Formulation for General Dispersive Media." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 658-665.*

A weakness of the finite-difference time-domain (FDTD) method is that dispersion of the dielectric properties of the scattering/absorbing body is often ignored and frequency-independent properties are generally taken. While this is not a disadvantage for CW or narrow-band irradiation, the results thus obtained may be highly erroneous for short pulses where ultrawide bandwidths are involved. In some recent publications, procedures based on a convolution integral describing  $D(t)$  in terms of  $E(t)$  are given for media for which the complex permittivity  $\epsilon^*(\omega)$  may be described by a single-order Debye relaxation equation or a modified version thereof. Procedures are, however, needed for general dispersive media for which  $\epsilon^*(\omega)$  and  $\mu^*(\omega)$  may be expressible in terms of rational functions, or for human tissues where multiterm Debye relaxation equations must generally be used. We describe a new differential equation approach, which can be used for general dispersive media. In this method  $D(t)$  is expressed in terms of  $E(t)$  by means of a differential equation involving  $D$ ,  $E$ , and their time derivatives. The method is illustrated by means of one- and three-dimensional examples of media for which  $\epsilon^*(\omega)$  is given by a multiterm Debye equation, and for an approximate two-thirds muscle-equivalent model of the human body.



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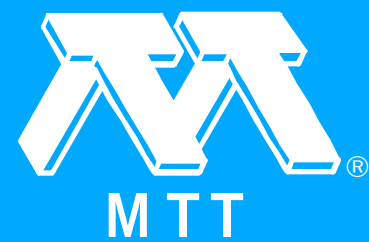
## End-Effects in Quasi-TEM Transmission Lines

*W.J. Getsinger. "End-Effects in Quasi-TEM Transmission Lines." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 666-672.*

Magnetostatic analysis of a finite-length two-wire transmission line yields simple closed-form expressions for inductive end-fringing and interaction between ends. A further argument relates the results to capacitive end effects. Application to microstrip-like lines, twin-strip line and coplanar waveguide is outlined. It is demonstrated by explanation and comparison with the literature that these effects are the dominant discontinuity elements in short lengths of line, vias, resonators, bends, and other basic microwave configurations.

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## Dispersion Characteristics of Open and Shielded Microstrip Lines Under a Combined Principal Axes Rotation of Electrically and Magnetically Anisotropic Substrates

Y. Chen and B. Beker. "Dispersion Characteristics of Open and Shielded Microstrip Lines Under a Combined Principal Axes Rotation of Electrically and Magnetically Anisotropic Substrates." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 673-679.

This paper examines the dispersion properties of microstrip transmission lines whose substrate permittivity and permeability tensors are rotated simultaneously. The analysis takes into account both shielded and open structures, including both single and coupled microstrip line geometries. The spectral domain method is utilized to formulate the dyadic impedance Green's function, and Galerkin's method is applied to find the propagation constants. Numerical studies are performed when the angular difference between the principal axes of  $[\epsilon]$  and  $[\mu]$  tensors is fixed, but both are rotated from 0 to 90 degrees. The dispersion characteristics for all structures are computed over a wide frequency band that ranges from 0.1 to 100 GHz. The study indicates that propagation properties of MICs with dielectrically and magnetically anisotropic substrates (such as composites) can be changed considerably by the misalignment of material and structure coordinates systems.

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# Abstracts

## Semi-Discrete Finite Element Method Analysis of Arbitrary Microstrip Elements--Static Solution

*M. Davidovitz and Z. Wu. "Semi-Discrete Finite Element Method Analysis of Arbitrary Microstrip Elements--Static Solution." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 680-686.*

The Semi-Discrete Finite Element Method is applied to solve the Poisson equation for a class of microstrip structures. This numerical technique is a variant of the conventional Finite Element Method. Its name stems from the fact that finite element approximation is implemented only along two of the Cartesian coordinates, while the solution dependence on the third is handled analytically. When applicable, this method is simpler and more economical than the conventional fully-discrete version. Convergence properties of the solution are examined, and its validity tested for a number of geometries through comparison with other solutions and published data.



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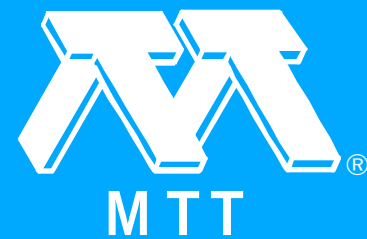


# Abstracts

## A Versatile Moment Method Solution of the Conventional and Modified Coplanar Waveguide T-Junctions

*A.A. Omar and Y.L. Chow. "A Versatile Moment Method Solution of the Conventional and Modified Coplanar Waveguide T-Junctions." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 687-692.*

The conventional and modified coplanar waveguide (CPW) T-junctions, both symmetric and nonsymmetric, are investigated using the full wave moment method with duality for the electric and magnetic currents. The method is shown to be accurate and computationally more efficient than the FDTD method previously used to solve these T-junctions. Our results show that the dispersion in the S -parameters of the different types of CPW T-junctions investigated can be minimized by a proper choice of the dimensions and locations of the air-bridges. The versatility of the method is demonstrated by its ability to solve complicated CPW structures with different types of air-bridges such as the modified CPW T-junction.



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## The Influence of Metallization Thickness on the Characteristics of Shielded of Cascaded Junction Discontinuities Coplanar Type Transmission Line

*T.-W. Huang and T. Itoh. "The Influence of Metallization Thickness on the Characteristics of Shielded of Cascaded Junction Discontinuities Coplanar Type Transmission Line." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 693-697.*

A full-wave analysis based on the mode-matching technique is applied to analyze cascaded junction discontinuities of coplanar type transmission lines, coplanar waveguide (CPW) and finline. Results for a CPW finline transition, a shielded CPW gap and a symmetric notch incorporating the finite metallization thickness effect are presented. The influence of metallization thickness on the coupling effect between cascaded junction discontinuities is also presented and discussed for the first time.



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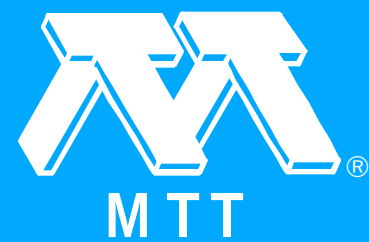
## Resonance of a Rectangular Microstrip Patch on a Uniaxial Substrate

*K.-L. Wong, J.-S. Row, C.-W. Kuo and K.-C. Huang. "Resonance of a Rectangular Microstrip Patch on a Uniaxial Substrate." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 698-701.*

Effects of uniaxial anisotropy in the substrate on the complex resonant frequency of the microstrip patch antenna are investigated in terms of an integral equation formulation. The complex resonant frequency of the microstrip patch antenna is calculated by using Galerkin's method in solving the integral equation. The sinusoidal functions are selected as the basis functions, which show fast numerical convergence. Numerical results also indicate that both the resonant frequency and the half-power bandwidth are increased due to the positive uniaxial anisotropy and, on the other hand, decreased due to the negative uniaxial anisotropy.

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## A Reciprocity Formulation for the EM Scattering by an Obstacle Within a Large Open Cavity

*P.H. Pathak and R.J. Burkholder. "A Reciprocity Formulation for the EM Scattering by an Obstacle Within a Large Open Cavity." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 702-707.*

A formulation based on a generalized reciprocity theorem is developed for analyzing the external high frequency EM scattering by a complex obstacle inside a relatively arbitrary open-ended waveguide cavity when it is illuminated by an external source. This formulation is also extended to include EM fields whose time dependence may be nonperiodic. A significant advantage of this formulation is that it allows one to break up the analysis into two independent parts; one deals with the waveguide cavity shape alone and the other with the obstacle alone. Thus, it is useful for independently estimating the scattering effects due to modifications in the waveguide cavity shape for a given type of large complex obstacle, and due to different types of complex obstacles for a given type of large open waveguide cavity shape, respectively, without requiring one to treat the entire configuration each time one of these is changed. The external scattered field produced by the obstacle (in the presence of the waveguide cavity structure) is given in terms of a generalized reciprocity integral over a surface  $ST$  corresponding to the interior waveguide cavity cross-section located conveniently but sufficiently close to the obstacle. Furthermore, the fields coupled into the cavity from the source in the exterior region generally need to propagate only one-way via the open front end (which is directly illuminated) to the interior surface  $ST$  in this approach, and not back, in order to find the external field scattered by the obstacle.

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## Concurrent Network Diakoptics for Electromagnetic Field Problems

*L.N. Merugu and V.F. Fusco. "Concurrent Network Diakoptics for Electromagnetic Field Problems." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 708-716.*

This paper presents a new modification to circuit based diakoptics equations which allows the efficient manipulation of equivalent circuit models which represent Maxwells equations. A new formulation of the diakoptics equations is given whereby torn subnetworks used to form the problem domain under consideration can be connected on a nearest neighbour basis. This formulation allows an algorithm to be written which is suitable for implementation on a parallel computer. In this work implementation is on a transputer array configured with two different topologies. The computational efficiency of each topology is appraised and considerable computational advantage demonstrated with respect to the classical sequential variant of the technique. The procedure is then applied to sample electromagnetic field problems in order to verify its utility. Finally it is used to compute the performance of a patch microstrip hybrid coupler.

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## 2 X 2 Quasi-Optical Power Combiner Array at 20 GHz (Special Section Short Papers)

*S. Kawasaki and T. Itoh. "2 X 2 Quasi-Optical Power Combiner Array at 20 GHz (Special Section Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 717-719.*

The design concept and the experimental results of a power combiner made of two FET oscillators for a quasi-optical array are reported. In order to demonstrate an approach by a quasi-optical method with a strongly coupled oscillator configuration, a 2 x 2 planar array is fabricated using a direct connection through a microstrip line. The input impedance of the slot radiator is taken into account as a circuit element to investigate the passive part of the array. In order to accomplish a sum radiation pattern, the length of the microstrip feed lines are regulated. At an operating frequency of 20 GHz, sum radiation patterns were observed in both the H-plane and the E-plane.

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## A Quasioptical Resonant-Tunneling-Diode Oscillator Operating Above 200 GHz (Special Section Short Papers)

*E.R. Brown, C.D. Parker, A.R. Calawa, M.J. Manfra and K.M. Molvar. "A Quasioptical Resonant-Tunneling-Diode Oscillator Operating Above 200 GHz (Special Section Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 720-722.*

A quasioptical resonant-tunneling-diode oscillator is demonstrated at frequencies above 200 GHz. The oscillator is stabilized by a semiconfocal open cavity. The maximum output power and the linewidth are approximately 50  $\mu$ W and 20 kHz, respectively, at a fundamental frequency of 210 GHz. By varying the cavity length, the oscillator frequency can be adjusted over a 0.4 GHz range in a repetitive manner. This behavior is explained by analogy with laser oscillators. The quasioptical RTD oscillator is well suited as a local oscillator for low-power radiometric mixers.





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## Determination of Schottky Diode Sampling Mixer Frequency Response from Diode Conductance Waveforms (Short Papers)

*G.G. Raleigh and J.V. Bellantoni. "Determination of Schottky Diode Sampling Mixer Frequency Response from Diode Conductance Waveforms (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 723-726.*

Conversion loss variations at microwave frequencies for Schottky diode harmonic sampling mixers are predicted from a time and frequency domain analysis of diode conductance waveforms. A circuit model for the mixer is used to find a nonlinear integral-differential equation governing the sampling mixer's time domain behavior. An iterative solution is used to determine the diode conductance waveform, whose fourier transform is the frequency response of the sampler. Experimental verification is given for three different values of sampling capacitors and two different sampling chamber delays over a 2 to 40 GHz range.

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## Parameter Extraction of Microwave Transistors Using a Hybrid Gradient Descent and Tree Annealing Approach (Short Papers)

*S.G. Skaggs, J. Gerber, G. Bilbro and M.B. Steer. "Parameter Extraction of Microwave Transistors Using a Hybrid Gradient Descent and Tree Annealing Approach (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 726-729.*

Tree annealing is a robust optimization scheme which can be used to find the "valleys" of an error surface. The problem of entrapment in local minima is not a factor with this type of optimization, however, it is much slower than gradient-based techniques. The method presented here attempts to take advantage of the speed of gradient-based methods and of the efficient pseudo-random searching abilities of tree annealing. The result is a technique which behaves as a directed multi-start gradient method. All minima encountered during optimization are recorded, thus providing alternatives in case of a non-physical final solution. The technique is used in the extraction of a modified Materka-Kacprzak model of a GaAs MESFET.

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# Abstracts

## Quasi-Static Analysis of Shielded Microstripline by a Modified Boundary Element Method (Short Papers)

*T.N. Chang and Y.T. Lin. "Quasi-Static Analysis of Shielded Microstripline by a Modified Boundary Element Method (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 729-731.*

This paper presents a modified boundary element method for analyzing the shielded microstrip-like structure. The boundary integral equations are derived via the Green's second identity with the adjoint fields chosen to satisfy the boundary conditions along the outside shielding conductor. Numerically, these result in a considerably reduced matrix size compared to that using free space Green's functions as the adjoint fields. The computation time for off-diagonal element of the matrix can be decreased by taking the Maclaurin series expansion forms of the infinite sums. Results for microstrip line are found in good agreement with those in the literature.



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## CAD of T-Septum Waveguide Evanescent-Mode Filters (Short Papers)

*V.A. Labay and J. Bornemann. "CAD of T-Septum Waveguide Evanescent-Mode Filters (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 731-733.*

This paper presents a mode-matching-based design of evanescent-mode waveguide filters with T-septum shaped metal inserts. Owing to the wideband characteristics of the T-septum waveguide, the proposed design constitutes a significant improvement over common evanescent-mode filters with respect to both size reduction and stopband behavior. The theoretical approach is verified at the example of a three-resonator 8.8.GHz filter prototype of less than 3/4 inch length. The second passband is beyond 27 GHz. Since the design procedure takes higher-order mode interactions into account, good agreement between theory and experiment is obtained over the entire measurement range between 8.2 and 40 GHz.

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## Asymptotic Analysis of Mode Transition in General Class of Circular Hollow Waveguides at the Infrared Frequency (Short Papers)

*Y. Kato and M. Miyagi. "Asymptotic Analysis of Mode Transition in General Class of Circular Hollow Waveguides at the Infrared Frequency (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 733-736.*

Correspondence between hybrid modes in small and large core circular hollow waveguides is discussed by using an asymptotic theory for the infrared. This mode changes or mode transitions in several hollow waveguides are discussed which depend on the cladding material and the mode order. For the dielectric-coated metallic waveguides, mode changes also depend on the thickness of the coated dielectric. For the singly cladded hollow waveguides, the region is shown in the plane of complex refractive index ( $n - jk$ ) of cladding material where the HE/sub 11/ mode in large core waveguides approaches the TE or TM mode.

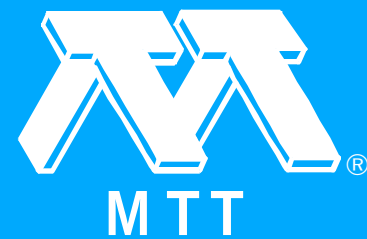


# Abstracts

## Finite Elements for Microwave Device Simulation: Application to Microwave Dielectric Resonator Filter (Comments and Authors' Reply)

*A. Abramowicz, S. Verdeyme and P. Guillon. "Finite Elements for Microwave Device Simulation: Application to Microwave Dielectric Resonator Filter (Comments and Authors' Reply)." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 737-738.*

In the above paper, an application of the finite element method to the computation of scattering parameters of dielectric resonator structures is presented. Existing possibilities of analyzing the whole filter structure (including input and output structures) seems to be the main advantage of the finite element method over other analysis methods. But presented results indicate that the accuracy of computation is the main problem in the finite element method. Two sections of the paper need close scrutiny.



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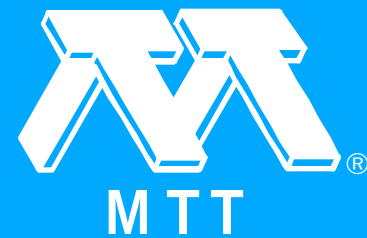
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## Moment Method Formulation of Thick Diaphragms in a Rectangular Waveguide (Corrections)

*A. Datta, B.N. Das and A. Chakraborty. "Moment Method Formulation of Thick Diaphragms in a Rectangular Waveguide (Corrections)." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 738-739.*

In the above paper, the following corrections should be made: 1) On page 592, the revised version of (1) should be...



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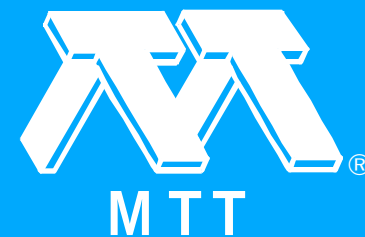
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## Call for Papers - Filters and Passive Components (Apr. 1993 [T-MTT])

*"Call for Papers - Filters and Passive Components (Apr. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 740-740.*



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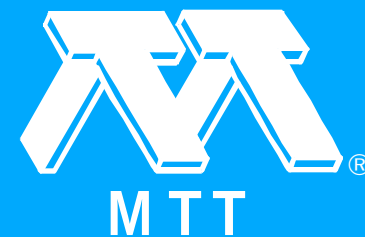
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## Call for Papers - 1993 IEEE GaAs IC Symposium (Apr. 1993 [T-MTT])

*"Call for Papers - 1993 IEEE GaAs IC Symposium (Apr. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 741-741.*



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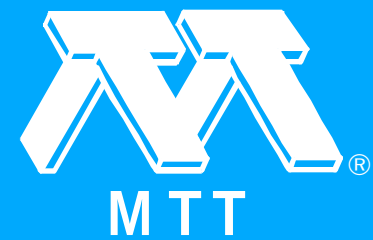
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*"Information for Authors (Apr. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 742-742.*



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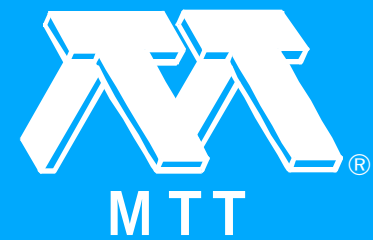




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*"Ask IEEE (Advertisement) (Apr. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.4 (Apr. 1993 [T-MTT]): 743-743.*



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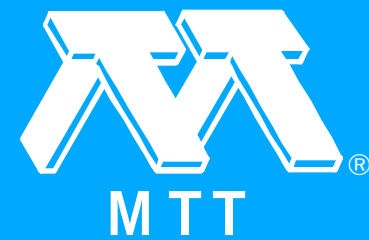
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*"Front Cover (May 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): f1-f1.*



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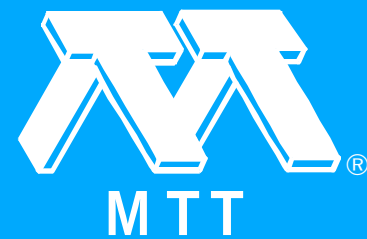


# Abstracts

## Design and Performance of Clock-Recovery GaAs ICs for High-Speed Optical Communication Systems

*Y. Imai, E. Sano, M. Nakamura, N. Ishihara, H. Kikuchi and T. Ono. "Design and Performance of Clock-Recovery GaAs ICs for High-Speed Optical Communication Systems." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 745-751.*

Design and performance of clock-recovery GaAs ICs are presented. Four kinds of ICs were developed: a limiting amplifier, a tuning amplifier, a rectifier, and a differentiator. The cascaded limiting amplifier together with a tuning amplifier achieved a 58-dB gain and a 10-degree phase deviation with 20dB input dynamic range at 10 GHz. A clock-recovery circuit successfully extracts a low-jitter 11-GHz clock signal of 1-dBm constant power from 10-Gb/s NRZ pseudorandom bit streams using a pulse pattern generator.



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## An AlGaAs/InGaAs Pseudomorphic High Electron Mobility Transistor with Improved Breakdown Voltage for X- and Ku-Band Power Applications

*J.C. Huang, G.S. Jackson, S. Shanfield, A. Platzker, P.K. Saldas and C. Weichert. "An AlGaAs/InGaAs Pseudomorphic High Electron Mobility Transistor with Improved Breakdown Voltage for X- and Ku-Band Power Applications." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 752-759.*

This work determined that RF drain current degradation is responsible for the poor power performance of wide-recessed PHEMT. A model based on surface states was proposed to explain this phenomenon, which then led to the use of charge-screen layers and a double-recessed gate process to suppress surface effects. Combined, these two modifications increased the device's gate-drain reverse breakdown voltage without causing a degradation in the transistor's RF drain current. This allowed the simultaneous achievement of high power-added efficiency and high power density which established a new performance record for power PHEMTs at X- and Ku-bands. Delay time analyses of single- and double-recessed PHEMTs revealed that the benefit of a larger breakdown voltage in the latter device design came at the cost of a larger drain delay time. Drain delay accounted for 45% of the total delay when the 0.35  $\mu\text{m}$ , double-recessed PHEMT was biased at  $V_{ds} = 6 \text{ V}$ .



## Varactor-Tunable Uniplanar Ring Resonators

*J.A. Navarro and K. Chang. "Varactor-Tunable Uniplanar Ring Resonators." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 760-766.*

In this paper, slotline and CPW ring resonators are introduced and integrated with varactor diodes to create electronically tunable uniplanar ring resonators. Varactors electronically tune the second resonant mode of the slotline ring over a 23% bandwidth from 3.03 to 3.83 GHz with a  $4.5 \pm 1.5$  dB variation in insertion loss. Similarly, a CPW ring resonator was tuned over a 22% bandwidth from 2.88 to 3.59 GHz. Both resonators offer the ground plane and center conductor on the same side of the substrate to allow easy series or shunt insertion of solid-state devices. DC biasing is naturally integrated in the slotline structure and straight forward in CPW. Monolithic implementation of these resonators would not require via holes to ground solid-state devices which should reduce processing complexity and increase production yields.



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## Calibration and Applications of Polarization-Correlating Radiometers

*A.J. Gasiewski and D.B. Kunee. "Calibration and Applications of Polarization-Correlating Radiometers." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 767-773.*

Hardware and associated software for non-mechanical rotation of the polarization basis of a dual linearly-polarized cross-correlating radiometer are demonstrated. The technique requires precise measurement of two orthogonal-mode antenna temperatures along with cross-correlation of the two orthogonal-mode field amplitudes. Collectively, these are the first three Stokes parameters. A polarized blackbody load was developed for accurate calibration of the orthogonal-mode and cross correlating channels. Using the hardware, rotation of the radiometer antenna's polarization basis by a matrix transformation was demonstrated by 91.65-GHz near-Brewster angle scans of a polarizing water surface. The experimental results demonstrate the viability of the rotation technique and suggest practical calibration schemes for airborne and spaceborne polarimetric radiometers. Application of the rotation technique in mechanically-scanned polarization-sensitive imaging radiometers will eliminate polarization coupling inherent in conventional fixed-feed dual-polarization scanner designs.

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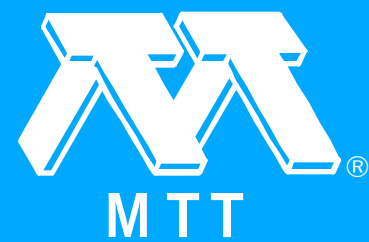


## Nonlinear Synchronized LC Oscillators: Theory and Simulation

*M. Odyniec. "Nonlinear Synchronized LC Oscillators: Theory and Simulation." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 774-780.*

The paper presents a rigorous analysis of synchronized oscillators. The analyzed circuits exhibit strongly nonlinear behavior such as frequency lock and existence of multiple solutions and yet their behavior can be fully determined by large signal characteristics obtained from harmonic balance simulation. The results can be directly applied to diode and transistor oscillators and can also serve as a benchmark in testing nonlinear simulators.





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## The Propagation Characteristics of Wave-Guiding Structures with Very Thin Superconductors; Application to Coplanar Waveguide YBa/sub 2/Cu/sub 3/O/sub 7-x/ Resonators

*B.B.G. Klopman, G.J. Gerritsma and H. Rogalla. "The Propagation Characteristics of Wave-Guiding Structures with Very Thin Superconductors; Application to Coplanar Waveguide YBa/sub 2/Cu/sub 3/O/sub 7-x/ Resonators." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 781-791.*

We have analyzed the propagation characteristics of wave-guiding structures with superconductors which are thin compared to the magnetic penetration depth. The complex propagation constant is evaluated within the framework of the modified spectral domain method without the need for numerical calculations in the complex plane. Good agreement is found with the results of other methods. The numerical analysis is instrumental in deducing results for the penetration depth and the surface resistance of YBa/sub 2/Cu/sub 3/O/sub 7-x thin films on sapphire with a PrBa/sub 2/Cu/sub 3/O/sub 7 buffer layer. We confirm recent observations of a non-single-gap BCS temperature dependence.

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## Field Analysis of Dielectric-Loaded Lens Applicator for Microwave Hyperthermia

*P.H. Alexander and J. Liu. "Field Analysis of Dielectric-Loaded Lens Applicator for Microwave Hyperthermia." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 792-796.*

A dielectric-loaded waveguide applicator for microwave hyperthermia is analyzed. The phase constant in the waveguide is determined from the numerical solution of the characteristic equation. The field pattern in human muscle which is produced by the applicator is determined by using the Kirchhoff-Huygens principle. The field focusing effect is dependent on the properties of the low permittivity dielectric slab centered in the water-filled waveguide. The greatest field enhancement is found to occur when the slab is 75 mm wide for a 150 mm x 100 mm waveguide at 430 MHz.

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## Modelling Multiple Discontinuities in Rectangular Waveguide Partially Filled with Non-Reciprocal Ferrites

*M.A. Solano, A. Vegas and A. Prieto. "Modelling Multiple Discontinuities in Rectangular Waveguide Partially Filled with Non-Reciprocal Ferrites." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 797-802.*

This work analyzes multiple 3-D discontinuities between rectangular ferrite-loaded waveguides. Each uniform section of waveguide is analyzed by means of Schelkunoff's method with improved convergence. Combining this method with the mode matching method allows the analysis of multiple discontinuities to be simplified. The theoretical results obtained in this way agree quite well with measurements.





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## Cut-off and Phase Constants of Partially Filled Axially Magnetized, Gyromagnetic Waveguides Using Finite Elements

*B.M. Dillon, A.A.P. Gibson and J.P. Webb. "Cut-off and Phase Constants of Partially Filled Axially Magnetized, Gyromagnetic Waveguides Using Finite Elements." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 803-808.*

A three component vector finite element formulation to model the propagation characteristics of partially filled, axially magnetized, gyromagnetic waveguides is described. Covariant-projection elements have been used to avoid spurious modes and periodic boundary conditions have been implemented to improve numerical efficiency. The classic quadratic functional derived from the vector, curlcurl, magnetic field equation is suited to evaluating the cut-off planes of gyrotropic waveguides. A known field transformation is used to reformulate the functional into a form convenient for calculating phase constants. Cut-off and phase constant solutions are presented for both fully and partially filled, longitudinally magnetized, ferrite loaded waveguides.

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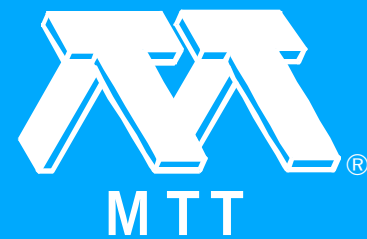


# Abstracts

## Automatic Generation of Starting Values for the Simulation of Microwave Oscillators by Frequency Domain Techniques

*M. Fillebock, M. Schwab and P. Russer. "Automatic Generation of Starting Values for the Simulation of Microwave Oscillators by Frequency Domain Techniques." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 809-813.*

In this paper a new approach to the start-up problem inherent to the large-signal analysis of autonomous circuits in the frequency domain is presented. By insertion of a simple network, depending on one parameter, the oscillator is damped to the stability limit where a linear analysis yields good results. The steady state of the undamped oscillator is then obtained by a continuation method corresponding to the successive removal of the damping network. With this procedure the degenerate solution may be excluded in a straightforward manner.



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## Resonance in a Superstrate-Loaded Cylindrical-Rectangular Microstrip Structure

*K.-L. Wong, Y.-T. Cheng and J.-S. Row. "Resonance in a Superstrate-Loaded Cylindrical-Rectangular Microstrip Structure." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 814-819.*

The complex resonant frequencies of the cylindrical-rectangular microstrip structure loaded with a dielectric super-strata layer is studied by using a rigorous full-wave analysis and the numerical results are obtained by using the Galerkin's moment method calculation. The numerical convergence for the selected sinusoidal basis functions with and without the edge singularity condition is also discussed. Numerical results for the dependence of the real and imaginary parts of the complex resonant frequencies on the superstrata permittivity and thickness are calculated and analyzed, which are also compared with those obtained for the planar microstrip structure.

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## A Transformed Symmetrical Condensed Node for the Effective TLM Analysis of Guided Wave Problems

*M. Celuch-Marcysiak and W.K. Gwarek. "A Transformed Symmetrical Condensed Node for the Effective TLM Analysis of Guided Wave Problems." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 820-823.*

We propose a novel TLM algorithm for the effective solution of arbitrary guided wave problems. The algorithm uses an appropriately transformed symmetrical condensed node introduced herein. In comparison with the previous SCN TLM formulation for the analysis of guiding structures, our approach maintains equivalent accuracy and generality while providing a 50% gain in terms of required computer memory and time. The advantages of our algorithm are verified by means of several examples, including full - wave analysis of waveguides filled with anisotropic and lossy media.

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## Analysis of Slow-Wave Transmission Lines on Multi-Layered Semiconductor Structures Including Conductor Loss

*J.-C. Liou and K.M. Lau. "Analysis of Slow-Wave Transmission Lines on Multi-Layered Semiconductor Structures Including Conductor Loss." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 824-829.*

Metal lines on semiconductor devices and circuits sometimes show slow-wave phenomena. To determine signal transmission characteristics along the lines, the typical assumption that metal is perfectly conducting is not always valid. In this paper, we use a simple and accurate means to include metallic loss in spectral domain analysis of planar transmission lines built on multi-layer semiconducting media. Experimental results with a modulation-doped field-effect transistor structure and comparison with the calculations are presented.



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## A Locally Conformed Finite-Difference Time-Domain Algorithm of Modeling Arbitrary Shape Planar Metal Strips

*J. Fang and J. Ren. "A Locally Conformed Finite-Difference Time-Domain Algorithm of Modeling Arbitrary Shape Planar Metal Strips." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 830-838.*

A general algorithm to model arbitrary shape planar metal strips by the finite-difference time-domain (FDTD) method is presented in this paper. With this method, fields in the entire computation domain are computed by the regular FDTD algorithm except those near metal strips where special techniques proposed in this paper are applied. Unlike globally conformed finite-difference algorithms, the computation efficiency of the regular FDTD method is maintained while high space-resolution is obtained by this locally conformed finite-difference method. Numerical tests have verified that a higher computation accuracy is achieved by this scheme than the conventionally used staircase approximation. The modeling of electrical characteristics of two crossed strip lines is provided as an example.



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## New Equivalent Networks with Simple Closed-Form Expressions for Open and Slit-Coupled E-Plane Tee Junctions

*P. Lampariello and A.A. Oliner. "New Equivalent Networks with Simple Closed-Form Expressions for Open and Slit-Coupled E-Plane Tee Junctions." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 839-847.*

Analytical expressions are presented for the elements of new equivalent networks for open and slit-coupled E-plane tee junctions. The expressions are in simple closed form, and their accuracy is verified by comparisons with measurements. Physically based "stored power" considerations are also developed in context to indicate how appropriate changes in the geometry can be taken into account.



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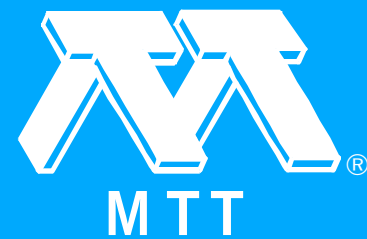


# Abstracts

## Simulation of High-Frequency Integrated Circuits Incorporating Full-Wave Analysis of Microstrip Discontinuities

*R. Kipp, C.H. Chan, A.T. Yang and J.T. Yao. "Simulation of High-Frequency Integrated Circuits Incorporating Full-Wave Analysis of Microstrip Discontinuities." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 848-854.*

We incorporate full-wave simulation of microstrip interconnects into circuit analysis and show how predicted responses diverge from those based on models from a modern microwave-circuit CAD package. A method is presented for characterizing microstrip interconnects and discontinuities through the method-of-moments applied to a mixed-potential integral equation. The speed is greatly improved through the use of a recently published techniques for rapid evaluation of microstrip spatial Green's functions. A microstrip circuit element is analyzed separately through this procedure, and scattering parameters are extracted from the computed current density. These parameters are passed to a circuit simulator, where small- and large-signal analysis reveal how differences in interconnect modeling affect predicted responses.



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## Bistatic Frequency-Swept Microwave Imaging: Principle, Methodology and Experimental Results

*D.-B. Lin and T.-H. Chu. "Bistatic Frequency-Swept Microwave Imaging: Principle, Methodology and Experimental Results." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 855-861.*

The basic principle, methodology and experimental results of frequency-swept microwave imaging of continuous shape conducting and discrete line objects in a bistatic scattering arrangement are presented. Theoretical analysis is developed under the assumptions of plane wave illumination and physical optics approximation. The measurement system and calibration procedures are implemented based on the plane wave spectrum analysis. Images of three different types of scattering objects reconstructed from the experimental data measured in the frequency range 7.5-12.5 GHz are shown in good agreement with the scattering object geometries. The results demonstrate that the developed bistatic frequency-swept microwave imaging system has potential as a cost-effective tool for the application of remote sensing, imaging radar, and nondestructive evaluation.

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## Electromagnetic Scattering from an Infinite Circular Metallic Cylinder Coated by an Elliptic Dielectric One

*J.A. Roumeliotis, H.K. Manthopoulos and V.K. Manthopoulos. "Electromagnetic Scattering from an Infinite Circular Metallic Cylinder Coated by an Elliptic Dielectric One." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 862-869.*

In this paper the scattering from an infinite circular, perfectly conducting cylinder, coated by an elliptic dielectric one, is considered. The electromagnetic field is expressed in terms of both circular and elliptical cylindrical wave functions, which are connected with one another by well-known expansion formulas. In the special case of small  $h = ka/2$  ( $a$  is the interfocal distance of the elliptic dielectric and  $k$  its wavenumber), exact, closed-form expressions of the form  $S(h) = S(0)[1 + gh^2 + O(h^4)]$  are obtained for the scattered field and the various scattering cross sections of the problem. Both polarizations are considered for normal incidence. Graphical results for various values of the parameters are given.

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## Accurate Analysis and Design of Millimeter Wave Mixers (Short Papers)

*F. De Flaviis, T. Rozzi, F. Moglie, A. Sgreccia and A. Panzeri. "Accurate Analysis and Design of Millimeter Wave Mixers (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 870-873.*

In recent years, various techniques have been developed for the study of microwave mixers. The present contribution stems from the method introduced in [1] for the nonlinear analysis, but differs in the linear part. In particular, we emphasize the circuit characterization of the mixer harmonics, removing the usual approximation of matched terminations and employing models that effectively represent network characteristics in the microwave and millimeter wave domain. This goal is achieved through the accurate knowledge of the various components occurring in the mixer and the use of accurate equivalent circuits. In order to validate the model, two subharmonic mixers operating at K-band (18-26 GHz) were realized. Reasonable agreement is achieved between theoretical and experimental results.

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## A Design Method for Lumped Broad-Band MMIC Matching Networks with Semiuniform Frequency-Dependent Losses (Short Paper)

*Q. Lin, H. Aghvami and I. Robertson. "A Design Method for Lumped Broad-Band MMIC Matching Networks with Semiuniform Frequency-Dependent Losses (Short Paper)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 873-876.*

A new design method for broad-band MMIC matching networks, which consist of lumped inductors and capacitors, is presented in this paper. Based on the fictitious transformation between the lossy network and the lossless one the transducer power gain (TPG) of the lossy network is calculated using impedance matrix and transmission parameter matrix methods. Then, on the basis of the result of TPG optimization, the matching network can be synthesized. Since only the complexity of the matching network needs to be specified, so the advantage of the "real frequency technique" is retained. In this design procedure the frequency-dependent losses of lumped elements can be considered. Thus the actual gain response tends to coincide with the desired performance more than when the losses of elements are neglected. An example is given to show the application of the new method to broad-band GaAs FET amplifier design.

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## X-Band Low Phase Distortion MMIC Power Limiter (Short Papers)

*T. Parra, J. Dienot, M. Gayral, M. Pouysegur, J.F. Sautereau and J. Graffeuil. "X-Band Low Phase Distortion MMIC Power Limiter (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 876-879.*

This paper describes the design and performance of a 8 GHz MMIC MESFET power limiter. This limiter incorporates a special gate biasing scheme and makes use of appropriate load conditions which reduce the unexpected phase variations experienced by the signal through the device. Measured performances (phase variations less than 8° over a 22 dB input power range) are found to be in agreement with the theoretical ones obtained from large signal simulations.



# Abstracts

## Breakdown in the Inhomogeneous Electric Field of a Microwave Transmit-Receive Switch (Short Papers)

*V. Semenov, D. Anderson and M. Lisak. "Breakdown in the Inhomogeneous Electric Field of a Microwave Transmit-Receive Switch (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 879-881.*

A detailed analytical investigation is made of the threshold for breakdown in microwave transmit-receive switches. The geometry of the keep alive contacts of the switch is modelled as a double cone configuration and the subsequent diffusion equation for the electron density in the presence of strongly inhomogeneous ionization is solved analytically. Predictions for the breakdown power are found to be in agreement with previously presented experimental results.



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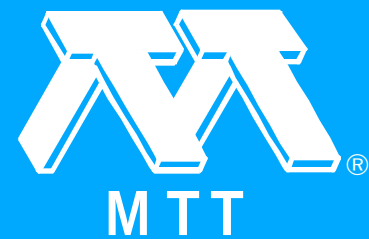
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## Impedance, Attenuation and Power-Handling Characteristics of Double L-Septa Waveguides (Short Papers)

*P.K. Saha and D. Guha. "Impedance, Attenuation and Power-Handling Characteristics of Double L-Septa Waveguides (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 881-884.*

Rectangular waveguides with two L-shaped septa attached to the broad walls in antipodal configuration have been shown theoretically to be an improved variant of the Double T-Septa Guide having larger cut off wavelength and broader bandwidth of the dominant TE mode. Numerical data on the attenuation, impedance and power handling capability of this new type of broadband guides are now presented here as additional design information.

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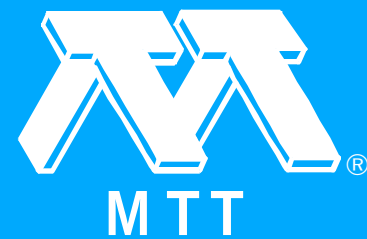


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## On the Use of Levin's T-Transform in Accelerating the Summation of Series Representing the Free-Space Periodic Green's Functions (Short Papers)

*S. Singh and R. Singh. "On the Use of Levin's T-Transform in Accelerating the Summation of Series Representing the Free-Space Periodic Green's Functions (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 884-886.*

The Levin's t-transform is shown to accelerate the summation of slowly converging series. This is illustrated by application transform to the series representing the free-space periodic Green's functions involving a single and double infinite summation. Numerical indicate that the transform converges rapidly than a direct summation the series. Thus, it provides considerable savings in computation time.



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## Computer-Aided Design of a Singly-Matched (S-M) Multiplexer with a Common Junction (Short Papers)

*J.-A. Gong and W.-K. Chen. "Computer-Aided Design of a Singly-Matched (S-M) Multiplexer with a Common Junction (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 886-890.*

In this paper, the formulas based on scattering parameters are presented for the design of a multiplexer composed of  $n - 1$  channel equalizers connected either in parallel or in series at a common junction with a  $1 - \Omega$  resistive generator and  $n - 1$  channel complex loads. It is known as the singly-matched (S-M) multiplexer. A new two-stage computer-aided design approach is developed for the S-M multiplexer. A design example of a three-channel singly-matched multiplexer including the designs of three individual S-M channel equalizers is given to demonstrate the approach.





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## Negative Differential Resistance (NDR) Frequency Conversion with Gain (Short Papers)

*R.J. Hwu, A. Djuandi and S.C. Lee. "Negative Differential Resistance (NDR) Frequency Conversion with Gain (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 890-893.*

The dependence of the conductance of negative differential resistance (NDR) devices in the presence of an rf signal of varying amplitude has been theoretically analyzed. Variable absolute negative conductance has been observed in both unbiased resonant tunneling devices and biased tunnel diode when the applied pump power is within the correct range. The theoretical observation of the dependence of the dc conductance of the NDR devices on the power level of the applied Pump signal is supported by the experimental results. Absolute negative conductance of NDR devices provides the possibility of oscillation and harmonic oscillation up to the cut-off frequency of the device. Biased oscillators and self-oscillating frequency multipliers have been experimentally demonstrated using a tunnel diode. Unbiased oscillators have also been successfully realized with two back-to-back connected tunnel diodes which exhibit an anti-symmetrical I-V characteristic.

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## The Introduction of Surface Resistance the Three-Dimensional Finite-Difference Method in Frequency Domain (Short Papers)

*D. Hollmann, S. Haffa, F. Rostan and W. Wiesbeck. "The Introduction of Surface Resistance the Three-Dimensional Finite-Difference Method in Frequency Domain (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 893-895.*

A full-wave treatment of lossy three-dimensional structures using the finite-difference method in frequency domain is presented. This accounts for both, dielectric and conductor losses. By introduction of a surface resistance the effect of conductor losses and surface roughness can be modeled very efficiently. The modifications of the finite-difference frequency domain (FDFD) algorithm are presented. Comparisons between the conventional approach using elementary cells with finite, conductivity and this new discretization method with surface current cells are given, and the advantages and limitations of the surface current model are shown.



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## TM-Scattering from a Slit in a Thick Conducting Screen: Revisited (Short Papers)

*S.H. Kang, H.J. Eom and T.J. Park. "TM-Scattering from a Slit in a Thick Conducting Screen: Revisited (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 895-899.*

TM plane-wave scattering from a slit in a thick conducting screen is reexamined. A Fourier transform technique is employed to express the scattered field in the spectral domain, and the boundary conditions are enforced to obtain simultaneous equations for the transmitted field inside the thick conducting screen. The simultaneous equations are solved to represent the transmitted and scattered fields in series forms. Approximate series solutions for scattering and transmission are obtained in closed-forms which are valid for high-frequency scattering regime.





# Abstracts

## A Procedure Defining Behavior of Weight Functions Near the Edge for Best Convergence Using the Galerkin Method (Comments)

*P.A.A. Laura, C.A. Rossit and D.V. Bambill. "A Procedure Defining Behavior of Weight Functions Near the Edge for Best Convergence Using the Galerkin Method (Comments)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 900-901.*

The authors are to be congratulated for their important and timely contribution. Their procedure for determining the behavior of the weight functions near the edge so as to accomplish optimum convergence using Galerkin's method for calculating linear functional of the theory of electromagnetism deserves special credit and constitutes, indeed, an original contribution. The writers feels that their approach will be of considerable interest to researchers in other fields of engineering and applied sciences i.e. heat and mass flow, fracture mechanics, etc.



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## A New Formulation of the Boundary Condition at Infinity for a Hybrid Radiation Mode and its Application to the Analysis of the Radiation Modes of Microstrip Lines (Corrections)

*W. Zieniutycz. "A New Formulation of the Boundary Condition at Infinity for a Hybrid Radiation Mode and its Application to the Analysis of the Radiation Modes of Microstrip Lines (Corrections)." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 901-902.*

In the above paper, a few corrections should be introduced as a result of additional analysis and numerical calculation:



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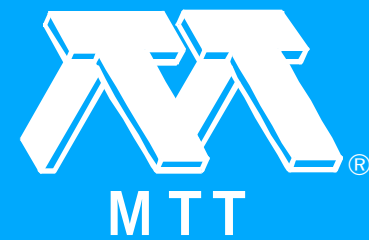
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## 1993 IEEE GaAs IC Symposium (Advertisement) (May 1993 [T-MTT])

*"1993 IEEE GaAs IC Symposium (Advertisement) (May 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 903-903.*



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## Call for Papers - Interconnections and Packaging (May 1993 [T-MTT])

*"Call for Papers - Interconnections and Packaging (May 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 904-904.*



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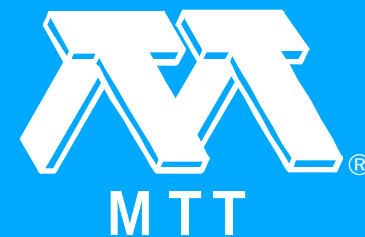
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## Call for Papers - Ultra-Wideband, Short-Pulse Electromagnetics (May 1993 [T-MTT])

*"Call for Papers - Ultra-Wideband, Short-Pulse Electromagnetics (May 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 905-905.*



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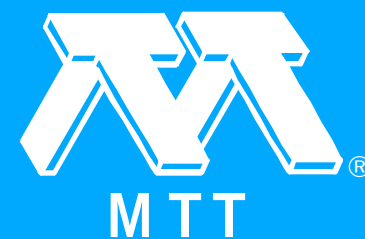
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## Call for Papers - 1994 IEEE-MTT-S International Microwave Symposium (May 1993 [T-MTT])

*"Call for Papers - 1994 IEEE-MTT-S International Microwave Symposium (May 1993 [T-MTT])."*  
*1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 906-906.*



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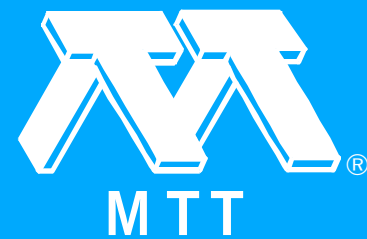
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# Abstracts

## Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (May 1993 [T-MTT])

*"Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (May 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 907-907.*



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## Information for Authors (May 1993 [T-MTT])

*"Information for Authors (May 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): 908-908.*



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## Back Cover (May 1993 [T-MTT])

*"Back Cover (May 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.5 (May 1993 [T-MTT]): b1-b1.*



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## Front Cover (Jun./Jul. 1993 [T-MTT])

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*"Front Cover (Jun./Jul. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): f1-f1.*



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# Abstracts

## Microwave Education in the U.S. and Several Other Countries

*J.C. Wiltse. "Microwave Education in the U.S. and Several Other Countries." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 911-912.*

This issue contains a special section on microwave education in Australia, Belgium, Canada, Italy, and the U.S. The intention is to summarize the approaches in several countries and provide some insight for providing better planning and improved teaching techniques for the future. In that vein, there are two papers dealing with the subject in the U.S. One of these, by Drs. Henning and Dunleavy, contains an overview and the results of a survey describing curricula, laboratory facilities, and specialized programs at many institutions. The second U.S. article, by Dr. M. Iskander, takes a different approach and describes a computer-assisted method for teaching electromagnetic in general, and microwaves in particular. This program, called the center for Computer Applications in Electromagnetic Education (CAEME) is an activity funded by the U.S. National Science Foundation and the IEEE to focus on stimulating and accelerating the use of computers, software tools, and graphics in electromagnetic education.



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## Educating Microwave Engineers in the United States

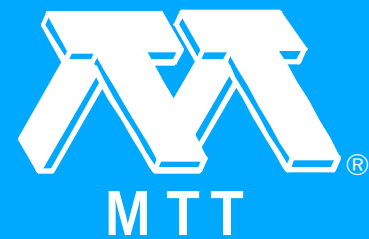
*R.E. Henning and L.P. Dunleavy. "Educating Microwave Engineers in the United States." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 913-919.*

Three knowledge areas in which a Microwave Engineer needs to be educated are reviewed, and implementation means discussed. It is shown that Microwave Engineering education in the U.S. occurs primarily after receipt of the (Bachelor's) engineering degree. The inevitability of specialized academic education within the field of Microwave Engineering is pointed out. Overall results from a broadly based survey U.S. Electrical Engineering departments' Microwave Engineering programs are presented. They include information on Master's and Doctorate degrees awarded, faculty, and sources and of research funding. Additional reference sources which contain information on U.S. Microwave Engineering are identified. Opportunities for making educational improvements on the graduate level of this multifaceted engineering specialization, which centrally regulated, are pointed out and illustrated by an example.

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## Computer-Based Electromagnetic Education

*M.F. Iskander. "Computer-Based Electromagnetic Education." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 920-931.*

Computers provide an exciting opportunity for boosting electromagnetic education and corporate training. Animated graphics of the wave propagation phenomenon, visualization of the abstract and highly mathematical subjects, one-on-one and self-paced tutoring, and the ability to mimic often unavailable and expensive laboratory experiments are among the often-cited benefits of a computer-based electromagnetic education. The activities of the NSF/IEEE Center for Computer Applications in Electromagnetic Education (CAEME) is reviewed here. This Center was established to stimulate and accelerate the use of computers and software tools in electromagnetic (EM) education. A reflection of the extensive software package developed and distributed by the CAEME Center is described, and examples of the developed software are presented. To help integrate available EM software in classroom teaching and corporate training, CAEME developed four multimedia lessons for instruction. These interactive media lessons integrate and allow individuals to interactively manipulate information from multimedia sources such as video, software, and animated graphics and also include instructional information such as quizzes and tutorials to help evaluate the students' performance. Features of these lessons are presented, and future developments in the Center's activities are discussed.

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## Microwave Engineering Education in Canada

*W.J.R. Hoefer. "Microwave Engineering Education in Canada." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 932-936.*

Microwave engineering education, as part of the Canadian engineering education system, is evolving in response to rapid changes in engineering practice that result from the explosion of knowledge, technological developments, national and international competition, globalization, and from pressing infrastructure renewal. The present system of Canadian engineering education is reviewed in general, and microwave engineering, in particular, is described. Issues and challenges are presented, and future developments and recommended actions are discussed.

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## The Status of Microwave Education in Italy

*R. Sorrentino and G.B. Stracca. "The Status of Microwave Education in Italy." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 937-942.*

After a short description of the engineering education system in Italy, and a brief historical account of the introduction of microwave courses in such studies, the paper illustrates the present situation of microwave education. Data are provided on schools where courses on microwaves and related disciplines are available, types of degrees, laboratories and computing facilities, and number of students. Typical syllabi in some universities are also discussed.

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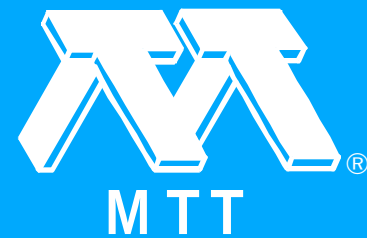


# Abstracts

## Microwave Education in Belgium

*A.V. Vorst. "Microwave Education in Belgium." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 943-947.*

Belgium is a small country, with 10 million inhabitants in a 30000 km<sup>2</sup> area. Engineering education is provided by 7 universities and a military school on a 5-year program, as well as by a limited number of schools on a 4-year program. This paper describes microwave education within the universities. It emphasizes the link between research and education, showing similarities and differences among the various centers of education. Specific microwave design expertise, capabilities, and facilities are described.



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## Microwave Engineering Education in Australia

*N. Fourikis. "Microwave Engineering Education in Australia." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 948-953.*

The emergence of Australian science/engineering is presented in its historical and socioeconomic milieu. Engineering education is then considered in tertiary educational institutions where microwave engineering is taught at the undergraduate and postgraduate levels. The Australian educational system provides education of a high standard for technicians, engineers, and scientists. While there was no indigenous microwave industry in Australia, microwave engineering has been actively pursued in academia and in several quasi-government organizations/ laboratories. In fields related to microwave engineering, Australia excelled in the areas of radioastronomy and microwave landing systems. In the 1980's indigenous microwave engineering firms appeared as a result of a determined effort to augment and strengthen the Australian manufacturing base. The recent emergence of the many centers described here and the appropriate fiscal policies put in place by the present government will aid the above process. In these new thrusts, universities and quasi-government organizations are destined to play a pivotal role.

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## Design and Analysis of Quasi-Integrated Horn Antennas for Millimeter and Submillimeter-Wave Applications

*G.V. Eleftheriades and G.M. Rebeiz. "Design and Analysis of Quasi-Integrated Horn Antennas for Millimeter and Submillimeter-Wave Applications." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 954-965.*

The purpose of this paper is to present a systematic process for the design of multimode quasi-integrated horn antennas, and to provide a full range of practical antenna designs for millimeter and submillimeter-wave applications. The design methodology is based on the Gaussian beam approach and the structures are optimized for achieving maximum fundamental Gaussian coupling efficiency. For this purpose, a hybrid technique is employed in which the integrated part of the antennas is treated using fullwave analysis, whereas the machined part is treated using an approximate model. This results in a simple and efficient design process. The developed design procedure has been applied for the design of a 20-, 23-, and 25-dB quasi-integrated horn antennas, all with a Gaussian coupling efficiency exceeding 97%. The designed antennas have been tested and characterized using both full-wave analysis and 91/370GHz measurements. The quasi-integrated horn antennas are also examined as feed elements for Cassegrain antenna systems and are proven to be comparable to the traditional machined corrugated horn feeds.

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## TE and TM Modes in Circularly Shielded Slot Waveguides

*J.L. Tsalamengas, I.O. Vardiambasis and J.G. Fikioris. "TE and TM Modes in Circularly Shielded Slot Waveguides." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 966-973.*

Cutoff wavenumbers and the field of TE and TM modes are evaluated in circularly shielded, single- or double-slot waveguides in case of infinitely thin fins. The formulation, based on field equivalence principles, is exact and leads to Carleman-type singular integral or integro-differential equations for the equivalent surface magnetic current across the slot(s). The solution of these equations is based on Neumann's expansion of the Hankel kernels and leads to numerically stable and efficient algorithms regardless of the slot widths. Numerical results for the cutoff wavenumbers, both TE and TM, are presented. By lowering the cutoff frequencies of the TE modes and by raising the corresponding ones of the TM modes considerable increase in the operating frequency bandwidth may be achieved after suitably selecting the various geometrical parameters of the configurations.



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## A Semi-Automatic 3-Port Network Analyzer

*M. Schoon. "A Semi-Automatic 3-Port Network Analyzer." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 974-978.*

A semi-automatic three-port network analyzer has been developed. The three-port network analyzer consists of an automatic two-port network analyzer, a switching network for RF rerouting and a software package. The design of the three-port network analyzer is based on a new method for obtaining accurate three-port S-parameters from measured two-port parameters. This method is based on a flow-chart description of the measurements. The resulting, overdetermined, nonlinear, equation system is solved numerically. No assumptions are made about the device under test or the terminations apart from that the latter must be known. The efficiency of the method is demonstrated by characterization of a two-way Wilkinson power divider. The three-port network analyzer has been used to characterize dual-gate MESFET's.

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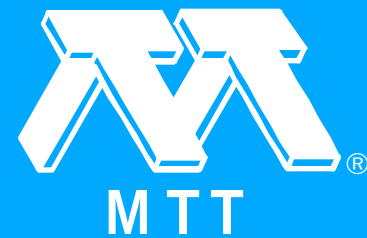


# Abstracts

## A Linear Dependence of $F_{\text{min}}$ on Frequency for FET's

*B. Hughes. "A Linear Dependence of  $F_{\text{min}}$  on Frequency for FET's." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 979-982.*

The minimum noise figure of a FET, expressed in decibels, is shown to increase approximately linearly with frequency to frequencies approaching the FET's  $F_{\text{max}}$ . This observation is useful for extrapolating noise figures and provides a simple frequency-of-merit.



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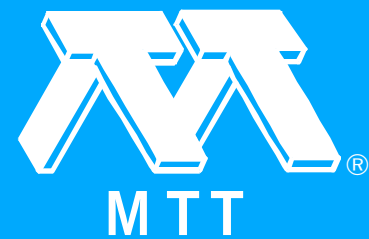
## Stability Analysis and Numerical Simulation of Multidevice Amplifiers

*M. Ohtomo. "Stability Analysis and Numerical Simulation of Multidevice Amplifiers." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 983-991.*

Stability analysis of multidevice amplifiers is made on a generalized circuit comprising two  $n$ -ports with  $S$ -matrices  $S$  (active devices) and  $S'$  (passive networks) connected at  $n$  interface ports. Open-loop transfer functions defined for a signal-flow graph and its  $(n-1)$  subgraphs of incident and reflected waves at the interface ports are expressed in terms of  $\det M/\text{sub } n/$  and its minors, where  $M/\text{sub } n/ = S'S - I/\text{sub } n/$  and  $I/\text{sub } n/ = n \times n$  identity matrix. It is shown that the Nyquist plots of the  $n$  transfer functions completely characterize the number of right-half complex-frequency-plane zeros of  $\det M/\text{sub } n/$ , and hence the amplifier stability. Insertion of an ideal circulator and isolators at the interface ports enables one to calculate the Nyquist plots and voltage distributions of possible instabilities using commercially available linear circuit simulators. Numerical simulations for two types of parallel-operated GaAs FET amplifiers are performed to verify the usefulness of the analysis to design-phase check on multidevice amplifier stability.

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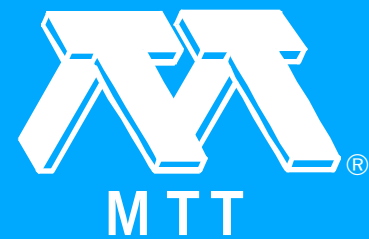
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## Cryogenic Characteristics of Wide-Band Pseudomorphic HEMT MMIC Low-Noise Amplifiers

*C.C. Yang, B.L. Nelson, B.R. Allen, W.L. Jones and J.B. Horton. "Cryogenic Characteristics of Wide-Band Pseudomorphic HEMT MMIC Low-Noise Amplifiers." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 992-997.*

Two wide-band (8-18 GHz) single-stage MMIC low-noise amplifiers (LNA's) using 0.2- $\mu$ m T-gate InGaAs pseudomorphic HEMT technology, designed and fabricated for room-temperature operation, were evaluated and compared at cryogenic temperatures below 20 K. One is a balanced design using 3-dB Lange couplers, and the other is a feedback design using a series RLC parallel feedback network. The gain flatness over the 8-18 GHz frequency band was maintained for both amplifiers at room and cryogenic temperatures, indicating that the topology for wide-band designs is insensitive to temperature of operation. As the physical temperature decreased from 297 K to below 20 K, the balanced LNA exhibited an average gain increase of 2 dB and as much as an eightfold reduction of noise temperature to 20 K, while the feedback LNA exhibited an average gain increase of less than 1 dB and an average fourfold reduction of noise temperature to 50 K. The negative feedback network of the feedback LNA resulted in less gain increase and less noise temperature reduction at cryogenic temperatures. The MMIC LNA's remained electrically and physically stable without adverse effects, such as breakage, at all test temperatures, and the measured results were repeatable.





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## Optically Controlled Oscillators for Millimeter-Wave Phased-Array Antennas

*D.J. Sturzebecher, X. Zhou, X.-S. Zhang and A.S. Daryoush. "Optically Controlled Oscillators for Millimeter-Wave Phased-Array Antennas." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 998-1004.*

A new approach for the design of optically synchronized millimeter-wave local oscillators based on a subharmonically injection-locked phase-lock-loop technique is introduced. The experimental results support the desired goal of frequency and phase coherency, phase shift control of millimeter-wave oscillators, and self-oscillating mixing to downconvert a millimeter-wave RF signal. Experimental results and theoretical analysis show the advantages of the proposed approach: larger locking range of two subharmonically locked oscillators, lower FM noise degradation, and smaller phase error caused by frequency detuning.

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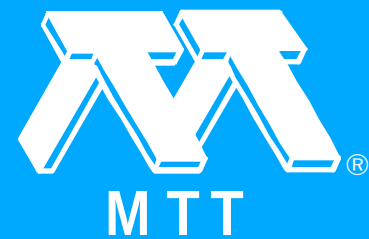


## Frequency-Dependent FDTD Modeling of Optically Controlled Dielectric Resonators

*Y. Shen, K. Nickerson and J. Litva. "Frequency-Dependent FDTD Modeling of Optically Controlled Dielectric Resonators." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1005-1010.*

A theoretical analysis is carried out, to describe the performance of optically controlled dielectric resonators. A previously developed frequency-dependent finite-difference time-domain formulation has been used to estimate the effect that solid state plasmas have on the resonant frequency of dielectric resonators. Optical generation of plasmas in contact with dielectric resonators is being considered here as a possible means of controlling the resonator's frequency. The effect that carrier diffusion and recombination-generation have on plasma permittivity and penetration depth are taken into account in this analyses. The results are compared with measurement and are shown to yield a quantitative estimate of the optically induced dielectric resonator frequency shift as a function of the illumination, properties of the plasma host semiconductor, and the properties of the dielectric resonator.





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## Characterization of Picosecond Pulse Crosstalk Between Coupled Microstrip Lines with Arbitrary Conductor Width

*Y. Qian and E. Yamashita. "Characterization of Picosecond Pulse Crosstalk Between Coupled Microstrip Lines with Arbitrary Conductor Width." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1011-1016.*

The propagation and crosstalk properties of picosecond electrical pulses along coupled microstrip lines with arbitrary strip widths are investigated. The current distributions and propagation constants of the dominant c- and n-modes in these asymmetric coupled striplines are calculated by using the spectral domain approach; and the full-wave analysis results obtained are incorporated into an FFT algorithm to simulate pulse distortion and crosstalk in the coupled transmission lines. Several samples of asymmetric coupled microstrip lines are fabricated and their characteristics are measured. The results of experiments are found to be in good agreement with those of computer simulations. This paper provides, for the first time, rigorous results of picosecond pulse distortion and crosstalk in asymmetric coupled transmission lines.

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## The Feature of the Narrow-Pulse Transmission on Conventional Coplanar Waveguides When Power Leakage is Present (Jun./Jul. 1993 [T-MTT])

*M. Tsuji, M. Taniguchi and H. Shigesawa. "The Feature of the Narrow-Pulse Transmission on Conventional Coplanar Waveguides When Power Leakage is Present (Jun./Jul. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1017-1023.*

Here we report a new type of pulse-shape degradation when a narrow pulse is transmitted on conventional coplanar waveguide (CPW). This degradation is not caused by the well-known dispersion of the phase constant of the CPW dominant mode, but by the complicated dispersion behavior of its attenuation constant due to the leakage effect. We investigate this type of degradation with two kinds of pulse having different half-power widths. The power leakage associated with a narrow pulse propagation also causes a novel type of the dynamic power coupling with neighboring circuits. We also investigate it theoretically and experimentally.

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## Design of Lightweight, Broad-Band Microwave Absorbers Using Genetic Algorithms (Jun./Jul. 1993 [T-MTT])

*E. Michielssen, J.-M. Sajer, S. Ranjithan and R. Mittra. "Design of Lightweight, Broad-Band Microwave Absorbers Using Genetic Algorithms (Jun./Jul. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1024-1031.*

In this paper, a novel procedure for synthesizing multilayered radar absorbing coatings is presented. Given a predestined set of  $N_m$  available materials with frequency-dependent permittivities  $\epsilon(f)$  and permeabilities  $\mu_i(f)$  ( $i = 1, \dots, N_m$ ), the proposed technique simultaneously determines the optimal material choice for each layer and its thickness. This optimal choice results in a screen which maximally absorbs TM and TE incident plane waves for a prescribed range of frequencies  $\{f_1, f_2, \dots, f_N\}$  and incident angles  $\{\theta_1, \theta_2, \dots, \theta_N\}$ . The synthesis technique presented herein is based on a genetic algorithm. The present technique automatically places an upper bound on the total thickness of the coating, as well as the number of layers contained in the coating, which greatly simplifies manufacturing. In addition, the thickness or surface mass of the coating can be minimized simultaneously with the reflection coefficient. The algorithm was successfully applied to the synthesis of wide-band absorbing coatings in the frequency ranges of 0.2-2 GHz and 2-8 GHz.



## Application of High $T_c$ Superconductors as Frequency Selective Surfaces: Experiment and Theory

*D. Zhang, Y. Rahmat-Samii, H.R. Fetterman, S. Prakash, R.F. Bunshah, M. Eddy and J.L. Nilsson. "Application of High  $T_c$  Superconductors as Frequency Selective Surfaces: Experiment and Theory." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1032-1036.*

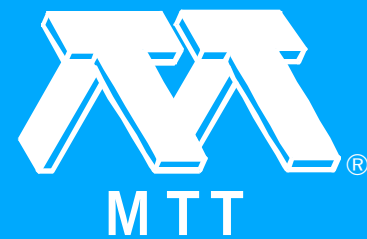
$YBa_2Cu_3O_{7-x}$  and  $Tl_2CaBa_2CuO_8$  high temperature superconducting thin films were utilized to fabricate frequency selective surfaces (FSS) at millimeter-wave frequencies (75-110 GHz). An analytical/numerical model was applied, using a Floquet expansion and the Method of Moments, to analyze bandstop superconducting frequency selective surfaces. Experimental results were compared with the model, and showed a good agreement with resonant frequency prediction with an accuracy of better than 1%. The use of the superconducting frequency selective surfaces as quasi-optical millimeter-wave bandpass filters was also demonstrated.

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## Multiple Microstrip Lines on a Multilayered Cylindrical Dielectric Substrate on Perfectly Conducting Wedge

*H.A. Auda and A.Z. Elsherbeni. "Multiple Microstrip Lines on a Multilayered Cylindrical Dielectric Substrate on Perfectly Conducting Wedge." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1037-1043.*

The quasi-TEM characteristics of a class of cylindrical microstrip lines are rigorously determined. The class of microstrip lines considered consists of multiple infinitesimally thin strips on a multilayered dielectric substrate on a perfectly conducting wedge. Expressions for the potential distribution inside and outside the dielectric substrate, charge distribution on the strips, and capacitance matrix of the microstrip lines are derived. The problems of a microstrip line on a cylindrically capped wedge and on a cylindrical dielectric substrate on perfectly conducting core are also considered as special cases. Sample numerical results based on the derived expressions are given and discussed.



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## Transverse Scattering Matrix Formulation for a Class of Waveguide Eigenvalue Problems

Z. Ma, E. Yamashita and S. Xu. "Transverse Scattering Matrix Formulation for a Class of Waveguide Eigenvalue Problems." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1044-1051.

Based on the mode-matching procedure, a unified transverse scattering matrix formulation is presented for the characterization of a class of waveguide eigenvalue problems, which include not only closed but also open structures. As examples, calculations are carried out on the dispersion characteristics of ridged waveguides and its variations, nonradiative dielectric (NRD) waveguides, groove guides, microstrip lines, finlines, and coplanar waveguides. Comparisons with published data are made, which verify the versatility and accuracy of this method. Besides its generality, this approach is also superior to some other techniques in simplicity and numerical efficiency.

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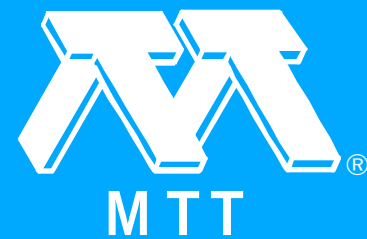


# Abstracts

## Boundary Element Analysis of a Trapezoidal Transmission Line (Jun./Jul. 1993 [T-MTT])

*B. Toland and T. Itoh. "Boundary Element Analysis of a Trapezoidal Transmission Line (Jun./Jul. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1052-1056.*

A full wave analysis of a transmission line with a trapezoidal cross section is described. The boundary element method (BEM) is used; and by making a convenient choice for the dyadic Green's function, the method is shown to be very efficient in comparison to appropriate alternative methods of analysis. Further, in this application, it is shown that for electrically small dimensions, spurious solutions are suppressed by the selection of integral equations. Finally, the analysis is verified by comparisons to calculated results from a vector finite element computer program, and some dispersion data are presented.



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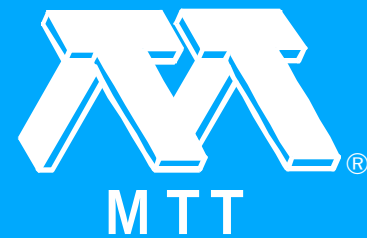


# Abstracts

## Reduction of Edge Reflections in the TLM Model (Jun./Jul. 1993 [T-MTT])

*I.G. Gosling. "Reduction of Edge Reflections in the TLM Model (Jun./Jul. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1057-1064.*

In the transmission-line matrix (TLM) method, spurious reflection is encountered at the edge of the mesh. By modeling the infinite region exterior to the mesh by transformation to a finite region and discretization by a second mesh, the magnitude of reflection is much reduced. Numerical results are presented together with an application.



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## Simulation of HEMT DC Drain Current and 1 to 50 GHz S-Parameters as a Function of Gate Bias (Short Papers)

*S.J. Mahon, M.J. Chivers and D.J. Skellern. "Simulation of HEMT DC Drain Current and 1 to 50 GHz S-Parameters as a Function of Gate Bias (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1065-1067.*

The usefulness over an extended range of a HEMT model previously validated for 1 to 25 GHz s-parameter model is shown. Experimental and simulation results for the dc drain current and 1-50 GHz s-parameters of a pseudomorphic 0.32- $\mu\text{m}$ -gate AlGaAs/InGaAs/GaAs HEMT are presented. The model predicts the device's dc current and s-parameters as a function of the applied gate bias with good accuracy. The core of the model is directly dependent on the HEMT wafer structure and the physical gate length. As part of the modeling procedure, a value of  $(1.77 \pm 0.07) \times 10^5 \text{ m/s}$  is found, confirming the results of other research, for the electron velocity in undoped pseudomorphic In/sub 0.15, Ga/sub 0.85/As under  $\sim 0.3 \mu\text{m}$  gates.

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## Millimeter Wave Three-Port Finline Circulator Using Distributed Coupling Effect (Short Papers)

*J. Mazur. "Millimeter Wave Three-Port Finline Circulator Using Distributed Coupling Effect (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1067-1070.*

The design and experimental results for a novel three-port finline circulator are presented for the frequency range 26-40GHz. The circulator consists of a T/sup E/ -junction cascaded with the section of ferrite coupled slot finlines magnetized in the propagation direction. The T/sup E/ -junction structure refers to a transition from unilateral single slot finline taper into coplanar line region via a tapered center conductor. The design procedure of the structure confirmed by experimental results is described. The proposed structure adjoins to the family of the distributed coupled ferrite line nonreciprocal devices suitable for application in the millimeter-wave range.

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## The Magnetostatic Waves in Ferrite Film with Losses (Short Papers)

*S.A. Vyzulin, A.E. Rosenson and S.A. Shekh. "The Magnetostatic Waves in Ferrite Film with Losses (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1070-1073.*

The influence of relaxation processes on dispersion equation solutions for surface and volume magnetostatic waves (MSW) propagating in ferrite film has been theoretically investigated. It has been shown that dissipation is the reason for the appearance of complementary MSW branches in frequency intervals which adjoin to "standard" branches in spectra. The existence of the threshold MSW wave numbers which are restricted above the spectra of possible wave numbers is established. Asymptotic frequencies and frequencies corresponding to the threshold values of wave numbers have been calculated. The features of dissipation effects on boundary locations of MSW existence ranges were calculated. The frequental dispersion of the losses spectra was also calculated.

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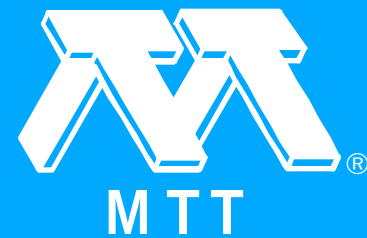


# Abstracts

## A New Implementation of a Multiport Network Analyzer (Corrections)

*A. Ferrero, U. Pisani and K.J. Kerwin. "A New Implementation of a Multiport Network Analyzer (Corrections)." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1074-1074.*

The above paper, contains two typographical errors in Appendix A.



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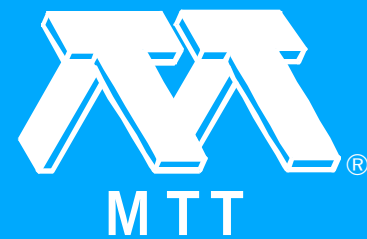


# Abstracts

## X-Band Thin Film Acoustic Filters on GaAs (Jun./Jul. 1993 [T-MTT])

*R.B. Stokes and J.D. Crawford. "X-Band Thin Film Acoustic Filters on GaAs (Jun./Jul. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1075-1080.*

The Semiconductor Bulk Acoustic Resonator (SBAR) is composed entirely of thin films, piezoelectric aluminum nitride (AlN) and metal electrode films (primarily aluminum). It is fabricated on gallium arsenide (GaAs) wafers by depositing the thin film layers on top of the wafer and then etching away the GaAs from below, leaving a thin membrane supported by its edges. SBAR resonators and filters can be fabricated as part of the HBT or MESFET Monolithic Microwave Integrated Circuit (MMIC) processes, offering the high selectivity associated with acoustic resonators and filters to the MMIC designer. This paper describes performance of a recent 1-pole SBAR filter which has only 6.1 dB insertion loss at 7.8 GHz (2nd harmonic) and 7.5 dB insertion loss at 11.6 GHz (third harmonic), with fractional bandwidths less than 1%. Also described are 2-pole (1.4% bandwidth) and 4-pole (1.8 % bandwidth) Chebyshev monolithic SBAR filters at 2.4 GHz, demonstrating flat passbands and good rejection. These results demonstrate that SBAR technology is practical for monolithic filters in MMICs at frequencies up to X-band.



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## Losses in Y-Junction Stripline and Microstrip Ferrite Circulators

*R.E. Neidert and P.M. Phillips. "Losses in Y-Junction Stripline and Microstrip Ferrite Circulators." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1081-1086.*

This paper describes a complete theory to calculate the dielectric, conductor, and magnetic losses of Y-junction stripline and microstrip ferrite circulators in terms of 3-port S-parameters. Calculations using this theory are presented, and compared with existing data for varied circulator parameters over a frequency range of 1-100 GHz.

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## Large-Signal HBT Characterization and Modeling at Millimeter Wave Frequencies

*D.A. Teeter, J.R. East and G.I. Haddad. "Large-Signal HBT Characterization and Modeling at Millimeter Wave Frequencies." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1087-1093.*

This paper presents a detailed large-signal analysis for the heterojunction bipolar transistor. Using a combination of computer models and corrected measurements, we have analyzed the bias and frequency dependence of the gain compression from 8 to 35 GHz for several HBT's. From 8 to 16 GHz, a commercial tuner system was used for making the measurements. However, beyond 26 GHz, an active load pull system was designed and constructed to circumvent problems created by component losses. Several comparisons between measured and modeled data are provided to illustrate the effectiveness of the characterization technique.

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## Matched-Line Directional Dividers

*T.J. Russell. "Matched-Line Directional Dividers." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1094-1104.*

A new class of passive microwave devices is described that provides for equal or unequal division of a signal from an input to two or more outputs--with the outputs isolated from each other. The matched-line directional divider consists of an input network connected through interconnection ports to a transmission line network. The input network typically consists of resistors. The transmission line network consists of generally parallel transmission lines that are coupled together at the interconnection ports and uncoupled at their output ports. Output match and isolation between output ports is obtained by designing the transmission line network to match the uncoupled output ports to the outputs of the input network. It is shown that by using tapered transmission lines, MLDD's can be designed to have high-pass frequency response. Five new types of coupled tapered line power dividers having terminating resistor configurations at the coupled line inputs are described.





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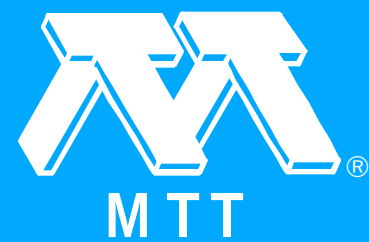
## Reciprocity Relations in Waveguide Junctions

*D.F. Williams and R.B. Marks. "Reciprocity Relations in Waveguide Junctions." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1105-1110.*

The Lorentz reciprocity condition is applied to junctions composed of reciprocal media which connect uniform but otherwise arbitrary waveguides. An expression relating the forward and reverse transmission coefficients is derived and factored into two terms: the first involving the phase of the reference impedance in the guide, and the second a new reciprocity factor. The usual condition equating the forward and reverse transmission coefficients is shown not to hold in the general case. Experimental evidence supporting the theoretical results is presented.

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## Computation of Cutoff Wavenumbers for Partially Filled Waveguides of Arbitrary Cross Section Using Surface Integral Formulations and the Method of Moments

*S. Shu, P.M. Goggans and A.A. Kishk. "Computation of Cutoff Wavenumbers for Partially Filled Waveguides of Arbitrary Cross Section Using Surface Integral Formulations and the Method of Moments." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1111-1118.*

A procedure for determining the cutoff wavenumbers of partially dielectric filled waveguides of arbitrary cross section is presented. A numerical approach based on surface integral formulations and the method of moments is used to obtain a matrix equation. Muller's method is then applied to find the wavenumbers that make the matrix determinant vanish. These are the cutoff wavenumbers. On the conducting walls of the waveguide, perfect electric conductor, perfect magnetic conductor, and imperfect conductor surfaces are considered. The transverse electric and magnetic cases are treated separately. The impedance boundary condition and the symmetry of the waveguide cross section are used to reduce the matrix size in the method of moments. Spurious modes have not been observed using this method. To validate the accuracy of this method, results for circular, partially filled rectangular, and two walled corrugated rectangular waveguides are compared to analytical results. Examples such as T-septate rectangular, coaxial, and dielectric-loaded double-ridged waveguide are also considered. Accurate prediction on the cutoff wavenumbers is achieved.





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## Analysis of Millimeter Waveguides on Anisotropic Substrates Using the Three-Dimensional Transmission-Line Matrix Method

*C. Bulutay and S. Prasad. "Analysis of Millimeter Waveguides on Anisotropic Substrates Using the Three-Dimensional Transmission-Line Matrix Method." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1119-1125.*

Three-dimensional condensed asymmetrical node, variable grid, transmission-line matrix (TLM) method has been used in analyzing several millimeter waveguides on anisotropic substrates. The dispersion characteristics of image guides together with field and energy confinement properties at millimeter-wave frequencies have been investigated. Edge coupled microstrip line on a uniaxial substrate is analyzed for the even and odd mode dispersion characteristics. Finally the same analysis is repeated for bilateral fin lines on uniaxial/biaxial substrates. The results obtained using other computational techniques are included in all of these cases to assess the competence of the method.

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## Electromagnetic Model of a Planar Radial-Waveguide Divider/Combiner Incorporating Probes

*M.E. Bialkowski and V.P. Waris. "Electromagnetic Model of a Planar Radial-Waveguide Divider/Combiner Incorporating Probes." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1126-1134.*

A field matching technique is used to develop an electromagnetic model for an M-way planar radial-waveguide divider/combiner incorporating probes. Based on this model, a broadband operation of the radial divider/combiner is investigated. The application of the developed model is shown in a design example of a 20-way power divider.

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## Thermic End-Fire Interstitial Applicator for Microwave Hyperthermia

*G. Cerri, R. De Leo and V.M. Primiani. "Thermic End-Fire Interstitial Applicator for Microwave Hyperthermia." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1135-1142.*

This paper presents the analysis of a "thermic end-fire" interstitial applicator for microwave hyperthermia, i.e., an applicator that performs a tip localized heating of the surrounding lossy medium. The antenna consists of a shorted coaxial cable with an annular radiating aperture at the end. The analytical approach is based on the equivalence principle, which leads to an integral equation for the equivalent magnetic current distribution on the aperture; solution is achieved by the Method of Moments. All theoretical results have been compared to experimental ones showing a good agreement in a wide frequency range,

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## MSSW and MSVW in a Multilayered Ferrimagnetic Structure with an Arbitrary Orientation Between Two Static Magnetizations

K. Sun. "MSSW and MSVW in a Multilayered Ferrimagnetic Structure with an Arbitrary Orientation Between Two Static Magnetizations." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1143-1148.

This paper presents a study of both magnetostatic surface wave (MSSW) and magnetostatic volume wave (MSVW) propagation in multilayered magnetic thin films with noncollinear magnetizations. YIG/GGG/YIG structure is used, where YIG and GGG are the abbreviations for yttrium iron garnet and gadolinium gallium garnet, respectively. The layered film is in the (110) plane. Due to the existence of both cubic and induced in-plane uniaxial anisotropy fields in the two YIG films, the two magnetizations ( $\vec{M}_1$  and  $\vec{M}_2$ ) are not aligned with the applied dc field. Since there is an arbitrary angle between  $\vec{M}_1$  and  $\vec{M}_2$ , there is a new configuration to study both MSSW and MSVW propagations. The interested MSVW propagation in the plane formed by  $\vec{M}_1$  and  $\vec{M}_2$  shows a different dispersion relationship from that in the direction perpendicular to the plane formed by  $\vec{M}_1$  and  $\vec{M}_2$ . For a given applied dc field normal to the film plane, MSVW is excited in the  $\vec{M}_2$  layer, while MSSW is excited in the  $\vec{M}_1$  layer. We have found that the angle between the two static magnetizations strongly affects the dispersion relationship. In addition, the effect of the separation between the two magnetic layers on the dispersion and time delay has been studied.





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## Two-Dimensional Mapping of the Microwave Potential on MMIC's Using Electrooptic Sampling

*D.R. Hjelme, M.J. Yadlowsky and A.R. Mickelson. "Two-Dimensional Mapping of the Microwave Potential on MMIC's Using Electrooptic Sampling." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1149-1158.*

An accurate technique for mapping the two-dimensional microwave potential in microwave circuits has been developed and tested. Using the direct electrooptic sampling technique and a de-embedding algorithm to remove substrate variation induced measurement errors, accurate two-dimensional potential maps with a dynamic range of 50 dB and spatial resolution of 10  $\mu\text{m}$  are obtained. De-embedding of the microwave potential from the measured, electrooptically modulated signal is achieved by deducing the substrate parameters from the measured average reflected optical power. Once the substrate is characterized, the microwave potential can be calculated from the electrooptic signal. The de-embedding procedure technique was successfully tested on a through-line and an open-end line of a TRL microstrip calibration standard.

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# Abstracts

## Coupled-Mode Analysis of Leaky Waves in Channel Waveguides Consisting of Anisotropic Material

*M. Geshiro, M. Hotta and T. Kameshima. "Coupled-Mode Analysis of Leaky Waves in Channel Waveguides Consisting of Anisotropic Material." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1159-1163.*

For the first time, a study is made of leaky waves in anisotropic circular channel waveguides consisting of uniaxial crystalline material, in which the optical axis is on the plane which is defined by the propagation axis and one of the transverse coordinates axes. The analysis is based on the theory of coupled modes. Mathematical discretization of the continuum of radiation modes offers satisfactorily accurate solutions of the coupled-mode equations. The characteristics of leakage losses and the field distributions of leaky waves in a LiNbO<sub>3</sub>/sub 3/ waveguide are discussed on the basis of the numerical results.



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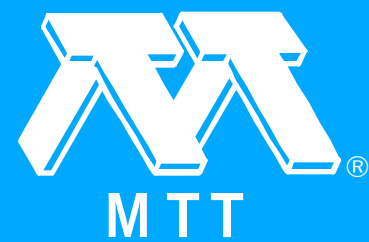
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## Generalized Multiport Reciprocity Analysis of Surface-to-Surface Transitions Between Multiple Printed Transmission Lines

*N.K. Das. "Generalized Multiport Reciprocity Analysis of Surface-to-Surface Transitions Between Multiple Printed Transmission Lines." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1164-1177.*

A new method of analysis of surface-to surface transitions between arbitrary combinations of multilayered printed transmission lines using a general multiport reciprocity formulation is presented. The scattering parameter at a given port of the transition is computed by directly relating it to simple reactions of the known eigenfields of the particular port on various induced strip currents or slot electric fields of other transmission lines. With simplifying practical assumptions in this general analysis, and by use of an efficient "singularity extraction technique," equivalent circuit models for particular cases are extracted with simple closed-form expressions for the equivalent circuit parameters. The multiport scattering matrix of the transition completely describes the coupling characteristics of the transition, and via standard network analysis can be conveniently used for design optimization of any port terminations and/or matching circuits. Detailed case studies of the general analysis include: 1) a single-layered microstrip line-to-slotline transition, 2) a microstrip-to-crossed covered microstrip transition, 3) a double microstrip line-to-slotline transition, and 4) a stripline-to-dual slotline transition.





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## Transients on Lossless Exponential Transmission Lines Using Allen's Method

*P. Bouchard, R.R.J. Gagne and J.-L. Lavoie. "Transients on Lossless Exponential Transmission Lines Using Allen's Method." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1178-1182.*

The exact analytical expressions of the time-domain step response matrix for the lossless exponential transmission line are developed, therefore extending the range of problems where Allen's method can be applied for the transient analysis of networks consisting of interconnections of linear distributed elements, lumped linear and/or nonlinear elements, and arbitrary sources. An indication as to the correctness of the expressions is obtained by comparing them to published results, which also helps to gain a better physical insight into the step response matrix. Moreover, the response to a step input and also the transient response to a sudden sinusoidal excitation are presented.

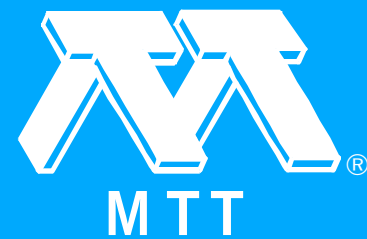
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## The Method of Lines for the Analysis of Rectangular Spiral Inductors

*F.J. Schmuckle. "The Method of Lines for the Analysis of Rectangular Spiral Inductors." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1183-1186.*

An accurate procedure is presented for the investigation of the electrical properties of rectangular spiral inductors. The models of the analyzed spiral inductors are composed of straight and bent multiple-line sections. The line sections are analyzed with the well-known Method of Lines (MoL). For the bends of coupled lines, a new analysis is used. The procedure considers all self- and mutual inductances of the straight multiple-line sections, as well as the electrical characteristics of the bends of coupled lines.



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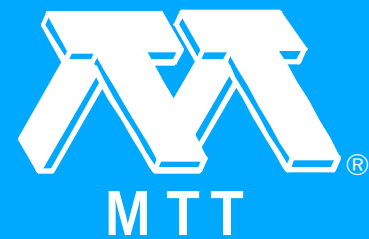
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## Triangular-Domain Basis Functions for Full-Wave Analysis of Microstrip Discontinuities

*R. Kipp and C.H. Chan. "Triangular-Domain Basis Functions for Full-Wave Analysis of Microstrip Discontinuities." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1187-1194.*

A numerical technique for computing the S-parameters of arbitrarily shaped microstrip discontinuities and interconnects is presented. The microstrip conducting surface is rendered in a triangular discretization. Unknown currents are expanded with triangular-domain basis functions in a method of moments solution to the mixed-potential integral equation (MPIE). Triangular basis functions offer several advantages over rectangular subdomain functions, including their ability to conform readily to arbitrary geometries without "staircase" effect. Examples comparing triangular-domain modeling with rectangular-domain modeling and experiment are given.

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## Rigorous, Multimode Equivalent Network Representation of Capacitive Discontinuities

*M. Guglielmi and A.A. Melcon. "Rigorous, Multimode Equivalent Network Representation of Capacitive Discontinuities." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1195-1206.*

In this paper we present novel, rigorous, multimode equivalent network representations for a variety of zero-thickness capacitive windows and obstacles in a parallel plate waveguide. A key feature of these representations is that the coupling between all of the modes excited is described by a matrix whose elements do not depend on frequency or absolute dimensions. The value of the results presented is that the networks developed can be used to analyze rigorously a large variety of single and coupled planar transmission line structures.

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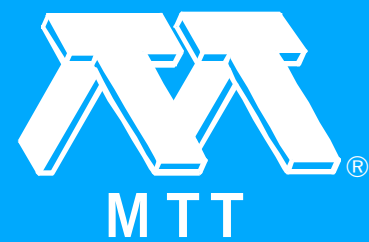
## Analysis of Inhomogeneously Filled Cavities Coupled to Waveguides Using the VIE Formulation

*A. Jostingmeier and A.S. Omar. "Analysis of Inhomogeneously Filled Cavities Coupled to Waveguides Using the VIE Formulation." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1207-1214.*

A method based on the volume integral equation (VIE) formulation is presented which can be used to analyze inhomogeneously filled cavities of arbitrary shape to which cylindrical waveguides of arbitrary cross section are coupled. The inhomogeneity inside the cavity is described by a spatially dependent permittivity. The method is applied to the problem of scattering by dielectric bodies inside waveguides. Furthermore it will be demonstrated how the convergence of the method can be accelerated.

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## An Efficient Finite Element Solution of Inhomogeneous Anisotropic and Lossy Dielectric Waveguides

*Y. Lu and F.A. Fernandez. "An Efficient Finite Element Solution of Inhomogeneous Anisotropic and Lossy Dielectric Waveguides." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1215-1223.*

An efficient finite element method is presented for the full wave analysis of dielectric waveguides. This method has four major features: 1) the ability to treat a wide range of dielectric waveguide problems with arbitrarily shaped cross section, inhomogeneity, transverse-anisotropy, and significant loss (or gain); 2) total elimination of spurious solutions; 3) direct solution for the (complex) propagation constant at a specified frequency; and 4) the use of only two components of the magnetic field, thus maximizing the numerical efficiency of solution. The resultant matrix eigenvalue problem is of canonical form and is solved with an efficient method, specially developed for this purpose, taking full advantage of the sparsity of the matrices. Numerical results are shown for a variety of microwave and optical waveguides including anisotropy and losses. These examples also include closed and open-bounded structures. The computational results agree very well with analytical and previously published results.



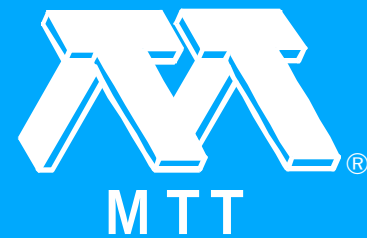


# Abstracts

## A Compact Ring-Style 8-Port Comparator Circuit Using Coupled Lines (Short Papers)

*G.P. Riblet. "A Compact Ring-Style 8-Port Comparator Circuit Using Coupled Lines (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1224-1226.*

A novel ring-type 8-port comparator circuit is described which has a circumference of only 1 wavelength at midband. It consists of a symmetrical arrangement of 4 coupled line sections etched on the top and bottom surfaces of a thin circuit board. All ports are external to the ring.



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## Metallization Effects on GaAs Microstrip Line Attenuation (Short Papers)

*J. Carroll and K. Chang. "Metallization Effects on GaAs Microstrip Line Attenuation (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1227-1229.*

The transmission line losses of plated gold GaAs microstrip were investigated from 5 to 30 GHz. Experimental attenuation coefficients were extracted from quality factor measurements of 50 Omega straight microstrip resonators. The measured attenuation coefficients for plated gold microstrip were found to be 38% higher than previously published data on evaporated gold microstrip, and 44% higher than Computer-Aided Design (CAD) simulations. Empirical bulk resistivities were found that correctly characterize GaAs plated line losses for CAD models. This paper indicates that GaAs microstrip line attenuation cannot be completely characterized by dc resistivity alone, and that empirical microstrip parameters are needed for accurate CAD modeling.

[Click on title for a complete paper.](#)



## Modeling of Transverse Propagation Delays in the GaAs/AlGaAs Modulation Doped Heterojunction Field Effect Transistors

*A.K. Goel and W. Xu. "Modeling of Transverse Propagation Delays in the GaAs/AlGaAs Modulation Doped Heterojunction Field Effect Transistors." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1230-1232.*

We have developed a computer-efficient algorithm to calculate the transverse propagation delays in a GaAs/AlGaAs MODFET. The model includes the intrinsic as well as the extrinsic parameters of the MODFET. The dependence of these delays on the various MODFET parameters such as its gate length, width and the gate metal resistivity have been studied.

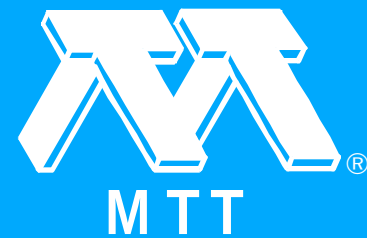


# Abstracts

## Calculation of Intercavity Coupling Coefficient for Side Coupled Standing Wave Linear Accelerator (Short Papers)

*R. Roy and O. Shanker. "Calculation of Intercavity Coupling Coefficient for Side Coupled Standing Wave Linear Accelerator (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1233-1235.*

Expressions are developed for the main to side cavity coupling coefficient of a side coupled standing wave linac structure and for the shift in cavity resonant frequency produced by the coupling iris. The theoretical predictions show reasonable agreement with the measured values.



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## Shape Function Optimization in the Finite Element Analysis of Waveguides

*H.E. Hernandez-Figueroa and G. Pagiatakis. "Shape Function Optimization in the Finite Element Analysis of Waveguides." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1235-1238.*

In this paper, a novel finite element technique is presented, which can substantially reduce the computational effort required for the analysis of waveguide structures. Demonstrative examples, whose finite element solutions are obtained by combining this technique with two well-known formulations-- $E_z$  and  $H_z$  and  $H$ -field-are given.

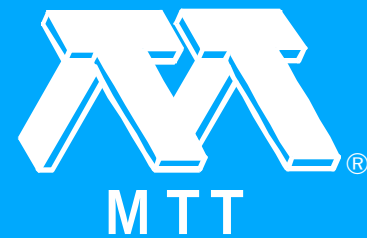
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# Abstracts

## Deterministic Approach to Full-Wave Analysis of Discontinuities in MIC's Using the Method of Lines (Comments and Authors' Reply)

*X.-h. Jiang, Z. Tang, Z. Chen and B. Gao. "Deterministic Approach to Full-Wave Analysis of Discontinuities in MIC's Using the Method of Lines (Comments and Authors' Reply)." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1239-1240.*  
There seems to be some negligence in the above paper. Equations (16) and (17) could not be deduced from expressions (6) to (15).



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## A Linear-Operator Formalism for the Analysis of Inhomogeneous Biisotropic Planar Waveguides (Corrections)

*C.R. Paiva and A.M. Barbosa. "A Linear-Operator Formalism for the Analysis of Inhomogeneous Biisotropic Planar Waveguides (Corrections)." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1240-1240.*

In the above paper, due to an algebraic error, the coefficients  $Q$ ,  $\alpha_{2/}$  and  $B$  with the radiation modes are incorrectly derived in Appendix III. Defining (with  $s = 1, 2$ )  $\alpha_s = \sin(\sigma_s/t')$  and  $b_s = \cos(\sigma_s/t')$ , then the following corrections should be made:

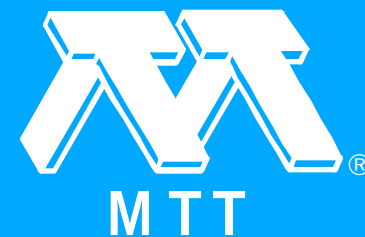
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# Abstracts

## Call for Papers - Ultra-Wideband, Short-Pulse Electromagnetics (Jun./Jul. 1993 [T-MTT])

*"Call for Papers - Ultra-Wideband, Short-Pulse Electromagnetics (Jun./Jul. 1993 [T-MTT])."*  
*1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1241-1241.*



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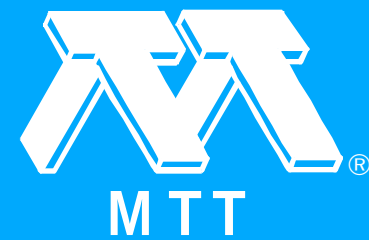




# Abstracts

## Call for Papers - Waves and Microwaves (Jun./Jul. 1993 [T-MTT])

*"Call for Papers - Waves and Microwaves (Jun./Jul. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1242-1242.*



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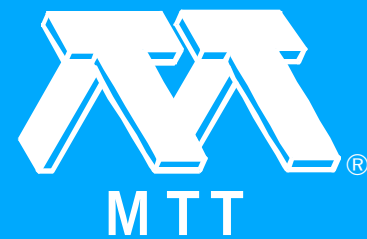
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# Abstracts

## Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Jun./Jul. 1993 [T-MTT])

*"Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Jun./Jul. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1243-1243.*



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# Abstracts

## New Books from IEEE Press (Advertisement) (Jun./Jul. 1993 [T-MTT])

*"New Books from IEEE Press (Advertisement) (Jun./Jul. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): 1244-1244.*



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# Abstracts

## Back Cover (Jun./Jul. 1993 [T-MTT])

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*"Back Cover (Jun./Jul. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.6 (Jun./Jul. 1993 [T-MTT]): b1-b1.*



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## Front Cover (Aug. 1993 [T-MTT])

*"Front Cover (Aug. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): f1-f2.*



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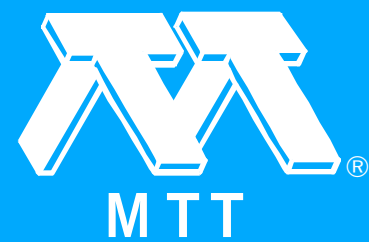
## Equivalent Circuit Parameters of an Aperture Coupled Open Resonator Cavity

*R.K. Mongia and R.K. Arora. "Equivalent Circuit Parameters of an Aperture Coupled Open Resonator Cavity." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1245-1250.*

In this paper, we use modified form of Bethe's small hole coupling theory to compute equivalent circuit parameters of an aperture coupled open resonator cavity. The open resonator cavity is composed of spherical mirrors of circular cross section. The cavity is coupled to a rectangular waveguide by means of a common hole in the mirror and the shorted end wall of the rectangular waveguide. Closed form expressions have been obtained for the equivalent circuit parameters. Experiments conducted in the W-band frequency range show good agreement with theory when an experimentally estimated correction to the transmission coefficient is applied for the thickness of the coupling holes.

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## Frequency and Time Domain Characterization of Microstrip-Ridge Structures

*A.G. Engel, Jr. and L.P.B. Katehi. "Frequency and Time Domain Characterization of Microstrip-Ridge Structures." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1251-1262.*

Microstrip-ridge structures, i.e., conducting strips which are mounted on ridges and are in the close proximity of other conductors on other ridges, are found in sub-millimeter/ terahertz monolithic circuits in conjunction with layered, ridged dielectric waveguides; in millimeter-wave monolithic circuits as microslab lines; in microwave monolithic circuits as integrated traveling-wave optical modulators; and in VLSI circuits as interconnects. A hybrid full-wave frequency domain technique which uniquely synthesizes well-known integral equation and mode-matching methods is shown to be applicable to the study of microstrip-ridge structures. Unlike most other integral equation techniques, the integral equation-mode matching (IEMM) technique is capable of characterizing a wide variety of nonplanar structures. Time domain results are obtained by utilizing a Fourier transform and an equivalent circuit model to evaluate the response at each frequency point. To introduce this method, several two-dimensional structures-specifically, coupled microstrips on ridges, coupled microstrip with an etched groove, and an electrooptic modulator are examined.

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## Design of Conical Corrugated Feed Horns for Wide-Band High-Frequency Applications

X. Zhang. "Design of Conical Corrugated Feed Horns for Wide-Band High-Frequency Applications." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1263-1274.

This paper presents a new analytical procedure for the design of the conical corrugated feed horns used in the millimeter and submillimeter wavelength range, which could achieve wide-band single-mode operation and wide-band, low return-loss impedance matching simultaneously. A test model of the feed horn designed using this procedure displayed excellent performance, and agreed well with the theoretical predictions.

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## Lossy Transmission Lines: Time Domain Formulation and Simulation Model

*P.S. Yeung. "Lossy Transmission Lines: Time Domain Formulation and Simulation Model." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1275-1279.*

The time domain quasi-TEM equations for lossy transmission lines with R, L, C, and G parameters is reformulated and solved to relate directly the currents and voltages at the line terminations, at present and past times. This allows a computer model to be set up for simulating circuits with nonlinear terminations in the time domain using general circuit simulators. This formulation describes propagation of two dynamic forward and backward waves and is the extension of the method of characteristics to the lossy case. Distortion and impedance changes are generated by finite convolutions with past history information at the line terminations. For constant R, L, C, and G, and for a skin effect approximation, the kernels of Green's functions for these convolutions are derived as analytic expressions.

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# Abstracts

## A Finite Difference Approach that Employs an Asymptotic Boundary Condition on a Rectangular Outer Boundary for Modeling Two-Dimensional Transmission Line Structures

*R.K. Gordon and S.H. Fook. "A Finite Difference Approach that Employs an Asymptotic Boundary Condition on a Rectangular Outer Boundary for Modeling Two-Dimensional Transmission Line Structures." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1280-1286.*

In this paper, the derivation of three asymptotic boundary conditions is presented. Techniques for implementing each of these on finite difference meshes with rectangular outer boundaries are discussed. Numerical results obtained using these boundary conditions in the finite difference analysis of both shielded and unshielded transmission lines are shown. We present detailed convergence studies on the use of each of these boundary conditions and discuss the memory requirements of each.



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# Abstracts

## An Efficient Algorithm for the Calculation of Parasitic Coupling Between Lines in MIC's

*J.M. Dunn, L.C. Howard and K. Larson. "An Efficient Algorithm for the Calculation of Parasitic Coupling Between Lines in MIC's." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1287-1293.*

A new algorithm is developed to calculate parasitic coupling between transmission lines in an efficient manner. The algorithm works by using the currents and voltages on the lines in the absence of parasitic to calculate independent voltage and current sources which then give the approximate coupling strength between the various lines. These sources are easy to place in a CAB circuit program. The algorithm is demonstrated on a double-stub filter structure. The observed splitting of the resonance, for this particular example, is modeled by using dependent sources, as calculated from the independent sources.



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## Design Criteria for Multistage Microwave Amplifiers with Match Requirements at Input and Output

*G. Macchiarella, A. Raggi and E. Di Lorenzo. "Design Criteria for Multistage Microwave Amplifiers with Match Requirements at Input and Output." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1294-1298.*

An approach to the design of multistage microwave amplifiers in a prescribed frequency band with requirements about the transducer gain flatness and the maximum magnitude of the reflection coefficient at input and output is presented. The interstage equalizers are designed by imposing a suitable constraint on the maximum transducer gain, obtainable directly from the specifications; the input and output equalizer are obtained by imposing only the matching requirement. The method proposed allows a separate design of each network which can be performed either through direct optimization or by means of a numerical synthesis.

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## Maximum Dynamic Range Operation of a Microwave External Modulation Fiber-Optic Link

*E. Ackerman, S. Wanuga, D. Kasemset, A.S. Daryoush and N.R. Samant. "Maximum Dynamic Range Operation of a Microwave External Modulation Fiber-Optic Link." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1299-1306.*

We fully analyze the analog performance of an external modulation fiber-optic link. We express relevant figures of merit including gain, noise figure, third-order intermodulation distortion, AM compression, and dynamic range in terms of the microwave scattering matrices of the modulator and detector circuits, and we predict the modulator bias condition promoting optimum link performance. Our predictions match the measured gain, noise figure, and dynamic range of an experimental 870-930 MHz external modulation fiber-optic link. Maximum spurious-free dynamic range--77 dB. MHz/sup 2/3/ (117 db·Hz/sup 2/3/)--occurs when the modulator is biased at its halfwave voltage, where the optical throughput is nearly pinched off.

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## Novel 18/36 GHz (M)MIC GaAs FET Frequency Doublers in CPW-Techniques Under the Consideration of the Effects of Coplanar Discontinuities

*M. Abdo-Tuko, M. Naghed and I. Wolff. "Novel 18/36 GHz (M)MIC GaAs FET Frequency Doublers in CPW-Techniques Under the Consideration of the Effects of Coplanar Discontinuities." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1307-1315.*

The design and performance of single-device and balanced versions of (M)MIC GaAs FET frequency doublers from 18 GHz to 36 GHz, fabricated in purely coplanar waveguide techniques, are presented. Coplanar discontinuities which are usually neglected are taken into consideration in the analysis and design. Spiral inductors and their associated parasitic capacitance are used for impedance matching and phase shifting purposes. The simulation technique used to characterize the spiral inductors is described in detail. Measurement and simulation results show good agreement. The investigated hybrid doublers have a minimum conversion loss of 7 dB while a maximum conversion gain of 6B is predicted for the monolithic version of the doublers. They are fabricated on ceramic and gallium arsenide substrates and are simple, cost effective, and applicable in low and medium power transmitter/receiver systems.



