# A NOVEL TECHNIQUE FOR EVALUATION AND INTEGRATION OF CONNECTORLESS (DROP-IN) MICROWAVE COMPONENTS

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## ABSTRACT

A novel technique for evaluation and integration of connectorless (drop-in) microwave components into subsystems is proposed. This technique utilizes a quick connect-disconnect device designed in STRIPGUIDE, a modified version of strip-line. This new method is flexible and simple to use and shows very good RF performance up to 40 GHz.

## INTRODUCTION

Integration of microwave components equipped with terminals into subsystems is achieved today by one of two general techniques:

(A) Connectorized Components. In most modern systems, such components are usually equipped with SMA (or equivalent) connectors. Evaluation as well as integration require mating connectors and some form of coaxial cable. The RF performance is very good but the technique is relatively expensive and results in an inefficient use of subsystem volume.

(B) Connectorless (drop-in) Components. These come in various types. The two most common are those with coaxial feed-thrus (usually in a hermetic enclosure) and those with microstrip tabs. Drop-in components are usually integrated into a subsystem by soldering/welding RF outputs to a microstrip transmission line "mother-board" (e.g. soft substrate, soldered or cemented to a metal ground plane). Evaluation of the individual components prior to integration as well as the subsystem prototype work is carried out either in a coaxial system using removable connectors (for the coaxial type drop-in components) or in a microstrip-coax test fixture (for microstrip drop-in components).

Although the microstrip integration technique offers reduced subsystem volume and weight, it has some serious draw-backs in performance: (1) RF performance of the integrated assembly is degraded due to ground discontinuities and RF leakage; (2) as a result, the correlation between the RF performance of the "prototype" and "integrated" versions of the subassembly is typically poor; (3) insertion losses associated with the microstrip may also be of some concern; (4) the RF terminals of the components are soldered or welded to the interconnecting microstrip, a technique which does not facilitate simple replacement of these components.

The technique proposed in this paper provides integration of drop-in components using a stripline-type connecting device which I call STRIPGUIDE[1]. This technique is described herein in detail, its advantages are shown and results of RF measurements are set forth.

## STRIPGUIDE

The electric field distribution in coaxial line, stripline and microstrip are shown in Fig.1. The usual stripline transmission line consists of printed conductors and two layers of dielectric symmetrically sandwiched between ground planes. The ground planes may be inter-connected with screws. Components are often embedded between ground planes.

In STRIPGUIDE, the printed center conductor is embedded in the dielectric medium. For a given impedance, the line width and dielectric thickness are similar to those required for stripline. The dielectric medium is "enclosed" by a ground shield and a recess is provided in the upper and lower ground planes to accept the component's RF feed-thru pins with minimum RF perturbation (Fig.2.). RF ground continuity is established by pairs of closely spaced screws through the component's mounting holes adjacent to the feed-thrus as shown in Fig.3 and Fig.4. RF connection for evaluation and integration is achieved by mechanical clamping. Neither cement nor solder is required. Thermal cycling tests from -55°C to 125°C show stable performance with this arrangement. Should the dielectric show evidence of "cold flow", the components' output pin terminals can be soldered to the STRIP-GUIDE center conductor at the final stage of integration. Thereafter, when replac-

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1 STRIPGUIDE is a trademark for these techniques and structures which are proprietary.



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ing a component, the small dielectric sections can be easily replaced.

The simple and flexible "clamping" structure of STRIPGUIDE, which has a similar electric field distribution to both coax and microstrip, makes it ideal for the following uses:

(A) A connecting device between any two drop-in components (coaxial type of microstrip) for system integration.

(B) A connecting device between coaxial connectors and drop-in components for evaluation prior to integration.

(C) A connecting device between drop-in components and ridge waveguide.

(D) A connecting device between packaged devices (such as FETs) and coaxial connectors for non-distructive evaluation.

Fig.3 shows a cross section of coaxial type and microstrip drop-in components connected to SMA through STRIPGUIDE for pre-integration evaluation. Fig.4 is an exploded view of a coaxial type drop-in SP4T switch evaluated using STRIPGUIDE. Fig.5 is an exploded view of a microstrip drop-in power divider evaluated using STRIPGUIDE. Fig.6 shows a waveguide/microstrip transition using STRIPGUIDE. Fig.7 shows the use of STRIPGUIDE as a connecting device between drop-in components.

