Solar B - EIS

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CHANGE RECORD

ISSUE	DATE	PAGES CHANGED	COMMENTS
01	29 February 2000	All new	
02	17 April 2000	All	Major update following the engineering meeting in Japan, 6-9 March 2000.
03	16 June 2000	3,4,6,7,8	Par 4.3.2 units of CLA added. Paras 8.3 & 8.4 added. Par 5.3 updated to reflect the larger ICU base area in contact with the S/C bus. Par 5.4 added. Co-planarity added in par 4.3.2. Par 4, drawing references to structure and templates updated; also mass, M of I, c of g and stiffness properties updated. Par 9, Power Budget updated. References to cables and connectors added to par 8.1 and Appendix 7 added. Par 4.3.3 changed to reflect 20mm dia shear pins.
04	05 July 2000	All	Major revision in preparation for the EIS UK PDR.
05	31 August 2000		Some minor editorial changes. Update of exclusion zone in par 6.6. Paras 13.1.1 and 13.1.3, level of test for the FM changed from PFT to AT. Par 4, change of drawing number for Launch Lock and inclusion of reference for ICU. Par 8.7. addition of pin-out information.
06	29 June 2001	All	Changes are detailed in ECRs 5, 6, 7 and 8
07	13 March 2002		Par 4, FR1 up-issued and note added about issue used for MTM/TTM. FR4 raised to issue 6. FR3 raised to issue F. Birmingham ftp site reference modified. Par 15, details of nitrogen purge connector added. Par 6.3.3, fastener torque added. Par 6.3.6 added on MLI. Par 10.3, clarification of mission data packet size. Pages 23, 27, 32 (pin-out data) updated reference ECR 22. Par 8.3 CAM voltages updated and par added for the survival heaters. Par 8.4 Main power converter freq changed; converter for 36V CAM deleted; CAM clock clarified as 32Hz. Appendix 6 raised to issue 7 Appendix 7 raised to issue 6

08	14 February 2003		Par 2.3, Block Diagram updated. Par 3, Issue numbers of document updated. Par 4, Issue numbers of documents updated; FR5 and FR6 added. Par 5.1 Latest mass estimate included. Par 6.2 Stiffness figure updated. Par 6.3.4, Reference to the alignment cube added. Par 6.3.6 Reference to MLI document added Par 6.3.5 Launch Lock no longer baseline. Par 6.6, updated. Par 6.9.4, NOTE added. Par 6.9.5 Table replaced by new one. Par 6.9.6 Sensor names corrected. Par 6.9.8 Table re-instated. Par 6.9.10 Table replaced by new one. Par 7.3.6 Temperature sensor name corrected. Par 7.3.8 Table replaced. Par 8.2 Connector pin-out tables updated. Par 10.4 added, EIS Memory Map. Par 13.1.1 Table updated Par 13.1.2 Table updated Par 13.1.3 Table updated Par 14.4 New co-ordinates for access hole added. Par 16, Swagelock bulkhead connector re-defined. New par 17 added, Non-flight Items. Appendix 5 raised to issue 4. Appendix 7 raised to issue 7. New Appendix 8 added for Connector Panel details.
09	25 February 2003	 34, 35, 36, 37	Par 6.2 Correction to MTM/TTM Notes added at bottom of tables for clarification of the screen connections. Par 10.4, Memory map updated.

Contents

APPENDICES	**1. Structure GA**	**SR8193**
	2. Mounting Template	**SR8154**
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Note: Appendices 1,2 and 8 are available on the Birmingham ftp site - see Section 4

Appendix 3 is available on the MSSL ftp site - see Section 4

1 INTRODUCTION

Solar-B will study the connections between fine magnetic field elements in the photosphere and the structure and dynamics of the entire solar atmosphere.
The mission will perform three basic types of observation with high spatial, spectral and temporal resolution :

Determination of the photospheric magnetic vector and velocity fields.
Observation of the properties of the resulting plasma structures in the transition region and corona.
Measurement of the detailed density, temperature and velocity of these structures.

The EUV imaging spectrometer (EIS) will obtain plasma velocities to an accuracy of $<= 10$ km s^{-1} along with temperatures and densities in the transition region and corona at <2 arc sec resolution.

2 OVERVIEW

2.1 Description

EIS consists of a multi-layer coated single mirror telescope, and a stigmatic imaging spectrometer incorporating a multilayer coated diffraction grating. The image produced by the primary mirror is imaged onto an entrance slit/slot and the light which passes through this spectrometer aperture is dispersed and re-imaged at the focal plane of the CCD detectors.

A separate electronics box (ICU) provides the instrument control functions and interface with the spacecraft.

For details of the system definition see RD 3

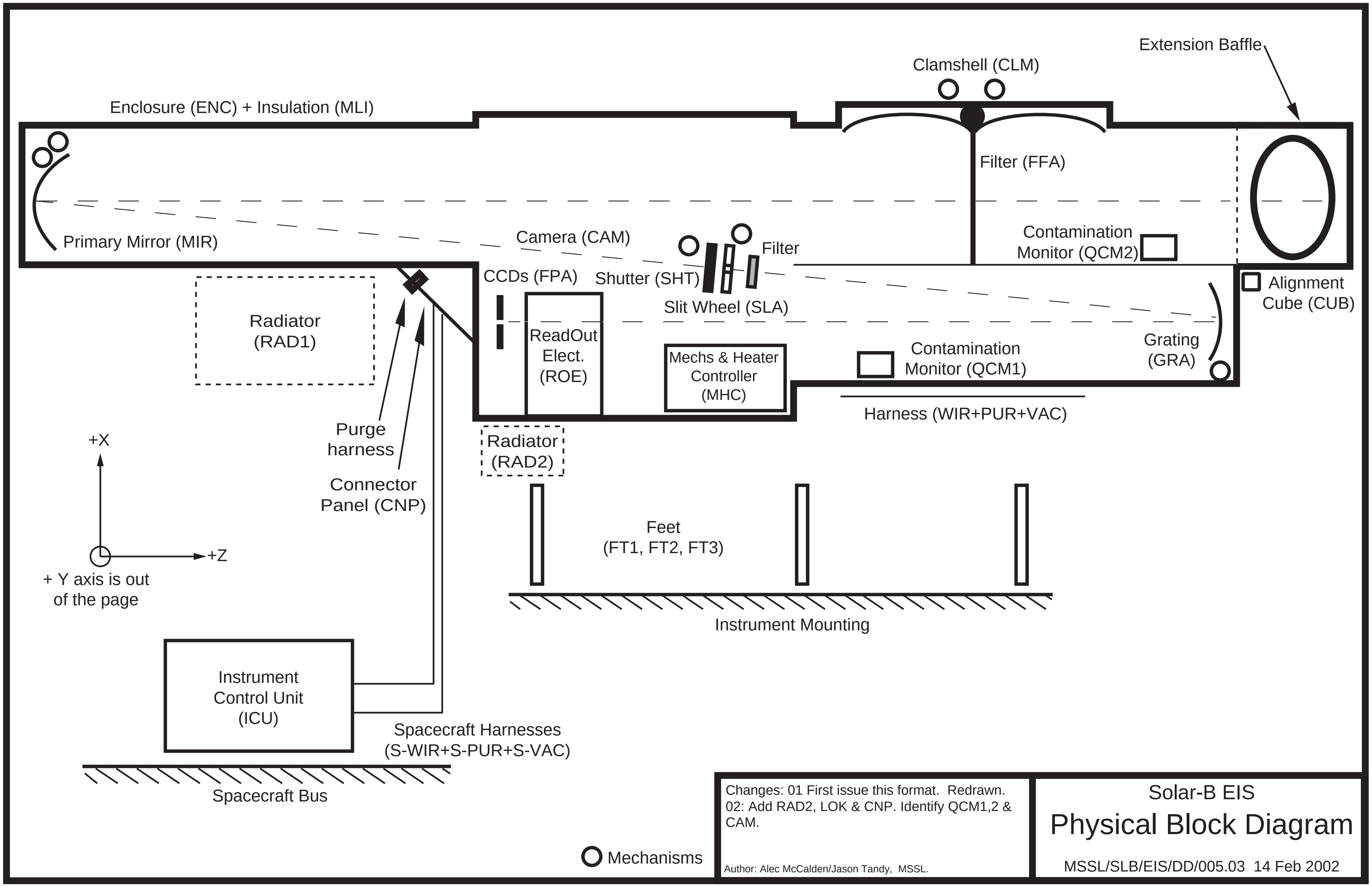
2.2 System Hierarchy

EUV Imaging Spectrometer
- Enclosure (Structure)
- Mirror Assembly
- Grating Assembly
- Slit-Slot Assembly
- Clamshell Assembly
- Camera Assembly
- Sensors and Heaters
- Mechanism and Heater Control Unit
- Thermal Blanket

Instrument Control Unit
- Processor
- Camera Buffer
- Spacecraft Interface
- Power Conditioner

Harness
- Electrical
- Purge

2.3 Block Diagram of EIS



3 APPLICABLE DOCUMENTS

RD 1	NAO/SLB-EIS/SP/MDP001.07	MDP-EIS-ICU Electrical Interface
RD 2	MSSL/SLB-EIS/SP/004.04	Mass Budget
RD 3	MSSL/SLB-EIS/SP/011.02	EIS System Definition
RD 4	MSSL/SLB-EIS/PA/003.01	Cleanliness Control Plan
RD 5	MSSL/SLB-EIS/PA/002.01	Product Assurance Plan
RD 6	SLB-124 iss 2.0	Environmental Conditions for Solar B
RD 7	SR8189_B.dxf	Station Dimension Reference
RD 8	SLB 120 iss 5.0	Solar B Electrical Design Standards (Japan)

4 FILE REFERENCES

The following files are available at the ftp site indicated

FR1	SOLARB-8193 P.dxf	EIS Spectrometer GA drawing	Birmingham
	(Note: SOLARB-8193 L2.dxf is the issue of the drawing relevant to the MTM/TTM)		
FR2	SR8154-C.dxf	Mounting Template Drawing	Birmingham
FR3	Deleted		
FR4	5275-300-3 iss 8	Instrument Control Unit ICD	MSSL
FR5	SR8434_E.dxf	Connector Panel	Birmingham
FR6	BU/SLB-EIS/TN031.01	MLI Description and Specification	Birmingham

Site addresses:

Birmingham	ftp://pc1.sr.bham.ac.uk/pub/solarb/mech
MSSL	ftp://ftp.mssl.ucl.ac.uk/projects/solarb/staging
NRL	ftp://tcrb.nrl.navy.mil

5 SPACECRAFT RESOURCE SUMMARY

The following sections provide the high level status of the mass and power budgets. No contingencies are held within the EIS project but rather they are held by the ISAS team and are available through a process of justifiable request.

5.1 Mass

Details of the Instrument Mass Budget are shown in RD 2. The overall mass is currently 61.03kg. The Harness is provided by ISAS and is not included in this budget.

5.2 Power

Mode	ICU	MHC	CAM	Mechs Pwr	Hot		Cold	
					Av Power	Pk Power	Av Power	Pk Power
Off	Off	Off	Off	Off	0.0	0.0	0.0	0.0
Boot	On	Off	Off	Off	14.2	17.1	14.2	17.1
Standby	On	Off	Off	Off	14.2	17.1	14.2	17.1
Emergency Safe	On	Off	Off	Off	14.2	17.1	14.2	17.1
Manual	On	On	On	On	29.8	55.3	39.8	55.3
Auto	On	On	On	On	29.8	55.3	39.8	55.3
Engineering	On	On	On	Off/On	29.8	55.3	39.8	55.3
Bake-out	On	Off	Off	Off	44.2	44.2	44.2	44.2

Note 1. All values are in Watts and refer to primary power.
Note 2. When the operational heaters are on the power is pulse width modulated. This excludes the CCD heater which is listed separately
Note 3. The design is such that operational heaters will be switched off while mechanisms are moved.
Note 4. Survival power is not included.
Note 5. The CCD heater will be used to decontaminate the CCD and will be used with other power systems switched down
Note 6. The difference between the hot and cold cases is due, when the instrument is hot, to a reduction in the average power of 10W as calculated in the current thermal model.

6 SPECTROMETER ENCLOSURE

6.1 Structure

The subsystems of the spectrometer enclosure are supported by a composite structure. This structure consists of a single base plate which performs the function of an optical bench. The optical elements are mounted directly (or near directly) from inserts within this composite base. The Spectrometer enclosure is formed by side and top composite panels which are held together with titanium inserts. The upper panel is divided into two parts, one of which is removable to provide access to the grating and slit-slot assemblies. Access to the mirror is via the associated end panel. The structure also provides for optical baffling.

The mechanical structure of EIS is shown in the drawing EIS Spectrometer GA SR8193, see Appendix 1 (file reference FR 1).

6.2 Stiffness

The lowest characteristic frequency is 58.8Hz about the mounting legs, as measured on the MTM/TTM.

6.3 Mechanical interface

6.3.1 Mechanical details

Details of the mechanical interface of EIS with the spacecraft are shown in the drawing GA, file reference FR 1 (see Appendix 1).

6.3.2 Specification of attachment surfaces

The attachment surface is a titanium insert within a moulded carbon fibre composite.
Surface roughness = 1.6µm CLA (Centre-Line-Average)
Co-planarity = ± 0.05mm between AO, BO and CO.

6.3.3 Attachment Fastening

There are three holes with 3 x 5/16" Unified tapped thread holes with 2x Concentric dia. 16.0 H7 (B0 & C0) and 1x Concentric dia.20.0 H7 (A0) holes for special shear bushes. The bolts are 3 x 5/16" Unified tapped thread with shear bushes 32mm long, concentrically positioned.
Fastener Torque: 18.9 - 21.7 Nm.
The required drawings are:
For A0 hole: drawing SR8217
For C0 hole: drawing SR8218
For B0 hole: drawing SR8219

6.3.4 Template

The Mounting Template is fitted with an alignment cube, which is used for initial co-alignment of the instrument with the spacecraft.
The details of the interface template are shown in the drawing Mounting Template, file reference FR 2 (see Appendix 2).

