Section 11

Annex C: Interface Control Document

BSM to PCAL

v 1.0

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1 Scope

This document outlines the ICD between the BSM (ATC) and the SPIRE Photometer Calibrator (PCAL) (UoC).

The contents of this document are intended for incorporation in the UoC ICD document, AD7

2 Documents

2.1 Applicable documents

	Title	Author	Reference	Date
AD1				
AD2	BSM -PCAL ICD drawing	I.Pain	ATC drawing number: SPIRE-BSM-021-003-001	15.Jun.01
AD3	PCAL ICD drawing	UoC	TBD	
AD4	ICD Structure - Mechanical I/F	B.Winter	SPIRE-MSS-PRJ-000xxx v1.0	Apr.01
AD5	SPIRE Harness Definition	D.K.Griffin	SPIRE-RAL-PRJ-000608 v0.3	30.May.01
AD6	TBD (harness run mechanical details)	TBD	TBD	TBD
AD7	??? (PCAL ICD document at UoC)	P.Hargraves	TBD	TBD

2.2 *Reference documents*

	Title	Author	Reference	Date
RD 1	Thermal Configuration Control Document	S.Heys	SPIRE-RAL-PRJ-000560	18.Apr.01

3 Functional Description and Block Diagram

See BSM Design Description, section 5, 6 for the functional description and general block diagram. The specific ICD block diagram is shown below.

The BSM interfaces directly to the SPIRE Optical Bench and the optical beam. Three elements of the BSM are of relevance to this ICD.

- The structural interface locates the BSM mechanism in place.
- The Photometer Calibrator (PCAL) has a direct interface to the back of the BSM structural interface,
- The PCAL wiring is carried via the BSM cryo-harness.

Thermometers are carried on board the BSM structure, and whilst these will be of use in diagnosis of the BSM thermal condition the thermometry wiring harness is not directly available to the BSM warm electronics.

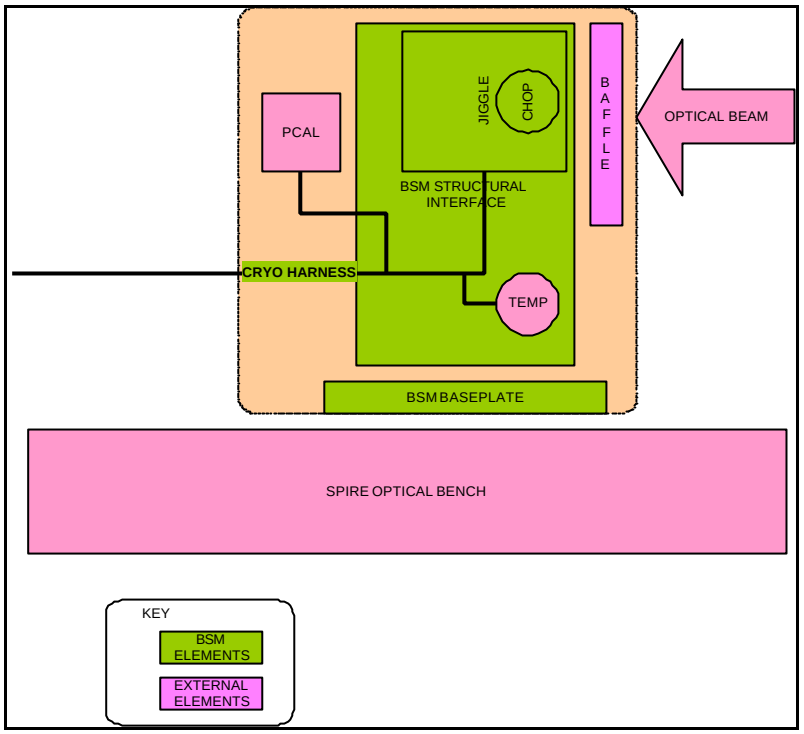

Figure 1: BSM-PCAL ICD BLOCK DIAGRAM

4 Inputs

The BSM receives input vibrations from the structure, at a high level during launch and at a low level during operation (spacecraft micro vibration environment). There is a feedback between the BSM and the structure due to the vibration response of the BSM.

4.1 *Resonance*

The principal resonant modes of the structure and the two suspended masses are presented below. A full analysis of the combined system is to be completed.

