5.5 SIR

SMART-1 NEAR Infrared Spectrometer

PFM User Manual

S1-SIR-MA-3003

Issue 2.0

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5.5.0 Document Control

5.5.0.1 Document change record

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5.5.0.3 Applicable Documents:

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AD1	Final MLI Fixation for PFM	S1-SIR-TN-3014	1.0

5.5.0.4 Reference Documents:

No.	document name	document number	Issue
RD1	EID-A	S1-EST-RS-3001	4.1
RD2	EID-B	S1-SIR-EID-3001	4.0
RD3	Space Engineering	ECSS-E-10-03 / 5.1.16	Draft 01F
RD4	EID-B DRD	S1-EST-DRL-3001	Issue 3
RD5			
RD6	SMART-1 Unit Level Environmental Test Specification	S1-SSC-TS-2001	
RD7	SIR Electrical ICD	S1-SIR-ICD-3003	3.0
RD8	SIR Mechanical ICD	S1-SIR-ICD-3001	5.0
RD9	Non-conformance Control System	ECSS-Q-20-09A	14.10.2000
RD10	SIR STDP	S1-SIR-PL-3001	3.1
RD11	SIR Calibration Report	S1-SIR-TR-3017	1.0
RD12	Near Infrared Spectrometry with SIR on SMART-1	Proceeding of the fourth international conference on Exploration and Utilisation of the Moon, ESTEC July 2000	
RD13	SPECTRAL INVESTIGATIONS OF THE MOON WITH THE SMART-1 NEAR INFRARED SPECTROMETER (SIR)		Abstract, new views of the Moon meeting
RD14	Lunar Source book	ISBN 0-521-33444-6	
RD15	Thermal ICD	S1-SIR-ICD-3002	3.1
RD16	Data Handling ICD	S1-SIR-ICD-3004	5.2
RD17	Assessment on Dark current Increase	S1-SIR-TN-3009	
RD18	Technical Note on Optical Design	S1-SIR-TN-3005	Feb 15, 2000
RD19	EMC Report	S1-SIR-TR-3013	1.0
RD20	Integration, handling and purging instructions (PFM)	S1-SIR-MA-3004	1.2
RD21	Command Database Change Notice	S1-SIR-DCN-3001	1.0
RD22	Experiment Operations Plan	S1-SIR-PL-3005	Draft

RD23	Summary of external interface verification: Payload	S1-IF-PL-66	1.1
RD24	Sun Illumination Constraints	S1-SIR-TN-3016	1.0
RD25	PFM User Manual Appendix Industry Procedures	S1-SIR-MA-3006	1.1
RD26	Selected Science Targets	S1-SIR-PRS-3001	1.0

5.5.0.5 Contents

Part I

5.5.1 Instrument Description

5.5.1.1 Science and Technology Objectives

5.5.1.1.1 Technology Objectives

SIR is a highly compact monolithic grating near infrared spectrometer covering the wavelength range from 0.94 to 2.40 µm. The spectral resolution is $\Delta\lambda_{Pixel}$ = 6 nm. The angular resolution is 1.11 millirad and is identical with the field of view (point spectrometer). SIR is very well suited to study the mineralogy of surfaces of solid planets, their satellites, comets and asteroids.

SIR consists of the Instrument Unit (optical unit) and the E-Box, which is located inside the spacecraft. The Instrument Unit consists of the sensor head (spectrometer) and the O-Box (front-end optics).

The primary objective of the Technology Experiment (TE) SIR was to space qualify a commercially available near-infrared (NIR) grating spectrometer from ZEISS. The commercial spectrometer is built around a monolithic quartz body and uses an InGaAs photo diode array detector sensitive in the 0.9 - 1.7 µm wavelength range. The mass of the sensor head with standard housing for the laboratory is ≈ 950 g including the cooling plate. After more detailed investigations it turned out that almost all materials of the spectrometer had to be changed for space application. Also the extension of the cut off wavelength from 1.7 to 2.4 µm turned out to be much more complicated then originally thought; mainly because of the heavily increased dark current and the therefore necessary reduced operation temperature. The structure of the sensor head got a complete new design because of the thermal and radiation constraints in space. The electronics were miniaturized. The functionality and the measurement accuracy were considerably improved compared to the commercial spectrometer (see [RD11] for results of the on-ground calibration).

5.5.1.1.2 Science Objectives

The Moon, the only natural satellite of the Earth, has followed a different evolution compared to the Earth. Samples from the Moon have documented that almost all endogenous activity of the Moon occurred during the first 1.5 b.y. and that after a violent beginning for most of the last 3 b. y. the Moon has passively collected and recorded the history of solar system activities in the Earth-Moon environment. Although lunar samples have provided evidence for differentiation including insight into processes which are not common on earth (e.g. “gardening”) the early evolution of the Moon and the formation of the primordial lunar crust and mantle are up to date not fully understood.

The main scientific objective of SIR is to achieve a detailed compositional analysis of the lunar surface for various geological / mineralogical and topographical units to address

questions related to the formation and evolution of the Moon. An additional objective is to search for signatures of ices in very weak illuminated crater bottoms at the South Pole. For a list of interesting target types see [RD12] and [RD13]. A more detailed scientific description is found in [RD2] and a very detailed description of Lunar Science is found in [RD14].

5.5.1.2 Science and Technology Performance Summary

The key parameters of the SIR near infrared spectrometer are listed in the table below. For more information concerning the performance of SIR the reader is referred to [RD11].

Table 1: *Characteristics of SIR*

Type of Instrument	*Grating NIR Point Spectrometer*
Wavelenght Range	*0.934 – 2.394 μm*
Spectral Resolution	$\Delta\lambda_{Pixel}$ *= 5.1 – 6.3 nm*
Dynamic (ADC)	*16 bit*
QE	*0.06 to 0.11*
Angular Resolution/ field of view	*1.11 mrad*
f-ratio of front-end optics	*2.5*
Aperture (main mirror diameter)	*72 mm*
Focal length	*180 mm*
Intergr. Times	*Variable, up to 528 ms for 2MHz and 264 ms for 4MHz read out frequency*
Power consumption	*Max. 4.1 W + 1 W for SIR internal heater*

5.5.1.3 Instrument Description

5.5.1.3.1 Functional Description

SIR's regular operation mode is the "burst measurement mode" (mapping of the surface) while the S/C is in the "nadir pointing mode". In addition, pointings to dedicated lunar features in "Off Nadir Mode" are planned on regular bases. Calibration observations of standard stars and lunar landing sites for radiometric calibration are needed from time to time.

In the lunar nadir pointing mode SIR will obtain as long as possible spectra -"burst spectra"- of the lunar surface (limited by the available down link capacity). This phase is called the "Lunar Mapping Phase", which will be the common phase. Off Nadir pointing includes pointing and tracking of lunar features for durations up to 10 sec by the spacecraft. The active tracking allows a spectral averaging for signal to noise increase (e.g. spectral search for ices in very low illuminated crater bottoms).

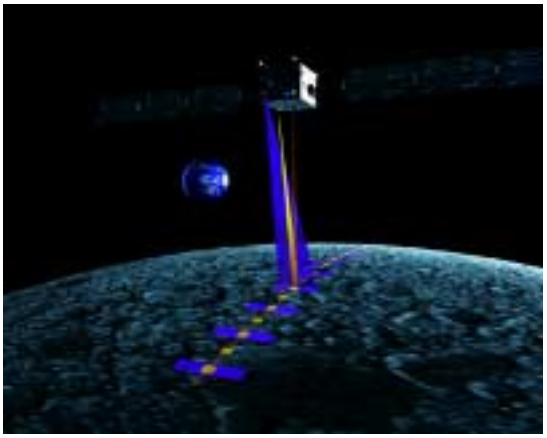


Figure 1: *SMART-1 spacecraft orbiting the Moon.*

How gets SIR information from the lunar surface? The reflected moonlight enters the optics box (O-Box), is then reflected by the main and secondary mirror in direction of the fiber optics. The fiber transmits the light to a filter and a slit. Thereafter the light passes the quartz body and reaches the dispersing grating. The dispersed light passes the quartz body again. It is reaching the second order filter which is glued on the detector window. After passing the window the light is absorbed by the photosensitive pixels. The released electrons of each pixel are collected and a sequential read out is performed after the integration time ended. The adjacent voltage will be measured for each pixel and the obtained values are converted to digits. The obtained values (counts) are finally embedded in the TM packages for sending them to the spacecraft's mass memory.