# Abstracts

## A Signal-to-Noise Enhancer Using Two MSSW Filters and its Application to Noise Reduction in DBS Reception

*T. Nomoto and Y. Matsushita. "A Signal-to-Noise Enhancer Using Two MSSW Filters and its Application to Noise Reduction in DBS Reception." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1316-1322.*

This paper describes the design and development of a new type of MSW signal-to-noise enhancer which consists of a microwave circuit using two MSSW filters, one of which operates as a frequency selective power limiter. It also describes the first application of such an enhancer to DBS reception. Compared with a conventional enhancer, the threshold level and the limiting action level of this enhancer are 13 dB and 27 dB lower, respectively, and the slope from the former to the latter is much steeper. As a result, the enhancer makes it possible to achieve 20-dB lower-power operation (below +10 dBm) of periphery driving circuits. In DBS reception below the FM threshold, the enhancer improves the S/N of the video signal by 2 to 8 dB.



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## Distortion in Off-State Arsenide MESFET Switches

*R.H. Caverly. "Distortion in Off-State Arsenide MESFET Switches." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1323-1328.*

This paper presents the results of an investigation into the origin and level of distortion generated by the off-state gallium arsenide MESFET when used as a microwave semiconductor control element. The results show that the drain-gate and gate-source capacitance nonlinearities generate distortion in the device in its off-state. These nonlinearities, which reflect the capacitance-voltage characteristic of the capacitances, can be reduced in as-fabricated devices by increasing the gate reverse bias voltage. The level of distortion monotonically increases with frequency throughout the usable range of the MESFET when used in a series reflective switch. In an SPDT switch application, where both on and off-state devices are used, the distortion level is relatively constant at frequencies in the vicinity of the gate bias cut-off frequency. The nonlinear off-state model is compared with both a SPICE-based analysis, and with experimental data on a GaAs MESFET SPDT switch. The main conclusions to be drawn from the study are that the dominate distortion generated by a GaAs MESFET used in a switch application occurs in the on-state, and that off-state distortion can be only slightly improved in as-fabricated devices.







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## Continuous Spectrum, Characteristic Modes, and Leaky Waves of Open Waveguides

*M. Mongiardo and T. Rozzi. "Continuous Spectrum, Characteristic Modes, and Leaky Waves of Open Waveguides." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1329-1335.*

The modes of open waveguides with nonseparable cross sections are derived by means of an extension of the resonance equation for the electromagnetic field. Such modes, forming a continuous spectrum, allow us to apply to discontinuity problems in open environments the techniques originally developed for closed waveguides. In this paper, the resonance equation is generalized according to functional analysis considerations. By this approach, it is possible to derive the modal spectrum from the simultaneous diagonalization of the real and imaginary parts of the admittance of the structure. A variational interpretation of the solution of the generalized resonance equation gives additional insight into the modes of open waveguides. The generalized resonance equation, when applied to three-dimensional objects, provides the well-known characteristic modes of these structures. The relationship between continuous spectrum, characteristic modes, and leaky waves is also discussed.

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# Abstracts

## Modified Broadside-Coupled Microstrip Lines Suitable for MIC and MMIC Applications and a New Class of Broadside-Coupled Band-Pass Filters

*M. Tran and C. Nguyen. "Modified Broadside-Coupled Microstrip Lines Suitable for MIC and MMIC Applications and a New Class of Broadside-Coupled Band-Pass Filters." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1336-1342.*

Modified broadside-coupled microstrip lines, suitable for microwave and millimeter-wave integrated and monolithic integrated circuit (MIC and MMIC) applications requiring wide bandwidths and tight couplings, are presented. Their analysis, based on the quasi-static spectral domain technique, is described. Using these broadside structures, a new class of broadside-coupled band-pass filters has been developed at X-band (8- 12 GHz) with about 1-dB insertion loss. Fair agreement between the measured and calculated results has been observed even though a major approximation is used.



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# Abstracts

## Measurement of the Complex Permittivity of Low-Loss Planar Microwave Substrates Using Aperture-Coupled Microstrip Resonators

*M.A. Saed. "Measurement of the Complex Permittivity of Low-Loss Planar Microwave Substrates Using Aperture-Coupled Microstrip Resonators." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1343-1348.*

This paper describes a technique for the determination of the complex permittivity of low-loss dielectric substrates at microwave frequencies. The technique utilizes an aperture-coupled microstrip resonator fed using a microstrip line in a two layer configuration. The ends of the resonator are shorted in order to avoid radiation. The technique can also be used for the measurement of the complex permittivity of other electronic materials such as thin and thick film materials at microwave frequencies. Nonresonant modes and conductor losses are taken into account in the analysis to improve the accuracy of the results. Analysis procedure as well as experimental results are presented.



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## Resonance in a Superstrate-Loaded Rectangular Microstrip Structure

*J.-S. Row and K.-L. Wong. "Resonance in a Superstrate-Loaded Rectangular Microstrip Structure." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1349-1355.*

The complex resonant frequency of a superstrate-loaded rectangular microstrip structure is investigated. The study is performed by using a full-wave analysis and Galerkin's moment method. The numerical convergence using sinusoidal basis functions, with and without considering the edge singularity to expand the unknown surface current distribution on the rectangular patch, is discussed. Numerical results for the effects of superstrata permittivity and thickness on the complex resonant frequency of the rectangular microstrip structure are also presented.

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## Analysis of a Thin Slot Discontinuity in the Reference Plane of a Microstrip Structure

*A.B. Kouki, R. Mittra and C.H. Chan. "Analysis of a Thin Slot Discontinuity in the Reference Plane of a Microstrip Structure." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1356-1362.*

This paper presents a perturbational approach based upon the spectral domain technique for the analysis of the discontinuity effects introduced by a thin slot in the ground plane of a microstrip line. The discontinuity problem is formulated in terms of the unknown slot field by using the notion of equivalent half-space problems, using a new rigorous procedure for deriving the TE-TM decomposition of the fields and equivalent transmission line models. The perturbation current on the infinite microstrip is computed once the electric field in the slot has been derived, and an equivalent circuit for the discontinuity is obtained from this perturbation current for the low-frequency regime. Computed results are presented and compared to the measured data.

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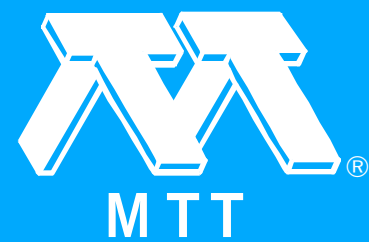
## Full-Wave Analysis of Radiating Planar Resonators with the Method of Lines

*A. Dreher and R. Pregla. "Full-Wave Analysis of Radiating Planar Resonators with the Method of Lines." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1363-1368.*

The method of lines (MoL) is extended to analyze radiating planar resonators by the use of absorbing boundary conditions. For stratified layers, an equivalent network is derived to set up a system equation by simple multiplication of hybrid matrices. As an example, the complex resonant frequency of a microstrip patch is computed and compared to results achieved with the integral equation method in spectral domain. The radiation in the near-field region is depicted by a vector plot of the energy flow, given by the real part of the Poynting vector.

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## Investigation of Multiple Rectangular Aperture Irises in Rectangular Waveguide Using TE/ $\text{sup } x$ over sub $\text{mn/}$ -Modes

*R. Yang and A.S. Omar. "Investigation of Multiple Rectangular Aperture Irises in Rectangular Waveguide Using TE/ $\text{sup } x$  over sub  $\text{mn/}$ -Modes." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1369-1374.*

With the use of proper aperture basis functions in conjunction with the moment method and TE/ $\text{sup } x$ / $\text{sub mn/}$ -modal expansion, the coupling effect of transverse irises with multiple rectangular coupling apertures in a rectangular waveguide has been investigated. Numerical studies carried out for twin- and triple-aperture coupling irises have been confirmed by the experiments. The simulation result for a Ka-band bandpass filter realized with triple-aperture irises gives a higher stop-band attenuation than that of a filter with single-aperture irises. The use of TE/ $\text{sup } x$ / $\text{sub mn/}$ -modal expansion is characterized by the reduction of both computer memory and CPU time requirements during the numerical study as compared with the commonly used TE/ $\text{sub mn/}$  - TM/ $\text{sub mn/}$  modal approach.

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## Generalized Dispersion Analysis and Spurious Modes of 2-D and 3-D TLM Formulations

*J.S. Nielsen and W.J.R. Hoefer. "Generalized Dispersion Analysis and Spurious Modes of 2-D and 3-D TLM Formulations." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1375-1384.*

The general dispersion relations are derived for the 2-D TLM shunt and series meshes and the 3-D TLM expanded and condensed node meshes. Implicit in the resulting dispersion relations are both their physical and spurious modal solutions. It is demonstrated that of the four schemes, only the 3-D expanded node mesh is free of detrimental spurious solutions.

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## Rigorous Boundary Integral Equation Solution for General Isotropic and Uniaxial Anisotropic Dielectric Waveguides in Multilayered Media Including Losses, Gain and Leakage

*F. Olyslager and D. De Zutter. "Rigorous Boundary Integral Equation Solution for General Isotropic and Uniaxial Anisotropic Dielectric Waveguides in Multilayered Media Including Losses, Gain and Leakage." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1385-1392.*

Bounded and leaky eigenmodes of arbitrary shaped polygonal dielectric waveguides embedded in a multilayered medium are determined based on a rigorous full-wave analysis. The dielectric waveguides consist of isotropic or uniaxial anisotropic material. Losses and gain inside the layers and the waveguides are allowed. The eigenmodes are determined with a boundary integral equation technique in conjunction with the method of moments. Results for the propagation constants are presented for a number of waveguides and, where possible, compared with published data. Special attention is devoted to the transition from a dielectric waveguide to a perfectly conducting waveguide when the loss tangent of the waveguide material changes from zero to infinity.

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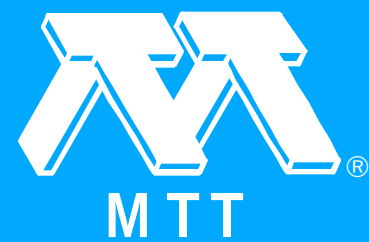
## Analysis of the Effects of a Resistively Coated Upper Dielectric Layer on the Propagation Characteristics of Hybrid Modes in a Waveguide-Shielded Microstrip Using the Method of Lines

*S.-J. Chung and L.-K. Wu. "Analysis of the Effects of a Resistively Coated Upper Dielectric Layer on the Propagation Characteristics of Hybrid Modes in a Waveguide-Shielded Microstrip Using the Method of Lines." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1393-1399.*

In this paper, propagation characteristics of even-symmetric hybrid modes in a waveguide-shielded microstrip in the presence of a resistively coated dielectric layer affixed to the top cover of the housing is analyzed with the method of lines. The resistive boundary condition is employed to model the resistive film. A shielded microstrip line having a unity strip-width-to-substrate-thickness ratio (i.e.,  $w/h_{\text{sub } 1/} = 1$ ) placed on top of a 0.635-mm-thick alumina substrate is considered. Based on a  $10h_{\text{sub } 1/} \times 7h_{\text{sub } 1/}$  reference housing, four different housing arrangements are obtained by varying the structural parameters of the resistively coated dielectric layer. Results obtained indicate that the effects of both the housing walls and the resistively coated upper dielectric layer on the dominant (quasi-TEM) mode are insignificant and may be ignored when frequency is above 15 GHz. For the higher order modes, resistive film appears to be transparent when film resistance is greater than about 1 k  $\Omega$ , it behaves as a good conductor when film resistance is much smaller than 100  $\Omega$ , and in between it results in nonlinear (and even oscillatory) higher order modal behaviors. Apparently, due to the increasing field concentration inside the upper dielectric (as suggested by the increasing  $\epsilon_{\text{sub } \text{reff}}$ ) for a given mode, both the maximum attenuation and the film resistance needed to achieve it increase with frequency and dielectric constant of the upper dielectric layer.

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## On the Mode-Coupling Formation of Complex Modes in a Nonreciprocal Finline

*C.-K.C. Tzuang and J.-M. Lin. "On the Mode-Coupling Formation of Complex Modes in a Nonreciprocal Finline." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1400-1408.*

This paper studies and models the mechanism for forming the complex modes commonly found in boxed quasi-planar or planar guided-wave structures. To illustrate the fact that the mode-coupling among the various forms of modes is closely related to the formation of complex modes, the dispersion characteristics of the complex propagation constants (or the so-called mode spectrum) of a nonreciprocal unilateral finline are obtained by the rigorous full-wave SDA (spectral-domain approach). It is found that in the mode spectrum of the nonreciprocal finline, a forward wave and a backward wave interact to produce a pair of complex modes. The interactions between two forward (backward) traveling waves, between a forward wave and a backward wave, and between two complex waves (modes) are modeled by applying the model-coupling theory. The concept of hypothetical modes is introduced in the model. These hypothetical modes are obtained by applying mode-coupling theory to the mode spectrum previously obtained. The approximate values obtained for the propagation constants of the three types of wave interactions using the model presented in the paper are in close agreement with those given by the full-wave SDA.

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## Nonreciprocal and Reciprocal Complex and Backward Waves in Parallel Plate Waveguides Loaded with a Ferrite Slab Arbitrarily Magnetized

*R. Marques, F.L. Mesa and M. Horno. "Nonreciprocal and Reciprocal Complex and Backward Waves in Parallel Plate Waveguides Loaded with a Ferrite Slab Arbitrarily Magnetized." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1409-1418.*

This paper presents a rigorous and systematic method of analysis of the electromagnetic wave propagation in parallel plate waveguides with a multilayered bianisotropic medium. The method is applied to the numerical study of parallel plate waveguides with a multilayered medium including lossless ferrite layers magnetized at an arbitrary direction. Both the propagation constant and the transmitted power are computed. Backward, i.e., power flux in opposite direction as phase velocity, and nonreciprocal complex modes have been found to be an essential part of the modal spectrum of the structures analysed here. A detailed investigation has been carried out about the parameters related to the appearance of these modes.

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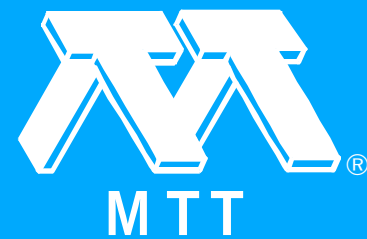


# Abstracts

## A Class of Symmetrical Condensed Node TLM Methods Derived Directly from Maxwell's Equations

*J. LoVetri and N.R.S. Simons. "A Class of Symmetrical Condensed Node TLM Methods Derived Directly from Maxwell's Equations." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1419-1428.*

A series of general transmission line matrix (TLM)-type methods, which include the symmetrical condensed node method, are derived directly from Maxwell's curl equations without recourse to transmission line models. Written as a system of conservation laws, Maxwell's equations in 3-D plus time are decomposed along the orthogonal characteristic directions of a rectangular grid. The Riemann invariants in this method correspond to the voltage pulses of the TLM method. A new method of handling inhomogeneous media is proposed based on a new transfer event. The dispersive nature of these schemes is also investigated.



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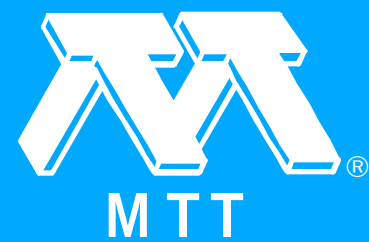
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## An Algorithm for the Treatment of Curved Metallic Laminas in the Finite Difference Time Domain Method

*C.J. Railton. "An Algorithm for the Treatment of Curved Metallic Laminas in the Finite Difference Time Domain Method." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1429-1438.*

The Finite Difference Time Domain (FDTD) method, implemented in Cartesian coordinates, is well proven as an efficient technique for the electromagnetic analysis of a wide variety of microwave structures. The standard FDTD method is, however, less efficient if the structure under investigation has boundaries which are not parallel to the coordinate axes. Techniques designed to overcome this problem such as locally or globally deformed grids, or the use of nonorthogonal coordinate systems have been reported but these impose a penalty in computational effort or in flexibility. In this contribution, an alternative technique is described whereby the standard Cartesian grid is maintained, and the existence of the material boundaries is accounted for by the use of special finite difference equations for the affected nodes. These equations take account not only of the position of the boundaries but also of the asymptotic field behavior in their vicinity. This technique results in a flexible, accurate, and efficient, implementation which is applicable to a wide range of MMIC and antenna structures.

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## Synthesis of Vector Parasites in Finite Element Maxwell Solutions

*D.R. Lynch, K.D. Paulsen and W.E. Boyse. "Synthesis of Vector Parasites in Finite Element Maxwell Solutions." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1439-1448.*

Closed-form solutions to driven boundary value problems are obtained for the discrete finite element forms of the double-curl, penalty, and Helmholtz equations, as realized on simple  $C^0$  bilinear elements. The solutions are expressed as a composite of physical and spurious vector modes, and are qualitatively similar to numerical solutions reported on more complex geometries. The findings reveal the critical role of discrete boundary conditions in determining the strength of the spurious modes; the overall superiority of the Helmholtz weak form; and the importance of proper boundary conditions for its successful use. In particular, one blend of normal and tangential conditions which appears well-posed is shown to be inappropriate; and a simple alternative is shown to work well.

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## Higher Order Modes in Suspended Substrate Microstrip Lines

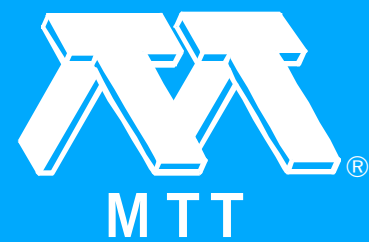
*I.P. Polichronakis and S.S. Kouris. "Higher Order Modes in Suspended Substrate Microstrip Lines." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1449-1454.*

The characteristics of both types of higher order modes in suspended substrate microstrip lines are evaluated using Spectral Domain Analysis. Also, the cutoff frequencies of the first two higher order modes are computed and the operation bandwidth is evaluated. The obtained results are compared with some estimated values given by other authors. Finally, design curves are reported for practical suspended substrate microstrip line structures.

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## A Microwave Measurement Technique for Characterizing the I-V Relationship for Negative Differential Conductance Devices (Short Papers)

*P. Huang, D.S. Pan and N.C. Luhmann, Jr.. "A Microwave Measurement Technique for Characterizing the I-V Relationship for Negative Differential Conductance Devices (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1455-1458.*

The practical procedures of a recently proposed technique to experimentally determine the I-V characteristics of negative differential conductance (NDC) devices are presented in this paper. The technique employs microwave reflection coefficients together with the measurable portions of the device's I-V characteristics to infer the I-V curve in the negative conductance region where oscillations tend to occur under normal dc bias conditions. The effects of higher harmonics at large signal levels are also taken into account in the calculation. The advantages of the method for high NDC devices have been pointed out in the stability analysis contained in a previously published letter. The technique was demonstrated in the case of a low NDC tunnel diode where the agreement between the deduced I-V curve using the described method and the dc measured I-V curve is within 5%. The I-V curve in the negative conductance region for another tunnel diode with much higher negative conductance is also obtained and a self-consistent accuracy of 5% is found.

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# Abstracts

## Scattering and Reception by a Flanged Parallel-Plate Waveguide: TE-Mode Analysis (Short Papers)

*T.J. Park and H.J. Eom. "Scattering and Reception by a Flanged Parallel-Plate Waveguide: TE-Mode Analysis (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1458-1460.*

The TE-mode characteristics of scattering and reception by a flanged parallel-plate waveguide are examined. The Fourier transform is used to represent the scattered fields in the spectral domain. The simultaneous equations for the transmitted field coefficients are solved to obtain the solution in an asymptotic series form. Numerical computations are performed to illustrate the behaviors of the scattered field and the transmission coefficients versus the aperture size.



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# Abstracts

## Analysis of This Inclined Rectangular Aperture with Arbitrary Location in Rectangular Waveguide (Short Paper)

*R. Yang and A.S. Omar. "Analysis of This Inclined Rectangular Aperture with Arbitrary Location in Rectangular Waveguide (Short Paper)." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1461-1463.*

An analysis is developed for calculating the coupling parameters of a thin inclined rectangular coupling aperture arbitrarily located in the transverse plane of a rectangular waveguide. The analysis uses the aperture basis 2-function approach of the moment method. The calculated results for different aperture geometries and for a X-band band-pass filter realized with three resonant apertures have been confirmed to a good accuracy with experiments.



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## Electric Fields of an H-Plane Tapered Iris (Short Papers)

*J.R. Natzke and T.K. Ishii. "Electric Fields of an H-Plane Tapered Iris (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1463-1465.*

Microwave electric fields of an X-band H-plane tapered iris are calculated and plotted using the moment method for the first time. The moment method results are compared with previously obtained experimental measurements and numerical results based on an equivalent circuit approach, giving confirmation that the tapered iris is both a reciprocal and asymmetrical network. The moment method results now reveal that the asymmetry stems from the asymmetry in the phase of the input and output voltage reflection coefficients, their magnitudes being equal.

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## Resonance in a Spherical-Circular Microstrip Structure with an Airgap (Short Papers)

*K.-L. Wong and H.-T. Chen. "Resonance in a Spherical-Circular Microstrip Structure with an Airgap (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1466-1468.*

The resonance problem of the spherical-circular microstrip structure with an airgap between the substrate layer and the ground conducting sphere is studied by using a rigorous Green's function formulation in the spectral domain and Galerkin's moment method calculation. Complex resonant frequencies are obtained in this study, which provide the resonant frequencies and half-power bandwidth of the structure. From the numerical results, it is found that with the increasing of the airgap thickness, the half-power bandwidth of the structure is considerably increased. This improves the low-bandwidth characteristics of microstrip structures. Details of the numerical results are presented and discussed.

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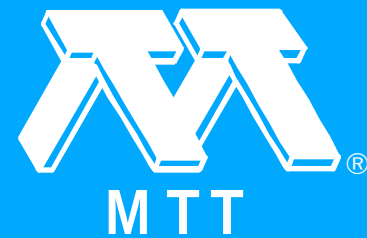


# Abstracts

## Useful Bessel Function Identities and Integrals (Short Papers)

*E.B. Manring and J. Asmussen, Jr.. "Useful Bessel Function Identities and Integrals (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1468-1471.*

A number of previously unpublished Bessel function identities and indefinite integrals are listed. These are useful in solving electromagnetic problems in cylindrical coordinates, including energy and power calculations, and mode orthogonalization in lossy media. Using these integrals in conjunction with two previously published indefinite Bessel function integrals, two orthogonality integrals are derived. Values of the indefinite integrals at limits of zero and infinity are also given.



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# Abstracts

## Theory for a Cylindrical Pillbox Accelerator Cavity Using Layered Structures for Reducing Skin-Effect Losses (Short Papers)

*W.C. Sailor, F.M. Mueller and B.E. Carlsten. "Theory for a Cylindrical Pillbox Accelerator Cavity Using Layered Structures for Reducing Skin-Effect Losses (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1471-1474.*

It is shown that for a cylindrical pillbox accelerator cavity operating in a TM/sub 0n0/ mode, the use of laminated conductors for the flat walls in conjunction with a multilayered dielectric structure for the round walls can decrease skin-effect losses by an order of magnitude over that of a copper cavity having the same accelerating field. The layered dielectric structure for the round walls works in a fashion similar to a quarter-wave interferometer. The laminated conductor on the flat walls reduces the ohmic losses by effectively increasing the skin depth.



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# Abstracts

## Unconditional Stability (Comments)

*K. Kurokawa. "Unconditional Stability (Comments)." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1475-1475.*

Some time ago, I gave three inequalities as a necessary and sufficient condition for unconditional stability.



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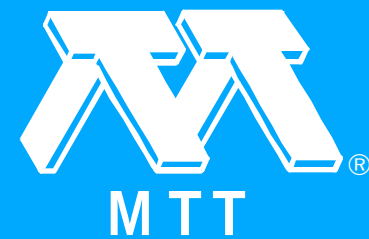




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## Call for Papers - Ultra-Wideband, Short-Pulse Electromagnetics (Aug. 1993 [T-MTT])

*"Call for Papers - Ultra-Wideband, Short-Pulse Electromagnetics (Aug. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1476-1476.*



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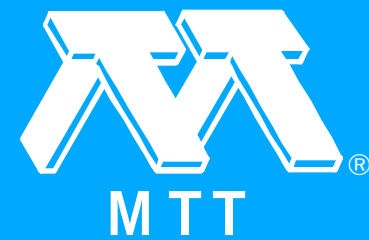


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## Call for Papers - Waves and Microwaves (Aug. 1993 [T-MTT])

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*"Call for Papers - Waves and Microwaves (Aug. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1477-1477.*



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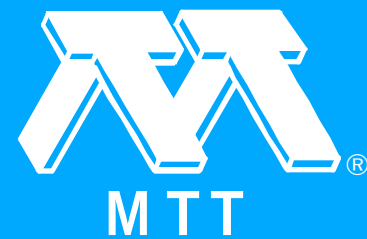
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## Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Aug. 1993 [T-MTT])

*"Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Aug. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1478-1478.*



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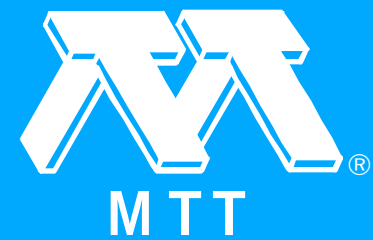
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## Information for Authors (Aug. 1993 [T-MTT])

*"Information for Authors (Aug. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1479-1479.*



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## 1992 International Conference on Acoustics, Speech and Signal Processing Videos (Aug. 1993 [T-MTT])

*"1992 International Conference on Acoustics, Speech and Signal Processing Videos (Aug. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): 1480-1480.*



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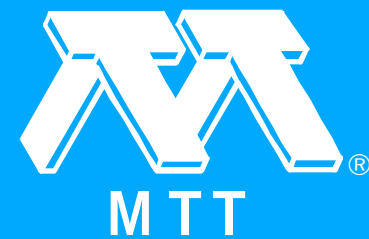
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## Back Cover (Aug. 1993 [T-MTT])

*"Back Cover (Aug. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.7 (Aug. 1993 [T-MTT]): b1-b2.*



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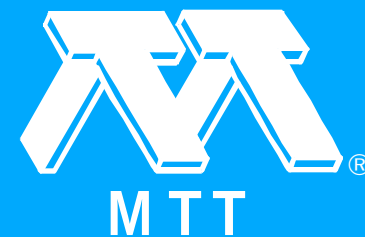


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## Front Cover (Sep. 1993 [T-MTT])

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*"Front Cover (Sep. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): f1-f2.*



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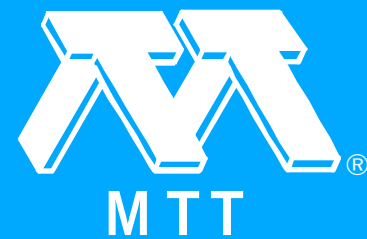


# Abstracts

## Guest Editorial (Sep. 1993 [T-MTT])

*A.K. Sharma and T. Itoh. "Guest Editorial (Sep. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1481-1481.*

Microwave and millimeter-wave monolithic integrated circuits utilizing grounded and ungrounded coplanar waveguides, along with other planar transmission lines such as microstrip and slot lines, referred to as coplanar MMIC'S (CMMIC'S), attributed to innovative and high performance with components and subsystems.



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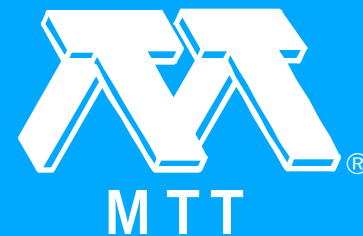


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## Reviewers for this Special Issue (Sep. 1993 [T-MTT])

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*"Reviewers for this Special Issue (Sep. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1483-1483.*



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# Abstracts

## On the Analysis of Single- and Multiple-Step Discontinuities for a Shielded Three-Layer Coplanar Waveguide

*K.M. Rahman and C. Nguyen. "On the Analysis of Single- and Multiple-Step Discontinuities for a Shielded Three-Layer Coplanar Waveguide." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1484-1488.*

Single- and multiple-step discontinuities for a shielded three-layer coplanar waveguide (CPW) are studied. The mode matching procedure is employed to obtain the scattering (S) parameters of the discontinuities. The analysis is validated through a comparison of the calculated S-parameters of a single step discontinuity for a shielded single-layer CPW and those published previously. Calculated S-parameters for various single, double, and triple step discontinuities are presented. Effect of the modal orthogonality criterion on the discontinuity S-parameters is given. Extensive investigation of the numerical convergence of the S-parameters is also described.



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# Abstracts

## Analysis of Bilateral Coplanar Waveguides Printed on Anisotropic Substrates for Use in Monolithic MICs

*Y. Chen and B. Beker. "Analysis of Bilateral Coplanar Waveguides Printed on Anisotropic Substrates for Use in Monolithic MICs." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1489-1493.*

The spectral-domain method is applied to the analysis of bilateral (double-sided) coplanar waveguides that are printed on electric and/or magnetic anisotropic substrates. A non-decoupling approach is used to solve the coupled differential equations for the transverse propagation constants inside the substrate. The dyadic admittance Green's function is derived for both open and shielded bilateral coplanar waveguides, taking into account the anisotropy of the material. Finally, numerical results, describing the propagation characteristics of these structures, are presented for both electric and magnetic wall symmetries.



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## Characteristics of a Coplanar Waveguide HEMT Mount on GaAs Substrate

*D. Mirshekar-Syahkal and A. Pote. "Characteristics of a Coplanar Waveguide HEMT Mount on GaAs Substrate." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1494-1498.*

In a special integrated coplanar waveguide HEMT mount, designed for a wide band (1-60 GHz) on-wafer measurement of the characteristics of HEMTs on GaAs, significant power loss as high as 30% of the input power over a range of frequencies is observed. This power loss is mainly attributed to the radiation through two via holes connecting the coplanar waveguide ground planes to the backside metallization in the mount. Based on this assumption, an approximate theoretical model is developed to substantiate the experimental observations.

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# Abstracts

## A CAD-Oriented Analytical Model for the Losses of General Asymmetric Coplanar Lines in Hybrid and Monolithic MICs

*G. Ghione. "A CAD-Oriented Analytical Model for the Losses of General Asymmetric Coplanar Lines in Hybrid and Monolithic MICs." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1499-1510.*

New analytical approximations are derived for the conductor losses of asymmetric coplanar waveguides (ACPW) and coplanar striplines (ACPS) on a finite-thickness dielectric substrate. The expressions hold for lines whose metallizations have thickness much smaller than the slot and strip widths, but suitably larger than the skin penetration depth at the operating frequency. The derivation is based on an extension of the conformal mapping approach formerly proposed by Owyang and Wu for symmetric lines in air. Comparisons with published data from quasistatic or full-wave numerical analyses are presented to validate the expressions derived for both the symmetric and the asymmetric case. The analytical characterization presented in the paper is well suited for inclusion into CAD codes for MMIC design.



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## A Moment Method Analysis for Coplanar Waveguide Discontinuity Inductances

*C.-W. Chiu and R.-B. Wu. "A Moment Method Analysis for Coplanar Waveguide Discontinuity Inductances." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1511-1514.*

Based on the concept of duality, the quasi-static equivalent inductance of a coplanar waveguide discontinuity is determined from the equivalent capacitance of its complementary structure, i.e., a coplanar strip discontinuity in the free space. For the capacitance calculation, an integral equation governing the excess charge distribution near the discontinuity is solved by the method of moments together with Galerkin's approach. Numerical results for the short end and symmetric step change are presented. The good agreement with the data available from the full-wave analyses reveals that this approach is simple, accurate, and very suitable in the CAD for MMIC.

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## FET Active Slotline Notch Antennas for Quasi-Optical Power Combining

*W.K. Leverich, X.-D. Wu and K. Chang. "FET Active Slotline Notch Antennas for Quasi-Optical Power Combining." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1515-1518.*

A new active antenna structure with applications in quasi-optical power combining is described. The active antenna combines a slotline FET oscillator with a notch antenna. The new structure was successfully used to create both E-plane and H-plane linear arrays as well as a 2-D array. Preliminary results of radiation patterns and the power combining efficiencies of the arrays are discussed.

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## Ultra-Wideband MMIC Active Power Splitters with Arbitrary Phase Relationships

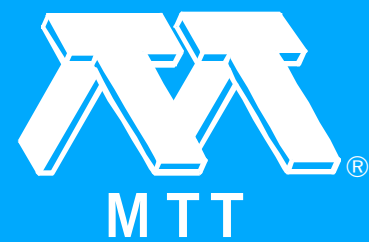
*H. Kamitsuna and H. Ogawa. "Ultra-Wideband MMIC Active Power Splitters with Arbitrary Phase Relationships." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1519-1523.*

Novel MMIC active power splitters, which allow arbitrary phase division over wide frequency ranges exceeding an octave in bandwidth, are proposed. An FET's inherent phase inversion properties together with phase adjustment circuits, e.g., common drain FETs followed by phase-shift transmission lines, can be successfully combined for broadband, arbitrary phase division. As an example of this technique, an MMIC active quadrature splitter has been designed and fabricated in a 1.1 mm x 0.7 mm chip area. A phase error of less than 5° with a magnitude imbalance of less than 1 dB has been demonstrated over a double-octave frequency range of 7.2-21.6 GHz. The MMIC active power splitter promises to make possible miniaturized, full MMIC signal processing components.

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## Experimentally Verifiable Modeling of Coplanar Waveguide Discontinuities

V. Radisic, D.R. Hjelme, A. Horrigan, Z.B. Popovic and A.R. Mickelson. "Experimentally Verifiable Modeling of Coplanar Waveguide Discontinuities." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1524-1533.

A general technique for obtaining the frequency-dependent scattering parameters of open waveguiding structures is discussed. The first step of the analysis is an iterative solution for the charge distribution on the electrodes which, in our case, uses the "straight line" solution, the one first derived by Maxwell, as the starting value. A calibrated optical sampling technique allows for direct verification of the validity of the quasi-static charge distribution for structures in which the dielectric layers are also electrooptic. (Common waveguiding dielectrics such as GaAs and InP are sufficiently electrooptic to yield more than sufficient signal-to-noise ratios for accurate verification.) In cases where the quasi-static solution is valid, it is shown that the full dynamics of the propagation problem can be recovered from an equivalent nonuniform transmission line, the parameters of which can be determined from the phase velocity and impedance distribution defined by the static charge distribution. Here, we present analysis of planar discontinuities in coplanar waveguides (CPW), but the method can be modified and applied to include active devices, as well as three-dimensional discontinuities, such as airbridges. The method is based on an iterative solution of the quasi-static charge distribution using successive over relaxation and the dynamics are introduced via the Riccati equation. Additional measurements performed on the "in-house" fabricated passive circuits using an HP8510 Network Analyzer verify the accuracy of the dynamical part of the method.

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# Abstracts

## Open and Short Circuits in Coplanar MMIC's

*K. Beilenhoff, H. Klingbeil, W. Heinrich and H.L. Hartnagel. "Open and Short Circuits in Coplanar MMIC's." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1534-1537.*

Coplanar MMIC stub configurations are investigated by means of the finite-difference method in the frequency domain. The open end, the short end, and a capacitively loaded short end (MIM-short) are analyzed. Their parasitic effects are described in terms of the effective length extension  $l_{\text{sub ext}}$ . The influence of the different line parameters is discussed and simple design rules are given.



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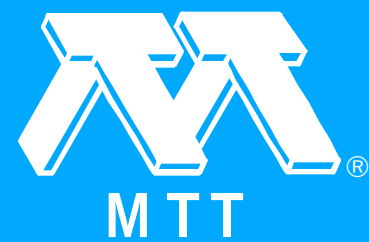
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## Full-Wave Analysis of Coplanar Waveguide Discontinuities Using the Frequency Domain TLM Method

*H. Jin and R. Vahldieck. "Full-Wave Analysis of Coplanar Waveguide Discontinuities Using the Frequency Domain TLM Method." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1538-1542.*

This paper presents a full-wave analysis of a variety of coplanar waveguide discontinuities using the frequency domain TLM method. The finite metallization thickness is taken into account as well as metal losses and the interaction of fundamental and higher order modes between cascaded discontinuities. Numerical results are presented for the frequency-dependent s-parameters of transitions between CPW and slotline, CPW and microstrip line and CPW-microstrip overlap transition. The effect of interactions between the CPW discontinuities and the CPW airbridges is also investigated.

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## Two-Port to Three-Port Noise-Wave Transformation for CAD Applications

*T.O. Grosch and L.A. Carpenter. "Two-Port to Three-Port Noise-Wave Transformation for CAD Applications." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1543-1548.*

A two-port-to-three-port noise wave transformation is presented that complements the similar transformation for S-parameters. Others have shown that transistor two-port S-parameters can be converted to three-port S-parameters when the common terminal is used as the third port. This paper shows how to calculate the three-port noise waves and noise temperatures from the two-port noise waves and temperatures. The transformation considers the general case where the common terminal of the three-port is not perfectly grounded. The formulation is then extended to the general case of a  $(n - 1)$ -port-to- $n$ -port transformation.

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## Characterization of Asymmetric Coplanar Waveguide Discontinuities

*N.I. Dib, M. Gupta, G.E. Ponchak and L.P.B. Katehi. "Characterization of Asymmetric Coplanar Waveguide Discontinuities." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1549-1558.*

A general technique to characterize asymmetric coplanar waveguide (CPW) discontinuities with air bridges where both the fundamental coplanar and slotline modes maybe excited together is presented. First, the CPW discontinuity without air bridges is analyzed using the space-domain integral equation (SDIE) approach. Second, the parameters (phase, amplitude, and wavelength) of the coplanar and slotline modes are extracted from an amplitude modulated-like standing wave existing in the CPW feeding lines. Then a  $2n \times 2n$  generalized scattering matrix of the  $n$ -port discontinuity without air bridges is derived which includes the occurring mode conversion. Finally, this generalized scattering matrix is reduced to an  $n \times n$  matrix by enforcing suitable conditions at the ports which correspond to the excited slotline mode. For the purpose of illustration, the method is applied to a shielded asymmetric short-end CPW shunt stub, the scattering parameters of which are compared with those of a symmetric one. Experiments are performed on both discontinuities and the results are in good agreement with theoretical data. The advantages of using air bridges in CPW circuits as opposed to bond wires are also discussed.





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## Coplanar Waveguide with Top and Bottom Shields in Place of Air-Bridges

A.A. Omar and Y.L. Chow. "Coplanar Waveguide with Top and Bottom Shields in Place of Air-Bridges." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1559-1563.

A convenient technique for the elimination of the coupled slot-line mode in coplanar waveguide (CPW) nonsymmetric circuits is proposed. This technique simply uses top and/or bottom ground plane shields and avoids the more costly air-bridges. These shields are easy to fabricate, however, may slightly affect the propagation of the CPW mode in the form of power leakage into the parallel plate TEM mode. This effect can be avoided by restricting operation to lower frequencies. Numerical comparisons between the effect of the shields and the air-bridges on a CPW filter are presented.

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# Abstracts

## Enhanced Dominant Mode Operation of a Shielded Multilayer Coplanar Waveguide via Substrate Compensation

*M.R. Lyons, J.P.K. Gilb and C.A. Balanis. "Enhanced Dominant Mode Operation of a Shielded Multilayer Coplanar Waveguide via Substrate Compensation." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1564-1567.*

The cutoff frequency of the first higher-order even mode in a shielded multilayer coplanar waveguide (CPW) is studied using the spectral domain approach (SDA). The effective dielectric constant for the dominant odd mode and first higher-order even mode in a shielded multilayer CPW is computed and compared to other published numerical results. Dielectric constant and substrate height are varied with respect to even mode cutoff frequency and plotted for several CPW structures. Different combinations of internal substrates are shown to produce even mode cutoff frequency maximization for increased odd mode operation bandwidth.



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## High Performance Direct Coupled Bandpass Filters on Coplanar Waveguide

*J.K.A. Everard and K.K.M. Cheng. "High Performance Direct Coupled Bandpass Filters on Coplanar Waveguide." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1568-1573.*

This paper describes the design and performance of shunt inductively coupled bandpass filters implemented on open coplanar waveguide. This new structure exhibits low radiation loss due to the removal of the capacitively coupled gaps encountered in end or edge coupled filters. Unloaded Qs greater than 540 have been achieved in unshielded single section resonators at 4 GHz on very thin substrates. These high Qs enable the design of filters with low insertion loss and good stopband rejection. Applications include low insertion loss, high Q printed filters where no screening is required, low noise oscillators and superconducting filters.

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## Picosecond Pulse Propagation on Coplanar Striplines Fabricated on Lossy Semiconductor Substrates: Modeling and Experiments

*J.-H. Son, H.-H. Wang, J.F. Whitaker and G.A. Mourou. "Picosecond Pulse Propagation on Coplanar Striplines Fabricated on Lossy Semiconductor Substrates: Modeling and Experiments." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1574-1580.*

A simple model for the propagation of high-frequency signals on coplanar striplines with lossy semiconductor substrates is proposed and demonstrated. This model incorporates the effect of a conductive substrate through the loss tangent in a distributed-circuit analysis extended to high frequencies. Very strong attenuation and dispersion due to the substrate are observed even when the GaAs conductance is only 1 mho/cm, corresponding to a doping density of around  $10^{15}$  cm<sup>-3</sup>. The accuracy of this model is tested with a direct comparison to experimental data, of picosecond pulse propagation on a doped-GaAs coplanar stripline (CPS) measured in the time domain using the electro-optic (EO) sampling technique. Good agreement is found in terms of the attenuation and phase velocity of the distorted pulses at four propagation distances up to 300  $\mu$ m. The pulse propagation on a multiple modulation-doped layer is also studied experimentally as a prototype of high-frequency signal propagation on the gate of a modulation-doped field-effect transistor (MODFET). The attenuation shows linear frequency dependence up to 1.0 THz, contrary to the cubic or quadratic dependence of coplanar transmission lines on low-loss substrates.



# Abstracts

## Full-Wave Space-Domain Analysis of Open Microstrip Discontinuities Including the Singular Current-Edge Behavior

*J. Sercu, N. Fache, F. Libbrecht and D. De Zutter. "Full-Wave Space-Domain Analysis of Open Microstrip Discontinuities Including the Singular Current-Edge Behavior." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1581-1588.*

A full-wave space-domain analysis is presented for the high-frequency characterization of microstrip discontinuities. This approach solves the electric field integral equation (EFIE) for the surface current density on the microstrip using the method of moments. The current expansion functions incorporate the singular edge behavior of the surface current, yielding a very accurate current modeling. Special attention is devoted to the analytical treatment of the singular terms in the electric field Green's dyadic. The numerical results focus on the S-parameters of some simple microstrip discontinuities and the comparison with results obtained with other techniques and from measurements.



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## A New Technique for the Quasi-TEM Analysis of Conductor-Backed Coplanar Waveguide Structures

*K.K.M. Cheng and J.K.A. Everard. "A New Technique for the Quasi-TEM Analysis of Conductor-Backed Coplanar Waveguide Structures." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1589-1592.*

Numerically efficient and accurate formulae based on the spectral domain method for the analysis of conductor-backed coplanar waveguide structures are presented. Quasi-TEM parameters are obtained for these waveguide structures by using piecewise linear functions to approximate the potential distribution at the air-dielectric interface. Techniques such as nonuniform discretization and bound estimation are described which demonstrate shorter computational times. Results on the characteristic impedance calculation of standard coplanar waveguide are given to demonstrate the numerical accuracy and efficiency of the method presented here.



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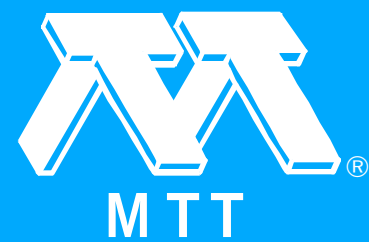
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## A Hybrid Yee Algorithm/Scalar-Wave Equation Approach

*P.H. Aoyagi, J.-F. Lee and R. Mittra. "A Hybrid Yee Algorithm/Scalar-Wave Equation Approach." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1593-1600.*

In this paper, two alternate formulations of the Yee algorithm, namely, the finite-difference time-domain (FDTD) vector-wave algorithm and the FDTD scalar-wave algorithm are examined and compared to determine their relative merits and computational efficiency. By using the central-difference divergence relation the conventional Yee algorithm is rewritten as a hybrid Yee/FDTD scalar-wave algorithm. It is found that this can reduce the computation time for many 3-D open geometries, in particular planar structures, by approximately two times as well as reduce the computer-memory requirements by approximately one-third. Moreover, it is demonstrated both mathematically and verified by numerical simulation of a coplanar strip transmission line that this hybrid algorithm is entirely equivalent to the Yee algorithm. In addition, an alternate but mathematically equivalent reformulation of the Enquist-Majda absorbing boundary condition based on the normal field component (relative to the absorbing boundary wall) is given to increase the efficiency of the hybrid algorithm in the modeling of open region problems. Numerical results generated by the hybrid Yee/scalar-wave algorithm for the Vivaldi antenna are given and compared with published experimental work.

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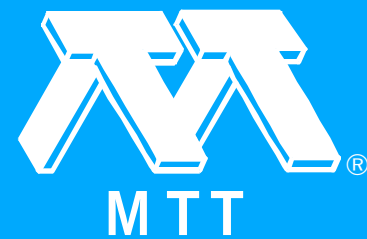


# Abstracts

## Full-Wave Analysis of Discontinuities in Conductor-Backed Coplanar Waveguides Using the Method of Lines

*S.-J. Chung and T.-R. Chrag. "Full-Wave Analysis of Discontinuities in Conductor-Backed Coplanar Waveguides Using the Method of Lines." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1601-1605.*

A three-dimensional analysis using the method of lines with nonequidistant discretization is described to investigate the discontinuities in shielded conductor-backed coplanar waveguides (CBCPW's). An extended approach concerning the treatment of the boundary conditions at the input and output ports is proposed in which the reflection and transmission coefficients can be directly obtained in a single calculation. The validity and convergence of the numerical results are checked and gaps with various shapes in CBCPW's are analyzed and compared. Finally, the frequency response of a simple step discontinuity is calculated as an application to unsymmetrical structure.



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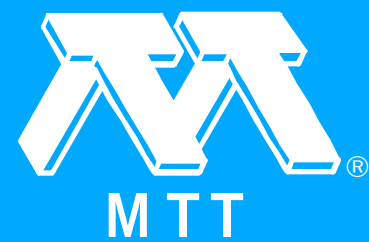
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## An Analytical Method for Direct Calculation of E & H-Field Patterns of Conductor-Backed Coplanar Waveguides

*M. Gillick, I.D. Robertson and J.S. Joshi. "An Analytical Method for Direct Calculation of E & H-Field Patterns of Conductor-Backed Coplanar Waveguides." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1606-1610.*

A new direct method of computing the electromagnetic field patterns surrounding the conductor-backed coplanar waveguide (CPW) structure is proposed. Analytical closed-form expressions describing the quasi-TEM field pattern in both the air and the dielectric substrate for conductor-backed CPW's are presented. This approach is based on a new technique which employs a series of inverse conformal mappings to transform a known field pattern from a rectangular structure back into the CPW structure in order to obtain its unknown field pattern directly. A computer program based on this method has demonstrated the speed at which the fields can be plotted compared to existing methods which require repetitive application. Graphical results of these field patterns are presented as a function of the CPW's geometry and dielectric substrate thickness. These field maps which have been directly drawn with true curvilinear squares enable the determination of power flow density, since the same power flows through each square. This direct method of characterizing the power flow density throughout the CPW structure could become an important design tool for the modeling of coplanar monolithic microwave integrated circuits (CMMIC's).

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## Full-Wave Modeling of Coplanar Waveguide Discontinuities with Finite Conductor Thickness

*A.M. Tran and T. Itoh. "Full-Wave Modeling of Coplanar Waveguide Discontinuities with Finite Conductor Thickness." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1611-1615.*

An extended version of the spectral domain approach (SDA) is developed to analyze discontinuities in open coplanar waveguide with finite metallization thickness. By making use of the exact Green's function in the spectral domain, the effects of surface wave and radiation phenomena are accurately accounted for. Both longitudinal and transverse components of the aperture electric fields are used in the analysis to allow modelling of structures with large transverse dimensions at high frequencies. The procedure also includes mode conversion near the discontinuities. As an illustration of the method, analytical steps and computed scattering parameters of the coplanar waveguide short-circuits and transitions will be provided and compared against measured data.

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## Transmission Characteristics of Finite-Width Conductor-Backed Coplanar Waveguide

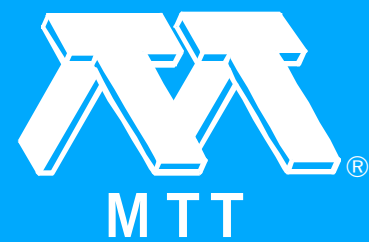
C.-C. Tien, C.-K.C. Tzuang, S.T. Peng and C.-C. Chang. "Transmission Characteristics of Finite-Width Conductor-Backed Coplanar Waveguide." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1616-1624.

This paper presents theoretical and experimental results for a finite-width conductor-backed coplanar waveguide (FW-CBCPW). The guiding characteristics of FW-CBCPW are investigated first by the rigorous method of mode matching. An FW-CBCPW through line is then placed within a test fixture commonly used in laboratories, and the scattering parameters of the through line are obtained theoretically by approximating the FW-CBCPW as a simple system of coupled transmission lines. Experimental results are shown to agree very well with the theoretical ones. In particular, the anomalous behavior observed in the transmission characteristic of the through line is related to the resonant phenomenon of the terminated side planes which are short-circuited at both input and output ends due to the test fixture. Finally, a technique of mode suppression in the side-plane regions is suggested for the improvement of signal transmission over a broad band of frequency spectrum. The effects of extra higher order modes on the transmission characteristics at high frequencies are also discussed.

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## A 3-D Mode Matching Technique for the Efficient Analysis of Coplanar MMIC Discontinuities with Finite Metallization Thickness

*F. Alessandri, G. Baini, M. Mongiardo and R. Sorrentino. "A 3-D Mode Matching Technique for the Efficient Analysis of Coplanar MMIC Discontinuities with Finite Metallization Thickness." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1625-1629.*

A technique is proposed for the efficient analysis of CPW discontinuities including finite metallization thickness. The transverse resonance technique (TRT) is modified by introducing an impressed source that allows a cavity of fixed, instead of variable, dimensions to be analyzed (impressed source technique, IST). At the same time, as with TRT, the field analysis of only homogeneously filled waveguides is required so avoiding the computation of frequency dependent as well as complex modes as with the conventional mode matching technique. On this basis, an extremely efficient code for the analysis of CPW discontinuities, applicable also to interacting discontinuities, is obtained. The same code, which incorporates the modal spectrum of L-shaped waveguide, can be used to compute a large class of CPW discontinuities including steps, gaps, open ends, etc. Computed results are shown to be in remarkable agreement with the experiments and confirm that the finite metallization thickness may significantly affect the electrical characteristics of CPW circuits.

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## Dispersion Characteristics of the Broadside-Coupled Coplanar Waveguide

*C. Nguyen. "Dispersion Characteristics of the Broadside-Coupled Coplanar Waveguide." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1630-1633.*

The dispersive properties for the even- and odd-modes of the broadside-coupled coplanar waveguide (CPW) are determined using the spectral domain method. Various numerical results of the even- and odd-mode effective dielectric constants as a function of frequency are presented and discussed. It is found that the structure has a very weak dispersion. This fact is further confirmed through a comparison between the calculated dynamic and quasi-static results of the even- and odd-mode effective dielectric constants. The low dispersion feature signifies the fact that the quasi-static analysis is adequate for designing practical microwave and millimeter-wave circuits employing broadside-coupled CPW.

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## An Extremely Small 26 GHz Monolithic Image-Rejection Mixer without DC Power Consumption

A. Minakawa and T. Hirota. "An Extremely Small 26 GHz Monolithic Image-Rejection Mixer without DC Power Consumption." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1634-1637.

This paper describes several design methods for an extremely small 26 GHz monolithic image-rejection mixer. The bias dependence of the drain LO injection mixer is also investigated. Consequently, it was found that there exists an optimum bias point for minimum conversion loss, and the mixer performed well even with zero drain bias voltage. The mixer is fabricated using a uniplanar technique. It consists of drain LO injection mixers, a reduced-size branch-line hybrid, and a Wilkinson divider with a compact layout. The chip measures only 1.6 mm x 1.3 mm, which is the smallest among those reported.

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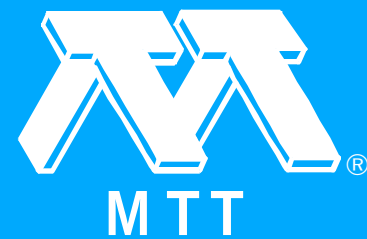


# Abstracts

## Theoretical and Experimental Characterization of Coplanar Waveguide Discontinuities (Short Papers)

*M. Yu, R. Vahldieck and K. Wu. "Theoretical and Experimental Characterization of Coplanar Waveguide Discontinuities (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1638-1640.*

This paper describes a new quasi-static technique for the analysis of coplanar and microstrip transmission line discontinuities. The method is a variation of the Space-Spectral Domain Approach (SSDA) which represents a novel combination of the 1-D Method of Line (MoL) and the 1-D Spectral Domain Approach (SDA). S-parameters and equivalent circuit parameters of abrupt and tapered microstrip and coplanar discontinuities, are calculated. Theoretical results are verified experimentally. A comparison with full-wave methods shows good agreement up to 40 GHz.



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# Abstracts

## Circuit Model for Substrate Resonance Coupling in Grounded Coplanar Waveguide Circuits (Short Papers)

*R.W. Jackson. "Circuit Model for Substrate Resonance Coupling in Grounded Coplanar Waveguide Circuits (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1641-1645.*

At high frequencies, grounded coplanar waveguide MMIC circuits can be prone to destructive intercircuit coupling effects due to substrate resonances. Analytic formulas for a simple circuit model of this coupling are presented in this paper. The model can be used with commercially available CAD in order to estimate the importance of such coupling for a particular circuit and substrate configuration. Results predicted by this model are compared to numerically rigorous spectral domain results and to experiment.



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## CPW Oscillator Configuration for an Electro-Optic Modulator (Short Papers)

*V. Radisic, V. Jevremovic and Z.B. Popovic. "CPW Oscillator Configuration for an Electro-Optic Modulator (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1645-1647.*

A CPW 2 GHz 3-port MESFET oscillator was designed with an electro-optic modulator application in mind. The oscillator has a self-biased gate. The source or drain ports can be used for external injection-locking. The frequency of oscillation, as well as the output power at the fundamental and first two harmonics were analyzed using a nonlinear device model and a harmonic balance technique. Comparison with measured results on a hybrid CPW oscillator fabricated on a Duroid substrate are presented.





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## Slotline Annular Ring Elements and Their Applications to Resonator, Filter and Coupler Design (Short Papers)

C.-H. Ho, L. Fan and K. Chang. "Slotline Annular Ring Elements and Their Applications to Resonator, Filter and Coupler Design (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1648-1650.

A slotline type of annular ring element has been developed as a new circuit component for resonator, filter, and hybrid coupler applications. Various coupling methods were devised for the use of this slotline ring in many applications. A new type of slotline dual-mode filter has been developed with a bandwidth of 12.3% and a stopband attenuation of more than 30 dB at the center frequency of 3.5 GHz. Another slotline type of cross-over hybrid ring coupler which utilized a slotline T-junction and a resistively-coupled slotline ring has also been developed with a bandwidth of more than 80%, an excellent power dividing balance of +0.2 dB, and a fairly good isolation of 35 dB. With the ease of adding series and shunt components, the slotline annular ring element should have many applications for MIC's and MMIC's.





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## A Low Noise, Phase Linear Distributed Coplanar Waveguide Amplifier (Short Papers)

*K. Minot, B. Nelson and W. Jones. "A Low Noise, Phase Linear Distributed Coplanar Waveguide Amplifier (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1650-1653.*

Details of the design, fabrication, and measured data for an InGaAs high electron mobility transistor (HEMT) decade-bandwidth distributed coplanar waveguide (CPW) amplifier are presented. Comparison to a similar microstrip design is made. The design methodology highlights described here include CPW transmission line loss modeling. The circuit features the best reported CPW distributed amplifier noise figure and phase performance over 2-20 GHz as well as an on-chip bias network and low dc power consumption. The minimum measured noise figure is 2.1 dB with 11 dB maximum gain. The measured phase linearity is less than  $\pm 5^\circ$  over 2-20 GHz which makes this circuit well suited for system phased array applications where phase matching and linearity are a primary concern.

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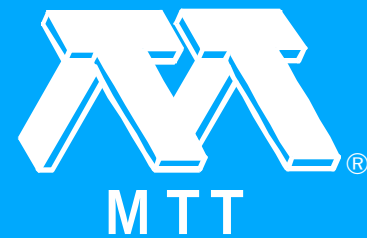


# Abstracts

## Coplanar Waveguide Transitions to Slotline: Design and Microprobe Characterization (Short Papers)

*W. Grammer and K.S. Yngvesson. "Coplanar Waveguide Transitions to Slotline: Design and Microprobe Characterization (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1653-1658.*

Three types of coplanar waveguide/slotline baluns, suitable for monolithic integrated circuits, are designed and characterized to 40 GHz, using microwave wafer probes. The results from each are compared, and methods of biasing the slotline discussed.



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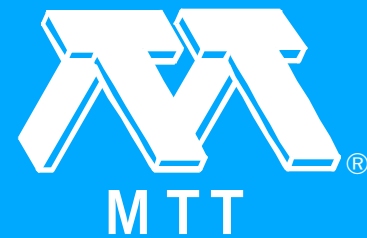
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# Abstracts

## Call for Papers - Waves and Microwaves (Sep. 1993 [T-MTT])

*"Call for Papers - Waves and Microwaves (Sep. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1659-1659.*



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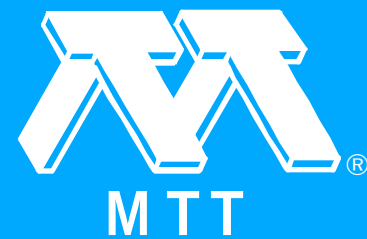
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## Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Sep. 1993 [T-MTT])

*"Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Sep. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): 1660-1660.*



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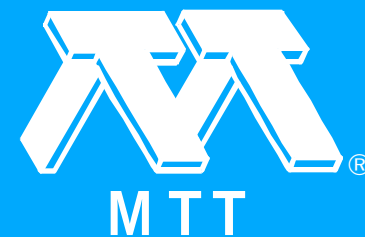
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# Abstracts

## Back Cover (Sep. 1993 [T-MTT])

*"Back Cover (Sep. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.8 (Sep. 1993 [T-MTT] (Special Issue on Modeling and Design of Coplanar Monolithic Microwave and Millimeter-Wave Integrated Circuits)): b1-b2.*



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# Abstracts

## Front Cover (Oct. 1993 [T-MTT])

*"Front Cover (Oct. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): f1-f2.*



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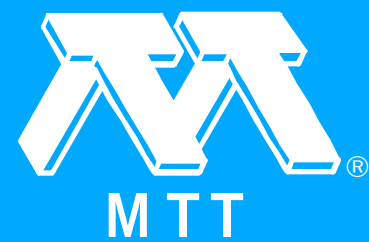
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## Guest Editor's Overview (Oct. 1993 [T-MTT])

*J.W. Mink and D.B. Rutledge. "Guest Editor's Overview (Oct. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1661-1663.*

Microwave and millimeter wave systems are in common use today and their range of applications is expanding. It is safe to predict that these systems will be utilized in the future across the spectrum of endeavors from communications, radar, to transportation, industrial and scientific applications. Satisfying this expanding demand mandates the utilization of previously unused, or little used, mm-wave and sub-mm-wave bands. i.e. the use of the frequency band from 30 GHz to 3000 GHz, in accordance with a long term trend toward systems operating at higher and higher frequencies. The necessary technology, however, is not very well developed at the present time, which holds in particular for the sub-mm-wave band above 300 GHz. In addition, this technology (as far as it is available) suffers from high fabrication cost and lack of convenient power sources. Component costs have been driven by the small size and tight tolerances associated with the 100–3000 GHz band and in the case of conventional waveguide components, by the need for hand assembly. Power sources were largely limited in the past to vacuum tubes requiring high primary power, and, again, restrictive tolerances. Moreover, these sources are liable to catastrophic failure. Solid state sources are more reliable but their output power tends to be very low at frequencies above 100 GHz due to the small physical size of the active region, resulting in the well-known  $1/f^2$  fall-off of available power. Hence a need exists to combine the outputs of many individual elements to satisfy the system power requirements.

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# Abstracts

## Focal Plane Imaging Systems for Millimeter Wavelengths

*P.F. Goldsmith, C.-T. Hsieh, G.R. Huguenin, J. Kapitzky and E.L. Moore. "Focal Plane Imaging Systems for Millimeter Wavelengths." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1664-1675.*

We discuss critical aspects of imaging system design and describe several different imaging systems employing focal plane array receivers operating in the 3mm-2mm wavelength range. Recent progress in millimeter-wavelength optics, antennas, receivers and other components permits greatly enhanced system performance in a wide range of applications. We discuss a radiometric camera for all-weather autonomous aircraft landing capability and a high sensitivity cryogenically cooled array for use in radio astronomical spectroscopy. A near-focus system for identification of plastic materials concealed underneath clothing employs a two element lens, and has been demonstrated in active (transmitting) and passive (radiometric) modes. A dual mode imaging system for plasma diagnostics utilizes both active and passive modes at its /spl sine/140 GHz operating frequency to study small-scale structure. The radiometric imaging systems employ between 15 and 256 Schottky barrier diode mixers while the imaging receivers for the active systems include 64 element video detector arrays.



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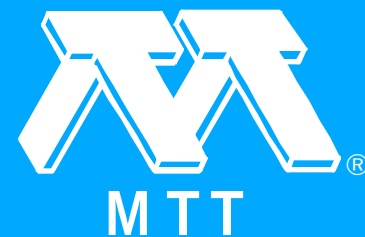


# Abstracts

## Long-Wave Optics

*D.H. Martin and J.W. Bowen. "Long-Wave Optics." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1676-1690.*

In this paper we set out the bases of the near-complete analytical methodology that now exists for the design of long-wave optical systems. We follow the Gaussian beam-mode treatment of free-space propagation, extend it to cover the transformations produced by conic-section reflectors or lenses, and incorporate both the propagation steps and the lens transformations into a matrix formulation readily applicable to networks of such reflectors or lenses. We demonstrate in the process the theorems of Fourier Optics and keep explicit the vectorial properties of the beam-fields. We show how recent formulations of partial coherence have made it possible to include partially-coherent beams in the same methodology. For the design of high-performance systems, the inclusion of higher-order mode-dispersion must be fully understood, the vector properties must be recoverable, and the paraxiality on which the methodology rests must be critically assessed. This paper gives emphasis to these aspects and presents a single systematic formulation embracing all the elements.



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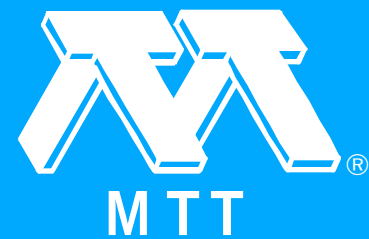
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## Gaussian Beam-Mode Analysis and Phase-Centers of Corrugated Feed Horns

*R.J. Wylde and D.H. Martin. "Gaussian Beam-Mode Analysis and Phase-Centers of Corrugated Feed Horns." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1691-1699.*

The notion of phase-center for a feed-horn is critically examined and, using Gaussian beam-mode analysis, several variously-defined phase-centers, including a maximal-gain phase-center, are investigated in detail for corrugated feed-horns in balanced hybrid mode. Expressions for the locations of these phase centers are derived which are applicable for a wide range of corrugated horn dimensions and for near-field as well as far-field distances.

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# Abstracts

## Mode Conversion at Diffracting Apertures in Millimeter and Submillimeter Wave Optical Systems

*J.A. Murphy, S. Withington and A. Egan. "Mode Conversion at Diffracting Apertures in Millimeter and Submillimeter Wave Optical Systems." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1700-1702.*

Diffraction effects, which occur when the fields in a beam waveguide are truncated at absorbing stops, can be conveniently analyzed using scattering-matrix theory applied to Gaussian-beam modes. We present recursion relationships for the elements of the scattering matrix when a nonaxially-symmetric beam illuminates an axially symmetric stop. We demonstrate the technique by calculating the total loss and beam profiles in a system comprising a diagonal horn, a lens, a window, and two off-axis mirrors. The finite size of each component is taken into account.



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## Slot-Fed Higher Order Mode Fabry-Perot Filters

*J. McCleary, M.-y. Li and K. Chang. "Slot-Fed Higher Order Mode Fabry-Perot Filters." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1703-1709.*

Low loss bandpass filters consisting of Fabry-Perot resonators excited by waveguide fed slots coupling to higher order resonator modes are demonstrated. For close reflector spacings, the waveguide couples efficiently through the slots to the TEM/sub 400/ and TEM/sub 300/ modes. The characteristics of both rectangular and circular waveguide feeds with various slot lengths and widths are presented. At X-band the filters have unloaded Q values which range from 1000 to 7000 with insertion losses less than 1 dB. The filters which have the rectangular waveguide feeds are mechanically tunable over a 20% bandwidth.

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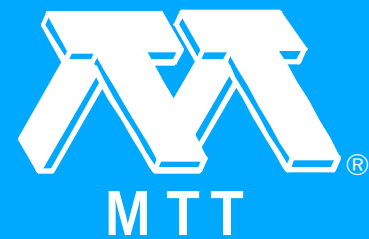
## Gaussian-Beam Open Resonator with Highly Reflective Circular Coupling Regions

*T. Matsui, K. Araki and M. Kiyokawa. "Gaussian-Beam Open Resonator with Highly Reflective Circular Coupling Regions." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1710-1714.*

A high-Q open resonator with new-type quasi-optical coupling regions is described. The resonator consists of a pair of spherical mirrors, on each of which a highly reflective, partially transparent circular region is fabricated with a diameter larger than several wavelengths. The signal is coupled in and out as a Gaussian beam by means of these regions. Both very weak coupling and very efficient mode conversion are simultaneously achieved. This results in a Q factor over  $2 \times 10^5$  and a high signal-to-noise ratio at 105.9 GHz. The Q factor of the open resonator can be varied by rotating the output mirror to change the angle between the directions of the conducting stripes on the two mirrors.

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## Tapered Slotline Antennas at 802 GHz

*P.R. Acharya, H. Ekstrom, S.S. Gearhart, S. Jacobsson, J.F. Johansson, E.L. Kollberg and G.M. Rebeiz. "Tapered Slotline Antennas at 802 GHz." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1715-1719.*

Tapered endfire slotline antennas, of the BLTSA type, have been fabricated on 1.7  $\mu\text{m}$  thin SiO/sub 2//Si/sub 3/N/sub 4/ dielectric membranes. Antenna patterns of the E-, H-, and D-planes have been measured at 802 GHz. The -10 dB beamwidths were found to be approximately 40° in all planes, with side lobe levels below -11 dB (-19 dB in the E-plane). The cross-polarized peaks in the D-plane are 8 dB below the co-polarized peak. A theoretical model for calculating the E- and H- plane patterns of tapered slotline antenna has been extended to include the co- and cross-polarized D-planes. Measured and calculated patterns show good agreement.

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## A Hybrid Dielectric Slab-Beam Waveguide for the Sub-Millimeter Wave Region

*J.W. Mink and F.K. Schwering. "A Hybrid Dielectric Slab-Beam Waveguide for the Sub-Millimeter Wave Region." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1720-1729.*

A hybrid dielectric slab-beam waveguide is suggested which should be well suited as transmission medium for the design of planar quasi-optical integrated circuits and devices operating in the mm and sub-mm wave regions. The new guide consists of a grounded dielectric slab into which a sequence of equally spaced cylindrical lenses is fabricated. (The center line of the slab guide is the axis of the lenses). The structure uses two distinct wave guiding principles in conjunction with each other to guide electromagnetic waves. In the direction normal to the slab surface, the guided fields behave as surface waves of the slab guide; their energy is largely confined to the interior of the dielectric and they are guided by total reflection at the slab surface. In the lateral direction the waves behave as Gauss-Hermite beammodes that are guided by the lenses which periodically reconstitute their cross sectional phase distribution, resulting in a wave beam that is iterated with the lens spacing. The guided fields are in effect TE and TM modes. The analysis of the new guiding structure is presented: The mode spectrum is calculated and the iteration loss due to the finite size of the lenses is estimated.

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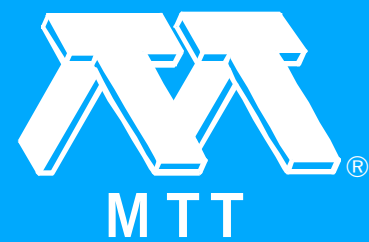
## A Planar Wideband 80-200 GHz Subharmonic Receiver

*B.K. Kormanyos, P.H. Ostdiek, W.L. Bishop, T.W. Crowe and G.M. Rebeiz. "A Planar Wideband 80-200 GHz Subharmonic Receiver." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1730-1737.*

A wideband planar subharmonic mixer has been designed for millimeter-wave operation. The receiver consists of a novel back-to-back Schottky-diode pair integrated at the base of a wideband log-periodic antenna and placed on a silicon lens. The wideband planar receiver results in state-of-the art-performance at 90 GHz (and 182 GHz) with a double-sideband conversion loss and noise-temperature of 6.7 dB (and 8.5 dB) and 1080 K (and 1820 K), respectively. These results are about 3 dB higher than the best tuned waveguide subharmonic mixers using planar diodes. The design is well suited for higher frequencies (up to 1 THz) and for the inclusion of biased back-to-back planar diodes to ease the LO power requirements. The planar subharmonic approach results in an inexpensive wideband receiver and the design can be easily extended to receiver arrays.

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## Double-Slot Antennas on Extended Hemispherical and Elliptical Silicon Dielectric Lenses

*D.F. Filipovic, S.S. Gearhart and G.M. Rebeiz. "Double-Slot Antennas on Extended Hemispherical and Elliptical Silicon Dielectric Lenses." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1738-1749.*

In this paper, the far-field patterns and Gaussian-beam coupling efficiencies are investigated for a double-slot antenna placed on hemispherical lenses with varying extension lengths. The radiation patterns of a double-slot antenna on a silicon dielectric lens are computed using ray-tracing inside the dielectric lens and electric and magnetic field integration on the spherical dielectric surface. The measured radiation patterns at 246 GHz and Gaussian-beam coupling efficiencies show good agreement with theory. The theoretical results are presented in extension length/radius and radius/lambda and therefore result in universal design curves for silicon lenses of different diameters and at different frequencies. The theoretical and experimental results indicate that for single units, there exists a wide range of extension lengths (ext. length/radius = 0.32 to 0.35) which result in high Gaussian-coupling efficiencies (50-60%) to moderately high  $f\#$ 's. These Gaussian-coupling efficiencies can be increased to 80-90% with the use of a  $\lambda/4$  matching-cap layer. For imaging array applications with high packing densities, an extension length/radius = 0.38 to 0.39 (depending on frequency) will result in peak directivity and a corresponding Gaussian-coupling efficiency 15-20% lower than for single units.

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## An Improved Solution for Integrated Array Optics in Quasi-Optical mm and Submm Receivers: The Hybrid Antenna

*T.H. Buttgenbach. "An Improved Solution for Integrated Array Optics in Quasi-Optical mm and Submm Receivers: The Hybrid Antenna." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1750-1761.*

The hybrid antenna discussed here is defined as a dielectric lens-antenna as a special case of an extended hemispherical dielectric lens that is operated in the diffraction limited regime. It is a modified version of the planar antenna on a lens scheme developed by Rutledge. The dielectric lens-antenna is fed by a planar-structure antenna, which is mounted on the flat side of the dielectric lens-antenna using it as a substrate, and the combination is termed a hybrid antenna. Beam pattern and aperture efficiency measurements were made at millimeter and submillimeter wavelengths as a function of extension of the hemispherical lens and different lens sizes. An optimum extension distance is found experimentally and numerically for which excellent beam patterns and simultaneously high aperture efficiencies can be achieved. At 115 GHz the aperture efficiency was measured to be  $(76 \pm 6)\%$  for a diffraction limited beam with sidelobes below -17 dB. Results of a single hybrid antenna with an integrated Superconductor-Insulator-Superconductor (SIS) detector and a broad-band matching structure at submillimeter wavelengths are presented. The hybrid antenna is diffraction limited, space efficient in an array due to its high aperture efficiency, and is easily mass produced, thus being well suited for focal plane heterodyne receiver arrays.





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## A 100-Element HBT Grid Amplifier (Oct. 1993 [T-MTT])

*M. Kim, E.A. Sovero, J.B. Hacker, M.P. De Lisio, J.-C. Chiao, S.-J. Li, D.R. Gagnon, J.J. Rosenberg and D.B. Rutledge. "A 100-Element HBT Grid Amplifier (Oct. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1762-1771.*

A 100-element 10-GHz grid amplifier has been developed. The active devices in the grid are chips with heterojunction-bipolar-transistor (HBT) differential-pairs. The metal grid pattern was empirically designed to provide effective coupling between the HBT's and free space. Two independent measurements, one with focusing lenses, the other without, were used to characterize the grid. In each case, the peak gain was 10 dB at 10 GHz with a 3-dB bandwidth of 1 GHz. The input and output return loss were better than 15 dB at 10 GHz. The maximum output power was 450 mW, and the minimum noise figure was 7 dB. By varying the bias, a signal could be amplitude modulated with a modulation index as large as 0.65. Tests show that the grid was quite tolerant of failures--the output power dropped by only 1 dB when 10% of the inputs were detuned. The grid amplifier is a multi-mode device that amplifies beams of different shapes and angles. Beams with incidence angles up to 30° were amplified with less than a 3-dB drop in gain.

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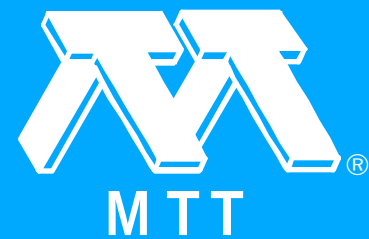


## A 6.5 GHz-11.5 GHz Source Using a Grid Amplifier with a Twist Reflector

*M. Kim, E.A. Sovero, J.B. Hacker, M.P. De Lisio, J.J. Rosenberg and D.B. Rutledge. "A 6.5 GHz-11.5 GHz Source Using a Grid Amplifier with a Twist Reflector." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1772-1774.*

We have constructed and tested an oscillator using a grid amplifier with external feedback from a twist reflector. The twist reflector serves two functions--it changes the output polarization to match the input, and its position sets the feedback phase. This permits a wider tuning range than has been possible with previous grid oscillators. The source could be continuously tuned from 8.2 GHz to 11.0 GHz by moving the twist reflector. By moving the polarizer and mirror in the twist reflector independently, a 1.8-to-1 frequency range from 6.5 GHz to 11.5 GHz was achieved. The peak effective radiated power was 6.3 W at 9.9 GHz.

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## Quasi-Optical VCOs

*T. Mader, S. Bundy and Z.B. Popovic. "Quasi-Optical VCOs." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1775-1781.*

Quasi-optical grid voltage controlled oscillators are presented. These VCOs are the first demonstration of a quasi-optical system consisting of several periodic arrays loaded with solid-state devices. A quasi-optical VCO consists of an array of oscillators, a variable capacitance array, and a mirror. The mirror provides feedback for locked power combining of a large number of MESFET oscillators that load a two-dimensional metal grid on a dielectric substrate. The frequency can be electrically tuned either with gate bias or with another array loaded with varactor diodes. When the varactor bias voltage is changed, the capacitance of the diodes changes, which in turn modulates the frequency of the output power-combined wave. Two types of arrays are presented, one consisting of short dipoles, and the other of bow-tie elements. As expected, the bow-tie VCO has better performance than the dipole VCO, due to its broadband impedance. A 10% tuning bandwidth with less than 2 dB power change was measured in the case of a bow-tie VCO.

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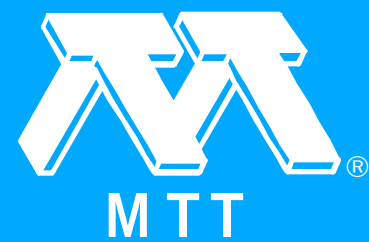
## A Monolithic Diode Array Millimeter-Wave Beam Transmittance Controller

*L.B. Sjogren, H.-X.L. Liu, F. Wang, T. Liu, X.-H. Qin, W. Wu, E. Chung, C.W. Domier and N.C. Luhmann, Jr.. "A Monolithic Diode Array Millimeter-Wave Beam Transmittance Controller." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1782-1790.*

Amplitude control of transmitted millimeter-wave beams by monolithic Schottky diode arrays is demonstrated. An array containing 4800 diodes has demonstrated control over the range 20-50% beam transmittance at 99 GHz and 20-70% beam transmittance at 165 GHz. Modulation testing on a second array (8640 diodes) with similar transmission characteristics has shown array control to 50 MHz with negligible loss of output response. An extensive evaluation performed for the 8640 diode array shows good agreement between array impedance parameters determined from quasi-optical measurements, theoretical calculations, and low frequency C-V measurements. The results have extended the range of quasi-optical functions demonstrated by solid-state power-combining arrays for application to millimeter-wave systems.

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## Quasioptical Millimeter-Wave Hybrid and Monolithic PIN Diode Switches

*K.D. Stephan, F.H. Spooner and P.F. Goldsmith. "Quasioptical Millimeter-Wave Hybrid and Monolithic PIN Diode Switches." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1791-1798.*

The PIN diode switch is an essential building block in many microwave and millimeter-wave systems. In this paper we report the development of a new type of quasioptical PIN diode switch. First, we briefly describe the quasioptical imaging application which motivated the development of the switch. Next, we explain the theory of switch operation in both its reflection and transmission modes. We present experimental results from measurements of both hybrid and monolithic circuits in the millimeter-wave range. The hybrid version exhibits losses in the reflection mode of 1 dB or less and isolation of 20 dB or more. Performance of the monolithic version is comparable, despite a PIN diode yield of less than 80%.

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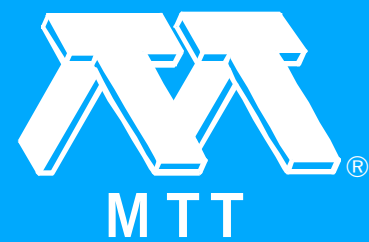
## Nonlinear Analysis of Phase Relationships in Quasi-Optical Oscillator Arrays

R.A. York. "Nonlinear Analysis of Phase Relationships in Quasi-Optical Oscillator Arrays." 1993 *Transactions on Microwave Theory and Techniques* 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1799-1809.

A dynamic theory of coupled oscillators is developed and applied to the class of loosely-coupled quasi-optical oscillator arrays. This theory permits the calculation of stable, steady-state phase relationships between the oscillators. The distribution of free-running frequencies and the coupling parameters are most important in determining the behavior of the arrays. It is found that free-running frequencies of the peripheral elements have the strongest influence on the steady-state phase relationships. The influence of randomness in the frequency distribution is considered for the case of broadside beamforming, establishing a critical value for the coupling strength in order to maintain mutual synchronization with a specified maximum beam deviation. Techniques for simplifying the calculation of phase relationships for some common coupling parameters are also developed. The theory is supported by new experiments and other published results.

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## A New Phase-Shifterless Beam-Scanning Technique Using Arrays of Coupled Oscillators

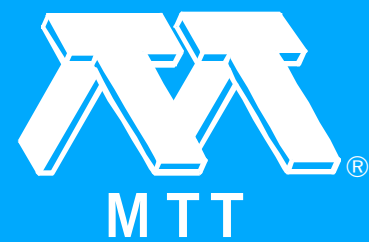
*P. Liao and R.A. York. "A New Phase-Shifterless Beam-Scanning Technique Using Arrays of Coupled Oscillators." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1810-1815.*

A method for electronic beam scanning in linear arrays of antenna-coupled oscillators is introduced which eliminates the need for phase shifters. It is shown that a constant phase progression can be established by slightly detuning the peripheral array elements, while maintaining mutual synchronization. This unusual nonlinear behavior is explained using coupled Van der Pol equations. A stability analysis provides theoretical limitations on the achievable inter-element phase shift. When the phase of the coupling is zero, the theory predicts an inter-element phase shift that can be varied continuously over the range  $-90^\circ < \Delta\theta < +90^\circ$ , and is independent of the number of oscillators in the array. An experimental four-element planar MESFET array was built, operating at 10 GHz with close to zero coupling phase, giving a measured phase progression that was continuously variable over the range  $-88^\circ < \Delta\theta < 66^\circ$ .

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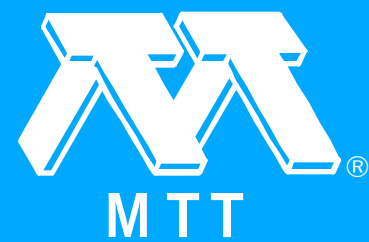
## Impedance in a Matrix of an Antenna Array in a Quasi-Optical Resonator

*P.L. Heron, G.P. Monahan, J.W. Mink, F.K. Schwering and M.B. Steer. "Impedance in a Matrix of an Antenna Array in a Quasi-Optical Resonator." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1816-1826.*

The power from numerous millimeter wave solid-state sources can be efficiently combined using quasi-optical techniques. One such technique is to place an array of active radiating sources within a quasi-optical resonator. The driving point impedance of each antenna is strongly affected by the presence of all other active antennas as well as by the mode structure and Q of the resonator. In this paper the impedance matrix for an array of antennas radiating into a piano-concave open resonator is determined through use of the Lorentz integral. The resulting expressions include the effect of diffraction loss and are valid for arbitrary reflector spacing, source frequency, array location and geometry. The result can be used to impedance match each active source to its antenna and thus facilitate design of an efficient power combining system. Simulations rising the impedance matrix in conjunction with an antenna impedance model are compared with two-port measurements.

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## Mode Analysis and Stabilization of a Spatial Power Combining Array with Strongly Coupled Oscillators

*S. Nogi, J. Lin and T. Itoh. "Mode Analysis and Stabilization of a Spatial Power Combining Array with Strongly Coupled Oscillators." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1827-1837.*

In order to attain stabilized power-combining operations of a strongly coupled active antenna array, mode analysis for the multi-moding problem of the array is presented, and an effective method for exciting only the in-phase power-combining mode is proposed. In a one-dimensional array of active antennas coupled mutually through microstrip lines, the frequencies and the voltage distributions of the normal modes are obtained. Stable modes of the array are identified using the averaged potential theory. Time evolutions of the mode amplitudes are also calculated. In order for only the desired power-combining mode to oscillate, appropriate resistors are introduced at the midpoints of the coupling lines between the active antennas. An experiment for the arrays with up to eight active antennas has been carried out using Gunn diodes. It has been confirmed that the introduction of the resistors is effective for stable excitation of the in-phase power-combining mode.

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## Quasi-Optical Planar Arrays with FET's and Slots

*S. Kawasaki and T. Itoh. "Quasi-Optical Planar Arrays with FET's and Slots." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1838-1844.*

This paper describes the design concept and the experimental results of prototypes of two-dimensional quasi-optical power combining arrays. Several different quasi-optical circuits were made to obtain the fundamental data for this study. How to incorporate the antenna input impedance into the active antenna circuit and how to analyze the strong coupling condition with two operation modes are addressed by using a large signal analysis. Several configurations of the circuits are demonstrated, such as a single active antenna operating at 9.3 GHz and 24.0 GHz, a 6-element linear power combining array operating at 15.6 GHz and 4-element and 16-element two-dimensional power combining arrays operating at 10.4 GHz and 7.8 GHz. Important characteristics such as antenna patterns and tuning ranges are discussed. Finally, the prospects for a two-dimensional monolithic quasi-optical power combining array are discussed.

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## A 60-GHz IMPATT Oscillator Array with Pulsed Operation

*A.C. Davidson, F.W. Wise and R.C. Compton. "A 60-GHz IMPATT Oscillator Array with Pulsed Operation." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1845-1850.*

This paper describes the design and operation of a 60-GHz quasi-optical power combining array employing IMPATT diodes in a weakly coupled, hybrid, two by four arrangement. Frequency-locked operation of all eight elements has been achieved for CW operation with a total radiated power in excess of 2 W. Approximately 61 W of DC power was required to drive the array. Pulsed operation was investigated as a means of preventing overheating. In particular, the locking behavior of these pulsed arrays was characterized. The array was pulsed with a 2- $\mu$ s rise time, low duty cycle, 4-kHz bias. Under these conditions, single frequency operation was observed throughout the duration of the pulse, including the turn-on period.

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## Millimeter and Submillimeter Wave Quasi-Optical Oscillator with Gunn Diodes

*J. Bae, Y. Aburakawa, H. Kondo, T. Tanaka and K. Mizuno. "Millimeter and Submillimeter Wave Quasi-Optical Oscillator with Gunn Diodes." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1851-1855.*

The grooved mirror type Fabry-Perot (GFP) oscillator is used for coherent power-combining of multi-elements in millimeter and submillimeter wave region. The admittance of the Gunn diode in oscillation has been measured experimentally in the millimeter wave region for designing the GFP oscillator. The gain characteristics of the diode has been found at the frequencies from 42 to 48 GHz from the measured results. With this Gunn diode in the GFP resonator, the oscillation has been observed. These experimental results indicated that for impedance matching between the diode and the resonant cavity the groove height must be adjusted.

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## Active Inverted Stripline Circular Patch Antennas for Spatial Power Combining

*J.A. Navarro, L. Fan and K. Chang. "Active Inverted Stripline Circular Patch Antennas for Spatial Power Combining." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1856-1863.*

A new active antenna configuration is proposed for spatial power combining applications. The active patch antenna uses an inverted stripline topology to take advantage of several features. These features include avoiding drilling through the circuit substrate to insert the diode and the use of air within the resonant cavity for reducing loss. The inverted substrate can serve as a radome for hermetic sealing. The active antenna and housing can be fabricated in modular form for reduced cost and easy replaceability of devices. The active inverted stripline patch antenna exhibits a much cleaner spectrum and greater stability than previously reported active antennas. The fixture serves as a ground plane, heat sink and support in an active planar array or as a mirror in a quasi-optical power combining resonator. A single active antenna operating at 9.23 GHz exhibited a 16 MHz locking bandwidth at 30 dB locking gain. Power combining efficiencies of over 89% have been demonstrated for a four element square array. The square array maintained injection-locking and power combining over a 60 MHz bias tuned bandwidth. Similarly, a four element diamond array showed over 86% combining efficiency and 50 MHz bias tuned bandwidth. Beam Steering was demonstrated by varying bias voltage to the individual antenna elements of the square array.

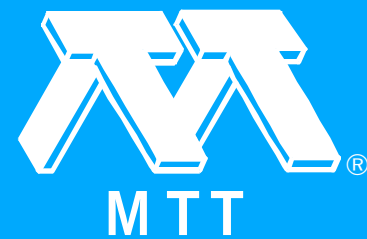
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## Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Oct. 1993 [T-MTT])

*"Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Oct. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.9 (Oct. 1993 [T-MTT] (Special Issue on Quasi-Optical Techniques)): 1864-1864.*



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*"Front Cover (Nov. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): f1-f2.*



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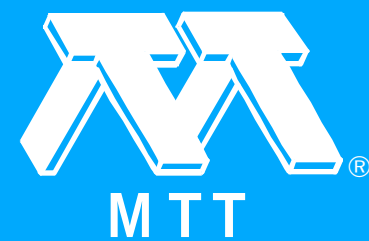
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## Hybrid High Temperature Superconductor/GaAs 10 GHz Microwave Oscillator: Temperature and Bias Effects

*N.J. Rohrer, G.J. Valco and K.B. Bhasin. "Hybrid High Temperature Superconductor/GaAs 10 GHz Microwave Oscillator: Temperature and Bias Effects." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1865-1871.*

Hybrid YBa/sub 2/Cu/sub 3/O/sub 7-x/ superconductor/GaAs microwave oscillators have been designed, fabricated and characterized. The planar oscillators were built on a single 10 mm x 10 mm LaAlO/sub 3/ substrate. The active elements in the hybrid oscillators were GaAs MESFETs. A ring resonator was used to select and stabilize the frequency. A superconducting ring, resonator had a loaded Q at 77 K which was 8 times larger than the loaded Q of a ring resonator fabricated out of copper. S-parameters of the GaAs FET were measured at cryogenic temperatures and used to design the oscillator, which had a reflection mode configuration. The transmission lines, rf chokes and bias lines were all fabricated from YBa/sub 2/Cu/sub 3/O/sub 7-x superconducting thin films. The performance of the oscillators was measured as a function of temperature. The rate of change of the frequency as a function of temperature was smaller for an oscillator patterned from a pulsed laser deposited film than for an oscillator patterned from a sputtered film. As a function of bias at 77 K, the best circuit had an output power of 11.5 dBm and a maximum efficiency of 11.7 %. The power of the second harmonic was 25 dB to 35 dB below that of the fundamental, for every circuit. At 77K, the best phase noise of the superconducting oscillators was -68 dBc/Hz at an offset frequency of 10 kHz and less than -93 dBc/Hz at an offset frequency of 100 kHz. At an offset frequency of 10 kHz, the superconducting oscillator had 12 dB less phase noise than the copper oscillator at 77 K. The superconducting oscillators at 77 K had 26 dB less phase noise than the copper oscillator operating at 300 K.

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## Spectral-Domain Analysis of Open and Shielded Slotlines Printed on Various Anisotropic Substrates

*Y. Chen and B. Beker. "Spectral-Domain Analysis of Open and Shielded Slotlines Printed on Various Anisotropic Substrates." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1872-1877.*

A rigorous full-wave analysis based on the spectral-domain approach for open and shielded slotline transmission lines is presented. The substrate materials under consideration are anisotropic, characterized by both their permittivity and permeability tensors. The formulation includes off-diagonal tensor elements to represent gyroelectric media, Ferrites, or the misalignment between the principal axes of the substrate and the coordinate system of the waveguide. Dyadic admittance Green's functions for every structure are obtained with the help of differential matrix operators in the Fourier-transformed domain, and the Galerkin method is employed to find the propagation constants numerically.



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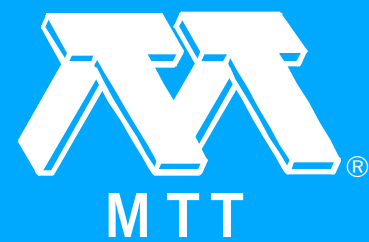
## Heating Characteristics of Thin Helical Antennas with Conducting Cores in a Lossy Medium--I: Noninsulated Antennas

*M.S. Mirotznik, N. Engheta and K.R. Foster. "Heating Characteristics of Thin Helical Antennas with Conducting Cores in a Lossy Medium--I: Noninsulated Antennas." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1878-1886.*

We report a combined theoretical and experimental study of the heating characteristics of helical antennas in lossy dielectric media. Proposed biomedical application of such antennas include angioplasty, hyperthermia, and catheter ablation of tissue. The study focuses on helical antennas, operated in the normal mode (wavelength greater than antenna diameter but comparable to antenna length), that are terminated at one end by a short circuit and at the other by a coaxial feedpoint. The analytical model is based on the helical sheath approximation, extended to the case of lossy media. In addition, experimental studies were performed on helical antennas immersed in aqueous electrolyte of various conductivity. The antennas show two distinct modes of propagation: a slow mode similar to that observed in helical antennas in loss-free media, and a faster mode. The analytical/numerical results are in good agreement with experimental data, thus demonstrating the validity of the model.

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## Identification of Propagation Regimes on Integrated Microstrip Transmission Lines

*J.S. Bagby, C.-H. Lee, D.P. Nyquist and Y. Yuan. "Identification of Propagation Regimes on Integrated Microstrip Transmission Lines." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1887-1894.*

There has been a resurgence of interest in the propagation characteristics of open integrated microstrip transmission lines. This is due in part to the discovery of diverse propagation regimes for higher-order modes on open lines. In contrast to the dominant EH/sub 0/ mode, three distinct propagation regimes exist for higher-order modes on microstrip transmission lines. In this paper, a rigorous spectral-domain integral equation formulation is used to analyze propagation in all three regimes. This formulation provides a clear physical picture of the different propagation regimes based on the mathematical location of poles and branch points in the complex spectral-variable plane. As an illustration, the formulation is applied to the case of an isolated uniform microstrip transmission line. The integral equation is discretized via the method of moments, and entire-domain basis functions incorporating suitable edge behavior are utilized to provide convergence with relatively few terms. The results obtained are compared to the results of other workers, and good agreement is observed.

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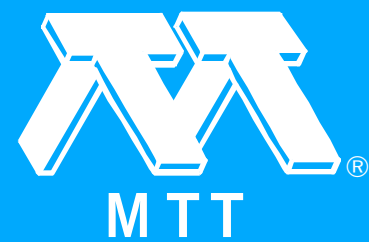
## Reflection and Transmission of Guided Electromagnetic Waves at an Air-Chiral Interface and at a Chiral Slab in a Parallel-Plate Waveguide

*F. Mariotte and N. Engheta. "Reflection and Transmission of Guided Electromagnetic Waves at an Air-Chiral Interface and at a Chiral Slab in a Parallel-Plate Waveguide." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1895-1906.*

Recently, the concept of chirowaveguides, which exhibit some novel and interesting properties due to electromagnetic chirality, was introduced and studied elsewhere. In this paper, we analyze theoretically another problem associated with chirowaveguides, namely, the problem of reflection and transmission of guided waves at an air-chiral interface and at a chiral slab located transversely in a parallel-plate waveguide. The notable features and the role of chirality of the medium on the reflected and transmitted guided waves are discussed, and physical insights into these results are provided. It is found that since the guided modes inside the chiral region of the waveguide are hybrid, in order to satisfy the boundary conditions at interfaces, the reflected and transmitted guided modes in the air regions of the waveguides need to be of TE and TM modes. The motivation behind this study is the potential applications of this problem to the design of novel measurement techniques for determining material parameters of chiral composites.

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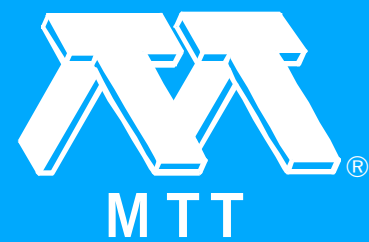
## Calculation of the Fundamental Mode Sizes in Optical Channel Waveguides Using Gaussian Quadrature

*N.A.F. Jaeger and B.P.C. Tsou. "Calculation of the Fundamental Mode Sizes in Optical Channel Waveguides Using Gaussian Quadrature." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1907-1912.*

A fast numerical method using Gaussian quadrature, which takes only seconds on a microcomputer, is presented for calculating the fundamental mode sizes in optical channel waveguides. Variational expressions for the square of the propagation constant,  $\beta^2$ , of the TE- and TM-like modes are derived using the vector wave equations. For channel waveguides with gradual refractive index distributions, these expressions approach the variational expression obtained using the scalar wave equation. To show the usefulness of our numerical technique we present the results for titanium indiffused lithium niobate channel waveguides, which are commonly used in integrated optical circuits. Since these waveguides have gradual refractive index distributions, both types of expressions give the same results; however, it takes less time to compute the mode sizes when using the variational expression obtained from the scalar wave equation. We find the calculated mode sizes are in good agreement with published measurements. From the comparison process, best fit parameters are obtained, which give mode sizes close to the values published in the literature. For one special case we are able to obtain an analytical variational expression and we use it to test the accuracy of our numerical method. We find that the values of  $\beta^2$  given by both methods agree to six significant figures.

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## Measurements on a 215-GHz Subharmonically Pumped Waveguide Mixer Using Planar Back-to-Back Air-Bridge Schottky Diodes

*P.H. Siegel, R.J. Dengler, I. Mehdi, J.E. Oswald, W.L. Bishop, T.W. Crowe and R.J. Mattauch. "Measurements on a 215-GHz Subharmonically Pumped Waveguide Mixer Using Planar Back-to-Back Air-Bridge Schottky Diodes." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1913-1921.*

This paper presents design and performance data for a 215-GHz subharmonically pumped waveguide mixer using an antiparallel-pair of planar air-bridge-type GaAs Schottky-barrier diodes. The waveguide design is a prototype for a 640-GHz system and uses split-block rectangular waveguide with a 2:1 width-to-height ratio throughout. The measured mixer noise and conversion loss are below that of the best reported whisker contacted or planar-diode mixers using the subharmonic-pump configuration at this frequency. In addition, the required local oscillator power is as low as 3 mW for the unbiased diode pair, and greater than 34 dB of LO noise suppression is observed. Separate sideband calibration, using a Fabry-Perot filter, indicates that the mixer can be tuned for true double sideband response at an intermediate frequency of 1.5 GHz. Microwave scale model measurements of the waveguide mount impedances are combined with a mixer nonlinear analysis computer program to predict the mixer performance as a function of anode diameter, anode finger inductance, and pad-to-pad fringing capacitance. The computed results are in qualitative agreement with measurements, and indicate that careful optimization of all three diode parameters is necessary to significantly improve the mixer performance.





## Single-Frequency Relative Q Measurements Using Perturbation Theory

*B. Tian and W.R. Tinga. "Single-Frequency Relative Q Measurements Using Perturbation Theory." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1922-1927.*

Traditionally, Q measurement requires a nonzero frequency bandwidth or time period. Contrasted to this, the principle of a new single-frequency relative Q measurement method is developed. It is found that Q is directly or inversely proportional to the normalized input resonant resistance if a moderate perturbation condition is satisfied. Theoretical proof and experimental verification of the single-frequency method's validity are presented. Consequently, a relative Q, often used in dielectric measurements, can be measured using a much simpler measurement system. Moreover, error analysis shows that, in making a relative Q measurement, the error in the single-frequency method is smaller than that in the traditional bandpass method when using a reflectometer.



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## Large Signal Design of Broadband Monolithic Microwave Frequency Dividers and Phase-Locked Oscillators

*R. Quere, E. Ngoya, M. Camiade, A. Suarez, M. Hessane and J. Obregon. "Large Signal Design of Broadband Monolithic Microwave Frequency Dividers and Phase-Locked Oscillators." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1928-1938.*

This paper presents a design method for phase-locked devices such as frequency dividers or injection-locked oscillators. The method requires a full nonlinear analysis of the circuit. This analysis relies upon Harmonic Balance techniques and is suitable for monolithic circuits simulation. First, a modified formulation of the general harmonic balance equation is proposed which includes the presence of probes. These probes allow us to suppress the degenerated solution of the HB equation in autonomous cases. Moreover, a global stability analysis of phase-locked regimes is carried out. It provides invaluable information on the nonlinear behavior of the device. In particular, synchronization bandwidths as well as power ranges for which the circuit can be synchronized are obtained from the stability loci drawn in the parameter space. All these features have been used to design a broadband monolithic frequency divider, and the simulated and experimental results have been compared with very good accuracy. Therefore, the method proposed is a very useful tool for the design of potentially unstable circuits.



# Abstracts

## Hybrid Couplers in Bilevel Microstrip

*M.D. Prouty and S.E. Schwarz. "Hybrid Couplers in Bilevel Microstrip." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1939-1944.*

Hybrid couplers can be built using a bilevel microstrip structure in which two strips are positioned broadside, one above the other. This simple geometry provides large coupling factors without the need for rigorous manufacturing tolerances. Remarkably, if the dielectric constant of one of the layers can be freely chosen, ideal hybrid coupler performance is achievable. Even when the choice of dielectric constant is constrained, good results can be obtained. A technique for achieving optimal design has been developed, and design curves are shown. Experiments confirm design predictions. The reentrant coupler may be analyzed as an interconnection of two bilevel couplers of the kind described here. This provides a simpler analysis than methods used earlier, and in some cases yields more accurate results.



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## Turnstile Reflecto-Polarimeter Using the Principal Incidence Method: Determination of Permittivities Up to 1200°C and Industrial Applications

*A. Bretenoux, C. Marzat and R. Sardos. "Turnstile Reflecto-Polarimeter Using the Principal Incidence Method: Determination of Permittivities Up to 1200°C and Industrial Applications." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1945-1949.*

Having designed a free-space reflecto-polarimeter at 10 and 35 GHz using circular horns and turnstile analyzers, the authors proceed to use this device to measure the dielectric constants of various substances at temperatures up to 1200° C. Prismatic samples are used to eliminate the influence of the back face of the sample as well as that of interference phenomena. Some results are given, and also a practical application of principal- or Brewster-angle incidence to the heating of substances using microwaves is described.

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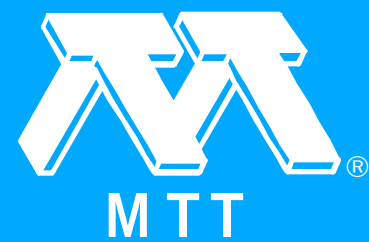
## A Nonreciprocal Tunable Waveguide Directional Filter Using a Turnstile Open Gyromagnetic Resonator

*J. Helszajn, C.S. Cheng and B.A. Wilcock. "A Nonreciprocal Tunable Waveguide Directional Filter Using a Turnstile Open Gyromagnetic Resonator." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1950-1958.*

The 4-port waveguide directional filter is a classic network in microwave engineering. The purpose of this paper is to describe one gyromagnetic version using an open gyromagnetic resonator in a dielectric-filled cavity. A property of the circuit is that it behaves as a 4-port circulator with one direction of circulation at one split frequency of the resonator and with the other direction for the other split frequency. An insertion loss between the coupled ports below 1.50 dB and an attenuation or isolation of typically 15 dB between the decoupled ports over most of the tuning range of the filter have been achieved. Its 3-dB bandwidth is typically 65 MHz. A typical tuning range of more than 1 GHz centered at about 10.5 GHz has been separately realized for each split branch.

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## Effects of Waveguide Wall Grooves Used to Hold Samples for Measurement of Permittivity and Permeability

*R. Luebbers. "Effects of Waveguide Wall Grooves Used to Hold Samples for Measurement of Permittivity and Permeability." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1959-1964.*

The complex permittivity and permeability of a material may be measured at microwave frequencies by placing a sample of the material in a waveguide and measuring the complex reflection and transmission coefficients. Whereas there are various approaches to holding the sample in place, for a thin rigid sample in place, for a thin rigid sample shallow grooves may be cut in the waveguide walls for this purpose. However, such grooves will be a source of error since higher order modes can be excited. In this paper the modal analysis method is used to illustrate the potential for error in measuring constitutive parameters of the sample introduced by the grooves.