6.3.5 Launch Lock

This is no longer the baseline.

6.3.6 MLI

The MLI blanket is hand fitted to the instrument. There are cut-outs provided around the attachment points to the spacecraft. A document detailing the MLI description and specification is given in FR6.

6.4 Mass properties

The spectrometer mass is provided in section 5.1.

6.4.1 Centre of Gravity

The centre of gravity is at:
X = 0.031m
Y = 0.72m
Z = 1.854m. The coordinate system is STA.

6.4.2 Moments and Products of Inertia

Moments	Products	
Ixx = 315.87 kg.m²	Ixy = -5.17 kg.m²	
Iyy = 281.80 kg.m²	Iyz = -63.10 kg.m²	
Izz = 36.64 kg.m²	Izx = -63.38 kg.m²	All at point STA

6.5 Motors

Electric motors are used in the EIS instrument to move mechanisms. The following table summarizes their characteristics:

Table 6.5 Mechanism Characteristics

Mechanism Subassembly	Translation	Actuator	Encoder	Average Duty Cycle	Peak Internal Power	Average Power
MIR Primary Mirror Subassembly	Coarse Position	Size 16, 4 phase stepper motor	Resolver	2 (20 sec) operations per day	20 W	0.0092 W
	Fine Position	Piezoelectric Transducer	Strain gauge	0.5 V step per five seconds	0.29 W	<0.05 W
SLA Slit/Slot Subassembly	Slit/Slot Exchange	Size 12, 4 phase stepper motor	Resolver	2 operations per hour	6 W	0.0084 W
	Shutter	Brushless DC motor	Optical encoder	1 operation every 5 seconds	2.65 W	0.0122 W
GRA Grating Subassembly	Focus Mechanism	Size 16, 4 phase stepper motor	Optical encoder	2 (20 sec) operations per month	20 W	0.0092 W
NOTE: Duty cycle, peak internal power, and average dissipated power values are preliminary estimates.						

6.6 Field of View and Exclusion Zone

The EIS instrument views the Sun through a front aperture at the end of a rectangular baffle tube. This baffle tube extends sunward beyond the thin aluminium filters. The angular size of the Sun is 0.5 degree and the baffles and aperture openings are sized to accommodate this angle plus a 2 mm margin all around.

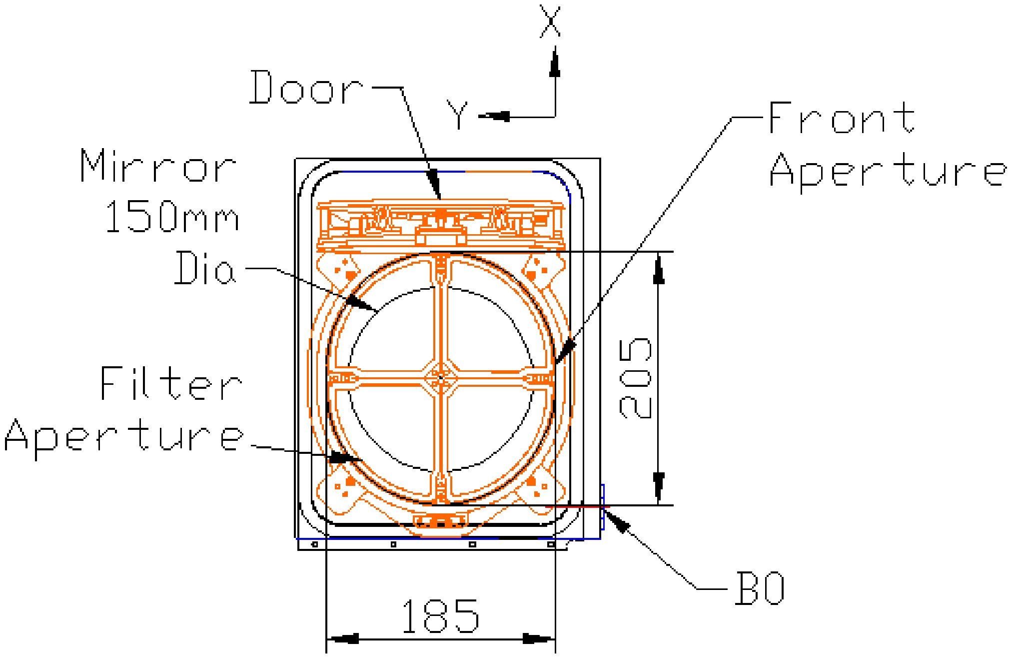


Figure 6.6a. EIS Entrance Aperture looking into instrument from +Z

The front aperture is actually an oval to accommodate the ±10 mm X translation of the primary mirror, but for simplicity the exclusion zones are represented as circular cones.

While the Sun only occupies a 0.5° cone angle, the front portion of the baffle tube serves to protect the thin aluminium filters from micrometeorites, orbital debris, and contamination. The most likely source of contamination or damage is from components of the Solar-B spacecraft itself. Outgassing from warm surfaces and particulates such as paint flakes will be very damaging to the filters. For this reason, the front baffle tube has been designed so that the filters have no direct line of sight to other components of the spacecraft.

In the present design, there is a light baffle ("Forward Baffle") midway between the filter and the entrance aperture. A conical zone of exclusion in front of the EIS aperture is configured in front of EIS such that no straight-line path outside this zone can reach beyond the middle baffle. Such an exclusion zone "Yellow" has a full angular extent of 65° about a line inclined 7.1° to the S/C Z direction in the YZ plane. A second conical exclusion zone of even higher importance is configured such that no straight line path outside this zone can reach the entrance filter. This "Red" exclusion zone has a full angular extent of 28° about a line inclined 1.3° to the S/C Z direction in the YZ plane. The apex points of the two cones are given in Table 6.6 below, together with other useful information about the front aperture.

The entrance aperture centre point location in S/C coordinates and foot point B0 are given as S/C STA coordinates in Table 6.6. The coordinates of BO are as supplied by the STA System (see file fairing.pdf from H Hara dated 1/18/00) and the EIS aperture has been calculated from this point. Should the STA location of BO move, the EIS aperture will move with it.

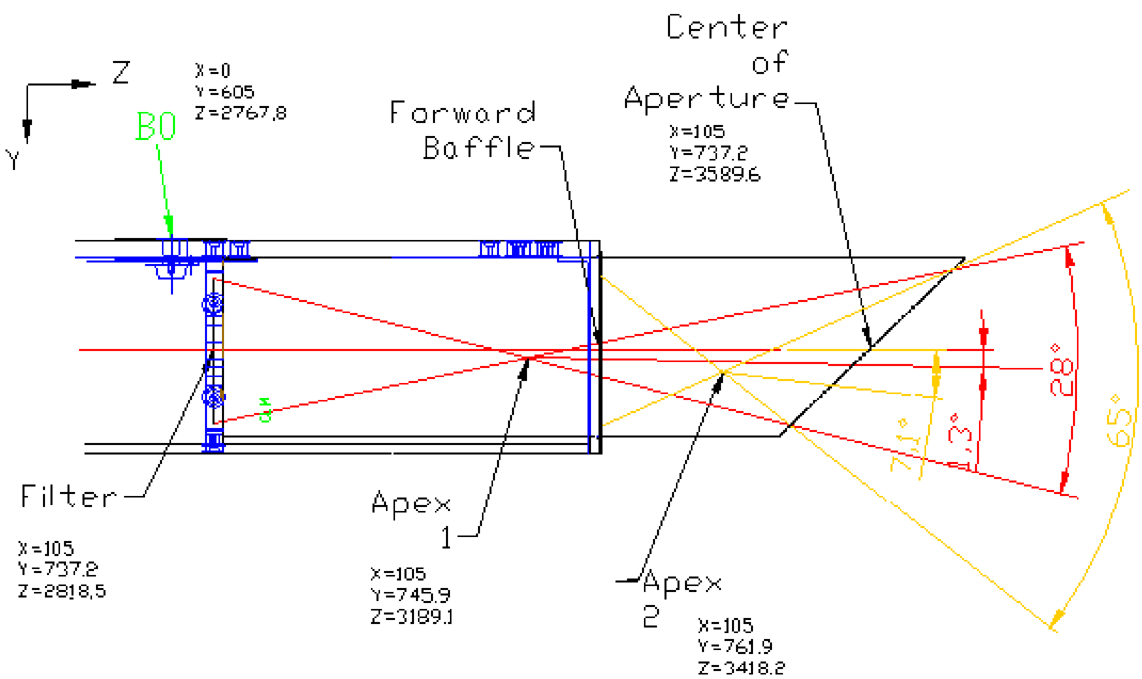


Figure 6.6b. EIS Exclusion Cones

Table 6.6. Location of EIS Entrance Aperture in STC Coordinates

S/C Coordinate	Footpoint B0 (mm)	Center of Filter	Apex of Cone 1	Apex of Cone 2	Center of EIS Aperture (mm)
X	0.0	105.0	105.0	105.0	105
Y	605.0	737.2	745.9	761.9	737.2
Z	2767.8	2818.5	3189.1	3418.2	3589.6
Cone Apex Angle			28°	65°	
Cone Angle WRT Z			1.3°	7.1°	

6.7 Disturbances

Disturbances to the spacecraft can be caused by both translating and rotational mechanisms.

6.7.1 Translating Mechanisms

6.7.2 Primary Mirror (MIR):

The primary mirror translates back and forth in the X direction by ± 8mm. This coarsely positions the image of the region of interest on the spectrometer slit. The selection of a single mirror telescope forces us to move the 2.3kg mirror assembly instead of a much smaller secondary mirror to do this. It is driven by one of the stepper motors mentioned above through a gearhead, which turns a ball screw. At its top speed of 200 steps/sec, the mirror can move 16 mm in 28.63 sec. It has already been determined that this is UA, but a speed reduction to 100 steps/sec brings us to a CA angular momentum, and further reductions can be made as necessary. The spreadsheet contains the time required for a 16 mm translation. The 16mm range is worst case, and corresponds to a slew from the East limb of the sun to the West limb. A mirror translation will be required whenever a new target is selected for EIS. This might occur on the order of once a day.

The cumulative angular momentum for the mirror translation is independent of the speed of the motion, depending only on the mass of the object, the distance from the S/C CG, and the distance traveled. For the EIS Primary mirror, the full range travel results in two UA values. These come into the CA range when moving smaller distances (on the order of 3mm), but we expect that since the motion is slow (taking ~1 min or more) the ACS can keep up with the disturbance. It is expected that re-pointing EIS will only occur when a new target is chosen for all Solar B instruments and the move can be made while fine pointing control is not required. If necessary, EIS can delay its move until the other instruments are finished exposing. It may be necessary to provide advance information to the ACS system to permit it to anticipate the disturbance. The S/C ACS engineers in Japan are studying this.

It is important to note that the range of this motion is limited to ±8mm in the X direction, so the cumulative angular momentum cannot grow beyond the maximum reported value. Any movement to an extreme position must be followed by a movement in the opposite direction. In the long term, the EIS targets will be randomly located on the sun and the cumulative angular momentum from the primary mirror will be zero.

a. **Grating Focus (GRA):** A grating focus mechanism is included, and incorporates the same motor and lead screw combination that is used for the primary mirror. Focus adjustments move the grating in the X-Z plane along a line making a 4.3° angle with the Z-axis. The disturbance was calculated for a 1mm movement of the grating, but normal movements are expected to be on the order of 0.25mm or less. The movement was assumed to take 60 sec. It is expected that several focus movements will be made during the commissioning of EIS, and once a best focus is attained, this mechanism will rarely be used. The speed of this movement could easily be increased, as the angular momentum is small.

6.7.3 Rotating Components:

There are three components that have rotational motions within EIS. The pivoting of the primary mirror during fine scan mode and the rotation of the shutter blade both are operational modes that involve continuous periodic motion. The third, the slit/slot interchange is an intermittent motion.

a. **Mirror Fine Scan (MIR):** The primary mirror fine scan is a rotation of the primary by up to 4 arc min about an axis located at the vertex of the mirror and oriented in the S/C Y direction. During the fine scan, the mirror moves very slowly, for example in steps of ~1 arcsec/sec. At the end of a scan, the mirror flies back to the starting position in about 2 sec. This "flyback" disturbance is calculated here (worst case). However, the sum of the fine scan and the flyback result is zero cumulative angular momentum for each scan cycle. The CG of the mirror is 3.81cm from the axis of rotation, so this is treated as a "static imbalance" disturbance. The disturbances are small since the angular travel is extremely small.

b. **Shutter (SLA):** The shutter blade is directly driven by a Kolmorgen 1" size stepper motor. The shutter is a thin disk with a sector cut out for the open position, so we have a static imbalance. The missing mass of this cutout is the source of this imbalance. Q for this item is 3.89E-6 Kg-m, and the worst cast rotational speed (15.7 rad/sec) is assumed for a 180°

rotation in 0.2 sec in the shortest exposures. The rotation axis of the shutter is in the X-Z plane and makes a 4.3° angle with the Z-axis. Reversing the shutter direction periodically possibly after every exposure can null the cumulative angular momentum.

EIS's shutter executes one complete cycle for each exposure, and the cadence can be as high as 1 Hz. This may be close to a vibration mode of the solar panels. The solar panel mode frequencies are TBD and must be determined on orbit. Exposure cadences must be chosen after launch to avoid exciting these resonances.

c. **Slit/Slot Mechanism (SLA):** The slit/slot mechanism is used to bring different sized apertures to the slit position. There are four apertures located 90° apart on a paddle wheel-like holder. A 90° rotation brings another slit into position. The mechanism is driven by a size 12 (0.75") CDA Astro stepper motor. A reducing gearhead is used to give the positioning accuracy required. The rotation axis is in the X-Z plane, nearly parallel to X. 14 sec are required to make the 90° movement, and intermittent operations several times per hour might occur in some observing plans. The device is tiny and moves slowly putting its disturbance into the "A" category.

