FDR of the SCT Power Supplies Report

ATLAS Project Document. No.	Institute Document No.	Created :	18/06/03	Page	1 of 5
ATC – RI – ER – 0053		Modified:	18/06/03	Rev.No.	1

REPORT OF THE FDR

ATLAS SCT POWER SUPPLIES

Abstract

The FDR of the SCT Power Supplies has been held at CERN on May 28th 2003. The procurement and construction of 10% of the system can start immediately; this pre-production will be used in the assembly sites and for the final validation of the design. The responsibilities of the different institutes for the final assembly of components and for the maintenance must be defined.

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Distribution: EB Members, SCT Members, all participants mentioned in the report.

PURPOSE OF THIS REVIEW

The objective of the review was to check that the design of the SCT power supplies satisfy the SCT requirements and that the pre-production process can be launched.

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AGENDA

The agenda and documentation are available at

http://agenda.cern.ch/fullAgenda.php?ida=a03655

OUTCOMES OF THE REVIEW

Several years of development have been spent and a final prototype system (PS0) has been produced and used. The tests done on PS0, together with the successful history of previous VME-based versions of the LV and HV modules indicate that the basic requirements of detector module powering and control have been met.

A crate containing 9 LV modules (a full crate holds 12) and 5 HV modules (a full crate holds 6) has been seen to function consistently and predictably when interfaced using the Prague Temporary crate controller and using the Prague software.

SYSTEM LEVEL

The overall Grounding, Shielding and Safety issues much be more detailed and an global drawing showing the different ground and power return connections should be produced.

Fault analysis at different levels must be done as this will be requested by the safety division (TIS). Examples of faults to be looked at are:

- what happens on the HV and LV outputs when a device fails in the LV or HV boards;
- can there be cross-talk on the distribution which could damage the front-end. For instance if the HV output brutally moves from 500V to 0V (because of a fault) can there be spikes on

the neighbouring lines (as far as can be seen from the documentation the HV lines are not shielded in the cable).

- What happens if the 48V return line is disconnected.
- What happens on the HV and LV outputs when 48V is momentarily interrupted? Are all outputs safe when the power is returned?

The interlock system foresees that an opening of a ROD rack door shut off the relevant VCSEL power supplies. How are these interlocks transmitted from USA15 to US15?

LV SPECIFICATIONS

The ripple specifications on the LV output are extremely tight and almost impossible to meet. It was not clear up to which frequency the measurements presented were done. It is recommended to use standard method to measure the ripple, including cables and load. Spectra of the noise & ripple would be good to know also, because there can be visible dominant frequencies of converters and digital circuits.

The value of the ripple in the specification should be changed to a more realistic value based on measurements made with the SCT modules.

It is not clear if the correct operation of the SELECT line had been tested with the prototype. If not, it should be done as soon as possible.

HV MANUFACTURING

Although no problems have been seen on the prototype boards, it may be worth to consider a conformal coating of the HV parts.

BACKPLANE

Some weakness on the 5V distribution has been observed on the prototype. The proposed measures to solve this problem are appropriate. It would nevertheless be useful that an analysis of the reasons for failing when the 5V is low be done.

The FASTON connectors used to connect the power input to the prototype backplane(s) were rather fragile. A more robust alternative should be considered or redundancy could be provided by simply doubling up the number of FASTON connectors.

CONTROL ISSUES

The overall system contains an enormous number of micro-controllers (more than 5000) running endless loop programs. The documentation provided includes about 40 pages of assembler code. This code should be very thoroughly documented (i.e one comment per line) and stored in EDMS or CVS in view of later maintenance.

It was mentioned that the code does not contain any watchdog mechanism (i.e a mechanism which reinitialises a controller in case of failure). This may need to be reconsidered.

The LV firmware is not complete with regard to the switching off of power to a barrel detector module which has out-of-range thermistor measurements. The requirements document is somewhat unclear on this aspect and should be made more specific.

The control of the crate is based on the ELMB running a special dedicated software (to drive the backplane protocol). It means that the SCT community is on their own for this part (i.e there is no support from the central DCS team) and as for the micro-controllers the code must be properly documented and stored in EDMS. The communication between the ELMB and PVSS should conform to the CANopen protocol and should use the ATLAS DCS standard, i.e. the OPC-CANopen server.

It has been mentioned that there will be up to 50 ELMB on a CAN branch. There is no reason to have such a high number as there must be one PC to control the crates of USA15 and one PC to control the crates of US15 and each PC is equipped with a 4-port CAN interface. Putting too many ELMBs on a branch can lead to high time responses.

Having less ELMBs on a bus makes the system more robust against single point failures (e.g. failure of a branch).

INTERLOCK

Consideration should be given to making the interlock matrix box such that its firmware may be reprogrammed in situ, possibly over the CAN Bus. The major benefit would be that any known faulty sensors could be easily excluded from the interlock logic. A study of this option and of the possible risks attached to it should be done.

At present, only a subset of the DCS sensors are routed to the interlock matrix. If all were made available, redundancy could be increased.

RELIABILITY ISSUES

The reliability of the crate main power supply (Power pack) has been addressed and a N+1 redundant scheme implemented.

No data concerning the reliability of the other modules (LV, HV and control) has been presented. It is recommended that some study be done in order to estimate the failure rate of these modules and as mentioned early the effect of a failure on the output voltages. An MTBF of 10^5 hours (common value for commercial power supplies) for the LV and HV boards leads to a failing device every 66 hours and hence to a non negligible maintenance problem.

MANUFACTURING AND ORDERING PROCESS

Although some parts of the procurement and manufacturing process are clearly defined, there are undefined steps (or not documented). They are:

- the manufacturing of the controller;
- the manufacturing of the backplane;
- the final assembly of the crate - backplane - power pack - controller - HV and LV boards and final test of the ensemble. This last point is the most important and place of final assembly, responsibility, tests, shipping must be defined.

The technical specification of the call for tender for HV and LV card manufacturing states that burn-in is done in the institutes. As burn-in is done to identify possible weak components and/or weak assembly procedures it would be better that it is done in the factory before delivery in order to avoid useless extra transports and may be disputes.

Together with the manufacturing procedures definition and assignment of responsibilities it is recommended to define the maintenance procedures and the responsibilities attached to them.

About 10% HV and LV spare modules will be produced. Although this amount seems adequate, the reliability tests will allow to predict how many running spares must be in the pit.

SUMMARY OF MAIN ACTIONS

Fault analysis at different levels must be done.

Maintain hardware and software documentation in EDMS and/or CVS in view of maintenance.

Estimation of the MTBF of the modules to be done in view of organizing the maintenance.

Define clearly the responsibilities of the different institutes for the final assembly of components and for the maintenance.

RECOMMENDATION

The procurement and construction of 10% of the system can start immediately. These parts can then be used for the tests in the assembly sites but also for the final validation of the design (check of the last modifications) and the reliability study.