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		Spectrometer Calibrator - Interface Control Document

Spectrometer Calibrator (SCAL) Flight Model & Flight Spare

Interface Control Document

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Update history

Date	Version	Remarks
7/9/01	1.0	First issue for DDR
6/02/02	2.0	Issue for IBDR.
05/07/04	3.0	Flight model ICD

List of Acronyms

Term	Meaning	Term	Meaning
AD	Applicable Document	IR	Infrared
ADC	Analogue to Digital Converter	IRD	Instrument Requirements Document
AIV	Assembly, Integration and Verification	IRTS	Infrared Telescope in Space
AME	Absolute Measurement Error	ISM	Interstellar Medium
AOCS	Attitude and Orbit Control System	JFET	Junction Field Effect Transistor
APART	Arizona's Program for the Analysis of Radiation Transfer	ISO	Infrared Space Observatory
APE	Absolute Pointing Error	LCL	Latching Current Limiter
ASAP	Advanced Systems Analysis Program	LIA	Lock-In Amplifier
ATC	Astronomy Technology Centre, Edinburgh	LVDT	Linear Variable Differential Transformer
AVM	Avionics Model	LWS	Long Wave Spectrometer (an instrument used on ISO)
BDA	Bolometer Detector Array	MAC	Multi Axis Controller
BFL	Back Focal Length	MAIV	Manufacturing, Assembly, Integration and Verification
BRO	Breault Research Organization	MCU	Mechanism Control Unit = HSMCU
BSM	Beam Steering Mirror	MGSE	Mechanical Ground Support Equipment
CBB	Cryogenic Black Body	M-P	Martin-Puplett
CDF	Cardiff, Department of Physics & Astronomy	NEP	Noise Equivalent Power
CDMS	Command and Data Management System	NTD	Neutron Transmutation Doped
CDMU	Command and Data Management Unit	OBS	On-Board Software
CDR	Critical Design Review	OGSE	Optical Ground Support Equipment
CEA	Commissariat a l'Energie Atomique	OMD	Observing Modes Document
CMOS	Complimentary Metal Oxide Silicon	OPD	Optical Path Difference
CoG	Centre of Gravity	PACS	Photodetector Array Camera and Spectrometer
CPU	Central Processing Unit	PCAL	Photometer Calibration source
CQM	Cryogenic Qualification Model	PFM	Proto-Flight Model
CVV	Cryostat Vacuum Vessel	PID	Proportional, Integral and Differential (used in the context of feedback control loop architecture)
DAC	Digital to Analogue Converter	PLW	Photometer, Long Wavelength
DAQ	Data Acquisition	PMW	Photometer, Medium Wavelength
DCU	Detector Control Unit = HSDCU	POF	Photometer Observatory Function
DDR	Detailed Design Review	PROM	Programmable Read Only Memory
DM	Development Model	PSW	Photometer, Short Wavelength
DPU	Digital Processing Unit = HSDPU	PUS	Packet Utilisation Standard
DSP	Digital Signal Processor	RAL	Rutherford Appleton Laboratory,
DQE	Detective Quantum Efficiency	RD	Reference Document
EDAC	Error Detection and Correction	RMS	Root Mean Squared
EGSE	Electrical Ground Support Equipment	SCAL	Spectrometer Calibration Source
EM	Engineering Model	SCUBA	Submillimetre Common User Bolometer Array
EMC	Electro-magnetic Compatibility	SED	Spectral Energy Distribution
EMI	Electro-magnetic Interference	SMEC	Spectrometer Mechanics
ESA	European Space Agency	SMPS	Switch Mode Power Supply
FCU	FCU Control Unit = HSFCU	SOB	SPIRE Optical Bench
FIR	Far Infrared	SOF	Spectrometer Observatory Function
FIRST	Far Infra-Red and Submillimetre Telescope	SPIRE	Spectral and Photometric Imaging Receiver
FOV	Field of View	SRAM	Static Random Access Memory
F-P	Fabry-Perot	SSSD	SubSystem Specification Document
EPGA	Field Programmable Gate Array	STP	Standard Temperature and Pressure
FPU	Focal Plane Unit	SVM	Service Module
FS	Flight Spare	TBC	To Be Confirmed
FTS	Fourier Transform Spectrometer	TBD	To Be Determined
FWHM	Full Width Half maximum	TC	Telecommand
GSFC	Goddard Space Flight Center	URD	User Requirements Document
HK	House Keeping	UV	Ultra Violet
HOB	Herschel Optical Bench	WE	Warm Electronics
HPDU	Herschel Power Distribution Unit	ZPD	Zero Path Difference
HSDCU	Herschel-SPIRE Detector Control Unit		
HSDPU	Herschel-SPIRE Digital Processing Unit		
HSFCU	Herschel-SPIRE FPU Control Unit		
HSO	Herschel Space Observatory		
IF	Interface		
IID-A	Instrument Interface Document - Part A		
IID-B	Instrument Interface Document - Part B		
IMF	Initial Mass Function		