6.7.4 Conclusions

All the disturbance torques except those associated with retargeting EIS by moving the Primary Mirror were found to be Acceptable (A) or Conditionally acceptable (CA). Steps that will be taken to minimize the UA effects on cumulative angular momentum are as follows: 1) The ACS system will study compensations for the EIS Primary Mirror movements. 2) Primary movements will be scheduled, not autonomous, and will occur within periods where fine pointing is not required by other instruments. 3) Movements of the Primary Mirror will be of duration consistent with the time constants of the ACS control system. 4) EIS will keep the moving mass to the practical minimum consistent with mechanical and optical constraints

Subsystem Name: Mechanical EIS Rev: E2 Date: 09-Aug-2000

Name of Moving Components	Moving Pattern						CM Position of Mov. Comp			Moving Mass/Inertia			Along Axis Disturbance		
	Type of Mov	Axis of Rotation/ Translat	Operation Frequency	Operation Interval T_1(s)	Duration of Mov τ_M(s)	Increment Angle $\Delta\theta_M$(deg)	X_M(m)	Y_M(m)	Z_M(m)	Mass m(kg)	Along Axis MOI I_M(kg m^2)	Transv Axis MOI J_M(kg m^2)	Cum. Ang. Momentum Σ_M(Nms^2)	Angular Momentum h_M(Nms)	Status
Trans.Mirror Mech	T(negl. motors)*	X	Intermittent	***	57.26	-0.717	0.133	0.725	-1.278	2.32	NA*	NA*	NA	NA	NA
						1.264									
Pivoting Mirror**	R	Y	Periodic	***	2	0.067	0.127	0.732	-1.287	1.3	2.48E-03	TBD	2.90E-06	1.45E-06	A
Shutter	R	Z (approx)	Continous	***	0.055	180	-0.021	0.747	0.663	0.049	1.58E-06	TBD	4.96E-06	9.02E-05	A
Slit/Slot****	R	X (approx)	intermittent	***	14	90	-0.031	0.716	0.663	0.032	2.07E-06	TBD	3.25E-06	2.32E-07	A
Grating	T(negl. motors)*	Z	infrequent	***	60	0.078	0.143	0.73	1.723	1.13	NA*	NA*	NA	NA	NA
						0.401									
Clamshell Front	R	Y	Once	0	1.0	90	0.244	0.746	1.329	0.6	0.0075	NA	1.18.E-02	1.18.E-02	UA
Clamshell Rear	R	Y	Once	0	1.0	-90	0.244	0.746	1.259	0.6	0.0075	NA	-1.18.E-02	-1.18.E-02	UA
Comments	Note1	Note 2	Note 3					Note4					Note 5		Note 6
	Note 1)R=Rotational, T=Translational 2)X,Y or Z in S/C Coord. 3)Continuous,Periodic,Irregular,etc. 4)Positions are in S/C Coord. 5) $\Sigma_M=h_M\tau_M=I_M\Delta\theta_M$ 6)A=Acceptable, CA=Conditionally Acceptable, UA Unacceptable, NA=Not Applicable CM position is STA (-0.024, -0.011, 1.537) [m].														

Name of Moving Components	Transverse Axis Disturbance																Remarks
	Angular Velocity ω_M(rad/s)	Dynamic Imbalance p(kg m^2)	Cum. Ang. Momentum Σ_M(Nms^2)	Status	Static Imbalance q(kg m)	Mom. Arm to S/C CM L_M(m)		Cum. Ang. Momentum Σ_M(Nms^2)	Status	Angular Momentum h_M(Nms)	Status	Misalign. γ_M(deg)	Cum. Ang. Momentum Σ_M(Nms^2)	Angular Momentum h_M(Nms)		Status	
Trans.Mirror Mech		NA	NA	NA	NA	NA	along Y	-4.74.E-02	UA	-8.28.E-04	CA	NA	NA	NA		NA	left out tiny motors
		NA	NA	NA	NA	NA	along Z	2.69.E-02	UA	4.70.E-04	A	NA	NA	NA		NA	left out tiny motors
Pivoting Mirror**	5.85E-04	TBD	TBD	TBD	0.04953	1.486		8.61.E-05	A	4.30.E-05	A						
Shutter	57.12	TBD	TBD	TBD	7.03E-08	0.999		1.260E-05	A	2.291E-04	CA##	-4.2	-3.64.E-07	-6.61.E-06	around X	A	MUST MEASURE P, will balance about rotion axis
Slit/Slot****	0.11	TBD	TBD	TBD	0	0		0	A	0	A	-4.2	-2.38.E-07	-1.70E-08	around Z	A	MUST MEASURE P, will balance about rotion axis
Grating		NA	NA	NA	NA	NA	along X	8.25.E-04	A	1.37E-05	A	NA	NA	NA		NA	left out tiny motors
		NA	NA	NA	NA	NA	along Y	1.62.E-04	A	2.69E-06	A	NA	NA	NA		NA	left out tiny motors
Clamshell Front	1.57	NA	NA	NA													
Clamshell Rear	-1.57	NA	NA	NA													
Comments	Note 7			Note 6		Note 8					Note 6				Note 6		
	Note 6)A=Acceptable, CA=Conditionally Acceptable, UA=Unacceptable, NA=Not Applicable Note 7) $\omega_M=\Delta\theta_M/\tau_M$ 8)LM is the distance between Mov Comp CM and S/C CM along the Axis of Rotation																

*-neglecting the inertias of the tiny motors that comprise the overall mechanisms, the Grating and Mirror mechs both have identical motors.
**- Assumed that the duration of the entire pivot of the mirror mechanism from +2arcmin to -2arcmin is 2 sec therefore w is 0.00058 in flyback mode
***- This is for the science side to specify.
****-We assumed that the slot would move 90° in 14 seconds.
This value is actually zero when combined with the cumulative angular momentum of the preceeding scan, so should be "A"
This value can be made A by adding balance weight to shutter blade. Worst case unbalance assumed here.
guessed-still need vendor data

The shutter will have various durations of movement and increment angles, the one mentioned is most common

If component weight and position are fixed cumulative angular momentum will not change regardless of how slowly component is moved.

The duration of this movement can be increased until the angular momentum is acceptable

28.63	τ_M(s) at maximum motot speed (200 steps/sec)
57.26	τ_M(s) at half maximum motor speed (100 steps/sec)

Name of Moving Components		Position of Mov. Comp in STA Coord.		
		X_{STA} (m)	Y_{STA} (m)	Z_{STA} (m)
Trans.Mirror Mech		0.109	0.714	0.259
Pivoting Mirror**		0.103	0.721	0.250
Shutter		-0.045	0.736	2.200
Slit/Slot****		-0.055	0.705	2.200
Grating		0.119	0.719	3.260
Clamshell Front		0.220	0.735	2.866
Clamshell Rear		0.220	0.735	2.796

6.8 Provisional EIS Co-alignment

The Solar B instrument complement must be sufficiently well co-aligned to have reasonable overlap of the three instrument's fields of view. To accommodate co-alignment at the spacecraft level, the EIS instrument will have an optical alignment cube. The alignment cube will be aligned to the EIS telescope optical axis to within 20 arc-seconds on an optical bench in the laboratory. The cube will be utilized to co-align the EIS optical axis with the axes of the spacecraft sun sensor and the other instruments. Along the north-south direction, the EIS field of view is 1024 arc-seconds and along the east-west direction the coarse mirror motion corrects for up to +/- 800 arc-second. Even with an additive 1 arc-minute tilt of the primary and grating, the EIS field still maintains complete coverage of the SOT field of view and is still well centered within the XRT field of view.

Table 10. Preliminary internal EIS co-alignment error budget (significant contributors only)

Subassembly	Significant error budget contributor
Alignment cube	10 arc-seconds transfer error to cube front face 20 arc-seconds mechanical variation total: 30 arc-seconds optical axis error note: cube face tolerance of <5 arc-seconds expected
Parabolic mirror	30 arc-seconds optic/mount tilt 30 arc-seconds structure tilt total: 60 arc-seconds of tilt, 120 arc-seconds equivalent solar error
Grating	30 arc-seconds optic/mount tilt 30 arc-seconds structure tilt total: 60 arc-seconds of tilt, 62 arc-seconds equivalent solar error
RSS total:	138 arc-seconds

Note: Additive error budgeting at the component interface level has been utilized to simulate a cross-coupled error. The gross errors in each component were root sum squared to produce the total.

6.9 Thermal interface

6.9.1 Attached Area

Area of attachment points are:

A0: 7.1 cm^2
B0: 8.2 cm^2
C0: 8.2 cm^2
Power flow across attachment point to be <5W in either direction

6.9.2 Heat Flux Across Attachment Points

	Off (non-op cold case)	Typical operating (av hot/cold)	Peak (operating)	Survival (25 deg hot survival)
Absolute W				
A0	0.03	0.5	0.8	0.04
B0	0.24	0.3	0.5	0.1
C0	0.02	0.1	0.2	0.04
Density W/cm^2				
A0	0.004	0.07	0.1	0.006
B0	0.03	0.04	0.06	0.01
C0	0.002	0.01	0.02	0.005

Note that this is required to be < 5W per attachment point in either direction

6.9.3 Heat Capacity

The heat capacity of the Spectrometer is 49555 J/K. The total heat capacity is calculated by multiplying an average heat capacity (850 J/kg.K) by the spectrometer mass (EIS budget - launch lock mass - ICU mass - external harness mass).

6.9.4 Acceptable Temperature Ranges

Critical Item	Operating	Survival
Mirror	+10 to +30°C	0 to +40°C
Piezo actuator	+10 to +30°C	0 to +40°C
Grating	+10 to +30°C	0 to +40°C
CCD	-55 to -45°C	-100 to + 60°C
Clamshell filter	TBC	TBC
Secondary filter	TBC	TBC
Slit-Slot	+10 to +30°C	0 to +40°C

CCD bakeout temperature +30°C

NOTE: These temperatures represent steady state limits and deviations beyond this range for limited durations for acceptance testing, are acceptable with consent from the EIS Project Manager.

6.9.5 Positions of Temperature Measurement

The following sensors are provided by the spacecraft at the locations indicated.

	Position of sensor in STA				Sensor Hardware ID (ID attached on each sensor)	Temperature range (deg C) TL: -50/+80 TH1: -150/+150	Resolution (deg C)
	X	Y	Z				
Front CLM				EIS-STR-1	GR01	TL	0.5
Rear CLM				EIS-STR-2	GR02	TL	0.5
CLM bulkhead				EIS-STR-3	GR03	TL	0.5
Particle shield				EIS-STR-4	GR04	TH1	1.2
ROE thermal shield ?				EIS-STR-5	GR05	TL	0.5
ROE box				EIS-STR-6	FQ41	TL	0.5
MHC base plate				EIS-STR-7	GR06	TL	0.5

6.9.6 Spacecraft Supplied Temperature Sensors

1. HKU Interface: seven on the enclosure, type Rosemount Aerospace Pt sensor model 118MF1000A
2. HCE Interface: three in total on survival heaters, type YSI GSFC specification 311P18-07A7R6

6.9.7 Interface Temperatures

Location	Operating	Survival
A0	+10°C to +30°C	-30°C to +40°C
B0	+10°C to +30°C	-30°C to +40°C
C0	+10°C to +30°C	-30°C to +40°C

Note: these temperatures are at the junction between the top of the legs and the EIS structure.

6.9.8 Properties of Outer Surfaces

	Surface material	Emissivity		Solar absorptivity	
		BOL	EOL	BOL	EOL
MLI	Black kapton	0.78	0.78	0.93	0.93
CCD radiator	White paint	0.90	0.88	0.12	0.14
ROE radiator	White paint	0.90	0.88	0.12	0.14

6.9.9 Operational Heaters

The maximum operational heater power is 15 watts.
Note 1: see the thermal model for detailed distribution of this power.
Note 2: the CCD heaters (total 38 watts for the 2 CCDs) will be used to decontaminate the CCDs and will be used with other power systems switched down.

6.9.10 Survival Heaters

HCE Circuit ID	Heater location (Node ID in thermal math model)	Heater Wattage	Sensor location (Node ID)	Sensor Hardware ID	ON/OFF Temperature (deg C)
Survival heater A	Base panel near GRA (6025)	1.5 W	MIR (6063)	59978	0 / +5
	MIR (6063)	3.5 W			
Survival heater B	GRA (6064)	5.0 W	GRA (6064)	59985	0 / +5
Survival heater C	Base panel near MIR (6047)	1.0 W	MIR (6063)	59984	0 / +5
	CCD (6070)	4.0 W			

Each port is 5 watts and details of the distribution of the power are shown in the thermal model.

7 INSTRUMENT CONTROL UNIT (ICU)

7.1 Mechanical Interface

7.1.1 Mechanical details

Details of the mechanical interface of the ICU with the spacecraft are shown in FR4, see Appendix 3.

7.1.2 Specification of attachment surfaces

The attachment point of the ICU is aluminium
Surface roughness = 1.6µm CLA (Centre-Line-Average)

7.1.3 Attachment Fastening

The ten mounting holes have a diameter of 5.40 +0.30 - 0.05mm, to suit 10-32 UNF mounting bolts. The interface details are referenced in par 7.1.1.
The fastener torque is 35.7 - 39.1 kgf-cm (standard MS 16996 - D/N)

7.2 Mass Properties

The mass of the ICU is given in section 5.1

7.2.1 Centre of Gravity

x = 163.81mm
y = 121.28mm
z = 55.61mm

These values are calculated with respect to a reference datum identified in FR4, ICU Interface, see Appendix 3.

7.2.2 Moments of Inertia

$I_{xx} = 0.063$ kg.m²
$I_{yy} = 0.038$ kg.m²
$I_{zz} = 0.084$ kg.m²

These values are calculated with respect to a reference datum identified in FR4, ICU Interface, see Appendix 3.

7.3 Thermal Interface

7.3.1 Attached Area

The base of the ICU will be machined flat but for the purpose of this section it is assumed that the whole area will provide useful thermal contact.