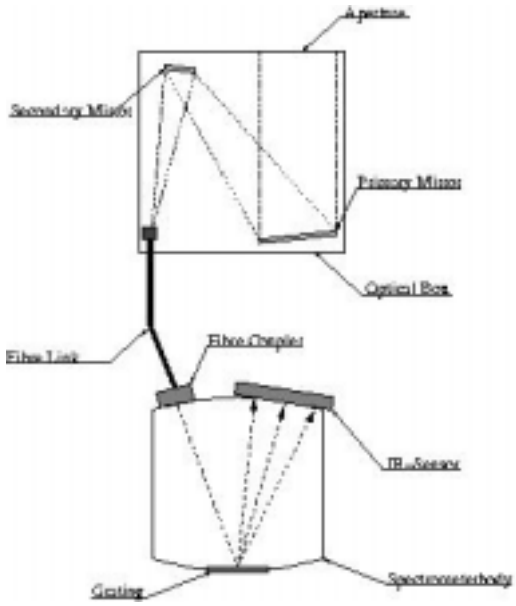


Figure 2: *Functional principle of SIR.*

5.5.1.3.2 Hardware Description

5.5.1.3.2.1 Instrument Unit and Electronic Box

SIR consists of two units and an interconnecting harness:

- ***Instrument Unit***: Consists of the sensor-head (spectrometer) and the optics box (O-Box) with its isostatic mount and radiator. The Instrument Unit contains all optical components of SIR and delivers analogue data for conversion to digital values in the E-Box. The main components of the O-Box (see figure 2, 3 and 5) are the off axis mirror system, the alignment mirror, the fiber flange, the feet, the radiator, the radiator feet, the cooling band and two supports for stabilizing the sensor-head. The sensor-head consists of a quartz housing, cap, optical fiber, optical edge filter, slit, quartz body, grating, sensor slit, sensor, cooling and shielding console, damping elements, heater, S/C heaters, several thermistors and the PCB with electronic components. Figure 4 gives an impression of the sensor-head internal.

- ***Electronics Box (E-Box):*** The E-Box is connected via the interconnecting harness to the Instrument Unit. The E-Box contains the main PCB, which includes among other things ADC, Microprocessor and CAN bus system. The E-Box has three electrical interfaces to the spacecraft (ground, power and data bus).

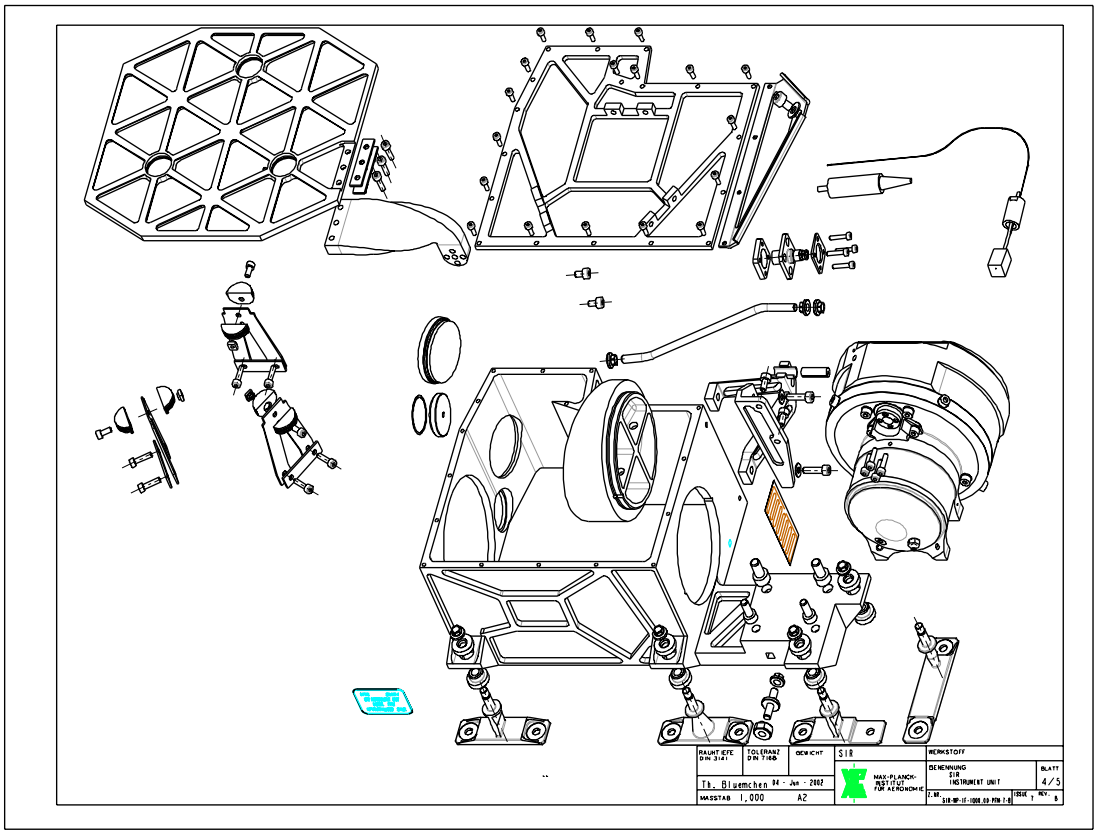


Figure 3: *Exploded view of the Instrument Unit.*

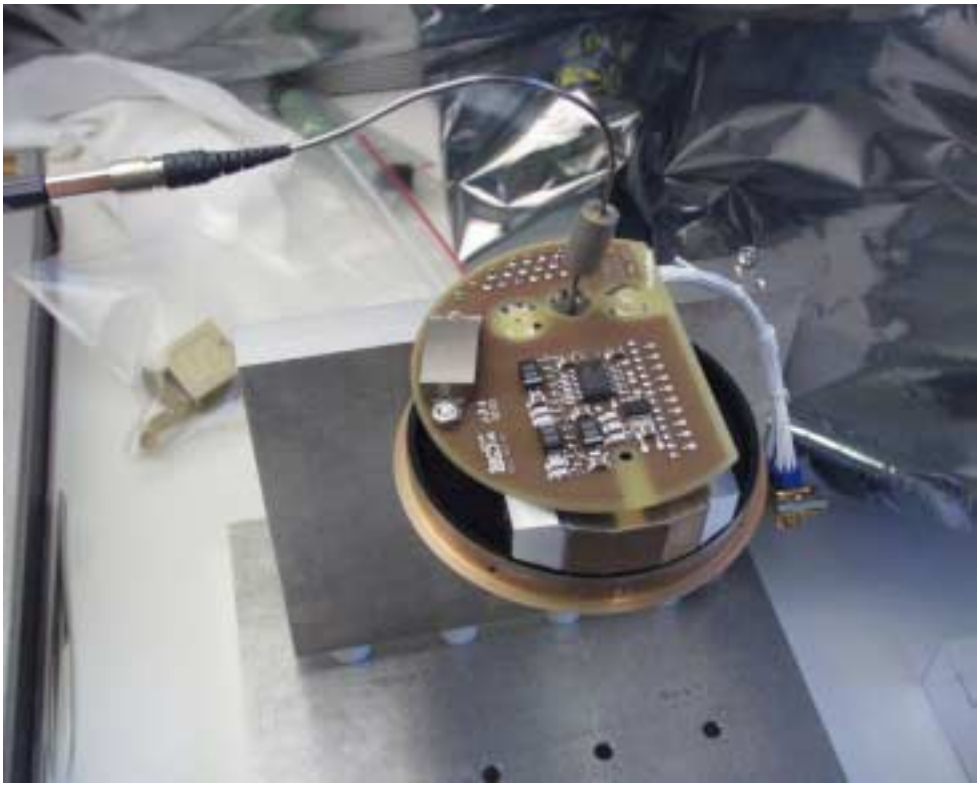


Figure 4: *Image of the sensor-head internal (QM).*

The Instrument Unit is mounted on the outer -X panel, while the electronics box is mounted inside the spacecraft on the same panel.

