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REPORT

TITLE:

Fixing Reliability Issues of Existing Thermal Printer Electronics

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1 Abstract

The objective is root causing the reliability issues in the HW/SW part of a thermal A6 printer unit being part of widely applied complex system. As the printers were already located in the field application, a board redesign was no option; only the software and firmware of the processor and programmable logic device of the printer electronics could be altered. Three major design flow shortages popped up immediately: The design was *poorly documented* and was *not up-to-date*, there were *no DFT structures* in place to run tests and diagnostics on the system and last but not least, there was a *poor communication* between the software and hardware team of company A (being the company that originally developed the system). As company A was not able to fix the issues, a third party consultant/design house (Q-Star Test) was selected to fix the bugs causing the printer to behave unreliable. The key in solving the issues was identifying and fixing the three shortcomings listed above. By doing so, the printer design was turned into a robust system that is easily tuneable. The new design also allowed to fix the print quality issues of which the old design also suffered but that could not be fixed due to the same three short comings identified above.

2 Background

Figure 1 shows the system block schematic of the printer unit. The printer electronics (MCU & CPLD) communicate with a main frame computer over a USB bus. The printer exists of several motors that are controlled through a central MCU, a small switch panel, a thermal print head and several sensors that provide info concerning the state of the printer. All necessary protocols for driving the motors and thermal print head are implemented in a CPLD that is located in between the MCU and print head, motors, switch panel and some sensors. The MCU takes care of the high level communication with the PC, schedules the data stream to the CPLD and reads status information of the CPLD and various other switches and sensors.

The software part for the MCU was designed by the software department of company A. The firmware for the CPLD was designed by the hardware team of company A.

As the printer electronics are already largely present in the field application, a board redesign was not an option. All problems are to be fixed by modifying the software and firmware of the processor and programmable logic device. The unreliable behavior costs company A a lot of money as field replacements were daily business. It was essential to fix these issues fast and reliably as such issues affect the name and business of the company. Several attempts made by company A to resolve the issues did not yield proper solutions. As company A was not able to solve the problems, Q-Star Test was hired to consult and fix the problems.

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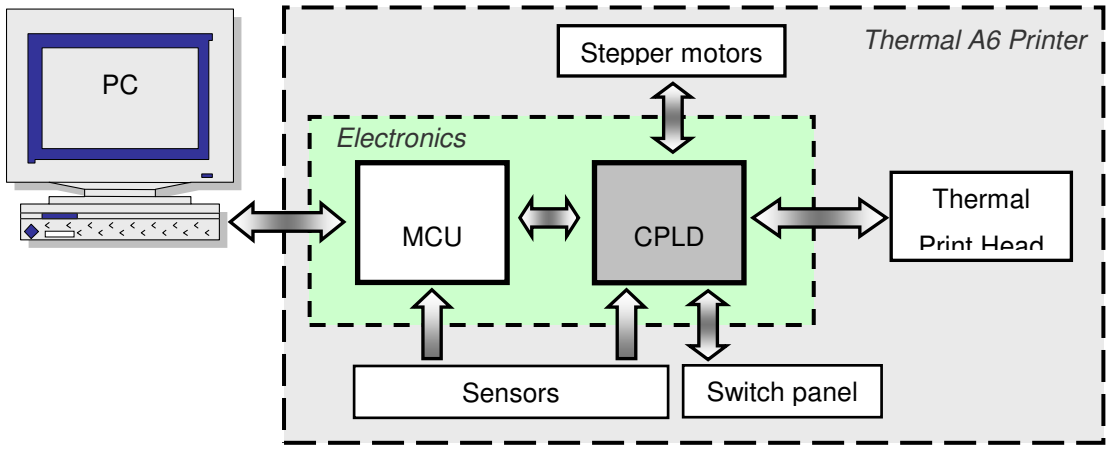

Figure 1 System block schematic

3 Work plan

In a first step, all information available about the design is collected. After studying the collected design info, the design is reviewed to identify potential weak spots in HW and SW that can be responsible for or might have an impact on the reliability of the printer operation.

Considering the constraints detailed above only the software and firmware of the processor and programmable logic device of the printer electronics can be altered. No PCB re-design can be done.

In order to make the work proceed smoothly, coaching the SW and HW teams of company A is done to increase the efficiency of the work.

4 Results

At the start of the design review process only limited system specifications were available. The documentation available was all but complete and no proper document revision system was in place. Essential parts of the system were not documented at all! There was no decent communication protocol between software and hardware designers of company A, both on the document level as on the personal level. The impotence to solve the issues had created disharmony between both teams as one team blamed the other being responsible for the troubles.

To get all the information needed to analyze the system, efforts were focused on two fields: the tedious task of reverse engineering the existing system and coaching the both teams to cooperate and provide Q-Star Test the information required to operate efficiently. Using this approach, this tedious task was executed successfully and all available information was compiled in a document enabling to start with the analysis of the design.

When investigating the design, many potential root causes for the reliability issues were identified both on the design and design for test (DFT) level. The CPLD design had a poor architecture and many rules for good-design-practice were violated, DFT structures were missing. The software looked fine except for diagnostic test functions. It was clear that the competence level of the software and hardware team was clearly unbalanced in favor of the software team. This imbalance was the fuel for the disharmony between the teams. In a sense the software team was right to blame the HW team,

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however, their arrogance prohibited them for looking for errors on their side (there were errors on their side as well). The technical excellence of Q-Star Test helped to back up the HW team and restore the harmony between the teams and get to a more fruitful cooperation.

The CPLD design had to be redesigned from scratch as the design had a spaghetti structure. Fixing an error in one part caused other parts of the structure that had nothing to do with the modified block to malfunction as well. A redesign was the only option. Whilst doing that, DFT structures were added enabling diagnosis of the integrity of individual system blocks, including the communication between the HW and SW parts. DFT structures were added in the software exploiting all the DFT features incorporated in the new CPLD design. By doing so, it became clear quickly that also the software had bugs that caused the reliability issues but were hidden all that time by the poorly designed CPLD. With all the test features in place, pretty soon after that all issues were solved.

Once the new system architecture was in place, company A was also able to fix some print quality issues that they were not able to solve before because of the poor system architecture.

5 Conclusions

The issues with this thermal printer were successfully solved. The key to the solution was proper documentation, improving design quality, the introduction of DFT structures and last but not least, proper coaching and cooperation of interdisciplinary design teams.

This stresses why the TWINS project has a very good reason to exist, as it focuses on all these levels. This case illustrates that not only technical matters are important to solve issues and move forward but that in the context of a co-design environment also the human factor is important as to assure a good interaction between the different teams involved.

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