Total area of attachment of the base of the ICU is 766.42 cm^2

7.3.2 Heat Flux Across Base of ICU

	Typical operating	Peak	Survival
Absolute W	21.3	25.3	0
Density W/cm^2	0.028	0.033	0

7.3.3 Heat Capacity

The heat capacity of the ICU is 5568 J/K. . The total heat capacity is calculated by multiplying an average heat capacity (850 J/kg.K) by the ICU mass.

7.3.4 Acceptable Temperature Ranges

Operating	Survival
-20°C to +50°C	-30°C to +65°C

7.3.5 Positions of Temperature Measurement

The following sensors are provided by the spacecraft at the locations indicated.

Sensor position					Sensor Hardware ID	Temperature range (deg C) TL: -50/+80 TH1: -150/+150	Temperature resolution (deg C)
Name	X	Y	Z				
Near base datum				EIS-ICU-1	FQ38	TL	0.5
Top of front panel				EIS-ICU-2	FQ40	TL	0.5

These values are calculated with respect to a reference datum identified on the drawing, FR4, see Appendix 3 .

7.3.6 Spacecraft Supplied Temperature Sensors

HKU Interface: two provided, type Rosemount Aerospace Pt sensor model 118MF1000A.

7.3.7 Interface Temperatures

Operating	Survival
-20°C to +50°C	-30°C to +65°C

7.3.8 Properties of Outer Surfaces

	Emissivity		Surface material
	BOL	EOL	
ICU surface	0.91	0.91	Chemglaze Z306
ICU base area	0.08	0.08	Alocrom 1200

8 ELECTRICAL INTERFACES

There are five electrical interfaces between EIS-ICU (Interface Control Unit) and Solar-B system components:

1. ICU – DIST (Distributor)
2. ICU – TCI-B (Telemetry Command Interface B)
3. ICU – HKU (House Keeping Unit)
4. ICU – HCE (Heater Control Electronics)
5. ICU – MDP (Mission Data Processor)

See Appendix 7 for a diagram showing further details.

8.1 MDP—EIS-ICU Electrical Interface

See section 4 in RD1 for details.

8.2 Electrical Pin-outs

The grounding scheme is shown in MSSL/SLB-EIS/DD002, see Appendix 5.
The scheme for cables and connectors is shown in MSSL/SLB-EIS/DD008, see Appendix 7.

See the following sheets for details of the connector pinouts:

ICU1 (DIST+TCI.PM & FM

Connector (PM): DBMA25P
Connector (FM): DBMA25P

Power+control+status
Cable: EIS-S-WIR08

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
28V Main Bus	3	2	+28V	PS	I		AWG20		DIST		28V	
28V Main Bus	5	4	+28V	PS			AWG20				28V	
28V Main Bus	16	15	+28V	PS	I		Removed by Melco		DIST		28V	
28V Main Bus	18	17	+28V	PS			Removed by Melco				28V	
Main Bus ret	2	3	COM	PS	I		AWG20		DIST		0V	
Main Bus ret	4	5	COM	PS			AWG20				0V	
Main Bus ret	15	16	COM	PS	I		Removed by Melco		DIST		0V	
Main Bus ret	17	18	COM	PS			Removed by Melco				0V	
Overall scn	1	-	-				Prepared for future use		-			
Overall scn	14	-	-				Prepared for future use					
Control Pwr On+	9	10	Sig	D	I		AWG 30 (was AWG26)		TCI-B		12V	
Control Pwr On-	10	9	Sig	D			AWG 30 (was AWG26)				12V	
Control Pwr Off+	11	12	Sig	D	I		AWG 30 (was AWG26)		TCI-B		12V	
Control Pwr Off-	12	11	Sig	D			AWG 30 (was AWG26)				12V	
Switch Monitor+	23	24	Sig	D	O		AWG 30 (was AWG26)		TCI-B			
Switch Monitor-	24	23	Sig	D			AWG 30 (was AWG26)					
Overall scn	13	-	-				Prepared for future use		TCI-B			
Overall scn	25	-	-				Prepared for future use					
Ground A	21						Not used					
Ground A	22						Not used					

ICU2 (CNP1) PM & FM

Connector (PM): DAMA15S
Connector (FM): DAMA15S

MHC & CAM RS-422
Cable: EIS-S-WIR01

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
MHC_CTL_TX+	1	2	Sig	D	O		AWG30 (was AWG26)		CNP			9600 Baud
MHC_CTL_TX-	2	1	Sig	D			AWG30 (was AWG26)					
MHC_TX_SCN	9	-	-			Screen to pin 12 using AWG26	Screen					
MHC_CTL_RX+	3	4	Sig	D	I		AWG30 (was AWG26)		CNP			9600 Baud
MHC_CTL_RX-	4	3	Sig	D			AWG30 (was AWG26)					
MHC_RX_SCN	11	-	-			Sceen not connected	-					
ROE_CTL_TX+	5	6	Sig	D	O		AWG30 (was AWG26)		CNP			9600 Baud
ROE_CTL_TX-	6	5	Sig	D			AWG30 (was AWG26)					
ROE_TX_SCN	13	-	-			Screen to pin 12 using AWG26	Screen					
ROE_CTL_RX+	7	8	Sig	D	I		AWG30 (was AWG26)		CNP			9600 Baud
ROE_CTL_RX-	8	7	Sig	D			AWG30 (was AWG26)					
ROE_RX_SCN	15	-	-			Sceen not connected	-					
COMMON	14	-	COM(2)			Secondary 0V	AWG26		CNP			
SCREEN	12		GND			Chassis	AWG26					

The cable is pin 1 to pin 1, pin 2 to pin 2, etc, unless stated otherwise

ICU3 (MDP) PM & FM

Connector (PM): DBMA25S
Connector (FM): DBMA25S

Command+status+data
Cable: EIS-S-WIR07

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
CMD_ENA+	7	8	Sig	D	I	Screen not connected	AWG30 (was AWG26)		MDP			3.9kHz
CMD_ENA-	8	7	Sig	D			AWG30 (was AWG26)					
CMD_CLK+	9	10	Sig	D	I	Screen not connected	AWG30 (was AWG26)		MDP			62.5kHz
CMD_CLK-	10	9	Sig	D			AWG30 (was AWG26)					
CMD_DAT+	11	12	Sig	D	I	Screen not connected	AWG30 (was AWG26)		MDP			31.3kHz
CMD_DAT-	12	11	Sig	D			AWG30 (was AWG26)					
ST_ENA+	19	20	Sig	D	O	Screen to pin 1	AWG30 (was AWG26)		MDP			3.9kHz
ST_ENA-	20	19	Sig	D			AWG30 (was AWG26)					
ST_CLK+	21	22	Sig	D	O	Screen to pin 1	AWG30 (was AWG26)		MDP			62.5kHz
ST_CLK-	22	21	Sig	D			AWG30 (was AWG26)					
ST_DAT+	23	24	Sig	D	O	Screen to pin 1	AWG30 (was AWG26)		MDP			31.3kHz
ST_DAT-	24	23	Sig	D			AWG30 (was AWG26)					
MD_ENA+	14	15	Sig	D	O	Screen to pin 1	AWG30 (was AWG26)		MDP			125kHz
MD_ENA-	15	14	Sig	D			AWG30 (was AWG26)					
MD_CLK+	16	17	Sig	D	O	Screen to pin 1	AWG30 (was AWG26)		MDP			2MHz
MD_CLK-	17	16	Sig	D			AWG30 (was AWG26)					
MD_BSY+	2	3	Sig	D	I	Screen to pin 1	AWG30 (was AWG26)		MDP			
MD_BSY-	3	2	Sig	D			AWG30 (was AWG26)					
MD_DAT+	4	5	Sig	D	O	Screen to pin 1	AWG30 (was AWG26)		MDP			1MHz
MD_DAT-	5	4	Sig	D			AWG30 (was AWG26)					
Overall scn	1	-	GND				AWG26		MDP			
Overall scn	13	-	GND				Not connected					
COMMON 1K	25	-	COM(1K)				AWG26		MDP			
COMMON	18	-	COM(2)				Not connected					

ICU4 (CNP2) PM & FM

Connector (PM): DEMA9P
Connector (FM): DEMA9P

Camera science data
Cable: EIS-S-WIR02

Sub-system Details								Remote Connection				
Name	**Pin No.**	**Twist with**	**Type**	**D/A**	**I/O**	**Interface**	**Cable**	**Interface**	**Unit**	**I**	**V**	**Speed**
ROE_SCI_STRB+	2	6	Sig	D	I		AWG22		CNP			32MHz
ROE_SCI_STRB-	6	2	Sig	D			AWG22					
SCREEN_STRB	1	-	GND			Use AWG26 to pin 1	Screen		CNP			
ROE_SCI_DAT+	4	9	Sig	D	I		AWG22		CNP			32MHz
ROE_SCI_DAT-	9	4	Sig	D			AWG22					
SCREEN_DAT	5	-	GND			Use AWG26 to pin 5	Screen		CNP			
OVERALL_SCN	7	-	GND				Prepared for future use		CNP			
COMMON	3	-	COM(2)			Secondary 0V	AWG26					

The cable is pin 1 to pin 1, pin 2 to pin 2, etc, unless stated otherwise

ICU5 (CNP3) PM & FM

Connector (PM): DCMA37S
Connector (FM): DCMA37S

MHC & CAM power
Cable: EIS-S-WIR03

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
28V MHC2 Switch	3	4	+28V	PS	O	Mechanisms	AWG22		CNP			
28V MHC2 ret	4	3	COM	PS			AWG22					
28V OpHtr Switch	5	6	+28V	PS	O		AWG20		CNP			
28V OpHtr ret	6	5	COM	PS			AWG20					
28V MHC1 Switch	10	11	+28V	PS	O	Electronics	AWG24		CNP			
28V MHC1 ret	11	10	COM	PS			AWG24					
28V MHC Mkup Switc	12	13	+28V	PS	O		AWG24		CNP			
28V MHC Mkup ret	13	12	COM	PS			AWG24					
28V CAM Mkup Switc	16	17	+28V	PS	O		AWG24		CNP			
28V CAM Mkup ret	17	16	COM	PS			AWG24					
P 13V CAM Switch D	28	29	+13V	PS	O	Screen to pin 1 using AWG26	AWG20 (was AWG24)		CNP			
Ground D	29	28	COM(2)	PS			AWG20 (was AWG24)					
P 8V CAM Switch C	30	31,34, 35	+8V	PS	O	Screen to pin 1 using AWG26	AWG20 (was AWG24)		CNP			
Ground C	31	30,34, 35	COM(2)	PS			AWG20 (was AWG24)					
P 7V CAM Switch B	32	33	+7V	PS	O	Screen to pin 1 using AWG26	AWG20		CNP			
Ground B	33	32	COM(2)	PS			AWG20					
N 8V CAM Switch C	34	30,31, 35	-8V	PS	O	Screen to pin 1 using AWG26	AWG20		CNP			
P 39V CAM Switch C	35	30,31, 34	+39V	PS			AWG20					
Overall scn	1	-	-			Chassis	AWG26		-			
Overall scn	19	-	-				Prepared for future use					

The cable is pin 1 to pin 1, pin 2 to pin 2, etc, unless stated otherwise

ICU6 (CNP4) FM only

Connector (PM): DAMA15S
Connector (FM): DAMA15S

CCD Op htrs & sensors
Cable: EIS-S-WIR04

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
CCD A Heater	2	3, 10	+28'V	PS	O		AWG24		CNP			
CCD A Heater ret	3	2, 10	COM	PS			AWG24					
CCD B Heater	10	2, 3	+28V	PS	O	Wired to pin 3 using AWG26	AWG24		CNP			
CCD B Heater ret	11		COM	PS			Removed by Melco					
CCD0 Sensor	5	6, 13	SIG	A	I		AWG30 (was AWG26)		CNP			
CCD0 Sensor ret	6	5, 13	SIG	A			AWG30 (was AWG26)					
CCD1 Sensor	13	5, 6	SIG	A	I	Wired to pin 6 using AWG30	AWG30 (was AWG26)		CNP			
CCD1 Sensor ret	14		SIG	A			Removed by Melco					
Overall scn	1	-	GND				Prepared for future use		CNP			
Overall scn	8	-	GND				Prepared for future use					

The cable is pin 1 to pin 1, pin 2 to pin 2, etc, unless stated otherwise

ICU7 (HKU) FM only

Connector (PM): DEMA9P
Connector (FM): DEMA9P

ICU temperature senso
Cable: EIS-S-WIR05

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
Overall scn	1	-	Screen			(No connection)	Screen		HKU			
Sensor 8	2	3, 7	SIG	A	O	ICU foot	AWG30 (wasAWG26)		HKU			
Sensor 8 ret	3	2, 7	SIG	A			AWG30 (wasAWG26)					
Sensor 9	7	2, 3	SIG	A	O	ICU top Wired to pin 3 using AWG30	AWG30 (wasAWG26) Removed by Melco		HKU			
Sensor 9 ret	8		SIG	A								

CNP1 (ICU2) PM & FM

Connector (PM): DAMA15P
Connector (FM): DAMA15P

MHC& CAM RS-422
Cable: EIS-S-WIR01

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
MHC_CTL_RX+	1	2	SIG	D	I		AWG30 (was AWG26)	Pin 1	ICU			9600 Baud
MHC_CTL_RX-	2	1	SIG	D			AWG30 (was AWG26)	Pin 2				
MHC_RX_SCN	9	-	STP			Screen to pin 9 using AWG26	Screen					
MHC_CTL_TX+	3	4	SIG	D	O		AWG30 (was AWG26)	Pin 3	ICU			9600 Baud
MHC_CTL_TX-	4	3	SIG	D			AWG30 (was AWG26)	Pin 4				
MHC_TX_SCN	11	-	STP			Screen to pin 11 using AWG26	Screen					
ROE_CTL_RX+	5	6	SIG	D	I		AWG30 (was AWG26)	Pin 5	ICU			9600 Baud
ROE_CTL_RX-	6	5	SIG	D			AWG30 (was AWG26)	Pin6				
ROE_RX_SCN	13	-	STP			Screen to pin 13 using AWG26	Screen					
ROE_CTL_TX+	7	8	SIG	D	O		AWG30 (was AWG26)	Pin 7	ICU			9600 Baud
ROE_CTL_TX-	8	7	SIG	D			AWG30 (was AWG26)	Pin 8				
ROE_TX_SCN	15	-	STP			Screen to pin 15 using AWG26	Screen					
COMMON	14	-	COM(2)			Secondary 0V	AWG26		ICU			

