Keys to Successful ASIC Design: Part 1

Francisco Tejada, PhD.

Introduction

There are multiple keys to having a successful ASIC design cycle. This paper will present what this author considers the most important. An overview of the cycle is shown in Figure 1. At every stage there are important considerations which interact with other stages. Communication between the designer and customer through the whole cycle is important so that issues can be discussed and resolved.

System Specifications and Architecture Overview

The first step in the ASIC design process is to determine the functionality needed for implementation. ASICs may implement something as simple as a filter with gain, or some digital function. Complex ASICs may contain analog and mixed signal components along with digital signal processing to implement a complete system. These complex systems are often called a System on a Chip (SOC).

Once the design functionality is well defined it is good to outline how the functionality will be implemented. As an example if an analog to digital converter is required as part of an SOC then determining the type of converter architecture is necessary. As the design implementation is solidified the inputs and outputs to the system should also be defined.

The pin count is an important consideration in the beginning of the process so that packaging can be planned. One often made mistake in the ASIC design process is ignoring the packaging until the design is almost complete. This can cause major headaches in the design.

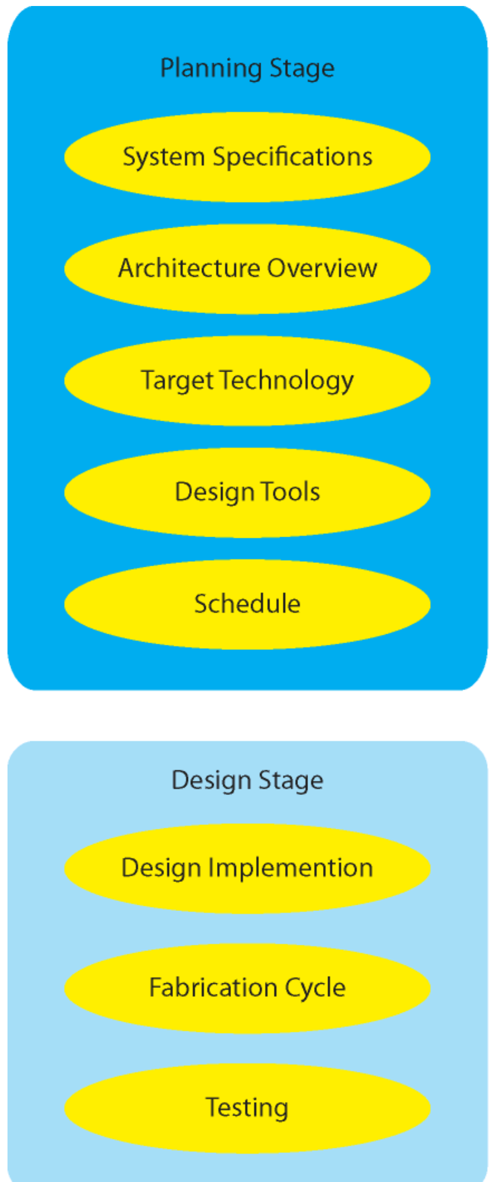

Figure 1 –ASIC Design Cycle

Technology, Tools and Schedule

Once the design is well defined there are three choices which go hand in hand. Choosing the fabrication technology, identifying which CAD tools to use and creating a realistic schedule for completion.

There are a wide range of fabrication processes currently available ranging from older processes with larger feature sizes (1.0 – 0.25 microns) to state of the art processes with fine feature sizes (0.18 – 0.06 microns). One rule of thumb to keep in mind is a finer feature size process is usually more expensive for a fixed amount of area. A purely digital chip that requires high frequency clocking or a high transistor count will benefit from a newer process because more transistors can be packed into the same area. An analog system can usually be implemented in a larger feature size process without penalty because analog components do not necessarily make use of smaller feature sizes. Operational Amplifiers, for example, require large area transistors to reduce noise and increase drive for many applications.

Many processes have options to change the front and/or back end processing during fabrication. Changes to the front end can add different types of MOSFETs or additional polysilicon layers. Changes to the back end can vary the number of metal layers available for routing or add more types of passive components such as capacitors and inductors. The use of these options can be tailored to meet the design requirements.

The targeted technology can determine the CAD tool in certain cases. Usually the foundry will supply a design kit for the process. The design kit gives the designer all of the files needed to simulate and verify the design. Design kits are built for specific CAD tools and foundries usually supply kits for a single CAD tool. One caveat is that many times the design kit requires the use of tools from multiple vendors in order to perform the complete design cycle. For example the design kit will provide simulation and layout primitives for one CAD tool while providing the verification files for another CAD tool. Fortunately when this is the case the foundry usually chooses CAD tools which can communicate which each other even though they are from different vendors. One issue that remains is the high cost of industry standard CAD tools. It is not uncommon for tool cost to be on par with engineering time cost.

One alternative to using the foundry supplied design kit is getting a design kit from the CAD tool vendor. Many of the smaller and more affordable CAD vendors will supply their users with toolkits for various foundries in order to gain customer usage. Many of these vendors have design kits for frequently used processes on hand. The other alternative is to build the design kit internally. This can be done for any CAD tool but it is mostly done with free tools that come with little support. Some designers have kits prepared for lower cost tools that they can bring to bear on a project. This is helpful when a project has a limited budget which can not support the use of the industry standard tools.

Having a proper design kit is critical to a successful design. The design kit should give you the ability to simulate the functionality of the design, run a design rule check (DRC) on the layout for violations, extract (EXT) the layout into a netlist and compare the extracted layout versus the schematic (LVS). One last important function is the ability to extract the layout with parasitics for re-simulation. This will be discussed in greater detail later.

The schedule should be determined by the designer. However in practice the customer often has a deadline in mind. It is very important not to rush the design cycle. Rushing the design often results in a product that does not function as intended. A consideration in determining the schedule is the available fabrication dates. Depending on how the design is going to be fabricated there may be submission dates only once every several months. This is determined by the foundry. It is important to start a project early to hit a specific run deadline.

Look for Part 2 of this article where we discuss Best Practices in the Design Process