The BSM structural interface forms a stiff body. The first twelve structural modes were determined by finite element analysis

FEA prediction for Response of structural interface		Approximate assembly response (see scale factor)
Mode	Frequency (Hz)	Frequency (Hz)
1	688	433
2	864	544
3	1781	1121
4	2715	1710
5	3058	1926
6	3284	2068
7	3345	2106
8	3614	2276
9	3957	2492
10	4097	2579
11	4677	2945
12	5185	3265
	mass of structure	291
	mass of assembly	734
	scaling for resonance	0.630

Table 1: Structural Interface Principal Modes

4.2 *Scale factor*

Pending a full resonant modes analysis, we may note that since the stiffness of the structural interface design remains unchanged, the assembly natural frequency scales as:

$$f_n = \frac{v\,(k/m)}{2\,?}$$

hence, $f_{n(assy)} / f_{n(struct)} = v(m_{struct} / m_{assy})$

The mass of the structure used for the FEA modes search was calculated at 291gm, and the full assembly mass (excluding contingency, the baseplate and fasteners below the structure base) is predicted at 734 gm . This yields a scaling factor of ~ 0.63, used in Table 1.

4.3 *Assumptions*

As the structural response remains above 250 Hz it may be assumed to be stiff for subsequent analysis of the SPIRE structure and for transmission of SPIRE optical bench motion to PCAL.

5 Outputs

The BSM will output a vibration to the Optical Bench and PCAL during chopping and jiggling. The primary output will be at the chop and jiggle frequencies : 2 Hz and 0.5 Hz respectively, with harmonics TBD. Local TBD resonances of the BSM (eg of the baffle, PCAL) may modify the harmonics.

Neglecting harmonics and any structural amplification (which should be small anyway, as the structure is stiff) the output forces take the form of a torque reaction in the structure in response to the acceleration of the mirror and jiggle frame in chop and jiggle.

An approximation to this torque reaction may be made by taking the inertia of the moving masses, and an average acceleration over the specified rise time.

The output seen at the PCAL has not been calculated, but based on discussions in the Structure-BSM ICD (SPIRE-ATC_PRJ-000587 Annex B) will probably be in the range 2-20 micro-g. This will not affect PCAL during its operation as the BSM is kept at rest during calibration

6 Interface drawing

- UoC drawing: TBD
- ATC drawing: SPIRE-BSM-021-003-001, 3 sheets attached below.
- ATC drawing: SPIRE-BSM-021-001-004, PCAL space envelope, attached below.

7 Mass Properties

PCAL has been assumed to mass 50gm for BSM strength and stiffness calculations, and to have a COG consistent with a solid volume as shown in space envelope drawing. The actual design mass and CoG must be transmitted to ATC as soon as available.

8 Mechanical Environment

This section outlines the interaction with the SPIRE BSM structure mechanical environment specified in AD4.

To Be Written

9 Thermal Interface

Cooling of PCAL is provided by contact to the BSM structure bulkhead

9.1 *Finish*

The BSM-PCAL interface surface (drawing AD2) will be aluminium alloy, grade 6082, coated with electroless nickel (nominally 10 microns) and gold (nominally 5 microns). The interface surface provides a precision central hole and three mounting holes, tapped M2.5, with locking inserts.

9.2 *Surface Area*

The contact surface area of the baseplate is TBD by PCAL.

9.3 *Contact Force*

At the contact face an approximate contact force of 1380 N (TBC) will be developed by three M2.5 socket head screws torqued to 0.23 (TBC) N-m

10 Harness Routing

The BSM prime and redundant harness are separate. Each harness includes the motor, sensor, thermometry and PCAL cables and interfaces via a fully populated 37-way MDM connector, as specified in AD5. The harness is run to the BSM as described in AD6, with a total length of 415 (TBC) mm.

It is TBD whether PCAL has a redundant element. If it does not, then the 4 wires and common screen from PCAL will run only to the prime BSM harness' 37 way MDM connector. The BSM redundant connector will in effect have 5 spare pins.

A flying lead (TBC) is delivered from PCAL to the BSM 37 way connector. The minimum path harness length will be ~160mm, but additional allowance will be required (50-80mm) to allow for removal of the 37 way MDM connector and soldering attachment of the flying lead. PCAL should therefore be delivered with a flying 300mm long. This will be cut to length and terminated by ATC.