The cable is pin 1 to pin 1, pin 2 to pin 2, etc, unless stated otherwise

CNP2 (ICU4) PM & FM

Connector (PM): DEMA9S
Connector (FM): DEMA9S

Camera science data
Cable: EIS-S-WIR02

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
ROE_SCI_STRB+	2	6	Sig	D	O		AWG22		ICU			32MHz
ROE_SCI_STRB-	6	2	Sig	D			AWG22					
SCREEN_STRB	1	-	STP			Use AWG26 to pin 1	Screen		ICU			
ROE_SCI_DAT+	4	9	Sig	D	O		AWG22		ICU			32MHz
ROE_SCI_DAT-	9	4	Sig	D			AWG22					
SCREEN_DAT	5	-	STP			Use AWG26 to pin 5	Screen		ICU			
OVERALL_SCN	7	-	STP			Chassis	Prepared for future use		ICU			
COMMON	3	-	COM(2)			Secondary 0V	AWG26					

The cable is pin 1 to pin 1, pin 2 to pin 2, etc, unless stated otherwise

CNP3 (ICU5) PM & FM

Connector (PM): DCMA37P
Connector (FM): DCMA37P

MHC & CAM power
Cable: EIS-S-WIR03

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
28V MHC2 Switch	3	4	+28V	PS	I	Mechanisms	AWG22		ICU			
28V MHC2 ret	4	3	COM	PS			AWG22					
28V OpHtr Switch	5	6	+28V	PS	I		AWG20		ICU			
28V OpHtr ret	6	5	COM	PS			AWG20					
28V MHC1 Switch	10	11	+28V	PS	I	Electronics	AWG24		ICU			
28V MHC1 ret	11	10	COM	PS			AWG24					
28V MHC Mkup Switc	12	13	+28V	PS	I		AWG24		ICU			
28V MHC Mkup ret	13	12	COM	PS			AWG24					
28V CAM Mkup Switc	16	17	+28V	PS	I		AWG24		ICU			
28V CAM Mkup ret	17	16	COM	PS			AWG24					
P 13V CAM Switch D	28	29	+13V	PS	I	Screen to pin 1 using AWG26	AWG20 (was AWG24)		ICU			
Ground D	29	28	COM(2)	PS			AWG20 (was AWG24)					
P 8V CAM Switch C	30	31,34, 35	+8V	PS	I	Screen to pin 1 using AWG26	AWG20 (was AWG24)		ICU			
Ground C	31	30,34, 35	COM(2)	PS			AWG20 (was AWG24)					
P 7V CAM Switch B	32	33	+7V	PS	I	Screen to pin 1 using AWG26	AWG20		ICU			
Ground B	33	32	COM(2)	PS			AWG20					
N 8V CAM Switch C	34	30,31, 35	-8V	PS	I	Screen to pin 1 using AWG26	AWG20		ICU			
P 39V CAM Switch C	35	30,31, 34	+39V	PS			AWG20					
Overall scn	1	-	-			Chassis	AWG26					
Overall scn	19	-	-				Prepared for future use					

The cable is pin 1 to pin 1, pin 2 to pin 2, etc, unless stated otherwise
The internal harness of the EIS structure will have an overall foil screen. Pins 1 and 19 will be connected to this.
The ROE chassis will be connected to the foil screen at the ROE.

CNP4 (ICU6) FM only

Connector (PM): DAMA15P
Connector (FM): DAMA15P

CCD Op htrs & sensors
Cable: EIS-S-WIR04

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
CCD A Heater	2	3, 11	+28V	PS	I		AWG24		ICU			
CCD A Heater ret	3	2, 11	COM	PS			AWG24					
CCD B Heater	10	2, 3	+28V	PS	I	Wired to pin 3 using AWG26	AWG24		ICU			
CCD B Heater ret	11		COM	PS			Removed by Melco					
CCD0 Sensor	5	6, 13	TEMP	A	O		AWG30 (was AWG26)		ICU			
CCD0 Sensor ret	6	5, 13	TEMP	A			AWG30 (was AWG26)					
CCD1 Sensor	13	5, 6	TEMP	A	O	Wired to pin 6 using AWG30	AWG30 (was AWG26)		ICU			
CCD1 Sensor ret	14		TEMP	A			Removed by Melco					
Overall scn	1	-	STP			Chassis	Prepared for future use		ICU			
Overall scn	8	-	STP				Prepared for future use					

The cable is pin 1 to pin 1, pin 2 to pin 2, etc, unless stated otherwise.
Pins 1 and 8 will be connected to the foil screen within the EIS structure harness. The pins are ready to take a connection to the screen of the harness between the ICU and CNP if added at a later date.

CNP5 (HKU) FM only

Connector (PM): DAMA15P
Connector (FM): DAMA15P

HKU temp sensors
Cable: EIS-S-WIR05

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
Overall scn	1	-	STP			Chassis	-					
Sensor 1	2	3, 4, 6, 8, 9	TEMP	A	O		AWG30 (was AWG26)		HKU			
Sensor1 ret	3	2, 4, 6, 8, 9	TEMP	A			AWG30 (was AWG26)					
Sensor 2	4	2, 3, 6, 8, 9	TEMP	A	O	Wired to pin 3 using AWG30	AWG30 (was AWG26) Removed by Melco		HKU			
Sensor 2 ret	5		TEMP	A								
Sensor 3	6	2, 3, 4, 8, 9	TEMP	A	O	Wired to pin 3 using AWG30	AWG30 (was AWG26) Removed by Melco		HKU			
Sensor 3 ret	7		TEMP	A								
Sensor 4	8	2, 3, 4, 6, 9	TEMP	A	O	Wired to pin 3 using AWG30	AWG30 (was AWG26) Removed by Melco		HKU			
Sensor 4 ret	15		TEMP	A								
Sensor 5	9	2, 3, 4, 6, 8	TEMP	A	O	Wired to pin 3 using AWG30	AWG30 (was AWG26) Removed by Melco		HKU			
Sensor 5 ret	10		TEMP	A								
Sensor 6	11	12, 13	TEMP	A	O		AWG30 (was AWG26)		HKU			
Sensor 6 ret	12	11, 13	TEMP	A			AWG30 (was AWG26)					
Sensor 7	13	11, 12	TEMP	A	O	Wired to pin 12 using AWG30	AWG30 (was AWG26) Removed by Melco		HKU			
Sensor 7 ret	14		TEMP	A								

Pin 1 will be connected to the foil screen of the EIS structure harness. The pin is ready to take a connection to the screen of the harness between the HKU and CNP if added at a later date.

CNP6 (HCE) FM only

Connector (PM): DBMA25P
Connector (FM): DBMA25P

Survival heaters
Cable: EIS-S-WIR06

Sub-system Details								Remote Connection				
Name	Pin No.	Twist with	Type	D/A	I/O	Interface	Cable	Interface	Unit	I	V	Speed
Survival Heater A	2	3	+28V	PS	I		AWG26		HCE			
Survival Heater A ret	3	2	+28V	PS			AWG26					
Survival Heater B	4	5 6	+28V	PS	I		AWG26		HCE			
Survival Heater B ret	5	4 6	+28V	PS			AWG26					
Survival Heater C	6	4 5	+28V	PS	I	Wired to pin 5 usin AWG26	AWG26		HCE			
Survival Heater C ret	7		+28V	PS			Removed by Melco					
Survival Sensor A	15	16	TEMP	A	O		AWG30 (was AWG26)		HCE			
Survival Sensor A ret	16	15	TEMP	A			AWG30 (was AWG26)					
Survival Sensor B	17	18 19 20	TEMP	A	O		AWG30 (was AWG26)		HCE			
Survival Sensor B ret	18	17 19 20	TEMP	A			AWG30 (was AWG26)					
Survival Sensor C	19	17 18 20	TEMP	A	O		AWG30 (was AWG26)		HCE			
Survival Sensor C ret	20	17 18 19	TEMP	A			AWG30 (was AWG26)					
Overall scn	1	-	STP			Chassis	-		HCE			
Overall scn	13	-	STP				-					

Pins 1 and 13 will be connected to the foil screen within the EIS structure harness. The pins are ready to take a connection to the screen of the harness between the HCE and CNP if added at a later date.

8.3 System Voltage List

EIS takes 28V (max 30V) from the spacecraft distribution and generates secondary voltages for sub-system use: +150V is generated in the MHC for drive of the mirror fine positioner. No detector high voltage is necessary.

Transient voltages due to switching of inductive loads will be reduced to less than 1V above the appropriate sub-system rail voltage.

Voltages used by sub-systems:
ICU:
+5V, +15V, +2.5V, -15V.

MHC:
+15V, -5V, +5V, -15V, -20V, +150V and +28V main bus

CAM:
+7V, -7V, +13V, +39V.

EIS also takes a nominal 50V from the spacecraft HCE for survival heater power. The actual voltage is specified as normal over the range 31.5 to 52.0V.

8.4 Frequency List

Main power converter (ICU)
Operation at 120kHz. Total power is about 30W.

Converter for fine mirror positioner driver (MHC)
Frequency 130kHz (TBC). Total power about 2.4W.

CAM Clock
32MHz.

ICU Processor Clock
20MHz.

MHC Processor Clock
9.816MHz.

9 POWER DISTRIBUTION

The power budget is given in paragraph 5.2.

Power distribution is shown in MSSL/SLB-EIS/DD003, see Appendix 6.

10 SOFTWARE INTERFACES

The ICU exchanges three types of data with the MDP. These are as follows:

10.1 TC packets

Telecommand packets consist of a command identifier (one byte) followed by up to 132 bytes. These are defined in par 6.2.1 of RD1.

The proposed EIS commanding structure is as follows:

CMD - IDS	FUNCTION
01 - 03	Status requests 1, 2 and 3 (Allocated by system side)
04	Memory Dump request (Allocated by system side)
05 – 0A	Memory Dump commands (Allocated by system side)
E5 - EA	Memory Uplink (Allocated by system side)
20 – 2F	Mode/miscellaneous commands
30 – 3F	PSU commands
40 – 4F	Camera commands
50 –7F	MHC commands
80 - DF	Sequence Table commands
F0 - FF	Spares

10.2 Status data

Status data packets (instrument HK) consist of a header of 4 bytes followed by up to 2 kbytes of status data. Details of the format are given in par 6.3 of RD1.

10.3 Mission data

Science data packets consist of a packet header of 256 bytes, followed by image data. The maximum size of the image data is ≤256 kpixels (16 bit pixel). For practical reasons a mission data packet is sent as a series of sub-packets. Details of these packets are given in figure 4.5-2 in RD1.

10.4 EIS Memory Map

The EIS memory map is shown in the following table:

EIS MEMORY MAP

EIS Memory Uplink/Dump

Rev: 1.0: 15 Nov 2000
Rev: 1.1: 24 Jan 2001
Rev. 2.0: 27 Mar 2001
Rev. 3.0: 13 Jun 2001; Add RAM Sub-ID
Rev. 3.1: 18 Jun 2001; Delete one of comments
Rev. 4.0: 08 Aug 2001; Change unit of uplink for EEPROM
Rev. 5.0: 12 Sep 2002; Add new memory maps for MHC
Rev. 6.0: 19 Feb 2003; Add new memory maps and few corrections
Rev.7.0: 20th Feb 2003; Modified ICU PROM ICU EEPROM End Addresses and sizes

Dump format = DUMP FORMAT-2 (Type IV)

No.	Memory	RAM-ID	Start addr.	End addr.	Size	Memory Table No.			Unit of	Upload Command			Possibility	Dump	Check	RAM Sub ID	
		(up to 10 characters)			(kByte)	upper	lower	(hex)	Uplink* (Byte)	IC	DC	BC1	of Upload	Command	after dump	Present	Next
0	ICU Program RAM	EIS_PRGRAM	0x000000	0x0BFFFF	768	1110(b)	0101(b)	(0xE5)	1 - 128	0x07	0xFC	0xE5	Yes	0x05	Yes	86	87
1	ICU Data RAM	EIS_DATRAM	0x000000	0x06FFFF	448	1110(b)	0110(b)	(0xE6)	1 - 128	0x07	0xFC	0xE6	Yes	0x06	Yes	88	89
2	ICU Data RAM	EIS_OBSTBL	0x070000	0x07FFFF	64	1110(b)	0111(b)	(0xE7)	1 - 128	0x07	0xFC	0xE7	Yes	0x07	Yes	90	91
3	ICU PROM	EIS_PROM	0x0C0000	0xC3FFF	16	1110(b)	1000(b)	(0xE8)	N/A	No Upload Command			No	0x08	Yes	92	-
4	ICU EEPROM	EIS_EEPROM	0x0C8000	0x1C7FFF	1024	1110(b)	1001(b)	(0xE9)	128	0x07	0xFC	0xE9	Yes	0x09	Yes	93	94
5	MHC RAM	EIS_MHCRAM	0x000000	0x00FFFF	64	1110(b)	1010(b)	(0xEA)	1 -128	0x07	0xFC	0xEA	Yes	0x0A	Yes	95	96
6	MHC ROM	EIS_MHCROM	0x010000	0x017FFF	32	1110(b)	1011(b)	(0xEB)	N/A	No Upload Command			No	0x0B	No		
7	MHC Parameter	EIS_MHCPAR	0x020000	0x020120	0.28	1110(b)	1100(b)	(0xEC)	N/A	Utilize Serial Command			Yes	0x0C	No		
8	MHC Buffer	EIS_MHCBUF	0x030000	0x097FFF	416	1110(b)	1101(b)	(0xED)	N/A	No Upload Command			No	0x0D	No		
9	CAM RAM	EIS_CAMRAM	0x000000	0x03FFFF	256	1110(b)	1110(b)	(0xEE)	128	0x07	0xFC	0xEE	Yes	0x0E	Yes		
10	HK TBL	EIS_HKTBL	0x000000	0x000237	0.55	1110(b)	1111(b)	(0xEF)	1-128	0x07	0xFC	0xEF	Yes	0x0F	Yes		

