Subject: Impact of the Grounding in the cold end for the DRCU design

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1 Scope of the document

This document intends to describe some design and programmatic the consequences of the grounding scheme with the grounding at the cold end.

2 Assumptions

For the time being, the specifications on the electronics are given mainly in the BDA SSSD document (Nov. 7, 2001 "Working version"). They correspond to the interfaces at the cold subsystems, JFET box and RF filters. However, they do not apply to the DRCU as a stand alone system, since the transformation of the specifications contained in the BDA SSSD to the DRCU should require to take into account the effect of the harnesses through a detailed modelling, which is not yet done. In the absence of precise specifications on the DCU and FCU interfaces, we have taken a conservative approach based on two simple principles, which should ensure the best performances:

- We should maximise the isolation between the analog electronics reference and the DCU chassis
- We should maximise the electrical isolation between the photometer and spectrometer analog electronics

While these principles should have no impact on the LIA and BIAS boards, they generate a modification of the overall DCU electrical architecture and of the implementation of the boards themselves inside the DCU box. The problems are linked with the DCU architecture, where the analog subsystems of the photometer and the spectrometer share the same acquisition and digitalisation board. This architecture was defined and presented to the system team more than 18 months ago (see DCU Design Document, March 3, 2001). A simplified block diagram is presented in fig 1.

The isolation problems is even more complicated by the redundancy of the different boards, where the BIAS and DAQ boards are redundant, while the LIA boards are not.

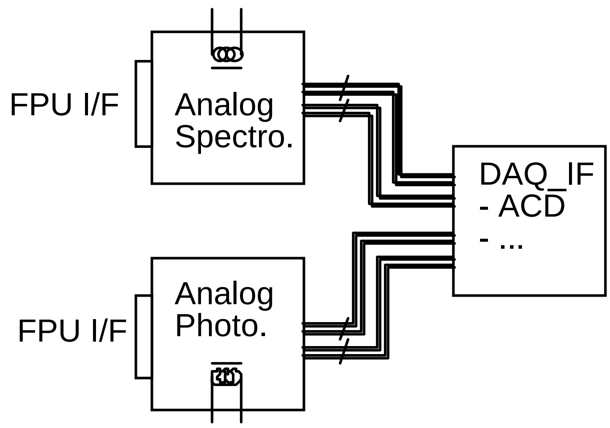

Figure 1: simplified DCU block diagram

3 Implications

To ensure a proper isolation of the analog and digital electronics, and of the spectrometer and the photometer, we should:

- modify the BIAS board in 2 boards, a BIAS_P and a BIAS_S boards
- split the DAQ_IF in two separate units, either on the same board, but with large shielding, or to build two separate boards
- modify the board implementation in the DCU box, and to create a real box partitioning with a metallic wall between the two half of the box (see fig. 2). This will generate a redesign of the connectors locations and pin-out.
- design a new backplane

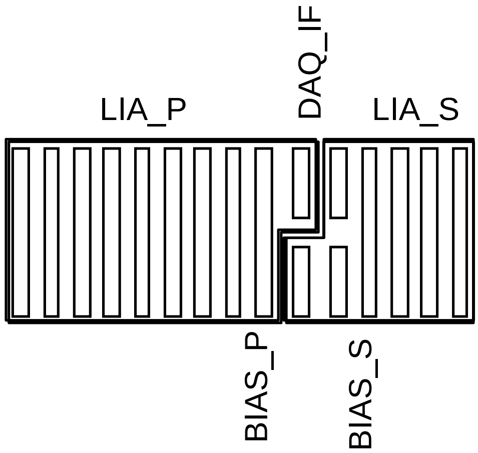

Figure 2 : Possible new implantation of the boards in the DCU, ensuring a good isolation between the spectrometer and the photometer

In addition to this we should implement high Common Mode Rejection Ratio differential interfaces between the DAQ_IF boards and the analog electronics. The best way to achieve high isolation is to use optocouplers. However, it is very unlikely that we could implement optocouplers on all the different lines, due to limitation in power consumption, space on the boards, and availability of components with the appropriate band pass. The implementation of these interfaces would require a totally new study.

Last but not least, we should implement a second DC/DC stage inside the spectrometer and photometer analog electronics. This would increase the power budget by 30%, and will add 2 more DC/DC units.

It shall be mentioned that it is not possible to fully isolate the analog electronics from the digital electronics, since the multiplexer for the LIA channels are located on the LIA boards and DACs are on the BIAS board. This should require a new layout for these boards with additional filtering.

4 Integration and acceptance testing of the DRCU

Another drawback of the ground end in the FPU is that the DRCU cannot be used as a stand alone system. Its performances should be always measured with a simulation of the FPU end and of the cryoharness. If such an approach is nevertheless adopted as base line, it means that we should get:

- Detailed specifications for all interfaces between the DRCU and the FPU
- An EMC oriented FPU simulator, including expected noise sources, for representative performance measurements.

Both of them should be provided by the system team.

5 Impact on the schedule

At this stage, it is difficult to asses the exact impact of these modifications on the schedule. The first step, getting the detailed specifications required for the new design can probably be achieved within a couple of month. Then, we should study in details the consequences of these specifications on the DRCU architecture, to understand if the solution exposed before is mandatory or if some intermediate solution could be incorporated. Again, this is probably of the order of a month. Then we will have to implement the new design, and of course, the larger are the changes, the longer is the delay. A minimum of 6 months seems to be required, but it can be of 1 year if all the modification listed above have to be implemented. There will be also a severe impact on the procurement of the PSU, since we should rewrite the specifications. It should be remembered that the PSU are now on the critical path for the delivery of the warm electronics to the system team.

6 Conclusions

At this stage of the project, the implementation of the grounding at the cold end would have dramatic programmatic impacts

- Modifications of the DRCU electronics architecture
- New studies for High CMRR differential interfaces
- Increase of the number of Power Supply Units, and further delay
- Schedule delays between several months and 1 year

In addition, such a configuration make the testing of the DRCU very difficult. The actual performances of the DRCU will not be measured before the integration at system level. This is not a situation acceptable for us, since we should deliver a subsystem, which meets detailed specifications validated by acceptance tests.

The exact advantage of the different grounding scheme is very difficult to quantify in the absence of an EMC modelling of the system. It was never demonstrated that the grounding in the cold end is better than the warm end expect with the argument that it has worked on previous balloon instruments. However, the warm end scheme have been adopted for Planck/HFI electronics, after a very detailed study. Without such a model, it is impossible to decide which one of the two schemes is the best, and how much worse is the other. Programmatic aspects should therefore be taken seriously in consideration in the definition of the EMC philosophy concept that will be in use for SPIRE.