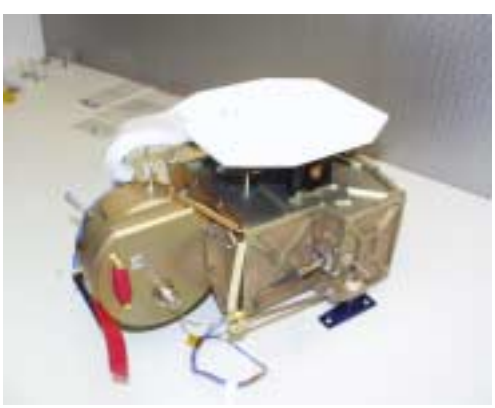


Figure 5 a/b: *The SIR Instrument Unit from different viewing geometries. The O-Box is located in the front (right image, below white radiator). The dust cap of the aperture (red) is visible too. The sensor-head (spectrometer) is located behind the optical box (right image) and connected with a cooling band (white) to the radiator. A special fiber-optics (silver cable in left image) connects the focal plane of the off-axis mirror system with the interior of the sensor-head. The isostatic mount consists of five feet (blue).*

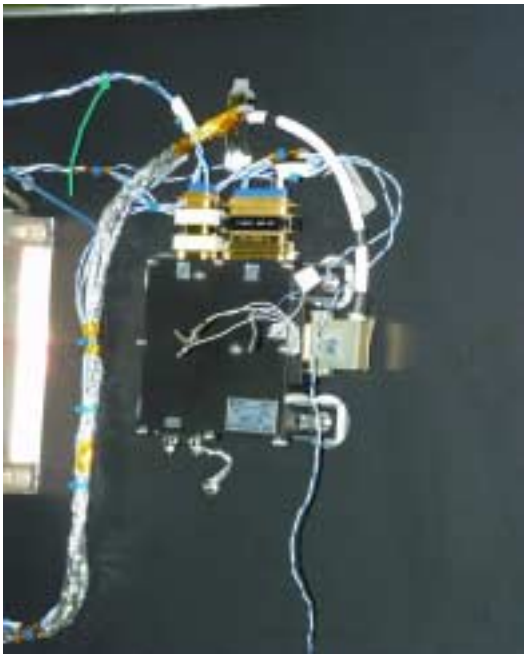


Fig. 6: *The SIR PFM electronics box. The box is located inside of the spacecraft.*

The purpose of the optical system is to collect the reflected light from the surface of the Moon and to guide it to the single fibre-strand. Its entrance is located in the focal plane. The spatial resolution of the optical system (1.11 millirad) is determined by the cross section diameter of the fiber optics and the focal length. The value of 1.11 millirad leads to a best resolution of 310 m at perilune. The optics-box is primarily the housing of two mirrors made out of aluminum. The main mirror has a diameter of 72 mm. To save space in the optical path, the front-end optics is folded (off-axis system) with a fixed plane mirror. This off-axis solution also avoids a reduction of the aperture, which would result from an on-axis system. Several advantages of a mirror system over a lens system (e.g. no chromatism, independence of the refraction index from the surrounding medium, lower weight) led to the mirror solution.

Figure 7: *Top view of the main SIR electronics.*

The electronics box contains a printed circuit board (PCB) equipped on both sides. The harness between the relative warm electronics box and the colder main instrument is thermally optimized to reduce the conductance. The temperature difference can reach up to 100 °C. This cold environment is needed to reduce both the dark current of the sensor and the emission from the surrounding instrument. Heaters with a total power of 2 W will keep the Instrument Unit above a minimum temperature to avoid damage. A further heater of 1 W is mounted inside SIR for fine-tuning in measurement phases. The three S/C heaters (2 W) are controlled by a spacecraft powered thermistor(s), the thermistor(s) are attached to the cooling finger (cooling console) inside the sensor-head.

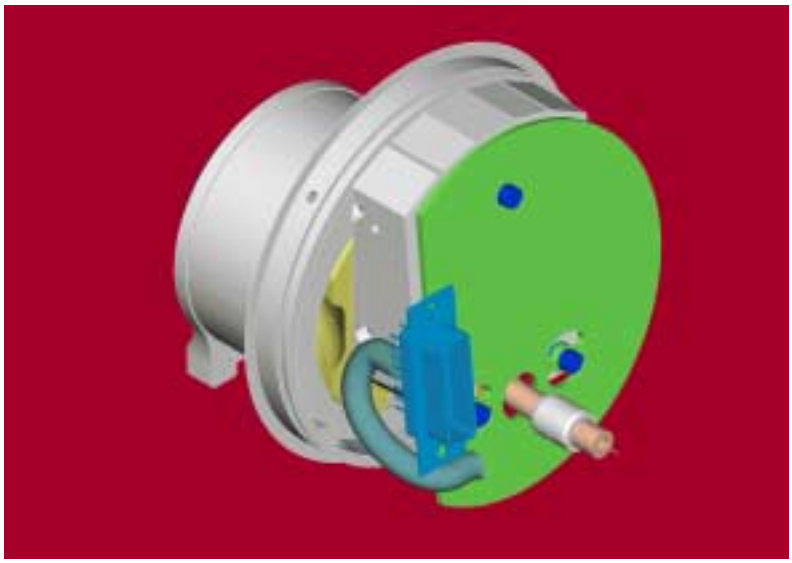


Figure 8: *Drawing of the integrated sensor-head with removed cap. The electrical connector J4 (blue) and the mounting pins (blue) of the PCB (green) are visible. Quartz housing and cooling finger are made from aluminum (silver). A small part of the quartz body is also visible (gold-yellow). The optical fiber (pink) pierces the PCB.*

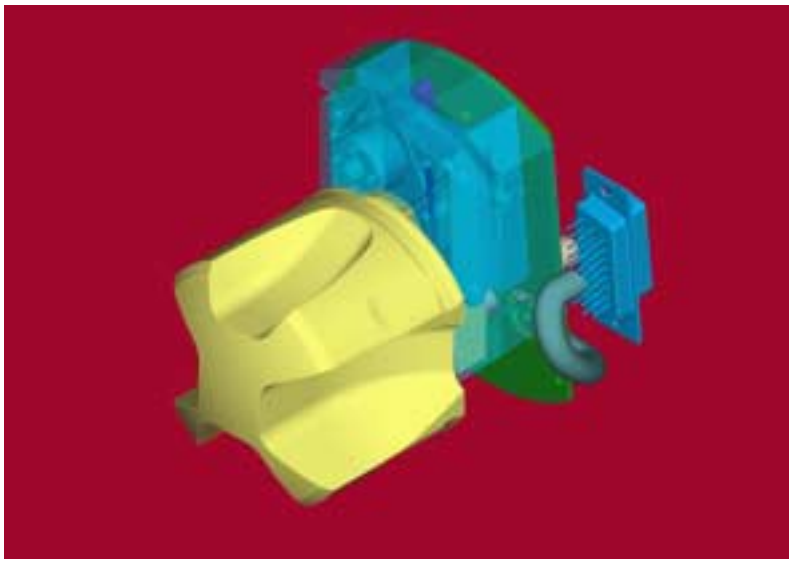


Figure 9: *Sensor-head drawing with removed Al housing. Visible are quartz body (gold-yellow), cooling finger (blue), PCB (green) and electrical connector J4 (blue).*

5.5.1.3.2.2 Optical Design

The purpose of the optical system is to collect the reflected light from the Moon and to guide it to a single fibre-strand, via a quartz body trough the grating and finally to the near-infrared sensor. The O-Box (front-end optics) of SIR is coupled with the fibre optics (single fiber-strand)[1] by a special plug. A fibre of 200 μm core diameter, this leads to 1.11 millirad resolution, is used for SIR. The numerical aperture of the fibre-optics (NA = 0.2) is small enough to accommodate in the future a large variety of front-end optics for other missions.

[1]Due to better transmission conditions we replaced the commercial fiber bundle by a special single fiber.

The fibre optics cross section could also be adjusted. The optical path is folded with a fixed plane mirror, which saves space in the housing design. The data for the entrance optics are given in Table 1. The values are computed on the constraint, that at maximum orbital speed (at perilune) the longest necessary exposure time does not lead to noticeable smearing of the ground spot and to an acceptable signal to noise ratio.