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1. Scope

The purpose of this document is to define the interfaces between the spectrometer calibrator (SCAL) and SPIRE.

Note that this document is applicable only to the flight model and flight spare versions of SCal. Issue 2.0 of this ICD (HSO-CDF-ICD-011-2-0) is valid only for the CQM version of SCal.

2. Documents

2.1. *Applicable documents*

All applicable documents are listed in the AD chapter of the CIDL (HSO-CDF-LI-029).

3. Mechanical Interface

The SCAL assembly will bolt directly to a baffle, provided by MSSL, which also houses SM8B (see Figure 1). To ensure adequate heat sinking, provision is made for the attachment of a thermal strap.

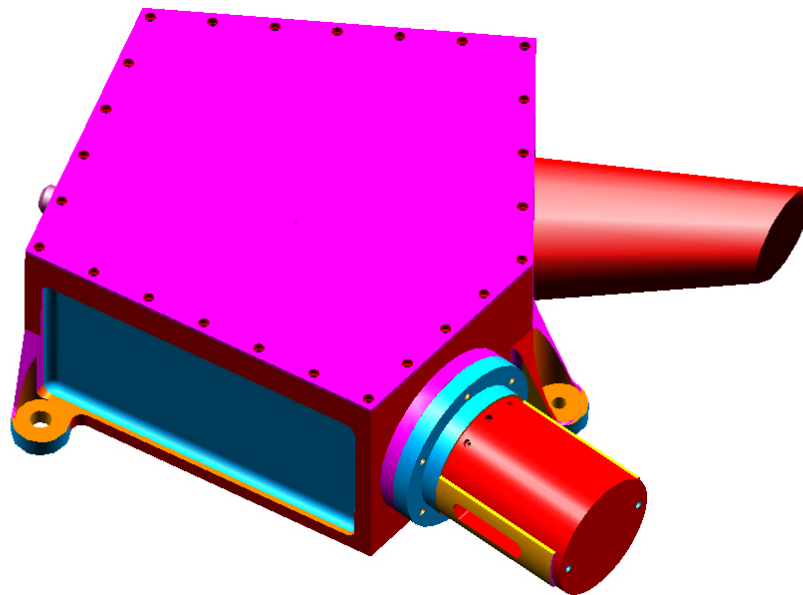


Figure 1 Isometric view of SCAL interface to baffle.

The SCAL interface drawing, SCAL-ICD-000, is shown in Figure 2. The MSSL side of the interface is detailed in the MSSL document number MSSL/SPIRE/SP004 issue 5.