## RF PERFORMANCE

STRIPGUIDE displays very good electrical performance: low insertion loss and VSWR and high isolation between adjacent line. One inch long STRIPGUIDE was tested for insertion and return loss over the 2-18 GHz range. The data, Fig.8, includes two SMA connectors (TEK-WAVE 10-2005-0000). Two 1/2" long parallel STRIP-GUIDES separated by a 2 mm conducting wall were tested for isolation. Fig.8. demonstrates the results which are better than the equivalent microstrip.

In the range 18 to 40 GHz, most networks and components are based on microstrip transmission lines, printed on soft, low dielectric substrates. Outputs are either specialized coaxial connectors (K[2] connectors for example) or waveguide. The STRIPGUIDE technique works with both:

(A) 1" long STRIPGUIDE was evaluated up to 40 GHz using a pair of K connectors. Insertion loss was better than 0.9 dB and return loss better than 13 dB (@ 40 GHz). The clamping technique is identical with the one used for the lower frequency range.

(B) A microstrip/waveguide transition is usually performed by some variety of ridge, used both for RF coupling and DC feed.[1][2]

2 Trademark of Wiltron

## ADVANTAGES OF STRIPGUIDE

(A) <u>RF Performance</u>. As demonstrated in the previous section, STRIPGUIDE as a single transmission line or when combined with coax or microstrip shows very good RF performance up to 40 GHz.

An important fact is that both evaluation and final integration of drop-in components and packaged devices can be done using STRIPGUIDE. This leads to good correlation between evaluated RF specifications and actual RF performance of components at final integration in the subsystem.

(B) <u>Flexibility</u>. Assembly for evaluation and integration is very easy, eliminating the need for a sophisticated technology center. Mechanical clamping leaves the components' leads clean and reassembly of components is extremely simple.

(C) <u>Space and cost effective</u>. Due to the use of drop-in components and the simplicity and flexibility of the technique, the volume and cost of subassemblies are minimized.

(D) <u>Integration standards</u>. Integration is one of the main problems in microwave systems today. The technique described here may lead to creation of integration standards and a common language between components and systems groups. Fig.10 is a schematic view of a subassembly using STRIPGUIDE.

## CONCLUSION

A new technique for evaluation and integration of drop-in components is shown and its advantages are described. The technique has been successfully employed for evaluation and integration into subsystems of various passive components, amplifiers and RF switches in the 2-18 GHz frequency range.

RF performance, integration options and features described in this paper are in the pioneering stage. Further development of this technique will lead to:

(A) Optimization of the STRIPGUIDE-coax, STRIPGUIDE-microstrip and STRIPGUIDE-ridge waveguide transitions.

(B) Creation of standards for the integration of drop-in components.

## REFERENCES

[1] Sabbir S. Moochalla and Chae An, "Ridge waveguide used in microstrip transition" Microwaves & RF, March 1984.

[2] Dov Herstein et al. "Waveguide to Microstrip Coupler Wherein Microwstrip Carries D.C. Biased Component". U.S. Patent Number 4,458,222, July 3, 1984.

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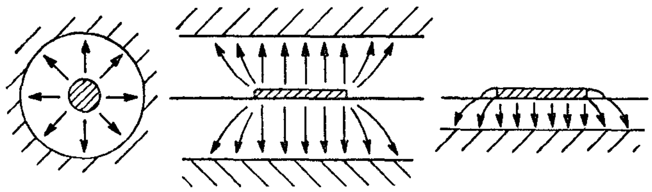

Fig.1: Field distribution in coax, stripline and microstrip.