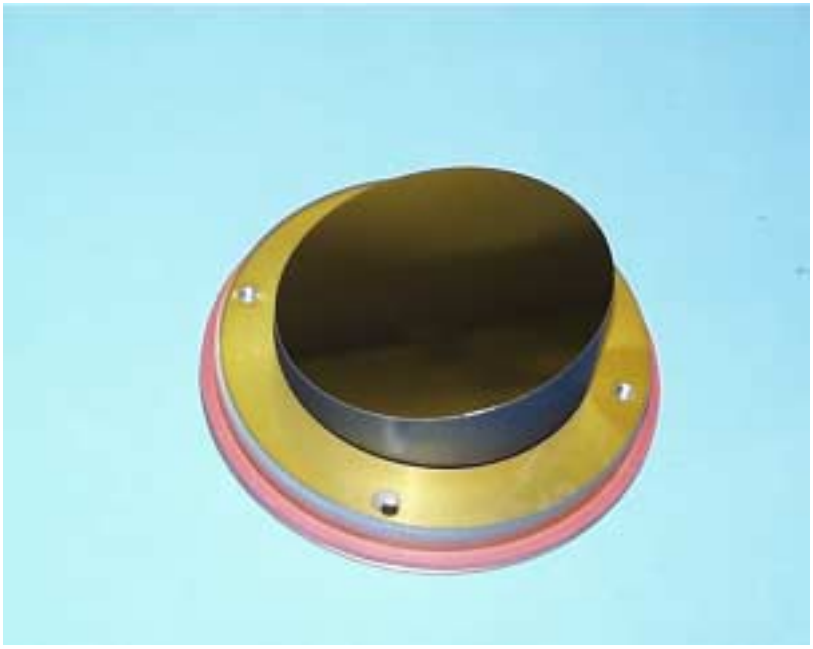


Figure 10: *Main mirror of SIR-(P)FM.*

5.5.1.3.2.3 Mechanical Design

The mechanical design of the SIR instrument is detailed in [RD8].

5.5.1.3.2.4 Thermal Design

The E-Box is collectively controlled, while the Instrument Unit is individually controlled. Three spacecraft powered heaters (total capacity of 2 W) and a spacecraft powered thermistor (+ redundant one) ensure the safety of the Instrument Unit. An additional heater of 1 W (resistors), controlled by SIR software, is attached to the cooling console. If necessary the heater will provide fine-tuning of the sensor temperature.

With its extended wavelength response out to 2.55 μm the SIR sensor requires cooling. The detector assembly itself needs to be cooled to an operational temperature below – 20 °C to reach reasonable dark values (TBC in flight). For applications under low illumination conditions, like e.g. above the lunar South Pole, operational temperatures between –70 and –60 °C are anticipated. An early thermal analysis based on the mechanical design and worst case assumptions showed that this can be achieved by a passive radiator of about 150 cm^2 size if it can radiate optimally to space. A cooling band and a cooling console connect radiator and

sensor assembly for system cooling. The instrument unit (except the upper surface of the radiator, the aperture and the cooling band) are covered with MLI blankets. For more details on this the reader is referred to [RD15].

5.5.1.3.2.5 Electronics

The SIR electronics was designed with special attention to mass and volume budget constraints and interfaces required by the spacecraft (especially SMART-1 data and power bus interface). The design is outlined in detail in [RD2], [RD7], the circuit drawings (confidential) and the electronic parts list (confidential).

The electronic parts are soldered on two printed circuit boards. The smaller board is located in the sensor head and the larger one in the electronics box (E-Box).

Figure 11 shows the block diagram of the SIR electronics. The functional blocks are explained in more detail in [RD2].

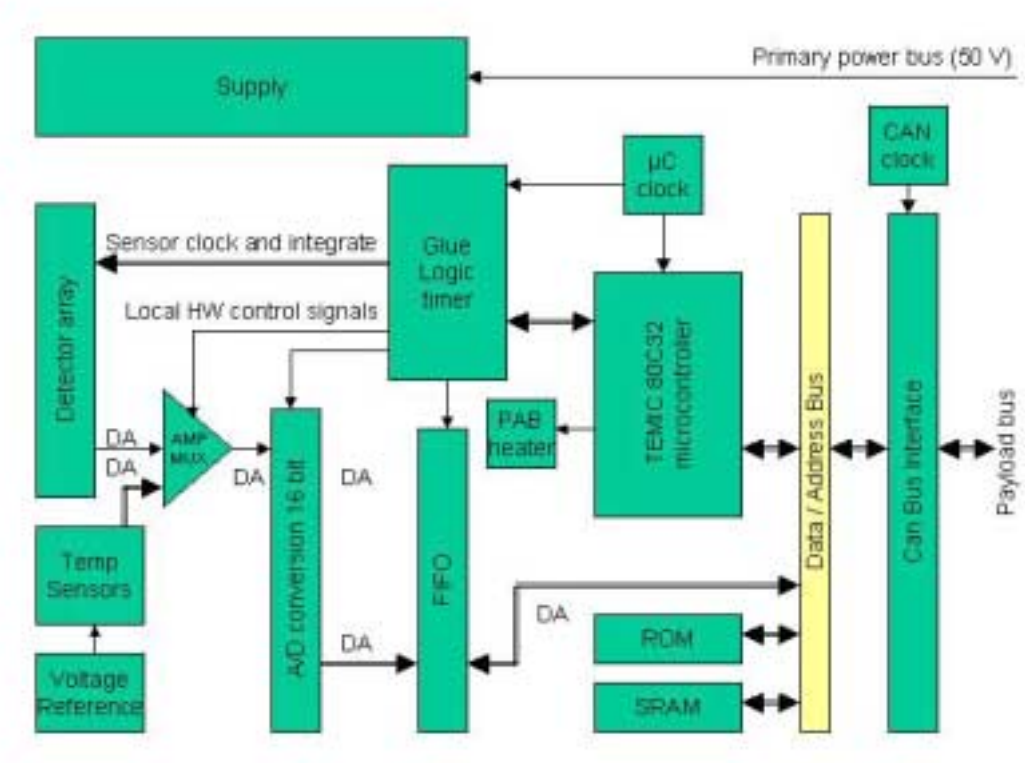


Figure 11: *Block diagram of the SIR electronics (simplified).*

5.5.1.3.2.6 Signal Chain

The detector array acts as an optoelectronic signal receiver. It is a multiplexed linear InGaAs photodiode array with 256 pixels. Its analog output signals are amplified and converted to 16 bit digital data and passed to a FIFO memory before being pre-processed in the microcontroller and finally send to the CAN bus interface.

The multiplexer transfers alternatively only analog signal sources for A/D conversion, providing housekeeping data from the instrument (temperatures, voltages, and currents drawn). These housekeeping data are also made available for transfer via the CAN bus interface.

5.5.1.3.2.7 Control Circuitry

The operation of the payload is controlled by an 8-bit microcontroller with external PROM and SRAM memory and glue logic, implemented in an FPGA integrated circuit. The control circuitry has to control acquisition of spectra and housekeeping data as well as data handling and exchange with the CAN bus interface.

5.5.1.3.2.8 CAN bus Data Interface

The interface electronics circuitry is implemented as required by the spacecraft prime contractor. A detailed circuit diagram is shown in [RD7].

5.5.1.3.2.9 Power Supply Section

From the spacecraft a 50 V bus voltage is available. The power supply section contains a serial voltage regulator for reducing the voltage to a level suitable for procurable DC/DC converters. The instrument power is isolated from the power bus and short circuit protected. The current is limited to a maximum of 500 mA. Two voltage regulators provide the instrument internal voltages (5V and 3.3V).

5.5.1.3.2.10 Heater

A 1 W heater resistor is used to provide heating of the sensor if temperature falls below a threshold limit in the operational mode of SIR. This heater is internally controlled by the SIR electronics and provides a finer tuning than the S/C powered heaters. The S/C heaters will ensure the safety of the instrument in operational and non-operational mode. SIR own heater power is drawn from the primary power bus. In case of a heater failure, a current drawn is limited by the current limiter circuitry contained in the supply section to a maximum of 0.5 A for the instrument.

5.5.1.3.3 Software description

5.5.1.3.3.1 Commands and Parameters

For a description of the commands and parameters see also [RD16].

