1.0 INTRODUCTION

Are your company's equipment requirements being driven by the need to decrease weight and increase density while achieving optimum performance? If so, you are probably using or considering the use of hybrid microcircuits or multichip modules (MCMs). Hybrids evolved due to their ability to satisfy volume restrictions and to integrate various technologies. While MCM features include the aforementioned hybrid attributes they are predicted to achieve even better electrical performance characteristics. At this point in time MCMs are also projected to provide the highest yielding form of technology integration.

The need for hybrid microcircuits arose from WWII requirements to reduce the size of electronic assemblies. The first effort, completed in 1944 by the National Institute of Standards and Technology (NIST) (formerly National Bureau of Standards (NBS)) and Centralab Electronics Division of Globe Union, developed a proximity fuze circuit for advance weapons. This device included screen printed conductors and resistors, discrete capacitors and miniature vacuum tubes mounted on a steatite ceramic substrate. Many improvements have resulted from this first simple circuit including well controlled, performance driven thin and thick film technologies to satisfy various military, medical, power and high frequency applications. Their usage, reliability and complexity have steadily increased since inception. An early commercial utilization was the development by Zenith Electronics Corporation of a thick film television tuner circuit in the 1960's. This device used thick film conductors and resistors delineated on a ceramic substrate. The development and use of varicap diodes allowed the use of this device in television receivers into the 1980's.

The dollar volume projections for hybrid microcircuits and MCMs will rise throughout the 90's. Discussion with MCM vendors indicates that costs for expensive technologies used in military applications will decrease as they move into high volume consumer products. It must be recognized that DoD program cuts have taken their toll. However, the features that led this technology development, plus the availability of mature design techniques, long term reliability and stable, baselined fabrication processes and facilities will continue to require their use for many applications (see Table 1). The automotive industry will provide the impetus to lead the growth of the hybrid/MCM market over the near future with the need for voltage regulators, ignition/engine control modules and sensors. Additionally, TechSearch International

Inc. forecasts the use of flip chip integrated circuits will double in the next six years. They will be used in various hybrid/MCM applications with a total of more than 1 billion flip chip integrated circuits projected for use. Figure 1 provides a breakdown of their use by commodity area.

Table 1: Hybrid and MCM Applications

• Electronic assemblies (power supplies, PCs, camcorders, aircraft electronics, medical equipment)
• Ruggedized packaging (automotive, military)
• High frequency applications (communications, radar)

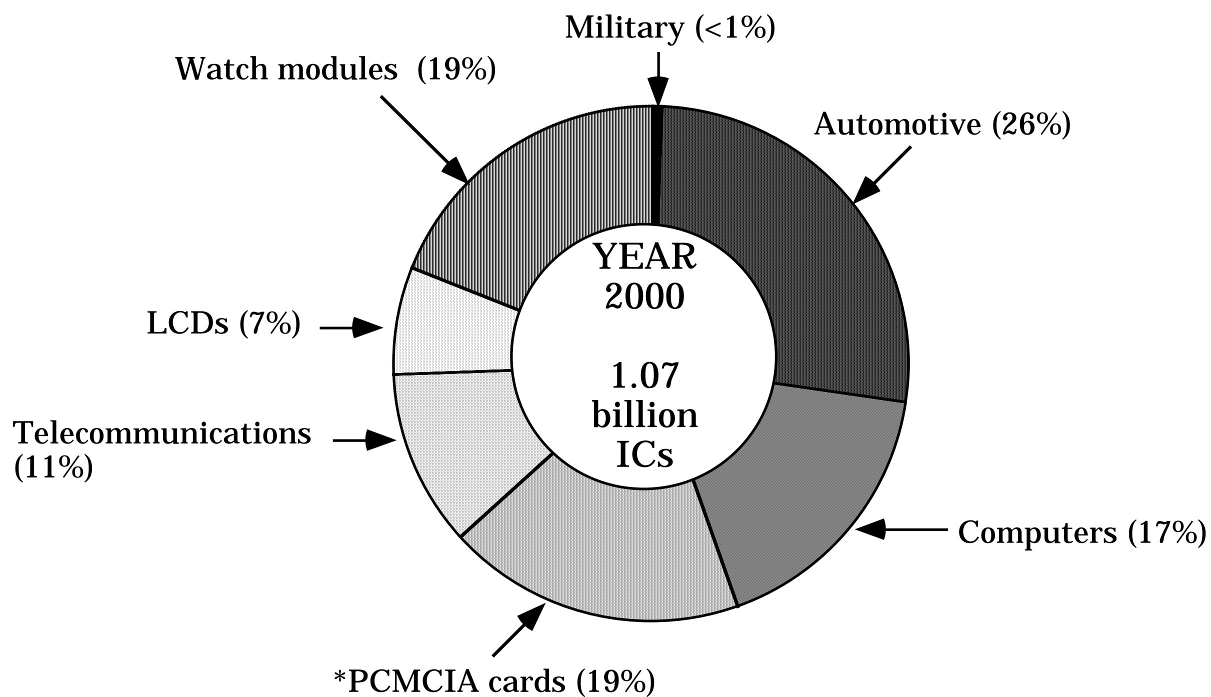

Figure 1: Flip Chip Usage by Commodity Area

* Personal Computer Memory Card International Association (PCMCIA)

A hybrid, defined by Webster as "something heterogeneous (i.e., consisting of dissimilar constituents) in origin or composition," can be used to describe either a hybrid microcircuit or a MCM. Controversy exists today over what the correct name of this packaging technology is, hybrid or MCM. MCM technology is also the latest device type to sound the death knell for hybrid microcircuits. This started with integrated circuits (ICs), especially linear types, followed by complex ICs and RF/microwave analog circuits supporting the argument that monolithic structures would be more reliable and cost effective. Also in some circles, MCMs are defined as the complex structures while hybrids are limited to those devices having 2 or 3 components. Regardless, there are still valid reasons for designing and using hybrids or MCMs, whether it be for:

- Packaging benefits (size, volume)
- Technology mixing (Si, GaAs)
- Performance (chip to chip capacitance)
- Circuit density (active devices/unit area)

Hybrids and MCMs will be a key ingredient in new equipment developments because they will continue to effectively interconnect the latest monolithic technologies providing optimum performance.

This report will provide guidance for the selection, test and use of these packaging approaches (hybrid microcircuits or MCMs) in commercial, medical, industrial and military applications stressing control of the selected packaging technology. However, when hybrids or MCMs are considered for use several important features must be considered. These devices will include various types of components with varying complexities. Hybrids will usually contain many different types of components while MCMs will have fewer, but more complex device types. It is therefore necessary to have familiarity with all types of components to adequately specify, procure and test these devices. Additionally, since these devices usually must satisfy custom or first time use, nonrecurring costs such as design, layout, special packaging and electrical characterization will be encountered. The designer will probably be faced with a single source due to technology constraints or low procurement volume. Additionally, from a performance point-of-view, device operating modes that are not tested, but which are identified as failures at first board test or system insertion can create problems.

Therefore emphasis must be placed on developing a workable test strategy that ensures schedules, budgets and device performance requirements are met. These factors must be considered when decisions to use multichip packaging are made.