COMMERCIAL GaAs MMIC APPLICATIONS in the UNITED STATES

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ABSTRACT

Commercial applications of GaAs MMICs in the United States are reviewed from both technology and market standpoints.

1. INTRODUCTION

Commercial MMIC development in the United States is a direct beneficiary of the 20 years of technology development for military MMICs. Beginning in the seventies, GaAs MMIC technology development in the U. S. was fueled primarily by the Department of Defense (DoD) requirements for advanced transmit and receive functions for phased array radar and ECM systems. Companies, such as TI, Raytheon, GE, Hughes, TRW and Westinghouse participated heavily in the DoD programs through contractual fundings.

As a result of DoD programs, many important technologies, such as 3 and 4 inch substrates, CAD tools, 0.4 um fine line wafer stepper lithography, state-of-the-art low noise and power FET devices were developed. These technologies are equally useful for commercial applications as they are for military applications. Furthermore, the 2,000 to 3,000 MMIC technical experts, trained and nurtured by defense programs, become the cornerstone upon which a thriving commercial MMIC market can be built.

With DARPA's seven year (1987-1994) U.S. $568 million MIMIC program going strong, DoD's requirements continue to maintain technological strongholds. However, commercial applications -- beginning in 1985 when Pacific Monolithics launched a down-converter MMIC for C-Band television receive only (TVRO) low noise block converter (LNB) applications -- gathered momentum in 1988-1989 and has since gained a more important role. Companies such as Alpha, Anadigics, Hittite, Hughes, ITT, MACOM, Motorola, PCSI, Pacific Monolithics, Qualcomm, Rockwell, TI, Triquint and Vitesse, are heavily engaged in the development of commercial MMICs.

2. SYSTEM BUILDING BLOCKS

In Figure 1, a block diagram of a super-heterodyne receiver front end is provided. An incoming RF signal is amplified by a low noise preamplifier. A band pass filter (BPF) is provided between the preamplifier and the mixer to reject image signals and to preserve the system noise figure. The mixer and oscillator convert RF frequency into IF frequency. For downconverter application, the IF frequency is lower than the RF frequency while for upconverter application, the IF frequency is higher.

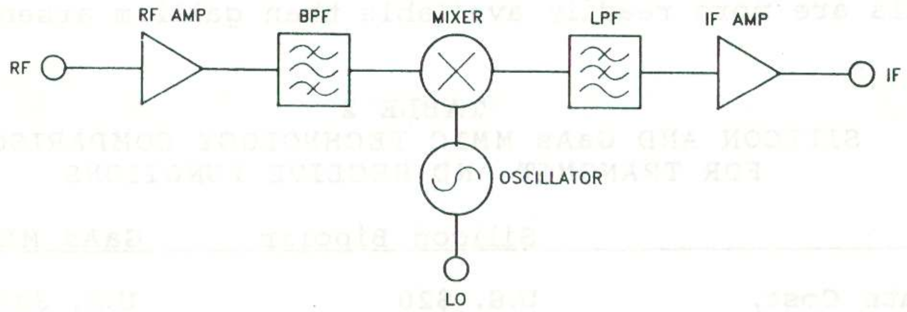

Figure 1. A Block Diagram of a Receiver Front End

A receiver front end for SONET is provided in Figure 2. The light signal is detected by a photodiode and the electrical signal is amplified by a transimpedance amplifier (TIA) which serves as a low noise preamplifier. The signal is again amplified by an automated gain controlled (AGC) amplifier and limiting amplifier before being retimed and regenerated.

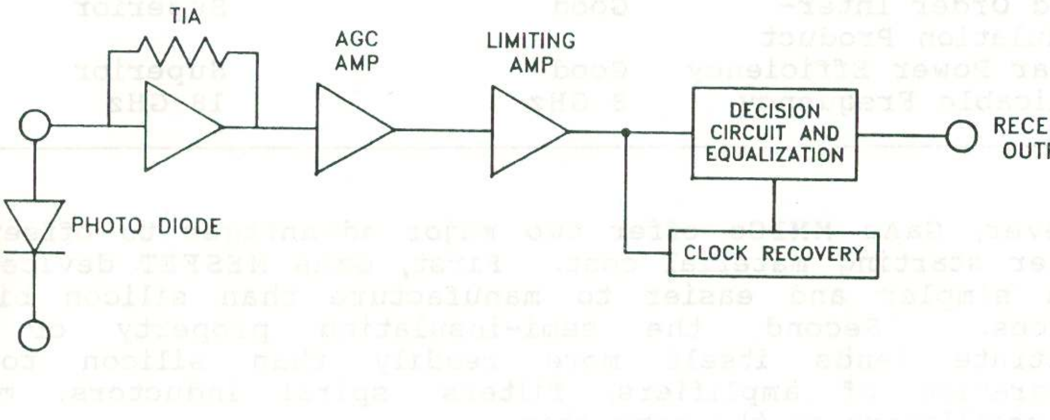

Figure 2. Sonet Receiver Front End

10 channels of television programs and uses a three-foot antenna dish. The broadcast frequency band is 11.7-12.2 GHz.

By the end of 1991, Primestar's dish-installed customer base was less than 100,000, which certainly trails the 2,100,000 installed bases in the U.K. and the 4,500,000 in Japan. This situation will likely change when Skypix (80 channels, three-foot dishes, 11.7 -12.2 GHz) launches its service in 1992 and when Hughes launches its DirecTV service in 1994, (150 channels, two-foot dishes, 12.2-12.7 GHz). Both Skypix and DirecTV will use compressed digital video technology so that between four to eight TV programs can be transmitted from a satellite transponder.

GaAs MMIC technology played a major role in these developments. Anadigics offers a downconverter MMIC (AKD12010) for outdoor dish and a tuner IC (ADC20010) for the IRD. AKD12010 covers the entire 11.7-12.2 GHz band and provides a 35 dB conversion gain with a 5.0 dB noise figure. ADC20010 covers .95-1.75 GHz band and offers a 9.0 dB conversion gain with a 8.0 dB noise figure. Both ICs have RF amplifier, mixer, local oscillator, image rejection filter and IF amplifier integrated on a single chip. The production quantity for each IC in 1992 is in the range of 200,000 to 300,000 per month.

5. VSAT

Demand for VSAT is approximately 200,000 per year. The VSAT receiver specification is similar to that of the DBS but has a more stringent phase noise requirement. As a result, when using an AKD12010, one may elect to use an external oscillator and bypass the on-chip oscillator in order to meet the low frequency stability requirements.

6. WIN and LEO

Motorola's wireless in-building (WIN) communication system and IRIDIUM, a space-based global phone system using low earth orbit (LEO) satellites will be candidates for high volume GaAs MMIC applications. WIN is an 18 GHz wireless in-building local area network (LAN) that will require GaAs MMICs for both transmit and receive functions. IRIDIUM will need a 1.6 GHz receiver MMIC for the telephone handset.

In 1990, Motorola launched an U.S. $100 million GaAs IC foundry investment in order to meet its high volume system requirement. The foundry is expected to deliver its first products during the summer of 1992.

7. GPS and CELLULAR/CORDLESS TELEPHONES

Starting in 1974, Rockwell began work on the DoD GPS program. In late 1990, Rockwell received a contract to produce miniaturized airborne GPS receivers (MAGR) using custom GaAs