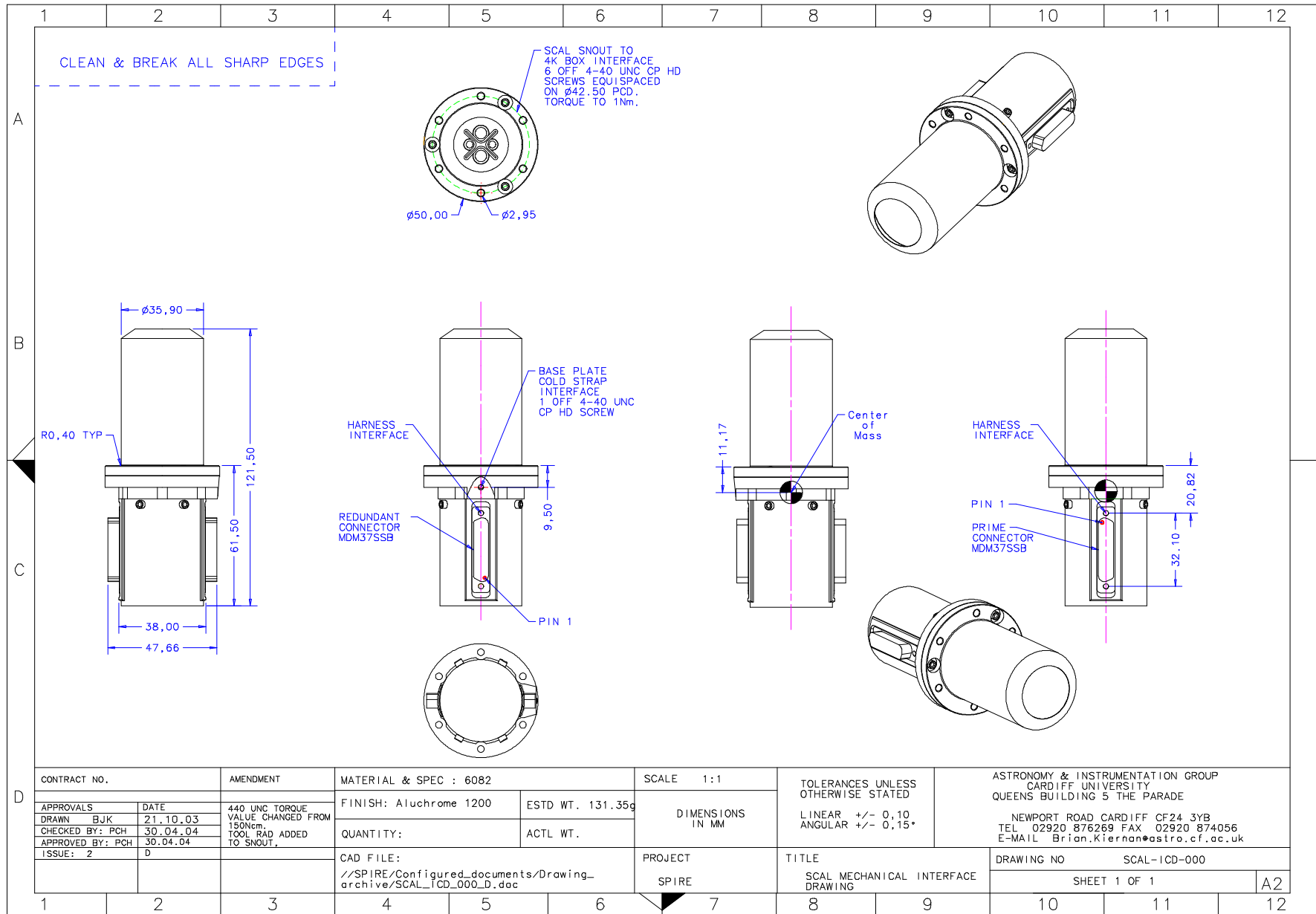


Figure 2 SCAL interface drawing

3.1. Mass

The mass estimate for the SCAL assembly is 132 g.

3.2. Centre of Gravity

Refer to Figure 2.

3.3. Resonance

A full mechanical analysis is in progress, but the first mode of the system will be above 800Hz.

4. Thermal Interface

There is no direct thermal interface between SCAL and the SPIRE optical bench, as SCAL is mounted off the SCAL/SM8 baffle. In the unlikely event that heat sinking through the baffle to the SOB proves insufficient, provision is made for a thermal strap from the SCAL baseplate directly to the SOB. A thermometer on the SCAL baseplate will monitor the temperature of the SCAL interface.