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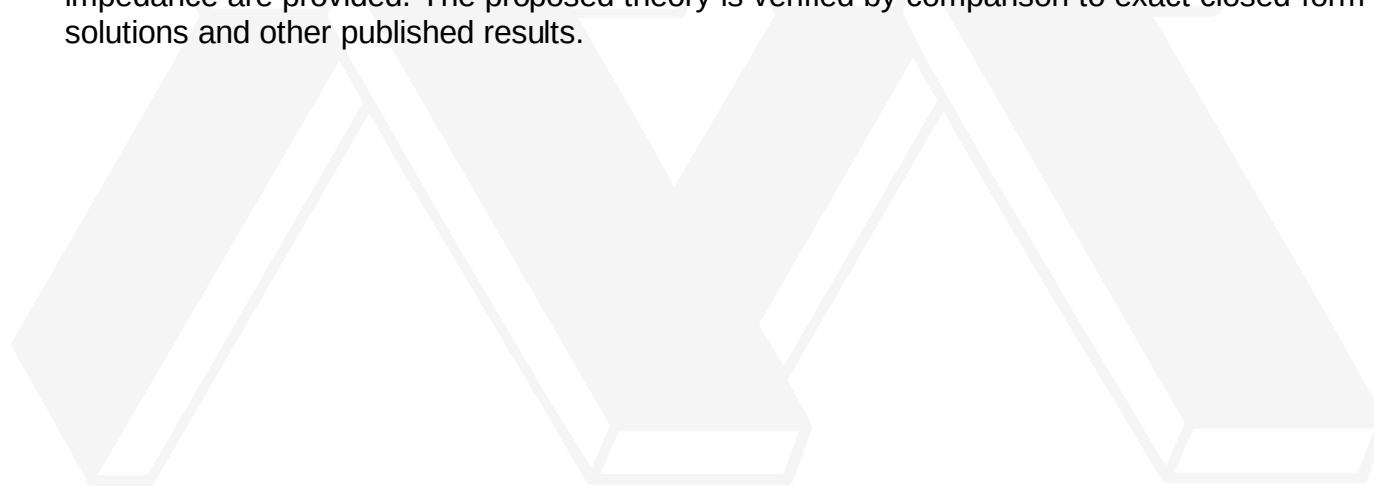
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## MFIE Analysis and Design of Ridged Waveguides

*W. Sun and C.A. Balanis. "MFIE Analysis and Design of Ridged Waveguides." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1965-1971.*

This paper presents a unified approach for the analysis and design of ridged waveguides by a magnetic field integral equation (MFIE) formulation. The MFIE approach allows accurate and complete solution via a simple numerical implementation of pulse basis functions. The emphasis of the paper is oriented to the design of ridged waveguides for applications in microwave components and systems, rather than to details of numerical algorithms. Erroneous bandwidth estimates due to neglect of the TE/sub 11/ mode in previous works have been corrected; and various useful design curves on cutoff frequency, bandwidth, attenuation, and waveguide impedance are provided. The proposed theory is verified by comparison to exact closed-form solutions and other published results.



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## Rigorously Modeling Short Bent, Graded-Index Dielectric Slab Waveguides

*H.J.M. Bastiaansen, J.M. van der Keur and H. Blok. "Rigorously Modeling Short Bent, Graded-Index Dielectric Slab Waveguides." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1972-1980.*

Circularly short bent, graded-index dielectric slab waveguides are mathematically modeled using both a direct integration method and a source-type integral equation method. The former method is easy to implement, requiring only small amounts of computer time. The latter method has the potential to be extended to a rigorous model for bent channel waveguides. Both homogeneous and inhomogeneous slab waveguide layers are considered. The mathematical models are validated through comparison of the numerical results with results obtained by the analytical resonance conditions. Numerous numerical examples are given.

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## Finite-Element Analysis of Axisymmetric Cavity Resonator Using a Hybrid Edge Element Technique

*J.-F. Lee, G.M. Wilkins and R. Mittra. "Finite-Element Analysis of Axisymmetric Cavity Resonator Using a Hybrid Edge Element Technique." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1981-1987.*

A modified finite-element technique for the analysis of axisymmetric cavities is presented. In this analysis an edge element approach is used in conjunction with a nodal approach to represent all electric field components in the cavity. A bilinear functional is formulated from which resonant frequencies and/or field distributions are obtained. Several geometries are investigated and corresponding results are presented as verification of the method.

[Click on title for a complete paper.](#)



# Abstracts

## Scattering by a Dielectric Obstacle in a Rectangular Waveguide

*J. Abdulnour and L. Marchildon. "Scattering by a Dielectric Obstacle in a Rectangular Waveguide." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1988-1994.*

A method for the computation of S-parameters associated with a rectangular waveguide with a rectangular or cylindrical obstacle of arbitrary complex scalar permittivity is presented. The method uses modal analysis and integral relationships to connect appropriate components of the field. In this way, convergence is achieved faster than by point-matching techniques. Our method is well adapted to resonance problems, as illustrated by comparison with both theoretical and experimental results.



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# Abstracts

## On Surface Integral Representations: Validity of Huygens' Principle and the Equivalence Principle in Inhomogeneous Bianisotropic Media

*J.C. Monzon. "On Surface Integral Representations: Validity of Huygens' Principle and the Equivalence Principle in Inhomogeneous Bianisotropic Media." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 1995-2001.*

Here we provide the mathematical foundation for general inhomogeneous (even discontinuous) media for the principle that Huygens devised with ingenious foresight over three hundred years ago (1690). We also validate the associated (and often used without a proof) equivalence principle as a natural extension of the isotropic formalism.



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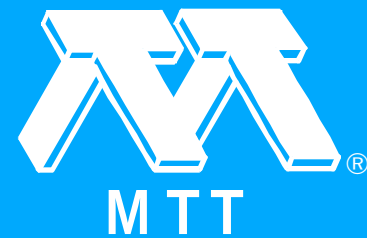


# Abstracts

## Full-Wave Analysis of Three-Dimensional Planar Structures

*A.M. Lerer and A.G. Schuchinsky. "Full-Wave Analysis of Three-Dimensional Planar Structures." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2002-2015.*

The development of microwave and millimeter-wave integrated circuits (MIC) is difficult to imagine now beyond reliable and efficient numerical simulation of wave interactions in real structures. To meet the challenge, sophisticated CAD tools based on the methods of field theory acquire a particular significance.



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## Absorbing and Connecting Conditions for the TLM Boundary Method

*Z. Chen, M.M. Ney and W.J.R. Hoefer. "Absorbing and Connecting Conditions for the TLM Boundary Method." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2016-2024.*

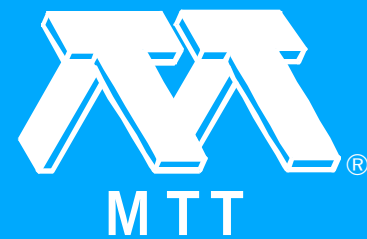
Absorbing and connecting boundary conditions are implemented for the transmission-line matrix (TLM) method. The approach is based on an equivalence previously established between the finite-difference-time-domain (FD-TD) method and the TLM method. Boundary conditions presently used for the FD-TD algorithm can be transformed into conditions that can be interfaced with two-and three-dimensional (2D and 3D) TLM schemes. Additional conditions are introduced for 3D-TLM symmetrical condensed node simulations to suppress instabilities caused by spurious modes, inherent to the model, and which are amplified by absorbing boundaries. Numerical results and the comparison with other methods show the good performance of the proposed algorithms.

# Abstracts

## Resonant Tunneling Diodes as Sources for Millimeter and Submillimeter Wavelengths (Short Papers)

*R. Bouregba, O. Vanbesien, P. Mounaix, D. Lippens, L. Palmateer, J.C. Pernot, G. Beaudin, P. Encrenaz, E. Bockenhoff, J. Nagle, P. Bois, F. Chevoir and B. Vinter. "Resonant Tunneling Diodes as Sources for Millimeter and Submillimeter Wavelengths (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2025-2027.*

High quality Resonant Tunneling Diodes have been fabricated and tested as sources for millimeter and submillimeter wavelengths. The devices have shown excellent I-V characteristics with peak-current ratios as high as 6:1 and current densities in the range 50-150 kA/cm<sup>2</sup> at 300 K. Used as local oscillators, the diodes are capable of the art output power delivered by AlGaAs-based tunneling devices. As harmonic multipliers, a frequency of 320 GHz has been achieved quintupling the fundamental oscillation of a klystron source.



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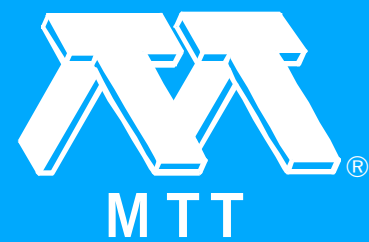
## Design and Performance of a Planar Star Mixer (Short Papers)

*S. Basu and S.A. Maas. "Design and Performance of a Planar Star Mixer (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2028-2030.*

This paper describes the realization of a hybrid star mixer as a planar circuit. The mixer has a minimum conversion loss of 5 dB and, for a conversion loss of less than 9 dB, spans over 2.2 GHz in IF bandwidth and 8 GHz in RF/LO bandwidth. The mixer employs a novel, planar balun structure, similar to conductor-backed CPW, that is suitable for realization as a monolithic circuit.

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## Invariance of $S_{21}/S_{12}$ and K-Factor Under Parallel Operation of Linear Two-Port Devices (Short Papers)

*M. Ohtomo. "Invariance of  $S_{21}/S_{12}$  and K-Factor Under Parallel Operation of Linear Two-Port Devices (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2031-2034.*

Based on a generalized circuit model for parallel-operated amplifiers with linear two-port devices, it has been proved that the S-parameter ratio  $S_{21}/S_{12}$  and hence MSG (Maximum Stable Gain) are invariant as long as the devices have an identical value of  $S_{21}/S_{12}$  and the input and output networks are reciprocal. The invariance of K-factor has been shown to hold for two cases: (i) devices are identical and input/output networks are lossless and symmetric with respect to each device, and (ii) identical admittances are added to the networks of case (i) so as to connect every device port with each other. Thus at least in these two cases, MAG (Maximum Available Gain) and U (Unilateral Gain) are invariant as well as MSG under parallel operation of linear two-port devices. The invariance of  $S_{21}/S_{12}$  and hence MSG applies to a variety of parallel-operated amplifiers such as distributed amplifiers and linear power amplifiers.

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# Abstracts

## A Model for Coplanar Waveguide Transmission Line Structure on Semiconductor Substrates (Short Papers)

*K.R. Nary, K.G. Bellare and S.I. Long. "A Model for Coplanar Waveguide Transmission Line Structure on Semiconductor Substrates (Short Papers)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2034-2037.*

An accurate model for coplanar waveguide transmission line structures on semiconductive substrates is presented. The model is useful for simulating long ( $> 0.5$  mm) interconnects on LSI and VLSI GaAs circuits as well as high speed Si ICs. When simulated in the frequency domain, the model shows an excellent match to measured S parameters of coplanar waveguide samples.



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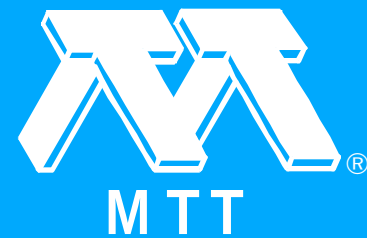


# Abstracts

## Mechanisms Determining Third-Order Intermodulation Distortion in AlGaAs/GaAs Heterojunction Bipolar Transistors (Comments)

*S.A. Maas, B. Nelson and D. Tait. "Mechanisms Determining Third-Order Intermodulation Distortion in AlGaAs/GaAs Heterojunction Bipolar Transistors (Comments)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2038-2039.*

We believe that statements in the above-referenced paper seriously misrepresent our work. In [2] we made the following points:



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# Abstracts

## Mechanisms Determining Third Order Intermodulation Distortion In AlGaAs/GaAs Heterojunction Bipolar Transistors (Reply to Comments)

A. Samelis and D. Pavlidis. "Mechanisms Determining Third Order Intermodulation Distortion In AlGaAs/GaAs Heterojunction Bipolar Transistors (Reply to Comments)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2039-2040.

The comments by Maas et al. give us an excellent opportunity to clarify some of the points they raise. These appear to be written in a spirit of overreaction and supported by personal statements in the authors' style of language.



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## Instantaneous Model of a MESFET for Use in Linear and Nonlinear Circuit Simulations (Comments)

*C. Camacho-Penalosa and J.T. Entrambasaguas-Munoz. "Instantaneous Model of a MESFET for Use in Linear and Nonlinear Circuit Simulations (Comments)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2040-2041.*

The purpose of this Letter is to address some issues regarding scientific priority, proper references to previously published work and professional ethics. In particular, we would like to comment on the paper by Corbella et al. published in IEEE Transactions on Microwave Theory and Techniques in July 1992. Hereon, we refer to Corbella et al.'s paper as [1]. In such paper, the authors claim to have proposed a "different approach in nonlinear modeling" and "a new circuit topology for the instantaneous simulation of the transistor". On the next page of their article, however, the authors state "The instantaneous model for a transistor, proposed previously in [8], is shown in Fig. 1." It must be noticed that "new" and "proposed previously" are self-contradictory terms, especially because the authors' "instantaneous model" was published in Dr. Entrambasaguas' Ph.D. thesis in 1990 as referenced by the authors in their [8], here referred to as [2].

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## Instantaneous Model of a MESFET for Use in Linear and Nonlinear Circuit Simulations (Reply to Comments)

*I. Corbella. "Instantaneous Model of a MESFET for Use in Linear and Nonlinear Circuit Simulations (Reply to Comments)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2041-2042.*

I was very surprised when I received from the editor of the IEEE Transactions on MTT a letter from my friend Carlos Camacho with the comments to the paper I published in these transactions. I had no previous notice from the authors and, at first, I was pleased because I thought that the comments would address some scientific issue, which would be interesting, not only for he and me, but also for all the microwave community. But the aim of the comment was very different and now I am forced to write a rebuttal with arguments and discussions that I am afraid will not be valuable to the readers of these transactions.





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## Optimum Noise Measure Terminations for Microwave Transistor Amplifiers (Comments)

*J.-C. Liu, S.-S. Bor and P.-C. Lu. "Optimum Noise Measure Terminations for Microwave Transistor Amplifiers (Comments)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2042-2043.*

Continued from the above letter, it is found that the determination of the stable region in Fig. 2 of the paper is another incorrect one.

[Click on title for a complete paper.](#)



# Abstracts

## On Optimum Noise Measure Terminations for Microwave Transistor Amplifiers (Reply to Comments)

*D.K. Paul and P. Gardner. "On Optimum Noise Measure Terminations for Microwave Transistor Amplifiers (Reply to Comments)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2043-2044.*

The commentators now assert that the stable region was calculated incorrectly in the paper. This is not true. It is perfectly valid to determine the stable region by plotting the input stability circle in the  $\Gamma_{in}$  plane and the output stability circle in the  $\Gamma_{out}$  plane, where  $\Gamma_{out}$  is the output load reflection coefficient. In Fig. 2 of the paper, both circles were plotted, for convenience and economy of journal space, on the same Smith chart. Stability was then verified by confirming that the proposed input and output terminations were in the stable regions in their respective planes.



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# Abstracts

## Analysis and Realization of L-Band Dielectric Resonator Microwave Filters (Comments on)

*S. Bialas and A. Abramowicz. "Analysis and Realization of L-Band Dielectric Resonator Microwave Filters (Comments on)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2044-2045.*

The application of a 2-D and 3-D finite element method to estimate the parameters of the structures with dielectric resonators deserves special attention. However, working through the above paper, one can find that some parts of it have been carelessly written.



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# Abstracts

## Analysis and Realization of L -Band Dielectric Resonator Microwave Filters (Reply to Comments)

*V. Madrangeas, M. Aubourg, P. Guillon, S. Vigneron and B. Theron. "Analysis and Realization of L -Band Dielectric Resonator Microwave Filters (Reply to Comments)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2045-2045.*

In the above paper, we applied the 3-D finite element method to design and to realize an L-band dielectric resonator filter.



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## Analysis and Realization of L -Band Dielectric Resonator Microwave Filters (Authors' Response to Comments)

*S. Bialas and A. Abramowicz. "Analysis and Realization of L -Band Dielectric Resonator Microwave Filters (Authors' Response to Comments)." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2045-2046.*

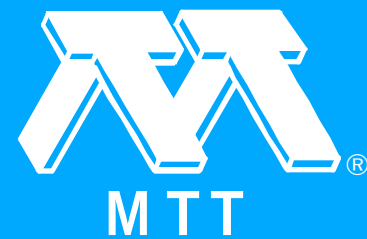
However, the resonant frequency of the filter presented in Fig. 17 is clearly higher than 1.56 GHz we must agree that the Figs. 16 and 17 in the paper represent the responses of the same filter and it is better to determine the resonant frequency and the insertion losses in the narrow-band.



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## Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Nov. 1993 [T-MTT])

*"Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Nov. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2047-2047.*



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## New Books from IEEE Press (Advertisement) (Nov. 1993 [T-MTT])

*"New Books from IEEE Press (Advertisement) (Nov. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): 2048-2048.*



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*"Back Cover (Nov. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.10 (Nov. 1993 [T-MTT]): b1-b2.*



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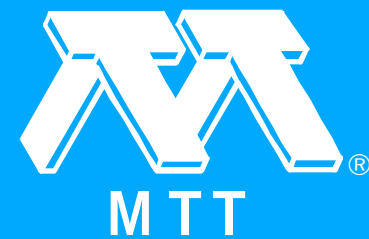


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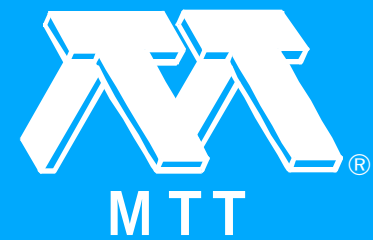


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*"Table of Contents (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2049-2050.*



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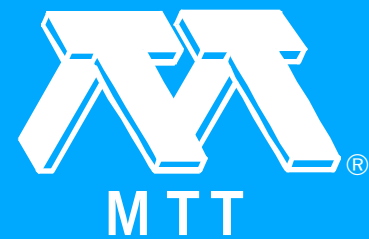
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## Guest Editors' Overview (Dec. 1993 [T-MTT])

*G.S. Smith and I. Bahl. "Guest Editors' Overview (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2051-2052.*

This Special Issue of the Transactions contains expanded versions of papers that were presented at the 1993 International Microwave Symposium (IMS) and the Microwave and Millimeter-Wave Monolithic Circuits Symposium (MMWMCS) held in Atlanta, Georgia. The 41 IMS and 5 MMWMCS papers were selected from the 92 IMS and 10 MMWMCS papers submitted for publication in this issue. The acceptance rate for the submitted papers was largely dictated by the page allocation set for the issue. A number of papers were rejected because the reviewers suggested substantial revision, and the publication deadline did not allow sufficient time for a second review. The authors of these papers were encouraged to revise and resubmit their papers for publication in a regular issue of the Transactions.

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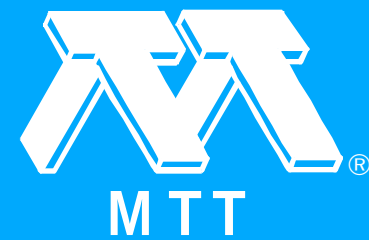




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## Reviewers for this Special Issue (Dec. 1993 [T-MTT])

*"Reviewers for this Special Issue (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2053-2053.*



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## The 1993 IEEE MTT-S International Microwave Symposium (Dec. 1993 [T-MTT])

*G.P. Rodrigue and C.T. Rucker. "The 1993 IEEE MTT-S International Microwave Symposium (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2054-2057.*

On behalf of the 1993 International Microwave Symposium Atlanta Steering Committee, we express our heartfelt thanks to the many who contributed to the great success of the 1993 IMS. You, the Society members, those whose papers were presented, are the focus of IMS, and you are the keys to every successful venture on the part of the Society. From all the reports we have received, IMS 1993 was a success. You came, you saw a little bit of the future, and we hope we helped you conquer at least a few of the fears brought on by the changing national and international business climate for the microwave community. If exhibitor attendance and booth rentals are a measure of "the business climate," things are indeed not bad at all. In 1993, 481 booths were occupied by 293 vendors, and we are told that the business contacts were of very high quality.



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## 1993 MTT-S Awards (Dec. 1993 [T-MTT])

*"1993 MTT-S Awards (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2058-2066.*



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## Full-Wave Characterization of Microstrip Open End Discontinuities Patterned on Anisotropic Substrates Using Potential Theory

*S.S. Toncich, R.E. Collin and K.B. Bhasin. "Full-Wave Characterization of Microstrip Open End Discontinuities Patterned on Anisotropic Substrates Using Potential Theory." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2067-2073.*

A technique for the full-wave characterization of microstrip discontinuities fabricated on uniaxial anisotropic substrates using a dynamic source reversal method based on potential theory is presented. The dynamic source reversal technique was introduced in 1989 by R. E. Collin and S. S. Toncich. The open end discontinuity is enclosed in a cut-off waveguide of infinite extent, with the anisotropic axis aligned perpendicular to the air-dielectric interface. A full description of the sources on the microstrip line is included with proper edge conditions built in. The resulting computer program is written in compiled BASIC and is intended for execution on personal computers possessing minimal memory and or processing resources. Extension to other discontinuities is discussed.

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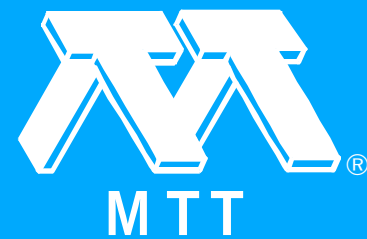


# Abstracts

## A Rigorous Analysis of Uniform Stripline of Arbitrary Dimensions

*M.H. Burchett, S.R. Pennock and P.R. Shepherd. "A Rigorous Analysis of Uniform Stripline of Arbitrary Dimensions." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2074-2080.*

This paper presents a rigorous and computationally efficient analysis for stripline of arbitrary dimensions based on the transverse resonance diffraction technique. Calculated higher order mode cutoff frequencies show excellent agreement, and attenuation factor shows good agreement with measured values for an air-filled stripline. The higher order mode cutoff frequencies, impedance, and attenuation factor results all show improved accuracy over conventional numerical or analytical techniques for a wide range of dimensional ratios.



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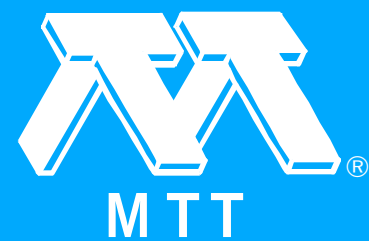
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## New Method for Measuring Properties of Nonhomogeneous Materials by a Two-Polarization Forward-Scattering Measurement

*A.P. Toropainen. "New Method for Measuring Properties of Nonhomogeneous Materials by a Two-Polarization Forward-Scattering Measurement." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2081-2086.*

A new method for measuring properties of granular materials with a two-polarization scattering measurement combined with a free-space phase measurement is introduced. The theoretical background of the measurement method is presented. Laboratory measurements of the depolarized scattering cross sections of white rice, green lentils, polystyrene beads, polyethylene beads, and mixtures of them at 10 and 35 GHz with a vector network analyzer and two horn antennas are presented. Results are compared with those based on first-order multiple scattering theory. Laboratory tests of the measurement of the relative effective permittivity of different materials by a phase measurement are presented. Also, laboratory tests of the compensation of the effects of changes in the number density and the permittivity of the inclusions of mixtures using a phase measurement are presented. A low-cost measurement setup for industrial measurements is also suggested.

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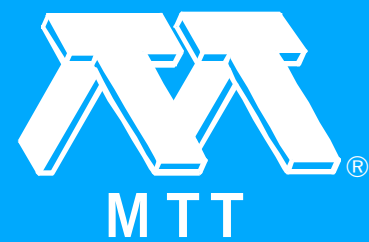
## Al-SiO<sub>2</sub>/Al Sandwich Microstrip Lines for High-Frequency On-Chip Interconnects

*J. Gondermann, E.G. Stein von Kamienski, H.G. Roskos and H. Kurz. "Al-SiO<sub>2</sub>/Al Sandwich Microstrip Lines for High-Frequency On-Chip Interconnects." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2087-2091.*

We present details on the high-frequency behavior of a downscaled 2  $\mu\text{m}$  wide microstrip line, fabricated with both signal and ground conductors on top of the substrate. A significantly reduced geometric dispersion for electric pulses with a bandwidth of several hundred gigahertz is found in time-resolved electrooptic sampling measurements. Additionally, the strong confinement of the electric field within these surface-mounted microstrip lines promises low substrate losses, even on doped substrates, and reduced crosstalk.

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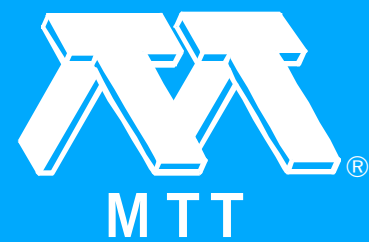
## Applied Field/Frequency Dependency of Propagation in Axially Magnetized Ferrite Waveguides

*B.M. Dillon and A.A.P. Gibson. "Applied Field/Frequency Dependency of Propagation in Axially Magnetized Ferrite Waveguides." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2092-2098.*

Vector finite element solvers are used to calculate phase constants and cutoff wave numbers in waveguides containing axially magnetized ferrite media. For phase constant calculations, ferrite characteristics are specified in terms of the applied field, frequency, and material characteristics including saturation magnetization and data from the hysteresis curve. Periodic boundary conditions are used with both finite element formulations to improve efficiency by reducing the size of the meshed region. Cutoff planes and phase shifts have been calculated for two examples, a Reggia-Spencer phase shifter and a ridged Faraday rotation section. In each case comparisons are made with measured data in the literature. The ridged Faraday section was found to be multimode over the design bandwidth. For completeness, the geometrical dependency of the cutoff plane in circular quadruply ridged waveguides is enunciated and compared with available experimental results.







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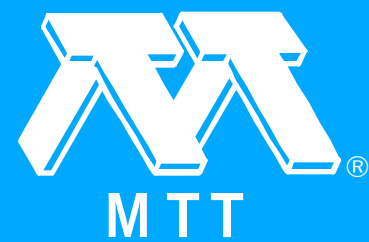
## Resonant Phenomena in Conductor-Backed Coplanar Waveguides (CBCPW's) (Dec. 1993 [T-MTT])

*W.-T. Lo, C.-K.C. Tzuang, S.-T. Peng, C.-C. Tien, C.-C. Chang and J.-W. Huang. "Resonant Phenomena in Conductor-Backed Coplanar Waveguides (CBCPW's) (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2099-2108.*

This paper presents a thorough and systematic investigation of resonant phenomena in conductor-backed coplanar waveguides (CBCPW's). We used a full-wave analysis first to establish benchmark results and a series of measurements have been conducted to confirm the theoretical results. As many as ten structures of different side-plane patterns were bulk and tested. All the test circuits exhibit many resonances over a frequency range, as measured in terms of two-port scattering parameters. Our full-wave analysis is capable of analyzing shielded guided-wave structures with finite-width substrate, and yields the scattering parameters of the coplanar waveguide circuits accounting for the overmoded-wave propagation. Finally, simple models are developed for physical understanding and interpretation of the resonant phenomena. When treating the side planes as patch resonators, we show that the resonant frequencies can be accurately estimated by this simple model. Followed by another MSL (microstrip-like) model, which considers the excitation of the first and the second MSL modes, the resonant frequencies thus obtained are also shown to be in very good agreement with measured results. By displaying the current distributions on the conductor strips in the through or resonant states of the test circuits, the MSL modes of resonances or the patch-type resonances can be clearly seen. When resonance occurs, the electromagnetic energy is confined or carried underneath the side planes and the signal energy can hardly propagate through the central signal line of the test circuit.

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## The Wave-Equation FD-TD Method for the Efficient Eigenvalue Analysis and S-Matrix Computation of Waveguide Structures

*D.V. Krupezevic, V.J. Brankovic and F. Arndt. "The Wave-Equation FD-TD Method for the Efficient Eigenvalue Analysis and S-Matrix Computation of Waveguide Structures." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2109-2115.*

A new finite-difference time-domain (FD-TD) method is presented for the efficient computation of both the hybrid-mode eigenvalues and the scattering parameters of waveguide structures. The FD-TD formulation is based on the direct discretization of the vector wave equation, and requires advantageously only one grid (instead of two displaced grids in the commonly used curl equation approach). Moreover, merely the solution of three (instead of six) coupled equations is necessary. For 2D eigenvalue problems, the utilization of actual 2D grids and graded meshes yields a further reduction in the computational requirements, and, e.g., the whole dispersion characteristic (including evanescent modes) may be calculated very efficiently. For the S-parameter calculation, an excitation with a sinusoidally modulated Dirac impulse train is utilized. This combines the efficiency of frequency-domain methods with the flexibility of the standard FD-TD method. Typical numerical examples, such as the resonance frequencies for an inhomogeneously filled waveguide resonator, the hybrid-mode propagation characteristics of dielectric waveguiding structures, and the scattering parameters of the discontinuity of a dielectric slab of finite length in a rectangular waveguide, demonstrate the efficiency of the method. The theory is verified by comparison with results obtained by other methods.

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## Broad-Band Uniplanar Hybrid-Ring and Branch-Line Couplers

C.-H. Ho, L. Fan and K. Chang. "Broad-Band Uniplanar Hybrid-Ring and Branch-Line Couplers." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2116-2125.

Novel uniplanar 180° and 90° hybrids suitable for MIC and MMIC are described. The new uniplanar crossover hybrid-ring magic-T coupler using a coplanar waveguide (CPW) and slotline provides substantially improved amplitude and phase characteristics over a broad bandwidth compared to conventional microstrip hybrid-ring couplers. Experimental results show that the uniplanar crossover hybrid-ring coupler has a bandwidth of more than one octave from 2 to 4 GHz with  $\pm 0.4$  dB power dividing balance and  $\pm 1^\circ$  phase balance. A uniplanar two-branch directional coupler using a coupled rectangular slotline ring has also been developed that has over 20 dB isolation over a bandwidth of more than 40% centered at 3 GHz with  $\pm 1$  dB power dividing balance. To fully utilize the advantages of uniplanar structures, transitions from CPW to slotline and coplanar strip (CPS) using uniform and non-uniform CPWs, slotlines, or CPSs are discussed. These transitions are uniplanar and simple to fabricate. No via holes are needed for ground connections, and integration with solid-state devices is easy. A pair of broad-band transitions using CPW shorts and slotline radial stubs is demonstrated with a 1 dB bandwidth of more than 5.2:1. The CPW-CPS transition shows a 1 dB bandwidth of more than two octaves.





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## Analysis and Measurement of NRD-Guide Leaky Wave Coupler in Ka Band

*D.-C. Niu, T. Yoneyama and T. Itoh. "Analysis and Measurement of NRD-Guide Leaky Wave Coupler in Ka Band." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2126-2132.*

A new structure for an NRD-guide directional coupler is developed. This structure combines two NRD guides and a dielectric slab guide in order to utilize a leakage mechanism for coupling. The coupling depends on this leaky mechanism, but not on field interactions as in a conventional proximity coupler. A theoretical formula is presented. The field along the NRD guide and the decay constant are measured at Ku band (35 GHz) and compared with the theoretical data. Reasonable agreement exists between the measured data and theoretical data.

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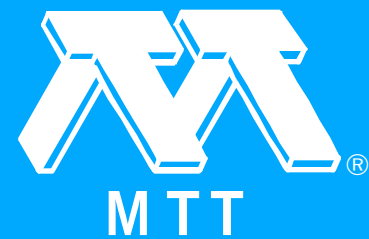
## Noise Design of Active Feedback Resonator BEF (Dec. 1993 [T-MTT])

*Y. Ishikawa, S. Yamashita and S. Hidaka. "Noise Design of Active Feedback Resonator BEF (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2133-2138.*

Active feedback resonator (AFR) filters can be used in design techniques for conventional passive microwave filters by introducing the noise temperature of a resonator. The noise figure (NF) of AFR filters can be analytically designed by using noise temperature. In this paper, three-pole AFR band elimination filter (BEF) is designed to evaluate the NF value. The measured results agree well with the theoretical values.

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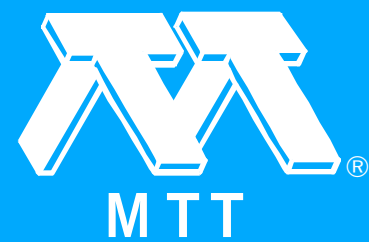
## High-Q Microwave Acoustic Resonators and Filters

*K.M. Lakin, G.R. Kline and K.T. McCarron. "High-Q Microwave Acoustic Resonators and Filters." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2139-2146.*

This paper presents recent experimental results and modeling obtained on high-Q microwave acoustic resonators and filters for use in oscillators and other frequency control applications. Overmoded resonators have exhibited an FQ greater than  $1 \times 10^{14}$  Hz (e.g.,  $Q = 68\,000$  at 1.6 GHz) with a strong inductive response suitable for one-port and two-port oscillator feedback circuits. Ladder filters fabricated with overmoded resonators have loaded Q's greater than 40 000 with 76 kHz bandwidth at 1.6 GHz. Aluminum nitride films were used for longitudinal transduction on Z-cut sapphire and lithium niobate substrates.

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## Design of a Low Loss SAW Reflector Filter with Extremely Wide Bandwidth for Mobile Communication Systems

*G. Muller, J. Machui, L. Reindl, R. Weigel and P. Russer. "Design of a Low Loss SAW Reflector Filter with Extremely Wide Bandwidth for Mobile Communication Systems." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2147-2155.*

Design and performance of a new low loss surface acoustic wave (SAW) reflector filter are presented. The structure is a dual-track configuration incorporating two interdigital transducers (IDT's) and reflectors in each track. Extremely wide bandwidth can be obtained if chirped IDT's and reflectors are used. From the theoretical conditions for low loss operation of the reflector filter a design rule for the distances between the chirped components and for their lengths has been derived. Due to the fact that the transfer function of the filter is predominantly determined by the reflectors, we have developed a new synthesis method for chirped reflectors. For the design of the reflectors we used phase-weighting and finger width-weighting techniques in order to reduce passband distortions and to improve both the shape factor and the stopband rejection. The filter has been fabricated on 128° YX-LiNbO<sub>3</sub>. The center frequency and fractional bandwidth were 200 MHz and 10%, respectively. A minimum insertion loss of 4 dB, a small passband ripple of about 1 dB, and a stopband rejection better than 35 dB have been measured. Excellent agreement between simulation and measurement has been found.

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## Improvement in Calculation of Some Surface Integrals: Application to Junction Characterization in Cavity Filter Design (Dec. 1993 [T-MTT])

*P. Guillot, P. Couffignal, H. Baudrand and B. Theron. "Improvement in Calculation of Some Surface Integrals: Application to Junction Characterization in Cavity Filter Design (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2156-2160.*

An integral method is presented for the accurate characterization of waveguide junctions which are commonly used in the design of cavity filters. The specific feature of this approach is a reduction of a surface integral to a simple contour integral and the consequent reduction in the computation time of the junction scattering parameters is more than 50%. The method is applied to calculate the electromagnetic coupling between circular cavities through rectangular irises as well as their coupling to the input and output waveguides. This method, in conjunction with an optimization procedure, is employed for the direct design of a dual mode cavity filter and the obtained results are in good agreement with experimental data.





# Abstracts

## Double Ridged Waveguide Phase Shifters for Broadband Applications (Dec. 1993 [T-MTT])

*E.-B. El-Sharawy. "Double Ridged Waveguide Phase Shifters for Broadband Applications (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2161-2165.*

This paper presents an electromagnetic mode matching analysis of dual ridged waveguide phase shifters. The waveguide is loaded with a high dielectric material between the ridges, and the troughs are filled with ferrite toroids. The present structure offers nearly twice the bandwidth and less variation in nonreciprocity versus frequency as compared to the conventional dual toroidal phase shifter. An optimum design that maximizes nonreciprocity has been found. Effects of the dielectric constant and the trough dimensions are also presented. A differential phase shift of more than  $100^\circ/\text{cm}$  has been predicted for the new phase shifter.



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## Wide-Band Waveguide and Ridge Waveguide T-Junctions for Diplexer Applications

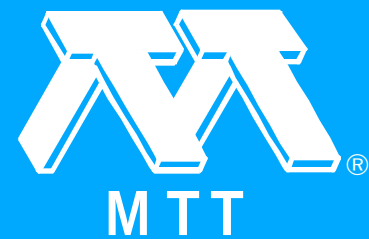
H.-W. Yao, A.E. Abdelmonem, J.-F. Liang, X.-P. Liang, K.A. Zaki and A. Martin. "Wide-Band Waveguide and Ridge Waveguide T-Junctions for Diplexer Applications." *1993 Transactions on Microwave Theory and Techniques* 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2166-2173.

Scattering parameters of E- and H-plane stepped waveguide and E-plane ridge waveguide stepped T-junctions are obtained using an extension of the three plane mode matching method. An optimization process is applied to find the T-junctions and steps dimensions that yield low reflection coefficient in one of the T-junction arms over a wide frequency band. An example of the design of a wide-band T-junction diplexer is presented. The diplexer filters are inductive window waveguide filters, and are rigorously modeled using mode matching and a novel two-dimensional curve fitting method, which drastically reduces the CPU time for optimization. The diplexer optimization procedure, as well as the filter modeling method, are described.

Experimental results on the optimized T-junction and the diplexer are presented; both showed excellent agreement with their computed optimum results, without any adjustments or tuning.

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## Modeling of Cylindrical Dielectric Resonators in Rectangular Waveguides and Cavities (Dec. 1993 [T-MTT])

*X.-P. Liang and K.A. Zaki. "Modeling of Cylindrical Dielectric Resonators in Rectangular Waveguides and Cavities (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2174-2181.*

The mode matching method is used to accurately model a generalized cylindrical dielectric resonator structure in a rectangular waveguide or cavity. The field distributions of different modes in cavities are given. The resonant frequencies of the cavities are calculated and compared to the measured data, showing very good agreement. The resonator structure can be a dielectric disk resonator, a ring resonator, a dielectric resonator with support, etc. This structure can be used in filter design as the basic element, which provides very good mechanical stability. The slot coupling between cavities is also analyzed, showing some interesting results.

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## Generalized Dual-Plane Multicoupled Line Filters

*S.-J. Yao, R.R. Bonetti and A.E. Williams. "Generalized Dual-Plane Multicoupled Line Filters." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2182-2189.*

This paper describes the general realization of elliptic function narrow-bandpass filters constructed from two adjacent planes of microstrip quasi-TEM line resonators. This dual-plane configuration allows nonadjacent coupling to be realized through small slots between the planes. Alternate sign coupling is realized by the appropriate positioning of the slot along the resonator length. A model developed from Bethe's small-hole coupling theory is used to predict these couplings. Adjacent resonator couplings are modeled using a coupled-line analysis modified to characterize the coupling of an inhomogeneous medium. The filter synthesis technique previously developed for waveguide cavity filters can be directly applied in designing a dual-plane filter.



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## Quasi-Optical Ferrite Reflection Circulator

*B. Lax, J.A. Weiss, N.W. Harris and G.F. Dionne. "Quasi-Optical Ferrite Reflection Circulator." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2190-2197.*

A quasi-optical Faraday rotation circulator utilizing a ferrite for microwave or millimeter-wave radiation is investigated experimentally and analyzed theoretically by a matrix formalism. Both reflection and transmission configurations at oblique incidence are examined. Numerical results in the band centered at 35 GHz are evaluated. Theory and experiment are compared over a 10-20% band. Notwithstanding the complexities resulting from oblique incidence, we find bandwidth, low loss, and isolation comparable to those of the transmission-type version now in system deployment. The principal advantage of the reflection configuration lies in the greater heat dissipation capability.

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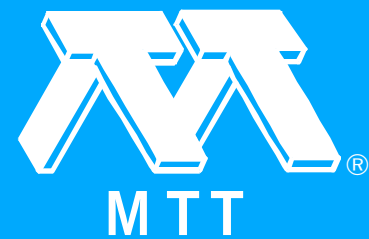
## Resonant Modes in Shielded Uniaxial-Anisotropic Dielectric Rod Resonators

*Y. Kobayashi and T. Senju. "Resonant Modes in Shielded Uniaxial-Anisotropic Dielectric Rod Resonators." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2198-2205.*

Rigorous field analyses by the mode matching method are presented for two types of dielectric rod resonators, including such uniaxial-anisotropic dielectrics as sapphire, which are placed between two parallel conducting plates (parallel plates type) and in a conducting cavity (cavity-open type). For the parallel-plates-type resonator, the cutoff conditions of resonant modes are discussed. Resonant frequencies of some lowest order modes for these resonators are calculated, and mode charts are presented to design the resonators. The theory is verified by experiments.

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## V-Band High-Efficiency High-Power AlInAs/GaInAs/InP HEMT's (Dec. 1993 [T-MTT])

*M. Matloubian, L.M. Jelloian, A.S. Brown, L.D. Nguyen, L.E. Larson, M.J. Delaney, M.A. Thompson, R.A. Rhodes and J.E. Pence. "V-Band High-Efficiency High-Power AlInAs/GaInAs/InP HEMT's (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2206-2210.*

In this paper, we report on the state-of-the-art power performance of InP-based HEMT's at V-band. Power HEMT's were fabricated using two different material layer structures. The power performances of these HEMT's were measured at 59 GHz. We were able to achieve an output power of 155 mW with 4.9 dB gain, and power-added efficiency of 30 percent from a 448- $\mu$ m-wide HEMT fabricated on a delta-doped channel layer structure. By using a double-doped layer structure, we were able to achieve an output power of 145 mW with 4.2 dB gain, and power-added efficiency of 24 percent. Output power of 288 mW with 3.6 dB gain and power-added efficiency of 20.4 percent were obtained by power combining two of the delta-doped channel HEMT's. These combinations of output power and efficiency are the best reported to date for InP-based HEMT's, and are comparable to the best results reported for AlGaAs/InGaAs on GaAs pseudomorphic HEMT's at this frequency.

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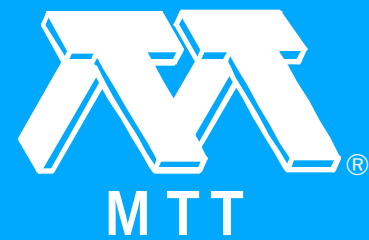


# Abstracts

## Measurement-Based Large-Signal Diode Modeling System for Circuit and Device Design

*D.E. Root, M. Pirola, S. Fan, W.J. Anklam and A. Cognata. "Measurement-Based Large-Signal Diode Modeling System for Circuit and Device Design." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2211-2217.*

A new relaxation-time large-signal table-based diode model for circuit simulation and an associated automated system which characterizes the device and generates the model data file, are presented. Excellent agreement between simulated and measured fundamental and second through fourth harmonic power levels is demonstrated for a HEMT diode up to frequencies of 48 GHz. Excellent agreement is demonstrated between simulated and measured large-signal oscillation frequency versus varactor tuning voltage for a varactor-tuned oscillator circuit fabricated with a varactor diode designed using the model.



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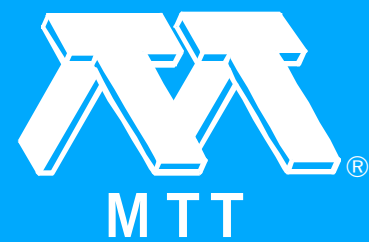
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## A Physically Based Small-Signal Circuit Model for Heterostructure Acoustic Charge Transport Devices (Dec. 1993 [T-MTT])

*J.S. Kenney and W.D. Hunt. "A Physically Based Small-Signal Circuit Model for Heterostructure Acoustic Charge Transport Devices (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2218-2226.*

A physically based small-signal circuit model for GaAs-AlGaAs Schottky gate heterostructure acoustic charge transport (HACT) devices is presented. Analytical expressions for the instantaneous and average channel current as a function of gate voltage are obtained from physical device parameters. The charge injection model is based on subthreshold current models for GaAs MESFET's. It is shown that the shape of the sampling aperture of the charge injection operation is approximately Gaussian. Good agreement is obtained between the measured dc channel current versus gate voltage and that predicted by the model. Equivalent circuits are also developed for the transfer and output sensing operations. Expressions for noise sources due to the physical processes that occur within the device are developed. Thermal noise, shot noise, and transfer noise are treated. The form of the analytic expressions for frequency response and noise figure allows easy implementation on commercially available CAE software. Simulations of both gain and noise figure performed on Libra™ are compared to measured data. Simulations agree with 10 percent of measured frequency response for a 160 tap HACT device. The predicted noise figure agrees within 1 dB of that measured for the same device.



# Abstracts

## Frequency Selective Limiters for High Dynamic Range Microwave Receivers (Dec. 1993 [T-MTT])

*J.D. Adam and S.N. Stitzer. "Frequency Selective Limiters for High Dynamic Range Microwave Receivers (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2227-2231.*

A new broadband frequency selective limiter, which provides over 14 dB of limiting across more than an octave bandwidth, is described. The limiter is fabricated with epitaxially grown YIG films in a stripline configuration and has a threshold power level of below 0 dBm. Multiple FSL's have been cascaded with amplifiers to allow compression of microwave signals with a power range of 60 dB into a range of less than 5 dB.



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## A 110 GHz Ozone Radiometer with a Cryogenic Planar Schottky Mixer

*O.P. Koistinen, H.T. Valmu, A. Raisanen, V.F. Vdovin, Y.A. Dryagin and I.V. Lapkin. "A 110 GHz Ozone Radiometer with a Cryogenic Planar Schottky Mixer." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2232-2236.*

A total power radiometer is presented for monitoring of the stratospheric ozone spectral line at 110 GHz. Special features such as a cooled planar Schottky mixer as the front end and efficient reduction of standing waves in the quasi-optics, are discussed in detail. The noise temperature of the receiver is 530 K (SSB), and the total bandwidth of the receiver is 1 GHz. A dual acousto-optical spectrometer is used for the signal detection.





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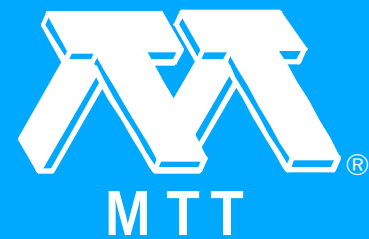
## 12-kW S-Band Solid-State Transmitter for Modern Radar Systems

*M. Hanczor and M. Kumar. "12-kW S-Band Solid-State Transmitter for Modern Radar Systems." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2237-2242.*

This paper presents the development of a 12-kW solid-state transmitter, operating over 2.7-2.9 GHz, used in modern surveillance and air-traffic control (i.e., MATCALS AN/TPS-73) radars. 12 kW of peak power with a pulse width of 100  $\mu$ s and duty cycle of 10 percent is achieved by combining 56 300 W high-power solid-state amplifiers. Other key performance parameters are pulse-to-pulse stability (MTI improvement factor of >90 dB), MTBF of >22 000 h, instantaneous bandwidth of 200 MHz, extremely high pulse fidelity and self-pulsing, low-voltage operation for high efficiency.

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## Predicted Performance of Semiconductor Junction Circulators with Losses

*L.E. Davis and R. Sloan. "Predicted Performance of Semiconductor Junction Circulators with Losses." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2243-2247.*

A study of the circulation properties of a gyroelectric medium consisting of a high-quality n-type semiconductor is given. Losses due to electron collisions are modeled by inclusion of the collision frequency  $\nu/c$  in the relative permittivity tensor. Broadband low-loss operation of a semiconductor slotline junction circulator above the extraordinary wave resonance frequency  $f_{\text{res}}$  appears possible at near-millimetric frequencies. Larger, applied static magnetic fields enable narrowband low-loss operation at frequencies below the resonance at  $f_{\text{res}}$ . A 40 GHz design is described for GaAs cooled to 77 K. The minimum inband insertion loss is 0.82 dB. InSb theoretically possesses still lower losses for a reduced applied magnetic field. An example at an operating frequency of 75 GHz in InSb is given.

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## Rigorous Analysis of Mixed Transmission Line Interconnects Using the Frequency-Domain TLM Method

*H. Jin, R. Vahldieck, J. Huang and P. Russer. "Rigorous Analysis of Mixed Transmission Line Interconnects Using the Frequency-Domain TLM Method." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2248-2255.*

A rigorous analysis of mixed transmission line interconnects is presented using an improved version of the frequency-domain TLM method. Direct via hole through connections and indirect coupling effects between layered microstrip and coplanar waveguides are investigated as well as the effect of bonding wire transitions between MMIC modules and the microstrip substrate carrier. This investigation is extended to include the abrupt transition from a GaAs-based microstrip line to a rib-type microstrip line, which has not been analyzed before. In the context of this work new developments of the frequency domain TLM method will be discussed. In particular it will be shown that the transmission line nodes used in the FDTLM can be obtained either by modifying the existing time-domain TLM nodes or directly in the frequency domain. The latter approach leads to a faster algorithm.





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## A General Method to Simulate Noise in Oscillators Based on Frequency Domain Techniques

*W. Anzill and P. Russer. "A General Method to Simulate Noise in Oscillators Based on Frequency Domain Techniques." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2256-2263.*

A perturbation theory for simulating the noise behavior in free running microwave oscillators based on a piece-wise harmonic balance technique is outlined. The single-sideband phase noise of an oscillator is derived from the system equations describing the deterministic and stochastic behavior. The method is neither limited to a certain circuit topology nor to certain types of noise sources. The theory is applied to a planar integrated microwave oscillator at 14 GHz to demonstrate the applicability of the theory. Simulated and measured single-sideband phase noise agree within the accuracy of measurement.

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## Computer-Aided Design of Microwave Frequency Doublers Using a New Circuit Structure

*Y. Xuan and J.L. Fikart. "Computer-Aided Design of Microwave Frequency Doublers Using a New Circuit Structure." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2264-2268.*

A new circuit structure for microwave frequency doublers is presented, which features effective suppression of fundamental and odd harmonics ( $> 50$  dB), conversion gain ( $> 3$  dB), and simplicity of the circuit itself. Furthermore, it can be used in both balanced and unbalanced output configurations, without requiring baluns or transformers. A novel differential amplifier developed as part of the doubler circuit is also described in detail. It used an inductor to replace the active current source in conventional differential amplifiers, which simplified the circuit and, more importantly, enabled the amplifier to operate at high microwave frequencies. Experimental results are given in the paper.

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## Yield-Driven Electromagnetic Optimization via Multilevel Multidimensional Models

*J.W. Bandler, R.M. Biernacki, S.H. Chen, P.A. Grobelny and S. Ye. "Yield-Driven Electromagnetic Optimization via Multilevel Multidimensional Models." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2269-2278.*

We present the foundation of a sophisticated hierarchical multidimensional response surface modeling system for efficient yield-driven design. Our scheme dynamically integrates models and database updating in real optimization time. The method facilitates a seamless, smart optimization-ready interface. It has been specially designed to handle circuits containing complex subcircuits or components whose simulation requires significant computational effort. This approach makes it possible, for the first time, to perform direct gradient-based yield optimization of circuits with components or subcircuits simulated by an electromagnetic simulator. The efficiency and accuracy of our technique are demonstrated by yield optimization of a three-stage microstrip transformer and a small-signal microwave amplifier. We also perform yield sensitivity analysis for the three-stage microstrip transformer.

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## Huber Optimization of Circuits: A Robust Approach

*J.W. Bandler, S.H. Chen, R.M. Biernacki, L. Gao, K. Madsen and H. Yu. "Huber Optimization of Circuits: A Robust Approach." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2279-2287.*

We introduce a novel approach to "robustizing" circuit optimization using Huber functions: both two-sided and one-sided. Advantages of the Huber functions for optimization in the presence of faults, large and small measurement errors, bad starting points, and statistical uncertainties are described. In this context, comparisons are made with optimization using  $l_1$ ,  $l_2$  and minimax objective functions. The gradients and Hessians of the Huber objective functions are formulated. We contribute a dedicated, efficient algorithm for Huber optimization and show, by comparison, that generic optimization methods are not adequate for Huber optimization. A wide range of significant applications is illustrated, including FET statistical modeling, multiplexer optimization, analog fault location, and data fitting. The Huber concept, with its simplicity and far-reaching applicability, will have a profound impact on analog circuit CAD.

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## A W-Band Integrated Power Module Using MMIC MESFET Power Amplifiers and Varactor Doublers

*T.C. Ho, S.-W. Chen, K. Pande and P.D. Rice. "A W-Band Integrated Power Module Using MMIC MESFET Power Amplifiers and Varactor Doublers." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2288-2294.*

A high-performance integrated power module using U-band MMIC MESFET power amplifiers in conjunction with W-band MMIC high efficiency varactor doublers has been developed for millimeter-wave system applications. This paper presents the design, fabrication, and performance of this W-band integrated power module. Measured results of the complete integrated power module show an output power of 90 mW with an overall associated gain of 29.5 dB at 94 GHz. A saturated power of over 95 mW was also achieved. These results represent the highest reported power and gain at W-band using MESFET and varactor frequency doubling technologies. This integrated power module is suitable for the future 94 GHz missile seeker applications.

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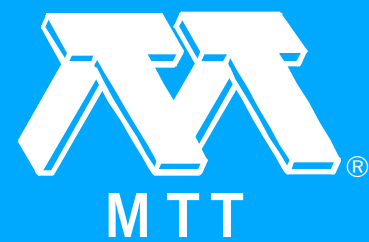


## Monolithic GaAs HBT p-i-n Diode Variable Gain Amplifiers, Attenuators, and Switches

*K.W. Kobayashi, A.K. Oki, D.K. Umemoto, S.K.Z. Claxton and D.C. Streit. "Monolithic GaAs HBT p-i-n Diode Variable Gain Amplifiers, Attenuators, and Switches." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2295-2302.*

We report on monolithic circuits integrating HBT's and p-i-n diodes using a common HBT MBE structure. An HBT variable gain amplifier using a p-i-n diode as a variable resistor achieved a gain of 14.6 dB, a bandwidth out to 9 GHz, a gain control range of >15 dB, and an IP3 of 28 dBm. A two-stage HBT p-i-n diode attenuator from 1-10 GHz and an X-band one-pole two-throw HBT p-i-n diode switch were also demonstrated. The two-stage p-i-n attenuator has over 50 dB dynamic range at 2 GHz and a maximum IP3 of 9 dBm. The minimum insertion loss is 1.7 dB per stage and has a flat response to 10 GHz. The X-band switch has an insertion loss of 0.82 dB and an off-isolation of 25 dB. The bandwidth is greater than 35% and the IP3 is greater than 34.5 dBm. These circuits consist of p-i-n diodes constructed from the base-collector MBE layers of a base-line HBT process. This work demonstrates the first monolithic integration of p-i-n diode switch, variable gain control, and attenuation functions in an HBT technology without additional processing steps or MBE material growth.





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## An MMIC-Compatible Tightly Coupled Line Structure Using Embedded Microstrip

*D. Willems and I. Bahl. "An MMIC-Compatible Tightly Coupled Line Structure Using Embedded Microstrip." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2303-2310.*

This paper presents a highly manufacturable coupled line structure for MMIC's which uses embedded microstrip to achieve tight coupling and employs the process steps necessary to make metal-insulator-metal (MIM) capacitors. Passive circuits demonstrated using this technique include a single-section 5-21 GHz broadband 3 dB coupler fabricated on both 75 and 125  $\mu\text{m}$  thick GaAs substrates and a 6-15 GHz 90° Schiffman section fabricated on a 125  $\mu\text{m}$  thick GaAs substrate. The coupler and the Schiffman section use tight (2 dB) to extremely tight (0.7 dB) coupling factors, respectively. Additionally, two single-section 2-7 GHz couplers are compared, one having a crossover and one without. This is the first time that a coupler has achieved such a wide bandwidth on thin GaAs substrates. Complete test data are presented, including the amplitude, isolation, and phase response of the couplers and the phase and amplitude response of the Schiffman sections.

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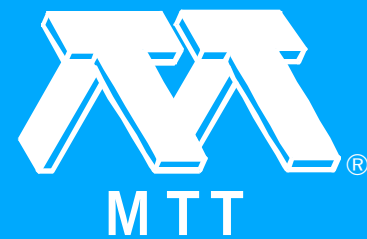


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## 12 GHz Low-Noise MMIC Amplifier Designed with a Noise Model that Scales with MODFET Size and Bias (Dec. 1993 [T-MTT])

*B. Hughes, J. Perdomo and H. Kondoh. "12 GHz Low-Noise MMIC Amplifier Designed with a Noise Model that Scales with MODFET Size and Bias (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2311-2316.*

A scalable, bias-dependent FET noise model was developed for MMIC design. A three-stage, 12 GHz, MMIC, low-noise amplifier (LNA) was designed with the model. The LNA has a 1.6 dB noise figure and 25.6 dB gain. Lumped elements were used to design an LNA that was significantly smaller per stage (0.31 mm<sup>2</sup>) than previous MMIC LNA's.



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## Rigorous Analysis and Design of a High-Performance 94 GHz MMIC Doubler

*S.-W. Chen, T.C. Ho, K. Pande and P.D. Rice. "Rigorous Analysis and Design of a High-Performance 94 GHz MMIC Doubler." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2317-2322.*

A 94 GHz monolithic microwave integrated circuit (MMIC) frequency doubler with 25 percent efficiency and 65 mW output power has been developed using Schottky-barrier varactor diode. Variations in the diode's performance as a doubler with its geometry and doping profile were analyzed for optimum efficiency and output power. Optimum doubler performance was obtained as a consequence of use of the optimized diode parameters resulting from this analysis. A simple but highly effective circuit topology was employed to transform the 50 Ohm terminations to optimum source and load impedances, and also to provide isolation between the fundamental and second harmonic signals at input and output ports. Measured results of the diode parameters as well as doubler response showed excellent agreement with the analysis. The doubler exhibits better performance than those reported in the literature at similar frequencies using an MMIC approach.

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## Monolithic Image-Rejection Optoelectronic Up-Converters that Employ the MMIC Process (Dec. 1993 [T-MTT])

*H. Kamitsuna and H. Ogawa. "Monolithic Image-Rejection Optoelectronic Up-Converters that Employ the MMIC Process (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2323-2329.*

This paper presents very small 30-GHz-band monolithic image-rejection optoelectronic up-converters that employ the HEMT-MMIC process for the first time. MMIC HEMT optoelectronic mixers are characterized by their direct photodetection and nonlinear characteristics. It is shown that common-source configurations have higher response than common-drain configurations, and up-converter applications are preferable to down-converter applications based on the HEMT direct photodetection characteristics. These characteristics are used to realize 30-GHz-band monolithic image-rejection optoelectronic up-converters. An in-phase divider and a branch-line hybrid with two HEMT optoelectronic mixers are successfully integrated into an MMIC chip with an area of 1.5 mm x 1.1 mm. Fundamental performance is demonstrated and excellent wideband performance, which comes from the well-balanced operation of monolithic integrated circuits, is confirmed. These monolithic optoelectronic mixers promise to realize compact and cost-effective 1-chip optical receivers for fiber optic links which support millimeter-waves.



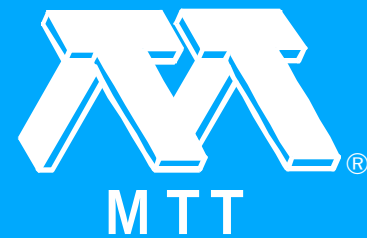


# Abstracts

## A Broadband, Planar, Doubly Balanced Monolithic Ka-Band Diode Mixer (Dec. 1993 [T-MTT])

*S.A. Maas and K.W. Chang. "A Broadband, Planar, Doubly Balanced Monolithic Ka-Band Diode Mixer (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2330-2335.*

This paper describes a new type of planar, monolithic diode mixer achieving 5-10 dB conversion loss and very low distortion and spurious responses over a 26-to 40-GHz RF and LO bandwidth and dc-12 GHz IF. The mixer has exhibited low loss and low distortion operating as both a downconverter and upconverter. Two types of diodes have been used: the first used the gate-to-channel junctions of  $0.2 \times 80 \mu\text{m}$  InGaAs HEMT's; and the second used Schottky diodes realized in HBT technology. The baluns are Marchand-like coplanar structures.



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## A D-Band Monolithic Fundamental Oscillator Using InP-Based HEMT's (Dec. 1993 [T-MTT])

*Y. Kwon, D. Pavlidis, T.L. Brock and D.C. Streit. "A D-Band Monolithic Fundamental Oscillator Using InP-Based HEMT's (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2336-2344.*

The design, analysis, and experimental characteristics of the first fundamental D-band monolithic HEMT oscillator are reported. The circuit is based on a dual feedback topology and uses 0.1  $\mu\text{m}$  pseudomorphic double heterojunction InAlAs/In/sub 0.7/Ga/sub 0.3/As HEMT's. It includes on-chip bias circuitry and an integrated E-field probe for direct radiation into the waveguide. The circuit was analyzed using both small-signal and large-signal methods, while carefully accounting for the high-frequency effects of the InP-based HEMT's. An oscillation frequency of 130.7 GHz was measured and the output power level was -7.9 dBm using HEMT's of small gate periphery (90  $\mu\text{m}$ ). The measured power characteristics were compared to the simulation and yielded good agreement. This represents the highest frequency of fundamental signal generation out of monolithic chips using three-terminal devices.

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## Novel Staggered Resonator Array Superconducting 2.3-GHz Bandpass Filter (Dec. 1993 [T-MTT])

*G.L. Matthaei and G.L. Hey-Shipton. "Novel Staggered Resonator Array Superconducting 2.3-GHz Bandpass Filter (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2345-2352.*

A novel stripline bandpass filter structure is presented which consists of a parallel array of equally spaced half-wavelength resonators. Couplings are controlled by introducing a small amount of stagger in the positions of the resonators. A very compact narrowband superconducting filter of this type was fabricated with excellent results. The design theory, computed and measured performance, and manner of construction are discussed.



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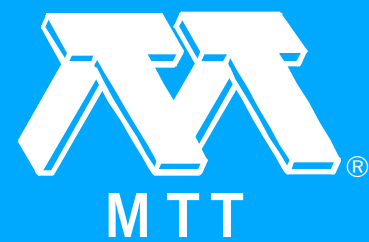
## Improvements in the Millimeter-Wave Subsystem for Josephson Junction Array Voltage Standard Systems

*H. Yoshida, Y. Sakamoto, U. Klein and T. Endo. "Improvements in the Millimeter-Wave Subsystem for Josephson Junction Array Voltage Standard Systems." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2353-2358.*

Improvements in the millimeter-wave subsystem have been accomplished to provide higher millimeter-wave power to a Josephson junction array chip. The 94-GHz oscillator output power has been increased to 90 mW by incorporating an InP Gunn diode. The frequency stability of the InP Gunn oscillator is maintained at  $10^{-10}$  of the center frequency. A low-loss dielectric waveguide has been installed in liquid helium to reduce the insertion losses of the millimeter waves to 3 dB/2.5 m. The improved millimeter-wave system has been confirmed to operate well in a Josephson junction array voltage standard system for voltage calibration at the 1-V level with the specified accuracy.

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## Full-Wave Analysis of Superconducting Microstrip Lines on Anisotropic Substrates Using Equivalent Surface Impedance Approach

*L.H. Lee, W.G. Lyons, T.P. Orlando, S.M. Ali and R.S. Withers. "Full-Wave Analysis of Superconducting Microstrip Lines on Anisotropic Substrates Using Equivalent Surface Impedance Approach." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2359-2367.*

A computationally efficient full-wave technique is developed to analyze single and coupled superconducting microstrip lines on anisotropic substrates. The optic axis of the dielectric is in the plane of the substrate at an arbitrary angle with respect to the propagation direction. A dyadic Green's function for layered, anisotropic media is used to formulate an integral equation for the current in the strips. To increase the efficiency of the method, the superconducting strips are replaced by equivalent surface impedances which account for the loss and kinetic inductance of the superconductors. The validity of this equivalent surface impedance (ESI) approach is verified by comparing the calculated complex propagation constant and characteristic impedance for superconducting microstrip lines on an isotropic substrate to measured results, and to numerical results by the more rigorous volume-integral equation method. The results calculated using the ESI approach for perfectly conducting coupled lines on an anisotropic substrate agree with the results by the finite-difference time-domain method. This efficient ESI technique is then used to study the effects of the optic axis orientation and the strip width on the characteristics of single and coupled superconducting microstrip lines on M-plane sapphire. The effects of the line separation and operating temperature on the coupled lines are also investigated.

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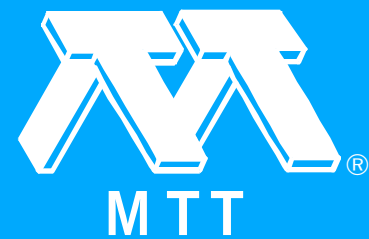
## Superconductive Digital Instantaneous Frequency Measurement Subsystem (Dec. 1993 [T-MTT])

G.-C. Liang, C.-F. Shih, R.S. Withers, B.F. Cole, M.E. Johansson and L.P. Suppan, Jr..  
*"Superconductive Digital Instantaneous Frequency Measurement Subsystem (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2368-2375.*

A five bit high-temperature superconductive digital instantaneous frequency measurement (DIFM) subsystem has been constructed for the determination of the frequency of unknown signals over a 500 MHz bandwidth, centered on 4 GHz, with a resolution of  $\pm 7.8$  MHz. The subsystem contains a cryogenic section with five discriminator modules utilizing superconductive delay lines, GaAs mixers, and power dividers. The subsystem also has a room temperature GaAs limiting amplifier and a silicon postprocessor. With a single tone CW input between -40 dBm and +10 dBm, the frequency quantization boundaries of the subsystem are, on average, 3.1 MHz from their design values. This system demonstrates the potential system level application of high-temperature superconductive electronics in instrumentation, communication, radar, and electronic warfare.

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## Feedforward Linearization of Analog Modulated Laser Diodes--Theoretical Analysis and Experimental Verification

*D. Hassin and R. Vahldieck. "Feedforward Linearization of Analog Modulated Laser Diodes--Theoretical Analysis and Experimental Verification." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2376-2382.*

This paper discusses feedforward linearization of directly modulated laser diodes for AM CATV lightwave transmission systems. Theoretical simulation and experimental results are presented showing a distortion cancellation of better than 20 dB over 850 MHz bandwidth. An investigation regarding tolerance and possible dispersion penalty in the system is performed. A noise analysis is presented including the theoretical examination of laser relative intensity noise (RIN) reduction by feedforward compensation.

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## Microwave-Optical Mixing in LinbO/sub 3/ Modulators

*G.K. Gopalakrishnan, W.K. Burns and C.H. Bulmer. "Microwave-Optical Mixing in LinbO/sub 3/ Modulators." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2383-2391.*

An investigative study of microwave-optical mixing in different configurations of LiNbO/sub 3/ Mach-Zehnder interferometric modulators is presented. In each case, models that describe mixer performance are developed and are shown to be in good agreement with measurements. For antenna remoting applications, a technique to down-convert RF signals is demonstrated by cascading in series a pair of Mach-Zehnder interferometric modulators. In general, it is shown that by virtue of their truly broad-band characteristics, interferometric modulators can also be employed as microwave mixers at frequencies up to 40 GHz.

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## Optimization of Electrooptic Sampling by Volume-Integral Method

*W. Thomann, M. Rottenkolber and P. Russer. "Optimization of Electrooptic Sampling by Volume-Integral Method." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2392-2399.*

A rigorous treatment of the influence of an inhomogeneous electric field on the differential polarization of an optical field, and the corresponding change in transmission of a retarder setup is presented. The method yields sensitivity coefficients employed directly in a volume-integral. In case of an external electrooptic probe tip a layered structure with a space-harmonic potential and a Gaussian sampling beam is investigated and results on sensitivity and spatial resolution are presented. The probing of inhomogeneous longitudinal and transverse fields with the same setup is demonstrated for a microstrip transmission line.

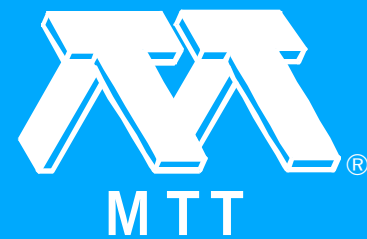
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## Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Dec. 1993 [T-MTT])

*"Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): 2400-2400.*



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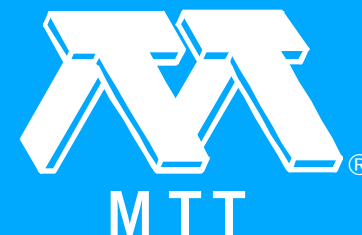
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## Index, IEEE [T-MTT] 1993, Volume 41, and MTT-S Sponsored Conferences

*"Index, IEEE [T-MTT] 1993, Volume 41, and MTT-S Sponsored Conferences." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): i1-i69.*



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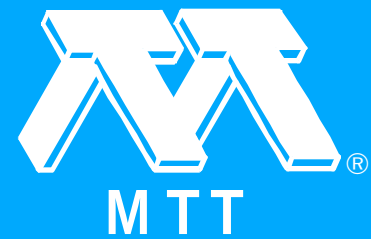
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## IEEE Spectrum (Advertisement) (Dec. 1993 [T-MTT])

*"IEEE Spectrum (Advertisement) (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): bm1-bm1.*



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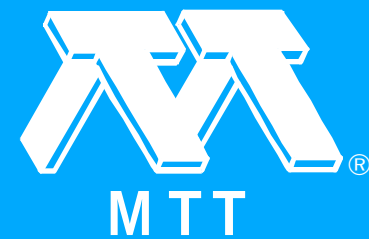
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## IEEE Member Get a Member Program (Advertisement) (Dec. 1993 [T-MTT])

*"IEEE Member Get a Member Program (Advertisement) (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): bm2-bm2.*



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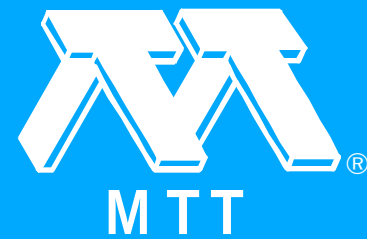
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## IEEE All-Society Periodicals Package (Advertisement) (Dec. 1993 [T-MTT])

*"IEEE All-Society Periodicals Package (Advertisement) (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): bm3-bm3.*



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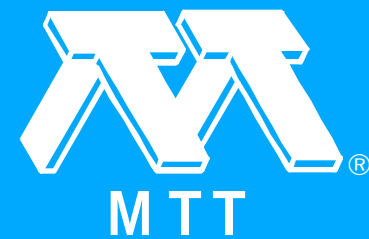
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*"Back Cover (Dec. 1993 [T-MTT])." 1993 Transactions on Microwave Theory and Techniques 41.11 (Dec. 1993 [T-MTT] (1993 Symposium Issue)): b1-b2.*



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## A Low-Noise Active Bandpass Filter

*W. Schwab and W. Menzel. "A Low-Noise Active Bandpass Filter." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 1-2.*

The design of narrow-band active bandpass filters with high-gain and low-noise figure is described. The filter configuration is a combination of low-loss suspended stripline resonators and active microstrip circuits with FET devices. Measured results of this filter configuration with two resonators and one active circuit are presented.

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## Numerical Stability and Numerical Dispersion of a Compact 2-D/FDTD Method Used for the Dispersion Analysis of Waveguides

*A.C. Cangellaris. "Numerical Stability and Numerical Dispersion of a Compact 2-D/FDTD Method Used for the Dispersion Analysis of Waveguides." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 3-5.*

The stability condition is derived for the compact two-dimensional FDTD (2-D/FDTD) scheme which was recently proposed for the dispersion analysis of waveguiding structures. It is shown that the upper limit of the Courant number depends on the desirable propagation constant  $\beta$  and is always smaller than the one for the standard FDTD scheme in two dimensions. The dispersion equation for the numerical scheme is derived also and is used to examine the impact of grid size on the accuracy of the calculated eigenvalues (frequencies) for the dominant and higher order modes.

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## Scattering Characteristics of Rectangular Coaxial Line Branching Directional Coupler

*S. Xu, X. Wu, W. Guo and Z. Li. "Scattering Characteristics of Rectangular Coaxial Line Branching Directional Coupler." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 6-8.*

The scattering characteristics of rectangular coaxial line branching directional coupler are investigated by an accurate approach, which combines the finite-element method with rigorous mode matching procedure. The impedance transform technique of the multimode network theory is used in the mode matching treatment so that the whole analysis of the 3-D discontinuity problem is significantly simplified. The accuracy and effectiveness of the present method are verified by experimental data.

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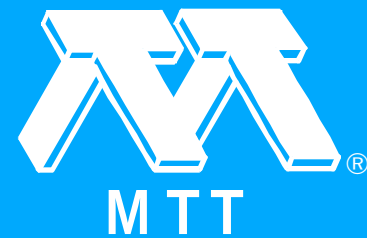


# Abstracts

## A Dual-Frequency Band Waveguide Using FSS

*R.J. Langley. "A Dual-Frequency Band Waveguide Using FSS." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 9-10.*

A waveguide is described that propagates at two-frequency bands with low loss and good bandwidth. The structure is achieved by the simple insertion of a frequency selective surface to form a guide within a guide. The transmission response is tailored by the response of the FSS. The technique lends itself to other waveguide geometries and many combinations of frequencies can be accommodated.



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## A 6--21-GHz Monolithic HEMT 2 x 3 Matrix Distributed Amplifier

*K.W. Kobayashi, R. Esfandiari, W.L. Jones, K. Minot, B.R. Allen, A. Freudenthal and D.C. Streit. "A 6--21-GHz Monolithic HEMT 2 x 3 Matrix Distributed Amplifier." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 11-13.*

The results of the first monolithic matrix distributed amplifier fabricated using pseudomorphic HEMT technology are reported. The HEMT matrix amplifier obtains a combination of high gain, wide bandwidth, and reasonable IP3 and noise figure. The best gain response is 20 dB from 6-21 GHz. The noise figure is 5.5 dB and the third-order intercept point is 21 dBm. In comparison to GaAs HBT and MESFET technologies, the HEMT matrix distributed amplifier shows the best promise for wide-band millimeter-wave applications.

[Click on title for a complete paper.](#)



## Full 360° Phase Shifting of Injection-Locked Oscillators

*X. Zhang and A.S. Daryoush. "Full 360° Phase Shifting of Injection-Locked Oscillators." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 14-16.*

A novel design is presented to produce analog phase shift of 0° to 360° in optically controlled oscillators which are subharmonically injection-locked. The proposed concept was analytically described and experimentally demonstrated by producing 360° of phase shift in an 8 GHz oscillator that is indirect optically injection-locked to a 4 GHz subharmonic frequency. This design concept could eliminate the need for switched delay-line phase shifters in the T/R modules of optically controlled phased array antennas, thus making T/R module more compact and efficient.



# Abstracts

## Patent Abstracts (Jan. 1993 [MGWL])

*"Patent Abstracts (Jan. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 17-23.*



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## Call for Papers - Electrical Performance of Electronic Packaging (Jan. 1993 [MGWL])

*"Call for Papers - Electrical Performance of Electronic Packaging (Jan. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 24-24.*



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# Abstracts

## Fourth International Symposium on Space Terahertz Technology (Advertisement) (Jan. 1993 [MGWL])

*"Fourth International Symposium on Space Terahertz Technology (Advertisement) (Jan. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 25-25.*



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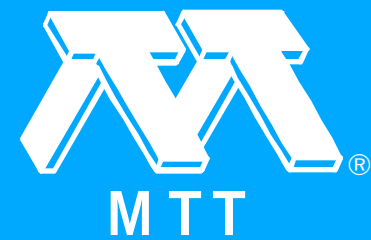
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# Abstracts

## 1992 IEEE Membership Directory (Advertisement) (Jan. 1993 [MGWL])

*"1992 IEEE Membership Directory (Advertisement) (Jan. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 26-26.*



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*"Copyright Form (Jan. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.1 (Jan. 1993 [MGWL]): 27-27.*



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## A Coplanar-to-Microstrip Transition for W-Band Circuit Fabrication with 100- $\mu$ m-Thick GaAs Wafers

*B. Golja, H.B. Sequeira, S. Duncan, G. Mendenilla and N.E. Byer. "A Coplanar-to-Microstrip Transition for W-Band Circuit Fabrication with 100- $\mu$ m-Thick GaAs Wafers." 1993 Microwave and Guided Wave Letters 3.2 (Feb. 1993 [MGWL]): 29-31.*

Results on a via-hole interconnect that links a coplanar waveguide (CPW) on one side of a 100-mm thick GaAs substrate to a microstrip line on the opposite side are presented. The measured insertion loss of a pair of back-to-back connections is 0.3 dB between 26.5 and 40 GHz. A lumped-element equivalent circuit of this via-hole interconnect has been extrapolated to W-band and used to design amplifiers at 94 GHz.

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## Ground Plane Effects in Monolithic Millimeter-Wave Integrated Circuits

*A. Vilcot and S. Tedjini. "Ground Plane Effects in Monolithic Millimeter-Wave Integrated Circuits." 1993 Microwave and Guided Wave Letters 3.2 (Feb. 1993 [MGWL]): 32-34.*

The effect of a lossy ground plane on the propagation parameters of a monolithic millimeter-wave microstrip on semiconductor substrate is studied. The full-wave Spectral-Domain Technique, which can take into account the thickness and conductivity of the ground plane, is used. When considering an ideal ground plane, the losses are very low and quasi-independent on the thickness of the semiconductor. Taking into account the losses of the ground plane, it is shown that the propagation losses are not only dependant on the thickness of the ground plane but also on the thickness of the semiconductor. These losses increase significantly as this thickness is reduced.

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## An Exact Expression for the Noise Resistance $R_{n/}$ for the Hawkins Bipolar Noise Model

*R.A. Pucel and U.L. Rohde. "An Exact Expression for the Noise Resistance  $R_{n/}$  for the Hawkins Bipolar Noise Model." 1993 Microwave and Guided Wave Letters 3.2 (Feb. 1993 [MGWL]): 35-37.*

A much used noise model for the bipolar transistor is that based on Hawkins formulation. The model, however lacks an expression for the noise resistance. An exact analytic expression, based on the noise correlation matrix approach, is developed for the noise resistance for this noise model.

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## A Half-Split Cylindrical Dielectric Resonator Antenna Using Slot-Coupling

*R.K. Mongia, A. Ittipiboon, Y.M.M. Antar, P. Bhartia and M. Cuhaci. "A Half-Split Cylindrical Dielectric Resonator Antenna Using Slot-Coupling." 1993 Microwave and Guided Wave Letters 3.2 (Feb. 1993 [MGWL]): 38-39.*

A half-split cylindrical dielectric resonator placed on a metallic plane and excited in its "magnetic dipole" mode is a potentially useful antenna element. The use of a microstrip line-slot feed scheme for exciting this antenna is reported. Experimental results show that the antenna displays the anticipated radiation pattern and it has a high operating frequency bandwidth (about 10%). Further, the overall antenna configuration can be easily integrated with MIC's.

Click on title for a complete paper.



## Coupling Between Slotlines Through a Conductor Backing

*T. Hirota and T. Itoh. "Coupling Between Slotlines Through a Conductor Backing." 1993 Microwave and Guided Wave Letters 3.2 (Feb. 1993 [MGWL]): 40-41.*

Leakage phenomena possible in conductor-backed slotlines were investigated through an analysis of coupled lines. Coupling between two slotlines with a finite width of conductor backing was examined. Obtained propagation constants for two modes of the coupled slotline confirm that coupling is caused by leakage through the conductor backing.



# Abstracts

## Optically Controlled Generation and True-Time-Delay Phase-Shifts of Broad-Band 60-GHz Signals

*S.-L.L. Huang, C.H. Lee and H.-L.A. Hung. "Optically Controlled Generation and True-Time-Delay Phase-Shifts of Broad-Band 60-GHz Signals." 1993 Microwave and Guided Wave Letters 3.2 (Feb. 1993 [MGWL]): 42-44.*

A new technique of generating true-time-delay phase shifts of broad-band microwave and millimeter-wave signals through optical control has been demonstrated. Continuous and precise phase shift with a range of  $360^\circ$  has been achieved without millimeter-wave signal loss. The microwave/millimeter-wave circuit and the optic-electronic intermixing structure can be monolithically integrated. Optical fiber distribution of the picosecond triggering pulses could be applied. The potential applications of this optical control technique are in phased-array radar and satellite-borne communication systems.



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## A 0.5-W Complementary AlGaAs-GaAs HBT Push-Pull Amplifier at 10 GHz

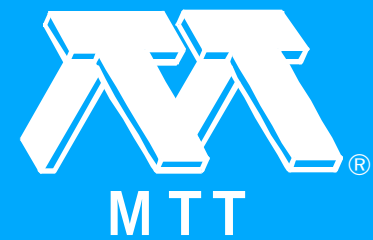
*H.Q. Tserng, D.G. Hill and T.S. Kim. "A 0.5-W Complementary AlGaAs-GaAs HBT Push-Pull Amplifier at 10 GHz." 1993 Microwave and Guided Wave Letters 3.2 (Feb. 1993 [MGWL]): 45-47.*

X-band high-efficiency complementary push-pull amplifiers using P-n-p and N-p-n AlGaAs-GaAs HBT's were demonstrated for the first time. One of the amplifiers achieved an output power of 500 mW with 6-dB gain and 41.8% power-added efficiency at 10 GHz. High efficiency was achieved by Class-B push-pull operation, which also results in second harmonic cancellations.

# Abstracts

## Patent Abstracts (Feb. 1993 [MGWL])

*"Patent Abstracts (Feb. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.2 (Feb. 1993 [MGWL]): 48-53.*



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## Call for Papers - Optical Microwave Interactions (Feb. 1993 [MGWL])

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*"Call for Papers - Optical Microwave Interactions (Feb. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.2 (Feb. 1993 [MGWL]): 55-55.*



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*"Ask IEEE (Advertisement) (Feb. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.2 (Feb. 1993 [MGWL]): 56-56.*



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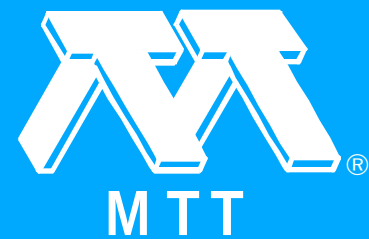
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## Editorial (Mar. 1993 [MGWL])

*T. Itoh. "Editorial (Mar. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 57-57.*

Recently, two incidents requiring my attention occurred regarding articles submitted to the IEEE Microwave and Guided Wave Letters. The first incident is a near-miss. One of the authors of an accepted article called my office and requested to pull this article from being printed on the grounds that the employer from whom the permission of submission had been granted subsequently reversed the decision. I called the IEEE and asked if the article can be removed from the issue already prepared. It turned out that the article was at the printer, but fortunately could be removed from inclusion in the issue without any additional cost. If it were one day later, a substantial cost would have been incurred. It has been the practice that such a cost would have been borne by the authors or their employer, but not by the IEEE or MTT-S. Note that at the time of submission of the article, the authors certified by way of the author check list and the IEEE Copyright form that all required clearance procedures were followed.

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## Impedance Modeling of a Whisker Mounted in a Rectangular Waveguide

*J. Xu and A.V. Raisanen. "Impedance Modeling of a Whisker Mounted in a Rectangular Waveguide." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 58-60.*

Theoretical impedance modeling of metal whisker, which is extensively used in millimeter- and submillimeter-wave Schottky diode mixers and frequency multiplier circuits, is presented. The moment method with Galerkin's technique is employed to analyze this structure with the help of the dyadic Green's function in a rectangular waveguide. Effects of whiskers with various types of shape on the embedding impedance are investigated. Theoretical results show good agreement with related results published before.

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## Silicon Micromachined Waveguides for Millimeter-Wave and Submillimeter-Wave Frequencies

*W.R. McGrath, C. Walker, M. Yap and Y.-C. Tai. "Silicon Micromachined Waveguides for Millimeter-Wave and Submillimeter-Wave Frequencies." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 61-63.*

Rectangular waveguide is commonly used up to high millimeter-wave frequencies. However, conventional machining techniques for waveguides operating above a few hundred GHz are complicated and costly. The development of silicon micro-machining techniques to create silicon-based waveguide circuits, which can operate up to high submillimeter-wave frequencies, is reported. As a first step, WR-10 waveguide has been fabricated from (110) silicon wafers. Insertion loss measurements of gold plated silicon waveguide show performance comparable to standard metal waveguides. It is suggested that active devices and planar circuits can be integrated with the waveguides, solving the traditional mounting problems.

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## 7.5--14-GHz CE HBT MMIC Linear Power Amplifier

*N.-L. Wang, W.-J. Ho, A.L. Sailer and J.A. Higgins. "7.5--14-GHz CE HBT MMIC Linear Power Amplifier." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 64-66.*

A common-emitter (CE) AlGaAs-GaAs HBT MMIC amplifier was made to operate in X-band. 1W CW output power was achieved in saturated power operation from 7.5 to 12 GHz. In class A linear power operation, it provides 26-dBm CW power. The amplifier shows low two-tone intermodulation distortion: better than -20 dBc IM/sub 3/ at 1-dB compression point throughout the 7.5--14-GHz bandwidth. The low third-order intermodulation distortion is a direct result of the excellent linear power performance of the CE AlGaAs-GaAs HBT. The combination of good efficiency, low third-order intermodulation distortion, and broad bandwidth in this MMIC amplifier clearly demonstrate the potential of the CE HBT in communication transmitter applications.

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## A Magnetically Switchable Ferrite Radome for Printed Antennas

*D.M. Pozar. "A Magnetically Switchable Ferrite Radome for Printed Antennas." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 67-69.*

A ferrite superstrata or radome layer can be used to control the radiation, reception, and scattering from a printed antenna or array by applying a dc magnetic bias field in the plane, of the ferrite, orthogonal to the RF magnetic field. By properly choosing the bias field, the effective permeability of an extraordinary plane wave propagation in the ferrite region can be made to be zero or negative over a certain frequency range, resulting in an evanescent wave behavior in the ferrite layer, and a large attenuation of the wave transmitted through the layer. Similarly, the radar cross section of the antenna will be reduced by twice this attenuation factor. A simple model capable of predicting the gross behavior of the ferrite radome layer is presented, and experimental data is shown to validate the concept.

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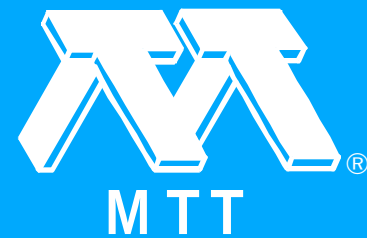


# Abstracts

## Active Varactor Tunable Bandpass Filter

*S.R. Chandler, I.C. Hunter and J.G. Gardiner. "Active Varactor Tunable Bandpass Filter." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 70-71.*

A microstrip active varactor tunable bandpass filter is presented. The filter is based upon the negative resistance method using a microstrip combline network. A 1.8-GHz, two-pole device with a bandwidth of 2% was constructed. 0.6 octave tuning with significant improvement in passband performance was achieved compared with its passive counterpart.



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## Acoustooptically Controlled True Time Delays

*W.D. Jemison and P.R. Herczfeld. "Acoustooptically Controlled True Time Delays." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 72-74.*

A novel microwave true time delay system is proposed that uses an acoustooptic cell to address the desired time delay. The system is compatible with high speed optical intensity modulation techniques and will therefore support microwave modulation frequencies into the millimeter wave range. The number of possible delays is a function of the acoustooptic cell properties and the desired isolation between delay paths. A 7-bit true time delay system appears feasible based on an assessment of commercially available acoustooptic cell technology.

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## Characterization of Resistive Transmission Lines to 70 GHz with Ultrafast Optoelectronics

A. Deutsch, M.R. Scheuermann, G. Arjavalingam, L. Kneller, J.K. Tam and C.W. Surovic.  
*"Characterization of Resistive Transmission Lines to 70 GHz with Ultrafast Optoelectronics."*  
*1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 75-77.*

The complete characterization of resistive transmission lines with the short-pulse propagation technique is extended to 70 GHz. The wide-frequency coverage is made possible by the use of ultrafast photoconductive switches for pulse generation and sampling. The picosecond optoelectronic sampling oscilloscope is described and results of measurements on thin-film strip transmission lines are presented.

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## Energy and Power Orthogonality in Isotropic, Discretely Inhomogeneous Waveguides

*E.B. Manring and J. Asmussen, Jr.. "Energy and Power Orthogonality in Isotropic, Discretely Inhomogeneous Waveguides." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 78-79.*

By analysis of the scalar potential forms of the fields, it is shown that energy orthogonality conditions for a discretely inhomogeneously-filled waveguide are actually a special case of the more general power orthogonality conditions when the fields are purely TE or TM. Power orthogonality expressions for hybrid modes may be expressed in a new form in terms of the TE and TM contributions of the H-field alone or the E-field alone. This form involves only a dot product, simplifying practical analysis when the fields are expressed in terms of TE and TM components, and clarifies the relationship between energy orthogonality and power orthogonality.

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## Directional Couplers Between Doubled-Sided Substrate Microstrip Lines Using Virtually-Terminated Coupling Slots

*C.-H. Ho, L. Fan, G.-M. Luong and K. Chang. "Directional Couplers Between Doubled-Sided Substrate Microstrip Lines Using Virtually-Terminated Coupling Slots." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 80-81.*

A new planar multilayer quadrature coupler is proposed. This new multilayer coupler consists of two microstrip lines that are coupled through two virtually-terminated narrow slots in a common ground plane. Experimental results are in fairly good agreement with a theory. With the advantages of compact size and simple design procedure, this new component should have many applications in multilayer microwave integrated circuits.

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# Abstracts

## A DC Voltage is Equivalent to Two Traveling Waves on a Lossless, Nonuniform Transmission Line

*C.-W. Hsue. "A DC Voltage is Equivalent to Two Traveling Waves on a Lossless, Nonuniform Transmission Line." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 82-84.*

A static dc voltage can be treated as two traveling waves propagating in opposite directions of a lossless, nonuniform transmission line. The amplitudes of these two traveling waves are a function of the characteristic impedance of signal line. The concept of two traveling waves is applied to a time-domain-scattering-parameters analysis in a lossless, nonuniform transmission line terminated with nonlinear loads.



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*"Call for Papers - Electrical Performance of Electronic Packaging (Mar. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 91-91.*



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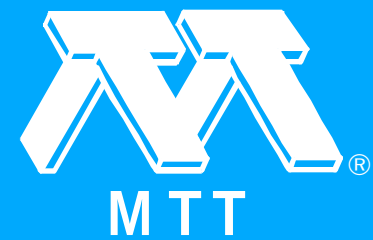
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*"Ask IEEE (Advertisement) (Mar. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.3 (Mar. 1993 [MGWL]): 92-92.*



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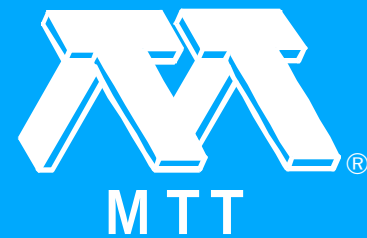
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## Editorial I (Apr. 1993 [MGWL])

*T. Itoh. "Editorial I (Apr. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 93-93.*

We have been experiencing a growing trend of defeating the purpose of this Letters journal by a number of authors. First, we have an increasing list of authors whose manuscripts have been accepted, but did not respond to our request of "final check" in a timely fashion. As you are aware, when the manuscript is accepted by this office, we request authors to send us the final corrected version together with a diskette. Even if the author considers no corrections needed, we need to receive such information before the printing process takes place at IEEE.

Publications of many letters are delayed by the lack of a timely response by the author. We are implementing, immediately, the following policy.



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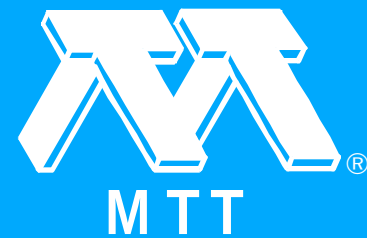


# Abstracts

## Editorial II (Apr. 1993 [MGWL])

*S.A. Maas and T. Itoh. "Editorial II (Apr. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 94-94.*

In the last few years the IEEE Microwave and Guided Wave Letters (MGWL), the IEEE Transactions on Microwave Theory and Techniques, and the IEEE MTT-S International Microwave Symposium Digest have experienced an increasing number of instances of unethical publication practices. The number of such incidents appears to be increasing, and thus has become a matter of great concern to the Editors of these journals and to the MTT Administrative Committee.



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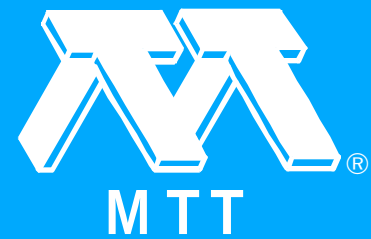


# Abstracts

## Active Cavity-Backed Slot Antenna Using MESFET's

*H.P. Moyer and R.A. York. "Active Cavity-Backed Slot Antenna Using MESFET's." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 95-97.*

An active cavity-backed slot antenna for quasioptical arrays is described. A packaged GaAs MESFET with a coplanar matching network was used for the oscillator circuit. This configuration yields the expected slot antenna radiation pattern with a compact layout, low cross-polarization, and increased directivity due to the cavity backing. The measured patterns with cavity backing show a significant improvement compared with the same oscillator without cavity-backing.



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## Broad-Band, Lossless Monolithic Microwave Active Floating Inductor

*G.F. Zhang and J.L. Gautier. "Broad-Band, Lossless Monolithic Microwave Active Floating Inductor." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 98-100.*

Broad-band, lossless microwave active floating inductor is proposed in this paper for general use in monolithic microwave integrated circuit. The attractive features of this active floating inductor are that 1) it is lossless, 2) it can operate over a wide microwave frequency range, 3) its size is independent of the inductance value, and 4) it can be easily made in MMIC.

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## Measurement of an Invariant in Directional Couplers

*I. Awai, A. Takasugi, M. Hano and R. Kitoh. "Measurement of an Invariant in Directional Couplers." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 101-103.*

It is studied how to measure an invariant of lossless four-port circuits with a reflection symmetry which result in directional couplers. The invariant  $K$  determines the isolation port as well as the coupling port with the amount of coupling, and thus the way of coupling is classified into three types corresponding to the cases  $K \leq -1$ ,  $-1 < K \leq 1$ , and  $K > 1$ . The value of invariant is easily calculated from S-parameters commonly obtained by a vector network analyzer in the microwave frequency band. It can be used for predicting the transmission characteristics of a directional coupler without building the matching circuits.

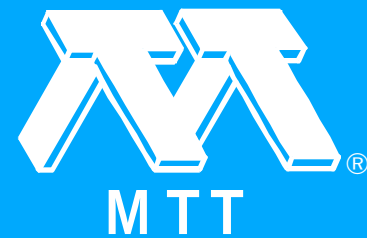


# Abstracts

## An Analytic Series Solution for H-Plane Waveguide T-Junction

*K.H. Park and H.J. Eom. "An Analytic Series Solution for H-Plane Waveguide T-Junction." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 104-106.*

A solution for the H-plane waveguide T-junction is obtained in analytic series form. A Fourier-Transform technique is employed to express the scattered field in the spectral domain in terms of parallel-plate waveguide modes. The boundary conditions are enforced to obtain simultaneous equations for the transmitted field. The simultaneous equations are solved to obtain the transmission and reflection coefficients in simple series forms. Comparisons between our solution and other existing results show excellent agreements.



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## A 10-GHz Amplifier Using an Epitaxial Lift-Off Pseudomorphic HEMT Device

*P.G. Young, R.R. Romanofsky, S.A. Alterovitz, R.A. Mena and E.D. Smith. "A 10-GHz Amplifier Using an Epitaxial Lift-Off Pseudomorphic HEMT Device." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 107-109.*

A process to integrate epitaxial lift-off devices and microstrip circuits has been demonstrated using a pseudomorphic HEMT on an alumina substrate. The circuit was a 10 GHz amplifier with the interconnection between the device and the microstrip circuit being made with photolithographically patterned metal. The measured and modeled response correlated extremely well with a maximum gain of 6.8 dB and a return loss of -14 dB at 10.4 GHz.

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## Time-Domain Design-Oriented Parametrization of Truncated Periodic Strip Gratings

*L. Carin, L.B. Felsen and M.R. McClure. "Time-Domain Design-Oriented Parametrization of Truncated Periodic Strip Gratings." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 110-112.*

Asymptotic methods are used to develop an algorithm that parametrizes time-domain plane-wave interaction with a truncated grating of periodically spaced, perfectly conducting strips in free space. By distinctly displaying the edge effects as well as the truncated Floquet mode contributions from the body of the grating, the model contains the necessary building blocks for time-domain, finite-grating design. Short-pulse, plane-wave diffraction results computed from the model are shown to agree well with numerical reference data, and salient properties of the time-domain Floquet-mode constituents in the model are highlighted via time-frequency representations.

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# Abstracts

## Optoelectronic Phase Locking of Microwave Signals Up to 4 GHz Using a Laser-Diode-Based Electrooptic Harmonic Mixer

*C.-L. Pan, K.-Y. Tang and H.-H. Wu. "Optoelectronic Phase Locking of Microwave Signals Up to 4 GHz Using a Laser-Diode-Based Electrooptic Harmonic Mixer." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 113-115.*

A reflection-mode GaAs electrooptical sampler has been used for constructing a harmonic mixer to optoelectronically phase-lock microwave signals up to 4 GHz in a laser-diode-based system. The conversion loss of the harmonic mixer is 81 dB. The phase noise degradation of the phase-locked 4-GHz signal at 5-kHz offset measured with respect to the 500 MHz synthesizer signal driving the laser diode is 38 dB.



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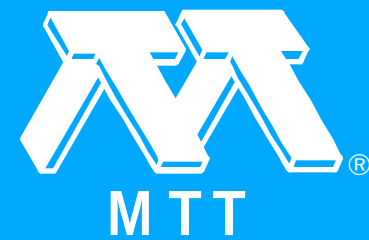
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## Call for Papers - Electrical Performance of Electronic Packaging (Apr. 1993 [MGWL])

*"Call for Papers - Electrical Performance of Electronic Packaging (Apr. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 123-123.*



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*"Ask IEEE (Advertisement) (Apr. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.4 (Apr. 1993 [MGWL]): 124-124.*



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## The Space Spectral Domain Technique Applied to a Finline Configuration

*N. Gupta and M. Singh. "The Space Spectral Domain Technique Applied to a Finline Configuration." 1993 Microwave and Guided Wave Letters 3.5 (May 1993 [MGWL]): 125-126.*

The method of space spectral domain, a novel combination of the conventional method of lines and spectral domain approach, is extended to analyze a class of finline resonators. The existing SSDA procedure is simplified using the property of the diagonal matrices, which leads to stability in numerical results with less computational efforts. As an illustration the resonant frequency for the rectangular and triangular finline resonator is computed.

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## An Efficient 2-D FDTD Algorithm Using Real Variables

*S. Xiao and R. Vahldieck. "An Efficient 2-D FDTD Algorithm Using Real Variables." 1993 Microwave and Guided Wave Letters 3.5 (May 1993 [MGWL]): 127-129.*

A two-dimensional finite difference time domain (FDTD) method is proposed for the full-wave analysis of arbitrarily shaped guided wave structures. By using a phase shift  $\beta \Delta z$  along the  $z$ -direction (propagation direction), and assume the limiting case of  $\Delta z$  approaching zero, the propagation constant of hybrid modes can be calculated by using a two-dimensional mesh with a truly two-dimensional grid size. Furthermore, by multiplying the field equation with an additional factor  $j$ , only real variables are used in the computation, leading to a very fast algorithm.

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## Direct Nonlinear FET Parameter Extraction Using Large-Signal Waveform Measurements

*A. Werthof, F. van Raay and G. Kompa. "Direct Nonlinear FET Parameter Extraction Using Large-Signal Waveform Measurements." 1993 Microwave and Guided Wave Letters 3.5 (May 1993 [MGWL]): 130-132.*

A new method is presented which permits a direct nonlinear FET parameter extraction of the drain current generator and the gate source capacitor from large-signal waveform measurements. For demonstration, the high frequency characteristics of the nonlinear drain current generator for a GaAs-MESFET and a MODFET are extracted. Significant differences between the dc and RF characteristics are observed and interpreted.

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## Nonlinear Model and Measurement Method for Microwave Mixers

*G. Vandersteen and A. Vander Vorst. "Nonlinear Model and Measurement Method for Microwave Mixers." 1993 Microwave and Guided Wave Letters 3.5 (May 1993 [MGWL]): 133-135.*

A novel approach to characterize and measure the static and dynamic nonlinear properties of a microwave mixer is described. It is based on the use of Generalized Volterra Series. The modeling capabilities of this novel approach are illustrated by simulation results of nonlinear microwave devices, as well as by measurement. Furthermore, a new measurement setup has been developed. It uses a sampling oscilloscope. It yields both the amplitude and phase of the different spectral components of the measured signal.

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## A Treatment of Magnetized Ferrites Using the FDTD Method

*J.A. Pereda, L.A. Vielva, A. Vegas and A. Prieto. "A Treatment of Magnetized Ferrites Using the FDTD Method." 1993 Microwave and Guided Wave Letters 3.5 (May 1993 [MGWL]): 136-138.*

The FDTD method is extended to include magnetized ferrites. The treatment of the ferrite material is based on the equation of motion using Gilbert's approximation of the damping term. The validity of the formulation is verified by applying it to the calculation of propagation constants in waveguides containing ferrites with transverse magnetization. The results for a rectangular waveguide filled with ferrites and those for a rectangular waveguide loaded with a centered ferrite slab are compared with the exact ones.



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## Harmonic Enhancement of Modulated Semiconductor Laser with Optical Feedback

*T.-D. Ni, X. Zhang and A.S. Daryoush. "Harmonic Enhancement of Modulated Semiconductor Laser with Optical Feedback." 1993 Microwave and Guided Wave Letters 3.5 (May 1993 [MGWL]): 139-141.*

A harmonic conversion approach for the efficient transfer of power to the desired harmonic of a directly modulated semiconductor laser diode is presented. This approach will help to overcome the limitations of modulation bandwidth that are associated with semiconductor laser diodes. In particular, the transfer of power from the second harmonic to the fourth harmonic of the modulation signal by the establishment of an external cavity matching to the fourth harmonic frequency is shown. The fourth harmonic at 5 GHz is at least 14 dB higher than the fundamental signal level.

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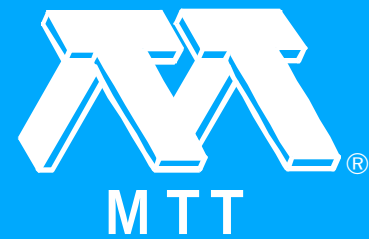
## 20-GHz High-Efficiency AlInAs-GaInAs on InP Power HEMT

*M. Matloubian, A.S. Brown, L.D. Nguyen, M.A. Melendes, L.E. Larson, M.J. Delaney, M.A. Thompson, R.A. Rhodes and J.E. Pence. "20-GHz High-Efficiency AlInAs-GaInAs on InP Power HEMT." 1993 Microwave and Guided Wave Letters 3.5 (May 1993 [MGWL]): 142-144.*

A single stage 20-GHz power amplifier was developed using double-doped AlInAs-GaInAs on InP HEMT. Output power of 516 mW (0.645 W/mm) with power-added efficiency of 47.1% with 7.1-dB gain were obtained from an 800- $\mu$ m wide device. The device had a saturated output power of more than 560 mW (0.7 W/mm). This is believed to be the highest combination of output power, power density, gain, and power-added efficiency reported for an InP-based FET at this frequency.

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## Pulsed L-Watt Heterojunction Bipolar Transistors at 35 GHz

*M.G. Adlerstein, M.P. Zaitlin, W. Hoke, E. Tong and G. Jackson. "Pulsed L-Watt Heterojunction Bipolar Transistors at 35 GHz." 1993 Microwave and Guided Wave Letters 3.5 (May 1993 [MGWL]): 145-147.*

High-peak power-pulsed operation of common emitter AlGaAs-GaAs HBT's at 35 GHz is reported. A 1.0 W peak power with 2.3-dB associated gain and power-added efficiency of 28% is obtained. Small devices gave up to 43% power-added efficiency with 190 mW output at 4.8-dB gain. Pulse length was 300 nS and duty cycle was 33%. The device design, small signal characteristics, and power results obtained are described.

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## A Quasi-Microstrip Traveling-Wave Power Divider/Combiner for Use in High-Density Packages

*D. Willems, I. Bahl and B. Kruger. "A Quasi-Microstrip Traveling-Wave Power Divider/Combiner for Use in High-Density Packages." 1993 Microwave and Guided Wave Letters 3.5 (May 1993 [MGWL]): 148-149.*

A low-loss miniature microstrip 4-way traveling-wave divider/combiner (TWD/C) that incorporates the package effects into the circuit design, i.e., the microstrip transmission line impedances partially includes the package wall as a ground plane, is presented. The TWD/C was designed using a full-wave electromagnetic simulator. Additionally, this TWD/C has less than a 0.3-dB insertion loss and a 1.6:1 VSWR at all ports over a 6-GHz bandwidth.