The approximate harness runs are shown below (note that cutouts and mounting arrangements are TBD)

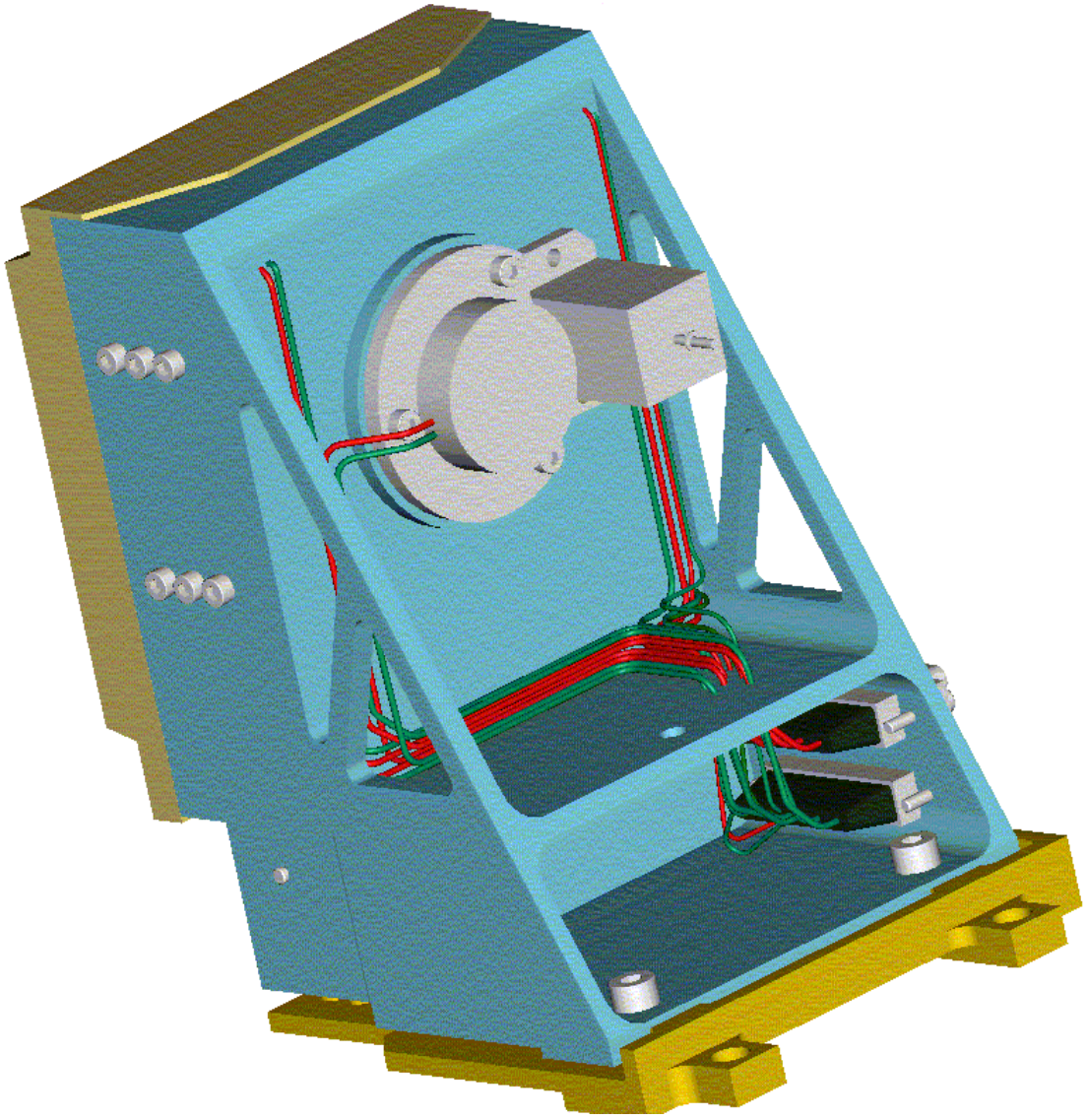

Figure 2 BSM on-board harness run (concept) showing prime and redundant harness runs

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