SPIRE CQM Instrument Level EMC Test Specification

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Reference Documents:

RD1 SPIRE EMC Control Plan - SPIRE-RAL-PRJ-000852 v 0.2
RD2 Document de Specification "Power Bench" pour SPIRE Sap-SPIRE-FD-0091-02
RD3 SPIRE AIV Plan – SPIRE-RAL-PRJ-000410 v3 draft
RD4 Instrument Testing on PLM EQM Level – HP-2-ASED-PL-0021

0 Scope:

An outline specification for the EMI susceptibility testing for the SPIRE CQM model is described for both instrument level and EPLM level testing,

1 Introduction:

The original intention of the EMC control plan (RD1) was to verify the effectiveness of the SPIRE instrument EMI protection by a warm radiative susceptibility test on the FPU fitted with dummy detectors. Due to the change in model philosophy (see HR-SP-RAL-RFW-001) this test will no longer be carried out. It will be replaced by a field-to-wire simulation of the radiative test carried out on the FPU with a functioning detector operating cold in the AIV cryostat.

The build standard of the electronics to be used with the CQM instrument (the QM1) means that there will not be a representative power supply in the DCU. It will be replaced by a "Power Bench" (see RD2)which runs from mains power and provides the DC supply lines for the MCU;SCU and DCU. It will not be possible, therefore, to carry out conducted susceptibility and emission tests on spacecraft 28 V line as it will be in the flight unit. This test will only be possible on the flight model electronics. Instead, a common mode conducted susceptibility test will be carried out on the DC lines from the power bench to the other electronics units. As a differential mode test is more difficult to set up, we will consider whether a differential mode test is required on these power lines depending on the results of the common mode test.

No testing is planned on the DPU at instrument level, what tests will be carried out at EQM EPLM level is TBD.

In summary the following tests are described in this note:

- Instrument level common mode conducted susceptibility test using the SPIRE "internal" DC supply lines.
- Instrument level field-to-wire simulation of a radiative susceptibility test with the FPU cold and in its most sensitive mode.
- Discussion of tests at EPLM level for radiative susceptibility test and possible common mode conducted susceptibility test using the SPIRE internal DC supplies.

2 Instrument Level Common Mode Conducted Susceptibility

Test Setup

It is proposed that the QM1 electronics are accommodated on a 3 shelf 19 inch rack as shown indicatively in figure one. The data harnesses from the DPU to the FCU and DCU will be the QM1 version of the warm interconnect harness. The power lines from the power bench will be provided with the power bench and must be long enough to reach the units as installed in the rack as shown. The FPU and JFET units will be in the cryostat and at operating temperature for this test.

Instrument Configuration

The build standard of the instrument will be as given in RD3.
Only prime side electronics will be provided with QM1.