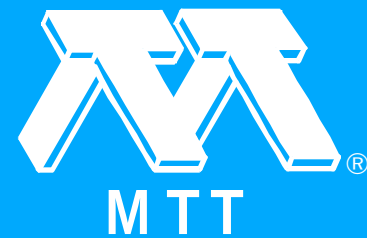
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## Modal Analysis of the Magic Tee

*T. Sieverding and F. Arndt. "Modal Analysis of the Magic Tee." 1993 Microwave and Guided Wave Letters 3.5 (May 1993 [MGWL]): 150-152.*

The full wave modal S-matrix of the magic-T-junction is derived by applying the mode-matching technique. Four standing wave solutions in suitably chosen subregions for the four side arms are superimposed in the common cavity region in the middle section. This yields rapid convergence and accurate results since the electric wall boundary conditions in the waveguide ports are met rigorously. The theory is verified by measurements at a magic-T-junction with standard X-band (WR 90) rectangular waveguide ports.



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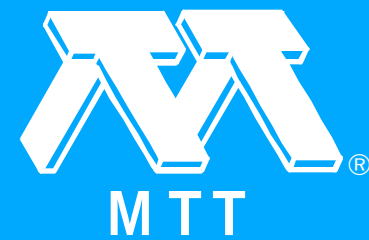
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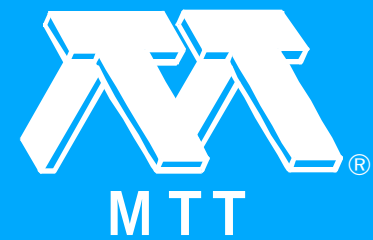
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## Consideration of Velocity Saturation in the Design of GaAs Varactor Diodes

*T.W. Crowe, W.C.B. Peatman, R. Zimmermann and R. Zimmermann. "Consideration of Velocity Saturation in the Design of GaAs Varactor Diodes." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 161-163.*

The design of GaAs Schottky barrier varactor diodes is reconsidered in light of the recent discovery of velocity saturation effects in these devices. Experimental data is presented which confirms that improved multiplier performance can be achieved.



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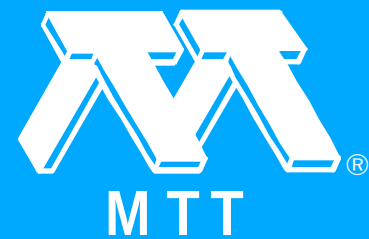
## A Quasi-Optical Amplifier

*C.-Y. Chi and G.M. Rebeiz. "A Quasi-Optical Amplifier." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 164-166.*

A quasi-optical amplifier suitable for Gaussian-beam applications is presented. The amplifier is based on the integrated horn antenna and uses polarization duplexing to isolate the output beam from the input beam. A prototype hybrid amplifier is reported here with a measured gain of 10.5 dB at 5.92 GHz. The amplifier design is uniplanar, compact, and is compatible with the fabrication process of HEMT transistors at millimeter-wave frequencies.

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## A High-Performance 94-GHz MMIC Doubler

*S.-W. Chen, T. Ho, F.R. Phelleps, J.L. Singer, K. Pande, P. Rice, J. Adair and M. Ghahremani.*  
*"A High-Performance 94-GHz MMIC Doubler." 1993 Microwave and Guided Wave Letters 3.6*  
*(Jun. 1993 [MGWL]): 167-169.*

A 94-GHz monolithic microwave integrated circuit (MMIC) frequency doubler with 25% efficiency and 65-mW output power has been developed. Variations in the diode's performance as a doubler with its geometry and doping profile were analyzed for optimum efficiency and output power. Optimum doubler performance was obtained as a consequence of use of the optimized diode parameters resulting from this analysis. Measured results of the diode parameters as well as the doubler response showed excellent agreement with the analysis. The doubler exhibits better performance than those reported in the literature at similar frequencies using an MMIC approach.

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## Wave Leakage from Groove NRD Structures

*Z. Ma and E. Yamashita. "Wave Leakage from Groove NRD Structures." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 170-172.*

It is shown that the offset of grooves in the groove NRD structure causes the leakage of power from the operating mode fields. Numerical results based on a full-wave analysis are provided to show the complex propagation properties of the operating mode as a function of the offset dimension of the grooves and the frequency. Mode conversion behavior between the operating mode and the dominant mode is also illustrated. Some conclusions about the usage of the GNRD guide are drawn.

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## High-Q Dielectrically Loaded Electrically Small Cavity Resonators

*A.E. Centeno and P.S. Excell. "High-Q Dielectrically Loaded Electrically Small Cavity Resonators." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 173-174.*

The quality factor (Q) of a dielectrically loaded cavity resonator is reduced due to conductor losses. An electrically small dielectrically loaded cavity resonator is described where the conductor losses are minimized by the use of corrugated cylindrical walls. When excited in the TE/sub 01d/ dielectric resonator mode the unloaded Q-factor was seen to be 89% higher for the corrugated cavity than an equivalent cylindrical cavity. The calculated conductor Q-factor was 4.7 times greater. The proposed cavity structure therefore allows the dielectrically loaded cavity to have an unloaded Q-factor determined primarily by the dielectric loss of the dielectric resonator.





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## A Broad-Band Uniplanar Branch-Line Coupler Using a Coupled Rectangular Slotline Ring

C.-H. Ho, L. Fan and K. Chang. "A Broad-Band Uniplanar Branch-Line Coupler Using a Coupled Rectangular Slotline Ring." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 175-176.

A new uniplanar branch-line coupler has been developed that provides substantially improved broad-band amplitude and phase characteristics when compared to conventional microstrip branch-line couplers. Experimental results show that the new coupler has over 20-dB isolation over a bandwidth of more than 40% centered at 3 GHz with  $\pm 1$ -dB power dividing balance.

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## Mutual Coupling Between Waveguide Apertures Mounted on a Common Conducting Surface Using a Time- and Fourier-Gated Pulsed FDTD Method

*J.C. Olivier. "Mutual Coupling Between Waveguide Apertures Mounted on a Common Conducting Surface Using a Time- and Fourier-Gated Pulsed FDTD Method." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 177-179.*

A time and Fourier gated pulsed finite difference time domain (FDTD) algorithm for computing mutual coupling between waveguide apertures is formulated. The method uses an incident pulse of short time duration (wide bandwidth) and a wide band ABC for lossless waveguides. It is capable of the computation of scattered or mutually coupled fields even if the intensity of the required fields is lower than the inherent reflection levels of the free space artificial truncation planes. The method is illustrated by computing the mutual coupling between two rectangular waveguides mounted on a common groundplane and bounded by a parallel plate waveguide.

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## Composite Anode Contact for Planar Transferred Electron Devices

*C.G. Diskus, A.L. Springer, K. Lubke, H.W. Lettenmayr and H.W. Thim. "Composite Anode Contact for Planar Transferred Electron Devices." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 180-181.*

In order to prevent the anode contact of transferred electron devices (TED's) from burning out, a Schottky contact is frequently used. Unfortunately this approach gives rise to a decrease in efficiency due to the built-in voltage of the Schottky contact. A possibility to avoid this decrease is to use a composite contact. By combining a short stripe of a Schottky metal with an ohmic contact, the loss of dc power dissipated in the Schottky anode contact is eliminated thereby maintaining to some extent the depletion layer necessary for preventing the formation of a stationary high field domain at the anode contact. With this approach, a 30% increase in efficiency of a CW operated field effect controlled transferred electron device (FECTED) oscillator at a frequency of 35 GHz has been obtained. The achieved efficiency of 3.8% is, to our knowledge, the highest efficiency obtained with a planar TEO at 35 GHz.

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## A Boundary Condition to Absorb Both Propagating and Evanescent Waves in a Finite-Difference Time-Domain Simulation

*V. Betz and R. Mittra. "A Boundary Condition to Absorb Both Propagating and Evanescent Waves in a Finite-Difference Time-Domain Simulation." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 182-184.*

A boundary condition that absorbs both propagating and evanescent waves in a finite-difference time-domain (FDTD) simulation is presented. A computationally efficient method of determining the values of the boundary condition input parameters is described. To illustrate the effectiveness of this boundary condition, it is used to truncate the computational domain of two FDTD simulations, namely a uniform microstrip line and a microstrip line with a gap discontinuity. In both cases, the results are found to be more accurate than those obtained with the conventional second-order Mur absorbing boundary condition.

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## Rigorous Modal Analysis of the Asymmetric Rectangular Iris in Circular Waveguides

*R. Keller and F. Arndt. "Rigorous Modal Analysis of the Asymmetric Rectangular Iris in Circular Waveguides." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 185-187.*

The rigorous field theory analysis is presented for the rectangular iris in circular waveguides as well as for rectangular iris coupled circular waveguide resonators. The theory is based on the full-wave mode-matching method for the key-building block discontinuity circular waveguide to a concentric smaller rectangular waveguide, associated with the generalized S-matrix technique. Arbitrary iris location and finite thickness are rigorously taken into account. The scattering parameters of a single transition and of a rectangular iris coupled one-resonator filter of about 12 GHz resonance frequency are presented as calculation examples. The theory is verified by comparison with measurements.

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## A High-Power Millimeter-Wave Frequency Doubler Using a Planar Diode Array

*B.J. Rizzi, T.W. Crowe and N.R. Erickson. "A High-Power Millimeter-Wave Frequency Doubler Using a Planar Diode Array." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 188-190.*

A balanced frequency doubler has been built using an integrated planar array of four varactor diodes. The maximum output power of 55 mW at 174 GHz is twice the power available from the previous best multiplier at a nearby frequency and was limited by the available pump source. The peak efficiency is 25 % at 150 mW input. Circuit parasitic and device heating do not appear to be significant at the present power levels and carrier velocity saturation effects appear to be reduced due to the series array configuration.

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## Ka- and W-Band PM-HFET DRO's

*J. Wenger and U. Guttich. "Ka- and W-Band PM-HFET DRO's." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 191-193.*

Dielectric resonator stabilized oscillators have been designed, fabricated, and investigated. The oscillators consist of microstrip matching and biasing circuits on alumina substrate, a dielectric resonator puck, and a low-noise quarter-micron InGaAs-GaAs pseudomorphic (PM) HFET as the active device. At 37 GHz and 81 GHz, output powers of 10 dBm and 0 dBm have been measured. The phase noise of the Ka-band and W-band oscillators has been determined to be -97 dBc/Hz at 100 kHz and -90 dBc/Hz at 1 MHz off carrier, respectively.

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# Abstracts

## Patent Abstracts (Jun. 1993 [MGWL])

*"Patent Abstracts (Jun. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 194-202.*



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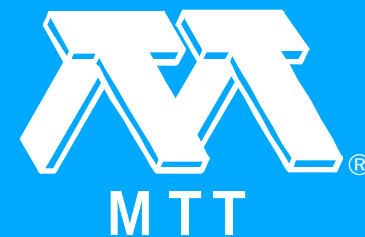
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## IEEE/LEOS 1993 Summer Topical Meetings (Jun. 1993 [MGWL])

*"IEEE/LEOS 1993 Summer Topical Meetings (Jun. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.6 (Jun. 1993 [MGWL]): 203-203.*



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## A Wide-Band 760-GHz Planar Integrated Schottky Receiver

*S.S. Gearhart, J. Hesler, W.L. Bishop, T.W. Crowe and G.M. Rebeiz. "A Wide-Band 760-GHz Planar Integrated Schottky Receiver." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 205-207.*

A wide-band planar integrated heterodyne receiver has been developed for use at submillimeter-wave to far-infrared frequencies. The receiver consists of a log-periodic antenna integrated with a planar 0.8- $\mu\text{m}$  GaAs Schottky diode. The monolithic receiver is placed on a silicon lens and has a measured room temperature double side-band conversion loss and noise temperature of  $14.9 \pm 1.0$  dB and  $8900 \pm 500$  K, respectively, at 761 GHz. These results represent the best performance to date for room temperature integrated receivers at this frequency.

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## Fast Waveguide Mode Computation Using Wavelet-Like Basis Functions

*R.L. Wagner, G.P. Otto and W.C. Chew. "Fast Waveguide Mode Computation Using Wavelet-Like Basis Functions." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 208-210.*

The use of wavelet-like basis functions for solving electromagnetic problems is demonstrated. In particular, the modes of an arbitrarily shaped hollow metallic waveguide using a surface integral equation/method of moments (MOM) formulation are found. A class of wavelet-like basis functions is used to produce a sparse MOM impedance matrix, allowing the use of sparse matrix methods for fast solution of the problem. The same method applies directly to the external scattering problem. For the examples considered, the wavelet domain impedance matrix has about 20% nonzero elements, and the time required to compute its LU factorization is reduced by approximately a factor of 10 compared to the original full matrix.

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# Abstracts

## Loss Calculation of Single and Coupled Strip Lines by Extended Spectral Domain Approach

*T. Kitazawa. "Loss Calculation of Single and Coupled Strip Lines by Extended Spectral Domain Approach." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 211-213.*

The extended spectral domain approach is used to calculate the losses of the strip lines of arbitrary thickness. This versatile method is applicable to single and coupled strip lines with isotropic and/or anisotropic substrates. Both the simpler quasistatic and the rigorous hybrid-mode formulation can be developed on the same basis. Numerical examples presented include loss calculations of the strip lines with thick, as well as thin conductors, where thickness is comparable to or less than the skin depth. Numerical results also reveal the usefulness and the limitation of the quasistatic analyses.



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## A Nine-MESFET Two-Dimensional Power-Combining Array Employing an Extended Resonance Technique

*A. Mortazawi and B.C. De Loach, Jr.. "A Nine-MESFET Two-Dimensional Power-Combining Array Employing an Extended Resonance Technique." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 214-216.*

A new spatial power combining circuit that forms a single resonant structure from many active devices is introduced. A large signal analysis of this power combiner was performed. Based on these results, a two- and a nine-MESFET two-dimensional combiner driving two- and nine-patch antenna elements, respectively, were designed and fabricated. Measured results are also presented. An effective radiated power of 6.06 W at 7.33 GHz was obtained from the nine-MESFET combiner.



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## Frequency Response of HBT's as Photodetectors

*E. Suematsu and H. Ogawa. "Frequency Response of HBT's as Photodetectors." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 217-218.*

Photodetection measurements of HBT's fabricated by the MMIC HBT process have been experimentally investigated for the first time. A 3-dB bandwidths of 2 GHz and more than 20 GHz have been achieved in a CE (common emitter) HBT and a CB (common base) HBT, respectively. The photoresponse of the CBHBT is approximately 25 dB higher than that of the CBHBT at 1 GHz. The CEHBT has a higher signal-to-noise ratio than a PIN/50-Omega FET-amplifier at 10 GHz.

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## Automatic Detection of Hopf Bifurcations on the Solution Path of a Parametrized Nonlinear Circuit

*V. Rizzoli and A. Neri. "Automatic Detection of Hopf Bifurcations on the Solution Path of a Parametrized Nonlinear Circuit." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 219-220.*

A numerical technique for the automatic detection of Hopf bifurcations on the solution path of a continuously parametrized nonlinear circuit operating in time-periodic steady state is discussed. The algorithm is based on the piecewise harmonic-balance technique, is truly general-purpose, and can be applied to any kind of nonlinear microwave subsystem without restrictions on circuit topology and device models. This new software tool is of key importance in the solution of complex CAD problems such as the detection of spurious tones in any nonlinear circuit, and the analysis of the injection locking of oscillators.

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## Closed-Form Expressions for Coefficients Used in FD-TD High-Order Boundary Conditions

*K. McInturff and P.S. Simon. "Closed-Form Expressions for Coefficients Used in FD-TD High-Order Boundary Conditions." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 222-223.*

Tirkas et al. recently presented an algorithm to implement absorbing boundary conditions (ABC's) of arbitrarily high order into the finite difference-time domain technique. However, they did not provide explicit formulas to determine the expansion coefficients used in the Pade approximations of the pseudo-differential operator. Instead, the user is required to determine the roots of a polynomial using numerical methods that require computational effort and yield only approximate results. Exact expressions for the desired coefficients that are valid for Pade expansions of any order are presented.

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## Rigorous Analysis of the Rectangular Waveguide Six-Port Cross Junction

*T. Sieverding and F. Arndt. "Rigorous Analysis of the Rectangular Waveguide Six-Port Cross Junction." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 224-226.*

The modal S-matrix of the general rectangular waveguide six-port cross junction key-building block is derived by applying the mode-matching technique. Rapid convergence and accurate results are achieved by the superposition of six standing wave solutions in the common cavity regions which meet the electric wall boundary conditions in the waveguide ports rigorously. The theory is verified by measurements at a six-port cross with standard Ku-band (WR 62) rectangular waveguide ports.

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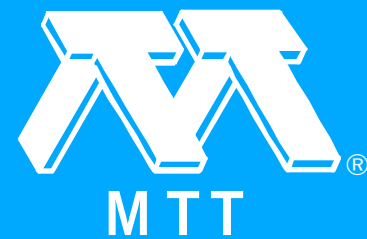


# Abstracts

## A Near-Optimum Discriminator Demodulator for Binary FSK with Wide Tone Spacing

*M.L. Stevens, D.M. Boroson and J.E. Kaufmann. "A Near-Optimum Discriminator Demodulator for Binary FSK with Wide Tone Spacing." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 227-229.*

Optical FSK communication systems often require large tone spacings to reduce bit-error rate (BER) degradation from laser linewidth induced crosstalk. Until now, discriminator detection of FSK for such wide tone spacings has fallen short of matched filter performance because of the suboptimal choice of a prefilter. A near-optimum demodulator for 240 Mbps, 3-times minimum orthogonal CPFSK, has been constructed, with a measured performance that is 0.5 dB from matched filter theory at  $10^{-9}$  BER. The design can be scaled to other data rates and tone spacings. The demodulator incorporates a novel frequency tracking loop that has good performance at low signal levels and no data-pattern dependence.



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## Full 360 Degrees Phase Shifting of Injection-Locked Oscillators (Comments)

*K.W. Wong, A.K.Y. Lai and X. Zeng. "Full 360 Degrees Phase Shifting of Injection-Locked Oscillators (Comments)." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 230-232.*

In the above letter, Zhang and Daryoush have given a novel design for a subharmonically injection locked local oscillator, consisting of two cascaded suboscillators, by which an analog phase shift of  $0^\circ$  to  $360^\circ$  can be produced.



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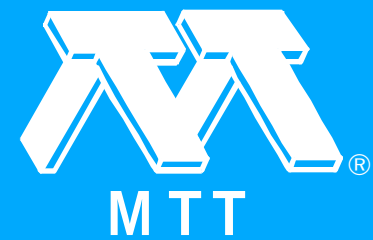
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*"Authors--Please Send an Electronic Version of Your Manuscript to the IEEE (Advertisement) (Jul. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.7 (Jul. 1993 [MGWL]): 239-240.*



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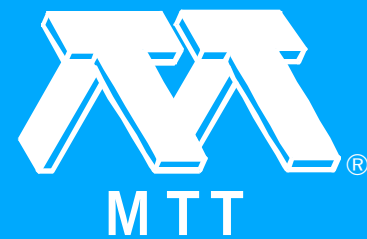


# Abstracts

## Efficient and Versatile Analysis of Microwave Structures by Combined Mode Matching and Finite Difference Methods

*M. Mongiardo and R. Sorrentino. "Efficient and Versatile Analysis of Microwave Structures by Combined Mode Matching and Finite Difference Methods." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 241-242.*

A combined mode matching (MM) and finite difference (FD) method is proposed for the analysis of passive microwave structures. By segmenting the structure into regions of separable geometries and irregular ones, where MM and FD are applied separately, the respective generalized admittance matrix (GAM) representations are obtained. This makes it possible to take advantage of the high numerical efficiency of the MM method as well as of the versatility of the FD method.



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## An Injection Locked Push-Pull Oscillator at Ku-Band

*X. Zhou and A.S. Daryoush. "An Injection Locked Push-Pull Oscillator at Ku-Band." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 244-246.*

A new MESFET push-pull oscillator at Ku-band has been designed and tested. This configuration demonstrated 1) a larger subharmonic injection locking range and 2) lower FM noise without using a frequency stabilized dielectric resonator. This new oscillator demonstrated significant potential for use in subharmonic optically synchronized local oscillators in phased array.

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## Accurate Transmission Line Characterization

*D.F. Williams and R.B. Marks. "Accurate Transmission Line Characterization." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 247-249.*

This letter introduces a new method for the characterization of transmission lines fabricated on lossy or dispersive dielectrics. The method, which is more accurate than conventional techniques, is used to examine the resistance, inductance, capacitance, and conductance per unit length of coplanar waveguide transmission lines fabricated on lossy silicon substrates.

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## Application of the FDTD Technique to Periodic Problems in Scattering and Radiation

*W.-J. Tsay and D.M. Pozar. "Application of the FDTD Technique to Periodic Problems in Scattering and Radiation." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 250-252.*

The finite-difference time-domain (FDTD) technique is applied to two-dimensional periodic problems in scattering and radiation. This method allows the direct and complete treatment of periodic scatterers and array having transverse or longitudinal inhomogeneities, and several examples are presented to illustrate the versatility of the technique. The FDTD grid needs only to be applied to a unit cell of the periodic structure, making the analysis very efficient from a computational point of view. The method is presently limited to broadside incidence, however.

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## Experimental Investigation of a Quasi-Optical Slab Resonator

*S. Zeisberg, A. Schuenemann, G.P. Monahan, P.L. Heron, M.B. Steer, J.W. Mink and F.K. Schwering. "Experimental Investigation of a Quasi-Optical Slab Resonator." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 253-255.*

A quasi-optical slab resonator for TE modes was experimentally characterized to demonstrate a planar technology for quasi-optical devices. Predicted and measured frequencies of resonance of the TE slab modes and electric field profiles are in close agreement.

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## A Dyadic Green's Function for the Plano-Concave Quasi-Optical Resonator

*P.L. Heron, F.K. Schwering, G.P. Monahan, J.W. Mink and M.B. Steer. "A Dyadic Green's Function for the Plano-Concave Quasi-Optical Resonator." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 256-258.*

An approximate dyadic Green's function is derived for a quasi-optical resonator. The Green's function is comprised of resonant and nonresonant terms corresponding to coupling to the modal and nonmodal resonator fields. The effect of losses due to diffraction, finite reflector conductivity and radiation are included. Experimental one- and two-port measurement of antennas in an X-band cavity compare favorably with theoretical predictions.

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## Effect of Finite-Width Backside Plane on Overmoded Conductor-Backed Coplanar Waveguide

*C.-C. Tien, C.-K.C. Tzuang and S.T. Peng. "Effect of Finite-Width Backside Plane on Overmoded Conductor-Backed Coplanar Waveguide." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 259-261.*

The full-wave mode-matching method is utilized to investigate the transmission characteristics of a conductor-backed coplanar waveguide (CBCPW) with a finite backside plane. Experimental results of the scattering parameters of the CBCPW through line are presented. The theoretical results of the proposed CBCPW model, which consider a finite backside-plane CBCPW to be a system of coupled transmission lines, are shown to agree very well with the experimental ones. The anomalous resonant phenomena in the transmission characteristics of a CBCPW through line and the effect of the finite-width backside plane are obtained and discussed.

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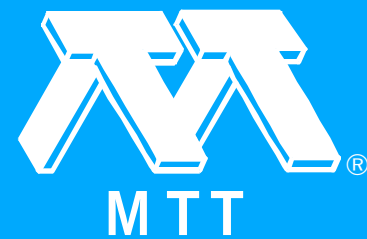


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## Microwave Structure Characterization by a Combination of FDTD and System Identification Methods

*B. Houshmand, T.W. Huaug and T. Itoh. "Microwave Structure Characterization by a Combination of FDTD and System Identification Methods." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 262-264.*

Microwave structure characterization is achieved by application of the system identification (SI) technique to the finite-difference time-domain algorithm (FDTD). The parameters of a deterministic auto-regressive moving-average model (ARMA) are computed recursively such that the model output matches the FDTD simulation. The ARMA model parameter convergence is rapid, and provides savings in the computation time.



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## A 2-GHz Three-Stage AlInAs-GaInAs-InP HEMT MMIC Low-Noise Amplifier

*S.E. Rosenbaum, L.M. Jelloian, L.E. Larson, U.K. Mishra, D.A. Pierson, M.S. Thompson, T. Liu and A.S. Brown. "A 2-GHz Three-Stage AlInAs-GaInAs-InP HEMT MMIC Low-Noise Amplifier." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 265-267.*

A three-stage monolithic microwave integrated circuit (MMIC) low-noise amplifier (LNA) has been fabricated using 0.15- $\mu\text{m}$  gate-length InP-based (AlInAs-GaInAs) high electron mobility transistor (HEMT) technology. The LNA exhibited less than 0.5-dB noise figure and greater than 35-dB gain from 2.25 to 2.5 GHz. The input and output return loss exceeded 15 dB across the band. These results are believed to be the best reported to date from a MMIC amplifier in this frequency range.

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## High-Efficient Class F GaAs FET Amplifiers Operating with Very Low Bias Voltages for Use in Mobile Telephones at 1.75 GHz

*C. Duvanaud, S. Dietsche, G. Pataut and J. Obregon. "High-Efficient Class F GaAs FET Amplifiers Operating with Very Low Bias Voltages for Use in Mobile Telephones at 1.75 GHz." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 268-270.*

High-efficient class F GaAs power FET amplifiers working with a very low drain bias voltage of 3 V required by the battery cells of portable telephones is reported. The transistor used has an optimized gate periphery of 2000  $\mu\text{m}$  and a gate length of 0.7  $\mu\text{m}$ . Under class F operation with a drain voltage of 3 V, it has demonstrated an output power of 24.5 dBm with 71% of power-added efficiency at the operating frequency of 1.75 GHz. Output harmonic levels lower than -25 dBc have been measured. The results obtained present the state of the art published for low bias voltage, low consumption power amplifiers required for mobile-telephone systems.

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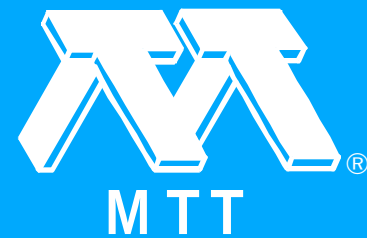


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## A 1-Watt X-Ku Band HBT MMIC Amplifier with 50% Peak Power-Added Efficiency

*F. Ali, M. Salib and A. Gupta. "A 1-Watt X-Ku Band HBT MMIC Amplifier with 50% Peak Power-Added Efficiency." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 271-272.*

A broad-band, high-efficiency MMIC power amplifier has been developed using AlGaAs-GaAs heterojunction bipolar transistors (HBT's). At 7-V collector bias, the fully matched monolithic amplifier produced 31 dBm CW peak output power with 9.2-dB peak gain and 50% peak power-added efficiency in the 8-15-GHz band. Several amplifiers from five different wafers have been successfully tested.



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## Low-Distortion and Low-Crosstalk Characteristics of Picosecond Pulses in a Dual-Plane Coupled Microstrip Lines Structure

*Y. Qian and E. Yamashita. "Low-Distortion and Low-Crosstalk Characteristics of Picosecond Pulses in a Dual-Plane Coupled Microstrip Lines Structure." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 273-275.*

Investigation of the propagation and crosstalk of ultrashort electrical pulses in a dual-plane coupled microstrip lines structure is reported. The current distributions and propagation constants of the dominant c- and pi- modes are calculated by using the spectral domain method, and the full-wave analysis results obtained are incorporated into a FFT algorithm to study pulse distortion and crosstalk in the transmission lines. Computer simulation results reveal the superior low-distortion, low-crosstalk characteristics of this transmission line structure, which can be used as interconnects in high-density, high-speed integrated circuits.

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## Design of a Dual Dielectric Rod-Antenna System

*M. Aubrion, A. Larminat, B. Chan and H. Baudrand. "Design of a Dual Dielectric Rod-Antenna System." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 276-277.*

A method is proposed for calculating the coupling coefficient between two dielectric antennas. The numerical solution is carried out by means of the full-wave analysis of the cascaded dielectric waveguides which represent the antenna. The obtained results for the coupling coefficient are in good agreement with the available experimental data. Moreover, the radiation patterns are calculated and presented.

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## Microwave Performance of Ion-Implanted 0.25-Micron MESFET for Low-Cost Applications Low-Power Gate GaAs MMIC's

*P.J. Apostolakis, J. Middleton, J. Kruse, D. Scherrer, D. Barlage, M. Feng and A.N. Lepore.  
"Microwave Performance of Ion-Implanted 0.25-Micron MESFET for Low-Cost Applications Low-Power Gate GaAs MMIC's." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 278-280.*

Low-power microwave performance of an enhancement mode (E-mode) ion implanted GaAs MESFET is reported. The 0.25- $\mu\text{m}$  x 100- $\mu\text{m}$  E-MESFET has a threshold voltage of  $V_{th} = 0.0$  V. At 1.0 mW operation of power with a bias condition of  $V_{ds} = 0.5$  V and  $I_{ds} = 2$  mA, a noise figure of 0.85 dB with an associated gain of 15 dB was measured at 4 GHz. These results demonstrate the GaAs E-MESFET is an excellent choice for low power personal communication applications.

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## High-Yield W-Band Monolithic HEMT Low-Noise Amplifier and Image Rejection Downconverter Chips

*H. Wang, K.W. Chang, T.N. Ton, M. Biedenbender, S.T. Chen, J. Lee, G.S. Dow, K.L. Tan and B.R. Allen. "High-Yield W-Band Monolithic HEMT Low-Noise Amplifier and Image Rejection Downconverter Chips." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 281-283.*

High-yield W-band monolithic integrated circuits (a three-stage low-noise amplifier (LNA), and a monolithic image rejection downconverter (IRD) using the LNA as the front end followed by an image rejection mixer (IRM)) are discussed. These MMIC's were fabricated in the 0.1- $\mu\text{m}$  AlGaAs-InGaAs-GaAs HEMT production line at TRW. The LNA demonstrated a typical 17-dB gain and 4.5-5.5-dB noise figure at 94 GHz. The complete monolithic IRD has a measured conversion gain of 7-9 dB with a single side-band (SSB) noise figure of 6 dB when downconverting 93-95-GHz RF signal to 50-500 MHz. The downconversion requires an LO power of 9 dBm. The development of these MMIC's shows the increasing maturity of GaAs based HEMT MMIC technology at W-band.

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## Energy and Power Orthogonality in Isotropic, Discretely Inhomogeneous Waveguides (Comments)

*P.R. Mclsaac. "Energy and Power Orthogonality in Isotropic, Discretely Inhomogeneous Waveguides (Comments)." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 284-285.*

In a recent letter, Manring and Asmussen discuss orthogonality relations for modes in cylindrical waveguides containing isotropic media whose permittivity may be discretely inhomogeneous. They develop these relations in terms of the TE and TM portions of the transverse electric and magnetic fields. As an example, they discuss the TE and TM modes of certain inhomogeneously-filled waveguides (for example, the axisymmetric modes in a coaxially-loaded circular cylindrical waveguide).

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# Abstracts

## Patent Abstracts (Aug. 1993 [MGWL])

*"Patent Abstracts (Aug. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 286-291.*



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## Call for Papers - Optical Fiber Communication Conference (Aug. 1993 [MGWL])

*"Call for Papers - Optical Fiber Communication Conference (Aug. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): 292-292.*



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## Back Cover (Aug. 1993 [MGWL])

*"Back Cover (Aug. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.8 (Aug. 1993 [MGWL]): b1-b2.*



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## Front Cover (Sep. 1993 [MGWL])

*"Front Cover (Sep. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): f1-f2.*



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## A Coherent Optically Controlled Phased Array Antenna System

*P.M. Freitag and S.R. Forrest. "A Coherent Optically Controlled Phased Array Antenna System." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 293-295.*

A true-time delay, optically controlled phased array antenna system whereby a large number (100-2500) of antenna elements can receive a series of microwave delays via use of a coherent optical carrier signal is described. Both transmit and receive antenna arrays are described, and the signal-to-noise ratio for a 128 channel system is calculated to be ~40 dB with an optical link loss of only ~3 dB for a 1 GHz instantaneous bandwidth at a wavelength of  $\lambda = 1.55 \mu\text{m}$ . It is shown that the use of coherent optically controlled phased array antennas provide improved controllability and immunity from noise and system losses over other architectures currently being investigated.



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## A Tuneable, Switchable Dielectric Grating

*M.D. Bushbeck and C.H. Chan. "A Tuneable, Switchable Dielectric Grating." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 296-298.*

Electromagnetic scattering characteristics of dielectric gratings are examined numerically using the finite-element method. The gratings are created by introducing pressurized dielectric fluid into periodic tubes within a dielectric sheet. A structure is presented which has an extremely narrow stop-band (total power reflection) immediately adjacent to a pass-band (total transmission). It is shown that the critical bands can be shifted by changing the fluid pressure, at a cost of only slightly less than perfect pass-band transmission (97%), while the rejection band remains perfect (100%). Thus, a unique tuneable, switchable frequency selective surface can be easily realized.

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## A High-Performance Monolithic Q-Band InP-Based HEMT Low-Noise Amplifier

*D.C.W. Lo, R. Lai, H. Wang, K.L. Tan, R.M. Dia, D.C. Streit, P.-H. Liu, J. Velebir, B. Allen and J. Berenz. "A High-Performance Monolithic Q-Band InP-Based HEMT Low-Noise Amplifier." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 299-301.*

We report a Q-band two-stage MMIC low-noise amplifier based 0.1- $\mu\text{m}$  pseudomorphic InAlAs-InGaAs-InP HEMT technology. The amplifier has achieved an average noise figure of 2.3 dB with associated gain of 25 dB over the band from 43 to 46 GHz. This noise figure is the best result ever reported for a monolithic amplifier at this frequency range. In addition, this InP-based amplifier consumes only 12 mW, which is at least three times lower than a GaAs-based counterpart, indicating that InP-based pseudomorphic HEMT's are well suited for very high density monolithic integration or an application where ultra low power consumption is required.

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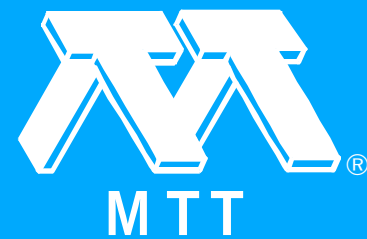


# Abstracts

## A New Approach to Quasi-Static Analysis with Application to Microstrip

*M.D. Prouty, K.K. Mei, S.E. Schwarz and R. Pous. "A New Approach to Quasi-Static Analysis with Application to Microstrip." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 302-304.*

The measured equation of invariance (MEI), a new, rapid technique for electromagnetic field analysis, is applied for the first time to planar circuit problems. Variations of the technique applicable to microstrip geometry are described. As demonstration, it is then applied to electrostatic analysis of structures held at different potentials, using novel umbilical meshes. The MEI technique offers the possibility of order-of-magnitude increases in computational speed for typical problems of microwave CAD.



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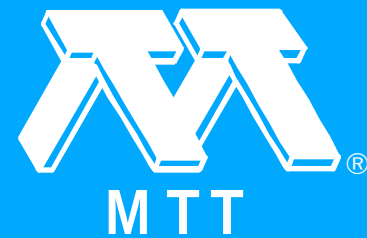


# Abstracts

## A New Interpretation of the Spectral Domain Immittance Matrix Approach

*W. Menzel. "A New Interpretation of the Spectral Domain Immittance Matrix Approach." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 305-306.*

A modified interpretation of the spectral domain immittance matrix approach based on the transformation of the principal axes for the spectral domain TE- and TM-field components is presented.



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## Vector Wave Equation 2-D--FDTD Method for Guided Wave Problems

*M. Okoniewski. "Vector Wave Equation 2-D--FDTD Method for Guided Wave Problems." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 307-309.*

A new compact FDTD algorithm for the full wave analysis of inhomogeneous wave guiding structures, using two dimensional mesh is proposed. The formulation is based on the vector wave equation, and in contrast with previous approaches, allows for the formulation of the algorithm in a real domain only. Moreover, since only transverse electric fields are used, two real, instead of six complex components have to be updated and stored, and since they are both defined at the same mesh nodes, the treatment of dielectric inhomogeneities is simplified. Numerical examples validating the method are presented.

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## Mode 1 and Mode 2 Designs for 94-GHz Microstrip Circulators

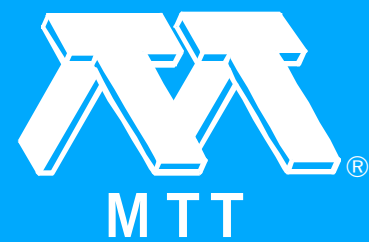
*A.M. Borjak and L.E. Davis. "Mode 1 and Mode 2 Designs for 94-GHz Microstrip Circulators." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 310-312.*

Details are given of two theoretical designs for a 94 GHz ferrite circulator in a quartz substrate, based on circulation modes 1 and 2, and their predicted performances are described. The 15-dB isolation bandwidths are 8 GHz and 3 GHz, respectively. The narrower bandwidth design has a larger ferrite radius, and this may provide some mechanical advantages in manufacturing. Other comparisons are made.

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## Effects of Amplitude, Phase, and Frequency Imperfections on the Performance of a Direct Conversion Receiver (DCR) for Personal Communication Systems

*K. Voudouris and J.M. Noras. "Effects of Amplitude, Phase, and Frequency Imperfections on the Performance of a Direct Conversion Receiver (DCR) for Personal Communication Systems." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 313-315.*

Results from a practical study of a direct conversion receiver (DCR) and its subsections, namely, power splitter, branch coupler hybrid, coupled lines band-pass filter, low-pass filter, balanced mixer, and oscillator, are presented. The receiver is designed for the 2-GHz frequency band, with particular reference to personal communications terminals for the digital european cordless telecommunications (DECT) standard. The DCR overall performance, based on measured figures of individual subcircuits, is analyzed with the aid of the "Eesof-Omnisys" simulator. Typical value for the signal-to-noise ratio 12 dBm for 10/sup -3/ bit-error rate. The receiver can tolerate amplitude and phase mismatches of 3% and 5°, respectively, as well as 1.2-kHz local oscillator drift. The dynamic range is 80 dB. The performance of the DCR fits well with the DECT specification.



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## A New Finite-Difference Time-Domain (FDTD) Algorithm for Efficient Field Computation in Resonator Narrow-Band Structures

*R. Mittra and P.H. Harms. "A New Finite-Difference Time-Domain (FDTD) Algorithm for Efficient Field Computation in Resonator Narrow-Band Structures." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 316-318.*

The finite-difference time-domain (FDTD) algorithm is a versatile method capable of solving a variety of problems from circuit component characterization to radiation analyses, but it exhibits slowness in convergence when employed for the study of resonant structures, because their transient responses often exhibit a ringing behavior for a long time. This communication describes a new approach, called the FDTD-update algorithm, that can substantially improve the convergence properties of the FDTD method when used to compute the response of resonant type structures a single frequency at a time. The filtering behavior of the algorithm is demonstrated by considering the problem of coupling into a cavity. Application to other problems is illustrated by solving the microstrip patch antenna configuration, for which the update algorithm is shown to enhance the accuracy of the results.

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## Application of Curved Parametric Triangular and Quadrilateral Edge Elements in the Moment Method Solution of the EFIE

*N.Y. Zhu and F.M. Landstorfer. "Application of Curved Parametric Triangular and Quadrilateral Edge Elements in the Moment Method Solution of the EFIE." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 319-321.*

The application is reported of curved parametric triangular and quadrilateral edge elements, which have been successfully applied in the finite-element method (FEM) in the last 10 years, as basis functions in the moment method (MM) solution of the electric field integral equation (EFIE). In this way, an arbitrarily shaped surface can be modeled more accurately than with conventional planar patches. Consequently, higher accuracy in the numerical solution can mostly be obtained, as demonstrated by numerical examples.

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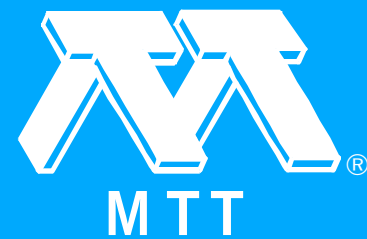


# Abstracts

## FDTD Analysis of Magnetized Ferrites: An Approach Based on the Rotated Richtmyer Difference Scheme

*J.A. Pereda, L.A. Vielva, A. Vegas and A. Prieto. "FDTD Analysis of Magnetized Ferrites: An Approach Based on the Rotated Richtmyer Difference Scheme." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 322-324.*

Electromagnetic wave propagation in magnetized ferrites is modelled by solving Maxwell's time-dependent curl equations coupled with the equation of motion of the magnetization vector. A discretization approach based on the rotated Richtmyer finite-difference scheme is proposed. The new approach has been used to calculate the phase constants of transversally magnetized ferrite-loaded waveguides. The numerical dispersion equation for TE/sub n0/ modes is derived. The results obtained with this approach for a ferrite-filled and a ferrite-slab loaded waveguide are compared with those obtained with Yee's scheme extended for the treatment of ferrites and with the exact results.



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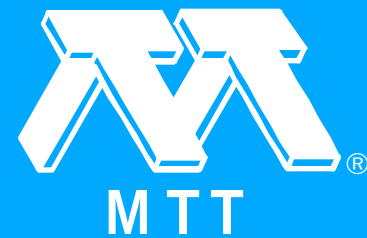


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## A 1.8-W, 6-18-GHz HBT MMIC Power Amplifier with 10-dB Gain and 37% Peak Power-Added Efficiency

*M. Salib, A. Gupta, F. Ali and D. Dawson. "A 1.8-W, 6-18-GHz HBT MMIC Power Amplifier with 10-dB Gain and 37% Peak Power-Added Efficiency." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 325-326.*

A two-stage 6-18-GHz high-efficiency AlGaAs-GaAs HBT MMIC power amplifier has been designed and tested. At 7-V collector bias, this fully matched monolithic amplifier delivered an output power of  $1.8 \pm 0.6$  W over the band. The peak output power was 2.45 W at 13 GHz with an associated gain of 11.1 dB and 36.7% power-added efficiency (PAE). Amplifiers from five different wafers showed similar performance.



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## Analysis of the Transition from Rectangular Waveguide to Shielded Dielectric Image Guide Using the Finite-Difference Time-Domain Method

*N.I. Dib and L.P.B. Katehi. "Analysis of the Transition from Rectangular Waveguide to Shielded Dielectric Image Guide Using the Finite-Difference Time-Domain Method." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 327-329.*

The transition from a rectangular waveguide to a shielded dielectric image guide is analyzed using the finite-difference time-domain (FDTD) method. This method has not been applied to three dimensional dielectric waveguide discontinuities before. The transition problem under consideration demonstrates the ability of the FDTD technique to model rather complex structures where two different transmission media exist. The calculated return loss agrees very well with data obtained using other techniques which validates the application of the FDTD method for this problem.

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## A Microstrip-Based Unit Cell for Quasi-Optical Amplifier Arrays

*N.J. Kolas and R.C. Compton. "A Microstrip-Based Unit Cell for Quasi-Optical Amplifier Arrays." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 330-332.*

A microwave scale model of an amplifying element suitable for millimeter-wave quasi-optical arrays is presented. Power is guided into the amplifier by short sections of waveguide and then fed into a microstrip based MESFET amplifier with an E-field probe. A second E-field probe couples the output signal into a similar waveguide feed on the back-side of the element. The output waveguide is orthogonal to the input to achieve isolation.

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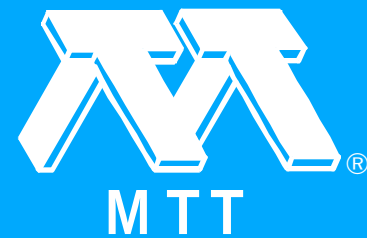


# Abstracts

## Modeling of Nonlinear Active Regions with the FDTD Method

*B. Toland, B. Houshmand and T. Itoh. "Modeling of Nonlinear Active Regions with the FDTD Method." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 333-335.*

The FDTD method is extended to include nonlinear active regions embedded in distributed circuits. The procedures necessary to produce a stable algorithm are described, and a single device cavity oscillator is simulated with this method.



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## Broad-Band Reactive Matching of High-Speed Directly Modulated Laser Diodes

*C.L. Goldsmith and B. Kanack. "Broad-Band Reactive Matching of High-Speed Directly Modulated Laser Diodes." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 336-338.*

The design and demonstration of an octave bandwidth impedance matching network for directly modulated diode lasers is focused upon. Compact semi-lumped matching structures have been designed and fabricated at microwave frequencies with near theoretical performance. The laser was matched to 50  $\Omega$  over the 2--4-GHz band, achieving greater than 13-dB return loss and a dramatic 10-dB improvement in fiber link insertion loss and sensitivity. Excellent agreement was obtained between measured and simulated fiber link performance.

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## Characterization of Planar Antennas Fabricated on GaAs Epilayers Containing as Clusters for Picosecond Short-Pulse Applications

*L. Carin, D.R. Kralij, M.R. Melloch and J.M. Woodall. "Characterization of Planar Antennas Fabricated on GaAs Epilayers Containing as Clusters for Picosecond Short-Pulse Applications." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 339-341.*

Coplanar-strip horn antennas are fabricated on GaAs grown by molecular beam epitaxy at substrate temperatures of 220, 250, and 270° C. These antennas are switched photoconductively using a picosecond laser to generate and detect freely propagating bursts of electromagnetic radiation. The dependence of the antenna performance on substrate growth temperature is assessed and is also compared with the performance of like antennas fabricated on oxygen-bombarded silicon on sapphire. It is shown that in our picosecond measurements the radiated pulse duration is not very sensitive to substrate growth temperature but the radiated intensity is highly sensitive to this parameter.

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# Abstracts

## Patent Abstracts (Sep. 1993 [MGWL])

*"Patent Abstracts (Sep. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 342-350.*



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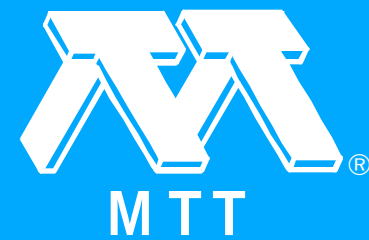
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## Call for Papers - Optical Fiber Communication Conference (Sep. 1993 [MGWL])

*"Call for Papers - Optical Fiber Communication Conference (Sep. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 351-351.*



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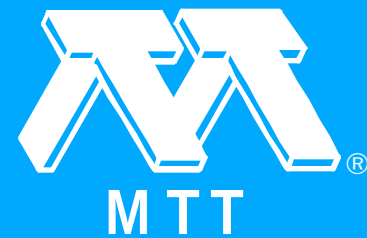
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## Second International Conference on Ultra-Wideband, Short-Pulse Electromagnetics (Advertisement) (Sep. 1993 [MGWL])

*"Second International Conference on Ultra-Wideband, Short-Pulse Electromagnetics (Advertisement) (Sep. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.9 (Sep. 1993 [MGWL]): 352-352.*



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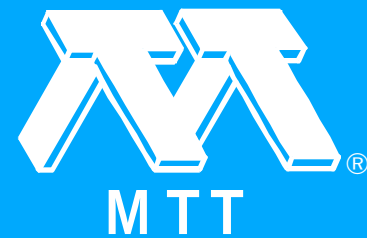


# Abstracts

## Automatic Impedance Matching with a Neural Network

*M. Vai and S. Prasad. "Automatic Impedance Matching with a Neural Network." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 353-354.*

A neural network is developed for the stub-tuning process. The determination of a double-stub solution by means of computer simulation is demonstrated. The applications to in-circuit, real-time microwave impedance matching are suggested.



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## Analysis of a Hemispherical Dielectric Resonator Antenna with an Airgap

*K.-L. Wong, N.-C. Chen and H.-T. Chen. "Analysis of a Hemispherical Dielectric Resonator Antenna with an Airgap." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 355-357.*

A probe-fed hemispherical dielectric resonator antenna with an airgap of hemispherical shape between the dielectric and the ground plane is investigated theoretically by using a Green's function formulation. Input impedance of the efficiently radiating mode of TE/sub 111/ is calculated and analyzed. It is found that, with the presence of the airgap, the antenna bandwidth, obtained from the 3-dB impedance bandwidth, can be considerably enhanced. This study provides a new design for bandwidth enhancement of the dielectric resonator antenna.

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## A 94-GHz Planar Monopulse Receiver

*C.C. Ling and G.M. Rebeiz. "A 94-GHz Planar Monopulse Receiver." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 358-360.*

This letter presents the first results on a 94-GHz integrated monopulse receiver. The receiver is based on a 23-GHz local oscillator driving four separate phase-coherent 94-GHz subharmonic mixers, and performs monopulse processing on the IF signals. All circuits are integrated on a single wafer, and are realized using uniplanar coplanar-waveguide (CPW), slot lines and coplanar striplines (CPS). These features result in a compact, low-cost system suitable for tracking systems operating in poor visibility conditions, as well as in collision avoidance receivers for automotive applications.

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## An Optoelectronic Attenuator for the Control of Microwave Circuits

*S.E. Saddow, B.J. Thedrez and C.H. Lee. "An Optoelectronic Attenuator for the Control of Microwave Circuits." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 361-362.*

An optoelectronic technique suitable for the control of microwave circuits has been demonstrated. Using a coplanar waveguide-photoconductive switch (CPW-PCS), the RF impedance is varied with a laser diode is varied. Using a fiber pigtailed AlGaAs laser diode and a silicon CPW-PCS, it is shown that 30 dB of RF attenuation can be achieved with a laser peak power of 375 mW. Intensity saturation of the Si:CPW-PCS was also observed and characterized to improve the attenuator performance.

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## High-Power 0.15- $\mu\text{m}$ V-Band Pseudomorphic InGaAs-AlGaAs-GaAs HEMT

*R. Lai, M. Wojtowicz, C.H. Chen, M. Biedenbender, H.C. Yen, D.C. Streit, K.L. Tan and P.H. Liu. "High-Power 0.15- $\mu\text{m}$  V-Band Pseudomorphic InGaAs-AlGaAs-GaAs HEMT." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 363-365.*

The dc and RF power performance of double heterostructure pseudomorphic InGaAs-AlGaAs-GaAs HEMT's at V-band is reported. A 0.15- $\mu\text{m}$  x 400- $\mu\text{m}$  device has demonstrated output power of 225 mW (0.55 W/mm) with 4.5-dB power gain and 25.4% PAE at 60 GHz. A 0.15- $\mu\text{m}$  x 320- $\mu\text{m}$  device demonstrated 31.1% PAE with 170 mW (0.53 W/mm) output power and 5.3 dB power gain. These data represent the highest reported combination of output power, power gain and power-added efficiency reported for a single device at V-band.

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## Two-Dimensional MESFET-Based Spatial Power Combiners

*A. Balasubramaniyan and A. Mortazawi. "Two-Dimensional MESFET-Based Spatial Power Combiners." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 366-368.*

A new spatial power combining structure capable of integrating many three terminal devices into two dimension is described. The combiners designed and fabricated using this structure do not suffer from multimoding problems. Effective isotropic radiated powers of 5.54 W and 17.38 W at 10.03 GHz were obtained from an eight and a sixteen MESFET combiner, respectively. These combiners are suitable for monolithic circuit implementation.

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## A Novel Split-Waveguide Mount Design for Millimeter- and Submillimeter-Wave Frequency Multipliers and Harmonic Mixers

*A.V. Raisanen, D. Choudhury, R.J. Dengler, J.E. Oswald and P.H. Siegel. "A Novel Split-Waveguide Mount Design for Millimeter- and Submillimeter-Wave Frequency Multipliers and Harmonic Mixers." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 369-371.*

A novel split-waveguide mount for millimeter and submillimeter wave frequency multipliers and harmonic mixers is presented. It consists of only two pieces, block halves, which are mirror images of each other. The mount provides parallel and series impedance tuning with two sliding backshorts at both the input and output frequencies while utilizing E-plane arms to provide an in-line waveguide input and output. Its fabrication is much easier than that of a traditional multifrequency waveguide mount. Waveguide losses are minimized by a very compact design with very short input and output waveguides. This mount is especially well suited for planar diodes used with microstrip or suspended stripline RF filters.

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## A Vertex-Based Finite-Volume Time-Domain Method for Analyzing Waveguide Discontinuities

*C.H. Chan and J.T. Elson. "A Vertex-Based Finite-Volume Time-Domain Method for Analyzing Waveguide Discontinuities." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 372-374.*

A vertex based finite-volume time-domain method is proposed for analyzing parallel-plate waveguide discontinuities. An irregular grid is chosen so that it can conform linearly to any discontinuity. In this scheme, the electric field vector is located at the vertices of the grid and the magnetic vector is located at the centroids of the elements formed by the grid. Reflection and transmission coefficients are calculated for the TE case. Excellent agreement is obtained for single- and double-step discontinuities when compared with the mode matching method.

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## A Hybrid Spectral/FDTD Method for the Electromagnetic Analysis of Guided Waves in Periodic Structures

*A.C. Cangellaris, M. Gribbons and G. Sohos. "A Hybrid Spectral/FDTD Method for the Electromagnetic Analysis of Guided Waves in Periodic Structures." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 375-377.*

A hybrid spectral/FDTD (finite-difference time-domain) method is introduced for the analysis of electromagnetic wave propagation in anisotropic, inhomogeneous periodic structures. Discrete Fourier series representations for the field components are used for the spectral calculation of spatial derivatives along the axes of periodicity. Thus, the computational domain is restricted to a single period. Maxwell's system is then solved as an initial value problem on a slightly modified FDTD grid for the prediction of the (eigen)frequencies of the propagating modes for a given value of the propagation constant. Numerical results for two-dimensional periodic structures are in excellent agreement with results obtained using other numerical methods.

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## Fast Sequential FDTD Diakoptics Method Using the System Identification Technique

*T.-W. Huang, B. Houshmand and T. Itoh. "Fast Sequential FDTD Diakoptics Method Using the System Identification Technique." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 378-380.*

The sequential finite-difference time-domain (FDTD) Diakoptics method is accelerated by the system identification technique. The time-domain convolution in Diakoptics is replaced by a difference equation with a small number of coefficients. Hence, the memory size is also reduced. The validity of this method is confirmed by comparison with simulated results from Microwave SPICE. The accuracy of this fast algorithm is also demonstrated by the analysis of cascaded circuit modules.

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## A Monolithic 75-110 GHz Balanced InP-Based HEMT Amplifier

*H. Wang, R. Lai, S.T. Chen and J. Berenz. "A Monolithic 75-110 GHz Balanced InP-Based HEMT Amplifier." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 381-383.*

A monolithic balanced amplifier covering the entire W-band (75-110 GHz) have been developed using 0.1- $\mu$ m pseudomorphic InAlAs-InGaAs-InP HEMT technology. This MMIC amplifier demonstrated first pass success with a measured gain of  $23 \pm 3$  dB and good return loss from 75 to 110 GHz. The noise figure of this amplifier is about 6 dB around 94 GHz. To our knowledge, this is the best reported broad-band and high gain performance of the monolithic amplifiers covering the entire W-band.

Click on title for a complete paper.



## Low Power Consumption InAlAs-InGaAs-InP HBT SPDT PIN Diode X-Band Switch

*K.W. Kobayashi, L.T. Tran, S. Bui, J.R. Velebir, A.K. Oki and D.C. Streit. "Low Power Consumption InAlAs-InGaAs-InP HBT SPDT PIN Diode X-Band Switch." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 384-386.*

The results of the first monolithic SPDT X-band PIN diode switch fabricated with InAlAs-InGaAs HBT's lattice matched to InP is reported. The InP-based HBT PIN diode switch achieves similar performance to a GaAs implementation but with half the power consumption. The insertion loss is 0.89 dB and the off-isolation is > 35 dB at 10 GHz. The IP3 is 29.6 dBm while the total power consumption is 10.2 mW. Monolithic integration of PIN diodes with an InP-based HBT process provides monolithic switch functions for use in microwave and millimeter-wave communication systems.

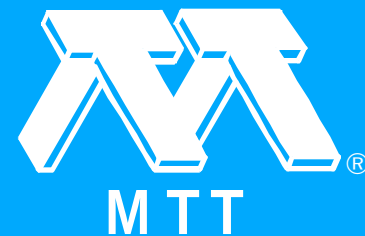


# Abstracts

## An Active Square Loop Frequency Selective Surface

*T.K. Chang, R.J. Langley and E.A. Parker. "An Active Square Loop Frequency Selective Surface." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 387-388.*

An active frequency selective surface incorporating PIN diodes as switches is discussed. Waveguide simulation studies show that the frequency response of the surface can be electronically switched from that of a reflecting structure to a transmitting structure. A semi-empirical model based on a series connected LC equivalent circuit approach gives agreement with measurements.



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## Reflection from Fractal Cantor Layers in a Rectangular Waveguide

*T.J. Cui and C.H. Liang. "Reflection from Fractal Cantor Layers in a Rectangular Waveguide." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 389-391.*

The multilayered medium modeled by a Cantor bar is a type of fractal structure that has found wide applications in some optical and quantum areas. The reflection properties of wave in a rectangular waveguide filled with fractal Cantor bar layers are investigated. By introducing a concept of self-similarity of networks, a novel exact self-similar algorithm for reflection and transmission coefficients is derived. Numerical examples show that the reflection from the fractal layer in a waveguide has some special properties.



# Abstracts

## Patent Abstracts (Oct. 1993 [MGWL])

*"Patent Abstracts (Oct. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 392-399.*



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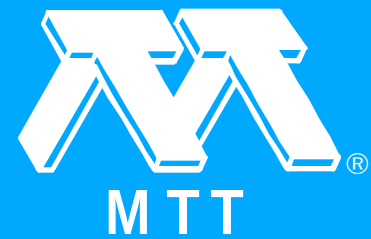
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## Call for Papers - Waves and Microwaves (Oct. 1993 [MGWL])

*"Call for Papers - Waves and Microwaves (Oct. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.10 (Oct. 1993 [MGWL]): 400-400.*



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## Editorial (Nov. 1993 [MGWL])

*S. Maas, T. Itoh and D. Masse. "Editorial (Nov. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 401-401.*

Many of you are wondering why the MTT-Transactions are being sent much later than their issue date. It is because the IEEE Publications Department has switched to electronic publishing as of January 1, 1993; a task which has proven to be more difficult than anticipated. Seventy-eight percent of the IEEE Transactions have switched and many were late. You should have on hand the April issue, and the May issue will be sent in the third week of September. The IEEE Publication Department has hired additional personnel and is using free-lance editors to expedite the process. By the end of the year, we should be back on schedule with the December Special Issue on the International Microwave Symposium being mailed at the beginning of January 1994. A special note will be published in the next MTT Newsletter to explain the publication problems we have encountered.



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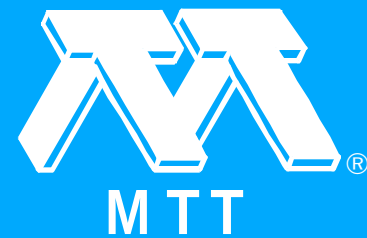


# Abstracts

## Time Reversal in Finite Difference Time Domain Method

*R. Sorrentino, L. Roselli and P. Mezzanotte. "Time Reversal in Finite Difference Time Domain Method." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 402-404.*

A simple modification of Yee's FDTD algorithm allows one to reverse the time direction in FDTD simulation in much the same way as with TLM method. Numerical microwave synthesis is therefore also possible by reversing the time in the FDTD algorithm.



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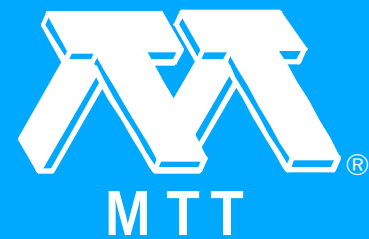
## Experimentally Determined Equivalent Network Scattering Parameters for Edge Slots in Rectangular Waveguide for Use as Reference Data

*D.A. McNamara and J. Joubert. "Experimentally Determined Equivalent Network Scattering Parameters for Edge Slots in Rectangular Waveguide for Use as Reference Data." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 405-407.*

Tabulated, experimentally determined, scattering parameters for edge slots in the narrow wall of rectangular waveguide are given over a range of frequencies. The suggestion is that these tabulated results be used instead of graphs (extant in the literature since the 1940's) from which it is difficult accurately to read off slot properties for comparison with theoretical techniques which may be proffered in future work by others.

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## Equivalent Circuits for MIS Microstrip Discontinuities

*J. Martel, R.R. Boix and M. Horno. "Equivalent Circuits for MIS Microstrip Discontinuities." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 408-410.*

Metal-insulator-semiconductor (MIS) microstrip open-end and microstrip gap discontinuities are characterized by means of equivalent circuits consisting of capacitors and resistors. The circuit parameters of these components are obtained in terms of the complex excess charge densities existing on the conducting strips of the discontinuities. These complex excess charge densities are computed by applying Galerkin's method in the spectral domain. The numerical results obtained for the equivalent circuit parameters of the discontinuities exhibit important variations with frequency, which become specially pronounced in the transition region between the slow-wave mode and the dielectric mode of the MIS microstrip lines involved in the discontinuities.

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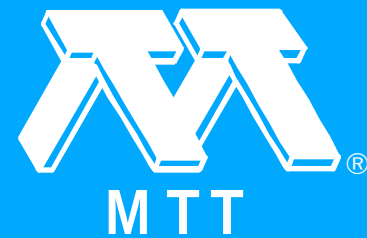


# Abstracts

## A Unique Single-Step Algorithm for Time-Stepping Electromagnetic Fields

*R.F. Bowers and C.H. Chan. "A Unique Single-Step Algorithm for Time-Stepping Electromagnetic Fields." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 411-413.*

A unique algorithm for time-stepping electromagnetic fields is developed that saves a significant amount of computer resources. It is applied to two-dimensional scattering problems and can be applied to any type of grid and finite difference scheme that uses the Yee time-stepping algorithm. The two-step finite difference equations are reduced to a single step which bypasses many redundant calculations. CPU and memory savings are presented.



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# Abstracts

## New Efficient Full Wave Optimization of Microwave Circuits by the Adjoint Network Method

*F. Alessandri, M. Mongiardo and R. Sorrentino. "New Efficient Full Wave Optimization of Microwave Circuits by the Adjoint Network Method." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 414-416.*

For the first time, the adjoint network method, which is well known in the area of circuit theory, is applied directly to the full wave model of microwave circuits. In this manner, the gradient of the objective function, which depends on all geometrical parameters of the microwave structure, is computed by just one full wave analysis, thus reducing dramatically the computational effort required by the optimization.



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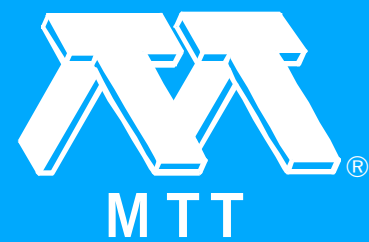
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## Fresnel Zone Plate Reflector Incorporating Rings

*Y.J. Guo and S.K. Barton. "Fresnel Zone Plate Reflector Incorporating Rings." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 417-419.*

A novel high-efficiency Fresnel zone plate reflector antenna is presented. The reflector consists of an inhomogeneous array of circular conducting rings printed on a grounded substrate. By adjusting the geometrical parameters of the rings and the distances between them, the reflector provides a space-varying phase correction required for focusing an incoming plane wave. Compared with a phase reversal zone plate, an average of 3-dB gain improvement and significant sidelobe reduction have been obtained.

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## High-Efficiency InP-Based HEMT MMIC Power Amplifier for Q-Band Applications

*W. Lam, M. Matloubian, A. Kurdoghlian, L. Larson, A. Igawa, C. Chou, L. Jelloian, A. Brown, M. Thompson and C. Ngo. "High-Efficiency InP-Based HEMT MMIC Power Amplifier for Q-Band Applications." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 420-422.*

Advanced millimeter-wave systems require high-efficiency MMIC power amplifiers to reduce physical size, weight, and prime power consumption. A high-efficiency MMIC power amplifier was developed using 0.15  $\mu\text{m}$  InP-based (Al/sub 0.48/In/sub 0.52/As/Ga/sub 0.47/ In/sub 0.53/ As) HEMT MMIC technology. The amplifier demonstrated state-of-the-art power performance, including 33% power-added efficiency and 24 dBm output power at 44 GHz. Potential applications include communication terminals and phased array antennas.

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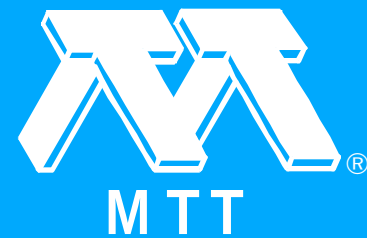


# Abstracts

## FDTD Analysis of an Active Antenna (Nov. 1993 [MGWL])

*B. Toland, J. Lin, B. Houshmand and T. Itoh. "FDTD Analysis of an Active Antenna (Nov. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 423-425.*

The FDTD algorithm is extended to perform a theoretical analysis of a two-element active antenna. A description is given of the procedures that were used to produce a stable large signal simulation of the active, nonlinear circuit. Some results are given and a comparison is made with measured data.



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## Leakage Phenomena in Multilayered Conductor-Backed Coplanar Waveguides

*Y. Liu and T. Itoh. "Leakage Phenomena in Multilayered Conductor-Backed Coplanar Waveguides." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 426-427.*

Leakage phenomena possible in the multilayered conductor-backed CPW's are investigated using the spectral domain technique with a complex root searching procedure. The obtained phase and attenuation constants confirm that the leakage is due to the presence of parallel plate mode which is slower than dominant CPW mode. It is found that the leakage can be controlled by introducing an additional dielectric layer. Two different multilayered structures are given as examples.

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# Abstracts

## Patent Abstracts (Nov. 1993 [MGWL])

*"Patent Abstracts (Nov. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 428-434.*



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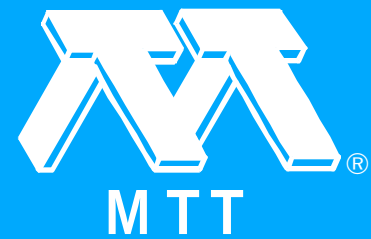
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## Call for Papers - Waves and Microwaves (Nov. 1993 [MGWL])

*"Call for Papers - Waves and Microwaves (Nov. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 435-435.*



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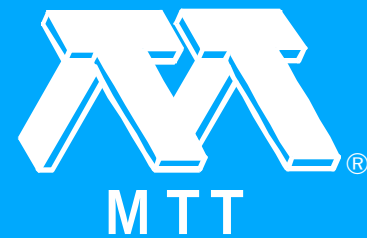
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## Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Nov. 1993 [MGWL])

*"Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Nov. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.11 (Nov. 1993 [MGWL]): 436-436.*



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*"Reviewers (Dec. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): 437-437.*



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## Some Considerations for Using the Finite Difference Time Domain Technique to Analyze Microwave Integrated Circuits

*J. Litva, C. Wu, K.-L. Wu and J. Chen. "Some Considerations for Using the Finite Difference Time Domain Technique to Analyze Microwave Integrated Circuits." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): 438-440.*

In this letter, we described the incorporation of the autoregressive method (AR model) and Litva's dispersive boundary condition (DBC) into the finite-difference time-domain method (FD-TD). It is found that the performance of the FD-TD technique is greatly enhanced when used to simulate microwave passive circuits. The results of this study show that for the analysis of typical high-Q circuits, CPU-time savings of up to 90% can be realized by combining AR model and FD-TD. After testing a number of different 50-ohm microstrip lines, we conclude that DBC shows good performance and gives excellent results when implemented with FD-TD, if the parameters are chosen properly. The use of this boundary condition can result in a considerable improvement in the accuracy of FD-TD simulations. These results help to demonstrate the usefulness of incorporating both the DBC and AR model with the FD-TD algorithm when analyzing practical microwave circuits.

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## A 100 GHz Coplanar Strip Circuit Tuned with a Sliding Planar Backshort

*V.M. Lubecke, W.R. McGrath and D.B. Rutledge. "A 100 GHz Coplanar Strip Circuit Tuned with a Sliding Planar Backshort." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): 441-443.*

A means of mechanically altering the electrical length of a planar transmission line would greatly enhance the use of integrated circuit technology at millimeter and submillimeter wavelengths. Such a mechanically adjustable planar RF tuning element, successfully demonstrated at 100 GHz, is described here. It consists of a thin metallic sheet, with appropriately sized and spaced holes, which slides along on top of a dielectric-coated coplanar-strip transmission line. Multiple RF reflections caused by this structure add constructively, resulting in a movable RF short circuit, with  $|S_{11}| \cong -0.3$  dB, which can be used to vary the electrical length of a planar tuning stub. The sliding short is used here to produce a 2-dB improvement in the response of a diode detector. This tuning element can be integrated with planar circuits to compensate for the effect of parasitic reactance inherent in various devices including semiconductor diodes and superconductor-insulator-superconductor (SIS) junctions.

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## Microwave-Optoelectronic Performance of a Ridged Heterostructure Microstrip Ring Resonator

*G.K. Gopalakrishnan, K. Chang, M.H. Weichold, H.F. Taylor and S.V. Iyer. "Microwave-Optoelectronic Performance of a Ridged Heterostructure Microstrip Ring Resonator." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): 444-446.*

Microwave-optical mixing is accomplished in a ridged heterostructure microstrip ring resonator. When compared to an identical circuit fabricated on semi-insulating GaAs, a 15-dB improvement in conversion loss is achieved.

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## A High Performance and Low DC Power V-Band MMIC LNA Using 0.1 $\mu\text{m}$ InGaAs/InAlAs/InP HEMT Technology

*R. Lai, K.W. Chang, H. Wang, K. Tan, D.C. Lo, D.C. Streit, P.H. Liu, R. Dia and J. Berenz. "A High Performance and Low DC Power V-Band MMIC LNA Using 0.1  $\mu\text{m}$  InGaAs/InAlAs/InP HEMT Technology." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): 447-449.*

We report the design and performance of state-of-the-art V-band MMIC LNA's using 0.1- $\mu\text{m}$  gate length pseudomorphic In/sub 0.60/Ga/sub 0.40/As/In/sub 0.52/Al/sub 0.48/As/InP HEMT's. The three-stage V-band LNA demonstrated an average of 3.0 dB noise figure between 56-64 GHz with 24-25.5 dB associated gain with a noise figure of 2.7 dB measured at 62 GHz. Furthermore, the dc power dissipation of this circuit was only 19.5 mW which is less than one-third the dc power dissipation of InGaAs/AlGaAs/GaAs HEMT versions. These results demonstrate the excellent potential of InP HEMT technology for millimeter-wave and low dc power applications.

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## A Novel Technique for Increasing the Scanning Range of Infinite Arrays of Microstrip Patches

*R.B. Waterhouse. "A Novel Technique for Increasing the Scanning Range of Infinite Arrays of Microstrip Patches." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): 450-452.*

A novel technique to reduce the magnitude of the active reflection coefficient at large scan angles for microstrip patch arrays is proposed. The method involves loading each element of the array with a varactor diode and then varying the bias to the varactor in order to reduce the impedance mismatch at the appropriate scan angle. A rigorous full-wave analysis in conjunction with an equivalent circuit model of the varactor diode was implemented to analyze the proposed loaded patch array. Significant improvement in the scan performance of the array was predicted using this technique.

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## Improved Equivalent Circuit for Determination of MESFET and HEMT Parasitic Capacitances from "COLD FET" Measurements

*P.M. White and R.M. Healy. "Improved Equivalent Circuit for Determination of MESFET and HEMT Parasitic Capacitances from "COLD FET" Measurements." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): 453-454.*

An improved equivalent circuit for MESFET and HEMT devices under zero drain bias pinched-off conditions is proposed. Parasitic gate and drain capacitances evaluated from low-frequency Y parameters using this circuit are approximately equal under conditions where equality would be expected from bond pad geometry considerations. In contrast, the previously used circuit considerably overestimates parasitic drain capacitance.

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## Asia-Pacific Abstracts (Dec. 1993 [MGWL])

*"Asia-Pacific Abstracts (Dec. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): 455-487.*



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*"Patent Abstracts (Dec. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): 488-495.*



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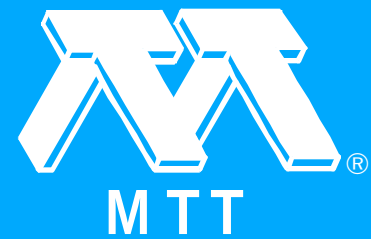
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## Index, IEEE Microwave and Guided Wave Letters, Volume 3, 1993

*"Index, IEEE Microwave and Guided Wave Letters, Volume 3, 1993." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): i1-i15.*



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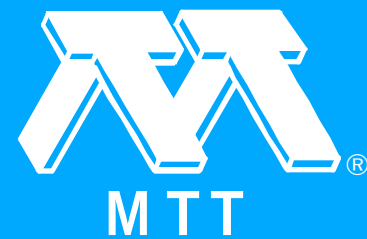
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## Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Dec. 1993 [MGWL])

*"Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Dec. 1993 [MGWL])." 1993 Microwave and Guided Wave Letters 3.12 (Dec. 1993 [MGWL]): bm1-bm1.*



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## Supplement to "Velocity of an RF Pulse Signal Propagating in a Waveguide"

*W. Su, I.M. Besieris and S.M. Riad. "Supplement to "Velocity of an RF Pulse Signal Propagating in a Waveguide"." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 1-5.*

An experiment was conducted in order to investigate the possible differences between velocity measurements based on the leading edge and falling edge of an RF pulse propagating in an air-filled waveguide. The experiment was performed using a test setup identical to that in [1], except that two PSPL Model 5810 pulse amplifiers were used to enhance the signal amplitude. The experimental observations demonstrate that there are no significant propagation velocity differences between leading edge and falling edge measurements.

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## Comparison Between First-Order and Second-Order Optical Phase-Lock Loops

*R.T. Ramos and A.J. Seeds. "Comparison Between First-Order and Second-Order Optical Phase-Lock Loops." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 6-8.*

A comparison between the performance of modified first-order and second-order optical phase-lock loops (OPLL's) is made, revealing that the modified first-order loop offers better performance when long loop delay time is present and a wide bandwidth loop filter is used. The introduction of a 10 dB gain margin from the critical gain can be used to keep the damping close to that expected when the delay time is negligible. If OPLL design is optimized for this gain margin and 5 MHz linewidth lasers are used, the increase in the phase-error variance with delay time is  $54 \text{ rad}^2/\mu\text{s}$  for a modified first-order and  $80 \text{ rad}^2\mu\text{s}$  for a second-order loop, confirming that modified first-order loops are less sensitive to loop delay.

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## Direction-Finding Performance of a Ka-Band ESM Receiver

*E. Boch and M. Stapleton. "Direction-Finding Performance of a Ka-Band ESM Receiver." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 9-10.*

Although development of Electronic Warfare (EW) receivers has begun to address the need to detect millimeter wave radars, very little ESM performance data have been provided to the system engineering community. This has partially been a result of the sensitivity of some millimeter wave applications. This paper provides a sample of direction-finding (DF) measurements derived from tests carried out on an advanced development model (ADM) millimeter wave (28-40 GHz) ESM receiver using an outdoor test range. DF accuracies of 5-6° rms are demonstrated as being readily attainable Ku-band using conventional amplitude comparison monopulse techniques [1-3] combined with high probability-of-intercept and large instantaneous dynamic range.

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## WETD--A Finite Element Time--Domain Approach for Solving Maxwell's Equations

*J.-F. Lee. "WETD--A Finite Element Time--Domain Approach for Solving Maxwell's Equations." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 11-13.*

A family of finite element time-domain methods, WETD(Theta), is derived to solve the time-varying Maxwell's equations. The proposed methodology is based upon the application of the Faedo-Galerkin procedure and the use of the Whitney 1-forms as bases to result in an ordinary differential equation in time for the electric field. Moreover, the resultant ordinary differential equation is solved by employing central and/or backward difference approximations. Since the WETD methods presented here are used in conjunction with tetrahedral finite element meshes, it imposes no limitations on the problem geometry. Also, in this contribution, a general stability condition has been derived for the WETD(Theta) method of which the central and backward differences are special cases corresponding to  $\Theta = 1$  and  $\Theta = 0$ , respectively.

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## 2.0 W CW X-Band GaInP/GaAs Heterojunction Bipolar Transistor

*W. Liu, T. Kim and A. Khatizbadeh. "2.0 W CW X-Band GaInP/GaAs Heterojunction Bipolar Transistor." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 14-16.*

We report 2.0 W CW (continuous wave) output power at 9.5 GHz with a GaInP/GaAs HBT having a total emitter area of  $2 \times 500 \mu\text{m}^2$ . The collector-emitter bias dependence and the frequency dependence of the large-signal performance of both the  $2 \times 400$  and  $2 \times 500 \mu\text{m}^2$  unit cells are described. The uniformity of the output power and power-added efficiency is also discussed.

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## Analytical and Experimental Evaluation of an Optical Fiber Ocean Mass Simulator

*L. Mullen, P.R. Herczfeld and M. Contarino. "Analytical and Experimental Evaluation of an Optical Fiber Ocean Mass Simulator." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 17-19.*

High-power blue-green laser systems are utilized for analyzing ocean parameters and searching for underwater objects. Testing in surveying missions using such systems is time-consuming and expensive. Therefore, an experimental ocean mass simulator is needed to test and perfect new approaches for underwater detection. This simulator must include water effects of attenuation, absorption, and scattering on the transmitted optical pulse. By examining equations and experimental data relating the backscattered signal from optical fiber and from water, correlations are found which qualify the fiber as an efficient ocean mass simulator.

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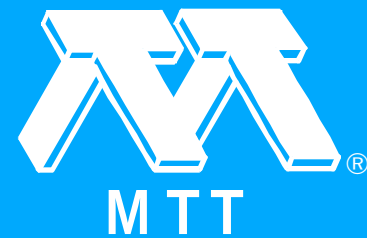


# Abstracts

## A Six-Element Beam-Scanning Array

*P. Liao and R.A. York. "A Six-Element Beam-Scanning Array." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 20-22.*

A six-element beam-scanning coupled MESFET oscillator array was designed and constructed. Resistively loaded transmission line networks were used to strongly couple each oscillator to its two nearest neighbors. Measured H-Plane radiation patterns indicate continuous scanning from -30 to +40 degrees (from broadside).



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## Dispersive Modes in the Time Domain: Analysis and Time-Frequency Representation

*L. Carin, L.B. Felsen, D. Kralj, S.U. Pillai and W.C. Lee. "Dispersive Modes in the Time Domain: Analysis and Time-Frequency Representation." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 23-25.*

Four algorithms for time-frequency (TF) distributions are considered for the processing and interpretation of dispersive time-domain (TD) data: The short-time Fourier transform, frequency and time-domain wavelets, and a new ARMA-based representation. The TF resolutions of the various distributions are discussed and compared with reference to results for the scattered fields from a chirped finite grating excited by a pulsed plane wave. The processing in the TF phase space extracts TD phenomenology, in particular the instantaneous dispersion relation--with its associated time-dependent frequencies--descriptive of the local TD Floquet modes on the chirped truncated grating.

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# Abstracts

## Patent Abstracts (Jan. 1994 [MGWL])

*"Patent Abstracts (Jan. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 26-30.*



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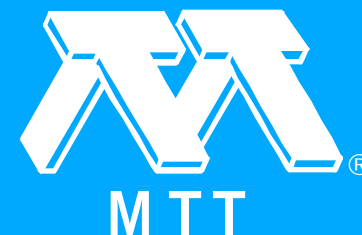
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## Call for Papers - Technologies for Wireless Applications (Jan. 1994 [MGWL])

*"Call for Papers - Technologies for Wireless Applications (Jan. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 31-31.*



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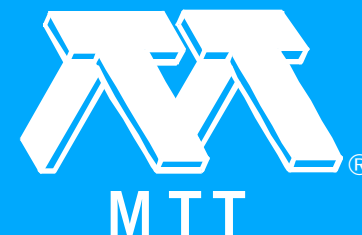
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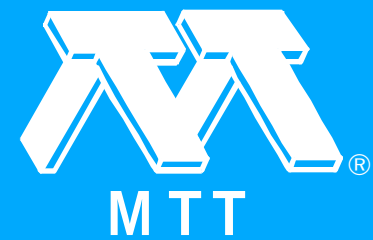
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## 1994 IEEE Prepaid Order Plan (POP) Plus (Advertisement) (Jan. 1994 [MGWL])

*"1994 IEEE Prepaid Order Plan (POP) Plus (Advertisement) (Jan. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): 34-34.*



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*"Back Cover (Jan. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.1 (Jan. 1994 [MGWL]): b1-b2.*



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## A 335 GHz Quasi-Optical Schottky Receiver

*W.Y. Ali-Ahmad and G.M. Rebeiz. "A 335 GHz Quasi-Optical Schottky Receiver." 1994 Microwave and Guided Wave Letters 4.2 (Feb. 1994 [MGWL]): 37-39.*

A quasi-optical Schottky receiver based on an integrated planar antenna-mixer structure has been developed and tested at 335 GHz. The receiver antenna is based on the quasi-integrated horn antenna with 23 dB directivity. At room temperature, the measured DSB antenna-mixer conversion loss and noise temperature at 335 GHz are 8.5 dB and 1750K, respectively. This simple and tunerless design has a noise figure within 1 dB of the best tuned room temperature waveguide mixer using a similar planar GaAs Schottky diode.

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## Beam Propagation Analysis of a Tapered Proton-Exchanged Lithium Niobate Optical Waveguide

*P.-K. Wei, H.-Y. Liu and W.-S. Wang. "Beam Propagation Analysis of a Tapered Proton-Exchanged Lithium Niobate Optical Waveguide." 1994 Microwave and Guided Wave Letters 4.2 (Feb. 1994 [MGWL]): 40-42.*

A simulation of tapered lithium niobate optical waveguide fabricated by the proton-exchanged method is presented. The Fresnel equation with an initial input field distribution is solved numerically using the semivectorial-polarized finite difference method and the Runge-Kutta method. The calculated and experimental results are in good agreement.

Click on title for a complete paper.



## Effect of a Modulated Source on a Multimode Cavity

*J.S. Hong. "Effect of a Modulated Source on a Multimode Cavity." 1994 Microwave and Guided Wave Letters 4.2 (Feb. 1994 [MGWL]): 43-44.*

Based on a 3-D model the effect of a modulated source on a multimode cavity has been investigated. It turns out that the amplitude modulated (AM) and the phase modulated (PM) sources cannot perturb the field distribution. Only the frequency modulated (FM) source can achieve this goal. It is also found that the key factor governing the field perturbation does not lie in shifting the eigenfrequencies and the modal variables, but lies in varying the ratios of the modal variables.



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## Use of Surface Passivation Ledges and Local Negative Feedback to Reduce Amplitude Modulation Noise in AlGaAs/GaAs Heterojunction Bipolar Transistors

*D. Costa and A. Khatibzadeh. "Use of Surface Passivation Ledges and Local Negative Feedback to Reduce Amplitude Modulation Noise in AlGaAs/GaAs Heterojunction Bipolar Transistors." 1994 Microwave and Guided Wave Letters 4.2 (Feb. 1994 [MGWL]): 45-47.*

It is shown that the use of surface passivation ledges and local negative feedback with an unbypassed emitter resistance reduce the AM noise of AlGaAs/GaAs heterojunction bipolar transistors (HBT's). The simultaneous use of both techniques improves the AM noise by 9 dB at 100 Hz offset. The correspondence between reductions in baseband noise and AM noise are described.

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## Conditions for the Equivalence of the Chen and Yee FDTD Algorithms

*K.L. Shlager, S.L. Ray, J.G. Maloney and A.F. Peterson. "Conditions for the Equivalence of the Chen and Yee FDTD Algorithms." 1994 Microwave and Guided Wave Letters 4.2 (Feb. 1994 [MGWL]): 48-49.*

A two-dimensional dispersion analysis of the recently proposed Chen Finite-Difference Time-Domain (FDTD) algorithm is presented and its properties evaluated. The dispersion properties of this scheme vary with respect to propagation angle, Courant stability factor, and the definition of numerical characteristic impedance. These dispersion characteristics can be used to identify parameters that make the Chen algorithm equivalent to the Yee FDTD algorithm.

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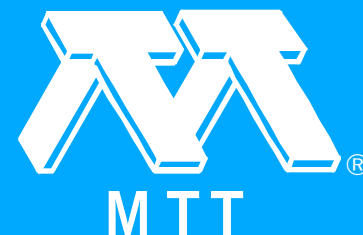


# Abstracts

## U-Band MMIC HBT DRO

*S. Chen, S. Tadayon, T. Ho, K. Pande, P. Rice, J. Adair and M. Ghahremani. "U-Band MMIC HBT DRO." 1994 Microwave and Guided Wave Letters 4.2 (Feb. 1994 [MGWL]): 50-52.*

A 46.3 GHz dielectric resonator stabilized oscillator (DRO) using AlGaAs/GaAs heterojunction bipolar transistor (HBT) and monolithic microwave integrated circuit (MMIC) technology has been designed, fabricated, and characterized. The oscillator exhibits 2.6 dBm output power with 5.870 dc-to-RF efficiency and less than -132 dBc/Hz phase noise at 5 MHz offset from the carrier. To our knowledge, this is the highest frequency oscillator ever reported using HBT devices and MMIC technology.



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*"Patent Abstracts (Feb. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.2 (Feb. 1994 [MGWL]): 53-60.*



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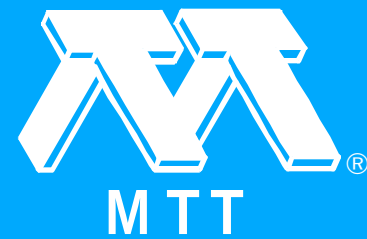
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## Call for Papers - Technologies for Wireless Applications (Feb. 1994 [MGWL])

*"Call for Papers - Technologies for Wireless Applications (Feb. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.2 (Feb. 1994 [MGWL]): 61-61.*



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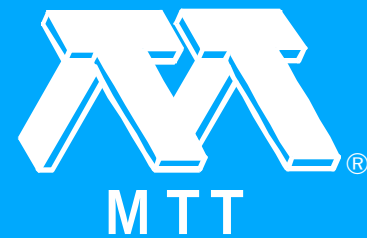
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## Second International Conference on Ultra-Wideband, Short-Pulse Electromagnetics (Announcement) (Feb. 1994 [MGWL])

*"Second International Conference on Ultra-Wideband, Short-Pulse Electromagnetics (Announcement) (Feb. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.2 (Feb. 1994 [MGWL]): 62-62.*



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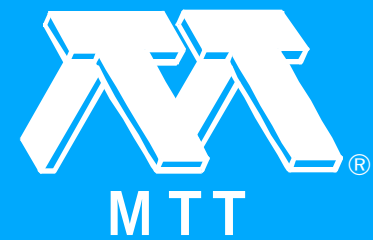
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## Call for Papers - 1994 Asia-Pacific Microwave Conference (Feb. 1994 [MGWL])

*"Call for Papers - 1994 Asia-Pacific Microwave Conference (Feb. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.2 (Feb. 1994 [MGWL]): 63-64.*



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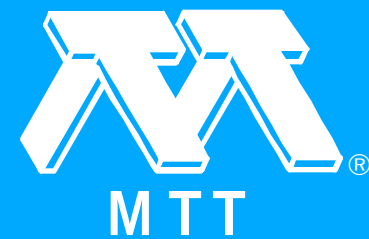
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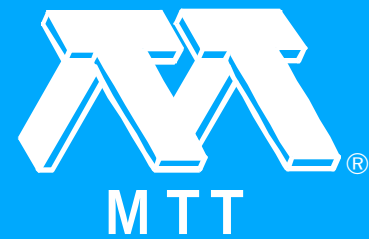
## High-Efficiency HBT MMIC Linear Power Amplifier for L-Band Personal Communications Systems

*T. Yoshimasu, N. Tanba and S. Hara. "High-Efficiency HBT MMIC Linear Power Amplifier for L-Band Personal Communications Systems." 1994 Microwave and Guided Wave Letters 4.3 (Mar. 1994 [MGWL]): 65-67.*

A heterojunction bipolar transistor (HBT) MMIC linear power amplifier is demonstrated for the 1.9 GHz Japanese Personal Handy Phone utilizing the  $\pi/4$  DQPSK modulation technique. At an operating voltage of only 3 V, an output power of 21 dBm and a power added efficiency of 35% are obtained along with a modulation vector error of 4.5% and an adjacent channel interference of -60 dBc in  $\pm 600$  kHz offset frequency bands.

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## Dynamic Range of Semiconductor Laser in the Presence of External Cavity

*T.-D. Ni, X. Zhang and A.S. Daryoush. "Dynamic Range of Semiconductor Laser in the Presence of External Cavity." 1994 Microwave and Guided Wave Letters 4.3 (Mar. 1994 [MGWL]): 68-70.*

This paper presents experimental observations of dynamic range of a laser diode in the presence of external optical feedback. The external cavity provides an efficient frequency response over a narrow band for high frequency carrier signal, while reducing the relative intensity noise for data signals away from the natural resonant frequency. The experimental results show that the spurious free dynamic range can be improved at least by 8 dB using optical feedback over a broad bandwidth. This technique can be used to simultaneously transmit high quality data signal as well as high frequency carrier signal.

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## 24 GHz Serrodyne Frequency Translator Using a 360° Analog CPW MMIC Phase Shifter

*S. Lucyszyn, I.D. Robertson and H. Aghvami. "24 GHz Serrodyne Frequency Translator Using a 360° Analog CPW MMIC Phase Shifter." 1994 Microwave and Guided Wave Letters 4.3 (Mar. 1994 [MGWL]): 71-73.*

A 360° analog CPW MMIC phase shifter is presented for the first time. The compact MMIC employs eight multilayer 3 dB quadrature couplers and was fabricated using low cost GaAs foundry processing techniques. The phase shifter was required to implement a narrow band serrodyne frequency translator at 24 GHz. With an arbitrary, small-shift, frequency translation of +5 KHz, the measured results demonstrated a carrier suppression of 30 dB and an image sideband suppression of 13 dB. This was achieved with a simple linear sawtooth signal, providing 22% of under-modulation. In addition, a 0 dB conversion loss was achieved and almost no control power was required.

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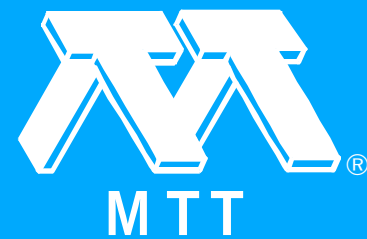


# Abstracts

## An Orthogonal Almost-Periodic Fourier Transform for Use in Nonlinear Circuit Simulation

*P.J.C. Rodrigues. "An Orthogonal Almost-Periodic Fourier Transform for Use in Nonlinear Circuit Simulation." 1994 Microwave and Guided Wave Letters 4.3 (Mar. 1994 [MGWL]): 74-76.*

This letter describes a new Almost-Periodic Fourier Transform (APFT) for use in nonlinear circuit simulation. First, a rigorous APFT theory based on the two norm is summarized. Then, the new transform is introduced. It is simple and fast to implement and the number of sampling points required is usually not much larger than the theoretical minimum. Aliasing effects are minimized with this APFT since the columns of the matrix implementation of its inverse are exactly orthogonal. Finally, results that confirm the performance expected from the theory are presented.



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## Monolithic 23.5 to 94 GHz Frequency Quadruple Using 0.1 $\mu\text{m}$ Pseudomorphic AlGaAs/InGaAs/GaAs HEMT Technology

*H. Wang, K.W. Chang, D.C.W. Lo, K.L. Tan, D. Streit, G.S. Dow and B.R. Allen. "Monolithic 23.5 to 94 GHz Frequency Quadruple Using 0.1  $\mu\text{m}$  Pseudomorphic AlGaAs/InGaAs/GaAs HEMT Technology." 1994 Microwave and Guided Wave Letters 4.3 (Mar. 1994 [MGWL]): 77-79.*

A monolithic 23.5 to 94 GHz frequency quadruple based on 0.1  $\mu\text{m}$  pseudomorphic AlGaAs/InGaAs/GaAs high electron mobility transistor (HEMT) technology has been developed. This frequency quadruple consists of a 23.5 to 47 GHz doubler, a 47 to 94 GHz doubler, and a 47 GHz buffer amplifier between the two doublers. It exhibits a measured conversion loss of 5-7 dB at output frequency from 94 to 98 GHz. To our knowledge, this is the first reported W-band (75-110 GHz) monolithic frequency quadruple using HEMT technology. It can be integrated with 23.5 GHz VCOs to construct low phase noise and stable frequency sources around 94 GHz.

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## Measurement of Radiation Efficiency of Dielectric Resonator Antennas

*R.K. Mongia, A. Ittipiboon and M. Cuhaci. "Measurement of Radiation Efficiency of Dielectric Resonator Antennas." 1994 Microwave and Guided Wave Letters 4.3 (Mar. 1994 [MGWL]): 80-82.*

Radiation efficiency (due to conduction and dielectric losses) of dielectric resonator antennas has been measured. Results show that for dielectric resonators placed directly on a metallic plane, the conduction losses are quite small. A radiation efficiency of  $> 98\%$  has been measured for dielectric resonator antennas operated in the dominant hybrid (HE/sub 11delta) mode. Theoretical considerations show scope of further improvement in the radiation efficiency by choosing optimum resonator parameters.

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## Broadband Faraday Rotation Sections Using Three Ridges

*B.M. Dillon and A.A.P. Gibson. "Broadband Faraday Rotation Sections Using Three Ridges." 1994 Microwave and Guided Wave Letters 4.3 (Mar. 1994 [MGWL]): 83-85.*

Triply-ridged circular waveguide cross-sections are proposed for wideband Faraday rotation applications. Finite element calculations for both the cut-off planes and the phase constants are presented to describe modal behavior. A comparison with the more conventional quadruply-ridged section indicates that there is a significantly increased single-moded bandwidth in the case of the triply-ridged section. In both cases the ridges reduce phase constant dispersion in the dominant pair of degenerate modes to provide broadband Faraday rotation.

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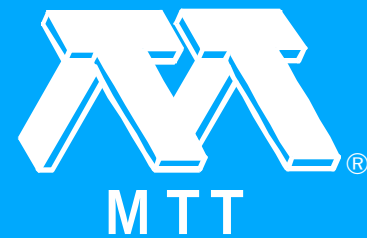


# Abstracts

## A Novel Coplanar Slow-Wave Structure

A. Gorur. "A Novel Coplanar Slow-Wave Structure." 1994 *Microwave and Guided Wave Letters* 4.3 (Mar. 1994 [MGWL]): 86-88.

A novel coplanar slow-wave structure that has the form of interdigitated-meander line is proposed in this letter for use in MMIC's. A simple analysis of this structure has been carried out by using empirical equations available in the literature and with the aid of CAD packages. A propagation velocity of about  $2.8 \cdot 10^8$  m/s was measured. Comparisons between theoretical and experimental results show good agreements.



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## Terahertz-Bandwidth Pulse Propagation on a Coplanar Stripline Fabricated on a Thin Membrane

*H. Cheng, J.F. Whitaker, T.M. Weller and L.P.B. Katehi. "Terahertz-Bandwidth Pulse Propagation on a Coplanar Stripline Fabricated on a Thin Membrane." 1994 Microwave and Guided Wave Letters 4.3 (Mar. 1994 [MGWL]): 89-91.*

An ultra-broadband coplanar stripline employing a durable 1.4- $\mu\text{m}$ -thick membrane substrate has been devised, fabricated, and tested. Nearly distortionless propagation of terahertz-bandwidth electrical pulses over lengths in excess of 4 mm has been experimentally demonstrated using subpicosecond test signals and a sampling measurement technique based on ultrashort-duration laser pulses. A comparison to pulse propagation data on identical coplanar strips on a GaAs substrate illustrates a dramatic improvement in the radiation attenuation and phase velocity dispersion for the membrane CPS with increasing frequency.

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## Patent Abstracts (Mar. 1994 [MGWL])

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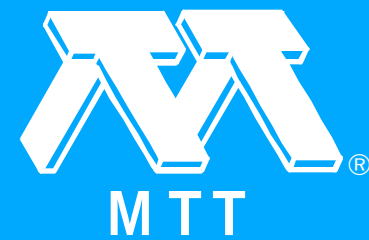
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## Fifth International Symposium on Space Terahertz Technology (Advertisement) (Mar. 1994 [MGWL])

*"Fifth International Symposium on Space Terahertz Technology (Advertisement) (Mar. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.3 (Mar. 1994 [MGWL]): 100-100.*



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## Study of the Effect of the $C_{\text{sub max}}/C_{\text{sub min}}$ Ratio on the Performance of Back-to-Back Barrier-N-N (bbBNN) Varactor Frequency Multipliers

*D. Choudhury, A.V. Raisanen, R.P. Smith and M.A. Frerking. "Study of the Effect of the  $C_{\text{sub max}}/C_{\text{sub min}}$  Ratio on the Performance of Back-to-Back Barrier-N-N (bbBNN) Varactor Frequency Multipliers." 1994 Microwave and Guided Wave Letters 4.4 (Apr. 1994 [MGWL]): 101-103.*

The effect of the  $C_{\text{sub max}}/C_{\text{sub min}}$  ratio on the performance of planar back-to-back Barrier-N-N/sup +/- (bbBNN) frequency multipliers is studied. A simplified physical model of the device is used to relate the electrical characteristics to the material and the structural parameters. Multiplication efficiency is evaluated using a large signal analysis approach. Results indicate that if the optimum device size for a given frequency is used, a high  $C_{\text{sub max}}/C_{\text{sub min}}$  ratio results in high efficiency.







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## A New Nonlinear I(V) Model for FET Devices Including Breakdown Effects

*J.P. Teyssier, J.P. Viaud and R. Quere. "A New Nonlinear I(V) Model for FET Devices Including Breakdown Effects." 1994 Microwave and Guided Wave Letters 4.4 (Apr. 1994 [MGWL]): 104-106.*

The nonlinear FET I(V) behavior, including gate conduction and breakdown, has been investigated using a pulse measurement setup. An excessive current source has been observed in addition to the usual gate breakdown current. From these measurements, a nonlinear model including the conduction, breakdown, and excessive current phenomenon is proposed for the nonlinear simulation of high-power circuits. This I(V) model presents an improvement in terms of load line prediction and limits for the high-power nonlinear circuit design.

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## The Capacitance of a Small Circular Schottky Diode for Submillimeter Wavelengths

*J.T. Louhi. "The Capacitance of a Small Circular Schottky Diode for Submillimeter Wavelengths." 1994 Microwave and Guided Wave Letters 4.4 (Apr. 1994 [MGWL]): 107-108.*

The capacitance of a small-area circular submillimeter wave diode is strongly affected by the edge effect of the charged anode. The correction factor due to the edge effect cannot be obtained analytically and the capacitance of a circular diode must be calculated using numerical methods. In this work a new, numerically derived formula for the junction capacitance of a small circular diode is presented.

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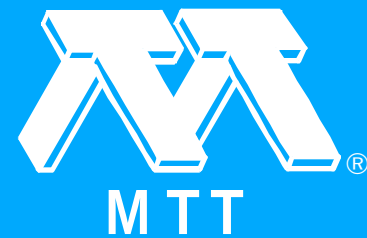


# Abstracts

## Floquet-Based FDTD Analysis of Two-Dimensional Phased Array Antennas

*J. Ren, O.P. Gandhi, L.R. Walker, J. Fraschilla and C.R. Boerman. "Floquet-Based FDTD Analysis of Two-Dimensional Phased Array Antennas." 1994 Microwave and Guided Wave Letters 4.4 (Apr. 1994 [MGWL]): 109-111.*

The finite-difference time-domain method with Floquet boundary conditions has been used to calculate the radiation characteristics of one- and two-dimensional phased array antennas for different scan angles in E- and H-planes. Considerable savings in computer memory and computation time are realized since only the central 3 elements for a 1-D array and 3 x 3 elements for a 2-D array are to be modeled.



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## Planar Amplifier Array with Improved Bandwidth Using Folded-Slots

*H.S. Tsai, M.J.W. Rodwell and R.A. York. "Planar Amplifier Array with Improved Bandwidth Using Folded-Slots." 1994 Microwave and Guided Wave Letters 4.4 (Apr. 1994 [MGWL]): 112-114.*

Active antennas on semiconductor substrates often suffer limited bandwidth. We report on a relatively broadband quasi-optical amplifier cell and 4x4 array using folded-slot antennas, suitable for monolithic power combining. Two orthogonally polarized cpw-fed folded slots are coupled to the input and output ports of a simple resistive feedback MESFET amplifier. The peak effective isotropic power gain in the transmission mode is 11 dB @ 4.3 GHz with 10% bandwidth for the single cell, a factor-of-ten improvement in bandwidth over a similar amplifier cell using patch antennas, and 32 dB @ 4.24 GHz with 8% bandwidth for the array.

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## Electrooptic Phase Tracking of Microwave Signals Beyond 18.5 GHz Using an Integrated Electrooptic Modulator as an Optoelectronic Harmonic Mixer in a Phase Lock Loop

*C.-L. Pan, G.-R. Lin, D.-Y. Chyou and H.-H. Wu. "Electrooptic Phase Tracking of Microwave Signals Beyond 18.5 GHz Using an Integrated Electrooptic Modulator as an Optoelectronic Harmonic Mixer in a Phase Lock Loop." 1994 Microwave and Guided Wave Letters 4.4 (Apr. 1994 [MGWL]): 115-117.*

We demonstrate electrooptic phase tracking of microwave signals beyond 18.5 GHz using a gain-switched laser diode as the optical clock. The key element of this system is a fiber-pigtailed integrated-optic Mach-Zehnder Modulator (IOM). The IOM functions as an optoelectronic harmonic mixer in a phase lock loop. The conversion loss of the OEHM is 66dB. The phase error and the single sideband phase noise density of the phase-locked 18.5 GHz signal is  $5.6 \times 10^{-5}$  rad/sqrt(Hz) and -54 dBc/Hz, respectively.





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## 500-GHz Characterization of an Optoelectronic S-Parameter Test Structure

*M.Y. Frankel. "500-GHz Characterization of an Optoelectronic S-Parameter Test Structure." 1994 Microwave and Guided Wave Letters 4.4 (Apr. 1994 [MGWL]): 118-120.*

We propose a compact, high-bandwidth optoelectronic S-parameter test structure and characterize its performance via electrooptic sampling over a 500-GHz frequency range. The test structure is shown to be well-behaved over a 300-GHz bandwidth, with further improvement potential. Active devices can be wirebonded into the structure for characterization, or they can be integrated on-wafer for improved performance.

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*"Patent Abstracts (Apr. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.4 (Apr. 1994 [MGWL]): 121-125.*



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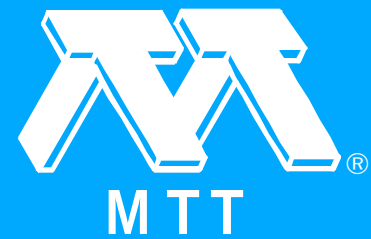
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## Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Apr. 1994 [MGWL])

*"Call for Papers - Emerging Commercial and Consumer Circuits, Systems and Their Applications (Apr. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.4 (Apr. 1994 [MGWL]): 126-126.*



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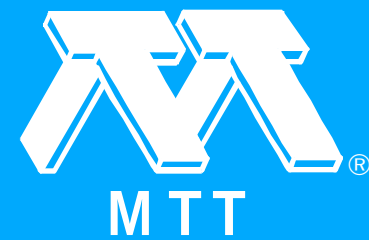




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## Call for Papers - Technologies for Wireless Applications (Apr. 1994 [MGWL])

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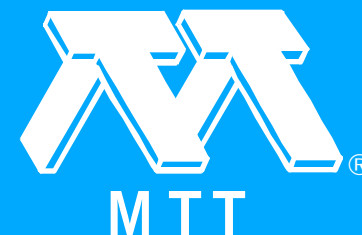
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## A New Quasi-Optical Oscillator with Gaussian Output Beam

*M. Kiyokawa and T. Matsui. "A New Quasi-Optical Oscillator with Gaussian Output Beam." 1994 Microwave and Guided Wave Letters 4.5 (May 1994 [MGWL]): 129-131.*

An oscillator, with a new quasi-optical resonator, called a Gaussian-beam oscillator, is described. The resonator consists of a plane mirror substrate and a concave spherical mirror with a highly reflective, partially transparent region. A high Q factor, obtained by this spherical mirror, results in a low phase noise of the oscillator and the output power is extracted from this region as a Gaussian beam. This oscillator also features an active circuit fabricated behind the resonator. The configuration is suitable for millimeter-wave integrated circuits. Experimental validity is carried out from an X-band prototype.