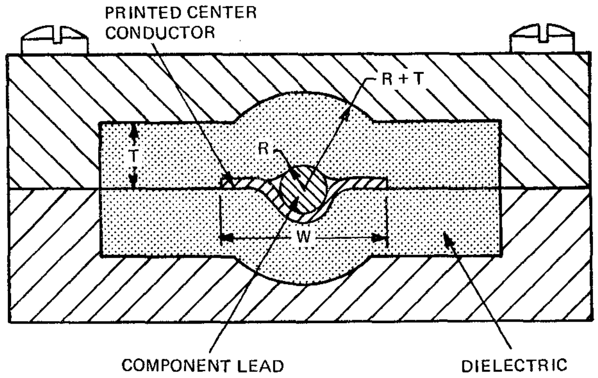


Fig.2: Cross-section of STRIPGUIDE.

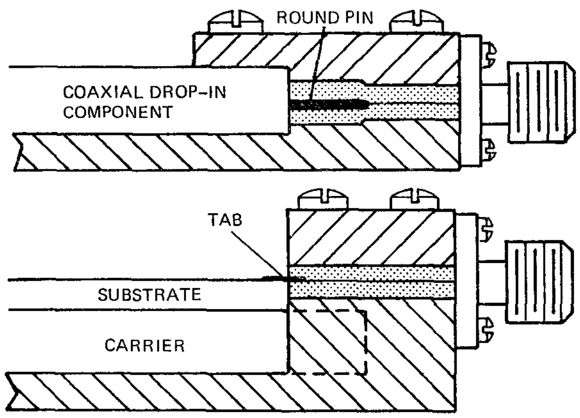


Fig.3: Coaxial-type (top) and microstrip (bottom) drop-in components connected to SMA (or equivalent) through STRIPGUIDE.

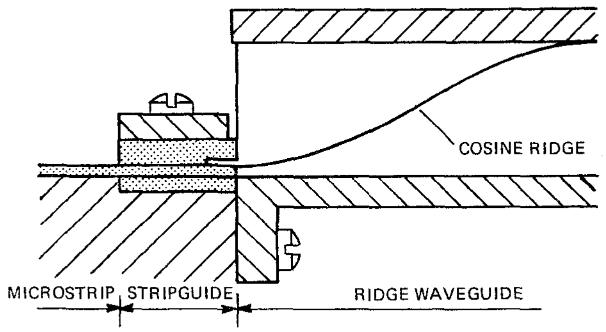


Fig.6: STRIPGUIDE as an interconnecting device between microstrip and ridge waveguide.

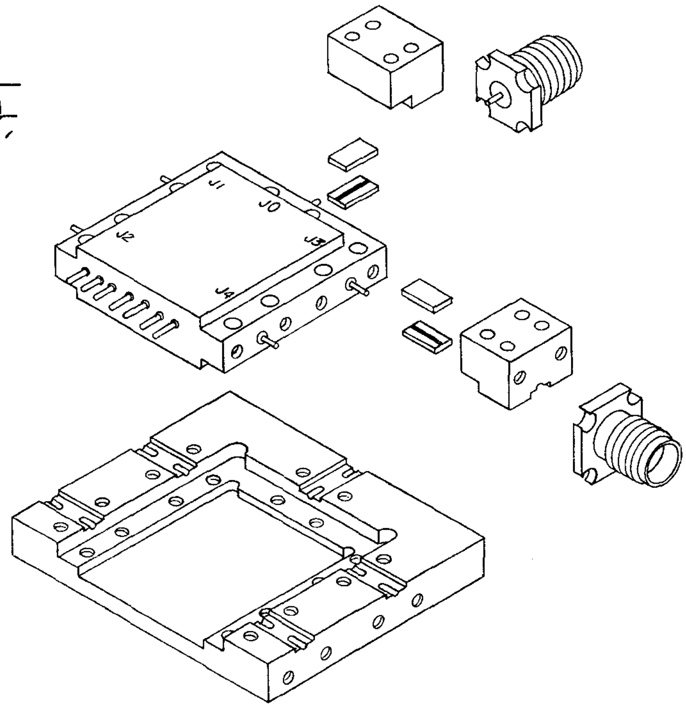

Fig.4: A coaxial-type drop-in SP4T switch module evaluated using STRIPGUIDE.