The SCAL interface surface will be aluminium alloy, grade 6061, coated with Aluchrom-1200. The MSSL interface surface provides a precision central hole and six mounting holes, tapped 4-40 UNC, with locking inserts.

4.1. Contact force

The six off 4-40 UNC bolts will be torqued to 1.0 Nm, which should provide a clamp force of around 1400 N.

4.2. Surface Area

Total thermal contact area with the SCAL/SM8 baffle box is 903 mm².

5. Optical Interface

The SCAL sources are placed at a pupil at the second input port to the FTS. The SCAL_A and SCAL_B sources fill 4% and 2% respectively of the pupil area, and are coated with a high (99%) emissivity finish. The rest of the pupil area is at the temperature of the SPIRE optical bench (SOB), and coated with the same high emissivity finish. Details of the SCAL optical interface are shown in Figure 3.

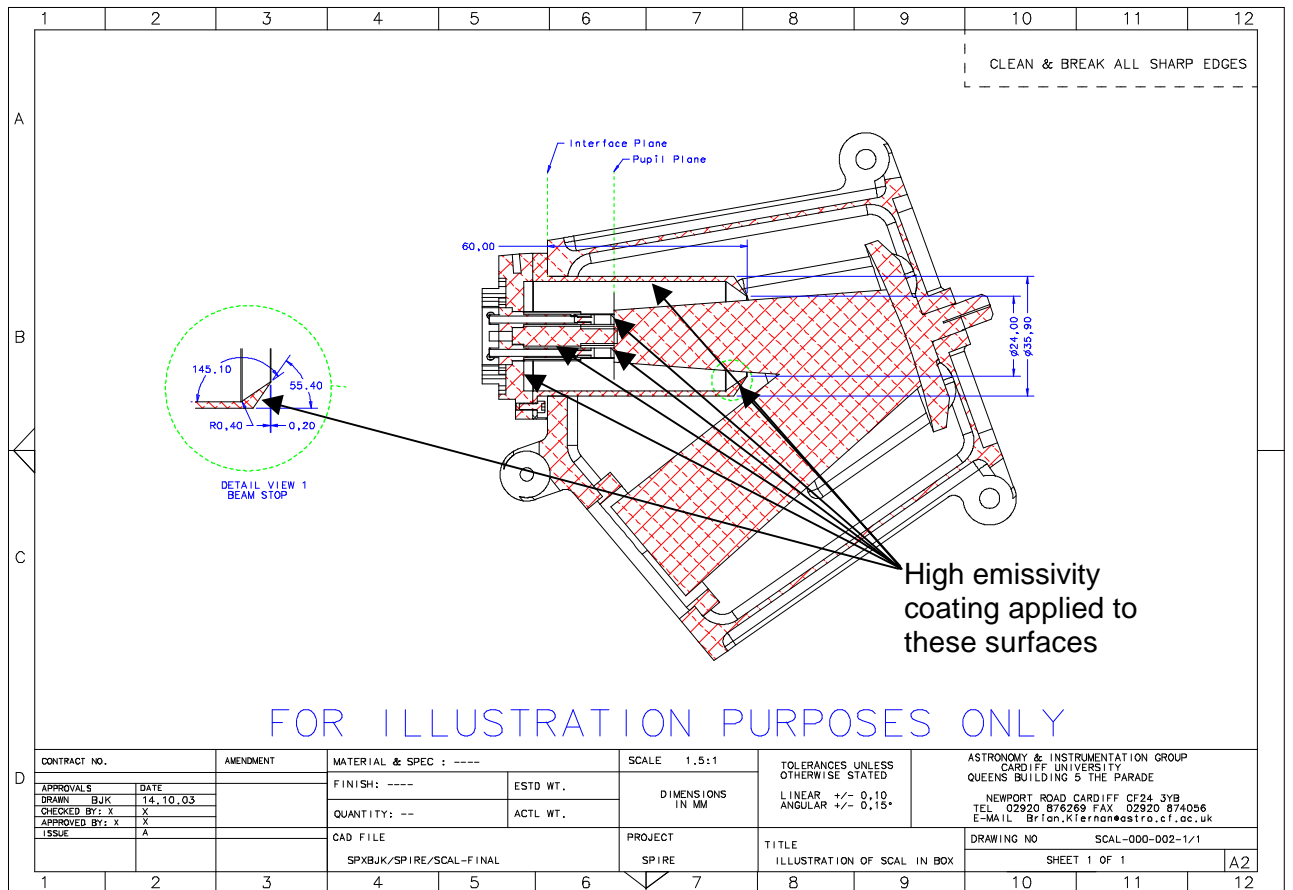


Figure 3 Illustration of SCal optical interface.

6. Electrical Interface

Independent current sources are required for each of the SCal sources (2 prime and 2 redundant). Details of the requirements are given in this section.

6.1. Heater Impedance

The nominal impedance of all SCAL source heaters is 500 Ω .

6.2. Maximum Drive Current

Maximum power is specified as 5mW (goal – 2mW), but we may want to run at higher power temporarily for faster warm-up. Therefore we have allowed for a maximum power dissipation of 15mW. Assuming a 500 Ω heater resistor, this gives a required drive current of 5.5mA.

6.3. Adjustability of Drive Current

12-bit resolution (minimum) is required in the range 0 – 5.5mA. This will give a minimum of 2275 adjustment steps in the target operating range.