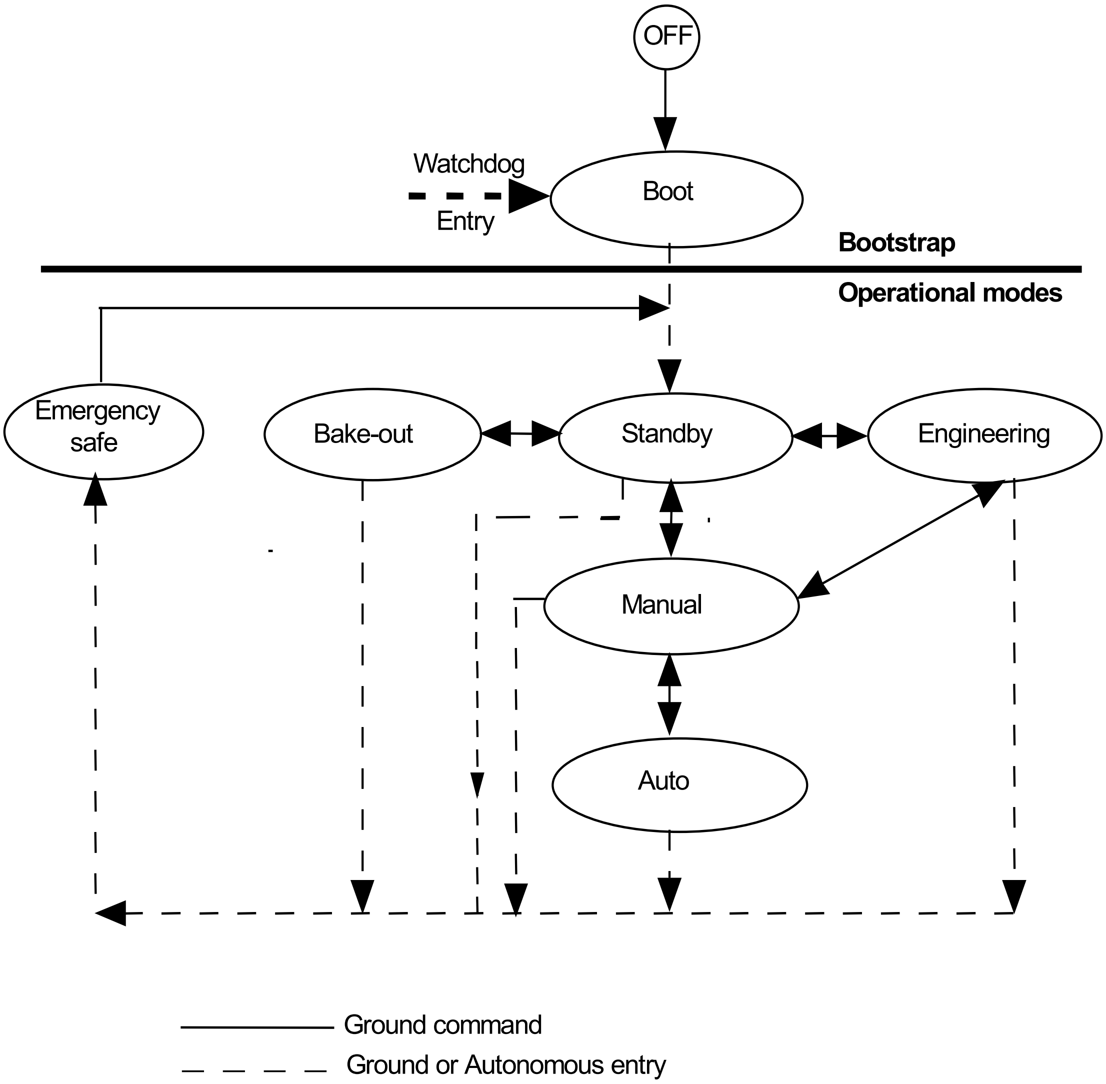
* This is related to the memory upload command. The command size is MAX. 128 bytes as shown in MDP-ICU I/F document.

Check of memory data is done with the ISAS ground support system after the memory dump.

RAM sub ID is allocated by the system MELCO.

11 INSTRUMENT MODES

The instrument modes are shown in the following diagram:



The following table defines the instrument mode transition commands:

Command ID	Command Parameter	Mode
21	01	Standby
21	02	Manual
21	03	Auto
21	04	Bake-out
21	05	Emergency safe
21	06	Engineering

12 CONTAMINATION CONTROL

Details for the contamination control of the EIS instrument in its assembly, integration and testing and commissioning phases are identified in the Cleanliness Control Plan, RD 4.

12.1 Contamination Tests

TBA

13 ENVIRONMENTAL TESTS

13.1 Mechanical Tests

13.1.1 Test Matrix (EIS System)

Test	MTM/TTM	PM	FM
Quasi-static load test [1]	QT	N/A	N/A
Acoustic test [1]	QT	N/A	N/A
Random vibration test [1]	QT	N/A	AT [2]
Low frequency shock test	QT	N/A	AT
Pyrotechnic shock test [1]	N/A	N/A	N/A

[1] Baseline is random vibration. Quasi static load test, acoustic test and pyrotechnic shock test will only be performed if these loads are found to be dominant in the design. Acoustic may be substituted for random, if this is found to be dominant.
[2] A protoflight test of either acoustic or random will be performed, whichever is considered dominant.

13.1.2 Test Matrix (Equipment within EIS)

Test	Assembly	PM	MTM/TTM	FM
Random vibration	MHC, ICU, ROE, FPA	N/A	N/A	PFT
Random vibration	Mirror, Slit/Slot, Grating	N/A	N/A	AT
Random vibration	Clamshell/Filter	N/A	QT	AT
Acoustic test	MHC, ICU, ROE, FPA	N/A	N/A	PFT
Acoustic test	Mirror, Slit/Slot, Grating	N/A	N/A	AT
Acoustic test	Clamshell/Filter	N/A	N/A	AT
Low frequency shock	MHC, ICU, ROE, FPA	N/A	N/A	PFT
Low frequency shock	Mirror, Slit/Slot Grating	N/A	N/A	AT
Low frequency shock	Clamshell/Filter	N/A	QT	AT
Pyrotechnic shock	ICU	N/A	N/A	AT

13.1.3 Test Matrix (Spacecraft)

Test	PM	MTM/TTM	FM
Quasi-static load test	N/A	QT[1]	N/A
Acoustic test	N/A	QT	TBD
Random vibration test	N/A	QT	AT
Low frequency shock test	N/A	QT	AT
Pyrotechnic shock test	N/A	QT[2]	N/A

[1] For OBU only; the telescopes will not be attached at this point
[2] Actual pyro-devices are used for this test

13.1.4 Test Levels

The test levels are defined in RD 6.

13.2 Thermal Vacuum Tests

13.2.1 Test Matrix (Spacecraft)

Test	PM	MTM/TTM	FM
Thermal vacuum	N/A	QT	AT
Thermal balance	N/A	QT	N/A

13.2.2 System Test Levels

The temperature range for the QT is -30°C to +60°C
The temperature range for the AT is -10°C to +50°C
The vacuum shall be better than 10^{-5} mm Hg
The Thermal Balance Test shall be conducted at lower extremes of temperature than the QT (TBD) and for a duration TBD.
Five cycles shall be performed for the thermal vacuum cycle test (TBC).

13.2.3 Test Matrix (EIS System)

Test	PM	MTM/TTM	FM
Thermal vacuum	N/A	N/A	AT
Thermal balance	N/A	QT	N/A

13.2.4 EIS System Test Levels

The temperature range for the AT is -10°C to +50°C
The vacuum shall be better than 10^{-5} mm Hg
Five cycles shall be performed for the thermal vacuum cycle test (TBC).

13.2.5 Test Matrix (Equipment within EIS)

Test	Assembly	PM	MTM/TTM	FM
Thermal vacuum	MHC, ICU, ROE, FPA	N/A	N/A	Q/T
Thermal vacuum	Mirror, Slit/Slot, Grating	N/A	N/A	AT
Thermal vacuum	Clamshell/Filter	N/A	QT	AT
Thermal balance	MHC, ICU, ROE, FPA	N/A	N/A	N/A
Thermal balance	Mirror, Slit/Slot, Grating	N/A	N/A	N/A
Thermal balance	Clamshell/Filter	N/A	N/A	N/A

13.3 EMC Tests

13.3.1 Test Matrix (EIS System)

Test	PM	MTM/TTM	FM
Conducted and radiated emission and susceptibility	NONE	N/A	ALL

13.3.2 Test Levels

The test levels are identified in the Solar B Electrical Design Standard, RD 8.

14 FAIRING ACCESS REQUIREMENTS FOR CLAMSHELL

14.1 General

The EIS clamshell (CLM) is a vacuum compartment that protects the EIS entrance filter from harmful environmental conditions (acoustics, contamination, debris, humidity, air gusts, etc.) before and during Solar-B launch. The filter is a very large thin aluminium filter and as such is quite fragile, an inadvertent touch or rush of air will almost certainly destroy it. The only safe way to launch such items is under a vacuum of <~1 torr. The CLM is a special chamber for this purpose, and has two doors that open when the instrument reaches orbit. It will remain under vacuum from the time of EIS integration until safely deployed in orbit.

14.2 Vacuum Requirement

The CLM is constructed to high vacuum standards and should be evacuable to less than 0.001 Torr. Use of vacuum greases and lubricants are avoided and organic materials are minimized. It is expected that the chamber can maintain a vacuum of < 1 torr for up to 21 days. In all such vacuum systems without active pumping, a gradual rise in pressure is expected with time due to outgassing of material from internal surfaces, diffusion of gas through seals, virtual leaks and real (but tiny) leaks. This means that the CLM will need to be reattached to a pumping station periodically. Re-pumping should be done whenever the pressure in the CLM approaches 1 torr. The frequency of this operation must be determined during the commissioning of the CLM by plotting the pressure versus time. Careful cleaning vacuum

baking and leak testing will be done to obtain the longest possible interval between pumping operations.
A portable GSE pumping station has been designed to safely perform this operation with the flight filters installed in the CLM. It can perform both evacuation and backfilling operations and will follow the CLM throughout the EIS development program and launch cycle. It is necessarily very slow in pumping and backfilling since the filters would not survive any rush of air into or out of the CLM. The pump connects to the CLM seal-off valve by a long copper tube (flexible) and Swagelok connectors.
The seal-off valve is required to be an integral part of the CLM to avoid having long pieces of tubing become part of the CLM vacuum compartment. The CLM also provides a rugged support for the valve body.
One or more vacuum gauges will be integral to the CLM so the pressure can be monitored during the launch cycle. It is possible that one gauge might be read by the MHC so the pressure could be found in the telemetry whenever EIS is interrogated. A main vacuum gauge will be required that reads out into an EGSE monitor. A [TBD] connector will be provided for this purpose.

14.3 Fairing Access

Using Astro-E as a model, fairing close-out is expected to occur on the order of 12 days prior to launch. While this is less than the expected 21-day hold time of the CLM, we must be prepared for situations where the hold time is exceeded. Removing the fairing is much too difficult to contemplate, but a hatch could provide the needed access to re-pump the CLM through the fairing. The hatch opening would need to be on the order of 200 mm in diameter to permit manual connection of the vacuum hose and operation of the seal-off valve.
The access hatch cover should be left open until 3 days before launch to allow continuous pressure monitoring via the EGSE cable. A data logging pressure monitor will be provided. A temporary hatch cover that passes the cable can be used to protect the S/C. For reliable pressure measurements, the same gauge, cable, and monitor should be used at all times.

14.4 Access Hatch Location

The CLM is presently located at Z=+2334mm relative to the origin of the S/C coordinate system. The size of access hole: ϕ 200 mm. The location of the centre of the access hole in Spacecraft STA coordinates is:

R= 1220.4 mm, Azimuth angle φ = 117 deg, Z = STA 2569 mm

X = R cos (72 deg) = 377.1 mm, Y = R sin (72 deg) = 1160.7 mm, Z = 2569 mm

In Solar-B Rocket I/F Conditions (Rev.1.0) the azimuth angle is φ = 117 deg at present.

At this point there should be about 250mm clearance between the EIS +Y panel and the fairing, and easy reach for an operator's hand. If necessary, small "finger wrenches" can be used in tight places. These can be tied to the operator's hand to prevent their being lost in the fairing.

14.5 Expected Launch Pad Operations

There should be near continuous monitoring of the CLM pressure from the time of the last pump-down until three days (or less) prior to launch. The CLM pressure will be plotted as a function of time and extrapolated to the end of the launch window. Should the pressure be predicted to rise above a predetermined limit, it will be necessary to re-pump the CLM.

This decision should be made [TBD] days before scheduled launch to avoid last-minute chaos. A final pump-down within a week of the expected launch window should suffice in any case. The launch preparation plan should include a critical decision point where a pump/no pump decision is made that allows the pumping work to be carried out with the minimum disruption of the rocket preparations.

The pumping process will require bringing the GSE pumping station to the rocket building, removing the hatch cover, connecting a vacuum hose, evacuating the hose, verifying vacuum hose integrity, opening the CLM valve and pumping until the desired pressure [TBD] is reached. The process is reversed at the end. The pumping time depends on the size and length of the hose and can be base-lined during CLM development. Estimated working time should be about two hours to start and two hours to close out after reaching the required pressure. The CLM pressure should be monitored as long as possible after valve closure to verify that a proper seal has been obtained. Two experienced vacuum operators should be on hand to conduct this operation safely.