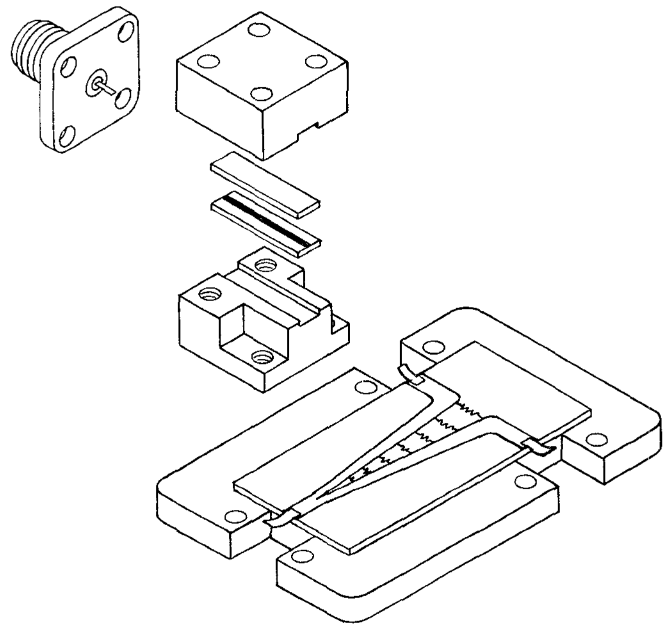

Fig.5: A microstrip drop-in power divider evaluated using STRIPGUIDE.

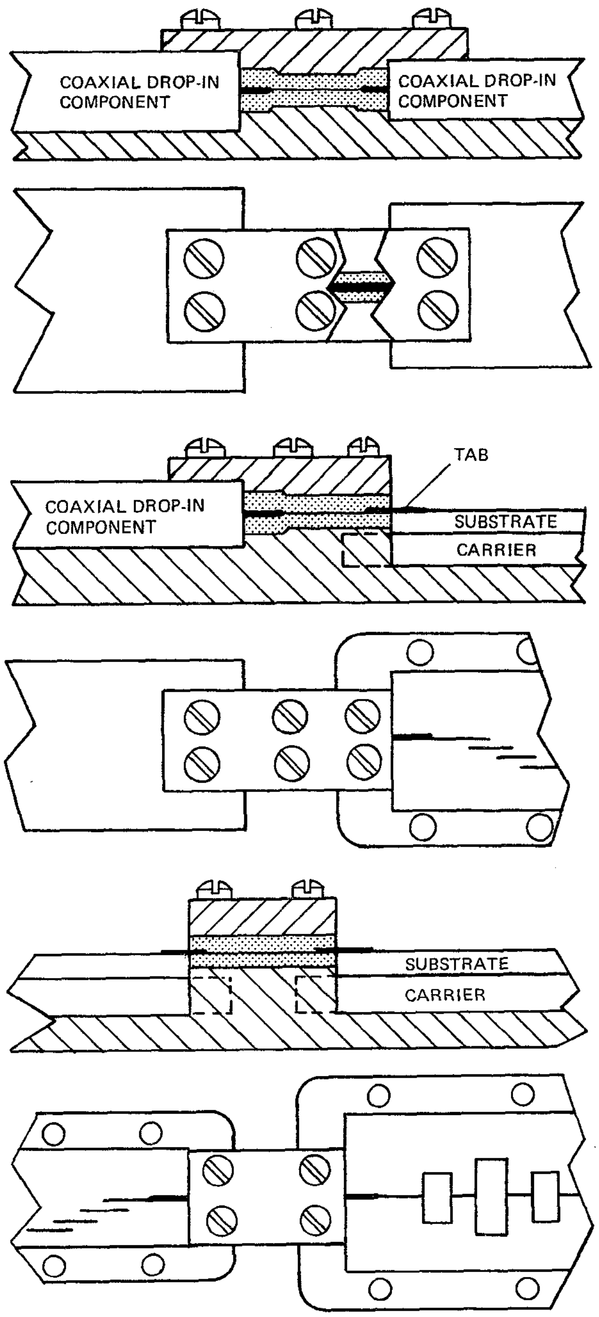


Fig.7: STRIPGUIDE connecting two coaxial-type drop-in components (top), a coaxial type and a microstrip drop-in component (center) and two microstrip drop-in components (bottom).

