# CIVIL APPLICATIONS WITH MM-WAVE MMIC's IN EUROPE

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## 1. INTRODUCTION/ABSTRACT

Although mm-wave MMIC's are relatively new components we have witnessed a significant progression of microwaves for civil applications in recent years. There are distinct advantages in moving higher in frequency once these components become available however and these will be discussed. Then we will see the availibility of MMMIC's (mm-wave monolithic IC's) at the present time and examine the specific needs of Europe and the rest of the world. The technologies that are being developed will be only touched on however as there are several invited papers already on the subject (M. BAYE, H. DAMBKES, A. CETRONIO) in this conference.

## 2. MICROWAVES IN CIVIL APPLICATIONS

Microwaves have long been present in professionnal electronics-military and telecommunications (ex. radio links). The advent of monolithic integrated circuits however has accelerated their introduction into the consumer market directly and indirectly by the lowering of the cost of hybrid circuits (a good example is DBS receivers). The most spectacular introduction of microwaves however is still to come : this will be the introduction of super smart cards that will enable unhindered passage of people, cars etc... with simultaneous indentification of the person or car, place, any debiting that needs to be done, and transmission of other information needed. An example ot this is in Figure 1 which shows a season ticket planned for an underground transportation system which debits its holder, accounts for distance travelled and time slots without stopping the passenger on the way out. Such a system illustrates the extent of the problem. It soon becomes obvious that the chosen frequency of 5,8 GHz (with a bandwidth of 10 MHz) is largely insufficient if one needs to account for all the passengers on an underground system in which case the bandwidth is not sufficient. The only possibility is to have a carrier at least 60 GHz and a banwidth of 1 GHz. The WARC 92 conference which took place in February drew some conclusions about the attribution of frequencies for these applications. This is not yet known at the time of writing but it is hoped that some information will be available for the oral presentation in April.

## 3. THE INTEREST OF MM-WAVE

The advantages of mm-waves can be listed in a general way as :

- High directivity for small antennas (but not too high as for IR systems) ;
- Wide bandwidths ;
- Rapid transactions ;
- Miniaturisation and low power consumption ;
- Multifunctions on one chip - small areas - less costly ;
- Discretion (above all around the 60 GHz absorbtion line) due to exponential attenuation rather than $1/D^2$ ;
- Less interference (fading due to reflexions) and man made noise.

These advantages are being put to practical use in such programmes as in ESPRIT (AIMS), RACE (Broadband Mobile System) and DRIVE (COMIS) which are the subjects of talks elsewhere.

The functions required by these systems are either one or two way communications between a moving person or object and a stationary beacon, or measurements of distance, speed and eventually temperature and chemical analysis of gases or radiometry.

## 4. EXAMPLES OF TECHNOLOGY USED IN MMMIC's

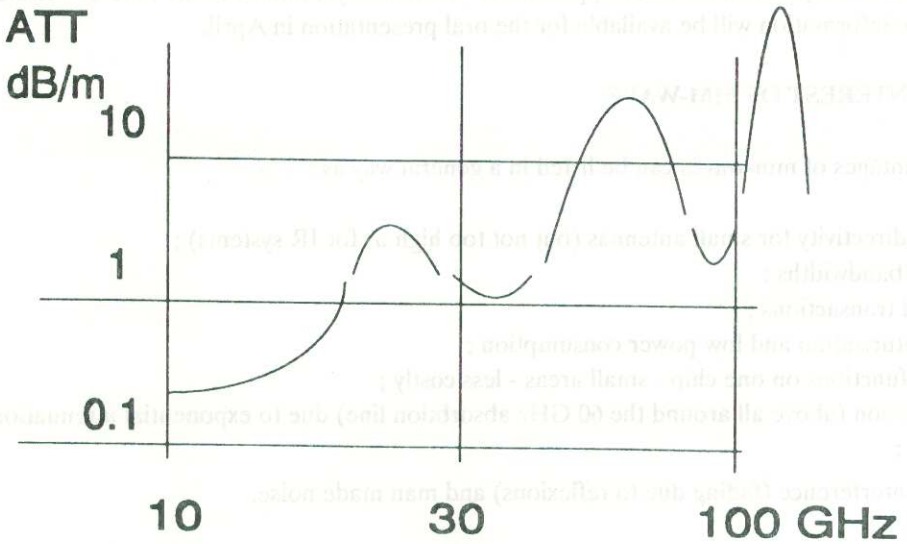
Examples will be given from four European manufacturers of potentially low cost technology for MMMIC's. It is based on epitaxial material, either MBE or MOCBD, and submicronic pseudomorphic HEMTS. No details will be given here (see the other articles on the subject) but it is important to point out that apart from the very sophisticated equipment that is needed for their manufacture these components are potentially as low cost IC's as MMIC's. The cycle time should be the same. The wafer cost is more but for high yield components this does not enter to a significant extent into the price. The importance of the manufacturability of the M3IC's is primordial. This is why such actions as AIMS and GIANTS were started over 2 years ago and the first results show that such promise can be realized. It is now a question of quantities which should enable the cost to follow the learning curve as previous IC families have done.

## 5. SOME APPLICATIONS OF MM-WAVES IN EUROPE

Some concrete examples will now be given of work going on in Europe in this field.

In most applications there are three frequency bands that are primarily used.