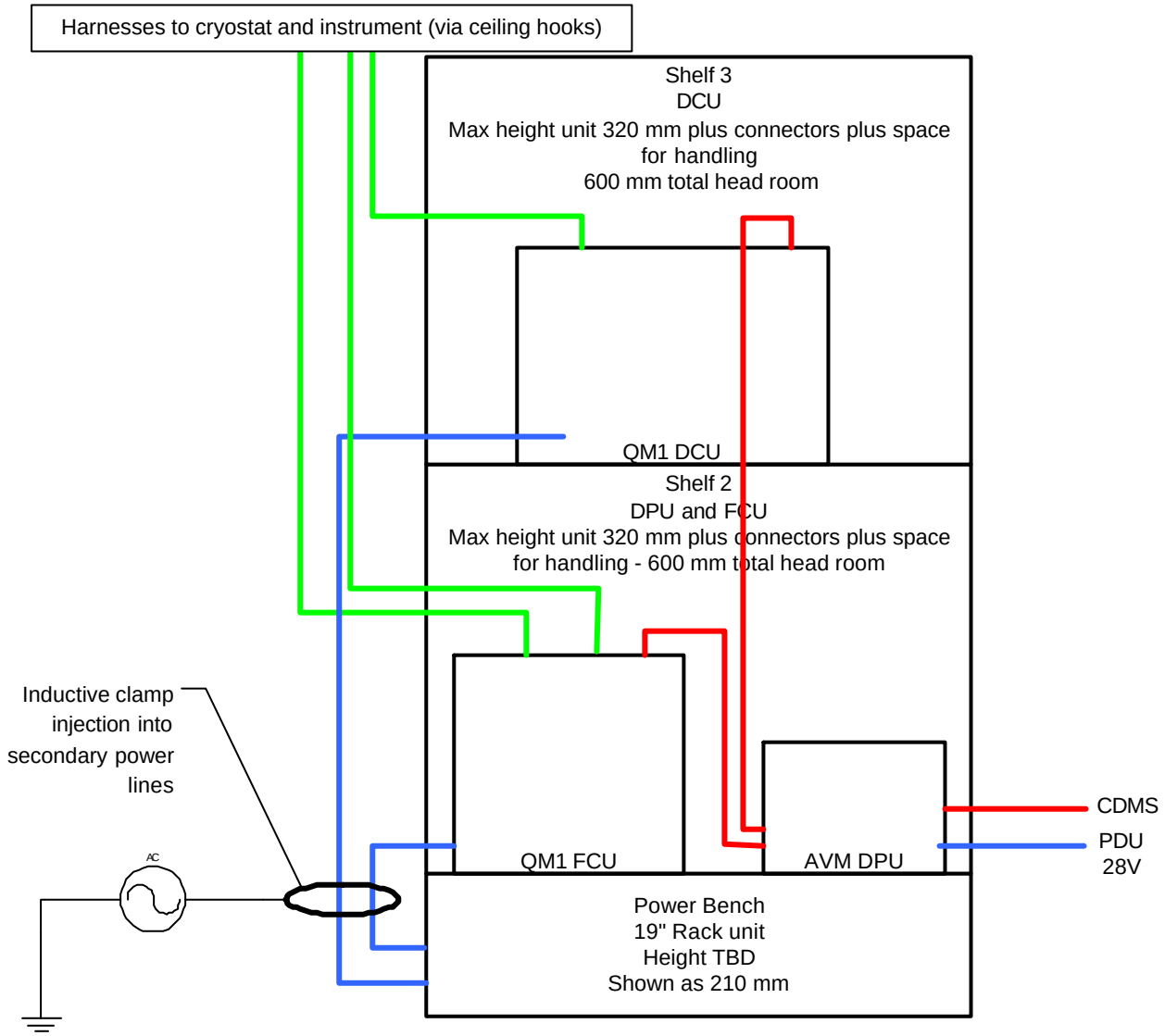

Figure 1: Sketch of electronics configuration for CQM instrument level test. This also shows where the EMI will be injected for the common mode conducted susceptibility test. We may do one power line bundle at a time.

Pre-conditions

The instrument will be placed in PHOT STANDBY mode.
In this mode the cooler will have been recycled; the photometer JFETs will be on and the detectors set to their optimum bias.
The facility cryostat will be set to its darkest condition.
Data from the detectors will be taken continuously at a sampling rate of 16 Hz .
The data from selected channels will be displayed on the QLA

Outline Test

Inductive injection clamp will be placed on each line in turn. The test will be designed to verify the effect of the maximum noise on each line given in RD2 section 5.1.1. Typically these are for 20, 50 or 100 mV "ondulation" anywhere in the frequency band from 30Hz to 20 MHz.

The frequency of the current supply will be swept slowly through the band at a large amplitude and the response of the detectors monitored. If any increase in noise is observed the sweep will be halted at that point and a small frequency range swept over more slowly to identify where the susceptibility lies.

Once any particular frequencies have been identified the source will be set to that frequency and the amplitude lowered until no interference is seen on the signals. How we calibrate the level of common mode appearing on the power line is TBD – one method could be that suggested in the IID-A – see figure 2 – but this requires access to the power lines themselves.