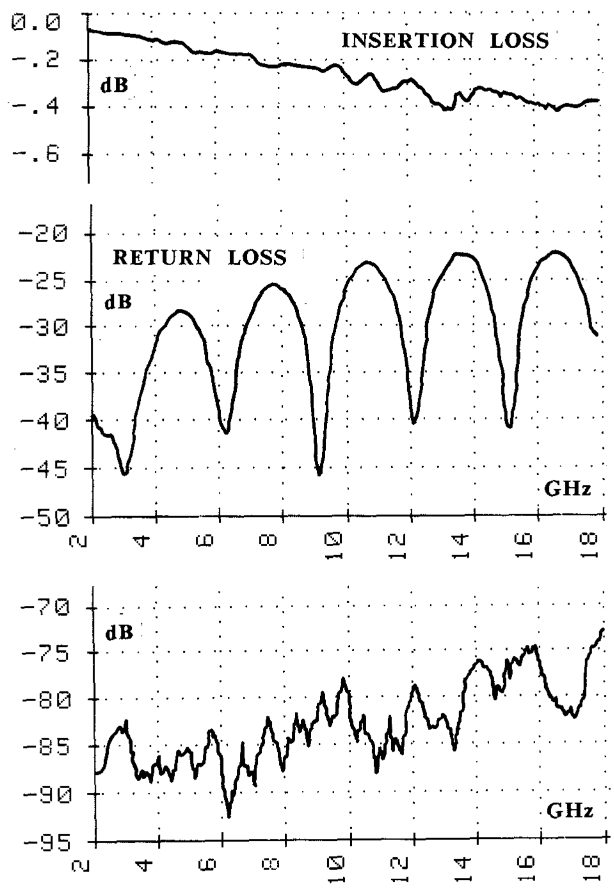


Fig.8: RF evaluation of STRIPGUIDE: Insertion Loss and return loss of 1" long 20 + 20 mil $E_R$ = 2.2 (top), isolation between two adjacent STRIPGUIDES, 1/2" long 2 mm wall separation (bottom).

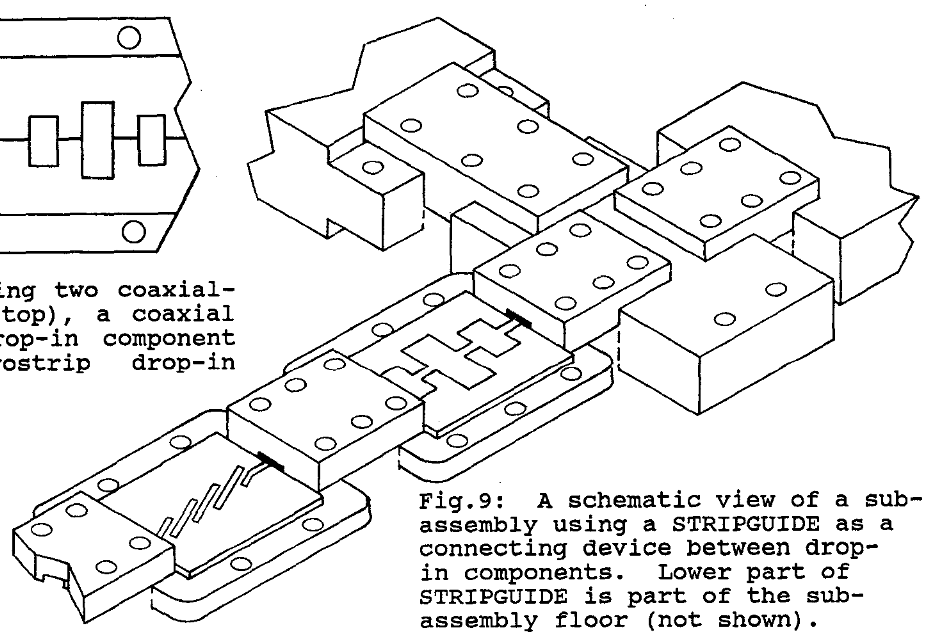

Fig.9: A schematic view of a sub-assembly using a STRIPGUIDE as a connecting device between drop-in components. Lower part of STRIPGUIDE is part of the sub-assembly floor (not shown).