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## Propagation Characteristics of Monolithic YBaCuO Coplanar Strip Transmission Lines Fabricated by Laser-Writing Patterning Technique

W.N. Maung, D.P. Butler, W. Xiong, W. Kula and R. Sobolewski. "Propagation Characteristics of Monolithic YBaCuO Coplanar Strip Transmission Lines Fabricated by Laser-Writing Patterning Technique." 1994 Microwave and Guided Wave Letters 4.5 (May 1994 [MGWL]): 132-134.

We report our studies on the propagation characteristics of YBa/sub 2/ Cu/sub 3/O/sub 7/-on-LaAlO/sub 3/ superconducting coplanar strip transmission lines and resonators fabricated with a novel laser-writing patterning technique. The measurements were performed in the 0.1 to 15 GHz frequency range at temperatures between 300 and 24 K. We show that at temperatures below the superconducting critical temperature, the S/sub 21/ parameter of our transmission lines was close to 0 dB at all the frequencies, while the Q-factor of the resonator structure was as high as 5000 at 6 GHz and 24 K. The transmission line propagation velocity was about 10/sup 8/ cm/s. Our results indicate that the laser-writing patterning technique can be effectively used to fabricate high-quality superconducting microwave elements and circuits.

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## A 100-GHz Monolithic Cascode InAlAs/InGaAs HEMT Oscillator

*Y. Kwon, D. Pavlidis, P. Marsh, T. Brock and D.C. Streit. "A 100-GHz Monolithic Cascode InAlAs/InGaAs HEMT Oscillator." 1994 Microwave and Guided Wave Letters 4.5 (May 1994 [MGWL]): 135-137.*

The design, fabrication, and experimental characteristics of a 100-GHz monolithic cascode HEMT oscillator are presented. A cascode pair of InAlAs/InGaAs HEMT's has been used as the active cell to enhance the negative resistance so that more process tolerance can be achieved. The monolithic circuit oscillates around 100 GHz with an output power of 2 dBm at a drain bias voltage as small as 0.9 V. This is the first demonstration of cascode HEMT oscillators at W-band.

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## Stability Analysis of Analog Frequency Dividers in the Quasi-Periodic Regime

A. Suarez, J.C. Sarkissian, R. Sommet, E. Ngoya and R. Quere. "Stability Analysis of Analog Frequency Dividers in the Quasi-Periodic Regime." 1994 Microwave and Guided Wave Letters 4.5 (May 1994 [MGWL]): 138-140.

A simulation technique allowing the determination of all the steady state regimes of synchronized devices, including the quasi-periodic operation, is presented here. Combined with a continuation method, it provides the circuit quasi-periodic solution paths as a function of any parameter of interest. The different bifurcation loci on a two-parameters space, obtained here both from periodic and quasi-periodic simulations, allow an easy prediction and deep understanding of the circuit behavior. By means of the proposed method, the possible working regimes of a M.M.I.C analog frequency divider have been determined and experimentally confirmed.

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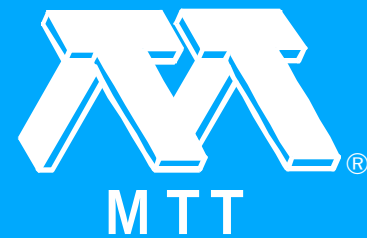


# Abstracts

## The Use of SPICE Lumped Circuits as Sub-Grid Models for FDTD Analysis

*V.A. Thomas, M.E. Jones, M. Piket-May, A. Taflove and E. Harrigan. "The Use of SPICE Lumped Circuits as Sub-Grid Models for FDTD Analysis." 1994 Microwave and Guided Wave Letters 4.5 (May 1994 [MGWL]): 141-143.*

A general approach for including lumped circuit elements in a finite difference, time domain (FDTD) solution of Maxwell's equations is presented. The methodology allows the direct access to SPICE to model the lumped circuits, while the full 3-Dimensional solution to Maxwell's equations provides the crosstalk and dispersive properties of the microstrips and striplines in the circuit.



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## Finite-Difference Time-Domain (FDTD) Analysis Using Distributed Computing

*V. Varadarajan and R. Mittra. "Finite-Difference Time-Domain (FDTD) Analysis Using Distributed Computing." 1994 Microwave and Guided Wave Letters 4.5 (May 1994 [MGWL]): 144-145.*

This paper describes an implementation of the Finite-Difference Time-Domain FDTD calculations using PVM [Parallel Virtual Machine] 3.2 and a cluster of workstations for a test problem involving a three-dimensional rectangular cavity. It is found that the speedup factors achieved in FDTD calculations can approach the maximum values for large problem sizes if the computation-to-communication ratios are maintained at values significantly greater than unity. It is also found that in order to achieve linear speedups, the problem sizes should be increased with the number of processors while adequate computation-to-communication ratios are maintained in the individual processors. The results demonstrate the potential of parallel distributed computing for FDTD calculations in Electromagnetic.

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## A Novel Heterojunction Bipolar Transistor Active Feedback Design

*K.W. Kobayashi, A.K. Oki, L.T. Tran, J.R. Velebir and D.C. Streit. "A Novel Heterojunction Bipolar Transistor Active Feedback Design." 1994 Microwave and Guided Wave Letters 4.5 (May 1994 [MGWL]): 146-148.*

This paper reports on the results of a novel active feedback amplifier design using Heterojunction Bipolar Transistors. The design incorporates positive feedback to increase the gain bandwidth response by as much as 50 %. The active feedback amplifier achieves a gain of 13.8 dB and a 3-dB bandwidth of 15.6 GHz. The active feedback is economical in size in comparison to a spiral inductor implementation. In addition, the active feedback network includes a means for electronically tuning the active feedback circuit in order to adjust the bandwidth response. A two-stage design achieves a tuneable bandwidth from 4-10 GHz with a fixed gain of 20 dB. The tuneability that this design offers is a convenient means for recovering from gain and bandwidth degradation due to process variation and fixture parasitic.

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## Short-Pulse Radiation with Low Cross-Polarization and a Related New Pulse Ringing Phenomenon in a Printed Antenna Element Covered by a Polarization Strip Grating

*A. Mohanty and N.K. Das. "Short-Pulse Radiation with Low Cross-Polarization and a Related New Pulse Ringing Phenomenon in a Printed Antenna Element Covered by a Polarization Strip Grating." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 157-159.*

Suppression of unwanted cross-polar radiation from a printed antenna element by placing a printed strip-grating on top is demonstrated for short-pulse radiation. It is discovered that an interesting pulse ringing effect occurs due to a new "grating resonance." A full-wave analysis is outlined that models the effect of the strip grating placed on top of a microstrip antenna element and predicts the new pulse-ringing effect.



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## FDTD Multimode Characterization of Waveguide Devices Using Absorbing Boundary Conditions for Propagating and Evanescent Modes

*L.A. Vielva, J.A. Pereda, A. Prieto and A. Vegas. "FDTD Multimode Characterization of Waveguide Devices Using Absorbing Boundary Conditions for Propagating and Evanescent Modes." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 160-162.*

The characterization of microwave devices by means of the FDTD method is highly dependent on the availability of suitable absorbing boundary conditions. This letter presents absorbing boundary conditions that are particularly appropriate for the analysis of waveguide devices because both propagating and evanescent modes are absorbed. Additionally, the modal decomposition of the total field provided by FDTD is shown to constitute an alternative procedure to frequency domain methods in the wideband multimode characterization of microwave devices.

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## FDTD Signal Extrapolation Using the Forward-Backward Autoregressive (AR) Model

*V. Jandhyala, E. Michielssen and R. Mittra. "FDTD Signal Extrapolation Using the Forward-Backward Autoregressive (AR) Model." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 163-165.*

In this paper, the forward-backward autoregressive model is employed to extrapolate time domain signatures generated by the Finite Difference Time Domain algorithm with a view to speeding up the process of obtaining the frequency responses of EM systems. It is shown that the present method requires considerably lower-order predictors than those needed in other AR models, e.g., those based on Yule-Walker equations, and is therefore computationally efficient.

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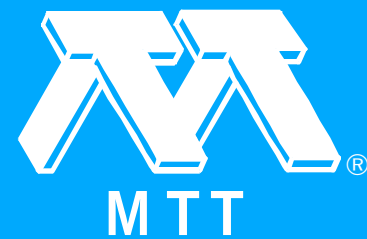


# Abstracts

## Electronic Beamsteering of Active Arrays with Phase-Locked Loops

*R.D. Martinez and R.C. Compton. "Electronic Beamsteering of Active Arrays with Phase-Locked Loops." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 166-168.*

A new electronic beamsteering technique for active arrays is presented along with experimental results at 10 GHz. The technique uses a single balanced diode mixer to phase-lock neighboring oscillators in an active array. Each oscillator has its own antenna that radiates energy into free space, so the phase difference between oscillators determines the direction of the main radiating beam. An offset voltage added to the phase-locked loop controls the phase difference and beam direction. Experimental results demonstrate over 100° of adjustable phase difference between neighboring oscillators. Because of its simplicity, this technique has significant advantages over traditional beamsteering arrays.



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## FDTD Analysis of Magnetized Ferrites: A More Efficient Algorithm

*M. Okoniewski and E. Okoniewska. "FDTD Analysis of Magnetized Ferrites: A More Efficient Algorithm." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 169-171.*

A more efficient FDTD algorithm is introduced for the analysis of structures involving magnetized ferrites. A critical issue of time and space synchronism ensuring second order accuracy is discussed, and a method to provide it based on extrapolation rather than interpolation used by previous authors is presented. Numerical examples validating the method are given.

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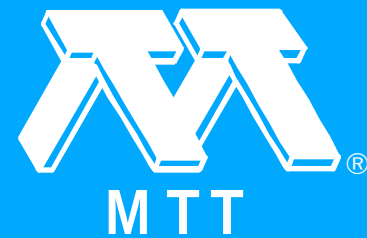


# Abstracts

## Variable Impedance Tuner for MMIC's

*W. Bischof. "Variable Impedance Tuner for MMIC's." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 172-174.*

A monolithic structure is presented for the tuning of MMIC's. With this tuner, either process deviations can be compensated or circuit parameters can be altered to meet different requirements. Measured results of a realized tuner agree well with the simulated model. Key design parameters are listed and a theoretical application for a narrow band amplifier at 27 GHz is simulated.



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## On-Wafer Measurement Impedance Lossy Substrates

*D.F. Williams and R.B. Marks. "On-Wafer Measurement Impedance Lossy Substrates." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 175-176.*

This paper introduces a new method for measuring impedance parameters in transmission lines fabricated on lossy or dispersive dielectrics. The method, which uses an independent calibration to provide an impedance reference, compares well with conventional techniques when applied to lossless substrates. The effectiveness of the technique is illustrated for resistors fabricated on lossy silicon substrates.

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## Time Domain Characterization of Lossy Arbitrary Characteristic Impedance Transmission Lines

*P. Ferrari, B. Flechet and G. Angenieux. "Time Domain Characterization of Lossy Arbitrary Characteristic Impedance Transmission Lines." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 177-179.*

This paper deals with the characterization of lossy transmission lines. The method developed here delivers the complex propagation constant gamma of any arbitrary length and characteristic impedance transmission line, embedded in an arbitrary environment. This approach is based upon time domain analysis of short pulse propagation. Measurements are done with a commercial digital sampling oscilloscope. Only two transmission lines of different lengths are required in order to extract gamma and to correct systematic errors of the measurement system. The problem of random errors is also addressed. The method is demonstrated with microstrip lines. A comparison of the developed technique with an other existing time domain approach and a classical frequency domain extraction is also carried out.

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## A New Frequency Domain Symmetrical Condensed TLM Node

*P. Berini and K. Wu. "A New Frequency Domain Symmetrical Condensed TLM Node." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 180-182.*

This paper reports the development of a new symmetrical condensed TLM node derived directly in the frequency domain. The new node can accommodate a graded mesh and can model lossy anisotropic media described by a static conductivity tensor along with complex permittivity and complex permeability tensors. The frequency domain TLM method is used to generate modal dispersion curves for m Wave and mm Wave guiding structures. The results compare the new node to existing time domain symmetrical condensed nodes.

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## Experimental Investigation on the Optical Unbalanced Mach-Zehnder Interferometers as Microwave Filters

*A.H. Quoc and S. Tedjini. "Experimental Investigation on the Optical Unbalanced Mach-Zehnder Interferometers as Microwave Filters." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 183-185.*

In this work, we study the propagation effects of a modulated lightwave signal in an unbalanced Mach-Zehnder interferometer (UMZI). Experimental results of the microwave frequency response of the structure are obtained using two lightwave network analyzers HP8702A and HP8510B with an optoelectronic HP83420A. It is shown that such an optical device could be used to perform a number of interesting microwave applications. The problems appearing in the coherent working regime and the possibility of integrated device realizations for millimeter-frequency signal processing are also discussed.

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## Photoconductive Step-Function Sampling

*J.-H. Son, J. Kim and G.A. Mourou. "Photoconductive Step-Function Sampling." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 186-188.*

Measurement of picosecond electrical signals using a photoconductive step-function gate is demonstrated analytically and experimentally. The time resolution of our step-function technique is limited only by the rise time of the step-function, which is approximately the same as the laser pulse width. Also, a regular, undoped semiconductor material, which is essential for the realization of a short-duration gate, can be used instead of the highly defected material. The use of undoped material gives 10 to 100 times higher sensitivity in the measurement than the impulse-function technique because of the high mobility of the undoped material.

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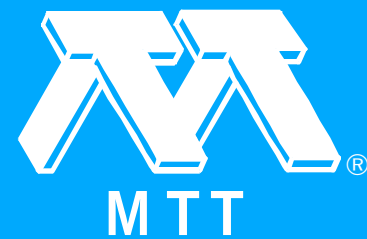


# Abstracts

## Modified Time-Domain-Scattering-Parameter Formulation for Incident and Reflected Waves on Lossless, Nonuniform Transmission Lines

C.-W. Hsue. "Modified Time-Domain-Scattering-Parameter Formulation for Incident and Reflected Waves on Lossless, Nonuniform Transmission Lines." 1994 *Microwave and Guided Wave Letters* 4.6 (Jun. 1994 [MGWL]): 189-190.

A DC steady state voltage is decomposed into two waves traveling in opposite directions of a lossless, nonuniform transmission line. Such a two-traveling-wave representation for a DC charged line is employed to modify the time-domain-scattering parameter formulation of a lossless, nonuniform transmission line having nonzero initial condition as well as nonlinear terminations.



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## Large-Signal Stability and Spectrum Characterization of a Medium Power HBT Using Active Load-Pull Techniques

*F.M. Ghannouchi, F. Beaugard and A.B. Kouki. "Large-Signal Stability and Spectrum Characterization of a Medium Power HBT Using Active Load-Pull Techniques." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 191-193.*

Large-signal stability and spectrum characterizations of a half-Watt HBT at 2 GHz for a class AB bias point are reported in this letter. Constant power, constant power-added efficiency, constant current gain contours, and second and third harmonic generation level contours over the whole Smith chart are presented. The characterization setup is an automated high power, multi-harmonic, active load-pull system that is based on six-port techniques and frequency discrimination using a controlled band pass YIG filter.

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## A Monolithically Integrated 120-GHz InGaAs/InAlAs/InP HEMT Amplifier

*R. Lai, H. Wang, K.L. Tan, D.C. Streit, P.H. Liu, J. Velebir, Jr., S. Chen, J. Berenz and M.W. Pospieszalski. "A Monolithically Integrated 120-GHz InGaAs/InAlAs/InP HEMT Amplifier." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 194-195.*

We report the design and gain performance for a two-stage 120-GHz monolithically integrated amplifier using 0.1- $\mu\text{m}$  gate length pseudomorphic In/sub 0.60/Ga/sub 0.40/As/In/sub 0.52/Al/sub 0.48/As/InP HEMT's. The two-stage amplifier demonstrated 10-12 dB gain measured between 119.5 to 123.5 GHz. To the best of our knowledge, this is the first demonstration of a monolithically integrated InP HEMT amplifier reported at D-band.

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## Multilayer Offset Fresnel Zone Plate Reflector

*Y.J. Guo, I.H. Sassi and S.K. Barton. "Multilayer Offset Fresnel Zone Plate Reflector." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 196-198.*

An offset phase-correcting Fresnel zone plate (FZP) reflector antenna based on the multilayer configuration is presented. The reflector consists of a conducting ground and four layers of conducting patterns separated by four dielectric substrates. An experimental prototype designed at 10.39 GHz was fabricated and tested. With a 0.32 m by 0.34 m elliptical reflector aperture and a pyramidal feedhorn, the antenna achieved -20-dB sidelobe level and 61% maximum efficiency. Compared with a phase reversal FZP of the same size, a 3.3-dB gain improvement and significant sidelobe reduction were obtained.

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## Meander-Line Polarizer for Arbitrary Rotation of Linear Polarization

*T.-K. Wu. "Meander-Line Polarizer for Arbitrary Rotation of Linear Polarization." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 199-201.*

A versatile meander-line polarizer is described and demonstrated for arbitrary rotation of linear polarization. This polarizer consists of eight-layer meander-line grids with rigid foam spacers between any two layers. It is shown that the field polarization rotation angle through this meander-line polarizer is twice the angle between the incident polarization and the polarizer grating lines. Hence, any polarization rotation can be accomplished by a simple mechanical rotation of this low-mass polarizer instead of rotating or modifying the much heavier antenna and its complex feed components.







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## Rigorous Analysis of an Aperture-Coupled Microstrip Antenna Fed by a Microstrip Line on a Perpendicular Substrate

*N.K. Das. "Rigorous Analysis of an Aperture-Coupled Microstrip Antenna Fed by a Microstrip Line on a Perpendicular Substrate." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 202-204.*

A rigorous analysis of an aperture-coupled microstrip antenna fed from a perpendicular microstrip line has been developed. A hybrid spectral/space-domain method is used, along with a general reciprocity formulation, to model the perpendicular microstrip feeding. Experimental results for a prototype model are compared with computed results, showing good agreements.

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## Oscillator Design for Maximum Added Power

*B.K. Kormanyos and G.M. Rebeiz. "Oscillator Design for Maximum Added Power." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 205-206.*

We report on a linearized technique for the determination of embedding networks that maximize the added power in a two-port oscillator design. The embedding networks are similar to the optimum networks presented by Kotzebue, but they are determined without the assumption of a constant voltage at the input port of the active device. The method presented here will result in a more accurate determination of the embedding networks for maximum power output from a device with a given set of two-port parameters.

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## Patent Abstracts (Jun. 1994 [MGWL])

*"Patent Abstracts (Jun. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 208-213.*



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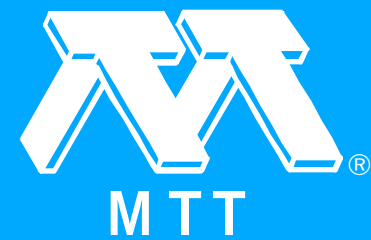
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*"Call for Papers - Microwave and Millimeter-Wave Photonics (Jun. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 214-214.*



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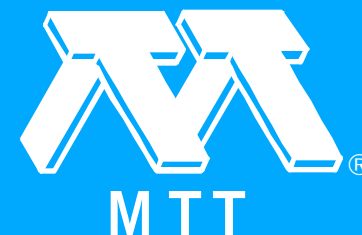
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*"IEEE Member Get a Member Program (Advertisement) (Jun. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 215-215.*



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## The 1994 IEEE Prepaid Order Plan (POP) (Advertisement) (Jun. 1994 [MGWL])

*"The 1994 IEEE Prepaid Order Plan (POP) (Advertisement) (Jun. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): 216-216.*



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*"Back Cover (Jun. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.6 (Jun. 1994 [MGWL]): b1-b2.*



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*"Front Cover (Jul. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): f1-f2.*



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## A Balanced Ka-Band GaAs FET MMIC Frequency Doubler

*M. Abdo-Tuko, R. Bertenburg and I. Wolff. "A Balanced Ka-Band GaAs FET MMIC Frequency Doubler." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 217-219.*

A simplified and miniaturized state-of-the-art balanced GaAs FET MMIC frequency doubler operating at 36 GHz has been designed and realized in coplanar waveguide technology. The passive part of the circuit is designed using an effective, in-house developed quasi-static finite-difference method for the analysis of coplanar structures while the active device is characterized by using the Curtice-Ettenberg model. The model makes use of the measured electrical values of the transistor and interpreted them through approximate empirical formulas. The results obtained demonstrate that by using simple models, which require very little computation time, it is possible to design an efficient frequency doubler in the Ka-band with a maximum conversion gain of 3 to 6 dB, without the need of using complicated transistor models or circuitry.





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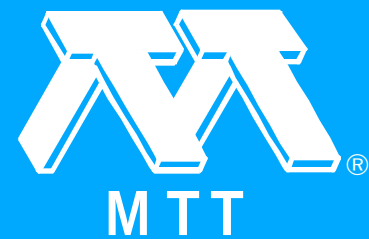
## A Traveling-Wave Resonant Tunnel Diode Pulse Generator

*R.Y. Yu, Y. Konishi, S.T. Allen, M. Reddy and M.J.W. Rodwell. "A Traveling-Wave Resonant Tunnel Diode Pulse Generator." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 220-222.*

Traveling-wave resonant tunnel diode (TWRTD) pulse generators comprising transmission lines periodically loaded by GaAs/AlAs resonant tunnel diodes (RTD's) are fabricated. The TWRTD pulse generators have convolved transition times of 3.5 ps when measured with an active probe. Using identical RTD's, TWRTD pulse generators can attain smaller transition times than those obtained with switching circuits employing a single RTD.

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## A Moment Method Analysis of a Folded E-Plane Short in Rectangular Waveguide

*J. Joubert. "A Moment Method Analysis of a Folded E-Plane Short in Rectangular Waveguide." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 223-225.*

A folded E-plane waveguide short is analyzed using a moment method formulation. A comparison of the numerical convergence of the method is shown for two different sets of basis functions: trigonometric aperture waveguide modes and weighted Gegenbauer polynomials. The theory is verified by measurements of a folded short in half-height X-band rectangular waveguide.

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## 20-GHz Power Combining Slot-Oscillator Array

*B.K. Kormanyos and G.M. Rebeiz. "20-GHz Power Combining Slot-Oscillator Array." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 226-228.*

A four-element power-combining array of quasi-optical slot oscillators has been constructed at 20 GHz. The array is placed on a dielectric substrate lens to increase the directivity and the effective isotropic radiated power (EIRP). The array delivers a total power output of 68 mW with an effective isotropic radiated power of 4.4 W. The DC to RF efficiency of the array is 12%. The substrate lens approach provides a planar design that eliminates substrate mode problems and, therefore, is easily scaled to millimeter-wave frequencies.

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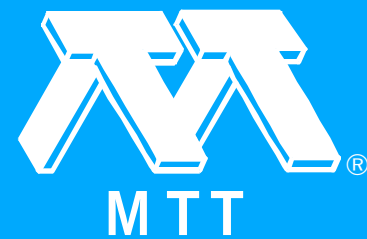


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## A Planar Broadband Balanced Doubler Using a Novel Balun Design

*D.F. Filipovic, R.F. Bradley and G.M. Rebeiz. "A Planar Broadband Balanced Doubler Using a Novel Balun Design." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 229-231.*

We report on the design and measurement of a broadband MIC balanced varactor frequency doubler. The design incorporates a novel balun to achieve a grounded CPW-to-slotline transition. The balanced structure offers inherent isolation in the output port from all odd harmonics including the fundamental frequency. Measurements show a port-to-port conversion loss between 8 and 10 dB over an output frequency range of 6-10 GHz. The design can be easily scaled to millimeter-wave frequencies using a monolithic approach.



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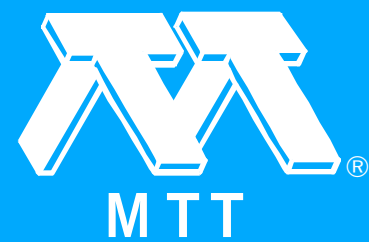
## Optimal Design of an Offset-Fed, Twin-Slot Antenna Element for Millimeter-Wave Imaging Arrays

*Y. Qian, S.-I. Iwata and E. Yamashita. "Optimal Design of an Offset-Fed, Twin-Slot Antenna Element for Millimeter-Wave Imaging Arrays." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 232-234.*

The optimal design of an offset-fed, twin-slot antenna suitable for millimeter wave imaging arrays is reported. The dimensions of the antenna and the slot separation for realizing a desirable beam pattern are obtained by using the spectral domain method. The optimal position of the feeding microstrips for perfect impedance matching is determined through a full-wave analysis using the FD-TD method, which takes into consideration both the slot elements and the feeding networks. The input characteristics of an optimally designed antenna is evaluated with a network analyzer, where a reasonable agreement with theoretical predictions is obtained.

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## A Novel Heterojunction Bipolar Transistor VCO Using an Active Tunable Inductance

*K.W. Kobayashi and A.K. Oki. "A Novel Heterojunction Bipolar Transistor VCO Using an Active Tunable Inductance." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 235-237.*

This paper reports on the results of a novel HBT Voltage Controlled Oscillator (VCO) that incorporates a bias-tunable active inductor. This development benchmarks the first demonstration of a tunable active inductance controlled HBT VCO of this type. The active inductor topology can obtain inductances of up to 10 nH at frequencies up to 10 GHz and can be bias-tuned over a similar range. VCO's were designed at 4 and 10 GHz by implementing different active inductance values. A 29% frequency tuning range from 3.54 to 4.73 GHz was obtained for the 4-GHz design. The output power varied from -1.2 to -0.2 dBm, respectively-less than 1 dB variation over the tuning range. The phase noise is -70 dBc/Hz at 100 kHz offset from the carrier. The new VCO topology can be implemented without the use of backside vias or microstrip-matching components and can be realized in a compact 1.0 x 0.7 mm<sup>2</sup> area. The variable active inductance VCO topology provides a compact, high performance alternative to the analog multi-vibrator oscillator circuit that generally has a smaller tuning capability and worse phase noise performance at microwave frequencies.

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## A Novel Compact Monolithic Active Regulated Self-biased InP HEMT Amplifier

*K.W. Kobayashi, R. Lai, G.I. Ng, K.L. Tan, R. Esfandiari, D.C. Streit and J.B. Berenz. "A Novel Compact Monolithic Active Regulated Self-biased InP HEMT Amplifier." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 238-240.*

This letter reports on the first results of a monolithic active regulated self-biased HEMT amplifier fabricated in InP technology. The self-bias scheme incorporates an op-amp-based HEMT regulator topology that regulates the bias current to within 6% over a threshold variation of  $\pm 0.2$  V. The dc yield based on this performance criteria was 75% across a wafer. The InP HEMT amplifier achieves an rf gain of 10-dB and a 3-dB bandwidth of 1-14 GHz. Across a wafer with a total threshold variation of 0.4 V, the gain variation was maintained to less than  $\pm 1$  dB. The compact integrated HEMT regulated amplifier circuit was realized using area-efficient analog design techniques that consumed less than  $1.3 \times 1.1$  mm<sup>2</sup>. This demonstration has far-reaching implications to the producibility and reliability of InP HEMT MMIC's.

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## A High-Performance W-Band Integrated Source Module Using GaAs Monolithic Circuits

*T.C. Ho, S. Chen, S. Tadayon, K. Pande, P. Rice and M. Ghahremani. "A High-Performance W-Band Integrated Source Module Using GaAs Monolithic Circuits." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 241-243.*

A high-performance integrated source module using a U-band MMIC HBT DRO and a U-band MMIC MESFET power amplifier in conjunction with a W-band MMIC high-efficiency varactor doubler has been developed for millimeter-wave system applications. This paper describes the development and performance of this W-band integrated source module. Measured results of the complete integrated source module show an output power of 10.6 dBm at 92.6 GHz and less than -126 dBc/Hz phase noise at 5 MHz offset from the carrier. These results represent the highest reported power and phase noise achieved at W-band using HBT, MESFET, and varactor frequency-doubling technologies.

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## A Pair of Hybrid Symmetrical Condensed TLM Nodes

*P. Berini and K. Wu. "A Pair of Hybrid Symmetrical Condensed TLM Nodes." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 244-247.*

This letter reports the development of a new time-domain hybrid symmetrical condensed TLM node. The new node can accommodate a graded mesh and model lossy anisotropic media described by diagonal tensors. The generalisation of an existing hybrid node to accommodate anisotropic media is also presented. The two hybrid nodes are complementary and provide the same computational advantages over the symmetrical condensed node originally proposed by Johns.

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## Cellular Automata as an Environment for Simulating Electromagnetic Phenomena

*N.R.S. Simons, G.E. Bridges, B.W. Podaima and A.R. Sebak. "Cellular Automata as an Environment for Simulating Electromagnetic Phenomena." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 247-249.*

In this letter, the application of cellular automata to the modeling of electromagnetic phenomena is investigated. Cellular automata are fully discrete computational models (in space, time, and variables) and are exactly computable using digital hardware. One type of cellular automata, the HPP lattice gas automaton, is applied here to the modeling of two-dimensional electromagnetic field problems. Lattice gas automata can be completely described in terms of binary variables and are capable of providing linear wave behavior. Two examples are presented to explore the proposed approach: one-dimensional plane wave propagation and plane wave scattering from a perfectly conducting rectangular cylinder.

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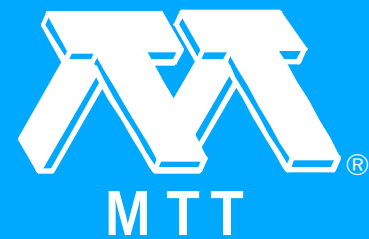
## Characteristics of Dielectric-Line-Loaded Conductor-Backed Slotline (CBS)

*J.-W. Huang and C.-K.C. Tzuang. "Characteristics of Dielectric-Line-Loaded Conductor-Backed Slotline (CBS)." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 250-252.*

The mode-coupling phenomenon prevents the conventional shielded conductor-backed slotline (CBS) from broadband applications. This paper proposes a modified CBS by adding a dielectric line of higher dielectric constant on the top of the slot region to circumvent the mode-coupling problem. The dispersion characteristics of the resultant dielectric line-loaded CBS are studied by using the full-wave space-domain Green's impedance function approach. The theoretic results show that the particular modified CBS significantly reduces mode-coupling phenomenon and is suitable for broadband applications. Furthermore, it is possible to adjust the values of the propagation constant and the characteristic impedance by changing the thickness of the dielectric line on top of the slot region. Finally, the design curves for the dielectric line-loaded CBS are provided for potential applications.

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## Superconducting Bolometric Mixers

*H. Ekstrom, B. Karasik, E. Kollberg and S.K. Yngvesson. "Superconducting Bolometric Mixers." 1994 Microwave and Guided Wave Letters 4.7 (Jul. 1994 [MGWL]): 253-255.*

Mixing at 20 GHz in niobium superconducting thin-film strips in the resistive state is studied. Experiments give evidence that electron-heating is the main cause of the nonlinear phenomena. The requirements on the mode of operation and on the film parameters for small conversion loss and the possibility of conversion gain are discussed. Measurements indicate a conversion loss between 1-8 dB and a DSB mixer noise temperature between 100 and 450 K at 20 GHz. The device output noise temperature at the mixer operating point can be as low as 30-40 K. A simple theory that is based on the assumption that the small signal resistance is linearly dependent on power is presented. This type of mixer is considered very promising for use in low-noise heterodyne receivers at THz frequencies.

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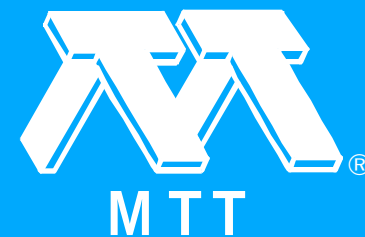




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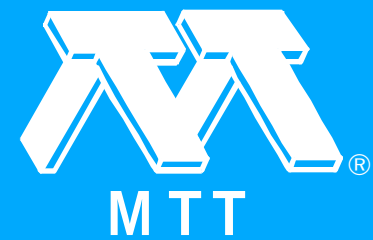
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## Wideband Characterization of Mutual Coupling Between High Density Bonding Wires

*H.-Y. Lee. "Wideband Characterization of Mutual Coupling Between High Density Bonding Wires." 1994 Microwave and Guided Wave Letters 4.8 (Aug. 1994 [MGWL]): 265-267.*

Mutual coupling between grounded bonding wires for high density IC packaging has been characterized over a wide frequency range using the Method of Moments in consideration of the ohmic and radiation losses. At high frequencies, the mutual inductance greatly increases due to the radiation-enhanced mutual coupling effect. For 500- $\mu\text{m}$ -long bonding wires, a minimum 200- $\mu\text{m}$  separation is required to maintain a 20-dB crosstalk level at low frequencies. This wideband analysis will be useful for designing packages and interconnection layouts of high frequency IC's with increased packaging density and operating frequency.

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## Validation and Extension to Three Dimensions of the Berenger PML Absorbing Boundary Condition for FD-TD Meshes

*D.S. Katz, E.T. Thiele and A. Taflove. "Validation and Extension to Three Dimensions of the Berenger PML Absorbing Boundary Condition for FD-TD Meshes." 1994 Microwave and Guided Wave Letters 4.8 (Aug. 1994 [MGWL]): 268-270.*

Berenger recently published a novel absorbing boundary condition (ABC) for FD-TD meshes in two dimensions, claiming orders-of-magnitude improved performance relative to any earlier technique. This approach, which he calls the "perfectly matched layer (PML) for the absorption of electromagnetic waves," creates a nonphysical absorber adjacent to the enter grid boundary that has a wave impedance independent of the angle of incidence and frequency of outgoing scattered waves. This paper verifies Berenger's strong claims for PML for 2-D FD-TD grids and extends and verities PML for 3-D FD-TD grids. Indeed, PML is > 40 dB more accurate than second-order Mur, and PML works just as well in 3-D as it does in 2-D. It should have a major impact upon the entire FD-TD modeling community, leading to new possibilities for high-accuracy simulations especially for low-observable aerospace targets.

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## Phase Noise Measurements of a D-Band Backward Wave Oscillator

*A.R. Harvey, G.M. Smith and J.C.G. Lesurf. "Phase Noise Measurements of a D-Band Backward Wave Oscillator." 1994 Microwave and Guided Wave Letters 4.8 (Aug. 1994 [MGWL]): 271-273.*

The difficulties encountered in measuring phase noise at millimetre wave frequencies have resulted in a scarcity of such data for backward wave oscillators. This paper reports the extension of a highly sensitive quasi-optical phase noise measurement system to D-band and presents phase noise spectra of a commercial backward wave oscillator at carrier frequencies between 120 and 160 GHz for offset frequencies in the range 10 kHz to 10 MHz. At small offset frequencies, the measured phase noise is typically 15 dB higher than solid state oscillators at this frequency.

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## 35-40 GHz Monolithic VCO's Utilizing High-Speed GaInP/GaAs HBT's

*K. Riepe, H. Leier, A. Marten, U. Guttich, J.M. Dieudonne and K.H. Bachem. "35-40 GHz Monolithic VCO's Utilizing High-Speed GaInP/GaAs HBT's." 1994 Microwave and Guided Wave Letters 4.8 (Aug. 1994 [MGWL]): 274-276.*

Design, fabrication and performance of Ka-band voltage-controlled oscillators (VCO's) are described. High-speed self-aligned GaInP/GaAs heterojunction bipolar transistors (HBT's) as active devices and varactor diodes using the base-collector junction of the HBT structure are implemented in the VCO's. The HBT's have an emitter area of  $2 \times 1.5 \mu\text{m} \times 10 \mu\text{m}$  and incorporate a highly carbon doped base layer and a thin GaInP hole barrier. Oscillators with center frequencies of 35, 37, and 40 GHz exhibit tuning ranges of up to 1 GHz and typical output powers of 1-3.5 dBm. Best measured phase-noise at 1 MHz off carrier is -107 dBc/Hz.

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## 44-GHz High-Efficiency InP-HEMT MMIC Power Amplifier

*W. Lam, M. Matloubian, A. Igawa, C. Chou, A. Kurdoghlian, C. Ngo, L. Jelloian, A. Brown, M. Thompson and L. Larson. "44-GHz High-Efficiency InP-HEMT MMIC Power Amplifier." 1994 Microwave and Guided Wave Letters 4.8 (Aug. 1994 [MGWL]): 277-278.*

A high-efficiency power amplifier was developed using 0.15- $\mu\text{m}$  gatelength, InP-based (GaInAs/AlInAs/InP), HEMT MMIC technology. The amplifier demonstrated state-of-the-art performance. The output power at 1-dB compression point was 28 dBm at 44.5 GHz. The corresponding power-added efficiency was 31% and gain was 7 dB. The total chip area was 2.5 mm<sup>2</sup>.

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# Abstracts

## Stability Condition for the Explicit Algorithms of the Time Domain Analysis of Maxwell's Equations

*M. Mrozowski. "Stability Condition for the Explicit Algorithms of the Time Domain Analysis of Maxwell's Equations." 1994 Microwave and Guided Wave Letters 4.8 (Aug. 1994 [MGWL]): 279-281.*

This letter presents the derivation of the stability condition for various types of time domain algorithms used in the solution of linear hyperbolic differential equations that arise in the investigation of transient electromagnetic fields. The stability condition of the algorithm is derived by investigating the properties of operators in suitably defined Hilbert spaces. Compared to the classical von Neumann stability analysis, the functional analysis approach gives more general results that can be easily applied to some recent and possible future time domain schemes.



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## 100-300 GHz Gunn Oscillator Simulation through Harmonic Balance Circuit Analysis Linked to a Hydrodynamic Device Simulator

*M.F. Zybura, S.H. Jones, G.B. Tait and J.R. Jones. "100-300 GHz Gunn Oscillator Simulation through Harmonic Balance Circuit Analysis Linked to a Hydrodynamic Device Simulator." 1994 Microwave and Guided Wave Letters 4.8 (Aug. 1994 [MGWL]): 282-284.*

Accurate and efficient calculations of the large-signal AC behavior of second-harmonic InP Transferred Electron Oscillators (TEO's) are presented. This is accomplished by combining a novel harmonic balance circuit analysis technique with a hydrodynamic device simulator employing the temperature dependent drift and diffusion equations. The electron transport simulations include a detailed heat flow analysis to update the temperature profile in the device. The nonlinear circuit analysis utilizes a fixed-point iterative method derived from the robust multiple reflection algorithm. To expedite the process and aid in convergence, an acceleration technique is also employed in this algorithm. The associated reduction in computation time allows for the inclusion of a hydrodynamic treatment of the Transferred Electron Device (TED) using the modified drift and diffusion equations. Comparisons are made with the published experimental data reported by Rydberg on second-harmonic 188 GHz InP TEO's.

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# Abstracts

## Patent Abstracts (Aug. 1994 [MGWL])

*"Patent Abstracts (Aug. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.8 (Aug. 1994 [MGWL]): 285-290.*



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## Call for Papers - 1995 SBMO/IEEE MTT-S International Microwave and Optoelectronics Conference (Aug. 1994 [MGWL])

*"Call for Papers - 1995 SBMO/IEEE MTT-S International Microwave and Optoelectronics Conference (Aug. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.8 (Aug. 1994 [MGWL]): 291-291.*



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## IEEE Member Get a Member Program (Advertisement) (Aug. 1994 [MGWL])

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# Abstracts

## First Demonstration of High-Power GaInP/GaAs HBT MMIC Power Amplifier with 9.9 W Output Power at X-Band

*W. Liu, A. Khatibzadeh, T. Kim and J. Sweder. "First Demonstration of High-Power GaInP/GaAs HBT MMIC Power Amplifier with 9.9 W Output Power at X-Band." 1994 Microwave and Guided Wave Letters 4.9 (Sep. 1994 [MGWL]): 293-295.*

We report for the first time the large-signal power performance of a MMIC amplifier based on GaInP/GaAs HBT's. A output power of 9.9 W and power-added efficiency of more than 30% are measured at X-band. These results compare favorably with those measured from AlGaAs/GaAs HBT's, demonstrating that GaInP/GaAs HBT's are suitable for microwave power applications.



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## FDTD Analysis of an Active Antenna (Sep. 1994 [MGWL])

*V.A. Thomas, K.-M. Ling, M.E. Jones, B. Toland, J. Lin and T. Itoh. "FDTD Analysis of an Active Antenna (Sep. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.9 (Sep. 1994 [MGWL]): 296-298.*

Coupled FDTD-SPICE simulations are performed for an active antenna problem. The results are comparable to previously published results using FDTD in conjunction with special integration techniques for the nonlinear elements. Some differences occur, and better agreement with experiment is observed for our newer approach. The main advantages are that all of the SPICE device models are directly available for FDTD modeling and the efficient SPICE integration schemes can be used directly. No user intervention is required for either the device models or the integration schemes.

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# Abstracts

## Wide-Band Transitions for Applications in MMIC's and OEIC's

*D. Mirshekar-Syahkal, D.J. Newson, D. Wake and I.D. Henning. "Wide-Band Transitions for Applications in MMIC's and OEIC's." 1994 Microwave and Guided Wave Letters 4.9 (Sep. 1994 [MGWL]): 299-300.*

Three different coplanar waveguide-to-slotline transitions on InP for operation around 30 GHz were designed. The performances of these transitions in back-to-back configuration were simulated and measured over 1-50 GHz. They were found to possess wideband characteristics. In particular, two of them had bandwidths as large as 35 GHz. The design of these transitions were carried out with the view to monolithically integrating tapered slot antennas with coplanar waveguide circuits on InP substrates.



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## A W-Band Monolithic, Singly Balanced Resistive Mixer with Low Conversion Loss

*K.W. Chang, E.W. Lin, H. Wang, K.L. Tan and W.H. Ku. "A W-Band Monolithic, Singly Balanced Resistive Mixer with Low Conversion Loss." 1994 Microwave and Guided Wave Letters 4.9 (Sep. 1994 [MGWL]): 301-302.*

We report the design, measured and simulated performance of a novel W-band monolithic, singly balanced resistive FET mixer utilizing 0.1- $\mu\text{m}$  pseudomorphic AlGaAs/InGaAs on GaAs HEMT technology. At an LO drive of +8 dBm, this mixer has exhibited a minimum measured conversion loss of 12.8 dB, nearly a 10 dB improvement over previously reported data in this frequency range. Furthermore, the mixer figure of merit, defined as  $P_{\text{sub 1-dB}} / P_{\text{sub LO}}$ , is at least +2 dBm, which is nominally 6 dBm better than that of comparable diode mixers at W-band. These results indicate the excellent potential of this mixer for integration with other circuit components in fully monolithic subsystems.

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## A High Efficiency V-Band Monolithic HEMT Power Amplifier

*R.E. Kasody, G.S. Dow, A.K. Sharma, M.V. Aust, D. Yamauchi, R. Lai, M. Biedenbender, K.L. Tan and B.R. Allen. "A High Efficiency V-Band Monolithic HEMT Power Amplifier." 1994 Microwave and Guided Wave Letters 4.9 (Sep. 1994 [MGWL]): 303-304.*

We report the performance of a monolithic V-band power amplifier using 0.15- $\mu\text{m}$  double heterostructure pseudomorphic InGaAs/AlGaAs/GaAs HEMT's. The amplifier using a 400- $\mu\text{m}$  device driving a 2 x 400- $\mu\text{m}$  device. It has demonstrated output power of 313 mW (0.39 W/mm) with 8.95 dB power gain and 19.9% PAE at 59.5 GHz. These data represent the highest reported combination of output power, power gain, and power-added efficiency reported for a V-band monolithic power amplifier.

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# Abstracts

## Patent Abstracts (Sep. 1994 [MGWL])

*"Patent Abstracts (Sep. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.9 (Sep. 1994 [MGWL]): 305-310.*



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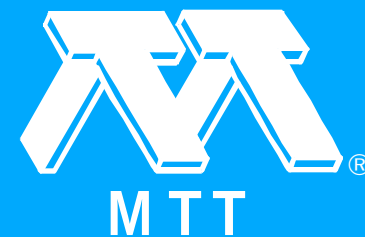
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*"Call for Papers - 1995 Asia-Pacific Microwave Conference (Sep. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.9 (Sep. 1994 [MGWL]): 311-311.*



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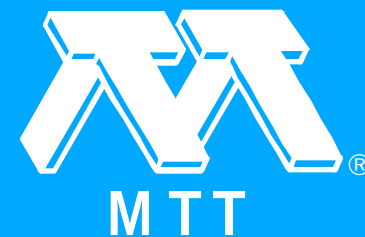
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## IEEE All Society Periodicals Package (Advertisement) (Sep. 1994 [MGWL])

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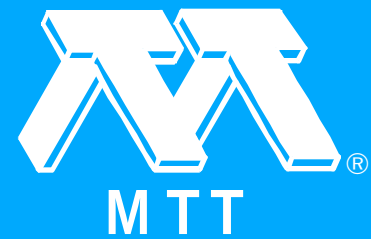
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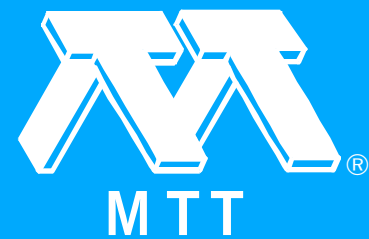
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## Characterization of the Perturbation Effect of a Probe Head Using the FD-TD Method

Y. Qian, S.-I. Iwata and E. Yamashita. "Characterization of the Perturbation Effect of a Probe Head Using the FD-TD Method." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 317-319.

The perturbation effect of a probe head in microwave measurement is investigated by using the FD-TD method. A two-simulation approach with improved accuracy is employed to predict the insertion loss caused by the probe head. Depending on the diameter and reclining angle of the probe head, a maximum insertion loss of up to 0.8 dB has been calculated for an example structure. This work provides a rigorous and quantitative estimation of the probe effect. The analysis results may also serve as a guidance for optimal designing and positioning of probe heads so that a minimum field perturbation during measurement can be expected.

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## A 5-10 GHz, 1-Watt HBT Amplifier with 58% Peak Power-Added Efficiency

*M. Salib, F. Ali, A. Gupta, B. Bayraktaroglu and D. Dawson. "A 5-10 GHz, 1-Watt HBT Amplifier with 58% Peak Power-Added Efficiency." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 320-322.*

Four 0.25-W GaAs Heterojunction Bipolar Transistors (HBT's) were combined in a single-stage hybrid microstrip amplifier. An output power of minimum 1 Watt (W) was achieved over the 5.5-9.5 GHz band with > 48% power-added efficiency (PAE). The peak PAE was 58% at 7 and 9.5 GHz with an average efficiency of 52% over the 5-10 GHz band. This result was reproduced on two more units with a minimum efficiency of 48% and an average efficiency of 51%. To our knowledge, this is the highest efficiency obtained from any 1-W amplifier covering 5-10 GHz bandwidth.

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## A Hybrid PEE-FDTD Algorithm for Accelerated Time Domain Analysis of Electromagnetic Waves in Shielded Structures

*M. Mrozowski. "A Hybrid PEE-FDTD Algorithm for Accelerated Time Domain Analysis of Electromagnetic Waves in Shielded Structures." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 323-325.*

A new algorithm for the time domain analysis of electromagnetic waves in shielded structures is presented. The algorithm combines the FDTD with a recently developed partial eigenfunction expansion (PEE) scheme to obtain acceleration in numerical calculation and savings in computer memory. An example of the application of the algorithm is presented showing an overall speed improvement.

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## Plane Wave Excitation of an Infinite Dielectric Rod

*R.B. Keam. "Plane Wave Excitation of an Infinite Dielectric Rod." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 326-328.*

The analysis of the fields induced inside and scattered externally by an infinite dielectric rod in an incident plane-polarized TEM wave is presented. It is assumed that the incident wave is polarized parallel to the rod, and that the dielectric has some significant loss. The analysis accounts for axial variation of the fields both inside and scattered by the rod. An investigation of the field distributions for a specific case is given, along with a brief discussion of the evaluation of integer order Bessel functions with complex argument.



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## An Ultra-Low Noise Cryogenic Ka-Band InGaAs/InAlAs/InP HEMT Front-End Receiver

*R. Lai, J.J. Bautista, B. Fujiwara, K.L. Tan, G.I. Ng, R.M. Dia, D. Streit, P.H. Liu, A. Freudenthal, J. Laskar and M.W. Pospieszalski. "An Ultra-Low Noise Cryogenic Ka-Band InGaAs/InAlAs/InP HEMT Front-End Receiver." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 329-331.*

We present here the design and performance of a 4-stage Ka-band cryogenic amplifier using a front-end 0.1 $\mu$ m gate length InP HEMT. The amplifier demonstrated 20-25 K uncorrected noise temperature ( $\sim$ 0.3-dB noise figure) from 31-33 GHz with 30-33 dB associated gain at 12 K ambient temperature. To date, this is the best reported HEMT cryogenic amplifier performance at this frequency band and is a factor of two improvement in noise temperature compared to previous designs.

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## Slotted Dielectric Resonators for Rigorous Design of a Four-Poles Dual Mode Filter

*D. Baillargeat, S. Verdeyme and P. Guillon. "Slotted Dielectric Resonators for Rigorous Design of a Four-Poles Dual Mode Filter." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 332-334.*

A new dual mode coupling technique is described. This new method replaces the classical coupling and tuning screws by slotted dielectric resonators. The theoretical analysis uses the three-dimensional finite element method. For the first time, a four-poles dual modes slotted dielectric resonators filter is rigorously designed, taking into account the dielectric losses. The experimental results show excellent agreement with the theoretical ones.

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## A Varactor-Tuned Patch Oscillator for Active Arrays

*P. Liao and R.A. York. "A Varactor-Tuned Patch Oscillator for Active Arrays." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 335-337.*

The design and construction of a relatively wideband quasi-optical voltage-controlled oscillator (VCO) is described. This VCO uses a varactor-tuned microstrip patch antenna and may be used as an element in quasi-optical power combining oscillator arrays. Measurements of this VCO indicate that over 1.3 GHz of tuning was achieved, with less than  $\pm 1.5$  dB of amplitude variation over that range.



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## Surface Wave Leakage Phenomena in Coupled Slot Lines

*Y.D. Lin and Y.-B. Tsai. "Surface Wave Leakage Phenomena in Coupled Slot Lines." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 338-340.*

Surface wave leakage phenomena of coupled slot lines are investigated with spectral domain analysis. When the guided mode in the coupled slot lines changes from bound mode to leaky mode, there is a frequency range, called "spectral gap," where only nonspectral solutions exist. If the width of the center conductor or slots is increased beyond a certain value this spectral gap may disappear, resulting in a frequency range where both bound mode and leaky mode can exist simultaneously.

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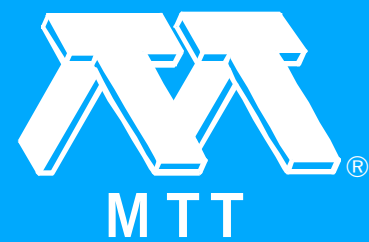
## A Novel Biased Anti-Parallel Schottky Diode Structure for Subharmonic Mixing

*T.-H. Lee, C.-Y. Chi, J.R. East, G.M. Rebeiz and G.I. Haddad. "A Novel Biased Anti-Parallel Schottky Diode Structure for Subharmonic Mixing." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 341-343.*

Subharmonically pumped mixers using zero-biased anti-parallel Schottky diode pairs produce good results, but require a larger LO power than biased Schottky diodes. Presented here is a novel planar-diode anti-parallel pair that allows independent biasing of the two diodes. This diode pair is integrated into a quasi-optical wideband receiver and the RF measurements on a 1.2- $\mu\text{m}$  anode diameter pair show a reduced LO power requirement at 180 GHz by a factor of 2 to 3 with a similar DSB conversion loss and noise temperature (9.7 dB and 1850° K) to an unbiased Schottky diode pair. This structure has potential for applications at submillimeter-wave frequencies where a large amount of LO power is not easily available.

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## Ultrawideband Absorbing Boundary Condition for Termination of Waveguiding Structures in FD-TD Simulations

*C.E. Reuter, R.M. Joseph, E.T. Thiele, D.S. Katz and A. Taflove. "Ultrawideband Absorbing Boundary Condition for Termination of Waveguiding Structures in FD-TD Simulations." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 344-346.*

A new method for ultrawideband termination of waveguides in finite-difference time-domain (FD-TD) grids is presented. The Berenger perfectly matched layer (PML) absorbing boundary condition is applied to terminate both perfect electrically conducting (PEC) and dielectric waveguides in two dimensions. Reflections of less than -75 dB are obtained over the entire propagation regime. Evidence is presented that the PML ABC is effective even for the evanescent energy present below cutoff in PEC waveguides and the multimode propagation present in dielectric waveguides.

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## An Active Phased Array with Optical Input and Beam-Scanning Capability

*S.T. Chew, T.K. Tong, M.C. Wu and T. Itoh. "An Active Phased Array with Optical Input and Beam-Scanning Capability." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 347-349.*

An active antenna array with optical input and beam scanning capability was developed. The phase shift between antenna elements is controlled by means of unilateral injection locking. The reference signal for injection locking is launched into optical fiber by a multiquantum-well InGaAs-InGaAsP distributed feedback laser. The RF signal is recovered by a photodetector at the other end of the link and fed to the RF circuit. Experimental result is presented and discussed.



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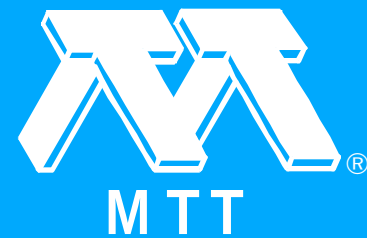


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## A 100-Transistor Quadruple Grid Oscillator

*W.A. Shiroma, B.L. Shaw and Z.B. Popovic. "A 100-Transistor Quadruple Grid Oscillator." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 350-351.*

A three-dimensional power combiner consisting of four oscillator grids stacked in parallel is presented. The 5-GHz quadruple grid oscillator delivers an effective radiated power 6.5 dB greater than that of a single grid, with a corresponding frequency shift of less than 5%. Comparisons are made between a single, double, and quadruple grid oscillator.



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## Extensions to the FDTD Method for the Analysis of Infinitely Periodic Arrays

*D.T. Prescott and N.V. Shuley. "Extensions to the FDTD Method for the Analysis of Infinitely Periodic Arrays." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 352-353.*

A number of methods are presented that improve the efficiency of Finite-Difference Time-Domain analyses of infinitely periodic structures. A procedure that provides a more effective implementation of absorbing boundary conditions, which enables the mesh to be drastically reduced in size, is presented. A method for data extraction involving the direct use of Floquet's theorem is demonstrated along with a technique for exciting the mesh, which helps to reduce the total computation time. These techniques are described and results are given that clearly show the improved performance of the absorbing boundaries.

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*"Patent Abstracts (Oct. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.10 (Oct. 1994 [MGWL]): 355-359.*



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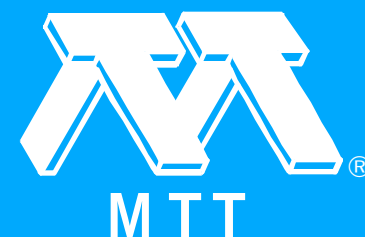
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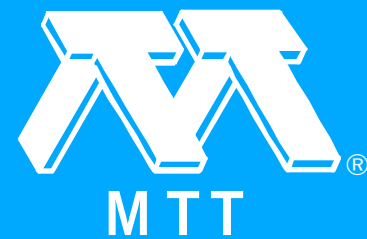


# Abstracts

## 35-GHz HEMT Amplifiers Fabricated Using Integrated HEMT-HBT Material Grown by Selective MBE

*D.K. Umemoto, D.C. Streit, K.W. Kobayashi and A.K. Oki. "35-GHz HEMT Amplifiers Fabricated Using Integrated HEMT-HBT Material Grown by Selective MBE." 1994 Microwave and Guided Wave Letters 4.11 (Nov. 1994 [MGWL]): 361-363.*

We have fabricated 35-GHz balanced low-noise amplifiers using pseudomorphic InGaAs-GaAs HEMT material monolithically integrated with HBT material grown by selective MBE. The 0.2- $\mu\text{m}$  T-gate HEMT amplifiers fabricated using a merged HEMT-HBT process have equivalent gain and noise figure compared to amplifiers fabricated using normal MBE and our baseline HEMT-only process. This demonstration of high performance HEMT amplifiers using integrated HEMT-HBT material and a merged HEMT-HBT process enables the fabrication of a new class of multifunction monolithic microwave integrated circuits.



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## RF Excitation of an Oscillator with Several Tunneling Devices in Series

*O. Boric-Lubecke, D.-S. Pan and T. Itoh. "RF Excitation of an Oscillator with Several Tunneling Devices in Series." 1994 Microwave and Guided Wave Letters 4.11 (Nov. 1994 [MGWL]): 364-366.*

An oscillator with several tunneling devices connected in series has a demanding excitation condition due to the DC instability of the series connection. An RF source with a frequency close to the oscillation frequency may be used to overcome this problem. The experimental demonstration of an RF source excitation of an oscillator with two tunnel diodes in series at 2 GHz is described here. The RF power necessary for the excitation is about 15 dB lower than the output power of the oscillator.

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## Radiation Pattern Prediction of the Unidirectional Dielectric Radiator (UDR)

*H. An, K. Wu and R.G. Bosisio. "Radiation Pattern Prediction of the Unidirectional Dielectric Radiator (UDR)." 1994 Microwave and Guided Wave Letters 4.11 (Nov. 1994 [MGWL]): 367-369.*

This letter presents a theoretical prediction of the radiation patterns of the unidirectional dielectric radiator (UDR) using a cavity approximation. The antenna structure is first modeled as an NRD resonator, and the electromagnetic fields at the radiating aperture of the antenna structure are then determined and used to calculate the radiation fields and the radiation patterns of the antenna. The validity of the analysis is confirmed by the measurement results.

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# Abstracts

## On-Wafer Calibration Techniques and Applications at V-Band

*M. Nishimoto, M. Hamai, J. Laskar and R. Lai. "On-Wafer Calibration Techniques and Applications at V-Band." 1994 Microwave and Guided Wave Letters 4.11 (Nov. 1994 [MGWL]): 370-372.*

There is considerable interest in HEMT MMIC applications operating at V-band and higher frequencies due to their low noise, high power, and high power efficiency capability. A quantitative investigation of calibration methods have been performed to study the effect of calibration techniques on V-band device measurements and model development. This work compares SOLT, LRM, and multi-line TRL calibrations relative to each other. The analysis is then applied to pseudomorphic InGaAs HEMT devices to provide useful information on the effect of calibration on small signal-intrinsic parameter extraction at V-band.



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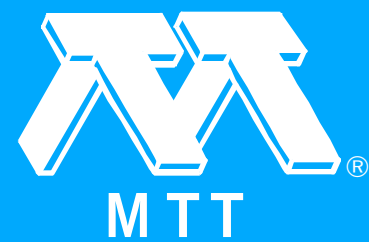
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## A Low-Noise Baseband 5-GHz Direct-Coupled HBT Amplifier with Common-Base Active Input Match

*K.W. Kobayashi and A.K. Oki. "A Low-Noise Baseband 5-GHz Direct-Coupled HBT Amplifier with Common-Base Active Input Match." 1994 Microwave and Guided Wave Letters 4.11 (Nov. 1994 [MGWL]): 373-375.*

This paper reports on an HBT direct-coupled 2-stage amplifier that uses active common-base input matching to provide multi-decade frequency performance from dc to 5 GHz. This work benchmarks the first reported HBT noise results of an HBT amplifier using common-base active input matching. The 2-stage amplifier consists of a common-base input stage that is directly coupled to a Darlington feedback amplifier output stage. The common-base input can be bias tuned to achieve  $> 13$ -dB return loss at 3 GHz and a minimum noise figure of 2.9 dB at 1 GHz. A gain of 17.5 dB with a 3-dB bandwidth greater than 5 GHz was achieved under low-noise input bias. This amplifier topology can be implemented without the use of a complex microwave process, which typically integrates backside vias and microstrip matching components. The compact amplifier consumes an area of  $0.82 \times 0.47$  mm<sup>2</sup>, which is 10 times smaller than a previously reported 2.5-4 GHz narrow-band passive matched HBT amplifier with similar noise and gain performance.

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## Modeling MESFET's for Intermodulation Analysis in RF Switches

*R.S. Virk and S.A. Maas. "Modeling MESFET's for Intermodulation Analysis in RF Switches." 1994 Microwave and Guided Wave Letters 4.11 (Nov. 1994 [MGWL]): 376-378.*

This paper describes a new model for a resistive GaAs MESFET and its application to calculations of intermodulation distortion in switches. The model uses an expression for the I/V characteristics of the device whose parameters are fit to the static I/V and its derivatives. This new model provides a reliable means of describing the nonlinear distortion generated by a MESFET switch.

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*"Patent Abstracts (Nov. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.11 (Nov. 1994 [MGWL]): 379-385.*



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## Call for Papers - Recent Advances in Microwave Technology (Nov. 1994 [MGWL])

*"Call for Papers - Recent Advances in Microwave Technology (Nov. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.11 (Nov. 1994 [MGWL]): 386-386.*



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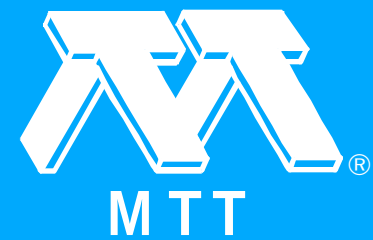
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*"Ask IEEE (Advertisement) (Nov. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.11 (Nov. 1994 [MGWL]): 387-387.*



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## IEEE Membership Application (Nov. 1994 [MGWL])

*"IEEE Membership Application (Nov. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.11 (Nov. 1994 [MGWL]): 388-388.*



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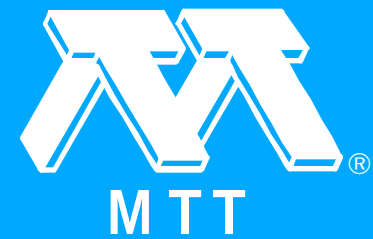


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## 1994 Reviewer List (Dec. 1994 [MGWL])

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*"1994 Reviewer List (Dec. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 389-389.*



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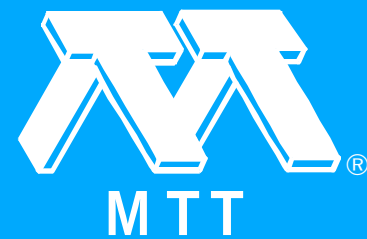
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## Accurate Frequency Domain Modelling of Coaxially Driven Axisymmetric Microwave Structures

*H.O. Ali and G.I. Costache. "Accurate Frequency Domain Modelling of Coaxially Driven Axisymmetric Microwave Structures." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 390-392.*

This letter presents a simple, yet accurate, finite-element frequency domain method of analysis applicable to coaxially driven, axisymmetric microwave structures. The method combines known techniques of modelling coaxially driven, non-radiating structures with those used to model radiating, non-coaxially driven microwave structures. As a result, the method is capable of modelling both types of structures. As an example of the various possible applications of the method, a monopole antenna realized with a ring resonator was analyzed and the results are reported. The results agree very well with the reported measured results for that antenna.



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## De-Embedding Slotline Propagation Parameters

*M.-H. Murgulescu, P. Legaud, E. Moisan, E. Penard and I. Zaquine. "De-Embedding Slotline Propagation Parameters." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 393-395.*

A new method for extracting the slotline propagation constants is presented. The test structure consists of coplanar access lines, coplanar-slotline transitions, and the slotline to be measured. Since no special mathematical computations are needed, the method may be directly implemented using commercially available microwave CAD packages. The method may be applied up to millimeter-wave wavelengths. The experimental results are compared to electromagnetic simulations.

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## Some Considerations About the Finite Difference Time Domain Method in General Curvilinear Coordinates

*E.A. Navarro, C. Wu, P.Y. Chung and J. Litva. "Some Considerations About the Finite Difference Time Domain Method in General Curvilinear Coordinates." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 396-398.*

Some considerations about the stability criterion and the dispersion of the Finite Difference Time Domain Method in General Curvilinear Coordinates are presented. An expression for the stability criterion and for the dispersion relation is found to be possible only for a mesh without curvature, and for this particular case, a dispersion relation is obtained in three dimensions. The analysis of this relation shows that a resolution of 10 cells per wavelength is enough in order to keep the dispersion error within a reasonable limit. A study of the reflection in the interface between two regions with different metrics is presented as well.

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## A DC to 38-GHz Distributed Analog Multiplier Using InP HEMT's

*Y. Imai, S. Kimura, Y. Umeda and T. Enoki. "A DC to 38-GHz Distributed Analog Multiplier Using InP HEMT's." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 399-401.*

A novel distributed analog multiplier is proposed. It employs Gilbert cells as the unit section of the distributed structure. The single-ended analog multiplier MMIC's are built using 0.1- $\mu$ m-gate-length InP HEMT's and uniplanar technology. The conversion gain is about -5 dB with LO power of 10 dBm. RF and IF 3-dB bandwidths are 38 and 16 GHz, respectively.

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## A Simple Technique for Minimization of ABC-Induced Error in the FDTD Analysis of Microstrip Discontinuities

*X.P. Lin and K. Naishadham. "A Simple Technique for Minimization of ABC-Induced Error in the FDTD Analysis of Microstrip Discontinuities." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 402-404.*

Imperfectly absorbing truncation boundaries in the simulation of microstrip circuits by the finite-difference time-domain (FDTD) method necessitate large computational domains, imposing a significant burden on the resources. Residual boundary reflection sometimes causes serious degradation of the computed parameters (e.g., oscillatory behavior). We introduce a simple modification of the FDTD implementation for microstrip discontinuities, wherein two sub-problems whose domains are reduced by bringing the absorbing boundary close to the circuit, are superposed to cancel the dominant boundary reflection. Computed results on transmission line and resonant type discontinuities demonstrate that significant computational savings can be achieved without compromising accuracy.

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## Large Signal Model for Analysis and Design of HEMT Gate Mixer

*R. Allam, C. Kolanowski, D. Theron and Y. Crosnier. "Large Signal Model for Analysis and Design of HEMT Gate Mixer." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 405-407.*

This paper examines the problem of modeling HEMT's for calculations of conversion gain and intermodulation. An accurate and simple large signal model of discrete HEMT's has been developed. The nonlinear elements of the model are assumed to depend exclusively on the gate-source voltage. The interpolation of the measured data, using polynomial expressions, provides a description of the HEMT's nonlinearities in a CAD software. Based on the model, a hybrid HEMT gate mixer has been built. The accuracy of the model has been verified, and we obtained good agreement between the measured and simulated results.

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## Rigorous Mode Matching Analysis of Mitered E-Plane Bends in Rectangular Waveguide

*F. Alessandri, M. Mongiardo and R. Sorrentino. "Rigorous Mode Matching Analysis of Mitered E-Plane Bends in Rectangular Waveguide." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 408-410.*

A rigorous full-wave analysis of 90° E-plane mitered bends is obtained in a simple and accurate way by using the segmentation technique. The bend is divided into various regions of rectangular and triangular shapes, characterized by the generalised admittance matrix representation. The method is used to investigate the properties of 90° E-plane bends in rectangular waveguide. It is shown that it is possible to design the mitering so as to locate the matching frequency as desired within the operational frequency band. Design charts are given providing the optimal mitering as well as the relative bandwidth of the reflection coefficient.

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## Heterostructure Barrier Varactor Simulation Using an Integrated Hydrodynamic Device/Harmonic-Balance Circuit Analysis Technique

*J.R. Jones, S.H. Jones, G.B. Tait and M.F. Zybura. "Heterostructure Barrier Varactor Simulation Using an Integrated Hydrodynamic Device/Harmonic-Balance Circuit Analysis Technique." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 411-413.*

Accurate and efficient simulations of the large-signal time-dependent behavior of GaAs/AlGaAs Heterostructure Barrier Varactor (HBV) frequency tripler circuits have been obtained. This is accomplished by combining a novel harmonic-balance circuit analysis technique with a physics-based hydrodynamic device simulator. The integrated HBV hydrodynamic device/harmonic-balance circuit simulator allows HBV multiplier circuits to be co-designed from both a device and a circuit point of view. Comparisons are made with the experimental results of Choudhury et al. for GaAs/AlGaAs HBV frequency triplers operating near 200 GHz. These comparisons illustrate the importance of representing active devices with physics-based numerical device models rather than analytical device models based on lumped quasi-static equivalent circuits.

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## Characterization of a Monolithic Slot Antenna Using an Electro-Optic Sampling Technique

*K. Kamogawa, I. Toyoda, K. Nishikawa and T. Tokumitsu. "Characterization of a Monolithic Slot Antenna Using an Electro-Optic Sampling Technique." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 414-415.*

The first electro-optic measurement of a monolithic antenna near-field is presented. A 10-GHz monolithic slot antenna is designed and precisely characterized by Electro-Optic Sampling (EOS). The fringing effect of a shorted slot and the influence of undesirable modes on the antenna's near field can be measured accurately. Therefore, the EOS technique is very effective for on-wafer measurement and the development of monolithic antennas.

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## Observation of Chaos in a Microwave Limiter Circuit

*C.M. Glenn and S. Hayes. "Observation of Chaos in a Microwave Limiter Circuit." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 417-419.*

Chaotic behavior has been observed in a microwave limiter circuit that consists of a shunt p-i-n diode cascaded with a 0.68-dB/MHz rolloff bandpass filter. The chaos manifests itself as a broad-band power spectral density of the output signal. The chaos appears and disappears as the incident power to the limiter circuit is increased, suggesting bifurcations and periodic windows in the chaotic region. Data are included that illustrate classic characteristics of chaos such as period doubling and broad-band spectra.

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# Abstracts

## Efficient Solution Method for Unified Nonlinear Microwave Circuit and Numerical Solid-State Device Simulation

*G.B. Tait. "Efficient Solution Method for Unified Nonlinear Microwave Circuit and Numerical Solid-State Device Simulation." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 420-422.*

A simple and very efficient harmonic-balance technique is presented that is suitable for the steady-state analysis of nonlinear microwave and millimeter-wave circuits that require physics-based, fully numerical simulations of charge carrier transport in the solid-state device. The practical integration of a numerical device simulator with a nonlinear circuit simulator requires a robust and fast circuit solution algorithm. The new circuit solution algorithm was applied to a test simulation of a 100- to 300-GHz multiplier circuit, achieving a savings in computational effort of 98% and a reduction in execution time by a factor of 33 over contending harmonic-balance techniques.



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## Bias-Dependent Noise Up-Conversion Factor in HBT Oscillators

*X. Zhang and A.S. Daryoush. "Bias-Dependent Noise Up-Conversion Factor in HBT Oscillators." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 423-425.*

This paper reports on the low-frequency noise up-conversion process in HBT transistors and their contributions to the close-in carrier phase noise of the HBT based oscillators. The experimental results of an HBT oscillator at 5.6 GHz demonstrate that the low-frequency noise up-conversion factor is primarily function of the transistor's phase variation to its quiescent point. Thus, in addition to the transistor's noise parameters of  $f_{sub c/}$  and  $N_{sub F/}$ , the phase sensitivity to the bias point provides another important transistor parameter in design of low phase noise oscillators. This concept can also be extended to oscillators based on other devices, such as BJT's, MESFET's and HEMT's.

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## Asia-Pacific Abstracts (Dec. 1994 [MGWL])

*"Asia-Pacific Abstracts (Dec. 1994 [MGWL])." 1994 Microwave and Guided Wave Letters 4.12 (Dec. 1994 [MGWL]): 426-455.*



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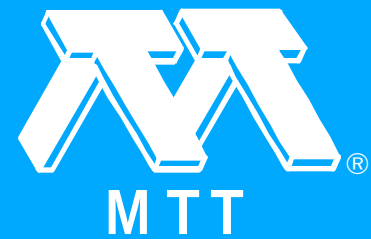
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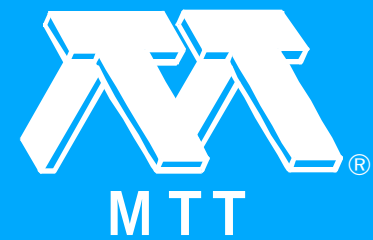
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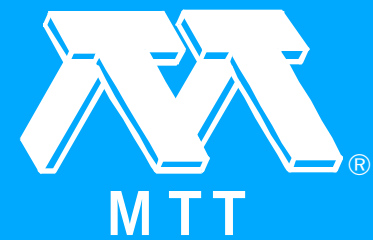
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## Meeting and Function Rooms (1993 Vol. I [MWSYM])

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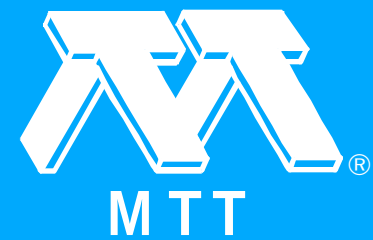
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## Welcome to the 1993 International Microwave Symposium (1993 Vol. I [MWSYM])

*G.P. Rodrigue and C.T. Rucker. "Welcome to the 1993 International Microwave Symposium (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): iii-iii.*

The 1993 IMS Steering Committee is most pleased to be hosting the 1993 International Microwave Symposium in Atlanta, the home of Gone With The Wind, the Braves, Delta, TNT, CNN, Georgia Tech, Coca Cola and, in 1996, the Summer Olympiad. We hope the microwave committee will accept our hearty welcome to the unique blend of yesterday and tomorrow that makes Atlanta a pleasure to visit. We know you will enjoy every minute you are here.



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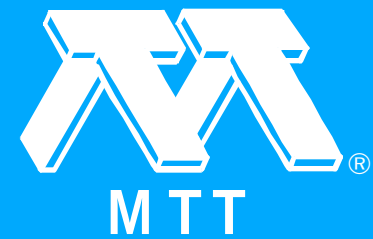
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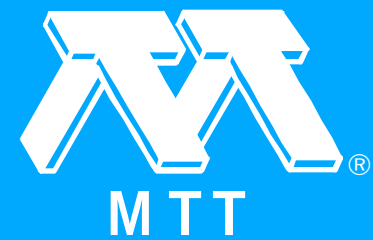
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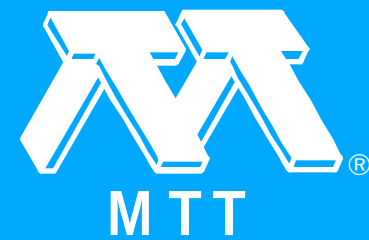


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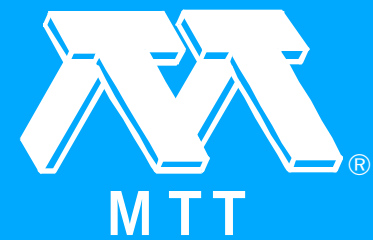


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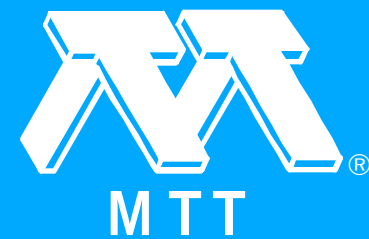
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## MTT-S Rump Sessions (1993 Vol. I [MWSYM])

*"MTT-S Rump Sessions (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 40-42.*



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## 1993 IEEE Microwave and Millimeter-Wave Monolithic Circuits Symposium Schedule (1993 Vol. I [MWSYM])

*"1993 IEEE Microwave and Millimeter-Wave Monolithic Circuits Symposium Schedule (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 43-43.*



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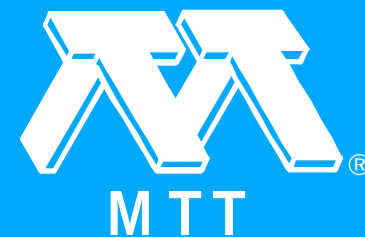
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## MTT-S International Microwave Symposium: Future Locations (1993 Vol. I [MWSYM])

*"MTT-S International Microwave Symposium: Future Locations (1993 Vol. I [MWSYM])." 1993  
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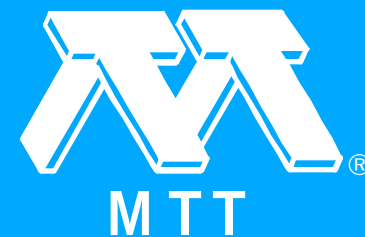
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# Abstracts

## Technical Program Contents (1993 Vol. I [MWSYM])

*"Technical Program Contents (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 45-81.*



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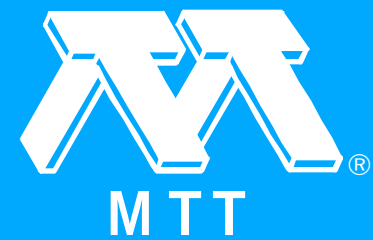
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# Abstracts

## Technical Sessions (1993 Vol. I [MWSYM])

*"Technical Sessions (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 83-83.*



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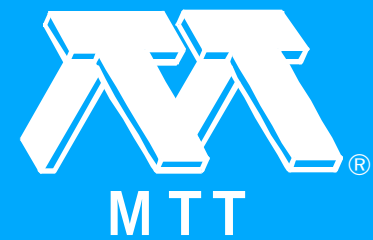
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# Abstracts

## Session A -- The Global Reach of Microwaves (Plenary)

*"Session A -- The Global Reach of Microwaves (Plenary)." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 84-84.*



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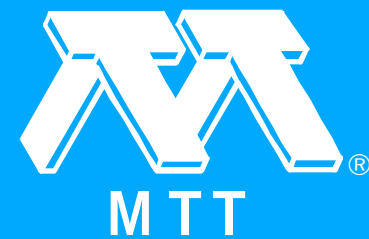
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## Session B (Joint with MMWMC Symposium) -- Advanced MMIC Technology

*"Session B (Joint with MMWMC Symposium) -- Advanced MMIC Technology." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 85-85.*



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# Abstracts

## A Highly-Efficient 7-Watt 16 GHz Monolithic Pseudomorphic HEMT Amplifier (1993 Vol. I [MWSYM])

*H.Q. Tserng and P. Saunier. "A Highly-Efficient 7-Watt 16 GHz Monolithic Pseudomorphic HEMT Amplifier (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 87-90.*

A record cw output power of 7-W with 4.5-dB gain and 30.8% power-added efficiency was achieved with a monolithic, single-stage, 0.25  $\mu\text{m}$  x 12-mm AlGaAs/InGaAs pseudomorphic HEMT amplifier at 16.3 GHz. At 5-W output, the power-added efficiency was 35% with 6-dB power gain. The chip size is 3-mm x 3.5-mm.



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## The Inductive Connection Effects of a Mounted SPDT in a Plastic SO8 Package (1993 Vol. I [MWSYM])

*F. Ndagijimana, J. Engdahl, A. Ahmadouche and J. Chilo. "The Inductive Connection Effects of a Mounted SPDT in a Plastic SO8 Package (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 91-94.*

An investigation of the electrical performances of an assembled SO8 package is presented. Using an equivalent electric network elaborated for the whole assembly, the isolation and the insertion losses are computed for a signal frequency up to 5 GHz. From our modelling and simulation results, the significant effect of the path connection to ground is shown, and the required modifications of the connecting layout are discussed. Our modelling concept, demonstrated on the SO8 package, is applicable on any single chip package.

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## An MMIC Linearized Amplifier Using Active Feedback (1993 Vol. I [MWSYM])

*J.C. Pedro and J. Perez. "An MMIC Linearized Amplifier Using Active Feedback (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 95-98.*

A single 2.4x2.4 mm<sup>2</sup> MMIC chip includes a L-band tuned MESFET Main Amplifier, and a nonlinear feedback path intended to improve its carrier-to-intermodulation margin, C/I. The circuit uses a novel concept of amplifier IMD cancellation, in which a small area MESFET based linearizer is directly applied to the terminals of the main active device. The linearizer provides a 15dB improvement on C/I, over a relative bandwidth of more than 12%. This is, to our knowledge, the first linearized amplifier integrated in MMIC form.

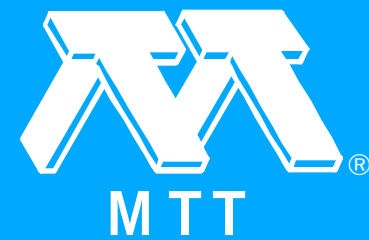
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# Abstracts

## Session C -- Intelligent Vehicle Highway Systems (IVHS) (Special Session)

*"Session C -- Intelligent Vehicle Highway Systems (IVHS) (Special Session)." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 99-99.*



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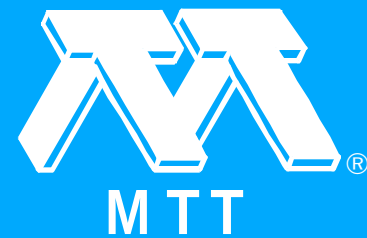


# Abstracts

## Intelligent Vehicle Highway Systems: Challenge for the Future

*J.M. Sussman. "Intelligent Vehicle Highway Systems: Challenge for the Future." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 101-104.*

Intelligent Vehicle Highway Systems is a new paradigm for transportation in this nation. It involves the intimation of technology in areas such as communications, information systems, sensors, and operation research methods with conventional transportation infrastructure to address many transportation issues that confront the nation at this time. It is a fundamentally new way of thinking about transportation.



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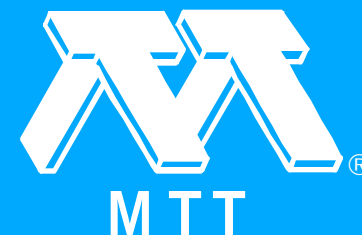
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# Abstracts

## Session D -- Microwave Power Modules (MPM) (Special Session)

*"Session D -- Microwave Power Modules (MPM) (Special Session)." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 105-105.*



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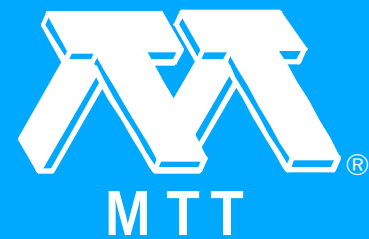
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## Introduction to the MPM: What It Is and Where It Might Fit

*R.H. Abrams, Jr. and R.K. Parker. "Introduction to the MPM: What It Is and Where It Might Fit." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 107-110.*

The Microwave Power Module (MPM) is introduced and described. The synergistic combination of technologies -- MIMIC driver, vacuum power booster, and integrated electronic power conditioning -- has a multitude of advantages for system applications. The MPM is capable of achieving performance not attainable with either solid-state or vacuum-electronics technology alone. Power, efficiency, and noise performance in the 6- to 18-GHz band in a compact lightweight package -- to be available in the first-generation MPM by June 1994 -- will be suitable for selected radar and EW applications. The second-generation MPM will be even more capable and suitable for insertion in a wider range of systems. The background of the MPM Program is detailed; MPM programmatic are presented. To ensure that next-generation MPMs will be even more advantageous to the military and civil system designer, technical challenges that must be met in a variety of technical areas are identified.

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# Abstracts

## MPM Applications: A Forecast of Near- and Long-Term Applications

*L. Cosby. "MPM Applications: A Forecast of Near- and Long-Term Applications." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 111-114.*

Applications for a family of microwave power modules (MPMs) in both military and civil systems have been surveyed and analyzed. Important applications in military radar, electronic warfare, missiles, communications, and space systems will generate demand for quantities in excess of 10/sup 6/ units over the next 15 years, while civilian demands will be an order of magnitude higher for data services and "smart highway" applications.



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# Abstracts

## MPM Technology Developments: An Industry Perspective

*J.A. Christensen, T.J. Grant, P.M. Lally, P. Puri, G. Dohler and S. Ludvik. "MPM Technology Developments: An Industry Perspective." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 115-118.*

The technologies and design approaches being used in the development of the Microwave Power Module are described. The tradeoffs to optimize the overall MPM subsystem performance and the designs and development status of each of the MPM component building blocks are presented. These include the MMIC driver amplifier, the Vacuum Power Booster, and Electronic Power Conditioner. Recent performance results will be available. Future technology enhancements and MPM performance capabilities will be projected.



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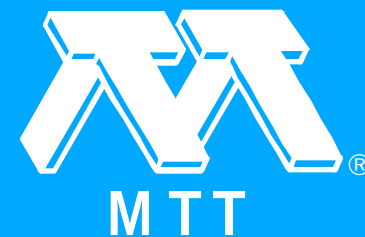
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## Session E -- Manufacturing Methods, Production and Packaging

*"Session E -- Manufacturing Methods, Production and Packaging." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 119-119.*



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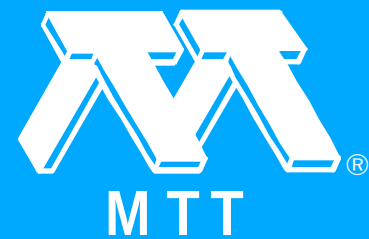
## Inexpensive Mixers for Hi-Rel Commercial Markets

*H. Kaylie and R. Setty. "Inexpensive Mixers for Hi-Rel Commercial Markets." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 121-122.*

Cellular and PCN markets are challenging manufacturers to reduce cost and improve reliability at the same time. To address these requirements an all weld, shielded metal case mixer was developed. Internal components were redesigned for manufacturability and improved reliability. The resultant product is lower in cost than a conventional mixer. Life tests indicate that the reliability goal (5 years) has been well exceeded.

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## Efficient Statistical Analysis of Microwave Circuit Performance Using Design of Experiments

*K.L. Virga and R.J. Engelhardt, Jr.. "Efficient Statistical Analysis of Microwave Circuit Performance Using Design of Experiments." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 123-126.*

Variations of circuit dimensions and material parameters about their nominal values result in microwave circuits that do not perform as expected. This paper describes how the method of Design of Experiments (DOE) maybe used with circuit simulations to statistically characterize the effects that variations of these circuit factors have on circuit performance. The results of a study that uses DOE for the reflection coefficient performance of an antenna radiator circuit are presented.

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## Computer Based Methods for Production Tuning of Microwave Components

*D.E. Stoneking. "Computer Based Methods for Production Tuning of Microwave Components." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 127-130.*

Three multivariate discrimination methods are applied as computer based tuning algorithms during the manufacture of over 9000 C-band power amplifiers. The three methods are parametric, nearest neighbor, and Monte Carlo discrimination. The nearest neighbor and Monte Carlo algorithms are found to be the most useful for tuning microwave components. Monte Carlo discrimination is judged to be the best method. Application of the nearest neighbor and Monte Carlo methods improved the rate of successfully reclaiming initially failing parts from 51% to 82% when compared with manual tuning techniques.

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## Electrical Characterization of Packages for Use with GaAs MMIC Amplifiers

*S.R. Smith and M.T. Murphy. "Electrical Characterization of Packages for Use with GaAs MMIC Amplifiers." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 131-134.*

A test methodology will be presented which combines the advantages of on-wafer RF probing with a TRL calibration to create a completely de-embeddable, novel "test fixture" capable of electrically characterizing most any style package or device. This scheme has been used to characterize many of the currently available microwave packages in order to identify appropriate packages for our MMIC amplifier products which cover frequencies up to 12 GHz. In addition, the technique has been employed to characterize injection molded plastic packages and to evaluate non-probeable MMICs.

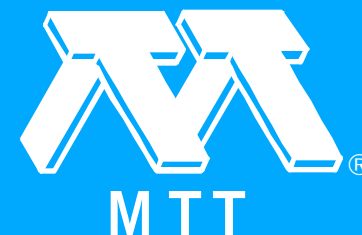
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## Session F (Joint with MMWMC Symposium) -- Broadband MMIC Circuits

*"Session F (Joint with MMWMC Symposium) -- Broadband MMIC Circuits." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 135-136.*



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## A Highly Integrated MMIC K-Band Transmit/Receive Chip (1993 Vol. I [MWSYM])

*H. Fudem, S. Moghe, G. Dietz and S. Consolazio. "A Highly Integrated MMIC K-Band Transmit/Receive Chip (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 137-140.*

A highly integrated wide-band MMIC Transmit/Receive (T/R) chip was designed for both commercial and military FM CW applications. The MMIC circuit was designed using 0.25  $\mu\text{m}$  pseudomorphic HEMT technology. The T/R chip has three 3-stage amplifiers, an active power divider, a diode double-balanced mixer, and a voltage controlled oscillator (VCO) all integrated on a single chip 96 X 71 mils (2.4 X 1.8 mm) in size.

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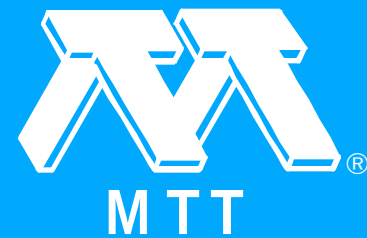


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## A New Compact Wideband Balun (1993 Vol. I [MWSYM])

*M.C. Tsai. "A New Compact Wideband Balun (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 141-144.*

A novel wideband balun has been developed for MMIC applications. The new approach utilizes simple RF reflection and coupling principles to achieve a wideband performance in a simple microstrip configuration. A balun with better than 2 dB of insertion loss, 1 dB and 5° of amplitude and phase balance over 7 to 19 GHz has been realized.



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## Ultra Low Impedance CPW Transmission Lines for Multilayer MMIC's (1993 Vol. I [MWSYM])

*M. Gillick and I.D. Robertson. "Ultra Low Impedance CPW Transmission Lines for Multilayer MMIC's (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 145-148.*

A new technique for realising low-loss coplanar waveguide transmission lines with ultra-low characteristic impedance on multilayer MMIC's is presented. The performance of these CPW lines is investigated experimentally with either (a) ground planes extended under the signal conductor or (b) the center conductor extended underneath the ground planes. Using this technique characteristic impedances as low as  $7\Omega$  have been realised. The technique has been compared extensively with the proven standard thin-film microstrip transmission line. The TFMS technique can be used for lines with characteristic impedance as low as  $3.6\Omega$ , but is found here to be significantly more lossy.

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## A Highly Compact, Wideband GaAs HEMT X - Ku Band Image-Reject Receiver MMIC (1993 Vol. I [MWSYM])

*R. Katz, M.V. Aust, R. Kasody, H. Wang, B. Allen, G.S. Dow, K. Tan, S. Lin and R. Myers. "A Highly Compact, Wideband GaAs HEMT X - Ku Band Image-Reject Receiver MMIC (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 149-152.*

A fully integrated MMIC receiver was designed and fabricated using the 0.2 $\mu$ m pseudomorphic InGaAs/GaAs HEMT process technology. This MMIC receiver incorporates a single-stage RF amplifier, a two-staged balanced LO amplifier, a single-stage IF amplifier, an IF switch and an image-reject diode mixer. Results from these receiver chips showed good conversion gain and image rejection in a single small chip over multi-octave frequencies. This chip operates from a single +5 Vdc and draws 280 mA. Total chip size is 5.5mm x 4.5mm.



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*"Session G -- MMW Systems and Techniques." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 153-154.*



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## Quasi-Optical Cavity Dumping at Millimetre Wave Frequencies

*G.M. Smith, J.C.G. Lesurf, Y. Cui and M. Dunn. "Quasi-Optical Cavity Dumping at Millimetre Wave Frequencies." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 155-158.*

A thin silicon wafer when illuminated by a Q-switched frequency doubled Nd-YAG laser is used as a very fast, ultra-low loss, quasi-optical, photo-conductive switch to cavity dump a millimetre-wave open resonator. This novel scheme should provide short pulses at millimetre wave frequencies with power gains of several hundred from conventional cw sources. Potential applications are in high resolution radar, plasma diagnostics and pulsed electron spin resonance experiments.

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## Quasi-Optical Power Combining of Solid State Sources in K/sub a/-Band

*H.M. Harris, A. Torabi, R.W. McMillan, C.J. Summers, J.C. Wiltse, S.M. Halpern and D.W. Griffin. "Quasi-Optical Power Combining of Solid State Sources in K/sub a/-Band." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 159-162.*

Planar arrays of HEMTs (high electron mobility transistors) have been fabricated and tested at 37 GHz. The square arrays, consisting of 9 or 16 devices, have been mounted in a Fabry-Perot interferometer, which provides frequency locking. Measured power output and frequency spectra will be given, and will be compared with analytical predictions. Output power is in the milliwatt range, and line width of a typical array is about 50 kHz.

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## W-Band MMIC Direct Detection Receiver for Passive Imaging System

*G.S. Dow, T.N. Ton, H Wang, D.C.W. Lo, W. Lam, B. Allen, K. Tan, J. Berenz, L. Yujiri, M. Mussetto and P. Lee. "W-Band MMIC Direct Detection Receiver for Passive Imaging System." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 163-166.*

We have demonstrated for the first time W-band MMIC direct detection receivers for passive millimeter-wave imaging applications. These receivers were developed using InGaAs HEMT based W-band LNA and preamplifier detector MMICs. The first receiver uses a 50 dB gain, 6 dB noise figure amplifier and a Schottky barrier diode waveguide detector. The amplifier uses four W-band MMIC LNAs. The second receiver consists of two 3-stage MMIC LNAs and a MMIC preamplified / detector chip. Individual receiver was integrated with a millimeter-wave camera system. Field imaging acquisition runs were performed using the camera in stepping pushbroom image acquisition mode with excellent results.

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## A Planar 94-GHz Transceiver with Switchable Polarization

*E.C. Niehenke, P. Stenger, T. McCormick and C. Schwerdt. "A Planar 94-GHz Transceiver with Switchable Polarization." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 167-170.*

Design and performance of a unique, low cost, planar microstrip 94-GHz transceiver is described. It includes a two axis, monopulse fed, four element, switchable, right hand-left hand circularly polarized patch antenna. All circuits are MMIC (mixer, IF amplifier, and RF PIN diode switch) interconnected with low loss, Z-cut quartz microstrip. The miniature 1.1-inch diameter by 0.25-inch thick transceiver operated both in the transmit as well as the receive mode with a 3-dB beamwidth of 58 degrees. When mounted as a feed for a 5-inch diameter parabolic dish, the assembly exhibited a 1.7-degree 3-dB beamwidth, 12-dB sidelobes, a gain of 26 dB, with a difference pattern null of 30 dB.

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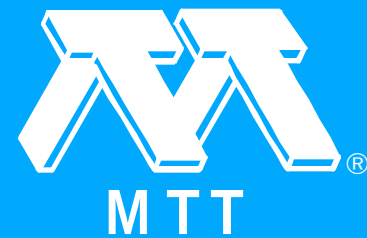


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## A W-Band Wafer Probe

*E.M. Godshalk. "A W-Band Wafer Probe." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 171-174.*

A W-band (75-110 GHz) wafer probe is presented. The probe uses ridge-trough waveguide to transition from a rectangular waveguide input to coplanar waveguide used on the probe board output. Research was conducted on radiation loss and moding in coplanar waveguide to minimize insertion loss and maintain a coplanar mode. The probe is shown to work successfully and data is presented for W-band HEMTs.



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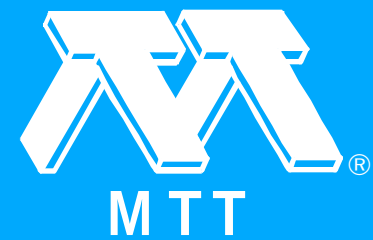
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## Session H -- Miniaturized and Active Filters

*"Session H -- Miniaturized and Active Filters." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 175-176.*



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## A Very Small Dielectric Planar Filter for Portable Telephones

*T. Ishizaki, M. Fujita, H. Kagata, T. Uwano and H. Miyake. "A Very Small Dielectric Planar Filter for Portable Telephones." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 177-180.*

A high performance dielectric filter with the size of 4.5mm x 3.2mm x 2.0mm has been developed. It has two planar resonators and is made of high permittivity multilayer ceramic in the Bi-Ca-Nb-O system. The performance is distinctive with its attenuation pole. An equivalent lumped circuit is derived to explain the behaviors of attenuation pole quantitatively.

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## Dual-Plane Coupled-Line Microwave Filter

*S.-J. Yao and R.R. Bonetti. "Dual-Plane Coupled-Line Microwave Filter." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 181-184.*

Realization of a bandpass elliptic filter which employs quasi TEM resonators at different planes coupled through small apertures is described herein. Bethe's small-hole diffraction theory is used to predict the aperture couplings. An experimental filter illustrates the concept and shows that the configuration is suitable for high-temperature superconducting thin film implementation.



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## Theoretical and Experimental Analysis of Microwave Tunable Recursive Active Filters Using Power Dividers

*L. Billonnet, B. Jarry and P. Guillon. "Theoretical and Experimental Analysis of Microwave Tunable Recursive Active Filters Using Power Dividers." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 185-188.*

We show how power dividers can be effectively employed in the design of microwave recursive filters in strict accordance to low frequency principles. We present analytical, computer-simulated and experimental results for an active recursive band pass filter, and for a newly developed tunable recursive active filter, employing a reflection-type microwave phase shifter and implemented on a Duroid substrate in the 2.75-3.75 GHz range.

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## A Dual-Mode Microstrip Ring, Resonator Filter with Active Devices for Loss Compensation

*U. Karacaoglu, I.D. Robertson and M. Guglielmi. "A Dual-Mode Microstrip Ring, Resonator Filter with Active Devices for Loss Compensation." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 189-192.*

A new bandpass filter design is presented which uses a dual-mode microstrip ring resonator with a pair of FETs which provide negative resistance to compensate for the losses in the ring. The measured results show excellent performance, with a 32 MHz 3-dB bandwidth centred at 1.48 GHz. The technique used in this paper is particularly attractive because of its ability to implement two transmission poles and two transmission zeros with only one ring if a suitable mode-coupling structure is designed. The advantage of the combined passive resonator and active device technique is that the poles and zeros of the filter are accurately defined by the ring dimensions, and the FETs only provide negative resistance to compensate for the ring losses. Hence, the filter is less sensitive to environmental changes than a filter based on entirely active techniques.

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## Noise Design of Active Feedback Resonator BEF (1993 Vol. I [MWSYM])

*Y. Ishikawa, S. Yamashita and S. Hidaka. "Noise Design of Active Feedback Resonator BEF (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 193-196.*

Active feedback resonator (AFR) filters are available to use design techniques for conventional passive microwave filters by introducing noise temperature of resonator. The noise figure (NF) of AFR filters can be analytically designed by utilizing noise temperature. In this paper, a three-pole AFR band elimination filter (BEF) is designed to evaluate NF value. The observed results agree well with the theoretical values.



# Abstracts

## Session I -- Status of Microwave Ferrite Technology (Special Session)

*"Session I -- Status of Microwave Ferrite Technology (Special Session)." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 197-198.*



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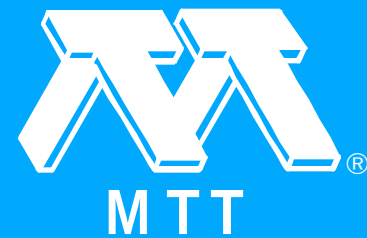


# Abstracts

## Status of Microwave Ferrite Technology in Europe

*L.E. Davis. "Status of Microwave Ferrite Technology in Europe." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 199-202.*

An overview of microwave ferrite-related activity in France, Germany, Spain, Poland and the UK is given. The topics include: ferrite materials and measurements, filters, junction circulators, numerical methods for gyrotropic planar circuits, coupled-line circulators and frequency-selective limiting.



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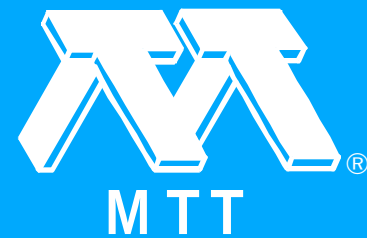


# Abstracts

## Status of Ferrite Technology in the United States

*D.C. Webb. "Status of Ferrite Technology in the United States." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 203-206.*

Within the past few years there has been a resurgence of interest in the United States in developing ferrite technology for microwave applications. Emphasis has been on new material growth techniques, especially thin-film approaches, as well as improved device configurations. Although much of the activity has been directed toward developing ferrite components that are compatible with monolithic circuits, there has also been steady progress in advancing the state-of-the-art in high-power waveguide technology to support vacuum electronics based systems.



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## Microwave Ferrite Technology in Japan: Current Status and Future Expectations

*Y. Murakami. "Microwave Ferrite Technology in Japan: Current Status and Future Expectations." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 207-210.*

An overview of the current status of Japanese microwave ferrite technology is presented. Some recent progress and topics in microwave isolators and circulators are discussed. Special emphasis is placed on recent developments in state of the art YIG thin film devices. Possible future applications of the technology in consumer electronics are projected in conclusion.

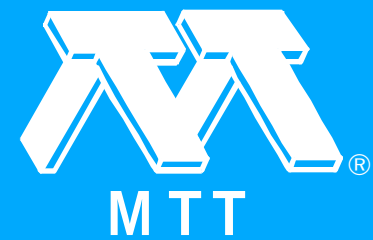
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## Session OF1 -- Interactive Forum I

*"Session OF1 -- Interactive Forum I." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 211-212.*



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## Analysis of LiNbO<sub>3</sub>/ Optical Modulator Using Coplanar-Type Electrodes

*T. Kitazawa, D. Polifko and H. Ogawa. "Analysis of LiNbO<sub>3</sub>/ Optical Modulator Using Coplanar-Type Electrodes." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 213-216.*

A comprehensive study is presented for the coplanar-type TW electrode of the Ti:LiNbO<sub>3</sub>/ optical modulator, taking the anisotropy of the LiNbO<sub>3</sub>/, the effect of the SiO<sub>2</sub>/ buffer layer, the overlay and the electrode thickness into consideration. Accurate hybrid-mode computations reveal that the figure of merit  $\Delta f/V_{\pi}$  is affected significantly by the electrode thickness and the overlay, and that the modulator performance can be improved by utilizing these effects advantageously. Also, numerical computations show that there exist the upper frequency limit  $f_u$ , where mode coupling occurs. Therefore, special care should be taken for the choice of the thickness of the LiNbO<sub>3</sub>.

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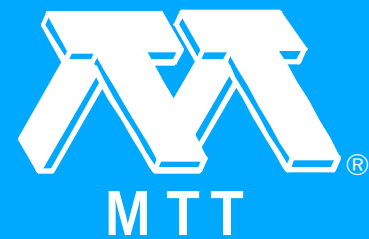
Authors

## A Large Signal Equivalent Circuit Model for Multielectrode Laser and Microwave Semiconductor Lasers for CAD Applications

*H. Elkadi, S. Maricot, R. Hamelin, J. Harari, J.P. Vilcot and D. Decoster. "A Large Signal Equivalent Circuit Model for Multielectrode Laser and Microwave Semiconductor Lasers for CAD Applications." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 217-220.*

We present an equivalent circuit large signal model of semiconductor lasers for microwave applications. The model is implemented on SPICE software and is based on a modified set of the monomode rate equations. The carriers density in the active region is related to the potential at the terminals of the active region by a polynomial approximation of the Fermi Integral. Different recombination mechanisms (Shockley-Hall-Read, spontaneous and Auger) are represented by separate terms and not as a global constant life time. The model also accounts for saturable absorption occurring in the case of multielectrode lasers. Different applications are presented. A study of the behaviour of a multielectrode laser with saturable absorbers, under static, transient and small signal conditions is performed. The study shows the bistability of this type of lasers and predicts an extremely wide band up to the millimetric frequencies range. Another application of the model is the matching of the impedance of the laser to the 50Ω of the microwave source; using passive reactive circuit.