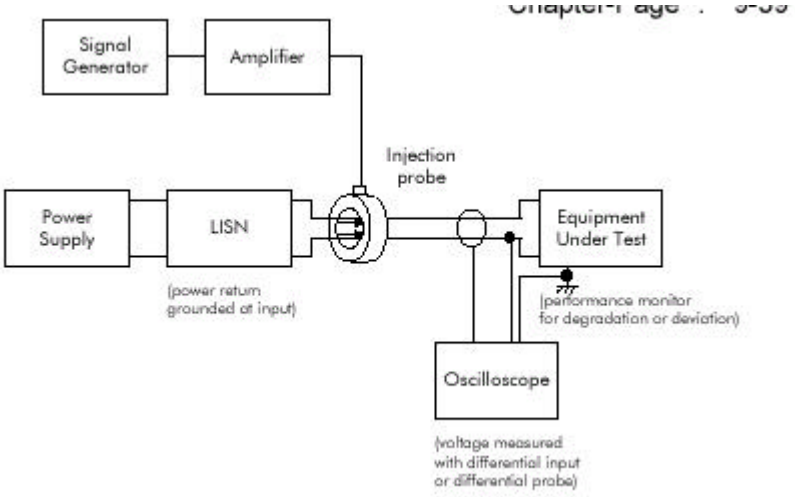

Figure 2: Common mode test setup with measurement technique as suggested in the Herschel-Planck IID-A.

3 Instrument Level Field-to-Wire Simulation

Test Setup

Figure 3 shows the basic set up for the test. The idea is to simulate the effects of RF radiation within the cryostat by directly injecting a voltage onto the isolated Faraday shield of the cryoharness and the FPU box. The instrument test cryoharness has been modified to allow the Faraday shield connection to be broken at the cryostat wall and a voltage source attached as shown in figure 4. It is difficult to calibrate this set up and the test will only give qualitative results.