6.4. Required Maximum Drive Voltage

The required maximum drive voltage, assuming a 30 Ω harness impedance in each direction, is 3.08 V. The voltage drop across the heater in this situation will be 2.75 V.

6.5. Drive Current Stability

The required repeatability for calibrator radiant power is 1%.

The stability and repeatability of the drive current should be within $5\mu\text{A}$ or 0.5% of the drive current, whichever is the greater.

6.6. Power Supply Redundancy

Separate power supplies are required for each SCAL heater – 2 prime, 2 redundant. Completely independent circuits will drive the prime and redundant SCAL heaters.

6.7. Thermometer Details

The thermometers to be used in the heater bodies are Lakeshore Cernox CX-1030-HT sensors.

6.8. Requirements on Thermometry Accuracy

The warm electronics requirements for the SCAL thermometers are:

- (1) Constant current drive
- (2) Drive current in the range 1 – 30 μA . Currents above this range may cause unacceptable self-heating.
- (3) 16-bit ADC resolution.
- (4) Stability: 1% on drive current required, driving through resistances of $(500+2000)\Omega$ ($2\text{k}\Omega$ from two harness wires), up to $\sim 35\text{k}\Omega$.

6.9. Connector Pin-Outs

Schematics of the SCAL connector pin allocation are shown in Figure 4 and Figure 5, with details listed in Table 1. The SCAL FPU harness (see SPIRE Harness Definition Document – SPIRE-RAL-PRJ-000608) is supplied by RAL. It is isothermal, and runs between SCAL and the RF filter box. All conductors will be made from copper, and the harness length and routing is defined by MSSL.

