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FLEXIBLE SINGLE CHIP SOLUTIONS FOR HIGHLY INTEGRATED MINIATURIZED SPACECRAFT

Abstract

The developments in space technology depend on and benefits from the developments in terrestrial technologies. An example is the introduction of transistors and integrated circuits (IC) which changed the design of electronics systems of space vehicles from vacuum tube based to transistor based design. Introduction of microcontrollers and microprocessors opened new horizons in the design of control systems and algorithms.

In addition the current trend of commercialization of space missions calls for multi-purpose, flexible, powerful and low cost solutions. Subsystems and sensors of these spacecraft should meet more stringent criteria such as lower power, smaller size and mass in addition to the environmental criteria for space applications. This paper discusses the potential of new consumer / automotive IC technologies in new generation space missions. Also we will introduce specific ICs which we have designed and successfully simulated to be used in low-cost spacecraft.

Communication and navigation are two main functions existing in almost all satellites. Designing each subsystem separately and using separate printed circuit boards (PCB) for each of them increases the size of the satellite. These new IC technologies provide the opportunity to combine all subsystems in a single package and reduce the size and mass while the saved volume can be used to increase the functionality of the satellite. Study shows that using the complementary metal-oxide-semiconductor (CMOS) IC technologies with transistor feature size (gate length) of less than 0.18 μm are practically radiation tolerant.

In order to be able to combine different functions, each subsystem is designed as an IC design library. An IC design library is a miniaturized design of a fully functional subsystem which is ready to be used in a chip. The complete chip will be constructed by putting these libraries next to each other and connect them.

As a proof of concept, we have designed four library components. The Class E amplifier and high efficiency amplitude modulator are two library components which together make an efficient amplitude

controlled power amplifier. The OLFAR active antenna receiver is a very low frequency receiver which uses the same antenna as the satellite transponder. And, finally, the GPS/Galileo receiver front-end is designed to use both GPS and Galileo navigation systems for satellite navigation.

This combination of communication, navigation and sensor libraries gives us a highly miniaturized, highly integrated and flexible chip which has a total area of less than 1 cm^2 and a mass of few grams.