15 NITROGEN PURGE

During integration and testing of the flight model with the spacecraft, the EIS instrument will be required to be purged with clean, dry nitrogen gas. The requirements for the nitrogen are:

1. Purge gas N_2 is at just a few psi above atmospheric pressure to give required flow rate
2. Flow rate 10 litre/hour
3. Gas cleanliness specification - class 10
4. Gas purity specification

    N_2 - 99.999%
    O_2 - < 2ppm
    H_2O - < 2ppm
    Volatile hydrocarbons < 1ppm

This will be a common requirement with the other instruments. Consideration should be given to a common supply with a combined purge manifold for the instruments.

The connector for the nitrogen purge is fitted to the connector panel and is shown in FR1 and Appendix 8. The connector is a Swagelok Bulkhead Female Connector 1/4" NPT to 1/4" Swagelok SS-400-71-4.

16 NON FLIGHT ITEMS

The following items are "red-tag" items and must be removed before flight

Main aperture cover
ARM plug for Clamshell
Vent port covers - total of three
Handling eye bolt
Connector savers

17 ACRONYMS

Acronym	Meaning
AT	Acceptance Test level
CAM	Camera
CCD	Charge Coupled Device

CLA	Centre-Line-Average
CLM	Clamshell
CNP	Connector Panel
DIST	Distributor
EIS	EUV Imaging Spectrometer
EUV	Extreme Ultra Violet
FPA	Focal Plane Assembly
GA	General Assembly
GRA	Grating assembly
GSE	Ground Support Equipment
HCE	Heater Control Electronics
HKU	House Keeping Unit
ICU	Instrument Control Unit
MDP	Mission Data Processor
MHC	Mechanism and Heater Controller
MIR	Primary Mirror assembly
OBU	Optical Bench Unit
PFT	Protoflight Test level
PSU	Power Supply Unit
QT	Qualification Test level
ROE	Read Out Electronics
SLA	Slit/Slot Assembly
TBC	To be confirmed
TBD	To be decided
TCI-B	Telemetry Command Interface - B
XRT	X-Ray Telescope

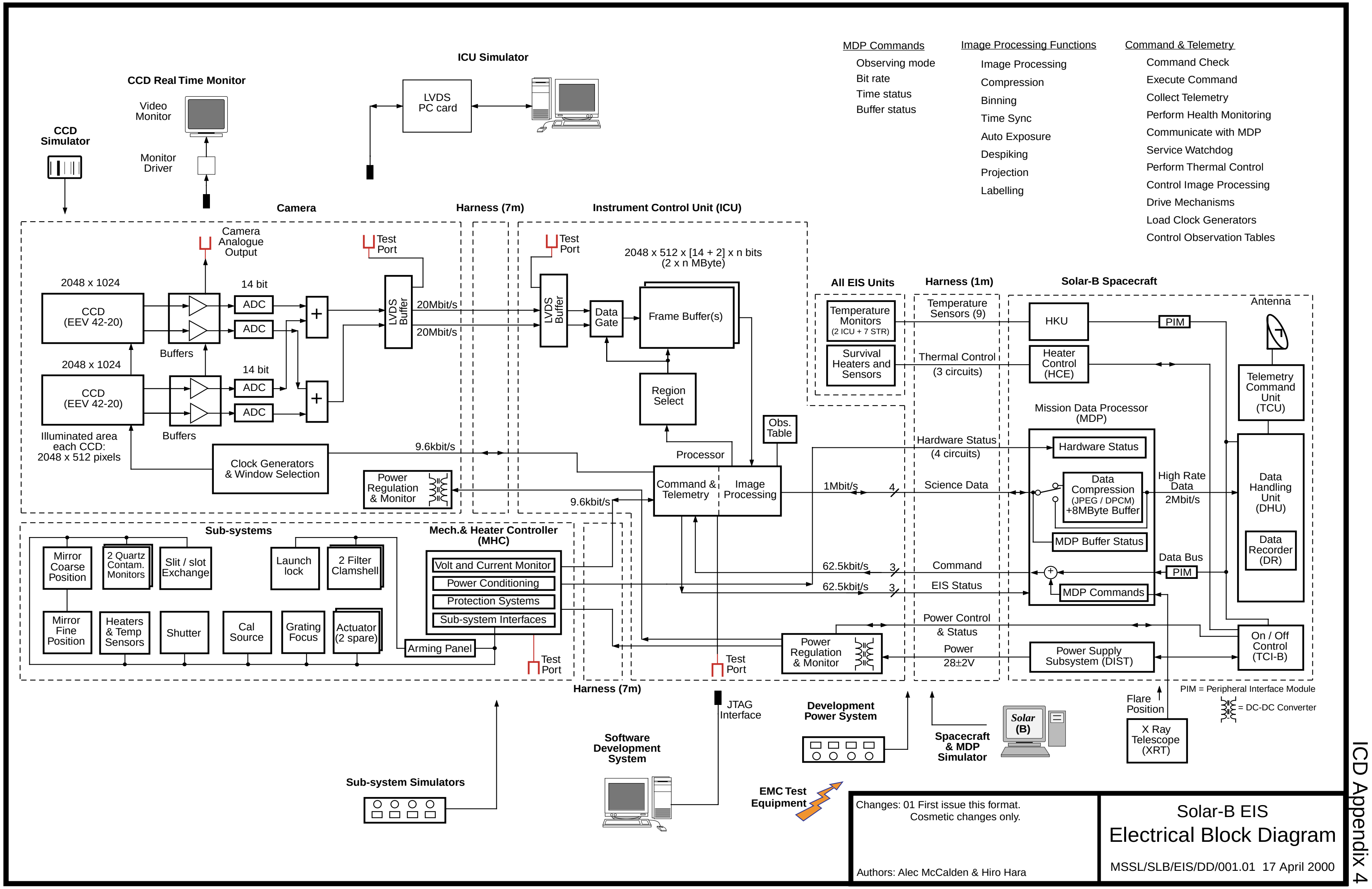
APPENDICES

Please note that Appendices 1, 2 and 3 are not reproduced in electronic format in this document, as they are in file formats not supported by Word.

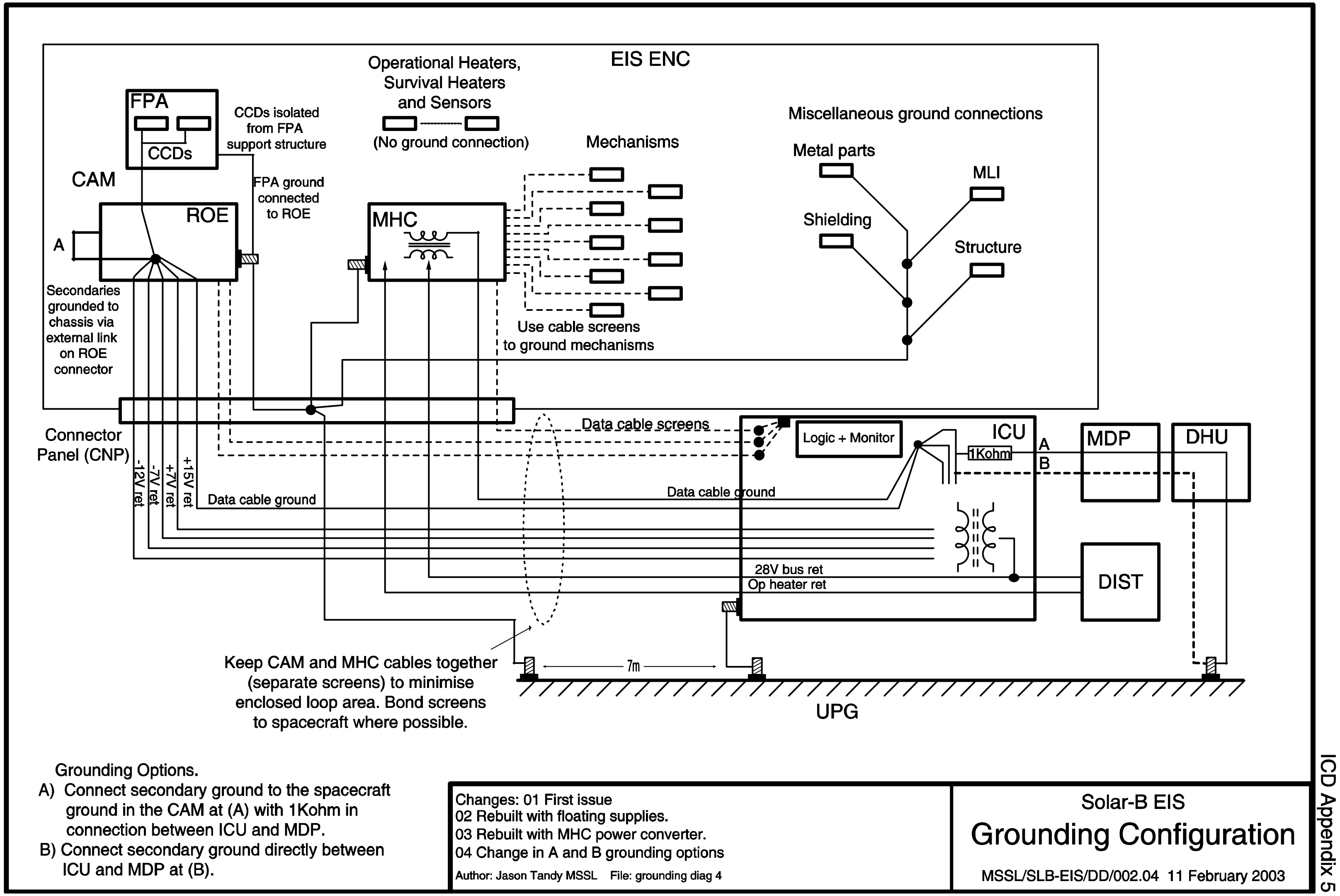
Appendix 1 is the EIS GA generated by Birmingham University and the file is accessible from their ftp site, see Section 4.

Appendix 2 is the Mounting Template drawing generated by Birmingham University and the file is accessible from their ftp site, see Section 4.

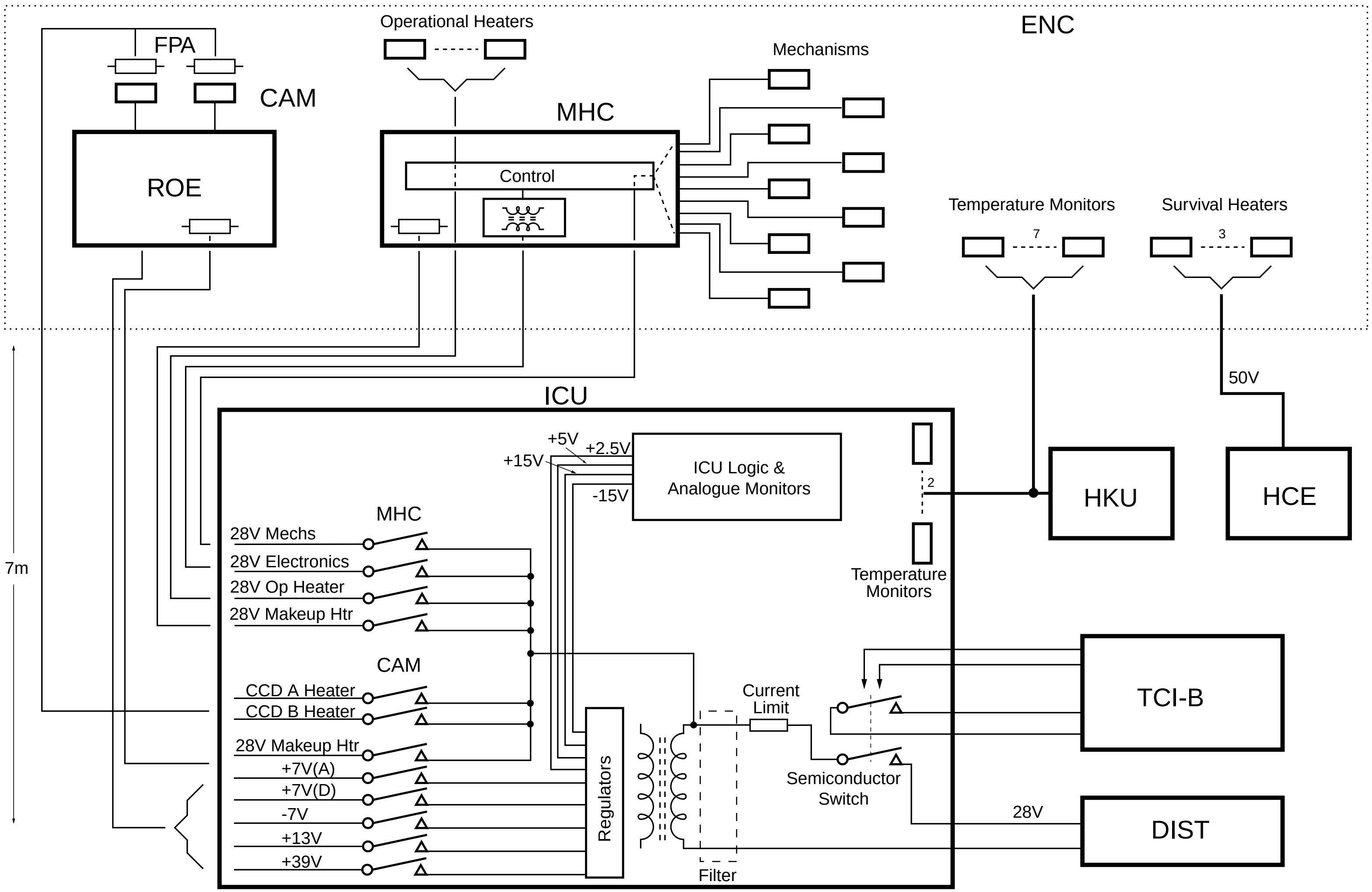
Appendix 3 is the Interface drawing for the ICU and the file can be downloaded from the MSSL ftp site, see Section 4.