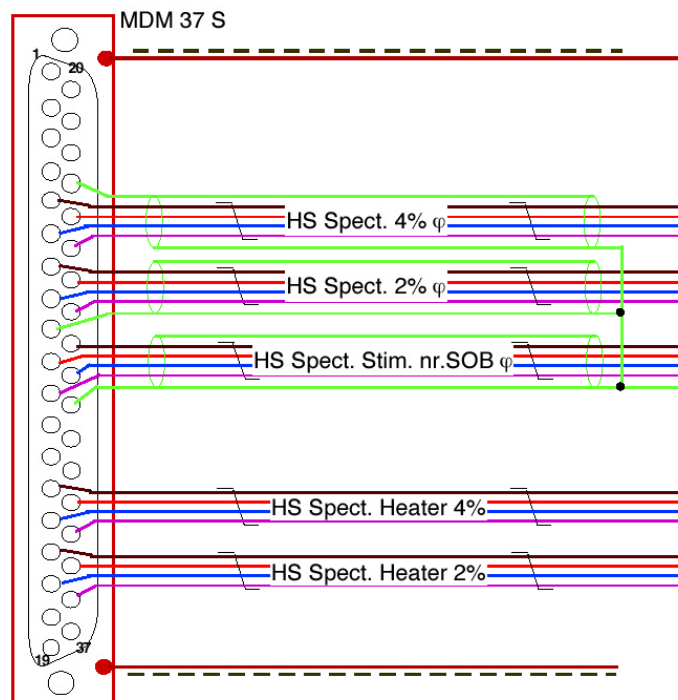


Figure 4 Schematic of SCAL connector wiring scheme. The same scheme is used for prime and redundant connectors.

Table 1 Pin allocations for SCal connectors.

Function	MDM-37-SSB 37-way socket	Max. current
HS Spect. 4% temperature I+ SCAL_A	5	10 μ A
HS Spect. 4% temperature V+	6	N/A
HS Spect. 4% temperature V-	24	N/A
HS Spect. 4% temperature I-	25	10 μ A
HS Spect. 4% temperature shld*	23	N/A
HS Spect. 2% temperature I+ SCAL_B	7	10 μ A
HS Spect. 2% temperature V+	8	N/A
HS Spect. 2% temperature V-	26	N/A
HS Spect. 2% temperature I-	27	10 μ A
HS Spect. 2% temperature shld*	9	N/A
HS Spect. Stim near SOB temperature I+	10	10 μ A
HS Spect. Stim near SOB temperature V+	11	N/A
HS Spect. Stim near SOB temperature V-	28	N/A
HS Spect. Stim near SOB temperature I-	29	10 μ A
HS Spect. Stim near SOB temperature shld*	30	N/A
HS Spect. 4% heater I+ SCAL_A	14	9 mA
HS Spect. 4% heater V+	15	9 mA
HS Spect. 4% heater I-	33	9 mA
HS Spect. 4% heater V-	34	9 mA
HS Spect. 2% heater I+ SCAL_B	16	7 mA
HS Spect. 2% heater V+	17	7 mA
HS Spect. 2% heater I-	35	7 mA
HS Spect. 2% heater V-	36	7 mA

