"Improve Design Quality Through Early, Focused Verification Testing"

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Introduction:

Human nature is a constant thorn in our sides. If only it was easier to do the right thing all the time instead of what is easiest. We know that we should watch what we eat, exercise, not drink too much and think before we act, but very few of us consistently follow these guidelines.

Since engineers are humans too they often succumb to the perils of ease. Some may gamble that by implementing a design specification along with a healthy dose of hard-knocks experience that the finished product will have a reasonable probability of success. The downside of the risk can be catastrophic to a product line and a company. Missing a market window, trailing revenue goals, redistributing resources to fix a problem, holding off potential customers, etc. can reek havoc with any company's resources and leave a trail of unhappy customers and employees.

The odds can be tipped in favor of a successful design by shifting design validation from the end to the beginning of the development cycle. Validation is only useful if you have the time in the development cycle to understand and integrate the results into the design. It is often very costly to make substantive changes late in a design cycle, so amendments are often avoided. Change in behavior can be hard work and it does not help that performing complete design validation is a detailed, methodical and time-consuming task.

The answer to this challenge is to utilize design methodologies and tools to hybridize and *focus* verification and "what-if" analyses early in the design cycles, without hindering the development schedule. Industry standards such as ATCA and various design tools, such as F9 Systems ATCA analysis products can assist engineers' early design validation activities. This article will focus on the utilization of these types of solutions.

The Big Picture

As companies vie to develop new products quickly the constant tradeoff between the time and cost of innovative internal design versus the need for verified quality and reliability continues to be a problem.

New specifications such as ATCA have attempted to address this situation by defining such things as physical and electrical requirements for enclosures, logic modules and backplanes. Adoption of these specifications allows companies who specialize in chassis or logic card design to concentrate on their core competencies and begin development without having to wait for the other components to be readily available. The result is that products can be available for sales sooner at a reduced development cost. In addition, full compliance to the current and future versions of standards allows products to be available for sale longer. All of these benefits should yield a greater financial return for the development effort.

However, before these products can be released they need to undergo extensive evaluation to insure that the intended specifications and regulatory requirements are met. This is time consuming and technically challenging since it can be like solving an equation with too many undefined variables.

For example, the enclosure developers must verify the thermal and signal integrity characteristics of their product before the product can be released. This includes all possible combinations of components and fault conditions. Conditions such as power dissipation per slot, effects due to unused slots, and number and type of air movers must be evaluated. Since few companies develop all the components required for a complete system there is often a problem of how to insure verification for the early adopters.

To address this problem the early developers have a few choices. Simulation analysis may be undertaken as one alternative. For example, CFD analysis can be performed to insure that the chassis provides adequate cooling for all the fault conditions and component choices. In order for CFD to be utilized for a new design, system models must be created and verified. Validation of these models generally requires that prototypes be made for all the components. This is time consuming and redirects engineering resources from the primary goal of getting the product completed and released. While this may be a reasonable possibility for an enterprise that has made this investment, it is cost and time prohibitive for companies who do not have the tools, expertise, or funding to complete such a rigorous program.

Signal integrity analysis can be even more difficult than thermal analysis. While tools are also available, the level of expertise required to obtain valid results is quite high. Simulation models must be created and verified, interconnect characteristics understood, material choices, layout and fabrication rules must all be considered and blended for optimum design choices. There are many signal integrity tools available and these tools are complex to use and require considerable experience to prevent a solutions that "appear" correct yet are not an exact representation of the actual system. In the end, it comes down to understanding whether the input *and* output is correct and what to do with the results. Again this is usually beyond the capabilities of many specialized companies because signal integrity analysis is not a core competency of most product development teams. Adding this capability to the development program is expensive and adds risk to releasing the product on a predictable schedule.

Focus on the Essential Design Parameters

Since there are many analyses alternatives and no silver bullet, early design verification can succeed if analyses are focused on crucial design parameters. Accounting uses an Acid Test ratio to quickly verify a company's viability. Engineers can perform a similar series of tests on their products early on by focusing on key areas such as thermal and power dissipation, skew and connectivity (TDR) and signal impedance (TDT). This allows early insight into the component and system characteristics, focus design efforts and help insure that the products will operate as intended and meet the required design specification requirements, such as ATCA.

For example, the ATCA specification requires dissipation of 200 watts per slot under all airflow conditions. Understanding all the requirements and combinations of slot population and fan failures can be a daunting exercise. Creating and running the permutation of combinations in a simulation program requires a significant investment of an engineer's time. Instead, by using an off the shelf thermal and power analysis blade such as F9 Systems's ATCA ThermalBlade, as a stand-in for an ATCA logic card, that mimics the heat dissipation, air-flow and component heights of a typical logic modules, an "Acid Test" for operability and specification compliance can be performed. Baseline fans may be turned on and off, power and thermal dissipation can be adjusted to simulate differing conditions and measurements can be taken. Using the resulting data engineers can verify the margin of thermal capacity, airflow resistance and the thermal profile of their intended chassis as a function of power and fan blower type. In any slot, they can detect on-card hot spots and thermal eddy points where component temperature limits might be exceeded. This type of testing provides engineers with the benefits of early design verification as well as the advantage of "what-if" analyses. The focus on key design parameters, such as those discussed above, enables engineers to make thoughtful, concise design decisions and revisions without damaging affects to budget and schedule.

In a different example, an engineer may need to verify whether a backplane meets the ATCA matched delay requirement (otherwise known as skew) of 17 ps within a channel. This is just one of the many requirements a product must adhere to if it is to be considered ATCA compliant. Assuming logic cards for the system are not readily available, a designer can either wait until they are fabricated, or develop a stand-in test card that has exacting signal integrity to insure the measurements taken will be for the device under test and not the test equipment or connector system. This may not be feasible due to engineering resource capabilities or the time and funding involved in such a development. However, by using an off the shelf test card, such as F9 Systems's Tx/Rx SignalBlade, as a stand-in for the missing logic cards, an "Acid Test" for operability and specification compliance can be performed. By performing Time Domain Transmission (TDT) through the stand-in logic cards that populate the backplane slots, measurement delay of transmit or receive channels can be performed and analyzed to provide the match delay results. In addition, by measuring the propagation properties of the channels on the backplane (through the stand-in logic cards), a good, basic understanding of the backplane's signal fidelity can be gained. An engineer can drill down a bit further using the F9 Systems Tx/Rx SignalBlade to understand if their backplane was constructed properly and if there are any discontinuities or faults on the board by performing Time Domain Reflectometry (TDR) by analyzing signals through connector pins as they relate to layers of etch. This type of what-if analysis can prevent the fabrication of faulty systems and save a company from a costly mistake. Through focusing on essential areas of interest, an engineer can verify key parameters early in a product's design cycle.

Summary

The prime focus of every development company is to get their product into the market as quickly yet reliably and inexpensively as possible. By changing design habits and shifting design verification early in the design as well as focusing on the verification of the most significant design features, the chances of a successful product launch increase dramatically.