The two "window" frequencies in the atmosphere, 35 and 90 GHz, and the oxygen "absorbtion" frequency of 60 GHz. Figure 2 shows typical attenuation figures. Table 1 shows the main areas of applications in the three frequency bands which are envisaged in Europe. One can see the diversity of the applications which is by no means exhausted, all of these will be discussed in the talk. Some handware will also be shown although most of these projects are being developed at this moment for new systems for the 90's and after.




**Atmospheric Attenuation in air at mm-wave Frequencies**

**FIG. 2**

## 6. AKNOWLEDGEMENTS

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| | 30 - 45 GHz | 58 - 65 GHz | 78 - 100 GHz |
|---|---|---|---|
| **AUTOMOBILE** | | | |
| 2-way Communication | | X | |
| Collision Avoidance | | | X |
| Toll | | X | |
| **RAILWAY** | | | |
| Urban | | X | |
| Train control | X | | |
| location | | X | |
| **AIRPORTS** | | | |
| Airport Surveillance | X | | X |
| **AIRCRAFT** | | | |
| Helico Anticollision | X | | |
| Altimeter | | X | |
| **SPACE** | | | |
| V-Sat | X | | |
| Inter Sat Comm | | X | |
| **COMMUNICATIONS** | | | |
| Mobile links | | X | |
| LAN / Short hop links | X | | |
| **INDUSTRIAL** | | | |
| Robots / measuring | | | X |

**Table 1**
**SOME APPLICATIONS ENVISAGED IN EUROPE FOR M3IC CIRCUITS**

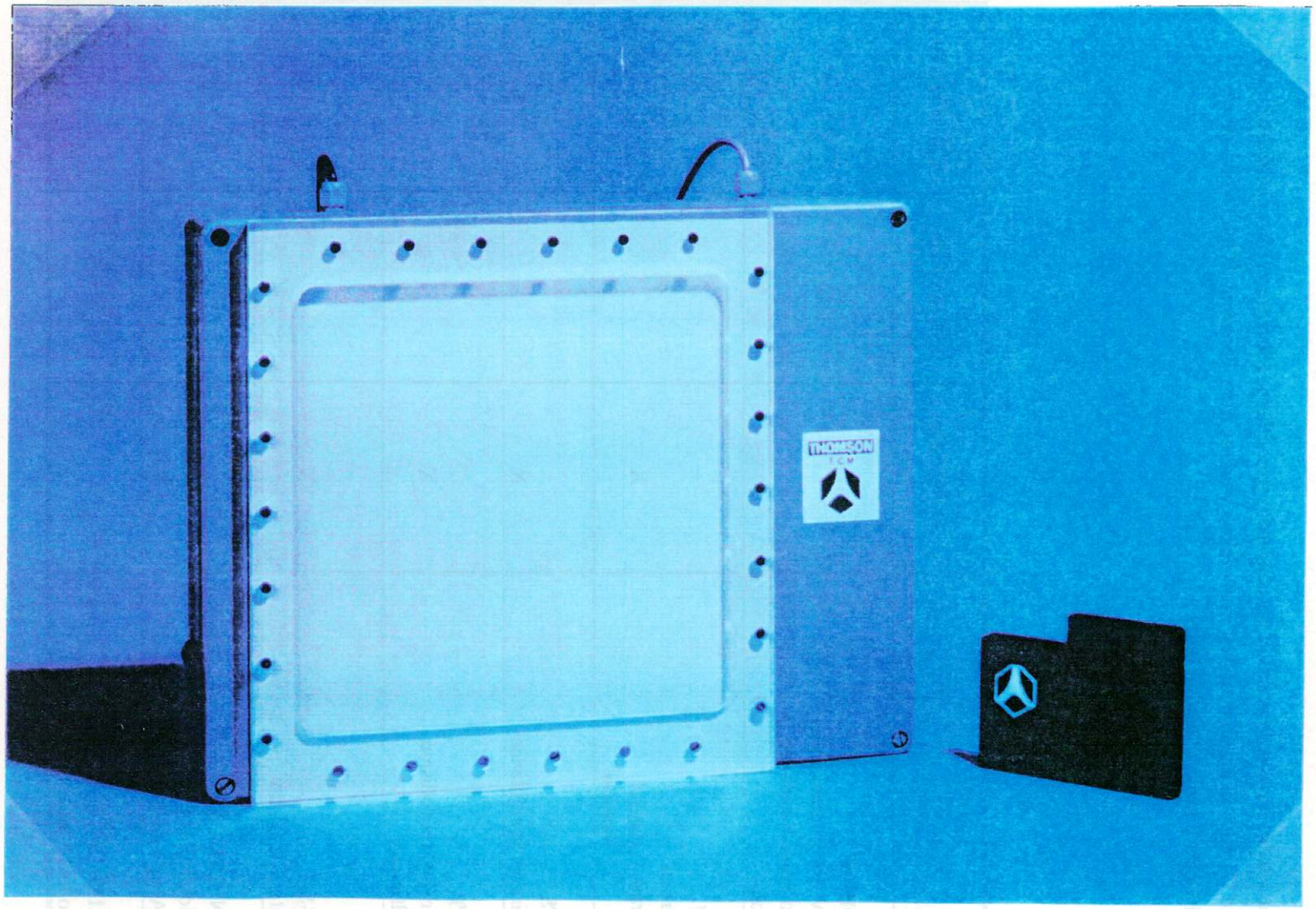


**FIG 1**
**AN AUTOMATIC DEBITING SYSTEM WITH BEACON AND BADGE FOR PUBLIC TRANSPORT**