SIR Modes:

- **Standby/Preparation Mode:** The PDA (Photo Diode Array) is clocked for sensor thermistor read out. Parameters for specifying integration time, read out mode or HK interval can be transferred. The preparation mode corresponds to standby mode, which still exists due to "historical" reasons.

- **Measurement Mode:** The instrument performs a burst measurement, taking n spectra with selected integration parameters. Continuous operation may be commanded. The measurement mode switches automatically back to preparation mode after the spectra have been obtained[2].

SIR has patch capability for reprogramming of the instrument software in flight (memory load/ memory dump and memory check commands).

5.5.1.3.3.2 Software Description

The instrument software is loaded immediately from the ROM into the processor RAM when the instrument is powered. Several default parameter values are set too. The temperature of the detector thermistor is measured continuously. If the temperature falls below the default temperature the heater is activated. The S/W is ready for accepting and processing commands just after powering. In case that new parameters are commanded to SIR while the instrument is already taking spectra (measurement mode) the new parameters will immediately affect the measurements. It is possible to stop or to change a running burst measurement by sending new commands or parameters.

5.5.1.3.3.3 Operational Parameters

Exposure time: This parameter defines the illumination time for the array. The exposure time has to be adapted to the dark current and the read out noise of the sensor for getting the maximal signal to noise ratio and to prevent saturation of the sensor. To cope with different illumination conditions at the detector, we have implement selectable exposure times from 0 to 528 ms (528 ms for 2MHz read out frequency, 264 ms for 4MHz). The maximum integration period without smearing has a duration of about 100 ms at a height of 300 km above the Moon. It is expected that exposure-times between 10 and 100 ms will be commonly used for spectral mapping of the lunar surface.

[2] Except for infinite burst!

Number of spectra: Defines the number of spectra that shall be taken. The duration of a spectral sequence depends on the measurement *interval time* and the *number of spectra* that have been selected. Spectra of the same sequence have always the same exposure time and readout parameters. A change of the selected exposure time and the related read out parameters is not possible while measuring, except if you interrupt the measurement by sending a preparation mode command. After "burst measurement" finishing the instrument leaves the measurement mode and enters the preparation mode automatically[3].

Measurement Interval Time: Time which is necessary to complete a single spectrum (illumination, read out, A/D converting and transmission via CAN) if the Mean Parameter equals 1. For higher Mean levels the interval time is adapted. The send spectrum consists either of a single spectrum or of an averaged spectrum. The interval time controls the data rate over the CAN-Bus.

H/K Acquisition Period: Time interval for H/K measurements (selectable only in Preparation Mode[4]).

(Heater-) Deactivation temperature: Selectable temperature. Value defines temperature limit at which the heater power of the internal SIR heater is switched OFF.

(Heater-) Activation temperature: Selectable temperature. Value defines temperature limit at which the heater power of the internal SIR heater is switched ON.

Number of spectra for Mean: SIR has the possibility to average spectra internally before sending them through the CAN-bus interface. This value defines the number of spectra that shall be averaged. Please consider that the averaging needs some processor time. Note that the "Number of Mean" differs from the "Number of Spectra".

ADC Clock Mode: This parameter defines the clock frequency of the digital circuit. A lower frequency leads to less read out noise while a higher frequency reduces the read out time.

Multiple ADC sampling: Parameter defines the number of ADC reads (1 to 16 reads are selectable). A larger number of reads reduce the read-out noise considerably (also for HK data) but increases for some cases the interval time.

First Memory Address: Defines the starting RAM address where the first byte of the uploaded program sequence will be stored.

Memory Length: The number of bytes that will be uploaded. A Memory Length of 0 stands for the maximum of 256 bytes.

Memory Data: New program sequence that replaces the old one in the memory.

[3] Except for infinite burst!
[4] In measurement mode the HK data is read before each spectrum.

5.5.1.3.3.4 EGSE – GSEOS

The SIR EGSE, used for testing the SIR instrument, consists of a standard PC equipped with a two channel CAN bus board that provides the instrument specific interfaces. It supports all stages of experiment development, from bench checking up to "quick-look" during flight operation. Using the same test system for the whole lifetime of the instrument avoids fragmentation and duplication of efforts, which would result in higher costs, more schedule and technical risk and reduced capability.

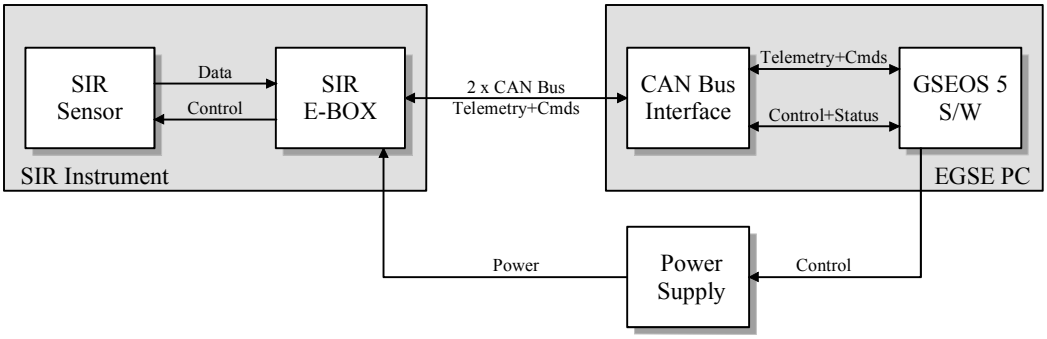


Figure 12: *SIR EGSE functional block diagram.*

The operating software is based on the test software package GSEOS 5 running on Windows NT. GSEOS 5 supports testing of instruments under near real-time conditions up to a data rate total of 400 Mbits/s (multiprocessing by two Pentium II-350) for both input and output directions. GSEOS 5 uses a data-driven concept in contrast to less efficient polling. It provides response times of less than 10 µs. The SIR requirements are significantly lower.
GSEOS 5 is user configurable. It is configured for the SIR project using the built-in G-compiler, which is based on C and enhanced in some properties to support the data-driven concept. GSEOS 5 provides numerous functional modules, as (1) command processor for single and batch commanding, (2) data decoder, (3) data display, (4) data monitoring, (5) command, status and data logging, (6) recording/playback, (7) network interface, etc. The central decoder module converts complex data streams to data packets, which can easily be accessed by their names for processing, recording, displaying, etc.
GSEOS 5 is the most recent, very versatile version of the GSEOS family. Foregoing versions have already supported numerous spacecraft instruments, like particle analyzers, magnetometers, mass memories, camera instruments and others. The development of GSEOS 5 has been a two years effort of a team of three software engineers.

GSEOS Configuration for SIR

This section describes the configuration of the GSEOS for the project SIR. The user may change this default configuration to support special test conditions.

