SOME ASPECTS OF FRENCH SOLID-STATE COMPONENT SPACE TECHNOLOGY

J. MAGARSHACK

Thomson CSF
Département Microélectronique Hyperfréquence
Domaine de Corbeville, 91401 Orsay (France)

SUMMARY

This paper will describe three particular aspects of work in FRANCE which has been carried out in the field of solid-state components for space applications.

These are .

- Domestic television reception at 12 GHz for the ground sector in which a better than 4 dB noise figure is obtained for an all-FET receiver (made by LEP).
- A switching matrix for an SSTDMA space borne system which is a rapid (less than 50 ns), redundant (each channel has 4 possible routes), PIN diode 8 x 8 way matrix (THOMSON CSF).
- A description of the reliability test programme for components (the Space Components Coordination Group) which is supported by the French Space Agency (CNES) and has defined a set of test procedures which is applied to other applications (not only space) and is used generally in EUROPE and beyond.

INTRODUCTION

Three widely different aspects of solid-state technology in FRANCE will be described to illustrate certain facets of the immense effort being undertaken at the present time in all domains of space applications.

In the ground segment there is much activity to develope cheap T.V. receivers at 12 GHz following the French decision (with GERMANY) to launch a domestic T.V. satellite in 1983. LEP has made a prominent contribution in this field.

In the space segment there is need for a multiple access routing system with on-board switching capability which could be used to implement the new services envisaged for telecommunication satellites such as the TELECOM series. A particularly appropriate switching matrix has been developed for this purpose at THOMSON CSF [4]*.

In general there is the extremely difficult question of the high reliability needed for components particularly for space craft of course, but also for many earth-borne applications in the military telecommunications, medical and other fields where the same degree of reliability is required. It is always very costly to undergo different tests for each application and a unique and universal set of rules and procedures has been set up by the French Space Agency (CNES) in liaison with ESA (European Space Agency) and many different national organisations [5, 6].

LOW NOISE FRONT END FOR TV SATELLITE RECEPTION AT 12 GHz

There are two distinct approaches to front end receiver design either using mixer diodes or FET's as preamplifiers, mixers and local oscillators [1]. The LEP has always maintained that the FET version will inevitably win in performance and that the cost of even discrete devices will tumble down as soon as the quantities become sufficiently high. This is now supported by Japanese predictions of 50 cents a FET for large quantities [2]. The front ends built at LEP (see [3] for details) have now been extensively tried out in land links in FRANCE (PARIS and PUY DE DOME) and with the EBS satellite in JAPAN. The latest figures for this receiver are :

- noise figure of 3.3 dB, IF frequency 900-1300 MHz, conversion gain 32 dB, frequency stability of the local oscillator, ± 1 MHz, over - 20° to + 60°C.

The overall power consumption is 0.75 W. This receiver is largely sufficient for adequate reception either individual or communal, of national and neighbouring country satellites in the extensive European plans for the 1980.

HIGH PERFORMANCE SWITCH MATRIX FOR COMMUNICATION SATELLITES

This matrix uses specially developed technology to ease assembly and maintenance, and increase reliability. Its primary purpose is to switch 8 independant in-coming signals to any of 8 outputs using 4 possible routes.

It has applications, above all, in channel reuse in multiple access systems (FDMA or TDMA) and also in redundant switching of failed components. For TDMA it is necessary to be able to switch very rapidly with controlled path-to-path jitter for all 256 paths. The matrix consists of 4, 8 x 8 submatrices each of which has 8 x 8-way Wilkinson divider circuits (1 in, 8 out) on an alumina board. Each output passes through a coaxial PIN switch to one of 8 entries to a similar 8-way Wilkinson combiner. The 8 divider boards are stacked one on top of the other and after connection to the switches are connected to 8 combiner boards stacked in a similar way but turned through 90°. The heart of the matrix is in the PIN diodes their mount and the coax push-on connectors at either side of the switches. The original features are in the specially designed PIN diodes, coax connectors and circuit mounting technology. The main specifications are :

- maximum power consumption 4,5 W,
- switch speed 50 ns,
- interpath tracking jitter < 5 ns for all 256 paths over the bandwidth 3.7 to 4.2. GHz.

RELIABILITY COORDINATION PROGRAMME FOR SPACE COMPONENTS

A considerable effort has been undertaken in the last ten years to unify all reliability programmes in FRANCE and in EUROPE. The main motivation for this was for space applications since in general for space borne components only a small quantity is needed and yet a very thorough development programme is required to attain the necessary reliability. The components then become too expensive (both for the customer and for the maker). It was seen however that the same

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phenomenon occurs in other fields such as military and telecommunications so an investigation was undertaken to see if a unified reliability programme could not be defined whereby one component could be tested for all these high reliability applications [6]. The results have been even more successful than was first envisaged since this procedure is now applied to even such consumer markets as the car industry.

Apart from setting up a universal set of procedures, a concensus was obtained of working methods of reliability control in the main industry groups throughout the country. In general the control is made directly in the factory by an independent team (who is recognised by the customer) who controls each stage of production and carries out the find acceptance tests. An example will be given of how this works in practice on the production of a microwave device.

CONCLUSIONS

An overall survey of space component activities in FRANCE would be impossible in one paper but the three examples chosen here are intended to show typical developments in three different areas related to space technology.

In general one can say that this field has never been so alive and the 80's will probably see a whole new approach to the subject as satellite applications move into every day life.

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