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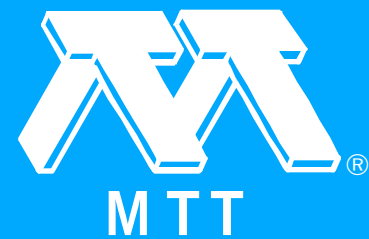
## Calibration of External Electro-Optic Sampling Using Field Simulation and System Transfer Function Analysis

*X. Wu, D. Conn, J. Song and K. Nickerson. "Calibration of External Electro-Optic Sampling Using Field Simulation and System Transfer Function Analysis." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 221-224.*

A field based calibration technique for external electro-optic (E-O) sampling has been proposed using the system transfer function approach and verified by simulation. The optical simulation incorporated with the Finite-Difference Time-Domain (FD-TD) full wave field analysis is used to predict the optical output in external E-O sampling and to evaluate the system transfer function. This calibration technique will enable us to de-embed the distortion in E-O sampling and to move E-O sampling further towards quantitative measurements. It is found that distortions can be introduced by probes due to their intrinsic frequency response determined by probe dimensions and materials. Generally, it is confirmed that thin probes exhibit less distortion in picosecond or subpicosecond measurements.

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## A Comparison of Noise Performance Between a PIN Diode and MMIC HEMT and HBT Optical Receivers

*H. Ogawa, S. Banba, E. Suematsu, H. Kamitsuna and D. Polifko. "A Comparison of Noise Performance Between a PIN Diode and MMIC HEMT and HBT Optical Receivers." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 225-228.*

The noise performance of MMIC HEMTs and HBTs are experimentally compared with conventional PIN photodiodes. HEMT and HBT are fabricated using a conventional MMIC process. These devices are characterized using a modified electrooptic on-wafer probe station and a LiNbO<sub>3</sub> optical external modulator. The attained signal-to-noise ratio of HEMT, HBT and PIN detectors at a signal frequency of 1GHz, an optical carrier of 0.83 $\mu$ m and a frequency bandwidth of 1MHz are 52.3dB, 55.9dB and 54.1dB, respectively.

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## MCQW Intensity Optical Modulator for InP Based MMIC/Photonics Integrated Circuits

*M.T.C. Silva, M.A.G. Martinez and P.R. Herczfeld. "MCQW Intensity Optical Modulator for InP Based MMIC/Photonics Integrated Circuits." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 229-232.*

This paper is concerned with chip level integration of photonic devices and MMICs. The focus is on a InP-based multicoupled quantum well intensity optical modulator. In the proposed configuration, the microwave field induces a periodic structure via the electrorefractive effect. The interaction of light with the induced grating yields a modulated optical signal. The paper discusses the structure and the expected performance of the device.

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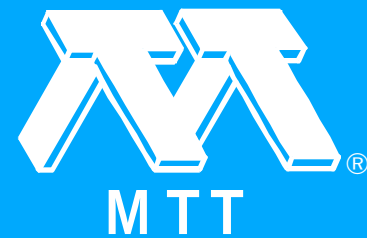


# Abstracts

## Broadband Microwave Matching of High Speed Photodiodes

*C.L. Goldsmith and B. Kanack. "Broadband Microwave Matching of High Speed Photodiodes." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 233-236.*

This paper discusses the successful demonstration of broadband impedance matching of high-speed photodiodes over the 2-4 GHz frequency range. The photodiodes were matched with a resistive/reactive matching technique which achieved a good output match while improving fiber link transmission response and sensitivity by as much as 6 dB.



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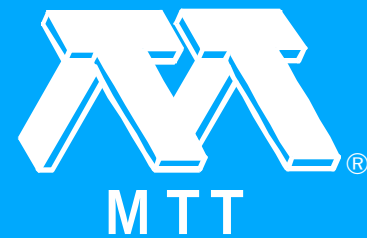


# Abstracts

## A Slow-Wave Resonant Electrode Design for Optical Modulators

*M. Yu and A. Gopinath. "A Slow-Wave Resonant Electrode Design for Optical Modulators." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 237-240.*

A slow-wave resonant electrode structure is proposed for the phase velocity matching between the RF wave and optical signal in III-V optical modulators. The resonant structure should result in reduced RF drive requirements for the modulator.



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## Holographic Imaging of Microwave Propagation

*H. Kitayoshi, B. Rossiter, A. Kitai, H. Ashida and M. Hirose. "Holographic Imaging of Microwave Propagation." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 241-244.*

A comparatively small plane scanning antenna and a general-purpose microwave spectrum analyzer were used to record two-tone continuous-wave holograms. Phase differences in the reconstructed holograms and the amplitude data on images extracted from these holograms enabled highly sensitive three-dimensional high-resolution electromagnetic wave propagation imaging and holographic radar imaging.

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## An Enhanced Active Load-Pull System for Highly Mismatched Power Transistor Measurements

*J.M. Coupat, P. Bouysse, J.M. Nebus and J.P. Villotte. "An Enhanced Active Load-Pull System for Highly Mismatched Power Transistor Measurements." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 245-248.*

The experimental characterization of highly mismatched power transistors has always been a very difficult task to achieve. Practically, it is not within the capabilities of mechanical tuning systems because of the inherent losses of these devices. Active load-pull systems allow to simulate highly reflective load impedances close to the edge of the Smith chart by driving the output of the device with a large available power source. However, in such conditions, experience shows that the transistor under test may be quickly damaged if the phase adjustment of the output injected power wave is not carefully and properly monitored. That means that classical active load-pull systems "suffer from" poor reliability for the measurement of highly mismatched power components. We propose in this paper a novel load-pull technique providing an attractive solution to these problems. It consists in performing fine and accurate electronic load perturbations around initial mismatches. The associated measurement set-up is described. Measurement results of silicon bipolar power transistors are given.

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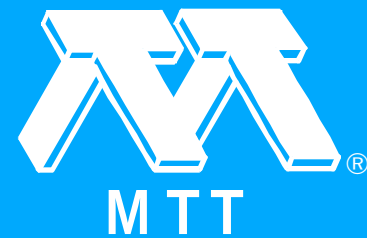


# Abstracts

## High Resolution Target Range Estimation Using Frequency-Stepped CW Radar

*G.A. Ybarra, G.L. Bilbro, S.M. Wu, S.H. Ardalan, C.P. Hearn and R.T. Neece. "High Resolution Target Range Estimation Using Frequency-Stepped CW Radar." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 249-252.*

An optimal signal processing algorithm is derived for obtaining high resolution target range estimates from a small set of narrow bandwidth frequency-stepped CW radar measurements. Performance of the optimization approach is illustrated using measured data obtained from an HP-8510 network analyzer.



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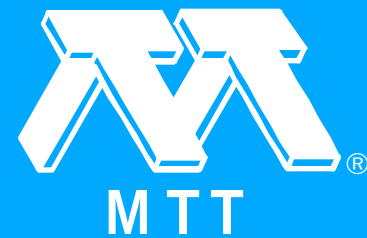


# Abstracts

## The Surface Roughness Measurement of Metals Using Microwave

*Z. Ding and J. Huang. "The Surface Roughness Measurement of Metals Using Microwave." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 253-256.*

A new principle of surface roughness measurement of metals using microwave is developed. The relations between surface roughness and reflected microwave power are found for the first time. A single chip microcomputer is used for processing and displaying the results. This method features non-contact inspection and real time operation as well as high accuracy and ease of application.



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## A New Method for Measuring Properties of Unhomogeneous Materials Using a Two-Polarization Forward-Scattering Measurement

*A.P. Toropainen. "A New Method for Measuring Properties of Unhomogeneous Materials Using a Two-Polarization Forward-Scattering Measurement." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 257-260.*

A new method for measuring properties of grainy materials using a two-polarization scattering measurement combined with the free-space phase measurement is introduced. Theoretical background of the measurement method is presented. Laboratory measurements of the depolarized scattering cross sections of white rice, green lenses, polystyrene grains, polyethylene grains and mixtures of them at 10 and 35 GHz using a vector network analyzer and two horn antennas are presented. Results are compared with those based on the first order multiple scattering theory. Also laboratory tests of the compensation of the effects of changes in the number density the permittivity of the inclusions of mixtures using a phase measurement are presented. A low-cost measurement set-up for industrial measurements is also suggested.

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# Abstracts

## Measurement-Based Large-Signal Diode Model, Automated Data Acquisition System, and Verification with On-Wafer Power and Harmonic Measurements

*D.E. Root, M. Pirola, S. Fan and A. Cognata. "Measurement-Based Large-Signal Diode Model, Automated Data Acquisition System, and Verification with On-Wafer Power and Harmonic Measurements." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 261-264.*

A new relaxation-time large-signal table-based diode model for circuit simulation is presented. Also presented is a fully automated system which characterizes the device and generates the tabular data file used by the model. Excellent agreement between simulated and measured fundamental and second through fourth harmonic power levels is demonstrated for a MODFET diode up to frequencies of 48 GHz.



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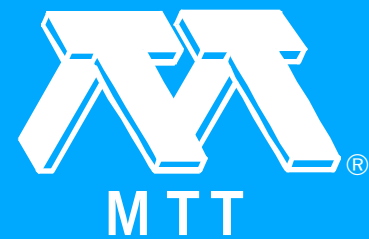
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## Characterization and Optimization of Electrooptic Sampling by Volume-Integral-Method and Application of Space-Harmonic Potential

*M. Rottenkolber, W. Thomann and P. Russer. "Characterization and Optimization of Electrooptic Sampling by Volume-Integral-Method and Application of Space-Harmonic Potential." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 265-268.*

The relationship between the electric field-components of planar microwave structures and optical fields of a Gaussian sampling-beam of an Electrooptic-Sampling-System for the case of direct probing or the use of an electrooptic probe tip are essential for the application of noncontact and non-invasive measurement of high-frequency integrated microwave circuits. The described volume-integral-method yields a rigorous treatment of the influence of the electrical field and the optical beam. In case of an external electrooptic probe tip a layered structure with a space-harmonic potential is investigated in detail and results on sensitivity and spatial resolution are presented.

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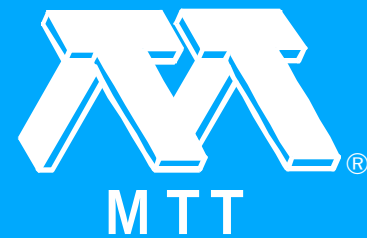


# Abstracts

## The Complex Permittivity of Aluminium Nitride Substrates

*P. Wright and L.E. Davis. "The Complex Permittivity of Aluminium Nitride Substrates." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 269-272.*

The complex permittivities of aluminium nitride substrates manufactured by several companies have been measured and found to be significantly different. The facility used for the measurements is described. Results of measurements of the thermal conductivities of the materials will also be reported.



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## Graphical Design Method for Traveling Wave Amplifier Based on Filter Theory

*C. Paoloni and S. Kosslowsky. "Graphical Design Method for Traveling Wave Amplifier Based on Filter Theory." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 273-276.*

A graphical procedure for a straightforward Traveling Wave Amplifier design is presented. The introduction of filter theory with respect to the conventional methods allows for a sensible improvement of the input and output VSWR of the circuit. The use of normalized parameters and charts brings a process independent applicability of the method.

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## High Efficiency Single and Push-Pull Power Amplifiers

*S. Toyoda. "High Efficiency Single and Push-Pull Power Amplifiers." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 277-280.*

In this paper, a high efficiency single and push-pull power amplifiers are described. We can construct the high efficiency power amplifier by using the higher harmonics along with the fundamental wave. By connecting the parallel resonators for the fundamental wave  $f_0$  and the third harmonic  $3f_0$  to the load circuit of the amplifier, we can synthesize a square wave which is necessary for obtaining the efficiency amplifier. The single and push-pull power amplifiers were constructed and tested. The operating frequency was 0.9 GHz, and the maximum output power and the power added efficiency were 36.1 dBm and 60 %, respectively, for the single amplifier and they were 39 dBm and 81 % for the push-pull power amplifier.

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## Thermal Stability Analysis of Multiple Emitter Finger Microwave AlGaAs/GaAs Heterojunction Bipolar Transistors

*L.L. Liou, B. Bayraktaroglu and C.I. Huang. "Thermal Stability Analysis of Multiple Emitter Finger Microwave AlGaAs/GaAs Heterojunction Bipolar Transistors." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 281-284.*

We developed a numerical electro-thermal model for AlGaAs/GaAs heterojunction bipolar transistors (HBTs) taking into account the nonuniform junction temperature rise due to self-heating. The model simulates both the dc current-voltage (I-V) characteristics and microwave performance of multi-emitter finger devices. The linear active region of the common-emitter I-V characteristics exhibits "current crush", where the collector current rapidly decays with increasing collector voltage due to the formation of highly localized hot spots within the device. It was also shown that a rapid fall off in the cut-off frequency and maximum frequency of oscillation occurs corresponding to the onset of this thermal instability. Methods of overcoming this instability using emitter ballast resistors and higher thermal conductivity substrates were discussed with corresponding effects on dc and microwave performance of the device.





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## Optimization of Trade-Offs Between Efficiency and Intermodulation in SSPAs Based on Experimental and Theoretical Considerations

*C. Duvanaud, P. Bouysse, J.M. Nebus, L. Lapierre and J.P. Villotte. "Optimization of Trade-Offs Between Efficiency and Intermodulation in SSPAs Based on Experimental and Theoretical Considerations." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 285-288.*

This paper examines the problem of improving trade-offs between power added efficiency and third order intermodulation in power FETs. Intermodulation and power added efficiency of a commercially available 4 watt power FET (FUJITSU FLM 7785-4C) have been fully characterized by using an active load pull technique. Significant variations of power added efficiency, third order intermodulation and differential gain compression versus bias conditions and load impedances are observed by experimentation and confined by theoretical non-linear analysis. Both experimentation and theoretical analysis proposed in this paper provide a valuable contribution to the optimization of trade-offs between power added efficiency and third order intermodulation in communication power amplifiers.

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## High Reliability Power GaAs MESFET Under RF Overdrive Condition

*H. Hasegawa, K. Katsukawa, T. Itoh, T. Noguchi and Y. Kaneko. "High Reliability Power GaAs MESFET Under RF Overdrive Condition." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 289-292.*

This paper reports on high reliability high power GaAs MESFETs with SiO<sub>2</sub>/sub 2/ passivation film. For these MESFETs, no degradation has been observed up to 1500 hours even under 8 dB gain compression condition.



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## Modeling a New Generation of RF Devices: MOSFETs for L-Band Applications

*J.C. Costa, D. Lovelace, D. Ngo and N. Camilleri. "Modeling a New Generation of RF Devices: MOSFETs for L-Band Applications." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 293-296.*

Results on large signal modeling efforts of a novel MOSFET technology for L-band RF applications will be presented. A parameter extraction procedure which yields accurate RF MOS large-signal models using DC and s-parameter data is presented along with a comparison of measured and modeled class-B amplifier, mixer and s-parameter data.

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## Design-Oriented Non-Linear Analysis of Class-AB Power Amplifiers

*F. Giannini, G. Leuzzi, E. Limiti and L. Scucchia. "Design-Oriented Non-Linear Analysis of Class-AB Power Amplifiers." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 297-300.*

In this work an efficient and reliable non-linear analysis method is proposed for the analysis and design of high-efficiency power amplifiers operating in any class. On the basis of a simplified device model, the method can be used for the optimization of efficiency, output power and drive level of a power stage. Its feasibility is demonstrated comparing the method with the results of a more elaborate non-linear CAD analysis program and with experimental data.

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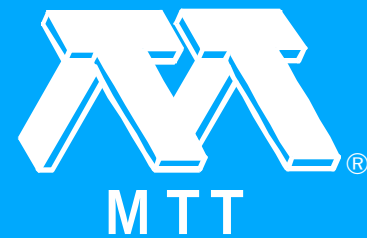


# Abstracts

## New Design Method for the Distributed Amplifier

*W. Wu, Q. Yang and T. Li. "New Design Method for the Distributed Amplifier." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 301-304.*

The inherent relations between the microwave distributed amplifier and the FIR (Finite Impulse Response) digital filter are determined by the digital signal processing theory. In accordance with the relations, the distributed amplifier can be designed in time domain and the window function technique can be introduced into the design method. In addition, the design example is offered to demonstrate that the design method is simple and effective.



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## Excess Noise in GaAs MESFET Oscillators

*G.L. Bilbro, A.N. Riddle and R.J. Trew. "Excess Noise in GaAs MESFET Oscillators." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 305-308.*

A new technique for numerically simulating oscillator noise spectra is introduced. Additive and multiplicative noise is simulated for three industrial GaAs MESFET designs (with buried-, uniform-, and ion implanted channels) oscillating in simple resonant circuits at a center frequency of  $f_0 = 4$  GHz. Each oscillator exhibits excess  $1/f$  noise so that  $S_{\Phi}(f) \propto f^{-3}$  for small offset frequency  $f$ . The simulation predicts that the buried channel oscillator is about 12 dB quieter than oscillators built around either the uniform channel or ion-implanted devices, partly because of differences in device  $Q$ 's. Using  $S_{\Phi}/Q$  as a figure of merit to account for different  $Q$ 's, the uniform channel device is 2 dB/ $Q$  quieter than the buried channel circuit and about 0.5 dB/ $Q$  quieter than the ion-implanted circuit.

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# Abstracts

## A General-Purpose Harmonic-Balance Approach to the Computation of Near-Carrier Noise in Free-Running Microwave Oscillators

*V. Rizzoli, F. Mastri and D. Masotti. "A General-Purpose Harmonic-Balance Approach to the Computation of Near-Carrier Noise in Free-Running Microwave Oscillators." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 309-312.*

The paper discusses a novel harmonic-balance approach to the computation of near-carrier phase and amplitude noise in free-running microwave oscillators. The well-known qualitative picture of phase noise generation is quantitatively re-stated in a way compatible with the needs of general-purpose CAD. The capabilities of previously available approaches to the same problem are extended under several aspects.



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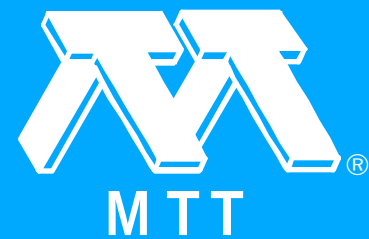
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## Optical Measurements of Microwave Grid Oscillator Power Combiners

*K.Y. Chen, P. Biernacki, A.R. Mickelson and Z.B. Popovic. "Optical Measurements of Microwave Grid Oscillator Power Combiners." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 313-316.*

A unique electrooptic sampling technique is used to measure the potential distribution on a 5.8 GHz 25-HEMT grid oscillator power combiner built on a GaAs electrooptic substrate. The grid oscillator is a two-dimensional planar array of HEMT oscillators, backed by a metal mirror that provides feedback and unidirectional radiation. From the measured potential distribution, the current distribution along the radiating leads and bias lines is found. No edge effects were observed on a square grid that is smaller than a free-space wavelength on the side. It was found that each unit cell in the grid can operate independent y and that the bias lines provide the boundary conditions necessary for oscillation. Knowing the exact current distribution is important for designing the output power of such quasi-optical combiners.

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# Abstracts

## A Novel Parallel Running System of Four Oscillators Coupled through an Eight-Port Hybrid

*I. Ohta and M. Higashio. "A Novel Parallel Running System of Four Oscillators Coupled through an Eight-Port Hybrid." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 317-320.*

This paper treats a novel parallel running system of four oscillators equally coupled to one another through an eight-port hybrid. This system is marked by easy analyzability and adjustability from the symmetrical construction. In addition, a combined power is distinguishably delivered to an arbitrary port of four output ports, that is, can be switched into four ways. Experimental corroboration is presented also.



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## A Push-Pull Self-Oscillating Mixer for Optically Fed Phased Array

*X. Zhou and A.S. Daryoush. "A Push-Pull Self-Oscillating Mixer for Optically Fed Phased Array." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 321-324.*

The optical control of the distributed electronics in phased array antennas requires specialized circuits which are compatible with the T/R level data mixing architecture. This paper presents a novel circuit, a push-pull self-oscillating mixer, that can perform three important functions: 1) oscillation, 2) frequency and phase locking to a reference signal, and 3) mixing with the data signals. This proposed circuit performs these three functions efficiently in a low power consuming circuit. Until now, these functions could be done only through independent circuits. This concept was analyzed and experimentally demonstrated at 12 GHz by use of a MESFET pair with a measured conversion efficiency as high as 13 dB and noise figure of 9 dB. Efficient subharmonic injection locking was also demonstrated. This design can be easily extended to HEMT and HBT at higher frequencies.





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## A Low-Noise 86-90 GHz Uniplanar Schottky-Receiver

*G. Gauthier, T.P. Budka, W.Y. Ali-Ahmad, D.F. Filipovic and G.M. Rebeiz. "A Low-Noise 86-90 GHz Uniplanar Schottky-Receiver." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 325-328.*

A millimeter-wave Schottky-receiver based on a coplanar-waveguide (CPW) fed double-slot antenna is described. The double-slot antenna is backed by an extended hemispherical silicon substrate lens. The design is uniplanar and requires no via holes or a backing ground-plane. The receiver results in a 6.9 dB measured double sideband (DSB) conversion loss at 86-90 GHz and a DSB noise temperature of 1200K. The DSB conversion loss drops to 5.7 dB when the residual matching-cap reflection loss (0.9 dB) and IF reflection loss (0.3 dB) are calibrated out of the measurements. The CPW-fed double-slot antenna results in a low-cost millimeter-wave uniplanar receiver with a performance that is within 3 dB of the best waveguide mixers at millimeter-wave frequencies.

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## Millimeter-Wave Simulation of a Series-Integrated Resonant Tunneling Diode Including Transit Time Effect

*C.C. Yang and D.-S. Pan. "Millimeter-Wave Simulation of a Series-Integrated Resonant Tunneling Diode Including Transit Time Effect." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 329-332.*

An oscillator scheme that substantially increases the millimeter-wave power generation capabilities of the quantum-well resonant tunneling diode (RTD) by a device-level series integration is analyzed. A series-integrated RTD including transit time effect has been simulated in great detail at millimeter-wave frequencies. Using the available experimental characteristics of a GaAs/AlAs quantum-well RTD, our simulation shows that, for example, 120 mW output power with 10% dc-to-RF conversion efficiency at a 5- $\Omega$  load can be obtained at 100 GHz, when ten such RTD's are integrated in series.

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# Abstracts

## Whisker Embedding Impedance for Millimeter Wave Diode Circuits

*J. Xu and A.V. Raisanen. "Whisker Embedding Impedance for Millimeter Wave Diode Circuits." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 333-336.*

This paper reports our newer developments on theoretical modeling of a whisker mounted in a rectangular waveguide. The moment method in conjunction with the dyadic Green's function is employed to analyze this structure. Effects of whiskers with various types of shape on the embedding impedance are investigated and presented.



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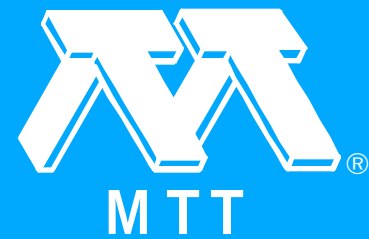
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## A 60GHz - Band Ultra Low Noise Planer - Doped HEMT

*T. Katoh, N. Yoshida, H. Minami, T. Kashiwa and S. Orisaka. "A 60GHz - Band Ultra Low Noise Planer - Doped HEMT." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 337-340.*

An ultra low noise AlGaAs/InGaAs HEMT with a 0.15 $\mu$ m T-shaped gate and Si planer-doped layer has been developed for millimeter-wave systems. The HEMT showed the extremely reduced minimum noise figure of 1.6dB and high associated gain of 6.5dB at 60GHz. The noise figure is the lowest value ever reported for the AlGaAs/InGaAs pseudomorphic HEMT.

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## A W-Band Subharmonically Pumped Resistive Mixer Based on Pseudomorphic Heterostructure Field Effect Transistor Technology

*H. Zirath, I. Angelov, N. Rorsman and C. Karlsson. "A W-Band Subharmonically Pumped Resistive Mixer Based on Pseudomorphic Heterostructure Field Effect Transistor Technology." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 341-344.*

This paper describes the first sub-harmonically pumped resistive mixer (SPRM) based on HFETs, operating in the W-band (75-110 GHz). Two HFET devices, specially designed for this application, were integrated together with a coupler, 180° phase shifter, and an IF-filter. Both theoretical and experimental results are presented in this paper. A minimum conversion loss of about 22 dB was experimentally obtained at an LO-power of 10 dBm.

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## Manufacturability of 0.1- $\mu\text{m}$ Millimeterwave Low-Noise InP HEMTs

*L. Nguyen, M. Le, M. Delaney, M. Lui, T. Liu, J. Brown, R. Rhodes, M. Thompson and C. Hooper. "Manufacturability of 0.1- $\mu\text{m}$  Millimeterwave Low-Noise InP HEMTs." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 345-348.*

We report on the manufacturability of state-of-the-art passivated 0.1- $\mu\text{m}$  low-noise InP HEMTs. These HEMTs offer an attractive, cost-effective solution to millimeter-wave satellite communications. We will discuss their yield and reproducibility, as well as typical performance at V- and W-bands.

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## GaAs HBT PIN Diode Attenuators and Switches (1993 Vol. I [MWSYM])

*K.W. Kobayashi, A.K. Oki, D.K. Umemoto, S. Claxton and D.C. Streit. "GaAs HBT PIN Diode Attenuators and Switches (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 349-352.*

We report on an AlGaAs/GaAs HBT 2-stage pin diode attenuator from 1-10 GHz, an X-band 1-pole 2-throw X-band pin diode switch. The 2-stage pin attenuator has over 50 dB dynamic range at 2 GHz, a maximum IP3 of 9 dBm. The minimum insertion loss is 1.7 dB per stage, has a flat response to 10 GHz. The X-band switch has an insertion loss of 0.82 dB, an off-isolation of 25 dB. The bandwidth is greater than 35 %, the IP3 is greater than 34.5 dBm. Both of these circuits consists of PIN diodes constructed from the base-collector MBE layers of our base-line HBT process. This work demonstrates the monolithic integration of pin diode switch, attenuation functions in an HBT technology without additional process or MBE material growth.

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## Passive FET MMIC Linearizers for C, X and Ku-Band Satellite Applications (1993 Vol. I [MWSYM])

*A. Katz, S. Moochalla and J. Klatskin. "Passive FET MMIC Linearizers for C, X and Ku- Band Satellite Applications (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 353-356.*

The design and measured performance of GaAs MMIC linearizers for use with space-borne traveling wave tube amplifiers (TWTAs) are presented. New space communications technology requires highly linear amplifiers. Linearizers correct for amplifier distortion to provide the needed linearity. The linearizers described in this paper operate at C, X and Ku-band, and are believed the first to be realized in MMIC form. They are based on a passive FET design similar to that of MMIC switches and attenuators. MESFET varactors and voltage variable resistors are used as control elements. They provide more than 2.5 GHz of bandwidth at Ku-band with an improvement of greater than 10 dB in TWTA carrier-to-intermodulation ratio (C/I), and with a phase change of less than 5 degrees.

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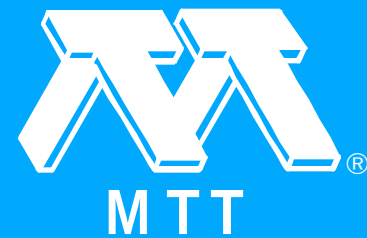


# Abstracts

## Low-Noise, Low DC Power Linear Amplifiers (1993 Vol. I [MWSYM])

*P.K. Ikalainen, L.C. Witkowski and K.R. Varian. "Low-Noise, Low DC Power Linear Amplifiers (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 357-360.*

Single and dual-gate distributed amplifiers designed for standard ion-implanted GaAs FETs and a newly designed Ku-band amplifier were processed using new high dynamic range FET process. State-of-the-art results were achieved in terms of simultaneous linearity, DC power, noise figure, and gain-bandwidth. OIP3/P/sub dc/ ratios of the amplifiers were in the range 1 to 13.7 with noise figures as low as 3 dB, 8 to 20 dB improvement in second-order linearity has been demonstrated as well.



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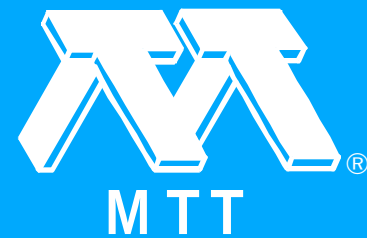


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## An MMIC Twin-Tee Active Bandpass Filter (1993 Vol. I [MWSYM])

*F.J. Rosenbaum, R.O. Gregory, W.D. Richard, W. Ou, F.G. Kuhns and T.M. Trimble. "An MMIC Twin-Tee Active Bandpass Filter (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 361-364.*

The design and performance of an MMIC active bandpass filter based on a twin-tee notch circuit are described. Design goals included a center frequency of 2 GHz and a Q that could be varied to well over 100. The device was fabricated in GaAs using 150  $\mu\text{m}$  transistors. Die size is approximately 1 square mm, and power dissipation is approximately 180 mW. Although Q values meet expectations, the measured center frequency is low.



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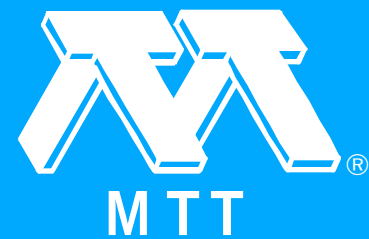
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## A Monolithic W-Band Preamplifier Diode Detector (1993 Vol. I [MWSYM])

*H. Wang, W. Lam, T.N. Ton, D.C.W. Lo, K.L. Tan, G.S. Dow, B. Allen and J. Berenz. "A Monolithic W-Band Preamplifier Diode Detector (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 365-368.*

A monolithic W-band preamplifier diode detector was developed based on 0.1  $\mu\text{m}$  pseudomorphic AlGaAs/InGaAs/GaAs HEMT technology. This chip consisted of a Schottky diode detector with a two-stage W-band low noise amplifier has a measured detector responsivity of 300 V/mW at 94 GHz and a tangential sensitivity of -62 dBm. This is the first reported monolithic preamplifier diode detector at this frequency. A higher sensitivity preamplifier detector which was built by cascade of two monolithic three-stage W-band LNA with the preamplified detector chip also shows a tangential sensitivity of -85 dBm. This monolithic chip is ideal for insertion into the W-band radiometer and passive imaging array systems.

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# Abstracts

## A Novel Three Phase-States Phase Shifter

*K. Nakahara, S. Chaki, N. Andoh, H. Matsuoka, N. Tanino, Y. Mitsui, M. Otsubo and S. Mitsui.  
"A Novel Three Phase-States Phase Shifter." 1993 MTT-S International Microwave Symposium  
Digest 93.1 (1993 Vol. 1 [MWSYM]): 369-372.*

A novel compact phase shifter switching three phase-states has been demonstrated. The novel phase shifter circuit is constructed by adding switching FETs to a conventional single-stage 2-phase-states phase shifter. A conventional 3-stage 2-phase-state phase shifter can be replaced by the novel 2-stage 3-phase-state phase shifter. The total chip size of the newly developed phase shifter is reduced to 2/3 of the conventional one. This paper reports on the design and the experimental results of the novel reflection and loaded-line types phase shifter MMICs.



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## Influence of the Gate Leakage Current on the Noise Performance of MESFETs and MODFETs

*F. Danneville, G. Dambrine, H. Happy and A. Cappy. "Influence of the Gate Leakage Current on the Noise Performance of MESFETs and MODFETs." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 373-376.*

In this paper, the influence of the gate leakage current on the noise performance of MESFETs and MODFETs is investigated. It is shown that the noise performance of FETs is strongly dependent on the gate leakage current value, especially at a few GHz. The theoretical results are discussed and are compared with experimental data.

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## A Cryogenic GaAs HBT Microwave Amplifier and its Application to a Superconductor Digital IC

*K.W. Kobayashi, J.H. Kobayashi, M. Leung, A.K. Oki, M. Matloubian, S. Chan and D.C. Streit. "A Cryogenic GaAs HBT Microwave Amplifier and its Application to a Superconductor Digital IC." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 377-380.*

This paper benchmarks the first microwave GaAs HBT amplifier results at 4.2° Kelvin. The amplifier nominal gain is 6 dB and is measured from 130 MHz to 10 GHz at fixture temperatures of 295 K, 77 K, and 4.2 K. The maximum gain variation over temperature was found to be about 2 dB. Maximum gain occurred at temperatures around 50-85 K, whereas at 4.2 K, the gain seemed to drop slightly from that at RT. Only slight RF evidence of carrier freeze-out was observed at a fixture temperature of 4.2 K, although, HBT junction temperatures are estimated to be around 25-30 K. Finally, this chip was integrated as a buffer amplifier with an HTS superconductor digital logic gate and has shown functionality up to 320 MHz.

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## Acceleration Sensitivity Study for Commercially Available SAW Oscillators

*R. McGowan, J. Kosinski, R. Lindenmuth, J. Himmel and T. Lukaszek. "Acceleration Sensitivity Study for Commercially Available SAW Oscillators." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 381-384.*

SAW stabilized oscillators are currently being considered for use in many future military systems. In operation, these devices will be subjected to harsh environmental conditions including temperature, humidity and vibration. This study was initially devised to accomplish two objectives. The primary objective was to determine the feasibility of using commercially available SAW oscillators to meet the stringent acceleration sensitivity requirement of  $10^{-11}$ g needed for state-of-the-art military applications. The second objective was to establish a performance baseline of acceleration sensitivity since there was very little preexisting data for use by system developers. However, when the acceleration sensitivity data collected for the various oscillators was correlated with the physical attributes of the oscillator circuits and SAW resonators, more general design guidelines could be inferred from the data for the production of vibration insensitive oscillators.

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## Full-Wave Analysis of Superconducting Microstrip Lines on Sapphire Substrates

*L.H. Lee, S.M. Ali, W.G. Lyons, R.S. Withers and T.P. Orlando. "Full-Wave Analysis of Superconducting Microstrip Lines on Sapphire Substrates." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 385-388.*

A computationally efficient full-wave technique is developed to analyze superconducting microstrip lines on M-plane sapphire in which the optic axis is in the plane of the substrate at an arbitrary angle with respect to the propagation direction. To increase the efficiency of the method, the superconducting strip is replaced by an equivalent surface impedance which accounts for the loss and kinetic inductance of the superconductor. Complex propagation constant and characteristic impedance are calculated and compared to both measured results and results obtained by the more rigorous volume-integral-equation method.

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## Improvements in the Millimeter-Wave System for Josephson Junction Array Voltage Standard Systems

*H. Yoshida, Y. Sakamoto, U. Klein and T. Endo. "Improvements in the Millimeter-Wave System for Josephson Junction Array Voltage Standard Systems." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 389-392.*

Improvements in the millimeter-wave system have been accomplished in order to generate higher and more accurate Josephson voltages directly. The 94-GHz oscillator output power has been increased to 90 mW by incorporating a new InP Gunn diode, and a low-loss dielectric waveguide has been installed in liquid helium in order to increase the millimeter-wave power available at the input of the Josephson junction array chip. The stability of the millimeter-wave frequency has been improved to the order of  $10^{-11}$ . The losses of the waveguide-to-microstrip transition have been investigated but remain a matter of further improvements.

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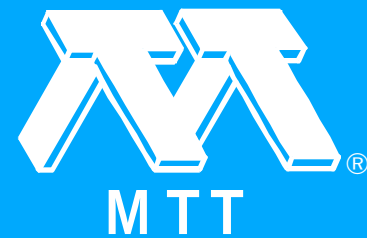


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## Al-SiO<sub>2</sub>/Al On-Chip Sandwich Microstrip Lines for Interconnects Up to 400 GHz

*E. Stein Von Kamienski, J. Gondermann, H.G. Roskos and H. Kurz. "Al-SiO<sub>2</sub>/Al On-Chip Sandwich Microstrip Lines for Interconnects Up to 400 GHz." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 393-396.*

We present a downscaled 2  $\mu\text{m}$  wide microstrip line fabricated with both signal and ground conductors on top of the substrate. On this waveguide, a significantly reduced geometric dispersion for 400 GHz bandwidth pulses is measured by time-resolved electrooptic sampling technique.



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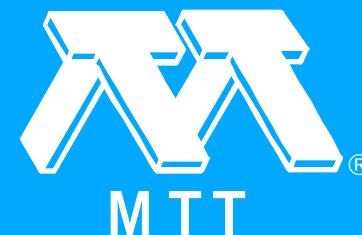


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## Session J (Joint with MMWMC Symposium) -- MMIC Control Circuits

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*"Session J (Joint with MMWMC Symposium) -- MMIC Control Circuits." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 397-398.*



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## A MMIC Subharmonically Pumped SSB Modulator (1993 Vol. I [MWSYM])

*A. Pospishil, M. Russo and M. Singh. "A MMIC Subharmonically Pumped SSB Modulator (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 399-402.*

An innovative monolithic Single Sideband Modulator (SSBM), which utilizes balanced subharmonically pumped mixers, has been developed. This SSBM is pumped at one half of the carrier frequency ( $f_{\text{sub c}}/2$ ). The typical measured performance of this device is excellent with  $> 40\text{dB}$  carrier suppression,  $> 25\text{dB}$  undesired sideband suppression and  $< 10\text{dB}$  conversion loss over a carrier bandwidth of 14 to 19GHz. Double sideband suppressed carrier (DSBSC) and unsuppressed carrier operation is also achievable with the same device when appropriate modulation signals are applied.

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## Narrow-Band MMIC Filters with Automatic Tuning and Q-Factor Control (1993 Vol. I [MWSYM])

*P. Katzin, B. Bedard and Y. Ayasli. "Narrow-Band MMIC Filters with Automatic Tuning and Q-Factor Control (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 403-406.*

Narrow-band, active MMIC filters are demonstrated at X-band. Results are presented for both band-pass and notch circuits fabricated using standard GaAs MESFET processes. A novel Master-Slave control circuit provides compensation for fluctuations in fabrication process and operating temperature, and it enables the filter to accurately track a reference signal.



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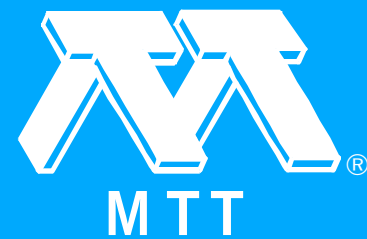


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## A New Circuit Structure for Microwave Frequency Doublers (1993 Vol. I [MWSYM])

*J. Fikart and Y. Xuan. "A New Circuit Structure for Microwave Frequency Doublers (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 407-410.*

A new circuit structure for microwave frequency doublers is presented, which features effective suppression of fundamental and odd harmonics ( $> 50$  dB), conversion gain ( $> 3$ dB) and simplicity of the circuit. Furthermore, it can be used in both balanced and unbalanced output configurations, without requiring baluns or transformers. Experimental results are also given in the paper.



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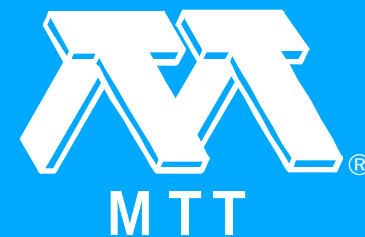
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## Session K -- Analysis of Quasi-Planar and Quasi Optical Structures

*"Session K -- Analysis of Quasi-Planar and Quasi Optical Structures." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 411-412.*



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## Microstrip Circuit Design Using Neural Networks

*T.-S. Horng, C.-C. Wang and N.G. Alexopoulos. "Microstrip Circuit Design Using Neural Networks." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 413-416.*

A new technique using neural networks to efficiently design microstrip circuits is presented. In our proposed method, a full-wave analysis is employed to rigorously characterize a microstrip circuit, which results in a finite set of pairs of input and output parameter vectors. The neurons, arranged as a three-layer network, are used to learn the mappings from input to output and then give accurate approximations for the output vectors at any arbitrary input. It is emphasized that a three-layer neural network is capable of performing any mapping if the right connections among the neurons can be made. A real example on the microstrip corporate feed design is given to illustrate the potential power of this technique.

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## The Resistance of Strip Conductors Embedded in a Two-Dimensional Field Distribution

*W. Heinrich. "The Resistance of Strip Conductors Embedded in a Two-Dimensional Field Distribution." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 417-420.*

The a.c. resistance of strip conductors is investigated. For geometries involving a two-dimensional field distribution, one finds an interesting behavior: Between the DC and the skin-effect regime, there exists a third characteristic frequency range. The paper provides details on that range and points out consequences for circuit modelling. A simplified description is proposed.

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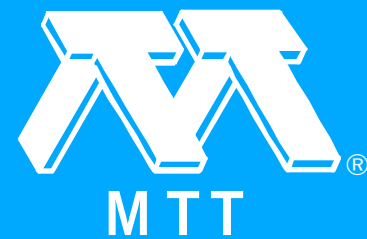


# Abstracts

## An Improved 2D-FDTD Algorithm for Hybrid Mode Analysis of Quasi-Planar Transmission Lines

*S. Xiao and R. Vahldieck. "An Improved 2D-FDTD Algorithm for Hybrid Mode Analysis of Quasi-Planar Transmission Lines." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 421-424.*

A significantly improved two-dimensional finite difference time domain (FDTD) method is proposed for the full-wave analysis of guided wave structures. By using a phase shift  $\beta \Delta z$  along the z-direction (propagation direction), and assuming the limiting case of  $\Delta z$ , the propagation constant of hybrid modes can be calculated by using a two-dimensional mesh with a truly two-dimensional grid size. Secondly, by appropriately arranging variables, only a real impulse response is involved. Furthermore, a new grading scheme is introduced allowing a gradually non-equidistant mesh in three dimension.



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## Efficient TLM Diakoptics for Separable Structures (1993 Vol. I [MWSYM])

*M. Righi, M. Mongiardo, R. Sorrentino and W.J.R. Hoefer. "Efficient TLM Diakoptics for Separable Structures (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 425-428.*

In this paper a new procedure for the efficient application of diakoptics to the TLM simulation of waveguide structures is described. The above procedure is based on the expansion of the time-domain Green's function for separable regions into eigenfunctions. The suggested procedure leads to a dramatical reduction of the numerical effort when compared to regular Johns Matrix operation. The procedure has been applied to an inductive iris in order to demonstrate how this new approach can be used to generate variable wide band absorbing boundaries that can be placed very close to the discontinuity.

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## Capacitance Computations in a Multilayered Dielectric Medium Using Closed-Form Spatial Green's Functions (1993 Vol. I [MWSYM])

*K.S. Oh and J.E. Schutt-Aine. "Capacitance Computations in a Multilayered Dielectric Medium Using Closed-Form Spatial Green's Functions (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 429-432.*

An efficient method to compute the 2-D and 3-D capacitance matrix of multiconductor interconnects in a multilayered dielectric medium is presented. The method is applicable to conductors of arbitrary polygon shape embedded in a multilayered dielectric medium with possible ground planes on the top or bottom of the dielectric layers. The computation time required to evaluate the space-domain Green's function for the multilayered medium, which involves an infinite summation, has been greatly reduced by obtaining a closed form, which is derived by approximating the Green's function using a ferrite number of images in the spectral domain. The corresponding space-domain Green's functions are then obtained using the proper closed-form integrations. The elements of the moment matrix are computed using the closed-form formulation, avoiding any numerical integration. The presented method showed good agreement when compared with other published results.

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## Circuit Level Modeling of Quasioptical Power Combining Open Cavities

*P.L. Heron, G.P. Monahan, J.E. Byrd, M.B. Steer, F.W. Schwering and J.W. Mink. "Circuit Level Modeling of Quasioptical Power Combining Open Cavities." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 433-436.*

A multiport circuit level model is developed for an open-cavity, quasioptical power combiner. The model is developed using Hermite-Gaussian beam mode theory, the Lorentz reciprocity theorem and determination of diffraction losses.

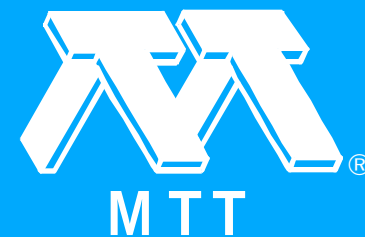
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# Abstracts

## Session L -- High-Q Filters for Communications Systems

*"Session L -- High-Q Filters for Communications Systems." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 437-438.*



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## Dual-Mode Dielectric Resonator Filters with Improved Spurious Performance

*R.R. Mansour. "Dual-Mode Dielectric Resonator Filters with Improved Spurious Performance." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 439-442.*

This paper presents novel configurations for dual-mode dielectric resonators operating in the HEH/sub 11/ mode or the HEE/sub 11/ mode. The use of the proposed configurations in the design of dual-mode dielectric resonator filters leads to a design with a remarkably improved spurious performance. Techniques to control the frequency separation between the resonance frequencies of the two dual-modes HEH/sub 11/ and HEE/sub 11/ are discussed. Experimental results are presented to verify the validity of the proposed configurations.

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# Abstracts

## A 4 GHz Dielectric Contiguous Output Multiplexer for Satellite Applications

*S.C. Holme and S.J. Fiedziuszko. "A 4 GHz Dielectric Contiguous Output Multiplexer for Satellite Applications." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 443-446.*

A 4 GHz output multiplexer is described which significantly reduces the size and weight of satellite transponders. The multiplexer utilizes dielectrically loaded cavities, mounted and tuned in a novel way to increase power handling up to 80 watts per channel. A coaxial T-junction coupled manifold cases tuning and results in a very small and light multiplexer unit.



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## Multimode Synthesis Procedure for Microwave Filters Based on Thick Inductive Windows

*M. Guglielmi, A. Alvarez and G. Gheri. "Multimode Synthesis Procedure for Microwave Filters Based on Thick Inductive Windows." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 447-450.*

For several types of microwave filters for space application it is important to manufacture hardware without tuning elements. For this to be possible, one needs a systematic procedure to convert ideal elements, such as resonators and impedance inverters, into actual waveguide lengths and discontinuities. The situation is further complicated by the fact that waveguide discontinuities excite higher order modes that interacting with each other can have very strong effects. In this paper we first outline the theory behind a very efficient computer code for the simulation of microwave filters based on thick inductive windows. Then we describe in detail a step-by-step procedure that, based on the code developed, allows for the rapid design of this class of microwave filters without any tuning elements. Two actual examples of design are also discussed and comparisons presented between measurements and simulations.

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## CAD of Microwave Junctions by Polynomial Curve Fitting

*J.-F. Liang and K.A. Zaki. "CAD of Microwave Junctions by Polynomial Curve Fitting." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. 1 [MWSYM]): 451-454.*

A circuit representation of lossless reciprocal microwave junctions is presented. Exact scattering parameters of the junction are determined by solving the electromagnetic boundary value problem at few frequencies and for few dimensions. Curve fitting is used to characterize the parameters continuously. This model can be used in any CAD or optimization program, reducing the computation time by several orders of magnitude, while preserving the high accuracy. Application of this model is demonstrated by designs of a low VSWR cavity filter and a broad band diplexer. Experimental data on the diplexer optimized by this method are included.

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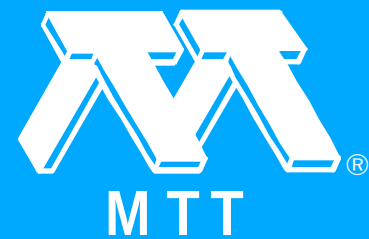
## Improvement in Calculation of Some Surface Integrals: Application to Junction Characterization in Cavity Filter Design (1993 Vol. I [MWSYM])

*P. Guillot, P. Couffignal, H. Baudrand and B. Theron. "Improvement in Calculation of Some Surface Integrals: Application to Junction Characterization in Cavity Filter Design (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 455-458.*

This rigorous method allows to reduce a surface integral to a contour integral. The application of this formulation to the study of a circular - to - rectangular waveguide junction reduces more than 50 % computation time of the scattering parameters. The method is applied to calculate the electromagnetic coupling of circular cavities by a rectangular iris. This approach, together with an optimization procedure has allowed the direct design of a filter without any further mechanical adjustments. The obtained results are in good agreement with experimental data.

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## Computer-Aided Design of Circular Ridged Waveguide Evanescent-Mode Bandpass Filters Using the FDTLM Method

*J. Huang, R. Vahldieck and H. Jin. "Computer-Aided Design of Circular Ridged Waveguide Evanescent-Mode Bandpass Filters Using the FDTLM Method." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 459-462.*

This paper describes the analysis and design of a circular ridged waveguide evanescent mode bandpass filter. Two and three resonators filters are presented for the 30GHz range. Insertion loss is typically below 1dB and return loss is better than 20dB on the average. The full-wave FDTLM method is used to compute the generalized s-parameters of the overall filter structures including the effect of finite metallization thickness and mode interaction between filter discontinuities. A comparison to other filter structures in circular waveguides shows excellent agreement between measured and computed results.

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## An Integrated T-Septum Waveguide Diplexer for Compact Front-End Applications

V.A. Labay and J. Bornemann. "An Integrated T-Septum Waveguide Diplexer for Compact Front-End Applications." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 463-466.

This paper introduces a new T-septum waveguide diplexer for compact integrated front-end applications in modern communication systems. The 8.74/10.14 GHz X-band design for four-percent channel bandwidths is one of the most compact waveguide diplexers ever presented. The size reduction is predominantly achieved by utilizing T-septum filter technology which reduces the dimensions of a typical waveguide filter by a factor of four to five. Moreover, a considerably improved stopband behavior towards higher frequencies is obtained. Together with a height-reduced waveguide E-plane T-junction, the overall diplexer dimensions are less than  $(30\text{mm})^3$ . The computer-aided analysis and design are based on mode-matching techniques and optimization procedures, respectively. The channel filters are separately synthesized and fine-tuned by a final optimization to meet diplexer specifications. The design can be scaled to other waveguide bands. The theory is verified by measurements at the example of an X-band T-septum filter configuration.

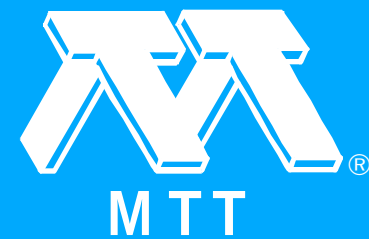
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# Abstracts

## Session M -- Ferrite and Non-Reciprocal Semiconductor Devices

*"Session M -- Ferrite and Non-Reciprocal Semiconductor Devices." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 467-468.*



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## Phase Shift Calculations in Axially-Magnetized Ferrites Using the Finite Element Method

*B.M. Dillon and A.A.P. Gibson. "Phase Shift Calculations in Axially-Magnetized Ferrites Using the Finite Element Method." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 469-472.*

A vector finite element solver is used to calculate the phase shift in uniform axially-magnetized gyromagnetic waveguides. Ferrite materials are characterized in the solver using standard material data, the applied field and the frequency. Calculations are compared with experimental results for two typical waveguide cross-sections: a quadrupally-ridged Faraday Rotation section and a reciprocal Reggia-Spencer section.

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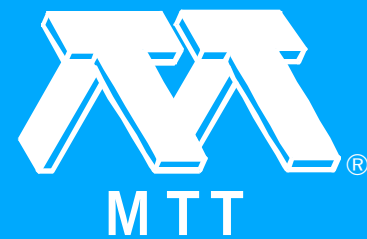


# Abstracts

## Double Ridged Waveguide Phase Shifters for Broadband Applications (1993 Vol. I [MWSYM])

*E.-B. El-Sharawy. "Double Ridged Waveguide Phase Shifters for Broadband Applications (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 473-476.*

This paper presents an electromagnetic mode matching analysis of dual ridged waveguide phase shifters. The waveguide is loaded with a high dielectric material between the ridges and the troughs are filled with ferrite toroids. The present structure offers nearly twice the bandwidth and less variation in nonreciprocity versus frequency as compared to the conventional dual toroidal phase shifter.



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## Frequency Selective Limiters for High Dynamic Range Microwave Receivers (1993 Vol. I [MWSYM])

*J.D. Adam and S.N. Stitzer. "Frequency Selective Limiters for High Dynamic Range Microwave Receivers (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 477-482.*

A new broadband frequency selective limiter which provides over 14 dB of limiting across more than an octave bandwidth is described. The limiter is fabricated with epitaxially grown YIG films in a stripline configuration and has a threshold power level of below 0 dBm. Multiple FSLs have been cascaded with amplifiers to allow compression of microwave signals with a power range of 60 dB into a range of less than 5 dB.

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## Semiconductor Junction Circulators

*L.E. Davis and R. Sloan. "Semiconductor Junction Circulators." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 483-486.*

Modern ferrite circulators operating above 40GHz, are narrowband devices, due to the ferrite materials available today. Tracking operation of junction circulators above 60GHz are, in principle possible employing magnetoplasmons. Theoretical results are presented showing broadband operation for idealised Gallium Arsenide cooled to 77K, and an example is shown for the frequency range 92-100 GHz. A narrowband, solution is also given where the losses due to electron collisions are modelled. The circulation conditions in the latter example are designed using intersecting impedance curves rather than the tracking solutions achieved in the lossless case.



# Abstracts

## Index of Authors (1993 Vol. I [MWSYM])

*"Index of Authors (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 487-492.*



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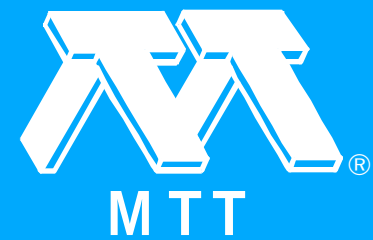


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## Exhibitors' List (1993 Vol. I [MWSYM])

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*"Exhibitors' List (1993 Vol. I [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.1 (1993 Vol. I [MWSYM]): 493-494.*



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*"Front Cover (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): f1-f2.*



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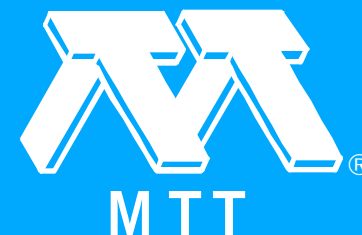
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## Meeting and Function Rooms (1993 Vol. II [MWSYM])

*"Meeting and Function Rooms (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): fm1-fm1.*



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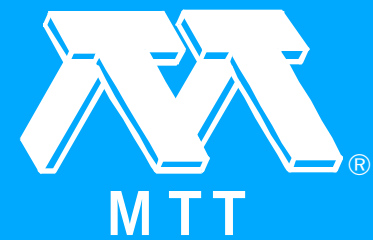
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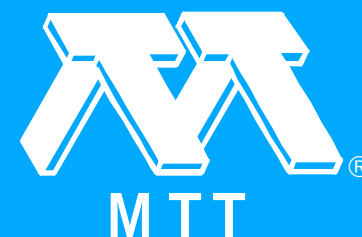
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## Table of Contents (1993 Vol. II [MWSYM])

*"Table of Contents (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): i-i.*



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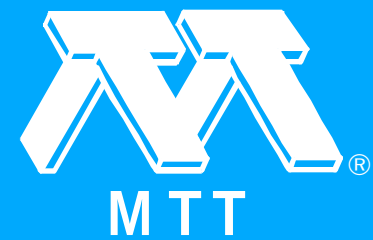
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## Panel Sessions (1993 Vol. II [MWSYM])

*"Panel Sessions (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): iii-v.*



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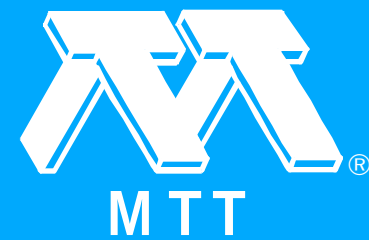




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## Technical Program Contents (1993 Vol. II [MWSYM])

*"Technical Program Contents (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): vii-xliii.*



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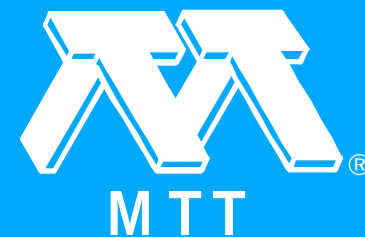


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## Technical Sessions (1993 Vol. II [MWSYM])

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*"Technical Sessions (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): xlv-xlv.*



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## Session N -- Phased Arrays I

*"Session N -- Phased Arrays I." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 495-495.*



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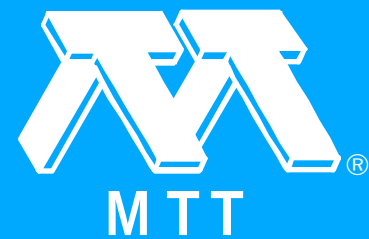
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## L-Band High Power Transmit/Receive Module for Electronically Scanned Cylindrical Array Radar

*P. Iassogna, G. Savit, D. Chau, M. Gallo, M. Kumar and P. Valentino. "L-Band High Power Transmit/Receive Module for Electronically Scanned Cylindrical Array Radar." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 497-500.*

This paper presents the development of an L-band solid-state transmit/receive (T/R) module operating over 1.2 - 1.4 GHz for an electronically scanned array radar. Silicon (Si) bipolar transistors are used in the high power amplifier in the transmit channel and GaAs FETs are used for the low-noise amplifier in the receive channel. Key performance parameters of the T/R module are an average output power of >280w peak, (100μs pulse width, 10% duty cycle) reflecting a gain of 23.5dB, noise figure of <2.8dB (LNA N. F. <1.2dB), receive gain of >32.5dB, and MTI improvement factor of 70dBc (pulse-to-pulse stability).

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## Comparison of CPU Level Data Mixing to T/R Level Data Mixing Architectures in Optically Controlled Phased Arrays

*R. Saedi, J. Wen, N. Samant, A. Daryoush, D. Sturzebecher and P. Herczfeld. "Comparison of CPU Level Data Mixing to T/R Level Data Mixing Architectures in Optically Controlled Phased Arrays." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 501-504.*

Directly modulated fiber optic links are employed to control the active T/R modules of large aperture phased array antennas. The viable architectures considered for distribution of the modulated carrier are CPU level data mixing and T/R level data mixing. In this study, custom designed fiberoptic links were developed for distribution of the modulated carrier at 5.5-5.8GHz operating at 1300nm, whereas fiberoptic links operating at 5GHz and 65±M150MHz were employed to provide the carrier and data separately, to the T/R modules generating the modulated carrier over 5.5 to 5.8GHz. These two architectures were used in optical control of a C-band 2x4 phased array antennas. The experimental comparison of fiber optic link performance is presented in this paper. Compression dynamic range of fiber optic link operating at 1300 nm was measured to be 72 dB.MHz over 5.5 to 5.8 GHz using the CPU level data mixing compared to the 77dB.MHz for the T/R level data mixing.

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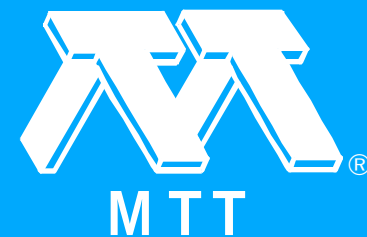


# Abstracts

## An X-Band Phased Array Microwave/Photonic Beamforming Network

*S.K. Banerjee, G. Zimmer, H.P. Feldle, P. Marten and L.P. Schmidt. "An X-Band Phased Array Microwave/Photonic Beamforming Network." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 505-508.*

In the following contribution an X-band microwave/-photonic phased-array radar demonstrator is described which is at present under development at Deutsche Aerospace in Ulm. The paper will present an experimental study of all critical components associated with a microwave/photonic beamforming network.



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## An Affordable Low-Profile Multifunction Structure (ALMS) for an Optoelectronic (OE) Active Array

*I.L. Newberg and J.J. Wooldridge. "An Affordable Low-Profile Multifunction Structure (ALMS) for an Optoelectronic (OE) Active Array." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 509-512.*

Three "Leap-Ahead" technologies that can be combined into a design to make affordable shared aperture active array radars are discussed in this paper. They are Microwave Multi-Chip Module packaging, digital radar, and photonic signal manifolding and true time delay beamsteering.



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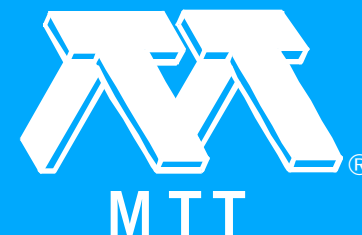
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## Session O -- Millimeter Wave Amplifier and Receiver Technology

*"Session O -- Millimeter Wave Amplifier and Receiver Technology." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 513-514.*



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## Millimeter-Wave, Cryogenically-Coolable Amplifiers Using AlInAs/GaInAs/InP HEMT's

*M.W. Pospieszalski, W.J. Lakatos, R. Lai, K.L. Tan, D.C. Streit, P.H. Liu, R.M. Dia and J. Velebir. "Millimeter-Wave, Cryogenically-Coolable Amplifiers Using AlInAs/GaInAs/InP HEMT's." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 515-518.*

The cryogenic performance of AlInAs/GaInAs/InP.1  $\mu\text{m}$  HEMT's is reported. Collapse free d.c. operation is observed down to the ambient temperature of 18 K. The application of these devices to Q- and E-band low-noise, cryogenically-coolable amplifiers is demonstrated. The measured record-breaking noise temperature of 15 K (noise figure of .2 dB) for a multi-stage 40-45 GHz amplifier with 33 dB of gain at the ambient of 18 K is in close agreement with the prediction of a simple noise model. A very low power consumption per stage of less than 1 mW is recorded. The noise temperature of the E-band cryogenic amplifier is less than 47 K at 70 GHz, demonstrating that the performance of HEMT receivers is now competitive with that of SIS receivers in the 3-mm wavelength atmospheric window.

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## A Monolithic W-Band Three-Stage LNA Using 0.1 $\mu\text{m}$ InAlAs/InGaAs/InP HEMT Technology

*H. Wang, R. Lai, T.H. Chen, P.D. Chow, J. Velebir, K.L. Tan, D.C. Streit, P.H. Liu and G. Ponchak. "A Monolithic W-Band Three-Stage LNA Using 0.1  $\mu\text{m}$  InAlAs/InGaAs/InP HEMT Technology." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 519-522.*

A monolithic W-band three-stage LNA based on 0.1  $\mu\text{m}$  pseudomorphic InAlAs/InGaAs/InP HEMTs has been developed. This LNA demonstrated a noise figure of 4.3 dB and an associated small signal gain of 19 dB at 100 GHz with a low dc power consumption of 20 mW. This is the best reported monolithic W-band LNA performance using InP-based HEMT technology and demonstrates the potential of InP HEMT technology for higher millimeter-wave applications.

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## 18-40 GHz Semi-Monolithic Balanced Cascade Amplifiers Using AlGaAs/InGaAs P-HEMT and GaAs MESFET

*M. Kimishima and T. Ashizuka. "18-40 GHz Semi-Monolithic Balanced Cascade Amplifiers Using AlGaAs/InGaAs P-HEMT and GaAs MESFET." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 523-526.*

18 - 40 GHz semi-monolithic balanced cascade amplifiers have been developed by using AlGaAs/InGaAs pseudomorphic HEMT's and GaAs MESFET's. This paper describes the design, fabrication and performance of the modules and exhibits superior advantages of semi-monolithic process technology for millimeter wave applications. It is demonstrated that the P-HEMT amplifier exhibits a gain of  $5.7 \pm 0.4$  dB, a noise figure of less than 3.6 dB, and the three stage amplifier exhibits again of  $15.6 \pm 0.8$  dB, a noise figure of less than 4.2 dB. input/output return losses of better than 9.0 dB and an 1 dB compressed power of greater than 11.0 dBm.

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## A Submillimeter-Wave Planar Low Noise Schottky Receiver

*W.Y. Ali-Ahmad, W.L. Bishop, T.W. Crowe and G.M. Rebeiz. "A Submillimeter-Wave Planar Low Noise Schottky Receiver." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 527-530.*

A planar quasi-optical Schottky receiver based on the quasi-integrated horn antenna has been developed and tested over the 230-280GHz bandwidth. The receiver consists of a planar GaAs Schottky diode placed at the feed of a dipole-probe suspended on a thin dielectric membrane in an etched-pyramidal horn cavity. The antenna-mixer results in a measured DSB conversion loss and noise temperature at 258GHz of  $7.2\text{dB} \pm 0.5\text{dB}$  and  $1310\text{ K} \pm 70\text{K}$ , respectively, at room temperature. The low cost of fabrication and simplicity of the design makes it ideal for submillimeter-wave receivers requiring a 10% bandwidth.





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## A 0.6-Watt U-Band Monolithic MESFET Power Amplifier

*T. Ho, K. Pande, F. Phelleps, J. Singer, P. Rice, J. Adair and M. Ghahremani. "A 0.6-Watt U-Band Monolithic MESFET Power Amplifier." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 531-534.*

A high performance four-stage MMIC power amplifier chip has been developed using 0.3- $\mu$ m gate-length and molecular beam epitaxial (MBE) MESFET technologies. These power MMIC chips have been combined to constitute a 47 GHz power amplifier with output power of 0.46 watts with associated gain of 16.6 dB. A saturated output power of over 0.58 watts was also achieved at 47 GHz. These results represent the highest reported power and gain at U-band from an MMIC amplifier utilizing a 0.3- $\mu$ m gate-length MESFET. This amplifier has potential application as a driver for a monolithic doubler to obtain more than 80 mW transmitted power at 94 GHz for W-band system applications.

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## V-Band High-Efficiency High-Power AlInAs/GaInAs/InP HEMTs (1993 Vol. II [MWSYM])

*M. Matloubian, L.M. Jelloian, A.S. Brown, L.D. Nguyen, L.E. Larson, M.J. Delaney, M.A. Thompson, R.A. Rhodes and J.E. Pence. "V-Band High-Efficiency High-Power AlInAs/GaInAs/InP HEMTs (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 535-538.*

In this paper we report on the state-of-the-art power performance of InP-based HEMTs at 59 GHz. Using a 448  $\mu\text{m}$  wide HEMT with a gate-length of 0.15  $\mu\text{m}$ , an output power of 155 mW with 4.9 dB gain, and power-added efficiency of 30.1% were obtained. By power combining two of these HEMTs we were able to achieve an output power of 288 mW with 3.6 dB gain and power-added efficiency of 20.4%. This is the highest output power reported with such a high-efficiency for InP-based HEMTs, and is comparable to the best results reported for AlGaAs/InGaAs on GaAs pseudomorphic HEMTs at this frequency.

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## GaAs/AlGaAs Multiquantum Well Structures Applied to High Frequency IMPATT Devices

*C.C. Meng, H.R. Fetterman, D.C. Streit, T.R. Block and Y. Saito. "GaAs/AlGaAs Multiquantum Well Structures Applied to High Frequency IMPATT Devices." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 539-542.*

The first CW operation of GaAs/AlGaAs multiquantum well IMPATT devices at 100 GHz has been achieved. Multiquantum wells were used to generate the avalanche injection current since these structures improve the non-linearity of the avalanche process and reduce the ionization rate saturation limitations. The operation and design principle, fabrication procedure and experimental results are presented in this paper. A 6.4 mW CW power output was achieved at 100.3 GHz.

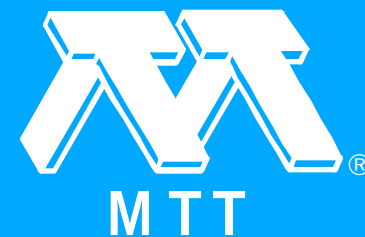
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# Abstracts

## Session P -- Solid State Devices & Circuits

*"Session P -- Solid State Devices & Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 543-544.*



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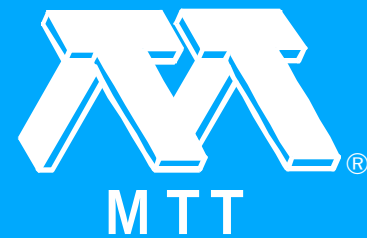


# Abstracts

## Silicon MOSFETs, the Microwave Device Technology for the 90s

*N. Camilleri, J. Costa, D. Lovelace and D. Ngo. "Silicon MOSFETs, the Microwave Device Technology for the 90s." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 545-548.*

Silicon MOSFET technology using 1.5 $\mu$ m gate lengths has demonstrated excellent performance for 900 MHz applications. Circuit results for low noise amplifiers, power amplifiers, mixers, and oscillators using this technology will be discussed in comparison to other device technologies. Device results for 0.6 $\mu$ m gate length devices showing the microwave performance of silicon MOS transistors are discussed. These results together with scaling predictions indicate that microwave silicon MOSFETS will play a major role in the 90s.



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## GaAs/GaAlAs Power HBTs for Mobile Communications

*H. Wang, C. Pinatel, M. Tsouli, J.O. Plouchart, A. Konczykowska, M. Riet, S. Vuye and P. Berdager. "GaAs/GaAlAs Power HBTs for Mobile Communications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 549-552.*

GaAlAs/GaAs power HBTs have been investigated for handsets in mobile cellular communication systems at 1.8 GHz. Different HBT's operating classes have been compared, and the choice of the optimum operating class has been discussed. Experimental measurements on a small chip size HBT of  $0.4 \times 0.4 \text{ mm}^2$  have shown 1 W output power with a power-added efficiency of 45%.

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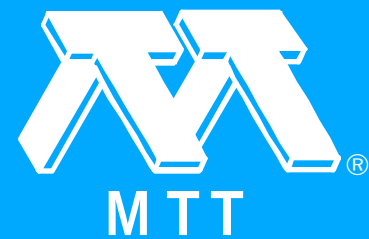


## The Temperature Dependence of PIN Diode Attenuators

*R.H. Caverly and G. Hiller. "The Temperature Dependence of PIN Diode Attenuators." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 553-556.*

This paper presents the results of a study of the effect of temperature on PIN diode resistance whose knowledge will allow designers of microwave PIN diode attenuators to predict attenuation changes with temperature. A theoretical and experimental study of PIN diodes of different geometries and passivations indicates that the resistance-temperature coefficient of low capacitance silicon dioxide passivated PIN diodes is in the range of -0.1% to + 0.1% per degree C. Microwave attenuation measurements were taken that validate this approximation.





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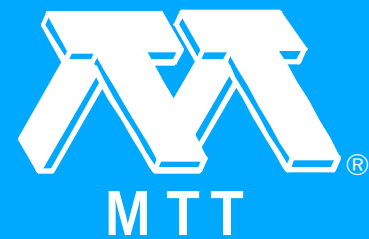
## A YIG-Tuned Nonlinear Transmission Line Multiplier

*D.W. Van Der Weide. "A YIG-Tuned Nonlinear Transmission Line Multiplier." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 557-560.*

This paper describes a distributed frequency multiplier with a YIG-tuned output filter for stable, yet infinitely tunable microwave signals. The multiplier is a nonlinear transmission line (NLTL) which can be driven with a 10-200 MHz, 1-3 W sinusoidal power source to produce a voltage sawtooth wave with >200 harmonics. These harmonics are selected by a YIG-tuned bandpass filter, resulting in sinusoidal outputs with low spurious content and a frequency stability derived from the source. This circuit offers tunability far exceeding that of step-recovery diode multipliers at the expense of increased size and lower efficiency. However, an important result of this experiment shows that practical monolithic multipliers for millimeter-wave outputs can be filtered with little or no degradation in their performance.

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## Reduced Phase Noise of a Varactor Tunable Oscillator: Numerical Calculations and Experimental Results

*V. Gungerich, F. Zinkler, W. Anzill and P. Russer. "Reduced Phase Noise of a Varactor Tunable Oscillator: Numerical Calculations and Experimental Results." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 561-564.*

Single sideband phase noise of a varactor tunable oscillator is much lower in case of using a resonator with coupled microstrip lines instead of a single microstrip line. Calculated and measured phase noise agree within the accuracy of measurements. The very low phase noise of -95 dBc/Hz at 100 kHz offset frequency has been achieved.

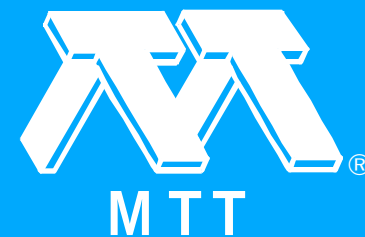
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# Abstracts

## Session Q -- (Focused Session) Developments in Global Communications

*"Session Q -- (Focused Session) Developments in Global Communications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 565-566.*



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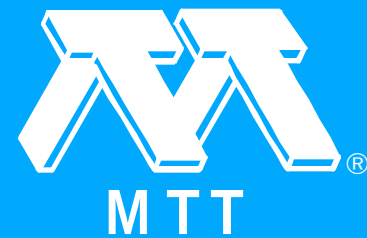


# Abstracts

## The Dawn of Knowledge Networking

*P.H. Stuntebeck. "The Dawn of Knowledge Networking." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 567-568.*

By the end of this decade, an evolution will occur from today's Intelligent Networks to the future Knowledge Networks. This evolution is driven by advances in switching and transmission technologies but also by expanded information systems and data bases containing detailed information about user needs.



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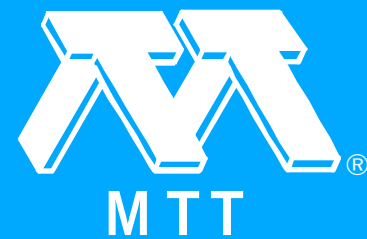


# Abstracts

## Transmission Technologies in Global Communications

*P.S. Henry. "Transmission Technologies in Global Communications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 569-570.*

Today's communication systems utilize three basic transmission technologies: copper, radio and fiber. The newest of these, fiber, can transport huge bandwidths ( $> 10$  Gb/s) across global distances, and promises still greater performance in the future. But raw bandwidth is not the only figure of merit for a transmission medium - each approach has its strengths, and, as the current explosion of wireless activity has taught us, new applications can rejuvenate even the most mature technologies. This talk presents an overview of the fundamental principles and limitations of signal transmission media, and offers some speculations about their roles in tomorrow's communications systems.



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# Abstracts

## High End Microwave Technologies in Global Communications

*C. Mahle. "High End Microwave Technologies in Global Communications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 571-574.*

Microwave technology has played a prominent role in telecommunications. For many years microwave radio links and microwave waveguides and coaxial cable have transported telephone and television communications across the country and under the oceans. In 1965 commercial satellite communications joined these media. The stringent requirements for cutting-edge performance and extreme reliability placed on the microwave equipment used in commercial geostationary satellite communications has led to the continued use of "high end technologies." In military satellite communications these factors also dominate; however, cost effectiveness of the service provided to customers in the marketplace is an additional important factor for commercial applications, especially with the future introduction of a larger number of low orbit satellites. For instance, the Milstar satellites are perhaps an order of magnitude more costly than commercial ones and their throughput is orders of magnitude lower, but their design is driven by the extreme requirements on performance and survivability. On the other hand, when comparing commercial satellite hardware to microwave equipment in the consumer market, such as a microwave oven, the compromise in the consumer market between performance and cost has shifted even further toward the lowest possible cost.



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# Abstracts

## The IRIDIUM/sup TM/SM/ Communications System

*R.J. Leopold and A. Miller. "The IRIDIUM/sup TM/SM/ Communications System." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 575-578.*

The goal of the IRIDIUM/sup TM/ System is to make instant global communications a reality. At first thought, it would seem that we already have global communications. From the U. S., we can place calls to a vast number of domestic and international locations. However, there are many areas without telephone service, not only in emerging countries, but in developed nations as well. Consider that in Russia, with a population of 250 million, there are only 10 million telephones. In India, there are tens of thousands of villages without telephone service. There are some countries whose telephone system is so archaic that thunderstorms routinely disrupt service; some countries have service within their boundaries, yet lack the capability of international calling. Our mission of world-wide, world-class communications is decidedly a reach-out goal.



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# Abstracts

## Session R -- Passive Components

*"Session R -- Passive Components." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 579-580.*



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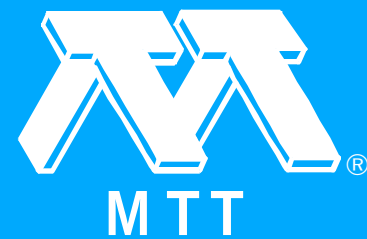


# Abstracts

## A MMIC Compatible Coupled Line Structure that Uses Embedded Microstrip to Achieve Extremely Tight Couplings

*D. Willems and I. Bahl. "A MMIC Compatible Coupled Line Structure that Uses Embedded Microstrip to Achieve Extremely Tight Couplings." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 581-584.*

This paper presents a highly manufacturable coupled line structure for MMICs which uses embedded microstrip to achieve tight coupling and only employs the process steps necessary to make MIM capacitors. Passive circuits demonstrated using this technique include a single-section 5 to 21 GHz broadband 3 dB coupler and a 6 to 15 GHz 90 degree Schiffman section. The coupler and the Schiffman section use tight (2 dB) to extremely tight (0.7 dB) coupling factors, respectively. This is the first time that a coupler has achieved such a wide bandwidth on a 125  $\mu\text{m}$  thick GaAs substrate.



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## A Broad-Band Uniplanar Slotline Hybrid Ring Coupler with Over One Octave Bandwidth

*C.-H. Ho, L. Fan and K. Chang. "A Broad-Band Uniplanar Slotline Hybrid Ring Coupler with Over One Octave Bandwidth." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 585-588.*

This paper presents a new uniplanar hybrid ring coupler using coplanar waveguide (CPW) and slotline. The coupler provides substantially improved amplitude and phase characteristics over a broad bandwidth compared to the conventional microstrip hybrid ring couplers. Experimental results show that the new coupler has a bandwidth of one octave from 2 GHz to 4 GHz with  $\pm 0.25$  dB power dividing balance and  $\pm 1^\circ$  phase balance.

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## A New Class of Branch-Line Directional Couplers

*J.W. Gipprich. "A New Class of Branch-Line Directional Couplers." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 589-592.*

The branch-line directional coupler consists of two parallel transmission lines connected by quarter wavelength shunt branches spaced one quarter wavelength apart. This paper describes a new class of branch-line directional couplers in which the shunt transmission line branches are replaced by shorted coupled transmission line pairs. The new circuit overcomes the limitations of the conventional circuit which may require for the shunt branches, unrealizable high impedance transmission line sections for loose coupling values and for some wideband multi-section designs.

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## Folded Stubs for Compact Suspended Stripline Circuits

*W. Menzel and F. Bogelsack. "Folded Stubs for Compact Suspended Stripline Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 593-596.*

Coupled line sections using both sides of a suspended stripline substrate can be regarded as stubs folded closely parallel to the stripline giving a number of advantages like compact setup, a simple, one-channel stripline mount, no waveguide modes, and additional degrees of freedom for circuit design. By an appropriate design, open and short-circuited series as well as shunt stubs covering a wide range of stub impedances can be realized. As examples for their application, a bandpass, a highpass, and a bandstop filter are presented.

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# Abstracts

## Modeling of Cylindrical Dielectric Resonators in Rectangular Waveguides and Cavities (1993 Vol. II [MWSYM])

*X.-P. Liang, H.-C. Chang and K.A. Zaki. "Modeling of Cylindrical Dielectric Resonators in Rectangular Waveguides and Cavities (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 597-600.*

Two methods for modeling composite cylindrical dielectric resonators in rectangular waveguides and cavities are presented. The first method adopts mode matching between rectangular and cylindrical regions. The second method approximates the cylindrical regions by slices of rectangular dielectric loaded waveguides, and computes the generalized scattering matrix of the total structure by cascading the generalized scattering matrices of the individual slices and junctions. Both methods were implemented and their results compare favorably with measurements.



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## Waveguide and Ridge Waveguide T-Junctions for Wide Band Applications

*H.-W. Yao, A. Abdelmonem, J.-F. Liang, X.-P. Liang and K.A. Zaki. "Waveguide and Ridge Waveguide T-Junctions for Wide Band Applications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 601-604.*

Scattering parameters of waveguide and ridge waveguide stepped T-junctions are obtained using an extension of the three plane mode matching method. An optimization process is applied to find the T-junctions and steps dimensions that yield low reflection coefficient in one of the T-junction arms over a wide frequency band. The optimized wide band T-junctions are useful in the design of wide band high power dividers, diplexers and multiplexer. An example of the design of a wide band T-junction diplexer is presented. Experimental results on the optimized T-junction and the T-junction diplexer are presented. The experimental results of both the T-junction and the diplexer showed excellent agreement with their computed optimum results, respectively.

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# Abstracts

## Session S -- Phased Arrays II

*"Session S -- Phased Arrays II." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 605-606.*



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# Abstracts

## A 4x4 Spatial Power-Combining Array with Strongly Coupled Oscillators in Multi-Layer Structure

*J. Lin and T. Itoh. "A 4x4 Spatial Power-Combining Array with Strongly Coupled Oscillators in Multi-Layer Structure." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 607-610.*

A 4x4 spatial power-combining array with strongly coupled oscillators in multi-layer (3-D) structure is presented. By connecting oscillator units with resistors, the stable in-phase mode oscillation is achieved. The design of multi-layer structure separates radiating elements from the active circuit.



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## An Eight MESFET Periodic Spatial Power Combiner

*A. Balasubramaniyan, J. Heinbockel and A. Mortazawi. "An Eight MESFET Periodic Spatial Power Combiner." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 611-614.*

An X-band eight MESFET two dimensional spatial periodic power combiner is designed and fabricated. This paper describes the theoretical analysis and experimental results obtained. The Effective Radiated Power of this combiner is 8.5 W at 9.73 GHz. This combiner is small, light weight, and suited for monolithic implementation.

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## A 100-Element HBT Grid Amplifier (1993 Vol. II [MWSYM])

*M. Kim, E.A. Sovero, J.B. Hacker, M.P. De Lisio, J.-C. Chiao, S.-J. Li, D.R. Gagnon, J.J. Rosenberg and D.B. Rutledge. "A 100-Element HBT Grid Amplifier (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 615-618.*

A 100-element 10-GHz grid amplifier has been developed. The active devices in the grid are chips with heterojunction bipolar transistor (HBT) differential pairs that include a resistive network to provide self-bias to the base. The planar metal grid structure was empirically designed to provide effective coupling between the HBT's and free space. Two independent measurements, one with focusing lenses, the other without, were used to measure the gain of the grid. In each case, the peak gain of the grid was 10 dB at 10 GHz with a 3 dB bandwidth of 1 GHz. The input and output matches are better than 15 dB at 10 GHz. The maximum output power is 450 mW, and the minimum noise figure is 7 dB. Tests show that the grid is quite tolerant of failures--the output power dropped by only 1 dB when the 10% of the inputs were detuned. The device amplifies beams with incidence angles up to 30° with less than a 3-dB drop in power.

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## Spatial Power Combining for Millimeterwave Solid State Amplifiers

*J.A. Benet, A.R. Perkons, S.H. Wong and A. Zaman. "Spatial Power Combining for Millimeterwave Solid State Amplifiers." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 619-622.*

A new method for obtaining high power amplification at millimeterwave frequencies using spatial power combining is being developed. The method uses orthogonally polarized fields to isolate the input and output waves of a two-dimensional array of solid state amplifiers. To demonstrate this new technique, a proof-of-concept model was developed using a 69-element array orthogonally polarized elements at 17 GHz.

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## Space Power Amplification with Active Linearly Tapered Slot Antenna Array

*R.N. Simons and R.Q. Lee. "Space Power Amplification with Active Linearly Tapered Slot Antenna Array." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 623-626.*

A space power amplifier composed of active linearly tapered slot antennas (LTSAs) has been demonstrated and shown to have a gain of 30 dB at 20 GHz. In each of the antenna elements, a GaAs monolithic microwave integrated circuit (MMIC) three-stage power amplifier is integrated with two LTSAs. The LTSA and the MMIC power amplifier have a gain of 11 dB and power added efficiency of 14 percent respectively. The design is suitable for constructing a large array using monolithic integration techniques.

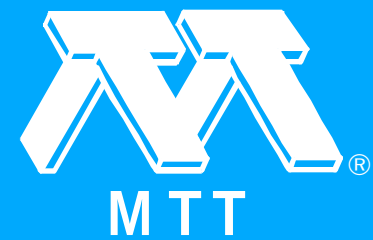
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# Abstracts

## Session T -- Non-Linear Modeling and Analysis

*"Session T -- Non-Linear Modeling and Analysis." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 627-628.*



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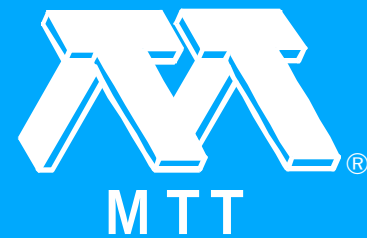


# Abstracts

## Numerical Optimization of Microwave Oscillators and VCOs

*V. Rizzoli, A. Costanzo and C. Cecchetti. "Numerical Optimization of Microwave Oscillators and VCOs." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 629-632.*

A new harmonic-balance optimization technique for single-frequency oscillators and broadband VCOs is introduced. The objective function is evaluated by a Newton-iteration based HB analysis, and an exact algorithm for the computation of the gradient is implemented. The optimizable performance in the VCO case includes the linearity of the tuning characteristic.



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# Abstracts

## Analysis of Strongly Nonlinear Circuits with a Frequency-Domain Method Coupled with a Consistent Large-Signal Model

*T. Narhi. "Analysis of Strongly Nonlinear Circuits with a Frequency-Domain Method Coupled with a Consistent Large-Signal Model." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 633-636.*

The paper describes an analysis method that extends the applicability of frequency-domain methods to strongly nonlinear circuits. Nonlinearities are described with Chebyshev expansions which are evaluated with a numerically stable three-term recurrence formula. The method is coupled with a novel, measurement-based consistent modelling approach which allows improved accuracy in describing the frequency-dependence of the measured small-signal parameters. The analysis method and the modelling approach are verified by comparing measurements and calculations on a MESFET mixer, driven with two and three tones.



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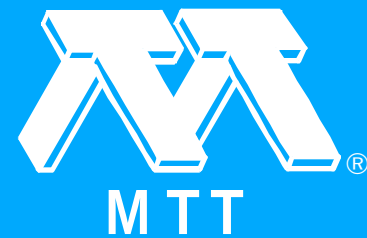


# Abstracts

## Analysis of Nonlinear Microwave Circuits Using the Compression Approach

*J. Kunisch, A. Bahr, M. Rittweger and I. Wolff. "Analysis of Nonlinear Microwave Circuits Using the Compression Approach." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 637-640.*

This paper describes the Compression Approach, a technique for comprehensive analysis of nonlinear microwave circuits which supplies a framework for combining linear field simulation methods and harmonic balance. The foundations of this approach are discussed. Simulation results of this method for a nonlinear transmission line are compared with those of a pure time-domain approach.



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## Nonlinear Model for Predicting Intermodulation Distortion in GaAs FET RF Switch Devices

*J.A. Pla and W. Struble. "Nonlinear Model for Predicting Intermodulation Distortion in GaAs FET RF Switch Devices." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 641-644.*

A nonlinear model for predicting IMD in GaAs FET RF switch devices has been developed. A new unified equivalent circuit model of the switch FET for the ON and the OFF states has been proposed. The nonlinearities of the test FET as a function of the gate bias were identified and modeled up to 40 GHz by fitting scattering parameter data. These nonlinearities were combined into a single nonlinear model constructed from a number of elementary linear and nonlinear elements. The nonlinear circuit equations were incorporated as a user defined model in LIBRA/sup TM/ to perform the harmonic balance technique. This new model has been used to predict the IMD and phase shifting performance of three of the individual bit chips (11.25, 22.5 and 180 degrees) of a 6 to 18 GHz wideband five-bit phase shifter. In this phase shifter, GaAs MESFETs are used as switch devices which configured the bits into high or low pass filter structures.

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## Direct Nonlinear Power MESFET Parameter Extraction and Consistent Modeling

*A. Werthof, F. van Raay and G. Kompa. "Direct Nonlinear Power MESFET Parameter Extraction and Consistent Modeling." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 645-648.*

A new method is developed which permits a direct non-linear FET parameter extraction of the gate source capacitor and diode, the drain current generator and the avalanche breakdown characteristics from large-signal waveform measurements. Differences between the DC and RF characteristics of the drain current generator and the breakdown characteristics are observed and interpreted. The measured FET output power and phase spectra are compared with the simulated results for different RF models of the nonlinear drain current generator. The proposed method is a valuable instrument for the analysis of the actually existing high frequency FET nonlinearities and can be helpful in the improvement large-signal FET models.

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## Analysis of Symmetric-Varactor Frequency Triplers

*K. Krishnamurthi and R.G. Harrison. "Analysis of Symmetric-Varactor Frequency Triplers." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 649-652.*

A simple analytical model for varactors that have a symmetric capacitance-voltage characteristic is introduced. This empirical but general model can be used to represent the reactance nonlinearity of quantum-barrier varactors, symmetric high-electron-mobility varactors and back-to-back BNN/sup +/- diodes. Using this model, a generalized large-signal analysis of symmetric-varactor triplers is developed. The analysis yields an expression for the maximum efficiency. It is further shown that a series-resonant circuit including a symmetric varactor can be described by Duffing's equation. The solution of this equation predicts hysteresis effects.

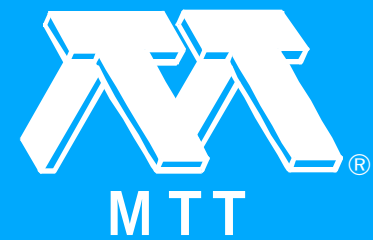
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# Abstracts

## Session U -- Solid-State Oscillators

*"Session U -- Solid-State Oscillators." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 653-654.*



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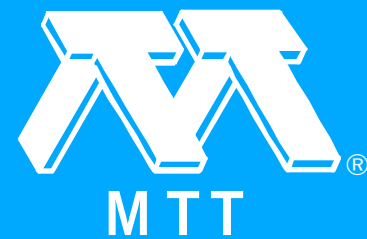


# Abstracts

## A General Method Based on Harmonic Balance Techniques to Simulate Noise in Free Running Oscillators

*W. Anzill and P. Russer. "A General Method Based on Harmonic Balance Techniques to Simulate Noise in Free Running Oscillators." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 655-658.*

A new approach using perturbation theory for simulating the noise behavior in free running microwave oscillators based on a piecewise harmonic balance technique is outlined and applied to a planar integrated microwave oscillator at 14 GHz. A single-sideband phase noise of -90 dBc/Hz at an offset frequency of 100 kHz was measured. Simulated and measured single-sideband phase noise agree within the accuracy of measurements. The method is neither limited to certain circuit topologies nor to certain nature of noise sources.



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# Abstracts

## A Fast-Tuned, Injection Locked, DDS-Based Local Oscillator for the 3.6 to 4.1GHz Frequency Range

*L.D. Cohen and K. Breuer. "A Fast-Tuned, Injection Locked, DDS-Based Local Oscillator for the 3.6 to 4.1GHz Frequency Range." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 659-662.*

A new fast-tuned (100 nsec) local oscillator design for the 3.6- to 4.1- GHz frequency range uses a direct digital synthesizer (DDS) to high-order subharmonically injection lock a VCO and thereby upconvert and broaden the DDS frequency range. The injection locking process provides the advantages of fast locking time (40 nsec) and reduction of reference source spurs in the locked VCO output.



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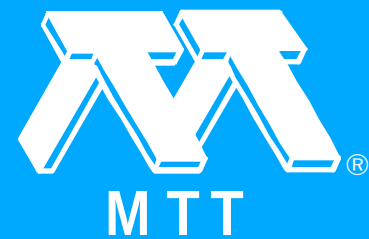
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## GaAs FET Direct Frequency-Modulators for 42-GHz-Band HDTV Radio Cameras and 7-GHz-Band FMD Pick-Up Transmitters

*H. Mitsumoto and K. Imai. "GaAs FET Direct Frequency-Modulators for 42-GHz-Band HDTV Radio Cameras and 7-GHz-Band FMD Pick-Up Transmitters." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 663-666.*

This paper describes the design of a direct frequency-modulator with high modulation sensitivity. With a dielectric resonator, two hyper-abrupt-junction varactors, and a GaAs FET, this design achieves a modulation sensitivity greater than 20 MHz/V in a 42-GHz-band frequency-modulator developed for HDTV radio cameras. When this design is used in a 7-GHz-band frequency-modulator for a field pick-up transmitter gathering emergency news, it provides an output power of 22 dBm, a differential gain of less than 3%, and a differential phase of less than 2°. All transmitters using this new frequency-modulator have high broadcast efficiency.

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## A Monolithic Dielectrically Stabilized Voltage Controlled Oscillator for the Millimeter Wave Range

*U. Guttich, J.M. Dieudonne and L.P. Schmidt. "A Monolithic Dielectrically Stabilized Voltage Controlled Oscillator for the Millimeter Wave Range." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 667-670.*

In this paper the design, fabrication and evaluation of a monolithic 29 GHz dielectrically stabilized voltage controlled oscillator (DVO) applying a MESFET as the active device are described. The novel design yields an oscillator with excellent phase noise behavior and frequency tuning capabilities. A phase noise N/C/sub FM/ of -100 dBc/Hz at 100 kHz off carrier and an output power of +8 dBm without significant deviation over the full tuning range of 45 MHz are obtained. A frequency stability of -6 ppm/°C is measured in the -20°C to +80°C temperature range for a +3 ppm/°C temperature coefficient of the dielectric resonator. The MMIC device is realized using a 0.25µm MESFET technology.

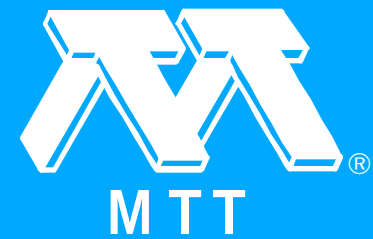
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# Abstracts

## Session V -- Wireless Local Area Networks (Focused Session)

*"Session V -- Wireless Local Area Networks (Focused Session)." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 671-672.*



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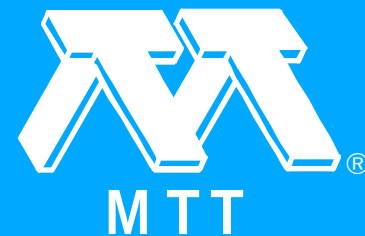


# Abstracts

## Research Activities on Millimeter Wave Indoor Communication Systems in Japan

*Y. Takimoto and T. Ihara. "Research Activities on Millimeter Wave Indoor Communication Systems in Japan." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 673-676.*

This paper describes the R&D activities on the millimeter-wave indoor communication systems in Japan, especially on the millimeter-wave propagation characteristics, system study on the indoor communications in the offices, development of active devices such as MMICs, and flat antennas.



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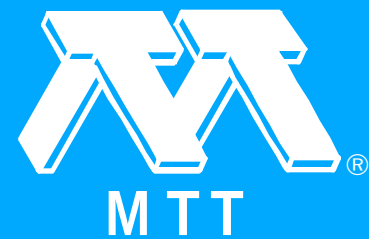


# Abstracts

## Australian Activities in Microwave Links for Wireless LANs

*R.A. Batchelor, J.W. Archer, T.S. Bird, S. Giugni, J.S. Kot, N. Nikolic, D.I. Ostry, T.M. Percival and A.C. Young. "Australian Activities in Microwave Links for Wireless LANs." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 677-680.*

The evolution of wireless connectivity will need to keep pace with the decrease in size of portable computers and the increase in available computing power. Relatively low bit-rate systems are now commonly available, and faster, second-generation systems are under development. In Australia, a program centred at the CSIRO Division of Radiophysics aims to develop third-generation wireless systems with capacities of order 100 Mbits per second in a cell. This paper discusses some of the issues relating to the design of millimetre-wave antennas and transceiver MMICS for operation at frequencies near the 60 GHz ISM band.



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# Abstracts

## Development of a Commercial, 38 GHz, Communication Link

*W. Gulloch, M. Politi, R. Nobili, M. Amati and G. Colombo. "Development of a Commercial, 38 GHz, Communication Link." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 681-684.*

This paper presents the work which has been carried out in the development of commercial radio links at Millimeter (MM) wave frequencies. The first part deals with the system aspects while in the second, results are presented for the MM wave components which have been developed. A common system approach has been used which is modular thus enabling the economic reuse of most of the lower frequency system functions. The modulation options which have been considered and their effect on the millimeter wave components are discussed. From this analysis a low cost system approach is presented based on the use of MMICs and broadband RF components. Offset 4QAM modulation (40QAM) was used in order to provide a good compromise between amplifier linearity and spectral efficiency. This system design has been implemented at 38 GHz and various system results are presented.



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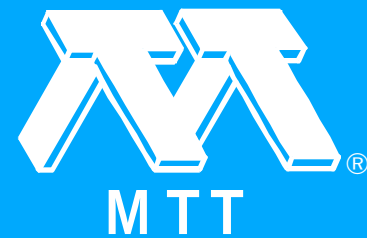


# Abstracts

## A Frequency Hopping Microwave Radio System for Local Area Network Communications

*D.A. Williams. "A Frequency Hopping Microwave Radio System for Local Area Network Communications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 685-690.*

This paper describes the design, development and evaluation of a frequency hopping radio transceiver operating in the 2.4-2.483GHz Industrial, Scientific and Medical (ISM) band. The principal application of the device is in portable computers where it facilitates "roving connectivity" to other portable or fixed computer systems.



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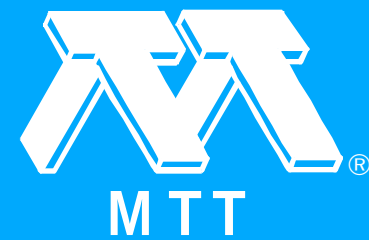




# Abstracts

## Session W -- Co-Planar Structures (Passive Components)

*"Session W -- Co-Planar Structures (Passive Components)." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 691-692.*



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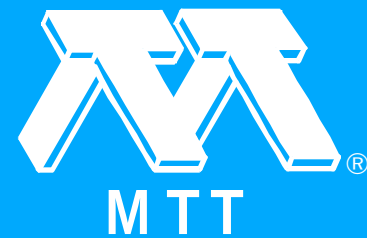


# Abstracts

## A Survey of European Activity on Coplanar Waveguide

*J.L.B. Walker. "A Survey of European Activity on Coplanar Waveguide." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 693-696.*

Although early work in Europe was directed at developing closed-form analytic expressions for  $Z_0$  and  $\epsilon_{\text{eff}}$  of a number of variants of CPW, much of the current work is application oriented. Amongst the topics being examined are CPW filters, mixers, couplers, and wideband electro-optic modulators. Work is also in progress on developing CAD data for CPW discontinuities, whilst theoretical work continues. This paper will present an overview of current European CPW work.



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# Abstracts

## Full-Wave Analysis of Various Coplanar Bends and T-Junctions with Respect to Different Types of Air-Bridges

*T. Becks and I. Wolff. "Full-Wave Analysis of Various Coplanar Bends and T-Junctions with Respect to Different Types of Air-Bridges." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 697-700.*

Air-bridges are indispensable to monolithic microwave integrated circuit design in coplanar waveguide technique. Based on an extension of the spectral domain analysis method to analyze three-dimensional metallization structures, various types of air-bridges within bends and T-junctions are investigated. Generalized scattering parameters are calculated in order to compare the different bridge layouts. The accuracy of the proposed method is checked by comparing with measurements.



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## Effects of Ground Equalization on the Electrical Performance of Asymmetric CPW Shunt Stubs

*N. Dib, M. Gupta, G. Ponchak and L. Katehi. "Effects of Ground Equalization on the Electrical Performance of Asymmetric CPW Shunt Stubs." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 701-704.*

A hybrid technique is used to study the effects of ground equalization on the electrical performance of CPW shunt stubs. Extensive experiments have been performed and the results are in good agreement with theoretical data. The advantages of using air-bridges in CPW circuits as opposed to bond-wires are also discussed.

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## Comparing Coax Launcher and Wafer Probe Excitation for 10mil Conductor Backed CPW with via Holes and Airbridges

*M. Yu, R. Vahldieck and J. Huang. "Comparing Coax Launcher and Wafer Probe Excitation for 10mil Conductor Backed CPW with via Holes and Airbridges." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 705-708.*

This paper presents an experimental comparison of coax launcher versus wafer probe excitation of 10mil conductor backed CPW. It was found that conductor backing of a CPW can cause serious moding problem when a coax launcher is used. Introducing via holes can eliminate this problem to some degree. In comparison, wafer probe excitation shows generally a better response but also here the backmetallization causes some moding problems. The transition effect from the coax launcher onto the CPW has been modeled numerically and good agreement was found with measured data.

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## 3D Characterization of Air Bridges and via Holes in Conductor-Backed Coplanar Waveguides for MMIC Applications

*S. Visan, O. Picon and V.F. Hanna. "3D Characterization of Air Bridges and via Holes in Conductor-Backed Coplanar Waveguides for MMIC Applications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 709-712.*

A 3D Finite Difference Time Domain (FDTD) Method is used to characterize either an air bridge or two via holes which can be used in a conductor backed coplanar waveguide (CPW) to suppress the coupled slotline like mode. The accuracy of the analysis is demonstrated through the comparison of theoretical results obtained using our FDTD method to experimental ones for a via hole ground in a microstrip. It is shown that the via holes discontinuity in a conductor-backed CPW is associated with reflection losses lower than that in the case of an air bridge discontinuity.

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## Full-Wave Analysis of Discontinuities in Uniplanar and Multiplanar Transmission Lines Using the Frequency-Domain TLM Method

*H. Jin, R. Vahldieck, P. Russer and J. Huang. "Full-Wave Analysis of Discontinuities in Uniplanar and Multiplanar Transmission Lines Using the Frequency-Domain TLM Method." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 713-716.*

This paper introduces a rigorous analysis of a variety of transmission line transition discontinuities and module interconnect assemblies in MMIC and miniature MIC circuits using the frequency-domain TLM method. Numerical results of frequency-dependent s-parameters are presented which include the effect of finite thickness and conductivity of the metallization as well as mode interaction between cascaded discontinuities. The effects of the bonding wire for module assemblies is investigated. It is found that the properties of the interconnect are largely depended on the total length of the wire and are quite insensitive to the shape of the wire. This is in a good agreement with experimental observations.

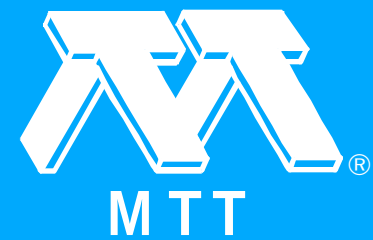
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# Abstracts

## Session X -- High Speed Fiber Optic Links- Systems

*"Session X -- High Speed Fiber Optic Links-Systems." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 717-718.*



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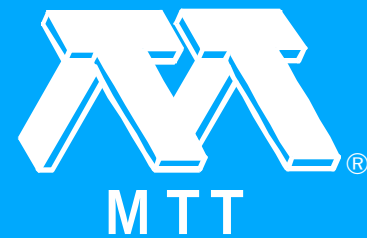


# Abstracts

## High-Performance Fiber-Optic Links for Microwave Applications

*C.H. Cox, III. "High-Performance Fiber-Optic Links for Microwave Applications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 719-722.*

There have been significant improvements in the performance of fiber-optic links over the last four years. We will review some of the advances that have been made since our previous comparison between directly and externally modulated links. We will also present new data on additional link parameters for both types of links.



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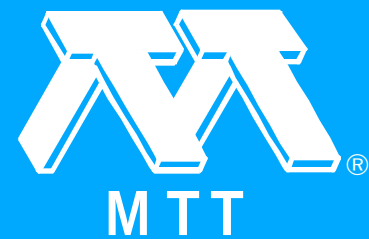
## Balanced Receiver External Modulation Fiber-Optic Link Architecture with Reduced Noise Figure

*E. Ackerman, S. Wanuga, J. MacDonald and J. Prince. "Balanced Receiver External Modulation Fiber-Optic Link Architecture with Reduced Noise Figure." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 723-726.*

We describe a fiber-optic link architecture which minimizes noise figure by combining the two complementary outputs of a Y-fed coupler electrooptic modulator in such a way that the optical noise cancels in a balanced receiver module. The demonstration link exhibits 9.5 dB insertion loss and 13.5 dB noise figure at 900 MHz.