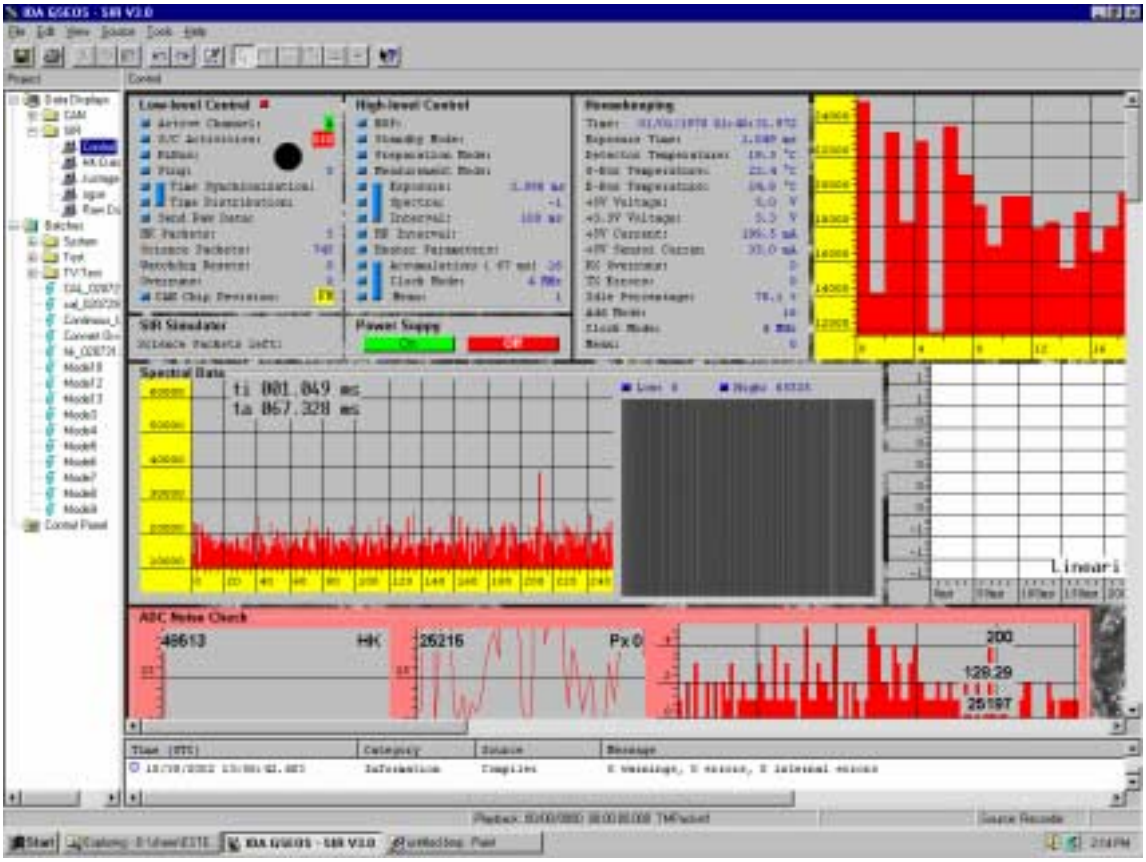


Figure 13: *Main screen of SIR – GSEOS.*

The screen of the GSEOS is separated in tree main windows:

A) ***Data Display Tree:*** The tree will be used to select a Data Display shown on the right window. Furthermore batch files (e.g. test procedures) can be started in this area. The Control Panel allows an access to internal modules of the GSEOS.
B) ***Data Display Area:*** This main part of the program shows Data Items to see the instrument state and Buttons to command the instrument. The Data Display "SIR\Control" allows the full access of all SIR instrument specific functions. The two other Displays "CAN\[debug]" and "SIR\Raw Data" are useful for debugging purposes.
C) ***Message Window*:** The Message Window informs about errors, warnings or simple information. In the current configuration the program logs all CAN data packets sent from the GSEOS to the SIR instrument.

In the Data Display "SIR\Control" can be found several groups of Data Items and Buttons. Each group corresponds to a special SIR function level:

1) ***Low-Level Control*:** Low level S/C commands like RIBUS, PING, TIME SYNC and TIME DIST. With "Active Channel" the main and redundant bus can be switched. With

the button “S/C Activities” every second a RIBUS will be send. Several counters are available also to watch the activities.

2) ***High-level Control:*** For control the SIR specific functionality. Here the modes can be switched and the parameter can be set. With the small button the parameter can be set and with the large button the parameter can be send to the instrument.
3) ***Housekeeping:*** In this group the H/K data of the instrument is shown. All H/K values are converted to physical units. For some values (e.g. currents) exist in addition a graphical plot (not shown in figure 12).
4) ***Spectral Data:*** The instrument science data can be found in a graphical display (“Spectral Data”). The x-axis represents the pixel number, the y-axis the pixel read out value. At the right is located a history of spectral data. In this graphic the x-axis represents the pixel number, the y-axis the time, and the color the pixel read out value. The color mapping of the pixel read out values can be adjusted by setting of “Low” (read out value mapped to black) and “High” (read out value mapped to white).
5) ***ADC Noise Check:*** Several plots for further pre analyses of the spectra.

5.5.1.3.4 On-Board Calibration

SIR does not have any active calibration source. Standard star and lunar landing site observations will be used for spectral calibration (see [RD10] for some details). The SIR on-ground calibration results ([RD11]) shall be compared with in flight results.

The goal of the calibration steps is to calculate corrected spectra showing the absorptions caused by lunar minerals.

5.5.1.4 Summary of Instrument Operation

SIR will scan the surface of the Moon mainly in the so-called “Burst Mode”. During this mode SIR takes continuously spectra while the spacecraft is flying above the surface. The “number of spectra” parameter defines the number of spectra to be measured. Short sequences of spectra or even a single spectrum is selectable for special targets. The SIR modes and all related command/parameters are outlined in [RD16].

- Stand-by Mode / Preparation Mode: Modes are identical. SIR is reaching this mode after powering the instrument. The sensor thermistor is read in this mode continuously to allow SIR heater regulation from the beginning.
- Measurement Mode: Operational mode of SIR. The instrument takes spectra. Several parameters can be selected (exposure time, number of spectra, interval time etc.).

5.5.2 System Characteristics and Constraints

5.5.2.1 Instrument System Budgets

5.5.2.1.1 Mass Budget

Table 2: *Measured mass of SIR - (P)FM*

Unit	Component	Mass [g]
Electronics box	Housing	381
	Electronics board and connectors	179
Harness H1	Including connectors and shield	95
Instrument Unit	Sensor head (incl. stand offs)	725
	Optical Box (incl. Radiator and stand offs)	903
	MLI	99
SIR Total		2382

5.5.2.1.2 Power Budget

- Stand-by Mode/Preparation Mode/Measurement Mode: 81 mA (107 mA with SIR heater ON) ➔ 4.2 W (5.5 W)[5]

5.5.2.1.3 Data Handling Budget

The maximum allowed data rate of SIR is 47.4 Kbit/s.

- Nominal data rate in burst mode: 43920 bit/s (549 bytes for an interval time of 100ms)
- Maximum data rate for HK only: 248 bit/s (25 H/K data's + 6 byte header / 1sec is the minimal acquisition time)

[5] Slightly depending on temperature.

5.5.2.1.4 Pointing and Alignment Budgets

The angular resolution of SIR is 1.11 mrad. This resolution is larger than the guaranteed pointing accuracy of the spacecraft (see [RD1]). Since the main scientific goal of SIR is to map the surface wherever the footprint is actually located it is more important to get the highest possible knowledge of the footprint location after spectra retrieval (re-tracing of ground spot), which should reach the needed accuracy.

A co-alignment between AMIE and SIR took place at ESTEC. SIRs field of view is located in the NIR filter area of AMIE. The position was verified after vibration testing at ESTEC. However, an in flight alignment verification will be necessary, preferable on the Moon limb (see [RD10] and chapter 5.5.7 for details).

5.5.2.2 Instrument Characteristics

1. Functional requirements: Depending on degradation of the detector due to radiation it is expected that SIR is able to achieve scientific relevant spectra for sensor temperatures below -20 °C [6]. However, for investigating the dark crater bottoms and the lunar polar regions a lower detector temperature is needed. Spectra with the lowest possible dark noise will be achieved when the –X panel was for several hours in shade. The minimum expected detector temperature is around -73 °C. In the case that the sunlight illumination leads to a cooling console temperature (an S/C themistor is attached to this console) of more than +14 ºC the instrument is switched OFF by the S/C software.

2. Key performance table of SIR (see table 1).

3. Calibration: The results of the performed on ground calibration of SIR are outlined in [RD11]. An in-flight calibration is necessary, preferable on standard stars, since a degradation of the sensor is expected due to cosmic/sun irradiation.

4. Pointing and stability analysis: See [RD10], [RD2], [RD18]

5. Radiation susceptibility/degradation of instrument: It is expected that the InGaAs sensor shows degradation during flight. An assessment is outlined in [RD17]. The solar absorbance of the conductive white paint of the radiator will increase somewhat. This leads to a warmer instrument when illuminated by the Sun in a later mission stage. The total increase of absorbance is a function of total exposure time and flux on the radiator which depends from the total time SIR will spend in sunlight. The degradiation of SIR optic transmissivity is expected to be low[7].

[6] It is expected that the sensors dark current will increase due to radiation degradation.
[7] Irradiation tests have been performed for glasses and fibers.

5.5.3 Interface Definition

5.5.3.1 Mechanical Interfaces

5.5.3.1.1 Mechanical ICD

See [RD8].