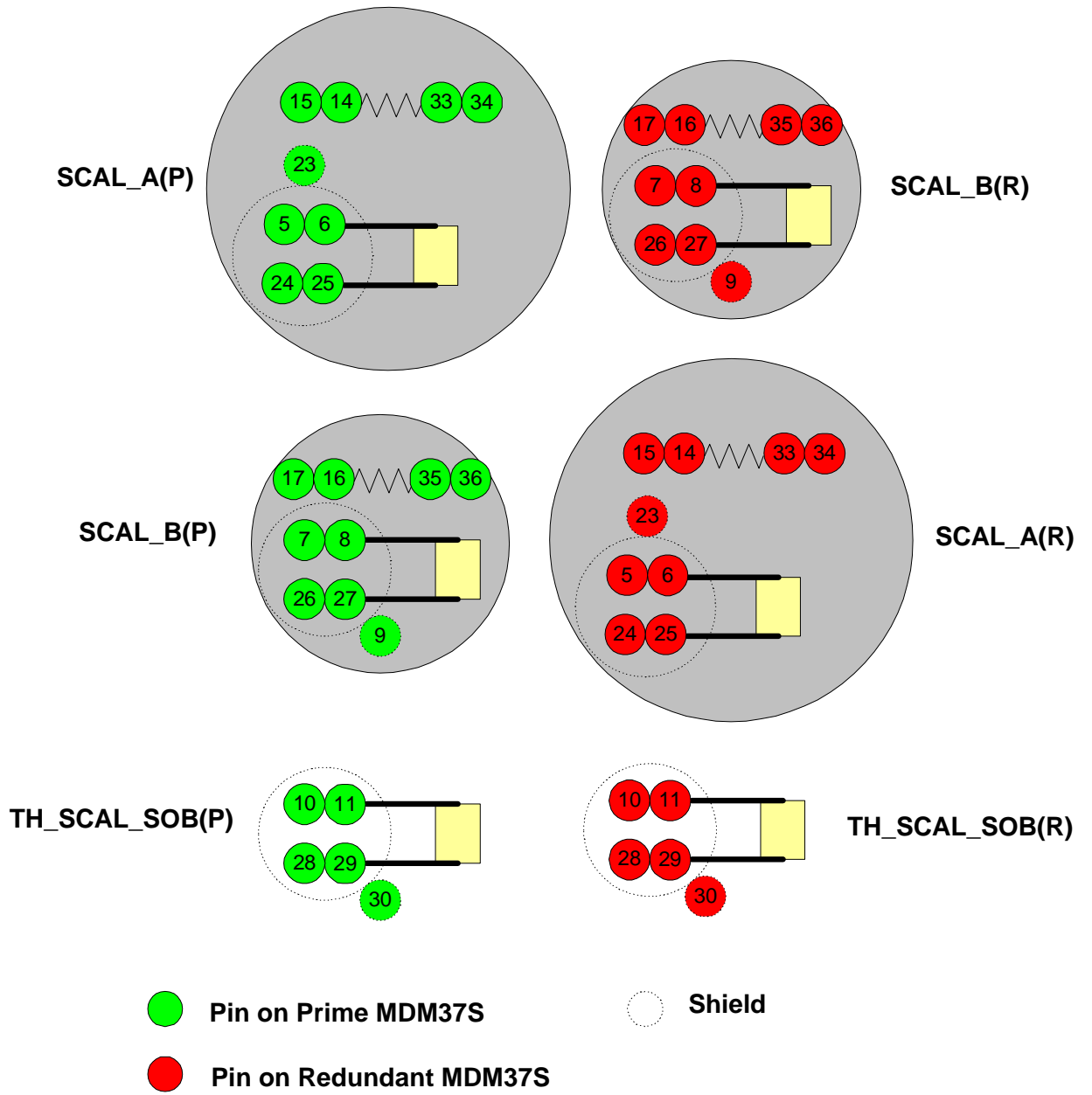


Figure 5 Schematic of pin allocation on SCAL prime and redundant connectors

7. Data Interface

The following information applies to both prime and redundant sources.

SCAL has two heated sources, each with its own thermometer. These sources are labelled as SCAL_A and SCAL_B.

Normal operation of SCAL will involve the continuous application of a specified drive current for the duration of the “on” state to each of the heater sources. Each heater source may be run independently, or together at different commanded current levels.

Each source may be controlled via a feedback loop if required.

7.1. Commands

Command ID	IFSI Designation	Name	Description
SCAL_A2		SCAL_A current level	Sets SCAL_A current level
SCAL_A3		SCAL_A read	Reads thermometer on SCAL_A
SCAL_B2		SCAL_B current level	Sets SCAL_B current level
SCAL_B3		SCAL_B read	Reads thermometer on SCAL_B
SCAL_SOB1		SCAL_SOB read	Reads thermometer at SCAL interface. Note – this command may be incorporated in the general SPIRE housekeeping.

7.2. PID parameters

The time constants stated in this table are those predicted for heating the sources to ~70K for good matching of the nominal telescope spectrum (80 K, 4% emissivity)

SCAL_A	Heating time constant (90% rise time)	60 minutes
	Average cool-down time (Operating temp. to <10K)	95 minutes
	Current drive	0-5.5mA with 12-bit resolution
	Thermometer readout	Cernox-1030 thermometer – calibration will be supplied
SCAL_B	Heating time constant (90% rise time)	30 minutes
	Average cool-down time (Operating temp. to <10K)	54 minutes
	Current drive	0-5.5mA with 12-bit resolution
	Thermometer readout	Cernox-1030 thermometer – calibration will be supplied

It may be necessary to reduce the warm up time by applying a warm-up sequence with a higher peak current. This should be provided for by the use of an OBS script in the DPU. Calibrated curves of applied power/current vs. equilibrium temperature will be provided for this purpose.