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## Improved Feedforward Linearization of Laser Diodes - Simulation and Experimental Results

*D. Hassin and R. Vahldieck. "Improved Feedforward Linearization of Laser Diodes - Simulation and Experimental Results." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 727-730.*

In this paper we discuss feedforward linearization of directly modulated laser diodes for AM CATV lightwave transmission systems. Theoretical simulation and experimental results are presented showing a distortion cancellation of better than 20dB over 850 MHz bandwidth. An investigation regarding tolerance and a possible dispersion penalty in the system is performed.

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## Microwave Signal Distribution Using an Optical Amplifier

*D. Mongardien, C. Moronvalle and F. Deborgies. "Microwave Signal Distribution Using an Optical Amplifier." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 731-734.*

It has been shown that up to 15 GHz, erbium doped fiber amplifiers (EDFAs) do not modify the  $S_{21}$  of an optical link. Here, we demonstrate that EDFAs do not alter the linearity either and can provide enough gain and power to split the microwave signal to 64 detectors with a 145 dB/Hz signal to noise ratio.

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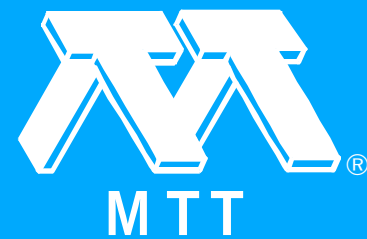


# Abstracts

## Rugged Optical Submodules for Microwave Applications

*Y. Combemale, F. Deborgies and P. Maillot. "Rugged Optical Submodules for Microwave Applications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 735-738.*

A new concept of microwave opto-electronic modules is presented. Those modules (laser transmitter and photodiode receiver) can either be used directly in any hybrid design of a microwave system involving optoelectronics or more conventionally fitted into a proper package. They are well suited for all the applications requiring stringent environmental conditions such as military or space.



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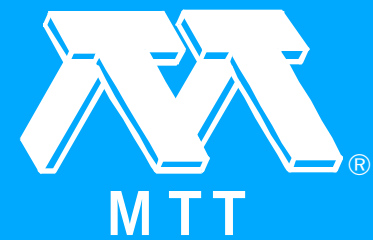
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# Abstracts

## Session Y -- Field Theoretic CAD

*"Session Y -- Field Theoretic CAD." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 739-740.*



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# Abstracts

## Modeling of Discontinuities in Microwave and Millimeter Wave Integrated Circuits Using the Curvilinear Finite Difference Time Domain Approach

*S. Kosanovich and R. Mittra. "Modeling of Discontinuities in Microwave and Millimeter Wave Integrated Circuits Using the Curvilinear Finite Difference Time Domain Approach." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 741-744.*

In this paper we describe a full-wave approach based upon the curvilinear Finite Difference Time Domain (FDTD) algorithm for accurate modeling of discontinuities in microstrip lines that do not conform to the Cartesian coordinate system. The use of the curvilinear FDTD approach circumvents the staircasing problem that arises in the TLM method, as well as in the conventional FDTD approach based upon the Yee-grid, and, consequently, allows one to accurately model arbitrary geometries without the use of a very fine mesh. The scattering parameters of several representative discontinuities are calculated, and numerical results are compared to those available from microwave simulators such as TouchStone.



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## Finite Element Analysis of MMIC Structures Using Absorbing Boundary Conditions

*J.S. Wang and R. Mittra. "Finite Element Analysis of MMIC Structures Using Absorbing Boundary Conditions." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 745-748.*

In this paper, three-dimensional finite element method (FEM) is employed in conjunction with first and second-order absorbing boundary conditions (ABCs) to analyze waveguide discontinuities and to derive their scattering parameters. While the application of FEM for the analysis of MMIC structures is not new, to the best of the knowledge of the authors the technique for mesh truncation for microstrip lines using the first and higher-order ABCs, described in this paper, has not been reported elsewhere. Numerical solutions for two representative waveguide discontinuities are obtained and compared with published data.

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# Abstracts

## Combining an Autoregressive (AR) Model with the FD-TD Algorithm for Improved Computational Efficiency

*J. Chen, C. Wu, K.-L. Wu and J. Litva. "Combining an Autoregressive (AR) Model with the FD-TD Algorithm for Improved Computational Efficiency." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 749-752.*

In this paper, we combine an autoregressive (AR) model with the FD-TD algorithm. It is shown that this greatly improves the computational efficiency of the FD-TD technique. The AR model can be set up using a short segment of the time domain trace generated by FD-TD. Through extrapolation, future segments of the response can be accurately predicted. It is shown that the AR model is more robust and accurate than other prediction techniques used with EM modeling. A number of numerical examples is shown.



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## Study of Gridding and Cell-Cell Interactions in the Method of Moments Analysis of Arbitrarily Shaped Planar Circuits

*J. Sercu, N. Fache, F. Libbrecht and D. De Zutter. "Study of Gridding and Cell-Cell Interactions in the Method of Moments Analysis of Arbitrarily Shaped Planar Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 753-756.*

A method of Galerkin analysis of polygonal planar circuits embedded in a multilayered medium is presented. The circuit is gridded up using rectangular and triangular cells. Rooftop basis functions are used. The paper focuses on an efficient calculation scheme for the cell-cell interactions. A microstrip low-pass filter is investigated and comparisons are made with measured and other simulated data. Grid accuracy and convergence are discussed.



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# Abstracts

## Rigorous 3D EM Simulation and an Efficient Approximate Model of MMIC Overlay Capacitors with Multiple Feedpoints

*M. Engels and R.H. Jansen. "Rigorous 3D EM Simulation and an Efficient Approximate Model of MMIC Overlay Capacitors with Multiple Feedpoints." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 757-760.*

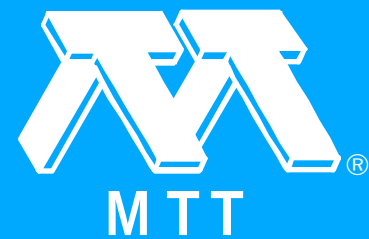
A systematic 3D electromagnetic analysis of MIM-capacitors with up to 4 feedstrips has been performed to investigate the electrical effects of feed widths and positions. Based on this, an efficient approximate CAD model of MIM-capacitor N-ports has been developed which is an extension and generalization of a recently published two-port model.



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## Rigorous Design of Sidewall Aperture Couplers

*T. Sieverding, J. Bornemann and F. Arndt. "Rigorous Design of Sidewall Aperture Couplers." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 761-764.*

The rigorous field theory CAD of rectangular waveguide sidewall aperture couplers is introduced which are coupled by rectangular apertures of different size. Based on the rectangular waveguide T-junction and the double-step discontinuity key-building block modal S-matrices which are calculated by the mode-matching method, the design takes rigorously into account both the finite wall thickness and the higher order mode interaction between all discontinuities. Design examples for rectangular aperture 10dB-, 8.34dB-, and 3dB-couplers in the waveguide Ku-band (12 - 18 GHz) demonstrate the efficiency of the design method. The theory is verified by excellent agreement with measurements.

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## Field Theory CAD of L-Shaped IRIS Coupled Mode Launchers and Dual-Mode Filters

*R. Ihmels and F. Arndt. "Field Theory CAD of L-Shaped IRIS Coupled Mode Launchers and Dual-Mode Filters." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 765-768.*

A rigorous field theory design method for L-shaped iris coupled TE/sub 10/-to-TE/sub 01/-mode launchers and dual-mode filters is presented. The theory is based on the full-wave mode-matching key-building block S-parameter description of the L-shaped iris in rectangular waveguides and allows, associated with the generalized S-matrix technique, the complete three-dimensional modeling of L-shaped structures and cascaded discontinuities. Arbitrary obstacle location and finite thickness are rigorously taken into account. An optimized design example of a very compact Ku-band (12-18 GHz) mode-launcher achieves 5% bandwidth with more than 20 dB return loss at the 90°- twisted WR62 in- and output waveguides. The computer optimized design of a Ku-band L-shaped iris coupled 4-pole dual-mode filter demonstrates good elliptic function behavior. The theory is verified by measurements.

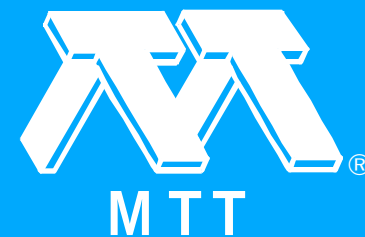
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# Abstracts

## Session Z -- Low Noise Millimeter Wave Receivers

*"Session Z -- Low Noise Millimeter Wave Receivers." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 769-770.*



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## A 547 GHz SIS Receiver Employing a Submicron Nb Junction with an Integrated Matching Circuit

*P. Febvre, W.R. McGrath, P. Batelaan, H.G. LeDuc, B. Bumble, M.A. Frerking and J. Hernichel. "A 547 GHz SIS Receiver Employing a Submicron Nb Junction with an Integrated Matching Circuit." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 771-774.*

A heterodyne receiver using an SIS waveguide mixer with two mechanical tuners has been built and characterized over a frequency range of 460 GHz to 630 GHz. The mixer uses high current density,  $0.25 \mu\text{m}^2$ , Nb/AIO/sub x/Nb SIS tunnel junctions with integrated superconductive RF circuits to tune the junction capacitance. A DSB receiver noise temperature as low as  $200 \pm 17$  K has been obtained at 540 GHz. In addition, negative differential resistance has been observed in the DC I-V curve at 487-491 GHz.

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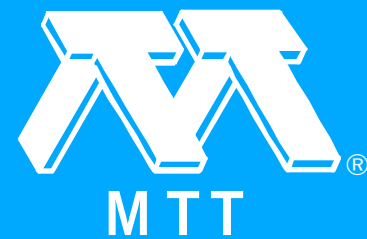


# Abstracts

## A 110 GHz Ozone Radiometer with a Cryogenically Cooled Planar Schottky Mixer

*O. Koistinen, H. Valmu, A. Raisanen, V. Vdovin, Y. Dryagin and I. Lapkin. "A 110 GHz Ozone Radiometer with a Cryogenically Cooled Planar Schottky Mixer." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 775-778.*

A total power radiometer is presented for monitoring of stratospheric ozone spectral line at 110 GHz. Special features, such as a cooled planar Schottky mixer as the front end and efficient reduction of standing waves in the quasi-optics, shall be discussed in detail. The noise temperature of the receiver is 500 K (SSB), and total bandwidth of the receiver is 1 GHz. A dual acousto-optical spectrometer is used for the signal detection.



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## A 94 GHz-Band Low Noise Downconverter

*H. Yoshinaga, K. Masuda, S. Takagi, B. Abe, K. Shibata, H. Kawasaki, H. Tokuda and I. Tokaji. "A 94 GHz-Band Low Noise Downconverter." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 779-782.*

A 94 GHz-band low noise downconverter has been developed by combining an InP-HEMT low noise amplifier, a pseudomorphic HEMT mixer and a dielectric resonator oscillator, each fabricated using the planar circuit technology. The downconverter shows a noise figure of less than 4.9 dB and a conversion gain of greater than 11 dB.

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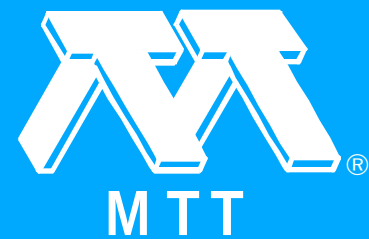
## A High Gain Low Noise 110 GHz Monolithic Two-Stage Amplifier

*H. Wang, K.L. Tan, T.N. Ton, G.S. Dow, P.H. Liu, D.C. Streit, J. Berenz, M.W. Pospieszalski and S.K. Pan. "A High Gain Low Noise 110 GHz Monolithic Two-Stage Amplifier." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 783-786.*

A high gain low noise 110 GHz monolithic two-stage amplifier using 0.1  $\mu\text{m}$  pseudomorphic AlGaAs/InGaAs/GaAs low noise HEMT technology is presented in this paper. This amplifier demonstrates a small signal gain of 19.6 dB at 110 GHz with a noise figure of 3.9 dB. A noise figure of 3.4 dB with 15.6 dB associated gain was obtained at 113 GHz. The small signal gain and noise figure performance are the best results ever achieved for a two-stage HEMT amplifier at these frequencies.

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## An F-Band Resistive Mixer Based on Heterostructure Field Effect Transistor Technology

*I. Angelov, H. Zirath, N. Rorsman, C. Karlsson and R.M. Weikle, II. "An F-Band Resistive Mixer Based on Heterostructure Field Effect Transistor Technology." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 787-790.*

A fundamentally pumped millimeterwave resistive mixer based on an HFET technology working at F-band (90-140 GHz) is described for the first time. Nonlinear simulations have been performed for this mixer based on an specially designed double delta-doped pseudomorphic HFET device developed for this application. A minimum conversion loss between 12 to 13 dB was measured with the RF fixed at different frequencies between 108 to 114 GHz at an RF power of -13 dBm. Both theoretical and experimental results are presented in this paper.

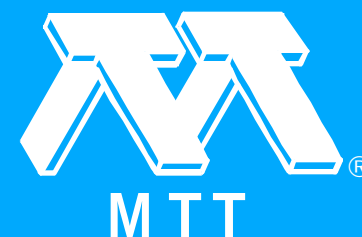
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# Abstracts

## Session AA -- Microwave Systems: Consumer and Commercial Applications

*"Session AA -- Microwave Systems: Consumer and Commercial Applications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 791-792.*



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## A Novel MMIC Power Amplifier for Pocket-Size Cellular Telephones

*M. Muraguchi, M. Nakatsugawa and M. Aikawa. "A Novel MMIC Power Amplifier for Pocket-Size Cellular Telephones." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 793-796.*

A novel MMIC power amplifier for cellular telephones is proposed. The amplifier which is named UBIC-PA (Unbalanced Bias Cascode Power Amplifier) enables making very compact monolithic integration in spite of the considerably low frequency of 900 MHz-band. The MMIC UBIC-PA has more than 40 dB gain, 29 dBm output power and 62% power added efficiency at the supplied voltage of 6V. The chip size of the MMIC without an output matching circuit is 2.4 x 2.4 mm. The size and cost of the UBIC-PA module is estimated at about 1/6 (0.2 cc) and 1/2 that of the former hybrid PA module. Moreover, the UBIC-PA improves power dissipation by more than 50% under medium and low output power conditions. This is very important for cellular telephones employing adaptive transmitter power control for battery saving.

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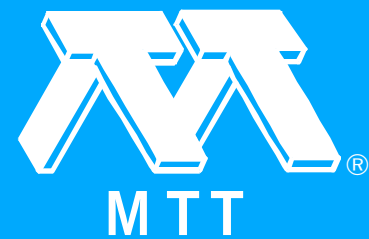
## A 2.45 GHz Wireless IC Card System for Automatic Gates

*K.-I. Konno, H. Wada and K. Matsukawa. "A 2.45 GHz Wireless IC Card System for Automatic Gates." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 797-800.*

A 2.45 GHz wireless IC card system has been developed for a non-contact type train station automatic gate system. This system consists of a compact transmitter-receiver equipment and non-contact wireless IC cards. The newly developed technology used in this system comprises a small-size dual-port slot antenna for the card, a modulation-demodulation scheme for stable data transmission, and a co-channel carrier allocation system for operation with multiple gates. Operation of this wireless card system, with its newly developed technology, has been successfully demonstrated.

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## RF Front End for Portable Satellite Terminal

*Y. Shemesh, A. Breitbard and R. Israel. "RF Front End for Portable Satellite Terminal." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 801-804.*

A briefcase portable satellite communication terminal was developed. The terminal enables fax, telex, or E-mail communication via the INMARSAT satellite system between any two points on earth. This paper describes the briefcase terminal front-end module. This super-component assembled on a single substrate demonstrates a transmit power of 30.8dBm and 2.5 dB receive noise figure. It is optimized for low cost, light weight and small size.

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## Doppler Measurement of Lateral and Longitudinal Velocity for Automobiles at Millimeterwaves

*N. Kees, M. Weinberger and J. Dettelsen. "Doppler Measurement of Lateral and Longitudinal Velocity for Automobiles at Millimeterwaves." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 805-808.*

In this paper a Doppler radar system is presented which is able to measure the lateral and the longitudinal speed of an automobile. The knowledge of the lateral speed gives a better understanding of the vehicle's dynamic behaviour especially in critical situations. The theoretical measurement accuracy is evaluated and compared to experimental data. The accuracy depends on the antenna configuration as well as on its beamforming properties. Data which were recorded during testruns in real environment are in good agreement with the theoretical expected values.

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# Abstracts

## Application of a Narrow Band FM-CW System in the Measurement of Ice Thickness

*D. Adler and M. Jacobs. "Application of a Narrow Band FM-CW System in the Measurement of Ice Thickness." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 809-812.*

An application of a narrow band radar technology for ice thickness measurement is presented. The method employed offers particular advantages for short distance measurements, conforms to FCC regulations for unlicensed operation and functions in unfavorable environmental conditions that affect optical and ultrasonic devices. The conventional FM-CW resolution is improved by inclusion of a phase shifter and by performing additional signal processing functions. Presented experimental data show better than 0.5" accuracy using only 150 MHz bandwidth.



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## Miniaturized, X-Band Solid-State Transmitter

*M. Mizan, D. Sturzebecher, T. Higgins and E. Maluszczyk. "Miniaturized, X-Band Solid-State Transmitter." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 813-816.*

A compact X-band solid-state transmitter capable of 26 watts peak output power, with state-of-the-art frequency stability is reported in this paper. A dielectric resonator oscillator (DRO), employed as a frequency source, has a frequency stability of 80 parts per million (ppm) over the temperature range of -50°C to +50°C. A six stage GaAs MESFET RF amplifier, with an associated gain of 37 dB, also functions as a pulse modulator by changing the gate bias voltages. The last amplifier stage consists of four amplifiers operating in a power combining configuration. The transmitter including the pulse modulator is packaged into a size 7.6 cm x 5.1 cm x 2.5 cm, and has a total weight of 0.22 Kgm, The transmitter operates from a  $\pm 12$  volt battery, and has an overall D.C. to RF conversion efficiency of 15%.

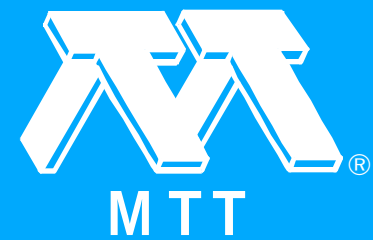
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# Abstracts

## Session BB -- Planar Structures

*"Session BB -- Planar Structures." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 817-818.*



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## Analysis of Microstrip Lines Coupled through an Arbitrarily Shaped Aperture in a Thick Common Ground Plane

*A.M. Tran and T. Itoh. "Analysis of Microstrip Lines Coupled through an Arbitrarily Shaped Aperture in a Thick Common Ground Plane." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 819-822.*

A flexible spectral domain analysis to characterize aperture-coupled microstrip lines with a common ground plane of finite conductor thickness is presented. In this approach, the coupling aperture is allowed to have any size, shape, and thickness. The effects of surface wave and radiation are also taken into accounts via the exact Green's function formulation in the spectral domain. Numerical results of the S-parameters generated using this method are presented for different aperture thicknesses and validated against known published data for the zero thickness case.

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## Effects of Air-Bridges and Mitering on Coplanar Waveguide 90° Bends: Theory and Experiment

A.A. Omar, Y.L. Chow, L. Roy and M.G. Stubbs. "Effects of Air-Bridges and Mitering on Coplanar Waveguide 90° Bends: Theory and Experiment." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 823-826.

The effects of the mitres and air-bridge dimensions and locations on coplanar waveguide (CPW) 90° bends are investigated using the moment method. An experiment is conducted to verify the accuracy of our calculations. These show that the CPW bends are mainly affected by the air-bridge height and location not the mitering.

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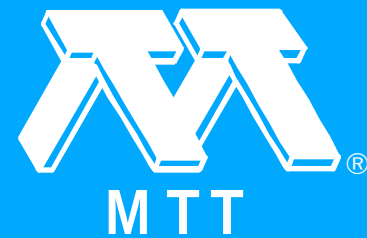


# Abstracts

## Experimental Results on Microshield Transmission Line Circuits

*T.M. Weller, G.M. Rebeiz and L.P. Katehi. "Experimental Results on Microshield Transmission Line Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 827-830.*

Presented here are the first experimental data on microshield circuits which use the membrane technology. Microshield shows potential for improved performance relative to current planar transmission line geometries. This paper will describe results on stepped-impedance filters and coplanar waveguide-to-microshield transitions.



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# Abstracts

## The Role of Higher Order Modes in the Characterization of a Shielded Transition to a Dielectric Waveguide

*A.G. Engel, Jr. and L.P.B. Katehi. "The Role of Higher Order Modes in the Characterization of a Shielded Transition to a Dielectric Waveguide." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 831-834.*

The S-parameters of a shielded sub-mm/THz monolithic transition between a layered ridged dielectric waveguide and a power source are determined from results obtained by an integral equation-mode matching method. The presence of higher order modes due to the shielding is considered. The electrical performance of a wide-band efficient transition is presented.



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## Characterization and Simulation of Bi-Quadratic Coplanar Waveguide Tapers for Time-Domain Applications

*W. Thomann, B. Isele, F. Stockeler, R. Weigel and P. Russer. "Characterization and Simulation of Bi-Quadratic Coplanar Waveguide Tapers for Time-Domain Applications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 835-838.*

The design and performance of a novel coplanar waveguide (CPW) taper for picosecond pulse applications is described. We have investigated tapers with largely differing widths varying from 62.5  $\mu\text{m}$  to 900  $\mu\text{m}$ . The circuit characteristics were simulated both in time domain and frequency domain using a 3D transmission-line-matrix (TLM) method. We found an optimum bi-quadratic shape which reduces the reflections from more than 5 % to below 2 % in comparison to a linear taper. The circuits were measured in the frequency range up to 40 GHz with a wafer prober. At 40 GHz, the insertion loss values were less than 0.4 dB. For a double taper risetimes of 6.4 ps were achieved which correspond to a bandwidth of 55 GHz.





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## Analysis of Broadside Coupled Strip Inset Dielectric Guide

*Z. Fan and S.R. Pennock. "Analysis of Broadside Coupled Strip Inset Dielectric Guide." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 839-842.*

A theoretical and numerical method is presented for the analysis of broadside-coupled strip inset dielectric guide. The method of analysis is based on an integral equation formulation and Galerkin's procedure. In addition to propagation constants for two fundamental and higher order modes, the characteristic impedances for the two fundamental modes are calculated using the total propagating power and the longitudinal strip currents. The propagation characteristics of two fundamental modes are then used to compute 4-port circuit parameters. These are essential for accurate analysis and design of coupled line circuits such as directional couplers.

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## Packaging and Interconnection Mutual Coupling Effects in Planar Structures and Discontinuities

*C. Amrani, M. Drissi, V. Fouad Hanna and J. Citerne. "Packaging and Interconnection Mutual Coupling Effects in Planar Structures and Discontinuities." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 843-846.*

In the present paper, an integral equations technique solved by the method of moment is used to analyse parasitic coupling in general shielded planar structures. Two main ones are studied: the coupling between a planar component and its enclosure and the coupling between planar components themselves. The first effect is illustrated by the calculated values of the effective permittivity of uniform planar lines and the S parameters for a suspended stripline stub discontinuity for different enclosure geometries. The mutual coupling between two small spaced microstrip stubs is also presented and discussed. Comparison with other numerical results as well as with other published experimental ones has verified the accuracy and the numerical efficiency of the present approach.

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# Abstracts

## Session OF2 -- Interactive Forum II

*"Session OF2 -- Interactive Forum II." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 847-848.*



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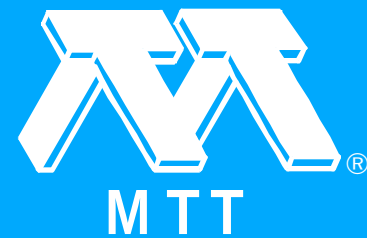


# Abstracts

## Measurements of PCS Microwave Propagation in Buildings

*Y. Tang and H. Sobol. "Measurements of PCS Microwave Propagation in Buildings." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 849-852.*

The indoor environments, which have not yet been generally characterized are critically important to PCS propagation. This paper describes measurements in different indoor environments and the application of a novel indoor loss-distance model. The dynamic effects of indoor activities by people are also examined.



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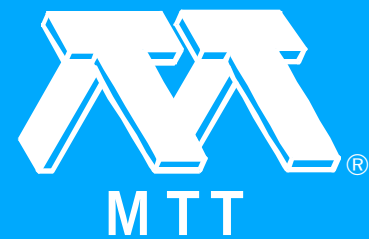


# Abstracts

## Indoor and Outdoor Propagation Measurements at 5 and 60 GHz for Radio LAN Application

*A. Plattner, N. Prediger and W. Herzig. "Indoor and Outdoor Propagation Measurements at 5 and 60 GHz for Radio LAN Application." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 853-856.*

An increasing demand for wireless communication between computers requires the allocation of new frequency ranges for this application. The propagation characteristics of these frequency bands have to be studied extensively in order to develop a set of channel models which are essential for the selection of the optimal modulation- equalisation- and error correction schemes. This paper presents the results of a variety of measurements both at 5 and 60 GHz which lead to a better understanding of the performance of the radio channel. Those measurements include swept frequency, delay spread and angle of arrival measurements (at 60 GHz) as well as investigations on space diversity.



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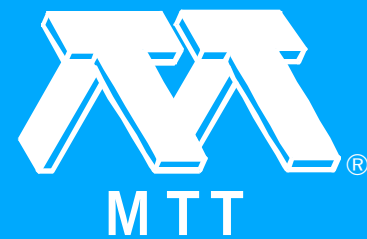
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## Test Results of an Experimental Autonomous Aircraft Landing System Utilizing a 94 GHz FM-CW Imaging Radar

*L.Q. Bui, D. Uecker, E. Loose and Y. Alon. "Test Results of an Experimental Autonomous Aircraft Landing System Utilizing a 94 GHz FM-CW Imaging Radar." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 857-860.*

An experimental system capable of aiding a pilot during adverse weather landings, primarily dense fog, has been built and tested both on the ground and in flight. The system includes a 94 GHz FM-CW radar as the front-end sensor and a back-end digital signal and image processor for image generation, enhancement, and transformation. The high performance 94 GHz radar utilizes a twisted cassegrain reflector, an external ILO, and an HEMT MIMIC LNA/image-reject mixer front end to overcome the low transmitted power and poor receiver noise qualities of typical W-band radar systems. The back-end processing hardware uses a number of processors in a flexible and reconfigurable pipeline architecture for implementation of a variety of different enhancement algorithms. This paper gives a detailed description of this system and the test results which have been recorded on the ground and in flight. The results indicate that this system has future commercial promise.



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## Pulse Distortion on Multilayer Microstrip Line

*A.K. Verma, R. Kumar and G.H. Sadr. "Pulse Distortion on Multilayer Microstrip Line." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 861-864.*

Effect of permittivity,  $w/h$  ratio and pulse duration on the distortion of Gaussian pulse is investigated. For  $w/h = 1$ ,  $\epsilon_r < 9.7$ , the pulse distortion becomes independent of  $w/h$  ratio. Using unified dispersion model, distortion of Gaussian pulse on composite substrate and suspended substrate is presented. In the case of composite substrate pulse distortion can be controlled by proper selection of  $w/h$  ratio and thickness of low permittivity substrate. The fractional change in  $\epsilon_r$  i.e.  $[\epsilon_r(f) - \epsilon_r(f=0)]/\epsilon_r$  can provide a measure for characterizing the pulse distortion.

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## A Causal Skin-Effect Model of Microstrip Lines

*J. He, N.S. Nahman and S.M. Riad. "A Causal Skin-Effect Model of Microstrip Lines." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 865-868.*

A complete transmission line model including skin-effect is derived to show effects of conductor skin loss on both the attenuation and phase factors. Frequency dependent behaviors of a microstrip line is also included in the model. Distortion of a short pulse due to the skin-effect including attenuation, dispersion, and propagation delay are investigated. Simulation results indicate that the skin-effect cannot be neglected in the phase factor in low conductivity transmission lines.

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## Investigations on the Reduction of Package Densities in Coplanar Circuits

*T. Becks and I. Wolff. "Investigations on the Reduction of Package Densities in Coplanar Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 869-872.*

One of the advantages of coplanar circuit design over microstrip design is the possibility to achieve higher package densities. The paper presents a modified method to calculate generalized scattering parameters for neighboured coplanar lines. A full-wave method is used to analyze important parameters as insertion loss, isolation and reflection not only for the coplanar mode but also for the conversion to the coupled slot line mode. Results for various structures on a GaAs-substrate are presented.

[Click on title for a complete paper.](#)



## Broadband Directional Coupler Using Dielectric Loaded Slit

*H. Oh-hash, H. Asao and O. Ishida. "Broadband Directional Coupler Using Dielectric Loaded Slit." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 873-876.*

A broadband 40dB directional coupler using coupling-slits opened in common ground conductors between parallel coaxial lines has been fabricated. Dielectric plates are loaded in the slits in order to compensate the directivity degradation due to ground conductor discontinuities at the slit ends. The directivity is greater than 24dB.



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## Experimental Investigations of CPW-Slotline Transitions for Uniplanar Microwave Integrated Circuits

*C.-H. Ho, L. Fan and K. Chang. "Experimental Investigations of CPW-Slotline Transitions for Uniplanar Microwave Integrated Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 877-880.*

Eight new coplanar waveguide (CPW) to slotline transitions using uniform and nonuniform CPWs or slotlines will be discussed. These transitions are uniplanar and simple to fabricate. No via-holes are needed for ground connections, and integration with solid state devices are easy. A pair of broad-band transitions using CPW shorts and slotline radial stubs is demonstrated with a 1 dB bandwidth of more than 5.2:1.

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# Abstracts



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## A Limiting Filter for Application in a GPS Receiver

*R. Tan and R. Levy. "A Limiting Filter for Application in a GPS Receiver." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 881-884.*

A limiting filter is a new type of microwave circuit device that is essentially a filter modified by the addition of PIN diodes or other protection devices that give the filter nonlinear limiting properties in its passband. In one potential application, for protecting the front end of a microwave receiver, a limiting filter would prevent receiver interference from out-of-band signals, as well as avoid receiver upset or damage by limiting in-band rf transients. The design specifications for the front end of a commercial global positioning system (GPS) were used as a guideline for designing the limiting filter. Measurements of the prototype limiting filter are compared to theoretical calculations, and rather good agreement with measurements has been observed.

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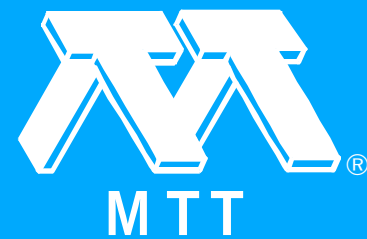


# Abstracts

## Compact 900 MHz Hairpin-Line Filters Using High Dielectric Constant Microstrip Line

*P. Pramanick. "Compact 900 MHz Hairpin-Line Filters Using High Dielectric Constant Microstrip Line." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 885-888.*

Several miniature bandpass filters have been developed by accurate modelling of experimental and computer generated coupling data of hairpin-line microstrip line resonators on high-K (K=80 to 90) substrates. The materials are temperature stable and of high quality factor. The experimental results show some novelty of the design approach. The method is useful in realizing planar filters for cellular radio and global positioning systems, and superconducting microstrip filters.



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## Minimax Microstrip Filter Design Using Direct EM Field Simulation

*J.W. Bandler, S. Ye, R.M. Biernacki, S.H. Chen and D.G. Swanson, Jr.. "Minimax Microstrip Filter Design Using Direct EM Field Simulation." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 889-892.*

For the first time we present minimax filter design with electromagnetic simulations driven directly by a gradient based optimizer. Challenges of efficiency, discretization of geometrical dimensions, and continuity of optimization variables are reconciled by a three stage attack: (1) efficient response interpolation, (2) smooth gradient estimation, and (3) dynamic data base updating. Design optimization of two microstrip filters illustrates our technique.

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## Characterization of the Resonant and Coupling Parameters of Dielectric Resonators for NRD-Guide Filtering Devices

*F. Frezza, A. Galli, G. Gerosa and P. Lampariello. "Characterization of the Resonant and Coupling Parameters of Dielectric Resonators for NRD-Guide Filtering Devices." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 893-896.*

Basic material to accurately design millimeter-wave filtering devices using variously-shaped dielectric resonators in Non-Radiative Dielectric waveguide is presented. By developing different approximate and rigorous theoretical methods, the resonant and coupling properties (frequencies, field configurations, unloaded and loaded quality factors, scattering parameters, etc.) are modeled and implemented in an adaptive code. Experimental comparisons through suitable measurements are performed to validate the theoretical and numerical results.



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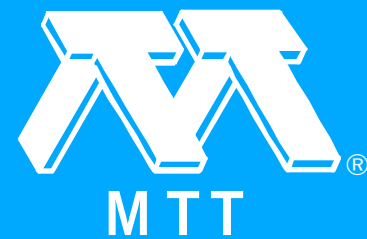


# Abstracts

## Efficient Full-Wave 3D and 2D Waveguide Eigenvalue Analysis by Using the Direct FD-TD Wave Equation Formulation

*V.J. Brankovic, D.V. Krupezevic and F. Arndt. "Efficient Full-Wave 3D and 2D Waveguide Eigenvalue Analysis by Using the Direct FD-TD Wave Equation Formulation." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 897-900.*

A modified finite-difference time-domain (FD-TD) formulation based on the direct discretization of the vector wave-equation is applied for the efficient analysis of hybrid-mode waveguiding structures. For both three- (3D) and two-dimensional (2D) waveguide eigenvalue problems, the FD-TD wave equation formulation requires advantageously only one grid, and merely the solution of three coupled equations are necessary. Numerical examples for the resonance frequencies for an inhomogeneously filled waveguide resonator, as well as for the fundamental- and higher-order-mode propagation factors for insulated image guides, shielded coupled dielectric guides, and lateral open dielectric ridge guides demonstrate the efficiency of the method. The theory is verified by comparison with results obtained by other methods.



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## Field-Analysis Model for Predicting Dispersion Property of Coupled-Cavity Circuits

*F. Dai and A.S. Omar. "Field-Analysis Model for Predicting Dispersion Property of Coupled-Cavity Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 901-904.*

Based upon the generalized mode-analysis technique, a rigorous numerical model for simulating 'cold'-tests of millimeter wave coupled-cavity slow-wave circuits is developed. This model provides not only the dispersion property but also the 'cold' RF field distribution in the structure. The result is compared with that obtained by Curnow's equivalent circuit.

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## Improved Formulation of the Singular Integral Equation Technique for Finline

*A. Sarhan and A.S. Omar. "Improved Formulation of the Singular Integral Equation Technique for Finline." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 905-908.*

An improved formulation of the singular integral equation (SIE) technique is presented to determine a complete set of finline normal modes of propagation. The present method allows the accurate determination of any number of finline modes. The convergence for the dominant mode as well as for the higher-order modes versus the series truncation order is shown.

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# Abstracts

## Field Theory Design of a Corrugated Septum OMT

*R. Ihmels, U. Papziner and F. Arndt. "Field Theory Design of a Corrugated Septum OMT." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 909-912.*

This paper presents a rigorous design method for corrugated septum orthomode transducers (OMTs) which combine the advantage of the stepped septum structure compactness with that of the phase matching potential of corrugated waveguide polarizers. Based on the modal scattering matrix method, the design takes into account the influences of both, the finite septum thickness and the higher order mode interaction at all discontinuities. Computer optimized design data are given for a Ku-band waveguide corrugated septum polarizer achieving a return loss of more than 20dB together with  $90^\circ \pm 0^\circ/-3^\circ$  differential phase shift for about 10% bandwidth. The theory is verified by own measurements and those of other authors.



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## Field Analysis of Shielded Uniaxial-Dielectric Rod Resonators

*Y. Kobayashi and T. Senju. "Field Analysis of Shielded Uniaxial-Dielectric Rod Resonators." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 913-916.*

The rigorous field analysis by the mode matching method is presented for two dielectric rod resonators including such uniaxial-dielectrics as sapphire, which is placed between two parallel conducting plates and in a conducting cavity. The resonant frequencies of the some lowest modes are calculated. The validity is confirmed by experiment.

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# Abstracts

## Time Domain Analysis of via Holes and Shorting PINs in Microstrip Using 3-D SCN TLM

*C. Eswarappa and W.J.R. Hoefer. "Time Domain Analysis of via Holes and Shorting PINs in Microstrip Using 3-D SCN TLM." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 917-920.*

The scattering parameters of microstrip via holes and shorting pins have been computed using 3-D SCN TLM method. The results agree well with the available data, thus demonstrating that the TLM method is a powerful tool applicable in the analysis of monolithic microwave integrated circuits of high density and high speed digital microwave circuits.



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## Flexibility in the Choice of Green's Function for the Boundary Element Method (1993 Vol. II [MWSYM])

*T.-N. Chang and Y.C. Sze. "Flexibility in the Choice of Green's Function for the Boundary Element Method (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 921-922.*

A more useful Green's function is chosen for quasi-static analysis of the shielded planar transmission lines by the boundary element method. The new employed Green's function satisfies the forced boundary conditions in a rectangular region. In this way, it is shown that not only the integral path can be performed merely along the line where the strip locates, but the integral equation is also simplified. The proposed method is useful to characterize multilayered structure. Finite metallization thickness can also be treated.

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# Abstracts

## Generation and Observation of Surface Waves on Dielectric Slabs and Coplanar Structures

*E.M. Godshalk. "Generation and Observation of Surface Waves on Dielectric Slabs and Coplanar Structures." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 923-926.*

Surface waves have been transmitted and received in dielectric slabs using microwave and millimeter wave wafer probes. Experimental results suggest that the TE/sub 0/ and TM/sub 0/ surface waves have been measured. Coupling between the coplanar waveguide mode and surface wave modes has also been achieved experimentally. This coupling is primarily due to the TM/sub 0/ and TE/sub 1/ modes that propagate beyond the ground plane edges of the coplanar waveguide.



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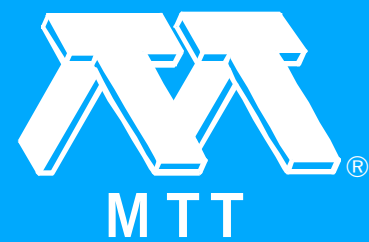
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## Full-Wave Analysis of Multiple Lossy Microstrip Lines on Multilayered Bi-Anisotropic Substrates and Imperfect Ground Metallization

Z. Cai and J. Bornemann. "Full-Wave Analysis of Multiple Lossy Microstrip Lines on Multilayered Bi-Anisotropic Substrates and Imperfect Ground Metallization." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 927-930.

An extended spectral-domain immittance approach is used to analyze multiconductor systems on layered bi-anisotropic substrates. Apart from the losses of the bi-anisotropic layers, the method takes into account the metallization thickness and losses of both the ground metallization and the multi-conductor system which can consist of conventional or high-T<sub>c</sub> superconductors. It is demonstrated that due to the order, permittivity and anisotropy of substrate layers, the propagation characteristics of a multi-conductor system can be influenced to obtain a frequency range of almost identical complex propagation constants for all fundamental modes involved. Such a behavior can be advantageously utilized in future applications of high-speed interconnects and high-directivity couplers. Since the algorithm is CPU-time efficient and operational on modern workstations, the developed model offers an attractive solution for modern MMIC design purposes. At the example of a coupled pair of microstrip lines on anisotropic substrate, results are compared with previously published data and are found to be in excellent agreement.

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# Abstracts

## A New Approach to the Microstrip Lines with Finite Strip Thickness and Conductivity

*J.-Y. Ke and C.H. Chen. "A New Approach to the Microstrip Lines with Finite Strip Thickness and Conductivity." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 931-934.*

A new approach is proposed for an analysis of microstrip line whose signal strip has finite thickness and conductivity. By this approach, the CPU time in computation may be much reduced. In this work, the phase constant  $\beta$  and attenuation constant  $\alpha$  of a microstrip line with finite strip thickness and finite conductivity are discussed, together with the current distributions along the signal strip.



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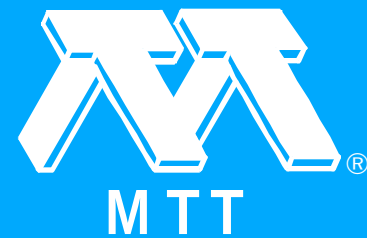


# Abstracts

## Fullwave Description of Propagation and Losses in Quasiplanar Transmission Lines by Quasi-Analytical Solution

*J.-W. Tao, G. Angenieux and B. Flechet. "Fullwave Description of Propagation and Losses in Quasiplanar Transmission Lines by Quasi-Analytical Solution." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 935-938.*

In this paper, we present a fullwave description of propagation and losses for some quasiplanar transmission lines by using a quasi-analytical solution. This latter is derived from a recently proposed modified transverse resonance method (MTRM), in which an analytical preprocessing has been introduced. The quasistatic contribution is obtained by an entirely analytical solution, so the resultant system of linear equations is very efficient. Furthermore, the resistive boundary conditions as well as the complex substrate permittivity are taken into account in an intrinsic manner, leading to an accurate determination of dielectric and conductor losses in lossy transmission lines. Theoretical and experimental results will be presented respectively for a lossless CPW and a lossy microstrip line.



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## Analysis of an Efficient TE/sub 0,n/-to-TE/sub 0,n+p/-Mode Converter in Circular Waveguides

A. Jostingmeier, C. Rieckmann and A.S. Omar. "Analysis of an Efficient TE/sub 0,n/-to-TE/sub 0,n+p/-Mode Converter in Circular Waveguides." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 939-942.

Mode converters which have recently been proposed for high power gyrotron applications are analyzed. For the computation of the local modes at each cross section of the converter, a generalized spectral domain technique is applied, while in the axial direction a waveguide taper analysis is made which is based on a generalized scattering matrix method.



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## Enhanced Dominant Mode Operation of Shielded Multilayer Coplanar Waveguide

*M.R. Lyons, J.P.K. Gilb and C.A. Balanis. "Enhanced Dominant Mode Operation of Shielded Multilayer Coplanar Waveguide." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 943-946.*

Variations of the even mode cutoff frequency are examined as a function of dielectric constant and height in a shielded multilayer Coplanar Waveguide (CPW). Specific combinations using internal substrates are shown to increase dominant mode bandwidth and produce maximization of the even mode cutoff frequency.

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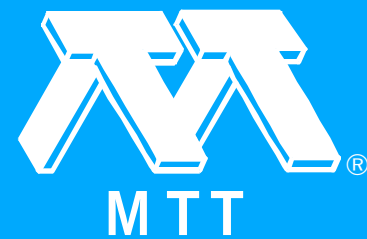


# Abstracts

## A Discussion on the Coupling Effects in Conductor-Backed Coplanar Waveguide MIC's with Lateral Sidewalls

*M.A. Magerko, L. Fan and K. Chang. "A Discussion on the Coupling Effects in Conductor-Backed Coplanar Waveguide MIC's with Lateral Sidewalls." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 947-950.*

Conductor-backed coplanar waveguide (CBCPW) with lateral sidewalls can support rectangular waveguide modes that couple with the dominant mode and can produce several undesirable results. These modes can be cutoff by reducing the lateral dimensions of the structure but for higher frequency operation the available circuit surface area is severely limited. The CBCPW is analyzed with a two-dimensional spectral domain method to demonstrate these coupling effects and the results provide insight to the characteristics of finite length structures.



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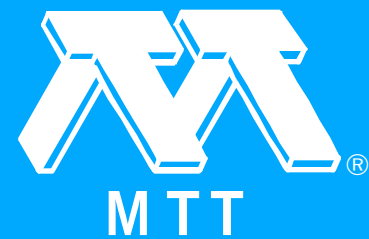
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## Analysis and Measurements of Coplanar Waveguide Discontinuities

*V. Radisic, D.R. Hjelme, Z.B. Popovic and A.R. Mickelson. "Analysis and Measurements of Coplanar Waveguide Discontinuities." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 951-954.*

A technique for characterizing the field distribution and modeling discontinuities in coplanar waveguide discontinuities will be presented. Several passive devices with discontinuities and parasitic have been fabricated on GaAs substrates, analyzed, and the models verified using network analysis and a unique optical sampling technique.

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## A Novel Quasi-TEM Analysis of Valley Microstrip Lines with Slit for Use in Multilayered MMICs

*A.S. Rong and Z.L. Sun. "A Novel Quasi-TEM Analysis of Valley Microstrip Lines with Slit for Use in Multilayered MMICs." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 955-958.*

This paper presents a novel Quasi-TEM analysis of valley microstrip lines with slits for use in multilayered MMICs. The characteristic impedance, effective dielectric constant, conductor loss and dielectric loss are obtained as functions of physical parameters. The original ideas of the present analysis include: (1) the introduction of fictitious polarization charges, which reduces the original structure into a easy to tackle valley microstrip lines imbedded in stratified media; (2) the construction of an auxiliary rectangular structure and flexible application of the Green's theorem, which allow us to exclude the fictitious charges from the total surface charges over the oblique strip in a simple manner; (3) use of the cubic B-spline interpolation, by which the contribution due to the boundary potentials in the auxiliary structure is approximated by a discrete set of potentials.

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## Accurate Quasi-Static Model for Conductor Loss in Coplanar Waveguide

*M.S. Islam, E. Tuncer and D.P. Neikirk. "Accurate Quasi-Static Model for Conductor Loss in Coplanar Waveguide." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 959-962.*

A quasi-static model for coplanar waveguide (CPW) including conductor loss has been developed. Comparison between experimental measurements on low-loss dielectric substrates and model calculations show excellent agreement. To model the conductor loss, the CPW is conformally-mapped into a parallel plate configuration, where current crowding and conductor loss are accounted for using scaled conductance.

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## Finite Difference Approach for Rigorous Full-Wave Analysis of Superconducting Microwave Structures

*M.A. Megahed and S.M. El-Ghazaly. "Finite Difference Approach for Rigorous Full-Wave Analysis of Superconducting Microwave Structures." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 963-966.*

A full-wave analysis of superconducting transmission line structures is presented. This approach avoids making any simplifying assumptions regarding the strip thickness and the electromagnetic wave inside the superconductor. The propagation constant, as well as the attenuation constant, are obtained rigorously by solving the eigen value problem resulting from the discretization of the wave equations using finite difference method. The corresponding eigen vectors are the possible modes. The current distribution inside the superconducting materials and the electromagnetic fields in the structure can be easily obtained.



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## Wideband Circuit Modelling of Waveguide Discontinuities by FD-TD Methods

*F. Moglie, T. Rozzi, P. Marcozzi and M. Politi. "Wideband Circuit Modelling of Waveguide Discontinuities by FD-TD Methods." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 967-970.*

FD-TD methods offer, in principle, promise of great flexibility for application to waveguide discontinuities of any kind. The problem of appropriate termination in the guide environment has recently been addressed. Main remaining disadvantages are the volume of computation involved, lack of analytical insight and inability, so far, to produce wideband equivalent circuits, which are prerequisites to effective CAD and synthesis. With a view to remedying these shortcomings, we discuss the extraction from the FD-TD analysis of wideband equivalent circuits. Two significant examples are considered: the inductive post and the 90° H-plane corner, including a modified form of the same. The circuits thus obtained are subsequently employed in the CAD problem of matching over the full waveguide band the modified corner by means of two inductive screws. Theoretical and experimental results are in excellent agreement yielding a reflection <-12 dB over the band and showing the effectiveness of the approach.

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## Spatial Interpolation of the Moment Matrix for Efficient Analysis of Microstrip Circuits

*T.W. Nuteson, K. Naishadham and R. Mittra. "Spatial Interpolation of the Moment Matrix for Efficient Analysis of Microstrip Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 971-974.*

An efficient moment method technique, based on spatial interpolation of the moment matrix, is developed for the analysis of microstrip circuit elements of arbitrary shape. Redundant calculations in the moment matrix are eliminated by utilizing various symmetries. The quasi-dynamic approximations of the Green's functions and closed-form analytical approximations of the Sommerfeld integrals are invoked to simplify the analysis. Sample computed results are presented on the current distribution obtained by interpolation of the moment matrix and agree very well with those evaluated without interpolation.

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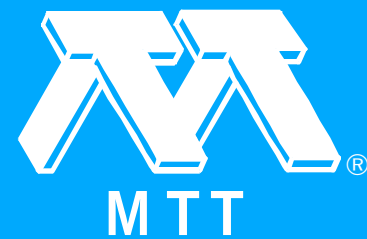


# Abstracts

## A New Schema for Combining Numerical and Analytical Methods for Rigorous Analysis of Waveguide Circuits

*K.-L. Wu, C. Wu and J. Litva. "A New Schema for Combining Numerical and Analytical Methods for Rigorous Analysis of Waveguide Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 975-978.*

A new schema is proposed for rigorous analysis of waveguide circuits which are composed of a number of discontinuities. The schema combines numerical techniques with analytical techniques, such as the mode-matching method. The concept is the following; for a general complicated segment of waveguide circuit, a numerical technique is used to generate the multi-mode general scattering matrix, while the mode-matching technique is used to deal with all the regular discontinuities. The final result is obtained by cascading the general scattering matrices. To validate the schema, a numerical example is given. The result obtained with the new schema agrees very well with results obtained using full numerical techniques and experiment results.



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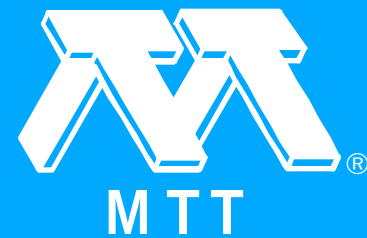


# Abstracts

## Treatment of Field Singularities in the Finite-Difference Approximation

*K. Beilenhoff and W. Heinrich. "Treatment of Field Singularities in the Finite-Difference Approximation." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 979-982.*

Due to the discretization of space, the Finite-Difference method cannot resolve exactly singularities of the electric and magnetic field at metallic edges. This paper presents a simple method which reduces the corresponding error without increasing the numerical efforts. The new edge formulation is tested by calculating the line parameters and the field pattern of an homogeneous MMIC coplanar-waveguide.



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## Space Domain Mode-matching Method (SDM<sup>3</sup>) -- An Efficient Technique for Complex Microwave Integrated Circuits

*K. Wu, Y. Xu and R.G. Bosisio. "Space Domain Mode-matching Method (SDM<sup>3</sup>) --An Efficient Technique for Complex Microwave Integrated Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 983-986.*

A novel approach named "Space-Domain Mode-Matching Method (SDM<sup>3</sup>)" is proposed to analyze complex microwave integrated circuits. This technique is based on the method of lines with vertical space discretization and conceptual Discrete Fourier Transforms (DFT) in multisubregions. This feature is exploited to improve the simulation related to the edge singularities on planar conductors. This novel approach is able to accurately model various bilaterally unbounded microwave circuits including composite, finite-width substrates and segmented topology. Numerical results are shown for both quasi-static and hybrid-mode analysis.

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# Abstracts

## Time Domain Analysis of Lossy Multi-Conductor Transmission Lines Using the Hilbert Transform

*T.R. Arabi and R. Suarez-Gartner. "Time Domain Analysis of Lossy Multi-Conductor Transmission Lines Using the Hilbert Transform." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 987-990.*

The objective of this paper is to present a novel approach of utilizing the Hilbert Transform to enforce the causality requirements on the electromagnetic fields in the analysis of high speed digital circuits. The technique is particularly useful in the absence of extremely accurate broad band data for the complex permittivity of lossy dielectric materials. Finally, in order to validate the accuracy and usefulness of this new approach, several numerical examples have been solved and compared to lossless and traditional non-causal models.



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## Efficient Implementation of the Spectral Domain Method Including Pre-Calculated Corner Basis Functions (1993 Vol. II [MWSYM])

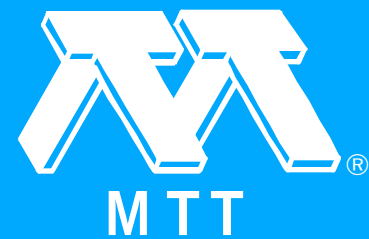
*S.A. Meade and C.J. Railton. "Efficient Implementation of the Spectral Domain Method Including Pre-Calculated Corner Basis Functions (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 991-994.*

A general implementation of the spectral domain method, formulated for planar microstrip circuits of arbitrary metallisation pattern is presented. The inclusion of a priori knowledge of the edge and corner singularities in the set of basis functions results in a large decrease in the order of the problem to be solved. Libraries of basis functions allow the rapid rigorous analysis of realistically complex circuits. Calculated S-parameters are given for three microstrip lowpass filters and compared to results from both measured and other techniques.

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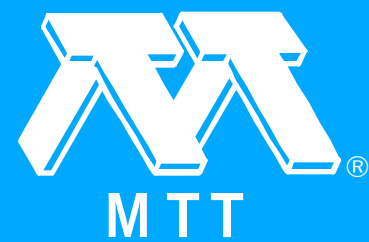
## Numerically Efficient Taper Analysis with Controlled Resolution

*A. Jostingmeier, C. Rieckmann and A.S. Omar. "Numerically Efficient Taper Analysis with Controlled Resolution." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 995-996.*

Circular waveguide tapers which are frequently used in gyrotrons are analyzed based on subdividing the taper into waveguide steps and uniform waveguide sections. Using a special subdivision and controlling the field resolution leads to a high speed-up factor compared to conventional approaches.

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## A Simplified 2D Graded Mesh FD-TD Algorithm for Calculating the Characteristic Impedance of Shielded or Open Planar Waveguides with Finite Metallization Thickness

*D.V. Krupezevic, V.J. Brankovic and F. Arndt. "A Simplified 2D Graded Mesh FD-TD Algorithm for Calculating the Characteristic Impedance of Shielded or Open Planar Waveguides with Finite Metallization Thickness." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 997-1000.*

A full-wave finite difference time-domain (FD-TD) algorithm is described for the efficient calculation of the characteristic impedance of planar waveguiding structures including the finite metallization thickness. The FD-TD algorithm is based on a two-dimensional graded mesh combined with adequately formulated absorbing boundary conditions. This allows the inclusion of nearly arbitrarily shaped, fully or partially lateral open or shielded guiding structures with layers of finite metallization thickness. Moreover, by a modified formulation, an actual 2D grid for 2D problems is obtained, i.e. the grid size for these problems is zero in z-direction as long as the waveguide is homogeneous in that direction. The characteristic impedances are calculated by using the related adequate power-voltage or power-current definitions, respectively, for structures suitable for usual integrated circuits, such as bilateral finlines, open microstrip line, lateral open triplate line, open slot-line, and open coplanar line. The theory is verified by comparison with results obtained by other methods.

Click on title for a complete paper.



# Abstracts

## Fast and Accurate Process-Oriented Model for CAD of MODFETs

*R.K. Vereseghazy and C.M. Snowden. "Fast and Accurate Process-Oriented Model for CAD of MODFETs." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1001-1004.*

A fast, quasi-two-dimensional physical MODFET model, capable of accurately simulating single-, multi-channel and pseudomorphic MODFETs has been developed. This has been used to predict DC, small- and large-signal microwave performance, and has been applied to microwave and millimeter wave device and circuit CAD.



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## Closed-Form Expressions for the Design of Microstrip Lines with Two Substrate Layers

*J.P.K. Gilb and C.A. Balanis. "Closed-Form Expressions for the Design of Microstrip Lines with Two Substrate Layers." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1005-1008.*

A simple closed-form expression for the effective dielectric constant of a microstrip on a two-layer substrate is presented. Results for single layer cases are incorporated in the formula to simplify it and increase the accuracy. The formula is curve-fitted from results computed with the Spectral Domain approach and is accurate to within three percent relative error over a wide range of parameters.

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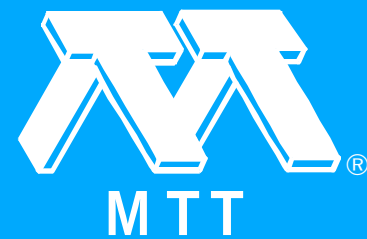


# Abstracts

## Robustizing Circuit Optimization Using Huber Functions

*J.W. Bandler, S.H. Chen, R.M. Biernacki, K. Madsen, L. Gao and H. Yu. "Robustizing Circuit Optimization Using Huber Functions." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1009-1012.*

We introduce a novel approach to "robustizing" circuit optimization using Huber functions both two-sided and one-sided. We compare Huber optimization with  $l_1$ ,  $l_2$  and minimax methods in the presence of faults, large and small measurement errors, bad starting points and statistical uncertainties. We demonstrate FET statistical modeling, multiplexer optimization, analog fault location and data fitting.



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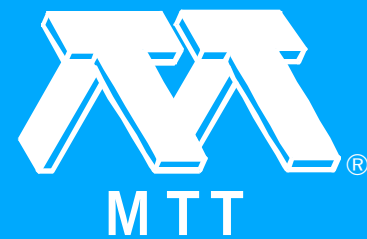


# Abstracts

## CAD Procedures for Planar Re-Entrant Type Couplers and Three-Line Baluns

*C.M. Tsai and K.C. Gupta. "CAD Procedures for Planar Re-Entrant Type Couplers and Three-Line Baluns." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1013-1016.*

A generalized network model for coupled multiconductor transmission lines is derived based on normal mode parameters. The model is used in the design of planar re-entrant type couplers. By rising this network model, the design of a planar re-entrant coupler can be derived from the design of a traditional two-line coupler. The design procedure for single-layer planar baluns using three-conductor transmission lines has also been developed based on this network model. Design procedures and examples are included.



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## Multilevel Multidimensional Quadratic Modeling for Yield-Driven Electromagnetic Optimization

*J.W. Bandler, R.M. Biernacki, S.H. Chen, S. Ye and P.A. Grobelny. "Multilevel Multidimensional Quadratic Modeling for Yield-Driven Electromagnetic Optimization." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1017-1020.*

Powerful multilevel multidimensional quadratic modeling has been developed for efficient yield-driven design. This approach makes it possible, for the first time, to perform direct yield optimization of circuits with components simulated by an electromagnetic simulator. Efficiency and accuracy of our technique are demonstrated by yield optimization of a small-signal amplifier.



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## Efficient FET Model Parameter Extraction Using Multi-Plane Data-Fitting and Bidirectional Search Technique

*F. Lin and G. Kompa. "Efficient FET Model Parameter Extraction Using Multi-Plane Data-Fitting and Bidirectional Search Technique." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1021-1024.*

A novel FET small-signal model parameter extraction technique is presented. It uses a new optimization approach, in which data-fitting is carried out on two reference planes instead of only one, and the objective function is minimized by a bidirectional search. As a result, all parameters of a commonly used 15-element small-signal FET equivalent circuit are, for the first time, clearly identified from only one set of measured S-parameters. A self-consistent generation of starting values can be involved regarding the FET in the passive pinch-off operating mode. Moreover, by applying multi-bias data-fitting, which is performed without increasing the number of ordinary optimization variables, it yields robust determination of both the overall bias-independent parasitic and bias-dependent intrinsic elements. For demonstration results are presented for a 0.5- $\mu\text{m}$  MESFET.







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## A Novel Lossy Microstrip Dispersion Model

*A.A. Tugulea and I.R. Ciric. "A Novel Lossy Microstrip Dispersion Model." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1025-1028.*

A new model is presented for evaluating the microstrip dispersion. The proposed model is simple and is based on the two-dimensional field equations of the microwave planar circuits. Quantitative results obtained fit well available experimental data and are compared with those corresponding to other models for both lossless and lossy structures.

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## Design of Low Conversion Losses Cold FET Mixers by Statistical Optimization of High Order Sidebands Loading

*J.F. Villemazet, M. Camiade and J. Obregon. "Design of Low Conversion Losses Cold FET Mixers by Statistical Optimization of High Order Sidebands Loading." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1029-1032.*

This paper proposes a new statistical approach allowing to define design rules of low conversion losses cold FET mixers. Applying these rules, an experimental mixer gives 4 dB intrinsic conversion losses at 7.5 GHz LO frequency with 10.5 dBm power and 10 MHz IF frequency.

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## Analytical Model of Noise in an Analog Frequency Divider

*O. Llopis, H. Amine, M. Gayral, J. Graffeuil and J.F. Sautereau. "Analytical Model of Noise in an Analog Frequency Divider." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1033-1036.*

The noise properties of a microwave analog frequency divider are investigated. The division is realized with a field effect transistor in a forced oscillation mode. An appropriate model is proposed for the calculation of the output signal phase and amplitude noises from the input signal phase noise and from the transistor low frequency noise data.

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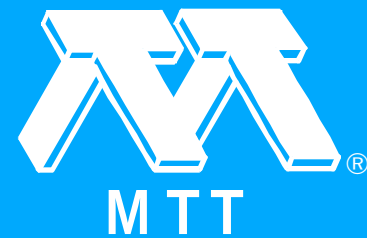


# Abstracts

## Determination of Stationary Traveling Waves on Nonlinear Transmission Lines

*J. Kunisch and I. Wolff. "Determination of Stationary Traveling Waves on Nonlinear Transmission Lines." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1037-1040.*

This work describes how stationary waves traveling on nonlinear transmission lines may be determined within the framework of harmonic balance. A particular property of the given formulation is that sparse matrix packages optimized for the solution of harmonic balance Newton update equations are not disturbed. The method is demonstrated for an LC line which supports the propagation of solitons of a well-known, analytically given form.



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## Accurate Small-Signal Modelling of a Double Barrier Resonant Tunnelling Diode (DBRTD)

*C.V. Sammut, N.J. Cronin, R.D. Schnell and H. Tews. "Accurate Small-Signal Modelling of a Double Barrier Resonant Tunnelling Diode (DBRTD)." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1041-1044.*

Reflection measurements between 45 MHz and 13 GHz on a DBRTD have resulted in a simple equivalent circuit model capable of predicting small-signal microwave properties to within  $\pm 5\%$  of measurement. The device capacitance-voltage characteristic obtained is the most extensive published to date and has been determined for the first time using experimental data over the whole of the test frequency range.

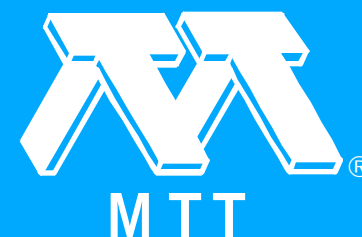
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# Abstracts

## Session CC -- High Speed Fiber Optic Links- Components Session

*"Session CC -- High Speed Fiber Optic Links-Components Session." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1045-1046.*



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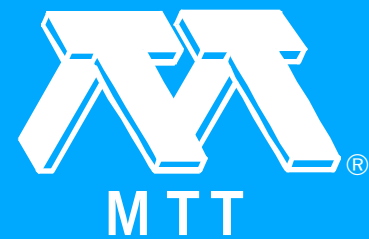
## 11 GHz Bandwidth GaAs MESFET/MSM OEIC Receivers

*J.S. Wang, C.G. Shih, W.H. Chang, J. Middleton, P.J. Apostolakis and M. Feng. "11 GHz Bandwidth GaAs MESFET/MSM OEIC Receivers." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1047-1050.*

We report state-of-the-art performance of direct ion implanted GaAs-MESFET with a 0.6  $\mu\text{m}$  gate length and MSM based OEIC receiver achieving a -3 dB bandwidth as high as 11 GHz for optical signals at the wavelength of 850 nm. The feedback resistance of the receiver is 1000  $\Omega$  and the effective transimpedance is 565  $\Omega$  into a 50  $\Omega$  load. The effective transimpedance-bandwidth (TZBW) product is 6.1 THz- $\Omega$  for this receiver.

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## Acousto-Optic Control of MMIC T/R Modules for Phased Array Beamsteering

*W.D. Jemison and P.R. Herczfeld. "Acousto-Optic Control of MMIC T/R Modules for Phased Array Beamsteering." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1051-1054.*

A novel beamsteering technique is presented which utilizes parallel optical signal processing within an acousto-optic (AO) cell to distribute phase and/or gain control signals to MMIC T/R modules which utilize digital phase shifters and/or gain controllers. An overview of the basic operating principles are presented along with experimental results which validate the technique.

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## A LiNbO/sub 3/ Microwave-Optoelectronic Mixer with Linear Performance

*G.K. Gopalakrishnan, W.K. Burns and C.H. Bulmer. "A LiNbO/sub 3/ Microwave-Optoelectronic Mixer with Linear Performance." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1055-1058.*

A pair of LiNbO/sub 3/ based Mach-Zehnder interferometric modulators with performance upto 40 GHz are cascaded in series to build a microwave-optoelectronic mixer. The dynamic range of the mixer is significantly enhanced by biasing the devices at quadrature. The mixer has potential for application in wide-band fiber-optic communication systems.

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## Fiber Optic Dual Delay Line for a Multi-Mode Radar Test Target Simulator

*A. Paoletta, S. Malone, T. Higgins, B. Scheiner and E. Adler. "Fiber Optic Dual Delay Line for a Multi-Mode Radar Test Target Simulator." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1059-1062.*

A fiber optic delay line has been designed for a multimode radar test target simulator. This delay line, operating between 3.0 to 3.6 GHz, has a fixed delay of 30  $\mu$ sec. Low transmission loss has been achieved using reactive matching techniques and a GRIN lens for optical coupling of the laser to the fiber. The transmission gain of a link consisting of the transmitter and receiver, connected with a short length of single-mode fiber, is -17 dB at 3.3 GHz with 1 dB variation across the band.

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## High Speed Optical Detectors for Monolithic Millimeter Wave Integrated Circuits

*K. Litvin, J. Burm, D. Woodard, W. Schaff and L.F. Eastman. "High Speed Optical Detectors for Monolithic Millimeter Wave Integrated Circuits." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1063-1066.*

Metal-semiconductor-metal photo diodes with interdigitated Schottky barrier fingers are being developed for applications in monolithic optical receiver circuits with the purpose of detecting millimeter wave modulation signals being transmitted via an optical carrier. The devices are planar and incorporate submicron finger spacings and a thin absorption region for speed with a buried stack of tuned Bragg reflectors for enhanced sensitivity at the carrier wavelength. These devices are being integrated with short-gate MODFET amplifiers to form the complete monolithic integrated optical receiver circuit.

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## Reactively Matched Optoelectronic Transceivers on InP Substrate for 6 GHz Operation

*S. Maricot, J.P. Vilcot, D. Decoster, J.C. Renaud, D. Rondi, P. Hirtz, R. Blondeau and B. de Cremoux. "Reactively Matched Optoelectronic Transceivers on InP Substrate for 6 GHz Operation." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1067-1070.*

We present the monolithic integration of optoelectronic devices with microwave impedance matching networks. Those are a GaInAs photodiode and a GaInAsP Buried Ridge Stripe structure laser emitting at 1.3  $\mu\text{m}$ ; both are fabricated on semi-insulating InP substrate. The matching networks, constituted of reactive components, have been designed to match these devices to 50  $\Omega$  at 6 GHz with a bandwidth close to 10%. Compared to an unmatched link, an improvement of 12 dB at 6 GHz is theoretically obtained; experimentally, it has been measured to 11.4 dB at 5.6 GHz.

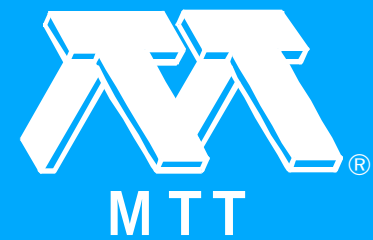
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## Session DD -- CAD of Passive Components

*"Session DD -- CAD of Passive Components." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1071-1072.*



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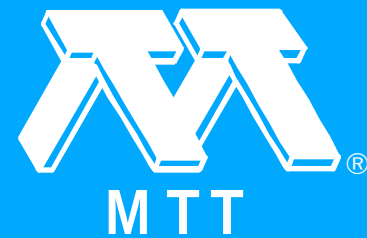


# Abstracts

## A New Result in the Synthesis of Incommensurate Line Networks

*L. Zhu and A. Fettweis. "A New Result in the Synthesis of Incommensurate Line Networks." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1073-1076.*

In this paper, an approach to computing the scattering matrix of a two-dimensional lossless network with two elements is first presented. Then, three examples are given to show how an incommensurate line network is realized. After that, recurrence formulas for calculating the scattering parameters of  $n$  cascaded two-dimensional networks are derived. Finally, to exhibit the outstanding merits of the new approach, a broadband double matching incommensurate line network is synthesized.



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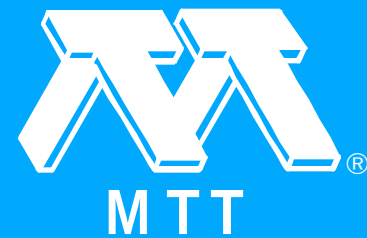


# Abstracts

## A Novel Matched Diplexer Configuration in E-Plane Technology

*A. Morini, T. Rozzi, D. De Angelis and W. Gulloch. "A Novel Matched Diplexer Configuration in E-Plane Technology." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1077-1080.*

A new arrangement for the realization of waveguide diplexers is proposed. A single inductive post, located in the cavity between the input waveguide and the bifurcation is used as matching element retaining full planar technology. This provides a inexpensive and effective solution.



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## Optimum CAD Procedure for Manifold Diplexers

*M. Guglielmi. "Optimum CAD Procedure for Manifold Diplexers." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1081-1084.*

In this paper a novel Computer Aided Design (CAD) procedure is described for the manufacture of the class of manifold diplexers which is based on filters implemented with thick inductive windows in rectangular waveguide. The procedure described essentially consists of decomposing the initial design task into four simpler sub tasks with clearly identified goals. Each sub task only involves the "software" (soft) tuning of a limited number of physical parameters so that the complete procedure can be executed very rapidly. The procedure described allows for the manufacturing of waveguide diplexers without any tuning elements and without any experimental characterization work thus substantially reducing production time and cost.

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# Abstracts

## An Explicit Design Technique for Wideband Couplers and High Quality Filters Using Periodic Topology

*K. Wu, D. Maurin and R.G. Bosisio. "An Explicit Design Technique for Wideband Couplers and High Quality Filters Using Periodic Topology." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1085-1088.*

A novel approach is introduced for computer-aided design (CAD) of wideband couplers and high-quality filters using periodic structures. This design technique consists of two explicit steps. The first step is to obtain single periodic cell parameters for a given electrical specification or vice-versa by the use of field-theoretical approaches in conjunction with the Floquet's theorem. The next step is to determine number of the given periodic cell used in wideband couplers or high-quality filters for a desirable coupling or filtering characteristic. Theoretical and experimental results are presented for non-uniform planar periodic coupler and filter, which are found to be in good agreement. Some interesting features of lossy and lossless periodic structures with finite number of cells are discussed.



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## Analysis of Branch Line Coupler in Suspended Stripline with Finite Metallization Thickness

*F. Alessandri, M. Mongiardo, R. Sorrentino and J. Uher. "Analysis of Branch Line Coupler in Suspended Stripline with Finite Metallization Thickness." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1089-1092.*

An efficient analysis of branch line coupler in suspended stripline technology is described. The finite metallization thickness of the stripline is fully accounted for by a rigorous full-wave technique. This is based on an improvement of the transverse resonance technique (TRT), which allows a resonator of fixed dimension to be considered. In this manner all the advantages of the TRT are kept (no complex modal spectra to be computed), while repeated field analyses to search for the resonant dimensions of the structure are avoided. The theory has been checked successfully against both experiments and theoretical results based on different numerical methods.

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# Abstracts

## Session EE -- Receiver Components

*"Session EE -- Receiver Components." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1093-1094.*



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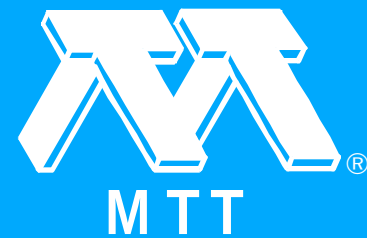


# Abstracts

## Low Noise Device and Amplifier Characterization for Deep Space Communication Applications

*J. Laskar, J.J. Bautista, B. Fujiwara, D. Scherrer and M. Feng. "Low Noise Device and Amplifier Characterization for Deep Space Communication Applications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1095-1098.*

The significant advances in the development of high electron mobility field-effect transistors (HEMTs) has resulted in cryogenic low-noise amplifiers (LNAs) which rival masers at S- and X-band. Further advances in the characterization and device technology at cryogenic temperatures may eventually supplant maser amplifiers at K/sub a/- band. A systematic cryogenic on-wafer study of advanced FET technology is performed and an empirical model for the cryogenic operation of ion-implanted MESFET technology is presented. Multi-stage HEMT based LNAs have been fabricated and characterized for operation at K/sub a/- band.



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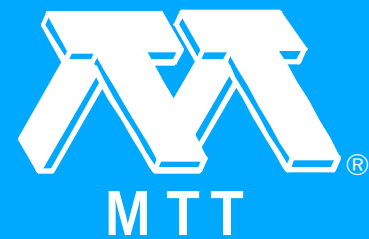
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## Characterization of MESFET and MODFET Microwave Noise Properties Utilizing Drain Noise Current

*M.N. Tutt, R. Menozzi and D. Pavlidis. "Characterization of MESFET and MODFET Microwave Noise Properties Utilizing Drain Noise Current." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1099-1102.*

The microwave drain noise characteristics have been studied for conventional long gate (1.0  $\mu\text{m}$  and 0.5  $\mu\text{m}$ ) GaAs MESFET's and short (/spl ap/ 0.15  $\mu\text{m}$ ) strained InGaAs/InAlAs/ InP MODFET's. Although the MODFET's have lower noise figures (F/sub min/ /spl ap/ 0.4dB at 10GHz) than the MESFET's (1.5dB at 10GHz), their measured drain noise currents are greater indicating that F/sub min/ does not describe the true device noise characteristics. Due to higher gain, estimated parastic contribution to the device noise is greater for the MODFET's than the MESFET's. The intrinsic channel noise has been modelled with an effective temperature associated with r/sub ds/, showing that carrier heating alone cannot explain the measured characteristics.

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## A 7 to 11 GHz AlInAs/GaInAs/InP MMIC Low Noise Amplifier

*S.E. Rosenbaum, C.S. Chou, C.M. Ngo, L.E. Larson, T. Liu and M.A. Thompson. "A 7 to 11 GHz AlInAs/GaInAs/InP MMIC Low Noise Amplifier." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1103-1104.*

Two-stage Monolithic Microwave Integrated Circuit (MMIC) low-noise amplifiers (LNAs) have been fabricated using 0.15  $\mu\text{m}$  gatelength InP-based AlInAs/GaInAs High Electron Mobility Transistors (HEMTs). The LNAs showed less than 1.2 dB noise figure and 21 to 22 dB gain over the 7 to 11 GHz band. While discrete devices have shown comparable or lower noise figures at spot frequencies, these results are believed to be the best reported to date for a broadband MMIC amplifier at these frequencies.

[Click on title for a complete paper.](#)



# Abstracts

## A Low Power GaAs MESFET Monolithic Downconverter for Digital Handheld Telephone Applications

*J. Birkeland. "A Low Power GaAs MESFET Monolithic Downconverter for Digital Handheld Telephone Applications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1105-1107.*

A monolithic GaAs MESFET downconverter for 1.9 GHz digital handheld telephone applications has been designed and fabricated. The downconverter operates from a single supply, and uses no dual gate or series biased FETs, which allows operation at lower supply voltages. The circuit exhibits 22 dB of conversion gain and 3.9 dB noise figure at a bias of 2.7 V and 5 mA, with a LO drive of -10 dBm. For a supply voltage of 1.25 V and a LO drive level of -13 dBm, conversion gain of 17.2 dB and noise figure of 4.3 dB is obtained.



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## 3 to 5 GHz Compact Microwave Delay Line

*J.L. Merenda, J. Pierro, S.M. Weiner and C. Fenniman. "3 to 5 GHz Compact Microwave Delay Line." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1109-1112.*

Recent advances in low cost, automated, planar microcoax interconnection technology have made possible dramatic reductions in the size and weight of microwave frequency delay lines. This new technology has been used in the design and implementation of a 3 to 5 GHz, 250-nsec microwave delay line having linear and spurious free third order dynamic ranges of 70 and 50 dB, respectively. This design was developed under a BAA contract with the US Navy. A detailed discussion of the delay line design is presented, along with measured performance data. These results are the first reported for a delay line of this type and represent a factor of 30 reduction in size and weight compared to conventional technologies.

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## VCO Based Chirp Generation for Broad Bandwidth Compressive Receiver Applications

*J.S. Levy, P.J. Burke, L.D. Cohen and R. Cecchini. "VCO Based Chirp Generation for Broad Bandwidth Compressive Receiver Applications." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1113-1116.*

This paper discusses an advance in state-of-the-art broadband chirp generation for compressive receiver applications. Linear chirp of 1-GHz bandwidth and 1- $\mu$ sec duration were generated with an ultralinear, millimeter wave, Gunn VCO and sawtooth waveform driver. The chirp generation circuit was developed for use as a swept local oscillator for a 500-MHz instantaneous bandwidth compressive receiver. Compressive receiver performance with this SLO approach demonstrates a >10 dB improvement in receiver noise floor relative to that obtained with a conventional impulse based SLO.

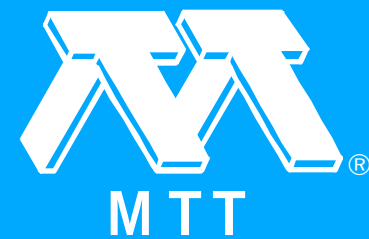
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# Abstracts

## Session FF -- Selected Russian Microwave Technologies (Special Session)

*"Session FF -- Selected Russian Microwave Technologies (Special Session)." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1117-1118.*



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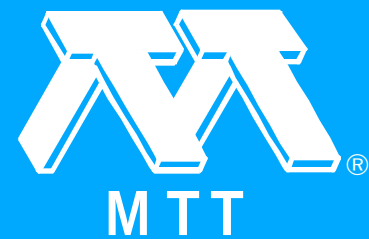
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## High-Power Millimeter-Wave Tubes

*M.I. Lopin, B.A. Belyavsky, K.G. Simonov, V.A. Cherepenin, A.D. Zakurdayev, B.S. Grishin, A.A. Negirev and A.S. Pobedonostsev. "High-Power Millimeter-Wave Tubes." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1119-1122.*

This paper discusses 8 mm and 3 mm high-power tubes which have been developed at ISTOK. At 8 mm wavelengths two systems are representative of ISTOK capabilities: (1) a medium power (10's of kW) TV/T chain using ppm focusing and a low-gain "see-through" final stage and (2) a three-beam 50 W cw klystron. Also, a 2 kW cw TWT was developed for industrial heating. For higher powers an Orotron-TWT (3 MW peak, 3 kW average power) has been developed. At 3 mm wavelength, a pulsed klystron with 1.5 kW power output and 300 MHz bandwidth has been developed, and a 25 W cw TWT with an 800 MHz bandwidth was produced. For frequency ranges 36-1500 GHz there are multiple-beam oscillator BWO's with ribbon-like beams which produce 40-2 mW.

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## A New Class of Self-Protecting Low-Noise Microwave Amplifiers

*Y.A. Budzinsky and S.P. Kantyuk. "A New Class of Self-Protecting Low-Noise Microwave Amplifiers." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1123-1126.*

The ESA (electrostatic amplifier) was originally developed by Robert Adler in the United States and independently by S. P. Kantyuk in the Soviet Union. It has been developed and extended at ISTOK to a family of devices having some unique properties. ESA's can provide low noise figures (1...4 dB from L- through Ku-bands), wide dynamic range, high resistance to jamming, linear amplitude and phase characteristics, and the ability to handle high levels of input power (up to 500 kW) without additional protection. In radar applications no additional protective devices such as multipactors, gas discharge T/R tubes, diode limiters, or switches are required. The recovery to maximum sensitivity after an input overload is typically 10-50 ns. These devices have been combined with magnetron oscillators to provide compact transmitters and are widely used in ground-based pulse-doppler radar systems.

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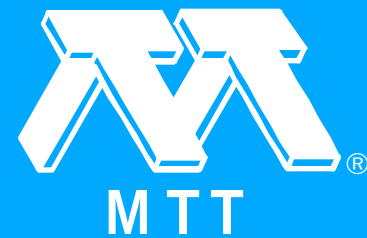


# Abstracts

## ISTOK"-A Leading Russian Microwave R&D Facility

*A.N. Korolyov. "ISTOK"-A Leading Russian Microwave R&D Facility." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1127-1128.*

This paper provides an introduction to the Research and Production Corporation "ISTOK". ISTOK has been in existence for over 50 years, and is a major research and production facility for microwave devices in the former Soviet Union. This paper briefly summarizes its primary areas of research and production activity.



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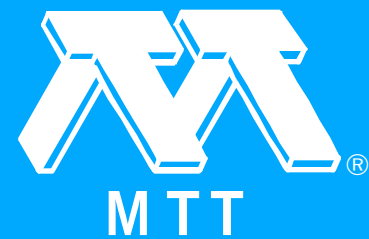
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## ISTOK Achievements in Solid-State Microwave Devices

*S.A. Zaytsev, V.N. Lebedev, I.A. Ledov, A.S. Negirev, A.D. Rodyonov, E.I. Ryzhik and A.M. Temnov. "ISTOK Achievements in Solid-State Microwave Devices." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1129-1130.*

The firm ISTOK has developed and produced a number of solid-state microwave devices for a variety of applications. This paper briefly summarizes the chief design characteristics and performance of a number of these devices.

[Click on title for a complete paper.](#)



# Abstracts

## Multiple-Beam Microwave Tubes

*A.S. Pobedonostsev, E.A. Gelvich, M.I. Lopin, A.M. Alexeyenko, A.A. Negirev and B.V. Sazonov. "Multiple-Beam Microwave Tubes." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1131-1134.*

ISTOK has been developing multiple-beam microwave tubes for the last 35 years and have produced a wide range of microwave and millimeter wave devices which are unique to ISTOK. Multiple-beam klystrons, TWT's, and BWO's provide low operating voltages, high power, low noise, and the possibility of larger operating bandwidth. The devices discussed include mbk's, pulsed multimode multiple-beam TWT's, and multiple-beam BWO's operating at wavelengths as short as 0.2 mm.



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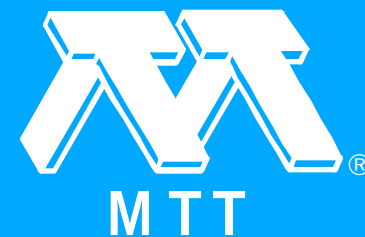
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## Session GG -- Biological Effects and Medical Applications (1993 Vol. II [MWSYM])

*"Session GG -- Biological Effects and Medical Applications (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1135-1136.*



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# Abstracts

## Microwave Bioelectromagnetics in Europe

A. Vander Vorst. "Microwave Bioelectromagnetics in Europe." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1137-1140.

The paper results from a survey made among about forty european research teams. It is divided according to research areas. References are replaced by the names and addresses of contributors, noted by alphabetical order of the city in which they are located, in view of possible cooperation.



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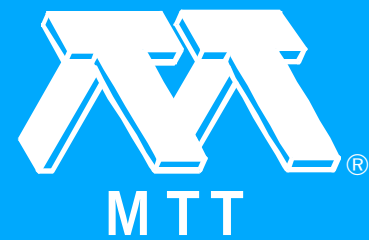


# Abstracts

## An Improved Diffraction Tomography for Imaging of High-Contrast Dielectric Objects

*K.-W. Suh, S.-Y. Kim and J.-W. Ra. "An Improved Diffraction Tomography for Imaging of High-Contrast Dielectric Objects." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1141-1144.*

An improved version of diffraction tomography has been developed for microwave imaging of high-contrast dielectric objects. It consists of three steps. First the spatially sliced projection functions are constructed from frequency-diversity measurement data at a fixed angle. Then the domain of those projection functions is adjusted to the same area of the actual object. After angular-diversity measurements, high-contrast dielectric profiles are reconstructed by backprojecting the qualified projection functions. Some numerical simulations are performed and those results are presented here.



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## Dielectric Imaging for Localisation and Detection of Breast Tumours

*A.W. Preece, R.H. Johnson, J.L. Green and M.P. Robinson. "Dielectric Imaging for Localisation and Detection of Breast Tumours." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1145-1146.*

A new type of resonant dielectric sensor has been developed, which is non-invasive but has adequate depth sensitivity for the detection of tumours. In measurement  $\epsilon'$  and  $\epsilon''$  are estimated from the changes in resonant frequency and Q factor respectively. A clinical measurement system has been tested on a breast tumour equivalent phantom and on patients and controls and has been shown to be capable of demonstrating the presence of a tumour.

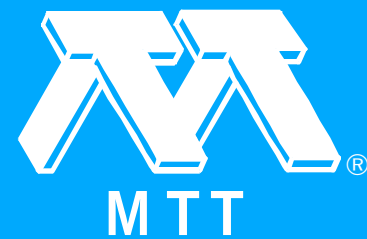


# Abstracts

## Thermal Modelling of Non-Ideal Interstitial Microwave Antenna Array Hyperthermia for the Treatment of Cancer

*K.L. Clibbon and A. McCowen. "Thermal Modelling of Non-Ideal Interstitial Microwave Antenna Array Hyperthermia for the Treatment of Cancer." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1147-1150.*

In clinical hyperthermia, 'ideal' parallel insertion of an interstitial antenna array for the treatment of cancer is virtually impossible. The effect of non-parallelism and variable antenna insertion depths on the electric fields, and thus the heating distributions, produced by such arrays is investigated in this paper, through the use of computational modelling.



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## Finite Difference Time Domain Modelling of Hyperthermia Applicators for Cancer Therapy

*N.M. Potheary and C.J. Railton. "Finite Difference Time Domain Modelling of Hyperthermia Applicators for Cancer Therapy." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1151-1154.*

In this contribution an enhanced version of the Finite Difference Time Domain (FDTD) method is used to calculate the field penetration and Specific Absorption Rate (SAR) pattern for a current sheet applicator used in Hyperthermia treatment. The FDTD method uses modified equations to rigorously model three dimensional dielectric boundaries and a non-uniform grid for computational efficiency. Results obtained using the FDTD method are compared with experimental measurements made on phantoms and excellent agreement is obtained.

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## RF and Microwave Ablation for the Treatment of Ventricular Tachycardia

*R.M. Rosenbaum, A.J. Greenspon, S. Hsu, P. Walinsky and A. Rosen. "RF and Microwave Ablation for the Treatment of Ventricular Tachycardia." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1155-1158.*

Current radio frequency (RF) ablation technology is limited by small lesion size. In order to enhance the size of RF-induced LV endocardial lesions we evaluated the effects of an enlarged distal electrode tip and increased RF power on lesion volume. Steerable electrode catheters with distal electrode tips of 4-12mm were studied in anesthetized dogs at power settings of 20-100 watts. Temperature (T) was continuously monitored from a thermistor located at the tip of the catheter. RF energy (500kHz, unmodulated) was applied between the tip of the catheter and a large skin electrode at four separate LV sites in each animal. Microwave ablation catheters with whip and helical antennae configurations were also tested with network analysis, temperature profiling in a phantom model and in vivo. RF lesion volume increased with increasing delivered power and enlarged tip size. Average tip T correlated with measured lesion volume ( $r=0.66$ ). Microwave catheters produced volume heating but the magnitude of heating was less than that observed for RF catheters. Catheter ablation of ventricular tachycardia may be enhanced by this technology.

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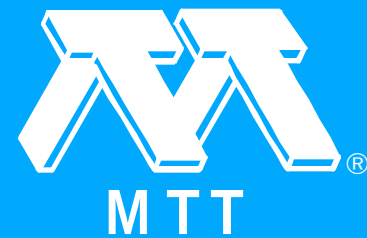


# Abstracts

## Nonlinear Dynamical Formulation for Describing Growth of Cancer Cells Based on Intracellular Constituents

*C.M. Krowne and A.P. Krowne. "Nonlinear Dynamical Formulation for Describing Growth of Cancer Cells Based on Intracellular Constituents." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1159-1162.*

A set of equations characterizing the interactions between RNA, DNA and proteins is postulated to describe the growth of tumor cells. From this set of equations, a method to determine the fixed points of the system is presented including the use of the Jacobian matrix. Assessment of the nonlinear dynamics around these fixed points is provided.



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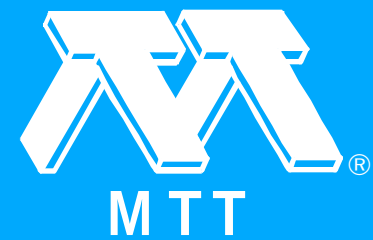
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## Index of Authors (1993 Vol. II [MWSYM])

*"Index of Authors (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1163-1167.*



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*"Exhibitors' List (1993 Vol. II [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.2 (1993 Vol. II [MWSYM]): 1169-1170.*



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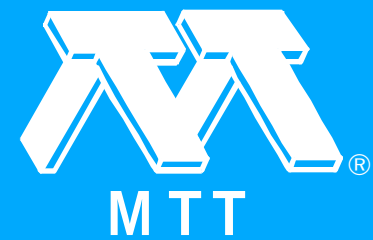
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## Conference Hotels (1993 Vol. II [MWSYM])

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*"Front Cover (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): f1-f2.*



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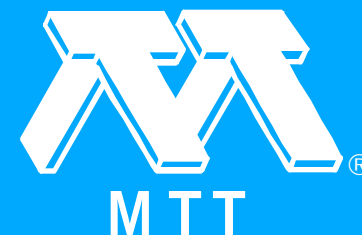
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## Meeting and Function Rooms (1993 Vol. III [MWSYM])

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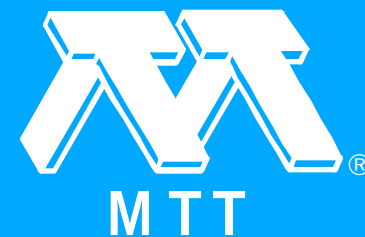
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## Technical Program Contents (1993 Vol. III [MWSYM])

*"Technical Program Contents (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): xi-xlvii.*



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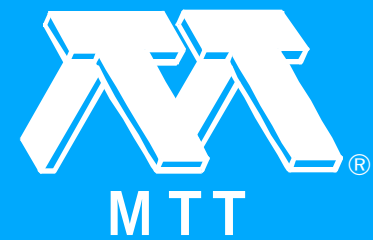


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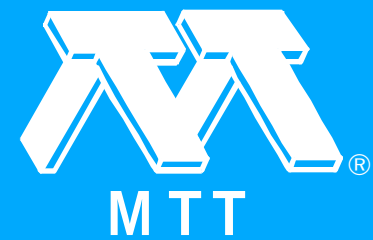
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## Session HH -- Device Modeling and CAD

*"Session HH -- Device Modeling and CAD." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1171-1171.*



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## Millimetre-Wave Device Modelling Differences in Microstrip and Coplanar Waveguide

*P.C. Walters, R.D. Pollard, J.R. Richardson and G. Gatti. "Millimetre-Wave Device Modelling Differences in Microstrip and Coplanar Waveguide." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1173-1176.*

The measurement of an active device produces results which are dependent on the transmission medium in which the device is embedded. These differences, insofar as a particular device is concerned, are related solely to its extrinsic elements, the intrinsic device being the same in all cases. Results are presented for on-wafer measurement and 2D simulation of a specially designed active device and its associated transmission structure in both microstrip and coplanar waveguide. This dual approach has the advantage of enabling a model for the intrinsic device to be validated and the extrinsic model elements for both structures to be obtained.

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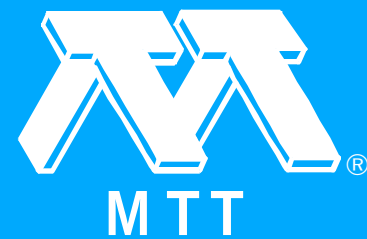


# Abstracts

## Accurate and Efficient Modeling of Hetero-FETs

*A. Abou-Elnour and K. Schuenemann. "Accurate and Efficient Modeling of Hetero-FETs." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1177-1180.*

Efficient numerical methods which are usually used in e.m. field problems are applied to solve Schroedinger's equation in semiconductors. The energy band structure of microwave heterostructure FETs is obtained by solving Poisson's and Schroedinger's equations self-consistently. The obtained results are used together with a two dimensional Monte-Carlo code to simulate the physical operation of the device. The model offers an accurate and efficient way to determine the DC and RF characteristics.



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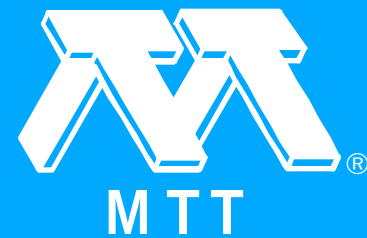


# Abstracts

## Characterization of Thermal Effects on Microwave Transistor Performance Using an Efficient Physical Model

*J.S. Atherton, C.M. Snowden and J.R. Richardson. "Characterization of Thermal Effects on Microwave Transistor Performance Using an Efficient Physical Model." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1181-1184.*

A physical model is described which is capable of predicting the effects of self-heating on MESFET performance whilst being efficient enough to run on a personal computer. Comparisons with the true DC characteristics for a number of devices of different gate lengths and microwave measurements demonstrates the validity of the model.



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## Instabilities Diagnosis and the Role of K in Microwave Circuits

*A. Platzker, W. Struble and K.T. Hetzler. "Instabilities Diagnosis and the Role of K in Microwave Circuits." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1185-1188.*

Many papers, textbooks and the leading CAD packages state that a Two-Port is stable if and only if  $K > 1$  and  $|\Delta| < 1$  (or an equivalent set of conditions). The stipulation that the statement is rigorous only if no poles of the unloaded circuit lie in the right half plane seems lost on current microwave designers who rely on  $K$  and  $|\Delta|$  for determining the stability of their designs. Examples showing oscillating circuits with  $K > 1$  and  $|\Delta| < 1$  are shown. The role of  $K$  as well as methods for diagnosing circuit stability are discussed.

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# Abstracts

## A Convolution-Based Black-Box Approach for Incorporating Linear Circuit Blocks Described by Frequency-Domain Data Into a Non-Linear Transient Time-Domain Simulator

*P. Halloran and T.J. Brazil. "A Convolution-Based Black-Box Approach for Incorporating Linear Circuit Blocks Described by Frequency-Domain Data Into a Non-Linear Transient Time-Domain Simulator." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1189-1192.*

The requirements of the microwave MMIC and high speed digital engineer have led to the need for a true transient time domain simulator capable of incorporating frequency-dependent phenomena. In this paper a new convolution-based black box approach is used to incorporate arbitrary linear circuit blocks, described by frequency-dependent s-parameters, into a general-purpose non-linear circuit analysis program (SPICE) yielding a general non-linear transient time domain simulator. The technique is validated by comparisons with measurement and with conventional SPICE simulation.



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# Abstracts

## Session II -- Coupling and Packaging Effects

*"Session II -- Coupling and Packaging Effects." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1193-1194.*



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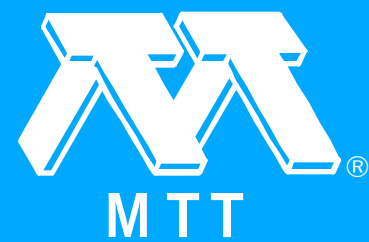
## Packaged Printed Transmission Lines: Modal Phenomena and Relation to Leakage

*L. Carin, G.W. Slade, K.J. Webb and A.A. Oliner. "Packaged Printed Transmission Lines: Modal Phenomena and Relation to Leakage." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1195-1198.*

The dispersion curves of the modes in shielded printed transmission lines often interact with the dispersion curves of box (package) guided modes in a classical coupled-mode manner. It is shown here that this effect is related directly to the phenomenon of leakage. We show that the dominant mode associated with a shielded printed transmission line can interact with box guided modes in a coupled-mode manner only if the corresponding dominant mode is leaky when the same transmission line is placed on a substrate of infinite transverse extent. Furthermore, we demonstrate that the modes of a shielded transmission line may support fields that are "leaky" in the sense that they are not confined to the designed guiding region (strip or slot), even though all the modes of the structure have either purely real or imaginary propagation wavenumbers. Numerical and experimental results are presented to show the effects of these phenomena.

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## Resonant Phenomena in Conductor-Backed Coplanar Waveguide (CBCPW) (1993 Vol. III [MWSYM])

*W.-T. Lo, C.-K.C. Tzuang, S.-T. Peng, C.-C. Chang, J.-W. Huang and C.-C. Tien. "Resonant Phenomena in Conductor-Backed Coplanar Waveguide (CBCPW) (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1199-1202.*

The resonant phenomena found in CBCPW integrated through line are investigated in details both experimentally and theoretically. Two CBCPW through-line test circuits are built and tested. One has uniform side planes and the other contains two slits in the middle of side planes. Three techniques are applied to investigate the resonant phenomena, namely, the patch antenna cavity model, the multi-mode model, and the full-wave space-domain integral equation approach. The measured transmission ( $|S_{21}|$ ) and reflection ( $|S_{11}|$ ) characteristics of the through lines are reported. At a representative resonant frequency of the measured data, the electric current distributions are displayed to demonstrate the fact that the side planes of the CBCPW contribute to the resonance in a way similar to planar patch antenna or two-dimensional planar circuits.

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## Coupling Phenomena in Conductor-Backed Slotline Structures

*Y. Liu, T. Hirota and T. Itoh. "Coupling Phenomena in Conductor-Backed Slotline Structures." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1203-1206.*

Leakage phenomena possible in conductor-backed slotlines were investigated through an analysis of coupled slotlines for possible application for a non-proximity directional coupler. Obtained propagation constants and experimental results confirm that coupling is caused by leakage through the conductor backing. It was found that the leakage can be controlled by a modification of the structures.

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## Measurement of NRD-Guide Leaky Wave Coupler in Ka Band

*D.-C. Niu, T. Yoneyama and T. Itoh. "Measurement of NRD-Guide Leaky Wave Coupler in Ka Band." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1207-1210.*

This paper describes a new structure for an NRD-guide directional coupler. This new structure combines two NRD guides and a dielectric slab. The coupling energy is carried by a leaky wave. The field along the NRD-guide is measured at Ka band (35 GHz) and compared with the theoretical data in this paper.

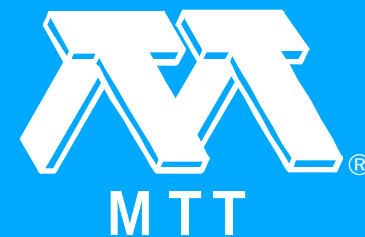
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# Abstracts

## Session JJ -- High Power Sources and Control Components

*"Session JJ -- High Power Sources and Control Components." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1211-1212.*



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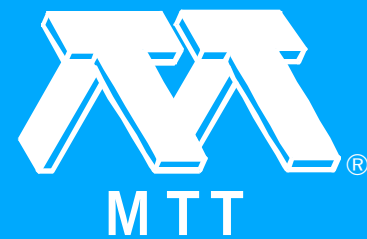


# Abstracts

## 12 KW S-Band Solid State Transmitter for Modern Radar Systems

*M. Hanczor and M. Kumar. "12 KW S-Band Solid State Transmitter for Modern Radar Systems." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1213-1216.*

This paper presents the development of a 12-KW Solid State Transmitter, operating over 2.7 - 2.9 GHz, used in modern surveillance and air-traffic control radars. 12-KW of peak power with a pulse width of 100 $\mu$ s and duty cycle of 10% is achieved by combining 56 300W High Power Solid State Amplifiers. Other key performance parameters are pulse-to-pulse stability (MTI improvement factor of >90dBc), MTBF of >22,000 hours, instantaneous bandwidth of 200 MHz, extremely high pulse fidelity and self pulsing low voltage operation for high efficiency.



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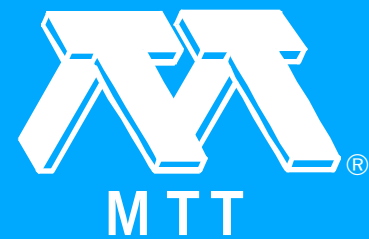
## High Power 14 GHz SSPA for SATCOM Applications

*R. Mallavarpu and M.P. Puri. "High Power 14 GHz SSPA for SATCOM Applications." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1217-1220.*

This paper describes the development of a 14.0GHz, 30W FET combiner/amplifier intended as a replacement for 50W TWTAs used in SATCOM uplink transmitter applications. The output stage of the amplifier consists of four 8W power FETs that are combined using a three dimensional combining circuit known as the spatial field power combiner. The entire amplifier is a self-contained unit with its own heat sink, high velocity blower and a regulator/sequencing circuitry for FET biasing. The amplifier results presented here show a  $P_{\text{sat}}=30\text{Wmin}$ ,  $P_{\text{sub}} 1\text{dB}=25\text{W}$ , AM/PM conversion=  $2^\circ/\text{dB}$  max, Noise Figure=4dB, and a typical two tone IM/sub 3=-25dBc with single carrier backed off 6dB from saturation. The high power handling capacity of the output combiner will enable development of 60 and 100W KU band SSPAs in the near future.

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## Monolithic, Photoconductive Ultra-Wideband RF Device

*A. Kim, L. Di Domenico, R. Youmans, A. Balekdjian and M. Weiner. "Monolithic, Photoconductive Ultra-Wideband RF Device." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1221-1224.*

A new monolithic, photoconductive ultra-wideband RF radiating device has been successfully demonstrated. The new device integrates the functions of energy storage, switch, and antenna onto a single semi-insulating (SI)-GaAs wafer substrate, so that the electrostatic energy stored in the device directly converts into ultra-wideband RF radiation. Pulse biasing the device to +2kV and -2kV, and subsequently triggering the device resulted in peak power intensities as high as 14.8 watt/cm at a distance of 40 cm.

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## Solid State 6x6 Transfer Switch for Cylindrical Array Radar

*M.E. Knox, P.J. Sbuttoni, J.J. Stangel, M. Kumar and P. Valentino. "Solid State 6x6 Transfer Switch for Cylindrical Array Radar." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1225-1228.*

This paper describes an L-band solid state 6x6 transfer switch for a cylindrical array radar. Si PIN diodes are used as switching elements to achieve low-loss, high reliability, low life cycle cost, and enhanced performance. The 6x6 transfer switch contains a novel compact 3x3 transfer switch as a building block. A low cost, batch fabrication manufacturing process is presented to reduce production cost. The 6x6 transfer switch operates over 1.2 - 1.4 GHz with insertion loss of 1.3 dB, isolation of 36 dB, and amplitude and phase error of  $\pm 0.25$  dB and  $2.7^\circ$  RMS, respectively.

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## Shunt-Mounted Harmonically-Tuned Power Rectifier for Distributed Power Converters

*D.P. Garrison, A. Lam, J.M. Borrego and R.J. Gutmann. "Shunt-Mounted Harmonically-Tuned Power Rectifier for Distributed Power Converters." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1229-1232.*

A RF power rectifier has been designed, constructed in surface-mount technology and evaluated for use in distributed power converters for advanced electronic packaging applications. With commercially available components, a 40 watt rectifier with a 100 MHz input from a 50 ohm source impedance provides 2.9 V output with 38% conversion efficiency. Detailed simulation and characterization indicates that 50 watt and 10 watt converters are capable of 70% and 80% conversion efficiency respectively, with low loss RF implementations.

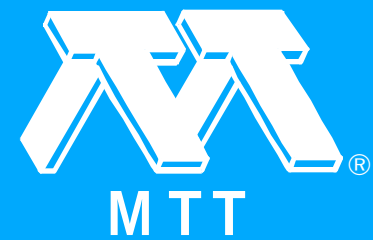
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# Abstracts

## Session KK -- Microwave Measurements

*"Session KK -- Microwave Measurements." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1233-1234.*



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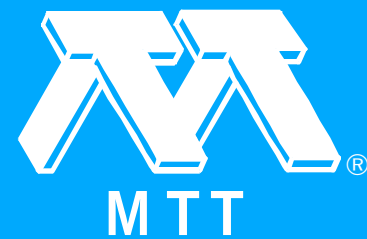


# Abstracts

## A Broad Band Time Domain Technique for the Measurement of the Frequency Dependent Complex Permittivity in Lossy Transmission Line Systems

*K.M. Lape and T. Rahal-Arabi. "A Broad Band Time Domain Technique for the Measurement of the Frequency Dependent Complex Permittivity in Lossy Transmission Line Systems." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1235-1238.*

The objective of this paper is to present a new numerical hybrid time/frequency domain technique for accurate broad band characterization of the complex dielectric constant of transmission line systems using the TDR. The properties of linear systems have been exploited to avoid the FFT truncation and aliasing errors introduced by processing data from measurement systems. The measurement accuracy has been significantly enhanced by extracting the ac variations of the dielectric constant instead of extracting the dielectric constant itself. Finally, in order to demonstrate the usefulness of the approach, a simple cable was characterized using this technique.