5.5.3.1.2 Mechanism Design

No mechanism

5.5.3.1.3 Alignment and Stability Analysis

An analysis of temperature influence on the focus quality is outlined in [RD18].

5.5.3.2 Thermal Interfaces

See [RD15]

5.5.3.3 Electrical Interface

See [RD7]

5.5.3.3.1 EMC Summary Results

See [RD19] and electrical design drawings (confidential).

5.5.3.4 Data Handling Interface

See [RD16]

5.5.3.5 GSE Interfaces

5.5.3.5.1 MGSE

For integration of SIR at ESTEC no uncommon tools are necessary. The purging of the SIR sensor-head needs to be performed with the SIR Purging Equipment which was delivered by MPAe. Purging instructions are outlined in [RD20].

5.5.3.5.2 EGSE

SIR EGSE hardware consists of a PC or notebook with CAN-bus interface and a power supply + LPSSPC simulating the S/C power unit (see also [RD2]). The used software is SIR GSEOS from IDA ([RD2]).

5.5.4 Instrument Handling Instructions

The instrument shall be stored with mounted red tag items. The sensor-head shall be purged with gaseous nitrogen. The details are summarized in [RD20].

Part II

5.5.5 Instrument operations

5.5.5.1 Constraints for operating SIR

The following list of constraints has to be considered during flight:

SIR is not allowed to be powered if …

1. The angle between the optical axis and the sun is less than 32 º or
2. The temperature of the cooling console is larger than +14 ºC or
3. The temperature of the E-box is higher than +40 ºC or
4. The SIR currents are out of specified range (nominal range 78 to 110 mA)
5. The S/C is in eclipse
6. The EP thruster is active or
7. The S/C is close or inside the radiation belts

The Sun in FoV situation is restricted during flight. The maximum duration shall not exceed a few seconds. Preferably the sun in FoV situation shall be avoided during flight (see also [RD24]).

5.5.5.2 Overview of Operating Principles

The nominal first in flight operation of SIR shall take place after the S/C has left the radiation belts[8]. The instrument is powered for the first time in space environment and a pre-commissioning procedure is executed. The SIR team request to have pre-commissioning in (nearly) real-time contact. The main commissioning, including first target pointings (Moon and Earth) will be performed after a successful pre-commissioning (also in nearly real time contact). The best time slots for this more complex procedure have to be identified in

[8] In case ESTEC defines an earlier window in which all SIR related constraints are fulfilled one could think about an earlier powering of SIR for a short health check.

cooperation with ESTEC. A further SIR operation is planned for the earth escape phase in which the alignment verification between AMIE and SIR shall take place[9]. Depending on the results of the former SIR operations a first bright star observation shall be executed to derive first in flight information about possibly changed radiometry. The nominal science operation starts after the lunar orbit has been entered and execution of the "lunar commissioning". The common observation mode is the nadir pointing mode. In this mode SIR will take "burst spectra". This series of spectra allows to perform scans of the lunar surface (mapping mode). For several lunar surface structures an active pointing of SIR and AMIE is requested ("active pointing to dedicated surface structures"). A number of scientific interesting targets is listed in [RD26]. The active pointing mode is also needed for taking calibration target spectra (lunar landing sites and bright stars).

5.5.5.3 Nominal Experiment Operational Plan

5.5.5.3.1 Ground Operational Plan

Instrument specific activities (see also [RD20]):

- Co-alignment between SIR and AMIE before vibration testing (already performed by ESTEC)
- Spectral test as part of the collective P/L test under room temperature conditions (already performed at ESTEC/SAAB/SSC)
- SIR MLI installation and removal of red-tag items just before LSS test (already performed by MPAe).
- Stimuli of SIR in LSS vacuum chamber test (cancelled by ESTEC).
- Re-purging of sensor head after LSS testing and installation of red-tag items (already performed by MPAe).
- Mounting of accelerometer for acoustic noise test (already performed by ESTEC, results not yet provided to MPAe, accelerometer dismounted by ESTEC/SAAB).
- Remove of dust caps and installation of vibration resistant front optics cover (vibration performed, details unknown to MPAe).
- Post-vibration alignment test (performed by ESTEC/SAAB/SSC, results not provided yet to MPAe).
- Before Xenon engine test stars the special dust cap of SIR has to be attached (see also [RD20]. Several red tag items have to be removed (performed by ESTEC/SAAB/SSC).
- Re-purging of sensor-head after EP E2E test and red-tag item installation. (already performed by MPAe)
- Various s/w tests including partly ESOC (for summary see [RD23], executed by SAAB/ESTEC/MPAe)
- Optics dust inspection before transport to Korou
- Last testing of SIR before transport/storage to Korou
- Last testing of SIR in Korou (TBC)
- Re-purging of sensor head if storage exceeds a half year (TBC).

[9] ESTEC preference is not to have (nearly) real time contact

- Final SIR MLI fixation and MLI flap taping before launch (see [AD1]) (to be executed by MPAe and SAAB)
- Removal of red-tag items before flight

5.5.5.3.2 In-Orbit Commissioning Plans

It was agreed to split the commissioning of SIR in a pre-commissioning and a (main) commissioning part. The pre-commissioning will be performed after a save distance to the radiation belts has been reached. Pre-commissioning will include HK data and dark spectra taking while commissioning will include additionally target pointing.

5.5.5.3.2.1 Pre-Commissioning

During pre-commissioning, after the radiation belts have been left, we will start to test the nominal operation of SIR by analyzing the housekeeping information (readout of thermistor temperatures and from nearly "dark frames" of the sensor array). Pre-commissioning of SIR shall take place preferably under low temperature conditions (detector T ≤ - 40 ºC) which require to have the –X panel for several hours in shade. Time slots in cruise having sufficient shade time durations and data link possibilities shall be identified in advance. The operations have to take the SIR constraints into account.

Sequence:

1) Monitoring of SIR S/C thermistor temperatures and SIR S/C heater line power for defining the sequence start time. AMIE optical head temperature, solar sensor temperature to be compared with SIR E-box. Check between the expected SIR temperature values and the monitored ones.
2) Consider the overall SIR constraints (verification)
3) Execute FC-PL-005.11-G – SIR switch ON (Nominal) –
4) Execute FC-PL-004.02-G – SIR health check with H/K every 10 sec for one minute –
5) Power OFF SIR FC-PL-005.12-G – SIR switch OFF –
6) Download SIR data from S/C
7) Display SIR HK data with GSEOS and compare values with S/C telemetry
8) Execute FC-PL-005.11-G – SIR switch ON (Nominal) –
9) Execute FC-PL-003.01-G – Commissioning_1 –
10) Execute FC-PL-005.12-G – SIR switch OFF (Nominal) –
11) Download SIR data from S/C for GSEOS displaying
12) First analysis of data
13) End of pre-commissioning

Expected min. duration: ~ 3 h

5.5.5.3.2.2 Commissioning

The commissioning procedure involves pointing requests to Moon and Earth. Time slots for earth and moon pointing including sufficient shade time shall be identified in advance. The commissioning procedure will take several hours. The procedure will be detailed after a successful pre-commissioning.

1) Monitoring of SIR S/C thermistor temperatures and SIR S/C heater line power for defining the start time of the procedure. AMIE optical head temperature, solar sensor temperature to be compared with SIR E-box temperature. Check between the expected temperature values and the monitored ones.
2) Consider the overall SIR constraints
3) Start single scan of the lunar disk by slewing the S/C with ≤ 1 mrad/sec (TBC)
4) Start to take spectra 10 sec before reaching the lunar limb and 10 sec after leaving the limb.
5) Repeat low slew scans in different modes (number and values TBD after pre-commissioning)
6) Point SIR to Earth. Take scans of the Earth. Spectra of an ice shield shall be included (e.g. Greenland). Take some darks.
7) Power SIR OFF
8) Download SIR data from S/C

5.5.5.3.2.3 Calibration

The alignment verification and a first star pointing procedure are described in section 5.5.7.3.

5.5.5.3.2.4 Commissioning in lunar orbit

Nadir pointing is needed. Identify obit segment where the footprint crosses the lunar terminator. Start measuring several minutes before the terminator is reached and extend the observation on the dark site.