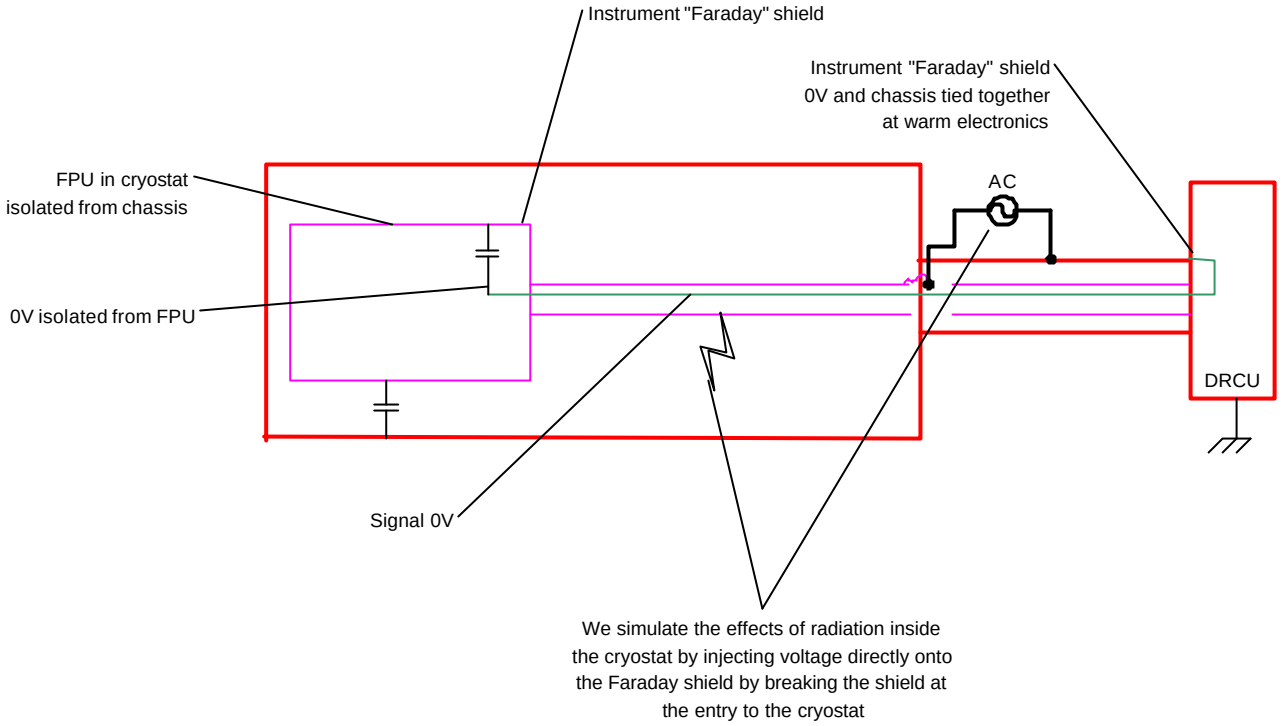

Figure 3: Test set up for the field-to-wire simulation of the radiation susceptibility test.

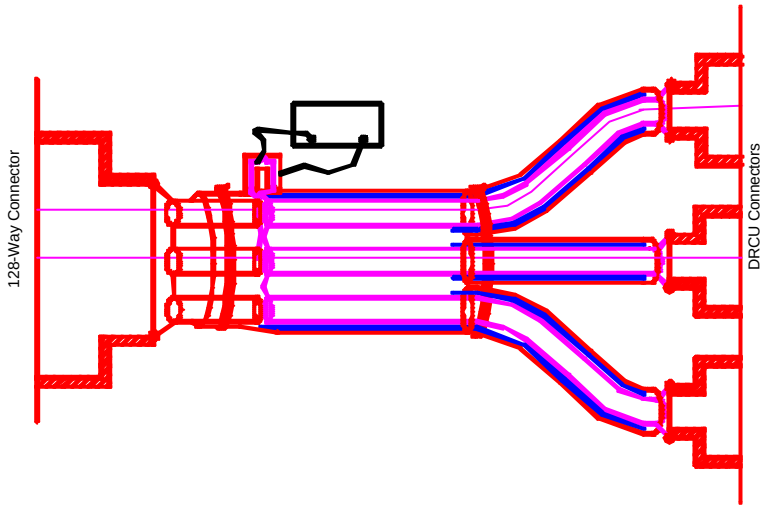

Figure 4: Details of the instrument test cryoharness design at the wall of the cryostat showing how the Faraday shield is broken to allow injection of voltage.

Instrument Configuration
As for common mode CS test

Pre-conditions
As for common mode CS test

Outline Test
The frequency of the supply will be swept slowly through the 30 Hz to 100 MHz band at a large amplitude (2 V p-p TBC) and the response of the detectors monitored. If any increase in noise is

observed the sweep will be halted at that point and a small frequency range swept over more slowly to identify where the susceptibility lies.

Once any particular frequencies have been identified the source will be set to that frequency and the amplitude lowered until no interference is seen on the signals. How we calibrate what this level of voltage on the Faraday cage means in terms of the radiative field is TBD,

4 Proposed Tests at EQM EPLM Level

We propose that the same secondary power line common mode conducted susceptibility test is carried during the Integrated System Test at EQM EPLM level. The test set up and instrument configuration will be as given in section 2. Doing this test will give us a baseline from which we can attempt to calibrate the outcome of the radiative test.

It is proposed by Astrium that a radiated susceptibility test is carried out on the EPLM with the full cryoharness in place and the electronics arranged in the same manner as will be done on the flight system. The details of this test are (will be) described in RD4.

The EQM radiative test will complete the EMC verification for the SPIRE instrument except for the Conducted Susceptibility and Emission on the primary power side of the DRCU. This last test cannot be carried out until delivery of the PFM DRCU (and associated PSU).