ICU Simulator
LVDS PC card
CCD Real Time Monitor
Video Monitor
Monitor Driver
CCD Simulator
MDP Commands
Observing mode
Bit rate
Time status
Buffer status
Image Processing Functions
Image Processing
Compression
Binning
Time Sync
Auto Exposure
Despiking
Projection
Labelling
Command & Telemetry
Command Check
Execute Command
Collect Telemetry
Perform Health Monitoring
Communicate with MDP
Service Watchdog
Perform Thermal Control
Control Image Processing
Drive Mechanisms
Load Clock Generators
Control Observation Tables
Camera
Harness (7m)
Instrument Control Unit (ICU)
Camera Analogue Output
Test Port
2048 x 1024
CCD (EEV 42-20)
Buffers
14 bit
ADC
LVDS Buffer
20Mbit/s
Data Gate
Frame Buffer(s)
2048 x 512 x [14 + 2] x n bits (2 x n MByte)
Region Select
Obs. Table
Illuminated area each CCD: 2048 x 512 pixels
Clock Generators & Window Selection
9.6kbit/s
Power Regulation & Monitor
Processor
Command & Telemetry
Image Processing
All EIS Units
Temperature Monitors (2 ICU + 7 STR)
Survival Heaters and Sensors
Harness (1m)
Temperature Sensors (9)
Thermal Control (3 circuits)
Hardware Status (4 circuits)
Science Data
1Mbit/s
Command
62.5kbit/s
EIS Status
Power Control & Status
Power 28±2V
Solar-B Spacecraft
HKU
PIM
Antenna
Heater Control (HCE)
Telemetry Command Unit (TCU)
Mission Data Processor (MDP)
Hardware Status
Data Compression (JPEG / DPCM) +8MByte Buffer
MDP Buffer Status
MDP Commands
High Rate Data 2Mbit/s
Data Handling Unit (DHU)
Data Recorder (DR)
Data Bus
On / Off Control (TCI-B)
Power Supply Subsystem (DIST)
Sub-systems
Mirror Coarse Position
2 Quartz Contam. Monitors
Slit / slot Exchange
Launch lock
2 Filter Clamshell
Mirror Fine Position
Heaters & Temp Sensors
Shutter
Cal Source
Grating Focus
Actuator (2 spare)
Mech.& Heater Controller (MHC)
Volt and Current Monitor
Power Conditioning
Protection Systems
Sub-system Interfaces
Arming Panel
Power Regulation & Monitor
PIM = Peripheral Interface Module
= DC-DC Converter
Flare Position
X Ray Telescope (XRT)
JTAG Interface
Development Power System
Spacecraft & MDP Simulator
Solar (B)
Software Development System
EMC Test Equipment
Sub-system Simulators
Changes: 01 First issue this format. Cosmetic changes only.
Authors: Alec McCalden & Hiro Hara
Solar-B EIS
Electrical Block Diagram
MSSL/SLB/EIS/DD/001.01 17 April 2000
ICD Appendix 4



EIS ENC
FPA
CCDs
CCDs isolated from FPA support structure
CAM
ROE
FPA ground connected to ROE
A
Secondaries grounded to chassis via external link on ROE connector
Operational Heaters, Survival Heaters and Sensors
(No ground connection)
MHC
Mechanisms
Use cable screens to ground mechanisms
Miscellaneous ground connections
Metal parts
MLI
Shielding
Structure
Connector Panel (CNP)
-12V ret
-7V ret
+7V ret
+15V ret
Data cable ground
Data cable screens
Data cable ground
ICU
Logic + Monitor
1Kohm
A
B
MDP
DHU
DIST
28V bus ret
Op heater ret
Keep CAM and MHC cables together (separate screens) to minimise enclosed loop area. Bond screens to spacecraft where possible.
7m
UPG
Grounding Options.
A) Connect secondary ground to the spacecraft ground in the CAM at (A) with 1Kohm in connection between ICU and MDP.
B) Connect secondary ground directly between ICU and MDP at (B).
Changes: 01 First issue
02 Rebuilt with floating supplies.
03 Rebuilt with MHC power converter.
04 Change in A and B grounding options
Author: Jason Tandy MSSL File: grounding diag 4
Solar-B EIS
Grounding Configuration
MSSL/SLB-EIS/DD/002.04 11 February 2003
ICD Appendix 5



28V main bus, 28V heater supplies or 50V heater supplies are not connected to structure or secondary ground anywhere inside the EIS instrument.

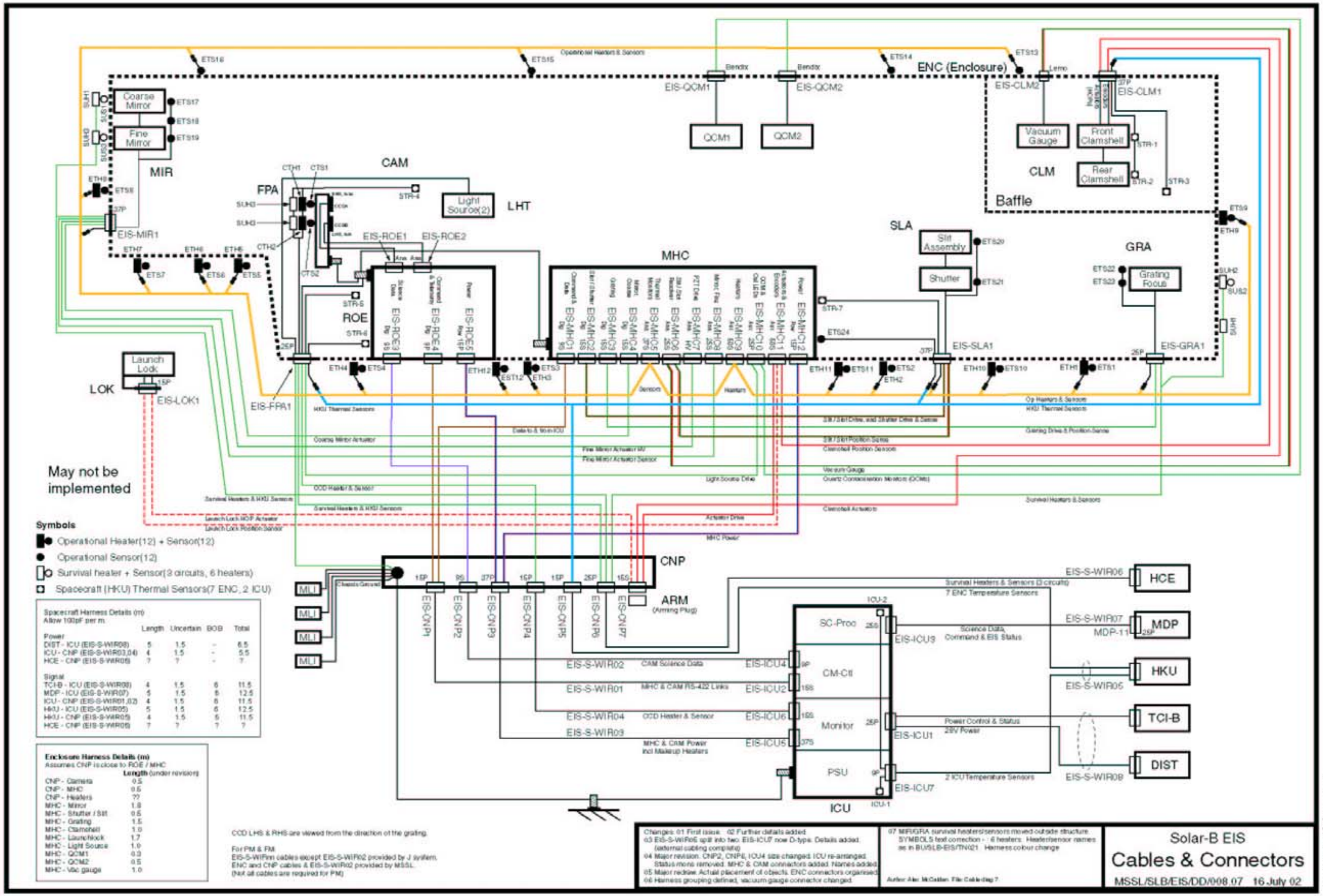
Changes: 01 First issue
02: Keep alive power removed. Op heater now 28V. Label changes.
03: Separate reg o/ps shown. 04: Current limits added.
05: MHC now 28V only; MHC details added. Makeup htrs added.
06: Now just one FPA heater. 2.5V line added in ICU.
07: Two FPA heaters, five CAM power lines, details added & corrected.
Author: Alec McCalden MSSL. File: Power dist 7

Solar-B EIS

Power Distribution

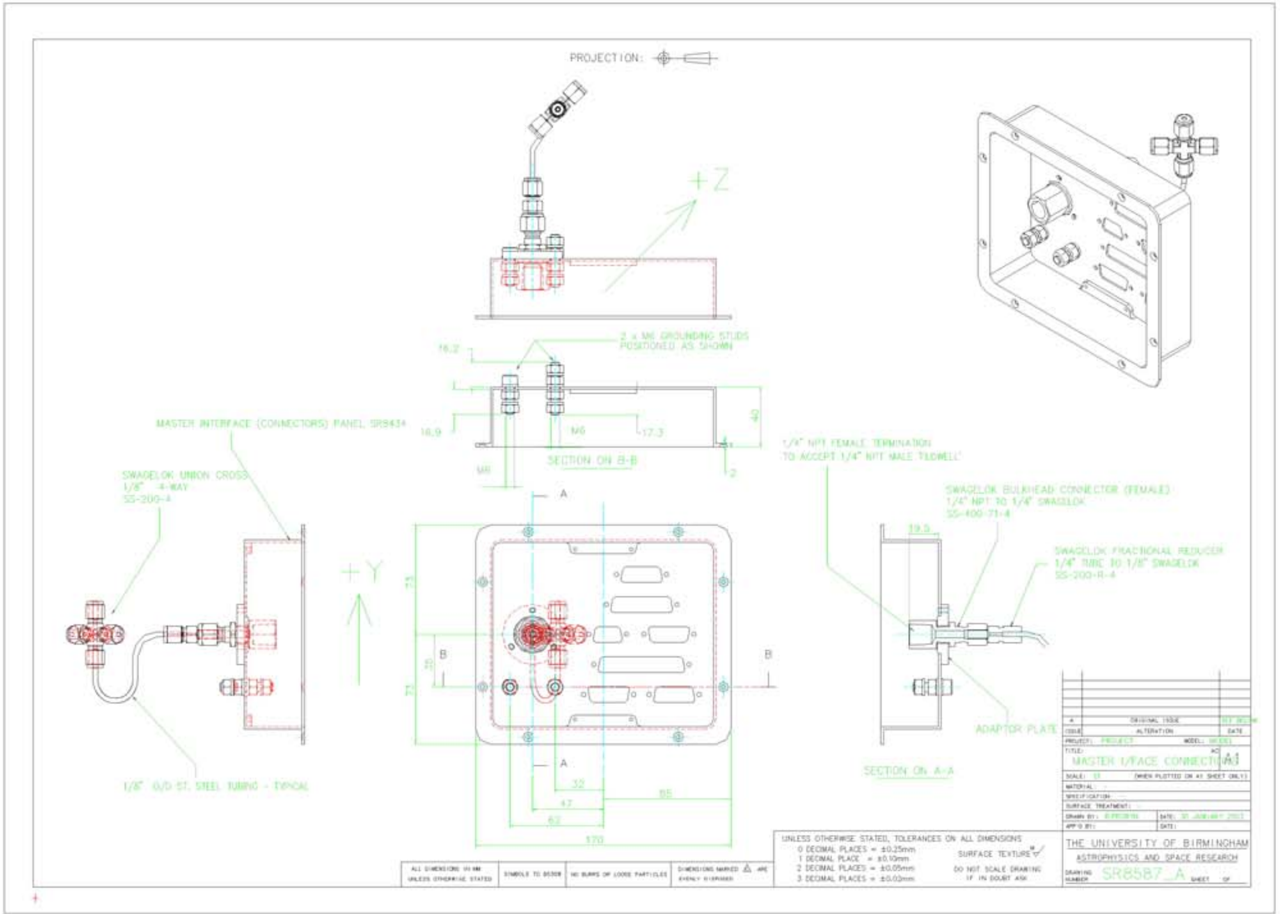
MSSL/SLB-EIS/DD/003.07 1 March 2002

ICD Appendix 6



ICD Appendix 7

Appendix 8


PROJECTION:
+Z
2 x M6 GROUNDING STUDS
POSITIONED AS SHOWN
MASTER INTERFACE (CONNECTORS) PANEL SR8434
SECTION ON B-B
SWAGELOK UNION CROSS
1/8" 4-WAY
SS-200-4
1/4" NPT FEMALE TERMINATION
TO ACCEPT 1/4" NPT MALE TEDWELL
SWAGELOK BULKHEAD CONNECTOR (FEMALE)
1/4" NPT TO 1/4" SWAGELOK
SS-400-71-4
SWAGELOK FRACTIONAL REDUCER
1/4" TUBE TO 1/8" SWAGELOK
SS-200-R-4
+Y
1/8" O/D ST. STEEL TUBING - TYPICAL
ADAPTOR PLATE
SECTION ON A-A
MASTER I/FACE CONNECTIONS
UNLESS OTHERWISE STATED, TOLERANCES ON ALL DIMENSIONS
0 DECIMAL PLACES = ±0.25mm
1 DECIMAL PLACE = ±0.10mm
2 DECIMAL PLACES = ±0.05mm
3 DECIMAL PLACES = ±0.02mm
SURFACE TEXTURE
DO NOT SCALE DRAWING
IF IN DOUBT ASK
THE UNIVERSITY OF BIRMINGHAM
ASTROPHYSICS AND SPACE RESEARCH
SR8587_A