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## Ultra-Wideband Characterization of Lossy Materials: Short-Pulse Microwave Measurements

*D. Kralj and L. Carin. "Ultra-Wideband Characterization of Lossy Materials: Short-Pulse Microwave Measurements." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1239-1242.*

Planar antennas are switched photoconductively to generate picosecond bursts of freely-propagating radiation with usable spectral amplitudes in the 5 to 85 GHz frequency range. This radiation is used to measure the frequency dependent, complex index of refraction of dispersive materials in reflection and transmission; new deconvolution techniques are also demonstrated for extracting frequency domain information from time domain measurements. Experimental results are presented for the particular case of water, and a discussion is included on the relative merits of reflection and transmission time domain measurements on materials.

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## MM-Wave Confocal Resonators for Vertical Structure Profiling in Semiconducting and Superconducting Materials

*J.S. Martens, L. Lee, K. Char, R. Withers, D. Zhang, V.M. Hietala, C.P. Tigges and J. Zolper.  
"MM-Wave Confocal Resonators for Vertical Structure Profiling in Semiconducting and Superconducting Materials." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1243-1246.*

The confocal resonator is a tool for quick, accurate, non-invasive and flexible surface impedance measurements. From the frequency dependence of surface impedance, the vertical conductivity/permittivity profiles have been determined for a variety of devices and device materials including implanted Si and GaAs wafers and superconductor-dielectric interfaces. The vertical spatial resolution can be as small as several nm and accuracy of the complex permittivity generally is better than 3 %.

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## Finite Element Analysis of Open-Ended Coaxial Lines

*D. Blackham and R. Pollard. "Finite Element Analysis of Open-Ended Coaxial Lines." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1247-1250.*

The open-ended coaxial line is used as a probe for sensing complex permittivity since the reflection coefficient varies as a function of both frequency and permittivity. Results from a finite element analysis of the open-ended coaxial line compare well with, published results. One aspect of measurement accuracy is derived from how well a model relating the reflection coefficient to complex permittivity matches the actual structure. Finite element analysis can be used as a tool to examine the effects on model accuracy of finite ground planes as well as profiles within the ground plane.

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## Transistor Noise Parameter Extraction Using a 50 Omega Measurement System

*P.J. Tasker, W. Reinert, B. Hughes, J. Braunstein and M. Schlechtweg. "Transistor Noise Parameter Extraction Using a 50 Omega Measurement System." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1251-1254.*

A "50 Omega" noise figure measurement system has been integrated into a fully automated s-parameter measurement system allowing for fast determination of transistor noise parameters as well as s-parameters, as a function of both frequency and bias. This functionality from such a simple measurement system is achieved using a new analysis technique, based on the "Noise Temperature Model", that allows, after s-parameter measurements and analysis, for the direct extraction of all four transistor noise parameters from a single noise figure measurement.

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# Abstracts

## A Novel Technique for Measuring Small Signal S-Parameters of an RF/Microwave, Transistor, Power Amplifying Stage for Use in Power Amplifier Stability Analysis

*G. Collinson and M. Jones. "A Novel Technique for Measuring Small Signal S-Parameters of an RF/Microwave, Transistor, Power Amplifying Stage for Use in Power Amplifier Stability Analysis." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1255-1258.*

A novel measurement method is described which enables the full small-signal s-parameters of an RF/Microwave transistor to be measured whilst it is simultaneously driven and optimally tuned at a higher frequency as an efficient, class B or class C power amplifying stage. This capability allows a classic, small signal, stability analysis of power amplifiers to be performed across frequencies below the power amplified carrier where parametrically pumped, subharmonic oscillations are often a problem. Measured s-parameters of a GaAs HBT transistor operating as an efficient, harmonically tuned, class B, PA stage at 870MHz are presented across the frequency range 50-700MHz. Analysis of these results shows the presence of negative resistance in the base and collector that is induced by the carrier.



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## A Systematic Error Analysis of HP8510 Time-Domain Gating Techniques with Experimental Verification

*K. Lu and T.J. Brazil. "A Systematic Error Analysis of HP8510 Time-Domain Gating Techniques with Experimental Verification." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1259-1262.*

The errors caused by using time-domain gating techniques on the HP8510 automatic network analyser are investigated systematically. These errors are divided into four categories: out-of-gate attenuation error, truncation error, masking error and multi-reflection aliasing error. A method to estimate the order of the magnitude errors resulting from time-domain gating is presented. Experiments to support the analysis are designed and carried out, giving results in good agreement with theory.



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# Abstracts

## A Robust Six- to Four- Port Reduction Algorithm

*C.M. Potter and G. Hji pieris. "A Robust Six- to Four- Port Reduction Algorithm." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1263-1266.*

The Six- to Four- Port Reduction technique has been enhanced in a number of ways. A more stable iteration strategy is presented, which shows improved performance in the presence of noise, and with non - ideal microwave hardware. The quality of the five Six- to Four- Port Reduction coefficients is also quantified by a new Variance technique, which allows their effect on reflection coefficient measurement accuracy to be predicted.



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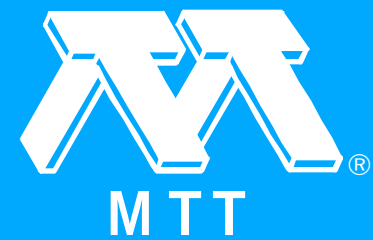
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# Abstracts

## Session LL -- Superconducting Filters

*"Session LL -- Superconducting Filters." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1267-1268.*



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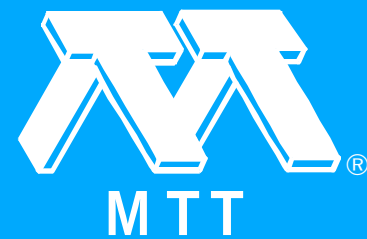


# Abstracts

## Novel Staggered Resonator Array Superconducting 2.3-GHz Bandpass Filter (1993 Vol. III [MWSYM])

*G.L. Matthaei and G.L. Hey-Shipton. "Novel Staggered Resonator Array Superconducting 2.3-GHz Bandpass Filter (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1269-1272.*

A novel stripline bandpass filter structure is presented which consists of a parallel array of equally spaced half-wavelength resonators. Couplings are controlled by introducing a small amount of stagger in the positions of the resonators. A very compact narrowband superconducting filter of this type was fabricated with excellent results.



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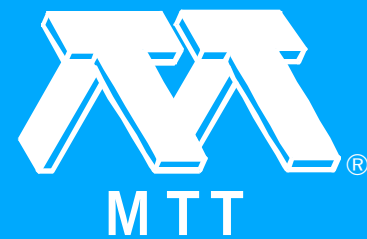


# Abstracts

## High Temperature Superconducting 8.45-GHz Bandpass Filter for the Deep Space Network

*G.L. Matthaei and G.L. Hey-Shipton. "High Temperature Superconducting 8.45-GHz Bandpass Filter for the Deep Space Network." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1273-1276.*

A high temperature superconducting stripline 8.45 GHz bandpass filter, designed for the Deep Space Network, is presented which has very low insertion loss, indicative of resonators with unloaded Qs greater than 10,000. The performance of this filter shows that practical, high Q multi-resonator devices can be constructed using lanthanum aluminate substrates in a stripline configuration.



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## Superconducting Narrow Band Pass Filters for Advanced Multiplexers

*A. Fathy, D. Kalokitis, V. Pendrick, E. Belohoubek, A. Pique and M. Mathur. "Superconducting Narrow Band Pass Filters for Advanced Multiplexers." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1277-1280.*

High temperature superconductivity can play an important role in miniaturizing multiplexer for communications applications. Filters for multiplexer can be built in miniature form with low loss and high selectivity. We have built X-band microstrip filters with a 50 MHz wide passband that provide 1.3 dB insertion loss at 77K using copper ground planes. Recent advances in double side coating of Lanthanum Aluminate substrates with  $\text{YBa}/\text{sub } 2/\text{Cu}/\text{sub } 3/\text{O}/\text{sub } 7\text{-delta}/$  (YBCO) will lower this figure to 0.6 dB. Circuit designs were evaluated for intermodulation distortion effects and an improvement over previous designs has increased the third order output intercept point to +29 dBm. Methods of non-destructive dielectric and conductor loss testing were used to evaluate materials throughout the filter development.

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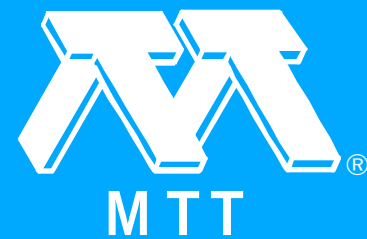


# Abstracts

## Design of Hybrid-Coupled Multiplexer and Diplexers Using Asymmetrical Superconducting Filters

*R.R. Mansour, F. Rammo and V. Dokas. "Design of Hybrid-Coupled Multiplexer and Diplexers Using Asymmetrical Superconducting Filters." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1281-1284.*

This paper demonstrates the feasibility of building high temperature superconducting hybrid-coupled multiplexer and diplexers employing filters with asymmetrical frequency characteristics. The design of pseudo-interdigital filters with improved skirt performance is discussed. Experimental and theoretical results are presented for superconducting filters, hybrids and a fully integrated C-band diplexer.



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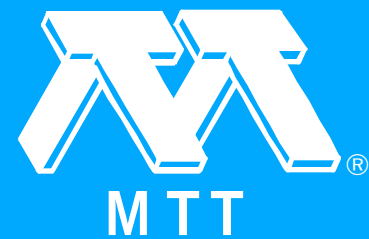
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## Narrow-Band YBCO Superconducting Parallel-Coupled Coplanar Waveguide Band-Pass Filters at 10 GHz

*R. Weigel, M. Nalezinski, A.A. Valenzuela and P. Russer. "Narrow-Band YBCO Superconducting Parallel-Coupled Coplanar Waveguide Band-Pass Filters at 10 GHz." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1285-1288.*

High-T<sub>c</sub> superconducting coplanar waveguide (CPW) three-pole, four-pole, and five-pole band-pass filters fabricated from in situ sputter deposited YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7-x</sub> thin-films on LaAlO<sub>3</sub> substrates with dimensions 10x25 mm are presented. The design is based on the evaluation of CPW test chips integrating differing resonators and transmission line structures. The measured data were fed into a CAD program using general transmission line elements instead of CPW elements. Both YBCO and gold versions were constructed and mounted in gold-plated brass test fixtures. At liquid nitrogen temperature (77 K), the filters were characterized by center frequencies at 10 GHz and bandwidths smaller than 1.3 %. Total insertion loss and out-of-band rejection values of the complete packaged devices were better than 2.2 dB and 30 dB, respectively.

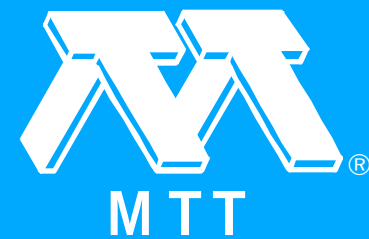
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# Abstracts

## Session MM -- Guided Waves: New Structures and Leaky Modes

*"Session MM -- Guided Waves: New Structures and Leaky Modes." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1289-1290.*



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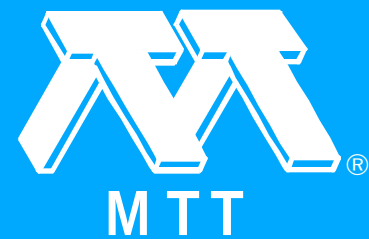
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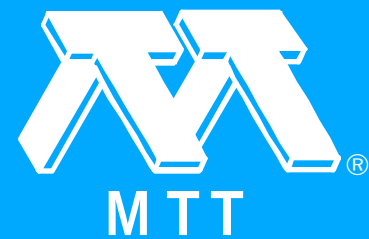
## Existence of a Leaky Dominant Mode on Microstrip Line with an Isotropic Substrate: Theory and Measurement

*D. Nghiem, J.T. Williams, D.R. Jackson and A.A. Oliner. "Existence of a Leaky Dominant Mode on Microstrip Line with an Isotropic Substrate: Theory and Measurement." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1291-1294.*

We have made the surprising discovery that a leaky dominant mode is present at higher frequencies on conventional microstrip line with an isotropic substrate, and we have confirmed its existence both theoretically and experimentally. The leaky mode exists independently of, and in addition to, the customary bound dominant mode. This new mode leaks power away from the line into the TM/sub 0/ surface wave supported by the surrounding grounded substrate, and may be responsible for spurious microstrip performance at higher frequencies. This could have important implications for millimeter-wave circuits.

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## Simultaneous Propagation of Both Bound and Leaky Dominant Modes on Conductor-Backed Coplanar Strips

*M. Tsuji, H. Shigesawa and A.A. Oliner. "Simultaneous Propagation of Both Bound and Leaky Dominant Modes on Conductor-Backed Coplanar Strips." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1295-1298.*

Contrary to expectations, we found recently that a new leaky dominant mode may be present on conductor-backed coplanar strips at the same time as the conventional bound dominant mode. The frequency range over which both these modes can propagate simultaneously increases as the strips become wider, and can be quite large even for fairly narrow strips. These new features, which could affect circuit performance significantly, have been derived theoretically and verified by measurements.

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## Microstrip Discontinuities on Cylindrical Surfaces

*J. Huang, R. Vahldieck and H. Jin. "Microstrip Discontinuities on Cylindrical Surfaces." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1299-1302.*

S-parameter analysis of microstrip discontinuities on cylindrical dielectric surfaces is presented using the full-wave frequency-domain TLM method. Microstrip step and gap discontinuities on the same side of the substrate as well as overlay coupling of two microstrip lines on opposite sides of the substrate are investigated. The finite conductor thickness is taken into account as well as the interaction of higher order modes between cascaded discontinuities.

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## Analysis of Wave Propagation Effects on Microwave Field-Effect Transistors

*M.S. Hakim and S.M. El-Ghazaly. "Analysis of Wave Propagation Effects on Microwave Field-Effect Transistors." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1303-1306.*

As the operating frequency increases, electromagnetic wave propagation effects on FET electrodes cannot be ignored. In this paper, these effects are investigated by analyzing two devices; the conventional MESFET and the INGfet, which is properly designed to exploit the wave propagation effects. The wave effects are analyzed using a CAD model which accounts for the semiconductor characteristics and the nonstationary electron dynamics, the electromagnetic characteristics and the parasitic elements of the device. The importance of including the wave propagation effects in the device analysis is strongly manifested in the results. It is shown that the amplification factor of the gainful mode of the INGfet is larger than that of the MESFET for higher frequencies and wider devices. Also, the INGfet exhibits higher gain when operated in the TWT mode and when terminated with 50-Ohm loads as well.

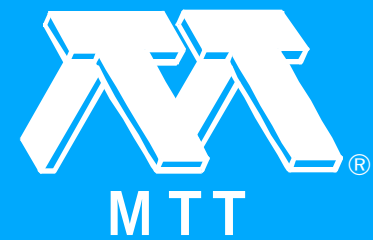
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# Abstracts

## Session NN -- Microwave Integrated Circuits

*"Session NN -- Microwave Integrated Circuits." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1307-1308.*



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# Abstracts

## A Novel Approach for Integrating High-Q Band-Pass Filters Into Microwave Integrated Circuit Assemblies

*G.E. Johnson, M.D. Medley, R. Levy, R.W. Larson, P. Ng and D.S. Mackie. "A Novel Approach for Integrating High-Q Band-Pass Filters Into Microwave Integrated Circuit Assemblies." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1309-1312.*

A new method of electromagnetically coupling an air-dielectric stripline interdigital or comb-line band-pass filter to a planar microwave circuit has been demonstrated. The filter structure can be solder or epoxy attached to the surface of the printed circuit board (PCB), resulting in a low-cost, high-performance assembly.



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## A Microwave Active Bandstop Filter with Tunable Centre Frequency

*R.G. Arnold and S.P. Marsh. "A Microwave Active Bandstop Filter with Tunable Centre Frequency." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1313-1316.*

An active bandstop notch filter based on a gyrator design is described. The realised filter produces an adjustable centre frequency range greater than an octave in the UHF and low microwave frequency bands. The design is capable of moderate quality factors and notch depths better than -45dB.

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## Coplanar Waveguide Filters

*A.K. Rayit and N.J. McEwan. "Coplanar Waveguide Filters." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1317-1320.*

Examples of highpass, lowpass and bandpass filters realised in coplanar waveguide are presented. Design is based on distributed circuit theory and is improved by extensive modelling of discontinuities. Equivalent circuits for these are presented, together with some design data. Symmetric and asymmetric designs appear to be equally successful. Modelled filter responses agree well with measurements, although there is an anomaly in the lowpass design which may be associated with odd mode excitation in shunt open stubs.

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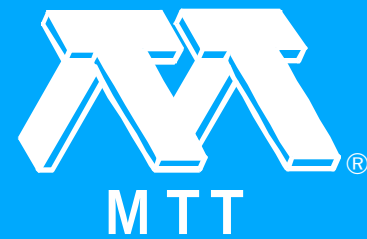


# Abstracts

## Slot-Coupled Double-Sided Microstrip Interconnects and Couplers

*C.-H. Ho, L. Fan and K. Chang. "Slot-Coupled Double-Sided Microstrip Interconnects and Couplers." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1321-1324.*

This paper presents a broad-band slot-coupled microstrip vertical interconnect and a microstrip double-layer quadrature coupler. The interconnect demonstrates less than 1 dB insertion loss over a 2.6 octaves bandwidth from 1.39 GHz to 8.5 GHz. The coupler shows an isolation of greater than 15 dB and phase quadrature of  $90^\circ \pm 2.5^\circ$  over 14% bandwidth.



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## A GHz-Band Ceramic Multi-Layer Substrate and its Application to a Hybrid IC

*Y. Taguchi, K. Miyauchi, K. Eda and T. Ishida. "A GHz-Band Ceramic Multi-Layer Substrate and its Application to a Hybrid IC." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1325-1328.*

A novel ceramic multi-layer substrate for mobile communication using alumina-glass composite ceramics and co-fired copper conductors are presented. Electrical characteristics in GHz frequencies of the substrate, copper conductor, transmission line, and via hole were evaluated. Hybrid integrated circuits such as an antenna switch were also demonstrated using the substrate. The results showed that the ceramic multi-layer substrate had good electrical characteristics enough for GHz-band applications. Using the ceramic multi-layer substrates, one can drastically reduce the size of RF circuit boards for mobile communication equipment.

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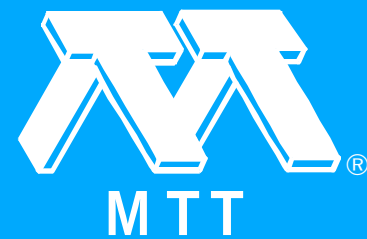


# Abstracts

## A 6.8-10.7 GHz EW Module Using 72 MMICs

*G. Garbe, R. Becker, M. Patel, W. Guthrie, S. Moghe, R. Williams and G. Giacomino. "A 6.8-10.7 GHz EW Module Using 72 MMICs." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1329-1332.*

A dual 6.8-10.7 GHz receive/transmit module with synthesized local oscillator (LOs) has been developed. The use of 72 MMICs allows this complex module to be implemented in a small, light weight package suitable for use in airborne systems. This module is combined with receive and transmit block converter modules to build a 2-18 GHz electronic warfare system.



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# Abstracts

## Session OO -- Microwave Probe Measurements

*"Session OO -- Microwave Probe Measurements." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1333-1334.*



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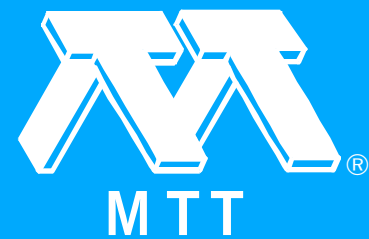
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## A New Probe for W-Band On-Wafer Measurements

*S.M.J. Liu and G.G. Boll. "A New Probe for W-Band On-Wafer Measurements." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1335-1338.*

A new W-band wafer probe based on a coaxial line design has been developed. With built-in bias tee, we achieve 2 dB insertion loss and better than 12 dB return loss from 75 GHz to 110 GHz. A probe without bias tee has 1.3 dB loss and 15 dB return loss at 94 GHz when optimized for narrow band application. S-parameters of discrete transistors and circuits have been accurately measured from 75 GHz to 110 GHz. Noise figure of active circuits have also been measured at W-band with these probes. To our knowledge, this covers the highest frequency achieved by direct on-wafer probing,

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## Full Two-Port On-Wafer Vector Network Analysis to 120 GHz Using Active Probes

*R. Yu, M. Reddy, J. Pusi, S. Allen, M. Case and M. Rodwell. "Full Two-Port On-Wafer Vector Network Analysis to 120 GHz Using Active Probes." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1339-1342.*

A millimeter-wave full two port on-wafer vector network analyzer (VNA) is implemented with monolithic GaAs directional time-domain reflectometer integrated circuits mounted directly on low-loss microwave wafer probes. The VNA performs S-parameter measurements to 120 GHz with  $\pm 0.2$  dB repeatability using a Line-Reflect-Match calibration method.

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## Ka-Band Power PHEMT On-Wafer Characterization Using Prematched Structures

A.K. Sharma, G.S. Dow, M. Aust, J. Canyon, B. Allen, S. Pak, D. Yang, Y. Hwang and K. Tan.  
*"Ka-Band Power PHEMT On-Wafer Characterization Using Prematched Structures."* 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1343-1346.

High power Ka-band power amplifiers have been developed using monolithic prematched structures utilizing power InGaAs pseudomorphic HEMT (PHEMT) devices. On-wafer load-pull impedance data on the structures containing  $0.15 \mu\text{m} \times 400 \mu\text{m}$ ,  $0.15 \mu\text{m} \times 800 \mu\text{m}$  and  $0.15 \mu\text{m} \times 1600 \mu\text{m}$  devices were obtained. Based on the above information, a two stage MIC amplifier consisting of a single  $1600 \mu\text{m}$  monolithic prematched structure driving four  $1600 \mu\text{m}$  monolithic prematched structures was realized. The amplifier achieved an output power of 1.6 watts (32.2 dBm) with 8.1 dB gain at 35 GHz.

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## Non-Invasive Waveform Probing for Nonlinear Network Analysis

*C.J. Wei, Y.A. Tkachenko and J.C.M. Hwang. "Non-Invasive Waveform Probing for Nonlinear Network Analysis." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1347-1350.*

A novel and non-invasive technique has been developed for the measurement of fundamental and harmonic S-parameters as functions of input frequency and power. The advantage of this technique was demonstrated on a GaAs field-effect transistor by plotting its drain current versus voltage trajectory at 5 GHz which clearly showed the origin of its nonlinearity.

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## Probe Tip Invasiveness at Indirect Electro-Optic Sampling of MMIC

*W. Mertin, C. Roths, F. Taenzler and E. Kubalek. "Probe Tip Invasiveness at Indirect Electro-Optic Sampling of MMIC." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1351-1354.*

For the first time, a systematic experimental investigation up to 40 GHz of the invasiveness of an electro-optic probe tip at indirect electro-optic sampling of MMICs is made. The direct electro-optic sampling technique is used to measure the influence on the transmission characteristic of a coplanar waveguide. As far as possible the results are compared with network analyzer measurements.

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## 300-GHz-Bandwidth Network Analysis Using Time-Domain Electro-Optic Sampling

*H. Cheng and J.F. Whitaker. "300-GHz-Bandwidth Network Analysis Using Time-Domain Electro-Optic Sampling." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1355-1358.*

We have demonstrated S-parameter measurements on simple passive circuit elements with 300-GHz bandwidth using an external-electro-optic, time-domain sampling technique. Clean, wideband input pulses were generated and transmitted to the device under test in a novel test fixture which integrated the optoelectronic signal source, the coplanar transmission lines, and the element to be measured on a monolithic low-permittivity substrate. A dramatic increase in the fidelity of short-electrical-pulse transmission, as evidenced by a 75% improvement of 3-dB bandwidth after 2 mm of propagation, was observed on a coplanar stripline supported by a quartz substrate when compared with a circuit fabricated on a GaAs substrate having permittivity approximately three times greater. The availability of this enhanced bandwidth has led to the demonstrated network analysis in the submillimeter-wave range using guided signals.

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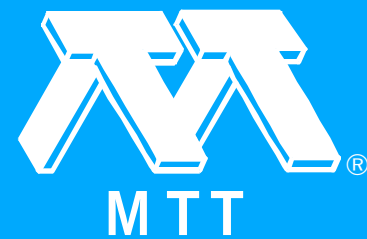


# Abstracts

## Time-Domain Network Analysis of MM-Wave Circuits Based on a Photoconductive Probe Sampling Technique

*J. Kim, J. Son, S. Wakana, J. Nees, S. Williamson, J. Whitaker, Y. Kwon and D. Pavlidis. "Time-Domain Network Analysis of MM-Wave Circuits Based on a Photoconductive Probe Sampling Technique." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1359-1362.*

We have developed a photoconductive probe sampling technique with 2-ps temporal resolution and  $\mu\text{V}$  sensitivity. Using the technique, we have measured S-parameters of millimeter-wave passive devices with a 120-GHz measurement bandwidth.



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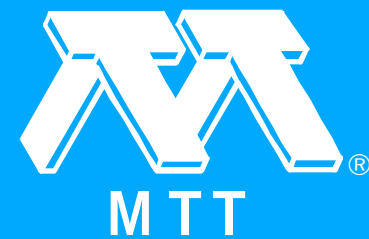


# Abstracts

## Session PP -- Transistor Power Amplifiers--I

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*"Session PP -- Transistor Power Amplifiers--I." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1363-1364.*



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## C-X Band 14W Power Amplifier Having Flat Gain and Power Response

*M. Mochizuki, Y. Itoh, M. Kohno, H. Masuno and T. Takagi. "C-X Band 14W Power Amplifier Having Flat Gain and Power Response." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1365-1368.*

A 5 to 10GHz 14W high power amplifier has been developed. It utilizes a multisection maximally flat impedance transformer whose length is designed to become a quarter wavelength at the highest frequency of the design band to achieve flat gain and flat power response over a wide bandwidth. With the use of this transformer, the amplifier has achieved a linear gain of  $7\pm 1$ dB, a 1dB compressed power of  $41.5\pm 0.8$ dBm, and a power-added efficiency of greater than 25% over 5 to 10GHz.

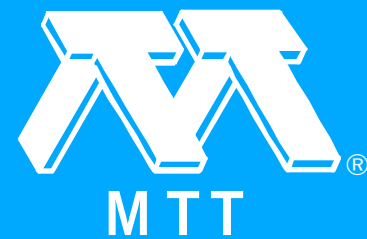


# Abstracts

## A Power Amplifier Yields 10 Watts Over 8-14 GHz Using GaAs MMICs in an LTCC Serial Combiner/Divider Network

*J.W. Gipprich, L.E. Dickens and J.A. Faulkner. "A Power Amplifier Yields 10 Watts Over 8-14 GHz Using GaAs MMICs in an LTCC Serial Combiner/Divider Network." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1369-1372.*

The main thrust of this work was to develop a high efficiency N-way combining scheme consistent with the physical geometries associated with X and Ku band active apertures. A 12-way combiner utilizing stripline serial feed networks in Low Temperature Cofired Ceramic (LTCC) was designed, fabricated and tested over an 8-14 GHz bandwidth. This combiner was integrated with 6 dual channel 1 watt MMICs to achieve 10 watts peak output power with greater than 86% combining efficiency at center band. The results of this work are described within this paper.



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# Abstracts

## Ku-Band Monolithic 7-Watt Power Amplifier Using AiGaAs/GaAs 0.25- $\mu$ m T-Gate Heterostructure FET Technology

*D.T. Bryant, K. Salzman and R. Hudgens. "Ku-Band Monolithic 7-Watt Power Amplifier Using AiGaAs/GaAs 0.25- $\mu$ m T-Gate Heterostructure FET Technology." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1373-1376.*

Two advanced Ku-band MMIC power amplifiers have demonstrated state-of-the-art performance at upper Ku-band. One design delivers 7.2 watts CW (9.3 watts pulsed) at 25-percent power-added efficiency (PAE). The other design delivers 32-percent PAE at 2.7 watts CW.



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## 20 GHz High Power High Efficiency HEMT Module

*C.H. Chen, H.C. Yen, K. Tan, L. Callejo, G. Onak, D.C. Streit, P.H. Liu and J.M. Schellenberg.*  
*"20 GHz High Power High Efficiency HEMT Module." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1377-1380.*

We are reporting the development of a high gain, high power and high efficiency K-band MIC power module employing four 1.6 mm pseudomorphic InGaAs HEMT devices. Power output of 3.2 Watts with 10 dB gain and 35% power-added efficiency at 3 dB compression was obtained at 20 GHz. The 1 dB bandwidth is 1.7 GHz.

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## Four-Watt 20-GHz Partial Monolithic Amplifier

*R. Yarborough, P. Saunier, H.Q. Tserng, K. Salzman, B. Smith and D. Heston. "Four-Watt 20-GHz Partial Monolithic Amplifier." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1381-1384.*

A 4-watt power amplifier with 28-percent power-added efficiency at 20 GHz has been demonstrated using 0.25- $\mu\text{m}$  heterostructure FET (HFET) device technology. The 4-watt, two-stage amplifier features a mostly monolithic approach with a portion of the input and output matching networks on alumina. The output matching network employs reactive matching elements on GaAs, followed by a Chebyshev coupled-line transformer/combiner on alumina to achieve a low-impedance match with minimal loss. This paper presents discrete 0.25- $\mu\text{m}$  HFET device results at 18 GHz and 20 GHz, as well as amplifier design and performance over a >3 GHz band.

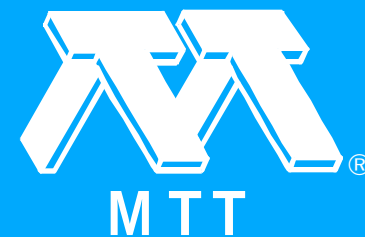
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# Abstracts

## Session QQ -- Optical Characterization and Device Modeling

*"Session QQ -- Optical Characterization and Device Modeling." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1385-1386.*



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## Broadband and Real-Time Waveform Sampling Using Optic-Microwave Phase-Locking

*S.L. Huang, H.-L.A. Hung and C.H. Lee. "Broadband and Real-Time Waveform Sampling Using Optic-Microwave Phase-Locking." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1387-1390.*

A real-time, 100-GHz, high-fidelity photoconductive sampling system has been demonstrated. The system provides a 4-ps time resolution, and 5- $\mu\text{V}/\text{spl}$  radic/Hz sensitivity. Potential application of this technique is the real-time characterization of monolithic/millimetre-wave integrated circuits with bandwidths higher than a conventional network analyzer.

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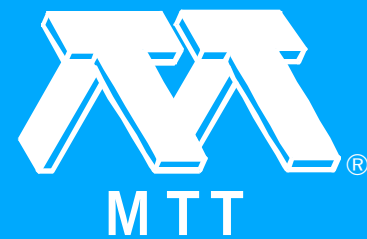


# Abstracts

## Design and On-Wafer Testing of Millimeter-Wave External Optical Modulators

*D. Polifko, K. Matsui and H. Ogawa. "Design and On-Wafer Testing of Millimeter-Wave External Optical Modulators." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1391-1394.*

Highly accurate computation of the microwave refractive index and impedance of the coplanar waveguides on Ti:LiNbO<sub>3</sub>, Mach-Zehnder external optical modulators is performed using the extended spectral domain approach. Narrowband millimeter-wave modulators based on these calculations have been designed, fabricated, and tested with a novel on-wafer, 0-40GHz, optical and electrical probe station.



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## Picosecond Photoconductive Switches Designed for On-Wafer Characterization of High Frequency Interconnects

*L.P. Golob, S.L. Huang, C.H. Lee, W.H. Chang, K. Jones, M. Taysing-Lara and T. DeAnni. "Picosecond Photoconductive Switches Designed for On-Wafer Characterization of High Frequency Interconnects." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1395-1398.*

Photoconductive switches fabricated by compatible microwave device processing techniques are used for on-wafer characterization of a long high-frequency interconnect, exceeding 160-GHz measurement bandwidth. Full characterization of this interconnect structure is important for determining cycle time of the future high speed computer.



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## The MESFET as an Optically Activated Microwave Switch - Theory and Experiment

*A. Madjar, A. Paoletta and P.R. Herczfeld. "The MESFET as an Optically Activated Microwave Switch - Theory and Experiment." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1399-1402.*

This paper presents a novel model for the optical switching of the MESFET. The model is based on basic principles and predicts the optical switching performance as function of the optical signal parameters, the bias level and the device physics and geometry. The results and conclusions from the theory are verified by measurements. The new model can serve as a design tool for designing an optimal MESFET for optical switching purposes.

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## A Study on the Negative Photoresponse of AlGaAs/GaAs MODFETs

*M.A. Romero and P.R. Herczfeld. "A Study on the Negative Photoresponse of AlGaAs/GaAs MODFETs." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1403-1406.*

A model for the mechanism of negative photoresponse, i.e., the decrease of drain current under illumination, in AlGaAs/GaAs MODFETs is presented. Also, a comprehensive experimental study discussing the dependence of this phenomena on gate to source bias voltage and optical power is reported. The negative photoresponse is attributed to trapping of photogenerated carriers in the GaAs buffer layer, causing a change in the potential profile and consequent reduction in the number of carriers in the 2-DEG channel.

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## A New Lightwave-Microwave Signal Conversion Method

*T. Berceli, M. Izutsu and T. Sueta. "A New Lightwave-Microwave Signal Conversion Method." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1407-1410.*

A new method of lightwave-microwave signal conversion has been developed and studied in detail. In many applications there is a need for mixing modulated lightwaves and microwaves. The new method offers many advantages providing a high mixing product in a wide frequency range. An optimum adjustment has also been found. The comparison of results achieved by utilizing HEMT and FET devices will be presented as well.

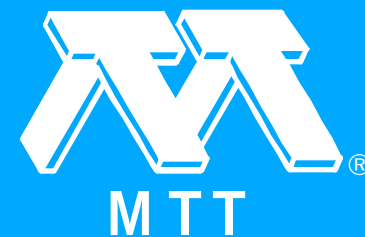
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## Session RR -- Superconducting Subsystem Technology

*"Session RR -- Superconducting Subsystem Technology." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1411-1412.*



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## Superconductive Digital Instantaneous Frequency-Measurement Subsystem (1993 Vol. III [MWSYM])

*G.-C. Liang, C.F. Shih, R.S. Withers, B.F. Cole, M.E. Johansson and L.P. Suppan.  
"Superconductive Digital Instantaneous Frequency-Measurement Subsystem (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1413-1416.*

A five-bit high-temperature-superconductive digital instantaneous frequency-measurement (DIFM) subsystem has been constructed for the determination of the frequency of unknown signals over a 500-MHz bandwidth, centered on 4 GHz, with a resolution of  $\pm 7.8$  MHz. The subsystem contains a cryogenic section with five discriminator modules utilizing superconductive delay lines, GaAs mixers, and power dividers. The subsystem also has a room-temperature GaAs limiting amplifier and a silicon postprocessor. With a single-tone CW input between -40 dBm and +10 dBm, the frequency quantization boundaries of the subsystem are, on average, 3.1 MHz from their design values.

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## High-Temperature Superconducting Matching Networks for Electrically Short Monopole Antennas

*A.Y. Piatnicia, S.H. Talisa, J.R. Gavaler, M.A. Janocko, J. Talvacchio, M.J. Buckley, K.M. Leader, J.A. Moellers and M.R. Schrote. "High-Temperature Superconducting Matching Networks for Electrically Short Monopole Antennas." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1417-1420.*

The benefits of using thin film high-temperature superconducting (HTS) matching networks for electrically short monopole antennas were demonstrated. Their performance was compared with similar matching networks made with gold, showing an efficiency improvement of 2 dB. A two-element array was also designed, fabricated and tested using HTS matching networks and short monopoles. The matching networks were configured as microstrip single stubs. This is the first demonstration of its type using thin film HTS material.

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## Tunable High Temperature Superconductor Microstrip Resonators

*J.A. Beall, R.H. Ono, D. Galt and J.C. Price. "Tunable High Temperature Superconductor Microstrip Resonators." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1421-1424.*

We have fabricated and characterized electrically tunable high temperature superconductor microstrip resonators incorporating YBa/sub 2/Cu/sub 3/O/sub 7-x/ superconductor and SrTiO/sub 3/ ferroelectric films. Early versions of these and similar devices were described previously. The resonators consist of two co-linear microstrip line-sections separated by a 5  $\mu$ m gap. The capacitance of the gap influences the frequencies of the odd-order coupled resonances. Inductively choked dc bias lines are attached to each line section so that a bias voltage can be applied to the gap. When the gap is filled with a ferroelectric material, the odd resonances can be tuned. Frequency shifts of 300 MHz have been observed with a bias voltage of 50 V for resonances at 5.6 GHz and 11.6 GHz. The tunability is independent of temperature from 4 K to 80 K. An upper bound for the loss tangent of the SrTiO/sub 3/ capacitor is extracted from the resonance Q, and we find  $\tan(\delta) < 0.07$  at 4 K. We believe that the Q values are limited by external loading, rather than by losses in the SrTiO/sub 3/, so the true value of  $\tan(\delta)$  is certainly less than our upper bound.

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## Parametric Interactions in High-Tc Superconducting Step Edge Junctions at X Band

A.Z. Kain and H.R. Fetterman. "Parametric Interactions in High-Tc Superconducting Step Edge Junctions at X Band." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1425-1428.

We have fabricated and tested both single junctions and series arrays of YBCO step edge junctions for four photon parametric effects at X band as a first step in developing a parametric amplifier at 60 GHz. The series array of 25 junctions at 10.3 GHz shows a 10 dB increase in reflected signal power as the pump power is increased, while the single junction at 12.2 GHz indicates a 2 dB change. The reflected power at the characteristic idler frequency of  $2\omega_p/\text{sub } p/\omega_s/\text{sub } s/$  is evidence of true Josephson junction parametric interaction. We are currently investigating the use of thallium based films at 60 GHz which offer a broader range of operating temperatures than does YBCO. Our design for a parametric amplifier at V band is a combination of microstrip based series arrays of junctions and an antipodal finline transition.

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## Noise Figure of HTS JJ MMIC Downconverter at 12GHz

*K. Suzuki, S. Yoshikawa, K. Yamaguchi, K. Hayashi, S. Fujino, T. Takenaka, T. Mitsuzuka, Y. Enomoto, K. Imai, F. Sugino-shita and N. Yazawa. "Noise Figure of HTS JJ MMIC Downconverter at 12GHz." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1429-1432.*

We report here the first deliberately made high temperature superconductivity (HTS) monolithic microwave integrated circuit (MMIC) for down-converting direct broadcast satellite (DBS) signals. A YBa/sub 2/Cu/sub 3O/sub 7-delta/(YBCO) step-edge microbridge Josephson junction (JJ), two 12GHz YBCO microstrip bandpass filters, a 1GHz YBCO filter, and current bias and voltage monitor circuits are successfully combined into a 20mm x 20mm MgO substrate and integrated into a frequency downconverter. The YBCO downconverter and a GaAs low noise amplifier(LNA) for intermediate frequency (IF=1GHz) are combined into a microwave cryostat and characterized by receiving direct broadcast satellite (DBS) signals. The noise figure has been first measured for such YBCO JJ MMIC downconverter as a subsystem. The dependence of noise figure and IF output on temperature, bias voltage and LO power has been studied. We have successfully demonstrated clear pictures of DBS bellow 40K.

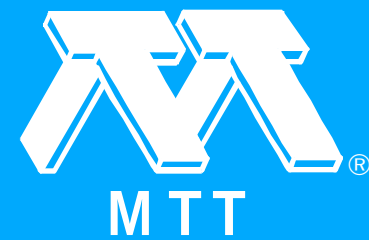




# Abstracts

## Session SS -- EM Analytical and Numerical Techniques I

*"Session SS -- EM Analytical and Numerical Techniques I." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1433-1434.*



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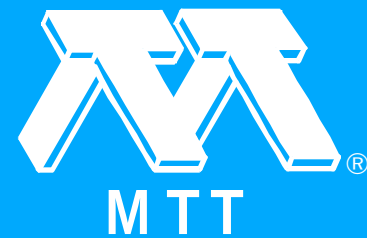


# Abstracts

## The FDTD Diakoptics Method

*T.-W. Huang, B. Houshmand and T. Itoh. "The FDTD Diakoptics Method." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1435-1438.*

A finite-difference time-domain (FDTD) Diakoptics method is developed in this paper. Sequential and parallel algorithms are provided to connect cascaded segments and to realize the modular computation of large circuits. The proposed methods are applied to a one-dimensional case to confirm their validity by comparison with the results from Microwave SPICE (MWSPICE).



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## Performance Study of One-Way Absorbing Boundary Equations in 3-D TLM for Dispersive Guiding Structures

*C. Eswarappa and W.J.R. Hoefer. "Performance Study of One-Way Absorbing Boundary Equations in 3-D TLM for Dispersive Guiding Structures." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1439-1442.*

Several absorbing boundary conditions based on one-way wave equations (mostly applied to the FD-TD method) have been studied and adapted for the 3-D Symmetrical Condensed Node analysis of guiding structures. The Absorbing Boundary Condition based on perfect absorption of waves at two incident angles has given superior results when compared to that of other absorbing boundaries. Reflections less than 2% over a large frequency spectrum have been obtained for dispersive structures like microstrip and finlines. These excellent absorbing boundary conditions can considerably reduce the computational domain, thus making possible the 3-D TLM analysis of planar and quasi-planar structures with moderate computer resources.

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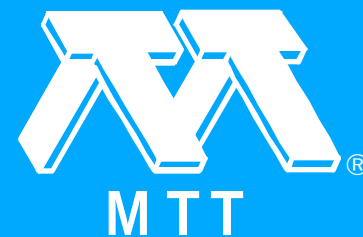


# Abstracts

## A New Look at the 3D Condensed Node TLM Scattering

*P.P.M. So and W.J.R. Hoefer. "A New Look at the 3D Condensed Node TLM Scattering." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1443-1446.*

A systematic impulse numbering scheme and impulse splitting operation are developed. The new numbering scheme reveals the physics of the scattering procedure. The impulse splitting operation allows new scattering matrices of special nodes to be derived in a straightforward manner.



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## Rigorous and Efficient Analysis of Hybrid T-Junctions

*F. Alessandri, M. Barba, M. Mongiardo and R. Sorrentino. "Rigorous and Efficient Analysis of Hybrid T-Junctions." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1447-1450.*

Although hybrid T-junctions (magic T's) are widely used in common microwave practice, no efficient method of analysis of such junctions is at present available. In this contribution we propose a very simple, yet rigorous and efficient model for the full-wave characterization of these junctions. The model is based on a suitable segmentation of the structure in conjunction with the admittance matrix description. When suitable modal expansions of the Green's functions are considered, a very high numerical efficiency is obtained. Numerical simulations show excellent agreement with measured data.

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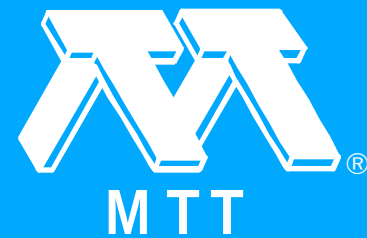


# Abstracts

## A Rigorous Analysis of the Higher Order Modes and Attenuation of Stripline of Arbitrary Dimensions

*M.H. Burchett, S.R. Pennock and P.R. Shepherd. "A Rigorous Analysis of the Higher Order Modes and Attenuation of Stripline of Arbitrary Dimensions." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1451-1454.*

This paper presents a rigorous and computationally efficient analysis for stripline of arbitrary dimensions based on the Transverse Resonance Diffraction technique. Calculated higher order mode cutoff frequencies show excellent agreement, and attenuation factor shows good agreement with measured values, and are more accurate than predictions from numerical or analytical techniques.



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## Two-Dimensional Transmission Line Matrix (TLM) Simulation of the Electromagnetic Fields in a Rectangular Section of a Discretized GaAs MESFET Channel with Arbitrary Doping Profile

*S. Dindo and M. Ney. "Two-Dimensional Transmission Line Matrix (TLM) Simulation of the Electromagnetic Fields in a Rectangular Section of a Discretized GaAs MESFET Channel with Arbitrary Doping Profile." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1455-1458.*

A two-dimensional lossy shunt TLM network is adapted to simulate the Maxwell field equations of a GaAs MESFET. By discretizing the channel into rectangular sections of single thickness, the new TLM technique is shown, with examples, that it can simulate the calculated electromagnetic fields of an arbitrarily doped channel section.

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# Abstracts

## Session TT -- Transistor Power Amplifiers II

*"Session TT -- Transistor Power Amplifiers II." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1459-1460.*



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## Low Voltage GaAs Power Amplifiers for Personal Communications at 1.9GHz

*D. Ngo, B. Beckwith, P. O'Neil and N. Camilleri. "Low Voltage GaAs Power Amplifiers for Personal Communications at 1.9GHz." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1461-1464.*

Personal communication systems operating at 1.9 GHz require high efficiency power amplifiers (PAs) operating at 3V or below. This paper summarizes the results of GaAs PAs constructed in a module and an MMIC format. These PAs operate at 3V with 30dB gain, 28dBm output power and 50% efficiency.

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## 3V Operation L-Band Power Double-Doped Heterojunction FETs

*N. Iwata, K. Inosako and M. Kuzuhara. "3V Operation L-Band Power Double-Doped Heterojunction FETs." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1465-1468.*

This paper describes the microwave power performance of double-doped AlGaAs/InGaAs/GaAs pseudomorphic heterojunction field-effect transistors (HJFETs) operated at a DC drain bias of 3V. The fabricated 1.1  $\mu\text{m}$  gate-length HJFET with an undoped AlGaAs Schottky layer exhibited a maximum drain current of 220mA/mm, a peak transconductance of 200mA/mm, and a gate-to-drain breakdown voltage of 21V. Power performance evaluated at a 3V drain bias for a 12mm gate-periphery device demonstrated a maximum output power of 1.4W with a 61% power-added efficiency at 950MHz. The results indicate that the double-doped pseudomorphic heterojunction FETs have a high potential for battery-operated portable power applications.

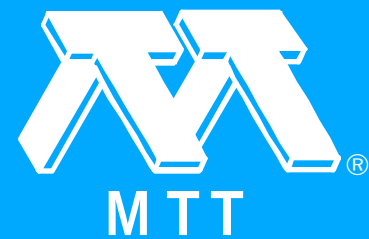
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## 4GHz High-Power High-Efficiency Pseudomorphic Power HEMT

*S.T. Fu, W.F. Kopp, M.Y. Kao, K.H.G. Duh, P.M. Smith, P.C. Chao and T.H. Yu. "4GHz High-Power High-Efficiency Pseudomorphic Power HEMT." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1469-1472.*

We are reporting on the record power performance of  $0.25\mu\text{m} \times 8\text{mm}$  double recessed GaAs-based Pseudomorphic High Electron Mobility Transistors (PHEMTs) at 4GHz. The  $0.25\mu\text{m}$  gate-length PHEMTs exhibit typical gate-to-drain breakdown voltage of more than 20 V, peak transconductance of 430mS/mm, and maximum drain current density of 450mA/mm. When the drain was biased up to 11V, the device delivered 5.7 W output power with 12.6dB power gain and 57% power-added efficiency (PAE). The device demonstrates an extremely broad drain bias range for efficient operation. It exhibits a maximum PAE of 72% with output power of 4.1 W under  $V_{\text{DS}} = 7\text{ V}$  condition. With 8 V drain bias, when the device was tuned for maximum output power, it delivered 4.3 W of  $P_{\text{2dB}}$  with 15.4dB power gain and 66% PAE. To the authors' knowledge, this is the highest PAE and power gain yet achieved by a solid state device with this output power at 4GHz.



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## Broadband High-Efficiency HBT MMIC Power Amplifier Fabricated with Re-Aligned Process

*J.J. Komiak, L.W. Yang, R.S. Brozovich, S.T. Fu and D.P. Smith. "Broadband High-Efficiency HBT MMIC Power Amplifier Fabricated with Re-Aligned Process." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1473-1476.*

The design and performance of a 6 to 10 GHz Heterojunction Bipolar Transistor MMIC power amplifier that produces 1.25 to 2.15 Watts at 30 to 46 % power-added efficiency with 9.5 to 12.5 dB of power gain will be described. With only 500  $\mu\text{m}^2$  of output periphery, record MMIC HPA power densities of 2.5 to 4.3 mW/ $\mu\text{m}^2$  have been demonstrated.

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## X-Band GaInP/GaAs Power Heterojunction Bipolar Transistor

*W. Liu, A. Khatibzadeh, T. Henderson, S.-K. Fan and D. Davito. "X-Band GaInP/GaAs Power Heterojunction Bipolar Transistor." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1477-1480.*

We report on the large-signal performance of GaInP/GaAs HBTs at X-band. A c.w.output power of 1.0 W is obtained from a GaInP/GaAs HBT consisting of ten  $2 \times 30 \mu\text{m}^2$  emitter fingers, corresponding to a power density of 3.33 W/mm. The associated power gain is 5 dB and the power added efficiency is 40 %. In addition, record-high  $f_{\text{sub T/}}$  of 50 GHz and  $f_{\text{sub max/}}$  of 116 GHz are measured from a 2-finger HBT. These results compare favorably with those measured from AlGaAs/GaAs HBTs, demonstrating that GaInP/GaAs HBTs are suitable for microwave power applications.



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## Quarter-Micron WSi/Au Gate AlGaAs/InGaAs HJFETs for Q-Band Power Applications

*T. Matsumura, M. Kanamori, Y. Oikawa and S. Shinozaki. "Quarter-Micron WSi/Au Gate AlGaAs/InGaAs HJFETs for Q-Band Power Applications." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1481-1484.*

Quarter-micron T-shaped (WSi/plated-Au) gate AlGaAs/InGaAs HJFETs for Q-band power applications are reported.  $F_{max}$  of 170GHz was achieved for the 100 $\mu$ m gate-width device.  $F_{max}$ 's of 115 and 90GHz were realized for 400 and 800 $\mu$ m gate-width devices, respectively, with 100 $\mu$ m unit gate finger width, by reducing the gate parasitic capacitance and the gate resistance employing Au-plating for the gate metal formation. An output power of 25dBm was obtained with a linear gain of 6.6dB at 40GHz band.

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# Abstracts

## Session UU -- Simulation and CAD Frameworks

*"Session UU -- Simulation and CAD Frameworks." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1485-1486.*



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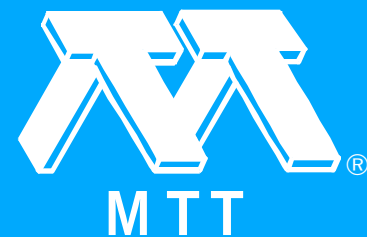


# Abstracts

## An Introduction to MHDL

*D.L. Barton and D.D. Dunlop. "An Introduction to MHDL." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1487-1490.*

The MIMIC Hardware Description Language (MHDL) was recently developed under the sponsorship of DARPA and is intended for use in describing microwave and analog hardware. We describe how MHDL addresses the key issues of (1) the representation of hardware hierarchical structure and support for multiple views and alternatives, (2) signal representation, including a mathematically-rigorous signal concept that allows a variety of signal formats such as time-based and frequency-based signals, (3) general capabilities for describing device behavior at multiple levels of abstraction, (4) compatibility with VHDL and support for mixed-mode simulation of hybrid circuits, and, (5) support for concurrent engineering and performance modeling in the development of microwave systems.



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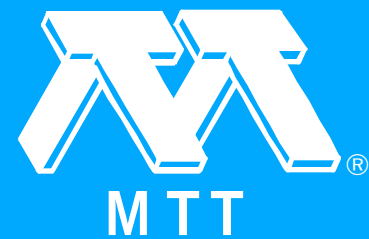
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## Object-Oriented Design of Microwave Circuit Simulators

*P. Carvalho, E. Ngoya, J. Rousset and J. Obregon. "Object-Oriented Design of Microwave Circuit Simulators." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1491-1494.*

To meet MMIC designers requirements, CAD softwares must continuously fit new specifications and offer new functions. To achieve this goal software architectures must be as flexible and extensible as possible, which is not the case at present. In this paper, an object-oriented design approach is proposed. An identification of the basic objects of circuit analysis is done and software architecture of typical circuit simulators are presented.

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# Abstracts

## Electromagnetic Simulator Interfacing to a General CAD Framework: Automatic, Electromagnetic-Based Mesh Generation

*P.J. Draxler. "Electromagnetic Simulator Interfacing to a General CAD Framework: Automatic, Electromagnetic-Based Mesh Generation." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1495-1498.*

An electromagnetic simulator has been interfaced through a custom-meshing program to a general CAD framework. Standard information within the CAD framework (netlist information, location in layout and maximum simulation frequency) is all that is needed to automatically generate a surface mesh (consisting of triangles and rectangles) for the circuit through a systematic multi-level procedure. Additionally, the unique physics of particular elements can be easily incorporated into the mesh generation, thus ensuring accurate simulation.



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# Abstracts

## Session VV -- Acoustic Filters and Resonators

*"Session VV -- Acoustic Filters and Resonators." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1499-1500.*



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## A New Low Loss SAW Filter Structure with Extremely Wide Bandwidth for Mobile Communication Systems

*J. Machui, G. Muller, W. Ruile, L. Reindl, R. Weigel and P. Russer. "A New Low Loss SAW Filter Structure with Extremely Wide Bandwidth for Mobile Communication Systems." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1501-1504.*

We present a low loss surface acoustic wave (SAW) filter with a dual-track configuration which is characterized by a new arrangement of interdigital transducers (IDTs) and reflectors in each acoustic track as well as a special electrical connection of the IDTs. Broadband filter characteristics can easily be achieved by using chirped components. The inherently good stopband rejection of the new structure has been further improved by applying proper weighting techniques to the IDTs and reflectors. A filter with a relative bandwidth of 10 % and a center frequency of 200 MHz has been designed by means of a new synthesis method. The filter has been fabricated on 128° Y-X LiNbO<sub>3</sub>/sub 3/. We measured a minimum insertion loss of 4 dB, a small passband ripple of about 1 dB, and a stopband rejection better than 35 dB. Excellent agreement between simulation and measurement has been found.

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## Design and Performance of Wide-Band HDT-Type SAW Filters with Low Loss and Improved Sidelobe Suppression

*R. Weigel, B. Bader, G. Fischerauer and P. Russer. "Design and Performance of Wide-Band HDT-Type SAW Filters with Low Loss and Improved Sidelobe Suppression." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1505-1508.*

Wide-band low-loss SAW filters employing interdigitated interdigital transducers (IIDT's) suitable for cellular radio systems are presented. The filters were fabricated on 36° YX-LiTaO/sub 3/ substrates. The sidelobe suppression has been improved by withdrawal weighting techniques. A design method which optimizes the weighting functions and number of fingers has been worked out. In the 500 MHz band, fractional bandwidths of up to 5.2 % with passband ripples smaller than 1 dB were attained. Insertion loss and sidelobe suppression were at 1.8 dB and 23 dB, respectively.

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## Transverse and Longitudinal Modes in Waveguide-Coupled Resonators

*W.D. Hunt, T. Cameron, J.C.B. Saw, Y. Kim and M.S. Suthers. "Transverse and Longitudinal Modes in Waveguide-Coupled Resonators." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1509-1512.*

Surface acoustic wave (SAW) waveguide-coupled (WGC) resonators are of considerable interest for narrow-band filter applications though until recently there has been little published on the acoustic details of their operation. As in any resonator, one must fully understand its mode structure and herein we study the SAW mode profiles in these devices. Transverse and longitudinal mode profiles in the resonant cavity of the device were measured at various frequencies of interest using a knife-edge laser probe. In addition we predict the mode profiles for the device structure by two independent methods. One is a stack-matrix approach adapted from integrated optics and the other is a conventional analytical eigenmode analysis of the Helmholtz equation. Both modelling techniques are in good agreement with the measured results.

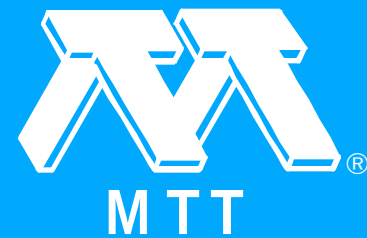


# Abstracts

## A Physically-Based Small-Signal Circuit Model for Heterostructure Acoustic Charge Transport Devices (1993 Vol. III [MWSYM])

*J.S. Kenney and W.D. Hunt. "A Physically-Based Small-Signal Circuit Model for Heterostructure Acoustic Charge Transport Devices (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1513-1516.*

This paper presents a small-signal circuit model for heterostructure acoustic charge transport (HACT) devices. Circuit elements and noise sources are derived from operating conditions and physical device parameters. Frequency response and noise figure are simulated using Libra/sup TM/. They agree within 1 dB of measured data.



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## High Q Microwave Acoustic Resonators and Filters

*K.M. Lakin, G.R. Kline and K.T. McCarron. "High Q Microwave Acoustic Resonators and Filters." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1517-1520.*

This paper presents recent experimental results and modeling obtained on high Q microwave acoustic resonators and filters for use in oscillators and other frequency control applications. Overmoded resonators have exhibited an FQ greater than  $1 \times 10^{14}$  Hz (e.g.  $Q=68000$  at 1.6 GHz) with a strong inductive response suitable for one-port and two-port oscillator feedback circuits. Ladder filters fabricated with overmoded resonators have loaded Q's greater than 40000 with 76 KHz bandwidth at 1.6 GHz. Aluminum nitride films were used for transduction on Z-cut sapphire substrates.

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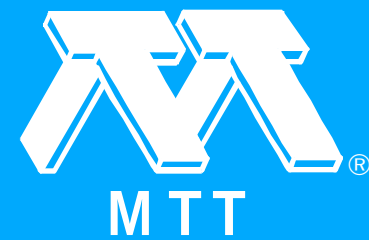




# Abstracts

## Session WW -- EM Analytical and Numerical Techniques II

*"Session WW -- EM Analytical and Numerical Techniques II." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1521-1522.*



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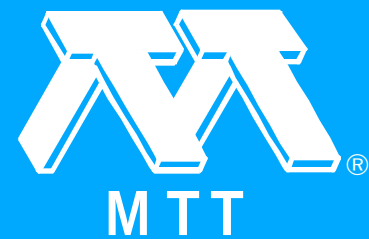
## A Novel Treatment of Open Dielectric Waveguides

*K. Sabetfakhri and L.P.B. Katehi. "A Novel Treatment of Open Dielectric Waveguides." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1523-1526.*

A spectral-domain approach is introduced for the analysis of a general class of open dielectric waveguides. This technique reduces the dimensionality of the space-domain integral equation by use of higher-order boundary conditions. A simple rectangular slab guide is treated as an example and the results are compared to other methods. For the numerical solution of the spectral-domain equations, the method of moments is employed with a Hermite-Gaussian entire-domain basis. It will be seen that only a few basis functions are sufficient to obtain satisfactory results.

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## Full Wave Characterization of Microstrip Open End Discontinuities Patterned on Anisotropic Substrates Using Potential Theory

*S.S. Toncich, R.E. Collin and K.B. Bhasin. "Full Wave Characterization of Microstrip Open End Discontinuities Patterned on Anisotropic Substrates Using Potential Theory." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1527-1530.*

A technique for the full wave characterization of microstrip open end discontinuities fabricated on uniaxial anisotropic substrates using potential theory is presented. The substrate to be analyzed is enclosed in a cut-off waveguide, with the anisotropic axis aligned perpendicular to the air-dielectric interface. A full description of the sources on the microstrip line is included with edge conditions built in. Extension to other discontinuities is discussed.

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## CPW Resonator Modelling on GaAs Using the Mixed Potential Integral Equation

*S. Sattler, T. Felgentreff and P. Russer. "CPW Resonator Modelling on GaAs Using the Mixed Potential Integral Equation." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1531-1534.*

With the advance of coplanar waveguides in monolithic millimeter wave integrated circuits (M<sup>3</sup>ICs) accurate modelling of planar geometries is going to take on more and more significance. Fully electromagnetic models for arbitrary geometries are required in order to include effects such as dispersion, radiation and coupling. A coplanar waveguide (CPW) resonator on grounded GaAs substrate is presented and investigated numerically using a space-domain integral equation method. The numerical results are compared with on wafer measurements and show excellent agreement. The exact calculation of the input impedance as well as the verification of unwanted parasitic resonances is reported. The coupling capacitance, the most sensitive design parameter, is used to tune the circuit and therefore its dependence of the gap width is plotted additionally.

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## A Vector Surface Integral Approach to Computing Inductances of General 3-D Structures

*S. Kim, S. Ali and J. White. "A Vector Surface Integral Approach to Computing Inductances of General 3-D Structures." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1535-1538.*

A new approach to calculating the magneto-quasistatic but frequency-dependent inductance of three-dimensional conductors is presented. A vector surface integral formulation is used, as this requires only a conductor surface discretization, and an excitation source which ensures current conservation is self-consistently computed. Results are presented to demonstrate that the method is effective for computing the inductance and the resistance for general 3-D structures.

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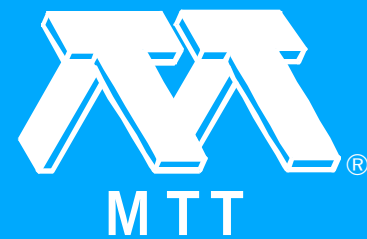


# Abstracts

## A New Full-Wave Integral Equation Method for the Analysis of Coplanar Strip Circuit Using the Mixed-Potentials Eigenfunction Expansion Technique

W.-T. Lo and C.-K.C. Tzuang. "A New Full-Wave Integral Equation Method for the Analysis of Coplanar Strip Circuit Using the Mixed-Potentials Eigenfunction Expansion Technique." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1539-1542.

The theoretic results obtained by the new full-wave integral equation formulation using the mixed-potentials eigenfunction expansion technique are presented. In contrast to what commonly known in the literatures the new formulation can analyze a three-dimensional coplanar strip discontinuity structure on a finite-width substrate. In the case of the reduced structure analyzed by the new method the theoretic results for a microstrip discontinuity problem are validated by comparing them with those obtained by the SDA (Spectral-Domain Approach) incorporated by the LINMIC/sup +TM/.



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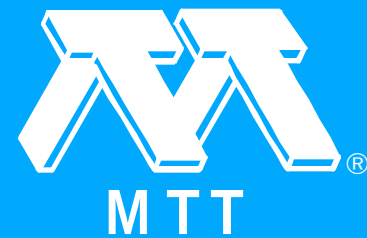


# Abstracts

## An Expression for the S-Parameters of Arbitrarily Oriented Microstrip Lines

*L.C. Howard and J.M. Dunn. "An Expression for the S-Parameters of Arbitrarily Oriented Microstrip Lines." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1543-1546.*

An approximate expression for the coupled S-parameters of skew microstrip lines is derived. The expression is compared to the model for parallel coupled lines. An experiment to test the approximation for skew lines is described, and measured and predicted results are compared.



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# Abstracts

## Late Papers (1993 Vol. III [MWSYM])

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*"Late Papers (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1547-1548.*



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## A New Concept of LANs: Passive Microwave Links Hooked Onto a Fiber Optic Backbone

*S. Meyer, J. Guena, J.C. Leost, E. Penard and M. Goloubkoff. "A New Concept of LANs: Passive Microwave Links Hooked Onto a Fiber Optic Backbone." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1549-1552.*

We present two new concepts that we propose to apply to microwave LANs: - Passive terminal stations, acting as transponders in which no microwave power is generated. This avoids users to be exposed to the microwave field generated in their terminals. - Fixed stations where most of the microwave active functions are transferred to a central station by means of a fiber optic link. This allows the microwave hardware in these stations to be very simple. An experiment regarding such a system, working at 2.45 GHz is presented.





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## Physically Based Circuit Model of GaAs MESFET as an Optical Port for Microwave Systems

*K.A.R. Razzooqi, N.J. Gomes and P.A. Davies. "Physically Based Circuit Model of GaAs MESFET as an Optical Port for Microwave Systems." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1553-1556.*

A GaAs MESFET large signal equivalent circuit model with optical illumination effects has been developed. The model includes accurate representation of the drain current dependence upon the operating voltages under different operational conditions. The model for the GaAs MESFET was implemented into the well-known circuit simulation program, PSpice. Simulated results obtained are shown to compare well with the measured results with a good fit to measured GaAs MESFET I/V characteristics over a wide bias voltage range and under both dark and illumination conditions. The RF response of the MESFET is also modelled and simulated. Such a circuit model is important in the design of optically controlled microwave circuits involving a GaAs MESFET as an optical interface.

[Click on title for a complete paper.](#)



# Abstracts

## Index of Authors (1993 Vol. III [MWSYM])

*"Index of Authors (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1557-1562.*



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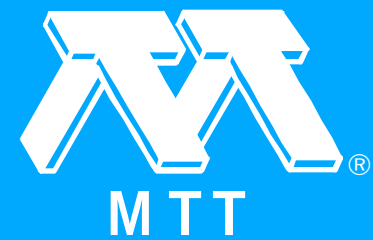
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# Abstracts

## Exhibitors' List (1993 Vol. III [MWSYM])

*"Exhibitors' List (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1563-1564.*



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# Abstracts

## Exhibition Guide (1993 Vol. III [MWSYM])

*"Exhibition Guide (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): 1565-1577.*



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# Abstracts

## Conference Hotels (1993 Vol. III [MWSYM])

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*"Conference Hotels (1993 Vol. III [MWSYM])." 1993 MTT-S International Microwave Symposium Digest 93.3 (1993 Vol. III [MWSYM]): b1-b2.*



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# Abstracts

## Front Cover (1993 [MCS])

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*"Front Cover (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): f1-f2.*



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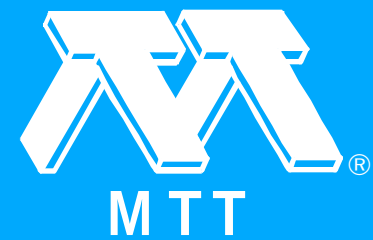
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# Abstracts

## Copyright (1993 [MCS])

*"Copyright (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): i-ii.*



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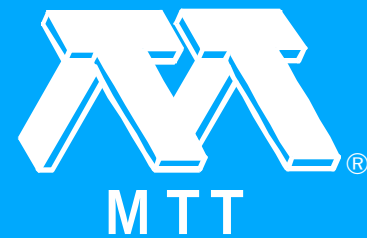
# Abstracts

## Message from the MMWMC Chairman (1993 [MCS])

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*H. Huang. "Message from the MMWMC Chairman (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): iii-iii.*

Welcome to the 1993 IEEE Microwave and Millimeter Wave Monolithic Circuits Symposium. Together with the MTT-S International Microwave Symposium, we have put together a strong technical program with excellent papers, as well as many social activities in the wonderful city of Atlanta, Georgia.



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# Abstracts

## Committees (1993 [MCS])

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*"Committees (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): iv-iv.*



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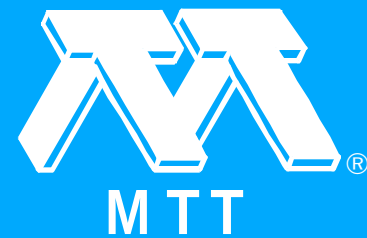


# Abstracts

## Message from the Technical Program Chairman (1993 [MCS])

*R. Gold. "Message from the Technical Program Chairman (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): v-v.*

On behalf of the Technical Program Committee, welcome to Atlanta and the 1993 IEEE Microwave and Millimeter-Wave Monolithic Circuits Symposium.



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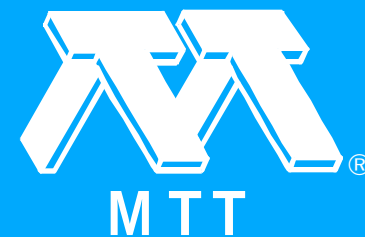
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# Abstracts

## Steering and Technical Program Committees (1993 [MCS])

*"Steering and Technical Program Committees (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): vi-vi.*



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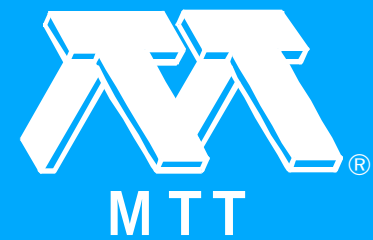
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# Abstracts

## Table of Contents (1993 [MCS])

*"Table of Contents (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): vii-xi.*



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## MMWMC Panel Session (1993 [MCS])

*"MMWMC Panel Session (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): xii-xii.*



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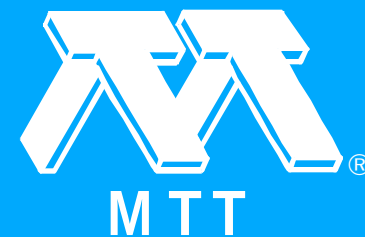
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# Abstracts

## Session I -- Opening Session (1993 [MCS])

*"Session I -- Opening Session (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): xiii-xiii.*



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# Abstracts

## The Commercial Markets for MMIC's

*M.J. Reid. "The Commercial Markets for MMIC's." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 1-2.*

The MIMIC Program has contributed significantly to the technology of monolithic circuits. This support has created a practical, small size and low cost technology that now allows U.S. firms to penetrate the domestic and international commercial and industrial markets for millimeter, microwave and RF components and subsystems.



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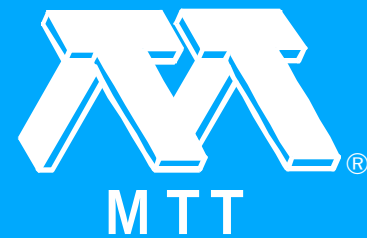


# Abstracts

## Present and Future of Mobile Communications in Japan (Invited Paper)

*M. Morishima. "Present and Future of Mobile Communications in Japan (Invited Paper)." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 3-6.*

In Japan, mobile communication subscribers have been increasing rapidly, in specialy cellular telephone, radio paging, trunked system (called MCA) and cordless phone. The digital cellular service is going into operation in the spring of 1993. The digital cordless telephone, digital trunked system and future public land mobile telecommunication system (FPLMTS) are now been considered.



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# Abstracts

## Session II -- MMIC for Personal Communications

*"Session II -- MMIC for Personal Communications." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 7-8.*



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## GaAs JFET Front-End MMICs for L-Band Personal Communications

*T. Ohgihara, S. Kusunoki, M. Wada and Y. Murakami. "GaAs JFET Front-End MMICs for L-Band Personal Communications." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 9-12.*

GaAs JFET low noise and low distortion amplifier and mixer MMICs for front-end use in L-band personal communications have been developed. These MMICs can be operated by a 3.0 V single biasing supply with a very low current dissipation of 4.0 mA. In order to achieve excellent low intermodulation distortion, a current mirror active biasing circuit using enhancement-mode JFETs, and a resistive mixing configuration were adopted.

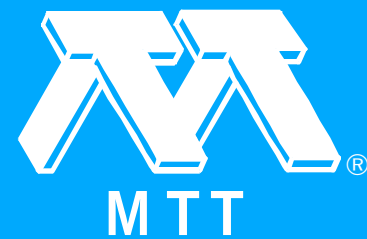


# Abstracts

## A High Performance 1.5 dB Low Noise GaAs PHEMT MMIC Amplifier for Low Cost 1.5-8 GHz Commercial Applications

*H. Morkner, M. Frank and D. Millicker. "A High Performance 1.5 dB Low Noise GaAs PHEMT MMIC Amplifier for Low Cost 1.5-8 GHz Commercial Applications." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 13-16.*

A three stage, 1.5 to 8 GHz, 1.5 dB noise figure monolithic GaAs PHEMT has been designed, fabricated, and tested. This MMIC uses state-of-the-art .15u gate PHEMT devices, self-biasing current sources, source follower interstage, resistive feedback, and on-chip matching to make a unique low noise amplifier. Typical gain of 21 dB, VSWR of 2:1, and P-1dB output power of 7dBm have been measured. The die area is small (0.40 mm sq.) and is compatible with surface mount packages. DC power requirements are low, consuming only 14mA from a single +5V supply. This MMIC LNA has the best combination of noise figure, gain, low current, match, wide bandwidth, and low cost of any advertised or published product to date.



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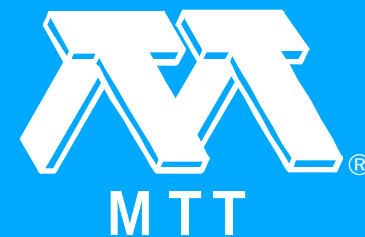
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# Abstracts

## Session III -- Commercial MMIC Applications I

*"Session III -- Commercial MMIC Applications I." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 17-18.*



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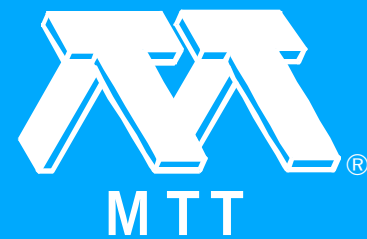


# Abstracts

## High-Efficiency AlGaAs/GaAs HBT Power Amplifier MMIC for 1.9GHz Japanese Digital Cordless Phone

*S. Hara, H. Sato, J.K. Twynam, M. Akagi, N. Nambu, N. Tanba, K. Yoshikawa, T. Kinoshita, M. Yagura, H. Tsuji, T. Shinozaki, T. Yoshimasu, T. Miyajima and T. Tomita. "High-Efficiency AlGaAs/GaAs HBT Power Amplifier MMIC for 1.9GHz Japanese Digital Cordless Phone." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 19-22.*

An AlGaAs/GaAs HBT power amplifier MMIC for 1.9 GHz Japanese digital cordless phone applications is demonstrated. A  $P_{\text{sub 1dB}}$  of 24 dBm and a  $P_{\text{sub 1dB}}$  power added efficiency as high as 40 % are achieved at voltage of only 3 V. This is the highest power added efficiency ever reported for such an amplifier operating at any voltage.



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## A 2.4GHz Single Chip Transceiver

*L.M. Devlin, B.J. Buck, J.C. Clifton, A.W. Dearn and A.P. Long. "A 2.4GHz Single Chip Transceiver." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 23-26.*

A single chip, GaAs transceiver is described. The circuit includes all transmit and receive switching, amplification, frequency conversion and level shifting. An on chip oscillator is also provided. Low receive current of 30mA from a +5V supply and a standby current of less than 0.5mA, make this an ideal component for battery powered operation.

Click on title for a complete paper.



## Low Voltage, High Power T/R Switch MMIC Using LC Resonators

*T. Tokumitsu, I. Toyoda and M. Aikawa. "Low Voltage, High Power T/R Switch MMIC Using LC Resonators." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 27-30.*

A novel T/R switch for high-power/low-distortion operation at low control voltage is proposed. LC-resonant switches composed of inductors, capacitors, and switching FET's are incorporated in the TX and RX arms to provide a reverse control scheme which removes the RF voltage limitation in the transmit mode. An LC-resonant T/R switch with total periphery of 2.88 mm exhibits 3-rd IMR less than -40 dB for input power up to 28 dBm when controlled at 0V/-2V.





# Abstracts

## 12 GHz Low-Noise MMIC Amplifier Designed with a Noise Model that Scales with MODFET Size and Bias

*B. Hughes, J. Perdomo and H. Kondoh. "12 GHz Low-Noise MMIC Amplifier Designed with a Noise Model that Scales with MODFET Size and Bias." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 31-34.*

A scalable, bias-dependent FET noise model was developed for MMIC design. A three-stage, 12 GHz, MMIC, low-noise amplifier (LNA) was designed with the model. The LNA has a 1.6 dB noise figure and 25.6 dB gain. Lumped elements were used to design an LNA that was significantly smaller per stage (0.31 mm<sup>2</sup>) than previous MMIC LNAs.



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## A 20-50GHz MMIC Amplifier with 21dBm Output Power and its Application as a Frequency Doubler

*H. Kondoh and A. Cognata. "A 20-50GHz MMIC Amplifier with 21dBm Output Power and its Application as a Frequency Doubler." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 35-38.*

A 20-50GHz MMIC amplifier, designed on a 0.25 $\mu$ m-gate PMODFET production IC process, has demonstrated a  $13 \pm 1.8$  dB gain with greater than 21dBm saturated output power across the band. A traveling-wave-input/power-combined-output configuration developed for the input stage design has facilitated area-efficient broadband impedance matching and also enabled the amplifier to operate as a frequency doubler. More than 10dBm output power was achieved over the 20-50GHz doubled frequency band for 20dBm input power.

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# Abstracts

## Session IV -- MM-Wave MMICs I

*"Session IV -- MM-Wave MMICs I." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 39-40.*



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## A W-Band Single-Chip Transceiver for FMCW Radar

*K.W. Chang, G.S. Dow, H. Wang, T.H. Chen, K. Tan, B. Allen, J. Berenz, J. Wehling and R. Lin. "A W-Band Single-Chip Transceiver for FMCW Radar." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 41-44.*

This paper reports a W-band transceiver implemented on a single-chip MMIC. The MMIC chip contains a W-band VCO, transmit amplifiers, a receiver low noise amplifier and a mixer. It is used as the front-end of a homodyne FMCW radar for target range and range rate sensing applications. The 6.9 X 3.6 mm<sup>2</sup> monolithic chip was fabricated using 0.1  $\mu$ m pseudomorphic InGaAs/AlGaAs/GaAs HEMT process technology. The transmitter output power is more than 10 dBm for frequencies between 90-94 GHz and maximum tuning bandwidth is 500 MHz for the VCO. The receiver channel has 6 dB conversion gain when the output transmitting power is 10 dBm. A complete radar system has been tested based on the single-chip MMIC front-end. The calculated range and range rate are in good agreement with the measurement data.

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## A Ka-Band HEMT MMIC 1 Watt Power Amplifier

*M.V. Aust, B. Allen, G.S. Dow, R. Kasody, G. Luong, M. Biedenbender and K. Tan. "A Ka-Band HEMT MMIC 1 Watt Power Amplifier." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 45-48.*

A 34-36 GHz, 1 watt 9 dB gain MMIC power amplifier has been developed which utilizes 0.15um pseudomorphic InGaAs/GaAs HEMT process technology. Power amplifier sites across the wafer were fully characterized with an on-wafer pulsed large signal S-parameter test set. Test results from these amplifier chips showed output powers > 30 dBm, with greater than 9 dB gain, and power added efficiencies > 20%. Overall chip size is 4.8 mm x 2.3 mm. This is the report of a Ka-Band MMIC power amplifier with 1 watt output power. A two-stage power amplifier module was developed using one chip to drive three chips. The resulting amplifier module has achieved 3 watt output power and 17dB gain from 34-36GHz.

Click on title for a complete paper.



## A D-Band Monolithic Fundamental Oscillator Using InP-Based HEMT's (1993 [MCS])

*Y. Kwon, D. Pavlidis, T. Brock and D.C. Streit. "A D-Band Monolithic Fundamental Oscillator Using InP-Based HEMT's (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 49-52.*

The design and experimental characteristics of the first fundamental D-band monolithic HEMT oscillator are reported. The circuit is based on a dual feedback topology and uses 0.1  $\mu\text{m}$  pseudomorphic double heterojunction InAlAs/In/sub 0.7/Ga/sub 0.3/As HEMT's. It includes on-chip bias circuitry and an integrated E-field probe for direct radiation into the waveguide. An oscillation frequency of 130.7 GHz was measured and the output power level was -7.9 dBm using HEMT's of small gate periphery (90  $\mu\text{m}$ ). This represents the highest frequency of fundamental signal generation out of monolithic chips using three-terminal devices.





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## A Broadband, Planar, Doubly Balanced Monolithic Ka-Band Diode Mixer (1993 [MCS])

*S.A. Maas and K.W. Chang. "A Broadband, Planar, Doubly Balanced Monolithic Ka-Band Diode Mixer (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 53-56.*

This paper describes a planar monolithic diode mixer achieving 5-10 dB conversion loss and very low distortion and spurious responses over a 26- to 40-GHz RF and LO bandwidth and dc-10 GHz IF. The diodes are the gate-to-channel junctions of 0.2 x 80  $\mu\text{m}$  InGaAs HEMTs, and the baluns are Marchand-like coplanar structures.

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## A Coplanar Millimeterwave Resonator on Silicon

*S. Sattler, T. Felgentreff and P. Russer. "A Coplanar Millimeterwave Resonator on Silicon." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 57-60.*

A CPW resonator in completely coplanar technique is built on grounded silicon substrate and the input impedance is investigated experimentally and numerically. The passive planar structure is extensively studied using a space-domain full-wave analysis method. The resonator is fed by a coplanar transission line through a capacitive gap and shows a marked resonance at the fundamental coplanar waveguide mode. Calculated data and measured data agree better than 5%.

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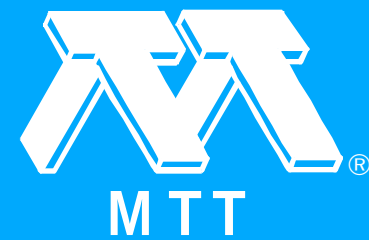




# Abstracts

## Session V -- Commercial MMIC Applications II

*"Session V -- Commercial MMIC Applications II." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 61-62.*



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## A Low Cost 77 GHz Monolithic Transmitter for Automotive Collision Avoidance Systems

*L. Raffaelli, E. Stewart, R. Quimby, J. Borelli, A. Geissberger and D. Palmieri. "A Low Cost 77 GHz Monolithic Transmitter for Automotive Collision Avoidance Systems." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 63-66.*

The design, integration and test results of a 77 GHz GaAs monolithic transmitter specifically optimized for low cost, large volume automotive collision avoidance systems is presented. Greater than +15 dBm of output power has been achieved at the output waveguide interface across a 1 GHz bandwidth using monolithic chips exclusively. This module, due to its small size, light weight and low production cost is a significant advance in MMW technology from traditional waveguide hybrid approaches and it now makes collision avoidance radars affordable.

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## Miniaturized Low Noise Variable MMIC Amplifiers with Low Power Consumption for L-Band Portable Communication Applications

*S. Hara, K. Osato, A. Yamada, T. Tsukao and T. Yoshimasu. "Miniaturized Low Noise Variable MMIC Amplifiers with Low Power Consumption for L-Band Portable Communication Applications." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 67-70.*

Miniaturized L-band low noise variable gain amplifiers are demonstrated for portable mobile communication equipment applications. The fabricated MMICs use D-mode GaAs MESFETs and need only positive bias. The amplifier has a noise figure of 3 dB and a gain of 14 dB. The chip size is approximately 1 mm x 1 mm and the current dissipation is only 1.8 mA.

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## Low Noise Wideband Fiber Optic MMIC-Based Receiver

*R. Khairandish, C.M. Gee, J. Paslaski and D. Huff. "Low Noise Wideband Fiber Optic MMIC-Based Receiver." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 71-74.*

A low noise wideband fiberoptic MMIC-based receiver consisting of a two-stage feedback amplifier with minimum gain of 10 dB and 5 dB maximum noise figure from 6 to 15 GHz is presented. This bandwidth and noise performance represents a significant improvement over available hybrid designs. The receiver is usable up to 17 GHz. The improved RF performance is obtained by flip-chip mounting a photodiode onto the MMIC chip which minimizes the parasitic, extending bandwidth and improving noise.



## Monolithic Image Rejection Optoelectronic Up-Converters that Employ the MMIC Process (1993 [MCS])

*H. Kamitsuna and H. Ogawa. "Monolithic Image Rejection Optoelectronic Up-Converters that Employ the MMIC Process (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 75-78.*

This paper presents very small 30-GHz-band monolithic image rejection optoelectronic up-converters that employ the HEMT-MMIC process for the first time. An in-phase divider and a branch-line hybrid with two HEMT optoelectronic mixers are successfully integrated in an MMIC chip area of 1.5 mm x 1.1 mm. Fundamental performance is demonstrated and excellent wideband performance, which comes from the well balanced operation of monolithic integrated circuits, is confirmed.





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## Picosecond MODFET IC Pulse Sharpener

*M.S. Shakouri, A. Black, D.M. Bloom, J. Perdomo, H. Kondoh and H. Vifian. "Picosecond MODFET IC Pulse Sharpener." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 79-82.*

We have fabricated a monolithic synthetic transmission line pulse sharpener using a high power .25  $\mu\text{m}$  InGaAs/GaAs MODFET IC process. This circuit sharpens a dc-to-5 GHz input to a pulse of at least 5 psec, 2V output transition. This first implementation of a pulse sharpening circuit in a MODFET IC process demonstrates the broadband capabilities of this technology for picosecond pulse sharpening applications.

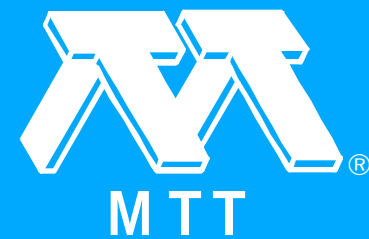
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## Session VI -- MMW MMICs II

*"Session VI -- MMW MMICs II." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 83-84.*



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## InP Based HBT Millimeter-Wave Circuit Performance to Technology and 40 GHz

*K.W. Kobayashi, L.T. Tran, S. Bui, J. Velebir, D. Nguyen, A.K. Oki and D.C. Streit. "InP Based HBT Millimeter-Wave Circuit Performance to Technology and 40 GHz." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 85-88.*

We report the first InP based HBT millimeter-wave amplifiers and oscillators designed in a microstrip environment and working up to 40 GHz. A 20-40 GHz balanced high intercept amplifier and a 30 GHz VCO have been successfully fabricated and tested. These circuits benchmark the first Inp HBT microstrip designs at Ka-band frequencies. The high intercept amplifier achieves a gain of 5 dB and an IP3 of 20 dBm at 35 GHz. The monolithic VCO uses a base emitter varactor diode to tune as high as 9% bandwidth from a nominal oscillation frequency of 30 GHz. The output power is invariant of VCO tuning and is about +9.9 dBm  $\pm$  0.5 dBm. The collector efficiency is 21%. The total power dissipation is 77 mW. These circuit demonstrations show great potential for HBTs in millimeter-wave communication systems.

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## Rigorous Design of a 94 GHz MMIC Doubler

*S.-W. Chen, T. Ho, F.R. Phelleps, J.L. Singer, K. Pande, P. Rice, J. Adair and M. Ghahremani. "Rigorous Design of a 94 GHz MMIC Doubler." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 89-92.*

A 94 GHz monolithic microwave integrated circuit (MMIC) frequency doubler with 25% efficiency and 65 mW output power has been developed. Variations in the diode's performance as a doubler with its geometry and doping profile were analyzed for optimum efficiency and output power. Optimum doubler performance was obtained as a consequence of use of the optimized diode parameters resulting from this analysis. Measured results of the diode parameters as well as doubler response showed excellent agreement with the analysis. The doubler exhibits better performance than those reported in the literature at similar frequencies using an MMIC approach.

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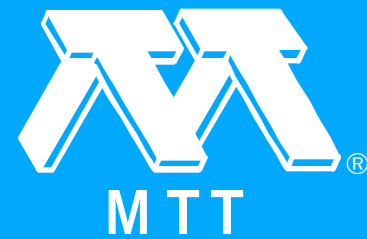


# Abstracts

## A Fully Integrated 35 GHz MMIC Receiver with On-Chip LO

*R. Ramachandran, C. Woo, M. Nijjar and D. Fisher. "A Fully Integrated 35 GHz MMIC Receiver with On-Chip LO." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 93-96.*

A fully integrated 35 GHz MMIC receiver chip has been designed, fabricated and tested. The chip contains a Low-Noise Amplifier (LNA), an active mixer, an IF amplifier, a local oscillator, and a buffer amplifier. The only external component required is the resonator. This feature was incorporated to accommodate both DRO and VCO implementations. Chip size is 54 x 80 mils (1.35 x 2 mm).



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## The Demonstration of Ka-Band Multi-Functional MMIC Circuits Fabricated on the Same PHEMT Wafer with Superior Performance

*A. Kurdoghlian, C.S. Wu, W. Yau, J. Chen, M. Hu, C. Pao and D. Bosch. "The Demonstration of Ka-Band Multi-Functional MMIC Circuits Fabricated on the Same PHEMT Wafer with Superior Performance." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 97-98.*

We have demonstrated the superior performance of Ka-Band MMIC power and Low noise amplifiers, both fabricated on the same wafer, using delta doped AlGaAs-InGaAs-GaAs PHEMT technology. The balanced power amplifier exhibited an output power of 500 mW with 12 dB associated gain; and a power added efficiency of 32 percent over the 34 to 36 GHz frequency range. The LNA circuit demonstrated a noise figure of 3.5 dB with an associated gain of 17 dB over the 33 to 37 GHz frequency range. The demonstration of these circuits proves that millimeter-wave multifunctional circuits can be fabricated on the same wafer without sacrificing individual circuit performance.



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## High Performance Q-Band 0.15 $\mu$ m InGaAs HEMT MMIC LNA

*K.H.G. Duh, S.M.J. Liu, S.C. Wang, P. Ho and P.C. Chao. "High Performance Q-Band 0.15 $\mu$ m InGaAs HEMT MMIC LNA." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 99-102.*

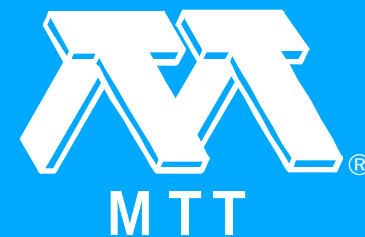
A monolithic three-stage pseudomorphic InGaAs HEMT low noise amplifier developed in our laboratory exhibits state-of-the-art low noise and gain performance at Q-band frequencies: it demonstrated 22 dB of gain with 3 dB noise figure from 41 to 45 GHz. From 35 to 50 GHz, it gave a flat gain response of over 22 dB gain across the Q-band range. This amplifier uses 0.15  $\mu$ m gate length GaAs-based pseudomorphic HEMTs with on-chip matching circuits and bias circuits. The chip size is 2.3x1.0 mm<sup>2</sup>.



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## Session VII -- Advanced MMIC Technology (Joint with IMS)

*"Session VII -- Advanced MMIC Technology (Joint with IMS)." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 103-104.*



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## A Highly-Efficient 7-Watt 16 GHz Monolithic Pseudomorphic HEMT Amplifier (1993 [MCS])

*H.Q. Tsemg and P. Saunier. "A Highly-Efficient 7-Watt 16 GHz Monolithic Pseudomorphic HEMT Amplifier (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 105-108.*

A record cw output power of 7-W with 4.5-dB gain and 30.8 % power-added efficiency was achieved with a monolithic, single-stage, 0.25  $\mu\text{m}$  x 12-mm AlGaAs/InGaAs pseudomorphic HEMT amplifier at 16.3 GHz. At 5-W output, the power-added efficiency was 35% with 6-dB power gain. The chip size is 3-mm x 3.5-mm.

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## The Inductive Connection Effects of a Mounted SPDT in a Plastic SO8 Package (1993 [MCS])

*F. Ndagijimana, J. Engdahl, A. Ahmadouche and J. Chilo. "The Inductive Connection Effects of a Mounted SPDT in a Plastic SO8 Package (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 109-112.*

An investigation of the electrical performances of an assembled SO8 package is presented. Using an equivalent electric network elaborated for the whole assembly, the isolation and the insertion losses are computed for a signal frequency up to 5 GHz. From our modelling and simulation results, the significant effect of the path connection to ground is shown, and the required modifications of the connecting layout are discussed. Our modelling concept, demonstrated on the SO8 package, is applicable on any single chip package.

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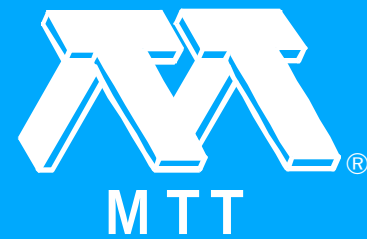


# Abstracts

## An MMIC Linearized Amplifier Using Active Feedback (1993 [MCS])

*J.C. Pedro and J. Perez. "An MMIC Linearized Amplifier Using Active Feedback (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 113-116.*

A single 2.4x2.4 mm<sup>2</sup> MMIC chip includes a L-band tuned MESFET Main Amplifier, and a nonlinear feedback path intended to improve its carrier-to-intermodulation margin, C/I. The circuit uses a novel concept of amplifier IMD cancellation, in which a small area MESFET based linearizer is directly applied to the terminals of the main active device. The linearizer provides a 15dB improvement on C/I, over a relative bandwidth of more than 12%. This is, to our knowledge, the first linearized amplifier integrated in MMIC form.



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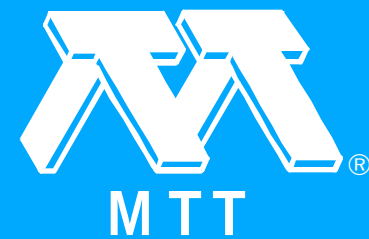




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## Session VIII -- Broadband MMIC Circuits (Joint with IMS)

*"Session VIII -- Broadband MMIC Circuits (Joint with IMS)." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 117-118.*



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## A Highly Integrated MMIC K-band Transmit/Receive Chip (1993 [MCS])

*H. Fudem, S. Moghe, G. Dietz and S. Consolazio. "A Highly Integrated MMIC K-band Transmit/Receive Chip (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 119-122.*

A highly integrated wide-band MMIC Transmit/Receive (T/R) chip was designed for both commercial and military FM CW applications. The MMIC circuit was designed using 0.25  $\mu\text{m}$  pseudomorphic HEMT technology. The T/R chip has three 3-stage amplifiers, an active power divider, a diode double-balanced mixer, and a voltage controlled oscillator (VCO) all integrated on a single chip 96 X 71 mils (2.4 X 1.8 mm) in size.

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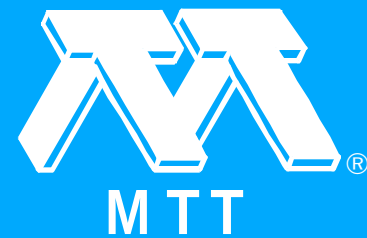


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## A New Compact Wideband Balun

*M.C. Tsai. "A New Compact Wideband Balun." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 123-126.*

A novel wideband balun has been developed for MMIC applications. The new approach utilizes simple RF reflection and coupling principles to achieve a wideband performance in a simple microstrip configuration. A balun with better than 2 dB of insertion loss, 1 dB and 5° of amplitude and phase balance over 7 to 19 GHz has been realized.



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## Ultra Low Impedance CPW Transmission Lines for Multilayer MMICs (1993 [MCS])

*M. Gillick and I.D. Robertson. "Ultra Low Impedance CPW Transmission Lines for Multilayer MMICs (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 127-130.*

A new technique for realising low-loss coplanar waveguide transmission lines with ultra-low characteristic impedance on multilayer MMIC's is presented. The performance of these CPW lines is investigated experimentally with either (a) ground planes extended under the signal conductor or (b) the center conductor extended underneath the ground planes. Using this technique characteristic impedances as low as  $7\Omega$  have been realised. The technique has been combined extensively with the proven standard thin-film microstrip transmission line. The TFMS technique can be used for lines with characteristic impedance as low as  $3.6\Omega$ , but is found here to be significantly more lossy.

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## A Highly Compact, Wideband GaAs HEMT X - Ku Band Image-Reject Receiver MMIC (1993 [MCS])

*R. Katz, M.V. Aust, R. Kasody, H. Wang, B. Allen, G.S. Dow, K. Tan, S. Lin and R. Myers. "A Highly Compact, Wideband GaAs HEMT X - Ku Band Image-Reject Receiver MMIC (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 131-134.*

A fully integrated MMIC receiver was designed and fabricated using the 0.2 $\mu$ m pseudomorphic InGaAs/GaAs HEMT process technology. This MMIC receiver incorporates a single-stage RF amplifier, a two-staged balanced LO amplifier, a single-stage IF amplifier, an IF switch and an image-reject diode mixer. Results from these receiver chips showed good conversion gain and image rejection in a single small chip over multi-octave frequencies. This chip operates from a single +5 Vdc and draws 280 mA. Total chip size is 5.5mm x 4.5mm.

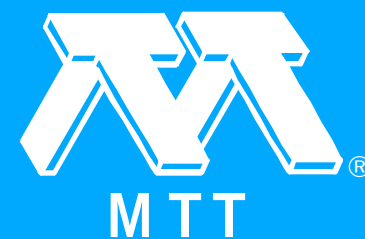
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## Session IX -- MMIC Control Circuits (Joint with IMS)

*"Session IX -- MMIC Control Circuits (Joint with IMS)." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 135-136.*



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## A MMIC Subharmonically Pumped SSB Modulator (1993 [MCS])

*A. Pospishil, M. Russo and M. Singh. "A MMIC Subharmonically Pumped SSB Modulator (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 137-139.*

An innovative monolithic Single Sideband Modulator (SSBM), which utilizes balanced subharmonically pumped mixers, has been developed. This SSBM is pumped at one half of the carrier frequency ( $f_{\text{sub c}}/2$ ). The typical measured performance of this device is excellent with  $> 40\text{dB}$  carrier suppression,  $> 25\text{dB}$  undesired sideband suppression and  $< 10\text{dB}$  conversion loss over a carrier bandwidth of 14 to 19GHz. Double sideband suppressed carrier (DSBSC) and unsuppressed carrier operation is also achievable with the same device when appropriate modulation signals are applied.

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## Narrow-Band MMIC Filters with Automatic Tuning and Q-Factor Control (1993 [MCS])

*P. Katzin, B. Bedard and Y. Ayasli. "Narrow-Band MMIC Filters with Automatic Tuning and Q-Factor Control (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 141-144.*

Narrow-band, active MMIC filters are demonstrated at X-band. Results are presented for both band-pass and notch circuits fabricated using standard GaAs MESFET processes. A novel Master-Slave control circuit provides compensation for fluctuations in fabrication process and operating temperature, and it enables the filter to accurately track a reference signal.

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## A New Circuit Structure for Microwave Frequency Doublers (1993 [MCS])

*J. Fikart and Y. Xuan. "A New Circuit Structure for Microwave Frequency Doublers (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 145-148.*

A new circuit structure for microwave frequency doublers is presented, which features effective suppression of fundamental and odd harmonics ( $> 50$  dB), conversion gain ( $> 3$  dB) and simplicity of the circuit. Furthermore, it can be used in both balanced and unbalanced output configurations, without requiring baluns or transformers. Experimental results are also given in the paper.

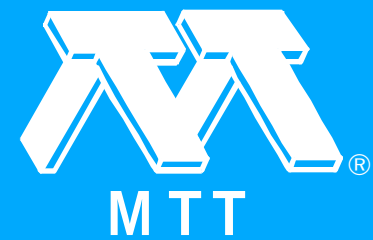
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## Session X -- Interactive Forum I (Joint with IMS)

*"Session X -- Interactive Forum I (Joint with IMS)." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 149-150.*



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## GaAs HBT PIN Diode Attenuators and Switches (1993 [MCS])

*K.W. Kobayashi, A.K. Oki, D.K. Umemoto, S. Claxton and D.C. Streit. "GaAs HBT PIN Diode Attenuators and Switches (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 151-154.*

We report on an AlGaAs/GaAs HBT 2-stage pin diode attenuator from 1-10 GHz and an X-band 1-pole 2-throw X-band pin diode switch. The 2-stage pin attenuator has over 50 dB dynamic range at 2 GHz and a maximum IP3 of 9 dBm. The minimum insertion loss is 1.7 dB per stage and has a flat response to 10 GHz. The X-band switch has an insertion loss of 0.82 dB and an off-isolation of 25 dB. The bandwidth is greater than 35 % and the IP3 is greater than 34.5 dBm. Both of these circuits consists of PIN diodes constructed from the base-collector MBE layers of our base-line HBT process. This work demonstrates the monolithic integration of pin diode switch and attenuation functions in an HBT technology without additional process or MBE material growth.

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## Passive FET MMIC Linearizers for C, X and Ku-Band Satellite Applications (1993 [MCS])

*A. Katz, S. Moochalla and J. Klatskin. "Passive FET MMIC Linearizers for C, X and Ku- Band Satellite Applications (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 155-158.*

The design and measured performance of GaAs MMIC linearizers for use with space-borne traveling wave tube amplifiers (TWTAs) are presented. New space communications technology requires highly linear amplifiers. Linearizers correct for amplifier distortion to provide the needed linearity. The linearizers described in this paper operate at C, X and Ku-band, and are believed the first to be realized in MMIC form. They are based on a passive FET design similar to that of MMIC switches and attenuators. MESFET varactors and voltage variable resistors are used as control elements. They provide more than 2.5 GHz of bandwidth at Ku-band with an improvement of greater than 10 dB in TWTA carrier-to-intermodulation ratio (C/I), and with a phase change of less than 5 degrees.

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## Low-Noise, Low DC Power Linear Amplifiers (1993 [MCS])

*P.K. Ikalainen, L.C. Witkowski and K.R. Varian. "Low-Noise, Low DC Power Linear Amplifiers (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 159-162.*

Single and dual-gate distributed amplifiers designed for standard ion-implanted GaAs FETs and a newly designed Ku-band amplifier were processed using new high dynamic range FET process. State-of-the-art results were achieved in terms of simultaneous linearity, DC power, noise figure, and gain-bandwidth. OIP3/P/sub dc/ ratios of the amplifiers were in the range 1 to 13.7 with noise figures as low as 3 dB. 8 to 20 dB improvement in second-order linearity has been demonstrated as well.



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## An MMIC Twin-Tee Active Bandpass Filter (1993 [MCS])

*F.J. Rosenbaum, R.O. Gregory, W.D. Richard, W. Ou, F.G. Kuhns and T.M. Trimble. "An MMIC Twin-Tee Active Bandpass Filter (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 163-166.*

The design and performance of an MMIC active bandpass filter based on a twin-tee notch circuit are described. Design goals included a center frequency of 2 GHz and a Q that could be varied to well over 100. The device was fabricated in GaAs using 150  $\mu\text{m}$  transistors. Die size is approximately 1 square mm, and power dissipation is approximately 180 mW. Although Q values meet expectations, the measured center frequency is low.

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## A Monolithic W-Band Preamplifier Diode Detector (1993 [MCS])

*H. Wang, W. Lam, T.N. Ton, D.C.W. Lo, K.L. Tan, G.S. Dow, B. Allen and J. Berenz. "A Monolithic W-Band Preamplifier Diode Detector (1993 [MCS])." 1993 Microwave and Millimeter-Wave Monolithic Circuits Symposium Digest 93.1 (1993 [MCS]): 167-170.*

A monolithic W-band preamplifier diode detector was developed based on 0.1  $\mu\text{m}$  pseudomorphic AlGaAs/InGaAs/GaAs HEMT technology. This chip consisted of a Schottky diode detector with a two-stage W-band low noise amplifier has a measured detector responsivity of 300 V/mW at 94 GHz and a tangential sensitivity of -62 dBm. This is the first reported monolithic preamplifier diode detector at this frequency. A higher sensitivity preamplifier detector which was built by cascade of two monolithic three-stage W-band LNA with the preamplifier detector chip also shows a tangential sensitivity of -85 dBm. This monolithic chip is ideal for insertion into the W-band radiometer and passive imaging array systems.

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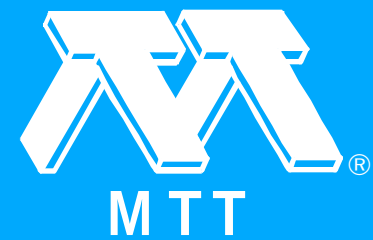


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