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White Paper

Circuit Analysis Success Stories

5110 Roanoke Place, Suite 101 College Park, Maryland 20740
Phone (301) 474-0607 Fax (240) 757-0053
www.DfRSolutions.com

Circuit Analysis and Simulation: Ensuring Successes and Resolving Catastrophes

Industry Best Practices

Those who interact closely with DfR realize that we proscribe to the theory of the Industry Best Practices. Trying to implement Best Practices can be challenging as there are 'buffet' of choices available and you and your colleagues must select those that are most appropriate for your product and your company.

However, even among this wide range of activities, there are three basic similarities

- Pushes analysis and simulation earlier in the product life cycle and farther down the supply chain
- Obtains fundamental information: the when, how, and why
- Implements feedback loop (i.e., continuous improvement)

Circuit Analysis and Simulation

Developing a fundamental understanding of the functional performance and limitations of an electronic circuit is an excellent example of a Best Practice. This is especially inline with Toyota development engineers, which can be four times (4X) as productive as their industry counterparts. They are able to accomplish this level of efficiency because of their focus on learning as much as possible at the lowest design level and using that knowledge to develop technology that can be used appropriately in future designs.

The case studies on the next page are an excellent demonstration of where our clients used Dr. Ron Wunderlich to implement Industry Best Practices for ensuring circuit performance. An especially powerful tool was Monte Carlo and worst-case simulation. In all cases, by being involved early and often, our customers saw significant reductions in development time, development cost, and avoided significant field issues.

On the following page, are examples where our customers did not follow Industry Best Practices. Unfortunately, these case studies are more about cleaning up and moving forward after major field issues.

Circuit analysis and simulation by an expert third party becomes even more critical as more and more electrical design is outsourced to low-cost countries. For more information about our circuit analysis and review services, please contact Ed Dodd (edodd@dfrsolutions.com) or Ron Wunderlich (rwunderlich@dfrsolutions.com)

Ensuring Success

Customer requested an examination of a transformer that was contracted to a second source in a low-cost country. After reviewing the design and taking it apart, it was discovered that the primary winding was too small and would cause overheating. This was later than verified on the bench. Since then, the 2nd source vendor has redesigned the transformer. Made suggestions to the customer how to avoid issues like this in the future.

When performing a final circuit review before production, we discovered that two power supplies being used were going to overheat in certain applications. Initiated an additional bench test, which confirmed the analysis. Provided recommendations on how to avoid the problem. While a success, if the customer had brought us in before prototype, could have saved the time and resources needed for an additional board spin.

A customer asked us to review a GFI/Thermostat circuit that contained a power supply and a processor. This design was outsourced to a vendor in a low cost country. Several design issues from a safety perspective were noted. After talking with the vendor, it was discovered that they where not aware of safety requirements, such as UL. If this design had been released to the public, there could have been safety issues and possible litigation.

Resolving Catastrophes

Customer was seeing failures with a PWM IC for a 24V to 5V isolated switching power supply. The root cause of the failures was due to the PWM IC going to a wide duty-cycle at start-up and saturating the transformer. The problem was resolved by redesigning the transformer to saturate at a higher current and was still able to fit in the same foot print.

Customer was spending several weeks in trying to resolve an EMC issue they were having. This was preventing them from not meeting FCC Class B regulations. In working with the customer, we were able to meet FCC Class B with margin **and** reduce the price of the current EMC filter. This was only possible through a detailed knowledge of switch mode power supplies.

Customer was having problems with some of their units in the field showing an oscillation on some of their analog outputs. The problem was traced down to the internal op-amps oscillation due to a capacitive load. The problem was resolved by creating a simulation model of the op-amp showing the oscillation and then compensating them to have sufficient phase margin under all conditions.

Customer was having an issue passing EMI and was causing them to slip their release date. The root cause was the circuitry's response was much higher than the signals they were amplifying. This problem was resolved by limiting the amplifier response along every stage in the circuitry and improving the layout where needed.

At each new revision of a design, fallout was getting worst. The root cause was the PLL on the CPU was jittering due to noise and the RS-485 communication bus then would lose sync. This was resolved by the relatively simple solution of replacing a high ESR tantalum capacitor with a low ESR ceramic.

Customer was seeing erratic behavior of their power modules in the field, but not in their lab. Root cause was that the power supply circuits were marginally stable and the load in the lab versus out in the field was slightly different. The problem was resolved by re-compensating the power supply and using simulation to verify that's its stable under varying load characteristics, which was virtually impossible to do on the bench

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