MIXED SIGNAL ASIC DESIGN FOR AUTOMOTIVE AND INDUSTRIAL APPLICATIONS

H. Casier
Mietec Alcatel, Brussels, Belgium

ABSTRACT

This paper describes the special aspects of mixed signal design in the ASIC environment. The knowledge of the application specific environment and of the function of the ASIC can be used advantageously to lower the cost and to enhance the performance at all levels of design. Several examples of this cost improvement and performance enhancement at device, circuit and system level are shown.

1. INTRODUCTION

The design of a mixed signal ASIC circuit for e.g. automotive or industrial applications shows two major differences in comparison to the design of a mixed signal Standard Component circuit. First, the environment of the ASIC circuit is very specific and well defined whereas the environment of the Standard Component is very general and undefined. Second, the ASIC circuit is tailored to the required function and specification whereas the Standard Component is designed to be very versatile and has a broad range of applications. Both ASIC circuit and Standard Component are designed for the lowest cost per function.

The well defined environment of the mixed signal ASIC circuit can be used to simplify the circuit design and lower the ASIC cost, but this can also be used to optimise the partitioning between the ASIC circuits and the surrounding components e.g. an integrated high peak current output driver can replace an external driver transistor or an input protection circuit can be integrated to replace external components. In both cases, the ASIC cost is increased but the total system cost is reduced. The well defined environment can also be used to implement extra features, which would not be possible in the general environment of the Standard Component.
Component e.g. the automotive lamp failure detector requires a comparator for voltages above or below the supply voltage. This can be done in an ASIC by using the car battery itself as supply for the comparator and by providing adequate input protection for the harsh Schaffner voltage peaks on the car battery.

The ASIC circuit is also tailored to the specific application and is designed to fulfill the required functions and specifications at the lowest cost. The lowest cost of an ASIC circuit means: a low production cost of the chip and surrounding system combined with a short design time and time to market. Such ASIC time schedule and cost objective does not allow to design world record new circuits, which require many design iterations and an optimised technology, tuned to the new product. As a result, the individual circuits on a mixed signal ASIC chip lag, in general, the specs of available state of the art standard components and they are produced in a standard, stable technology. However, since the mixed signal ASIC is tailored to the specific application, it allows a larger integration density compared to the Standard Component and in many cases, the whole system is integrated on a single chip. Besides the obvious cost reductions of this system integration, it also allows the ASIC designer to design at the system level. This system level design together with the application specific knowledge often results in innovative design concepts and superior performance of the mixed signal ASIC system.

In conclusion, both the specific and well defined environment and the specific and well defined function of the mixed signal ASIC circuit are used advantageously to lower the cost of the final system. The same application specific knowledge, in combination with the system or circuit rethinking is also often exploited to enhance the performance of the system. Both cost lowering and performance enhancement are achieved at all levels of design: device/technology level, circuit level, ASIC system level and full system level. In the paragraphs below, several examples of these effects at different levels are shown.

2. Low cost device at the technology level

This device is a simple voltage reference circuit, based on technological properties. In analog CMOS processes, sometimes transistors with different threshold voltages are available. This threshold voltage difference is the result of a well controlled additional implantation in the active region of the transistor and can be used as a simple and reasonably stable voltage reference (fig. 2.1).