Sequence:

1) Monitoring of SIR S/C thermistor temperatures and SIR S/C heater line power for defining the sequence start time. AMIE optical head temperature, solar sensor temperature to be compared with SIR E-box temperature. Check between the expected SIR temperature values and the monitored ones.
2) Consider the overall SIR constraints (verification)
3) Execute FC-PL-005.11-G – SIR switch ON (Nominal) –
4) Execute FC-PL-004.02-G – SIR health check with H/K every 10 sec for one minute –
5) Display SIR HK data with GSEOS and compare values with S/C telemetry
6) Execute the lunar commissioning procedure (parameter settings and order are TBD)
7) Execute FC-PL-005.12-G – SIR switch OFF (Nominal) –
8) Download data from S/C for GSEOS displaying

9) First analysis of data
10) End of lunar commissioning

5.5.5.3.3 Flight Operations Plans by Mission Phase

To prepared when final orbit is known.

5.5.5.4 Failure Detection and Recovery Strategy

The standard operation of SIR will be performed via time tagged commands. In case of failure detection the instrument shall be powered OFF. Essential for observation planning is the notice of the SIR constraints (see section 5.5.5.1).

5.5.5.4.1 Recognize Failures by TM

A visualization of the SIR TM data requires the SIR GSEOS software. ESOC does unfortunately not plan to monitor P/L telemetry. The delay in detecting system failures, indicated in SIR's HK data, depends on the data retrieval time.

S/C telemetry data: The SIR team needs access to some S/C quick look data. Especially the temperature measured by the SIR S/C thermistors, the power consumption of SIR, the power consumption of the S/C heater(s) attached to SIR and the –X panel temperatures beneath SIR are from special interest. In case of malfunctions it could be advisable to have access to other S/C HK data.

Table 3: *Failures of SIR are indicated if dedicated values are outside the nominal range*

	Nominal range
SIR total ampacity	78 to 110 mA [10]
P/L Bus voltage (nominal)	49 to 50.5 V [11]
Temperatures at S/C SIR Instrument Unit thermistor[12]	+14 to –78 °C for operational case[13] +51 to –78 °C for non-op case
Temperatures at S/C SIR E-Box thermistor	-9 to +40°C for operational case -20 to +46 °C for non-op case[14]

[10] A slight temperature depended drift is normal; values might change when degradation of electronics takes place.
[11] The voltage range in which SIR is able to operate is somewhat larger than the here defined EID-A range.
[12] Acceptance level temperatures.
[13] The temperature that is scientifically relevant should be lower than approximately –20 °C.
[14] The SIR E-Box has ±5 °C tested safety margin for proper operativeness. It is expected that the safety margin is considerably higher then the tested values.

Important SIR telemetry data: It's possible to downlink SIR HK data with preference by selecting the APID 1001d. A failure is indicated if one HK value is outside the ranges in table 4:

Table 4: *Failures of SIR are indicated if dedicated values are outside the nominal range*

	Nominal range
W/D reset counter	0
Detector temperature (sensor thermistor)	-73 to -20 °C for scientific relevant measurements[15]; for T above + 14 °C the instrument shall be OFF powered
YSI thermistor temperature	+14 to –78 °C for operational case Compare values with S/C thermistor values!
SIR E-Box temperature (thermistor is attached to DC-DC converter housing)	+10 to +70 °C
+ 5 V voltage	± 0.2 %
+3.34 V voltage	± 0.5 %
+5V E-Box current	160 … 320 mA
sensor head current	30 … 55 mA (temperature depending)

All limits have to be verified in pre-commissioning and commissioning.

5.5.5.4.2 What to do after failure detection?

1. In case that one limit in table 3 and 4 is exceeded the instrument must be switched OFF.
2. Inform SIR project team about failure (Tel. +49 5556 979 433 or 359 or 374 or 152 or 419)

In case of a failure/hanging system a reboot by powering the instrument OFF and ON again could be necessary (S/C commands).

[15] A value below -78 °C shall be avoided.

5.5.6 Modes Description

5.5.6.1 Summary of all Nominal and Back-up Modes

See next page for standby/preparation and measurement mode.

5.5.6.2 Mode Transition Diagram

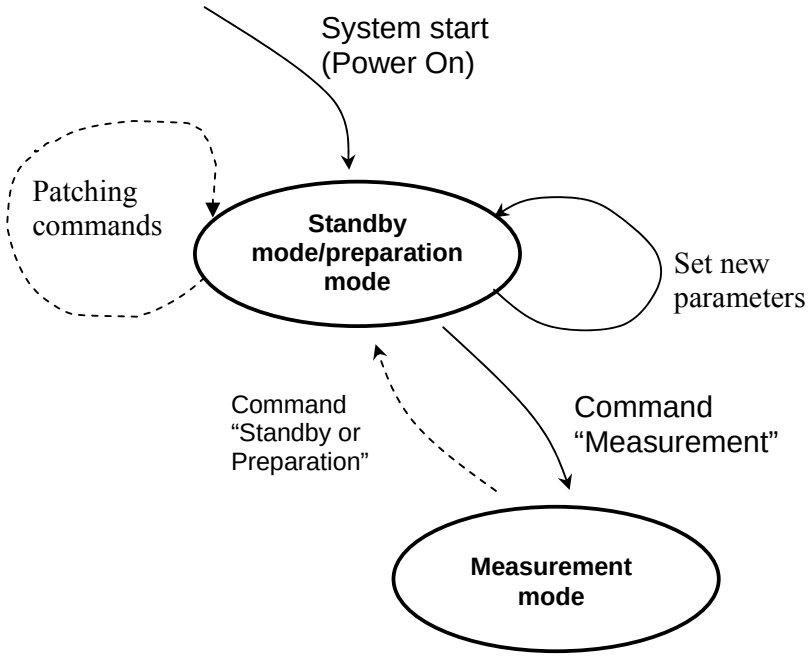


Figure 13: *Mode transition diagram. The transition from Measurement Mode to Standby/Preparation Mode is performed automatically except for a infinite “burst measurement”. Patching commands can be used to change SIR’s internal software.*

5.5.6.3 Detailed Mode Description (see also flight control procedures)

```
# -----------------MODES-----------------
#Nr_of_modes: 4

   Mode: OFF
   Mode_class: OFF
   Nominal_power: 0.0
   Nominal_data_rate: 0.0
   Equivalent_power: 0.0
   Equivalent_data_rate: 0.0
   Mode_transitions: G00511ZA       # SIR SWITCH ON (TO STANDBY)

   Mode: STANDBY
```

```
   Mode_class: STANDBY
   Nominal_power: 4.1
   Nominal_data_rate: 0.0
   Equivalent_power: 4.1 5.2 4.1        # second value with heater on
   Equivalent_data_rate: 0.0 248.0 0.0  # second value with housekeeping
   Mode_transitions: G00512ZA G002C
   Mode_actions: G003C G004C G005C G006C G007C G008C G009C G010C G011C \
      G00101ZA G00102ZA G00103ZA G00104ZA G00105ZA G00106ZA G00107ZA
      G00108ZA G00109ZA G00110ZA \
      G00201ZA G00202ZA G00203ZA G00204ZA G00205ZA G00301ZA G00401ZA

   Mode: PREPARATION
   Mode_class: STANDBY
   Nominal_power: 4.1
   Nominal_data_rate: 0.0
   Equivalent_power: 4.1 5.2 4.1
   Equivalent_data_rate: 0.0 248.0 0.0
   Mode_transitions: G00512ZA G001C
   Mode_actions: G003C G004C G005C G006C G007C G008C G009C G010C G011C

   Mode: MEASUREMENT
   Mode_class: MEASUREMENT
   Nominal_power: 4.1
   Nominal_data_rate: 0.0
   Equivalent_power: 4.1 5.2 4.1
   Equivalent_data_rate: 0.0 43920.0 0.0 #43920 highest data rate (100 ms
interval)
#  Mode_transitions: # not needed due to implementation strategy
#  Mode_actions: No mode actions necessary! This mode is only entered via
N003C
```

5.5.6.3.1 Standby/Preparation Mode

The originally separated standby- and preparation mode have now the same effects. Therefore it is possible to set all parameters already in standby mode and to enter the measurement mode straight without transition via the preparation mode.

After powering SIR the instrument reaches the standby/preparation mode. The standby/preparation mode is the transition between the non-powered mode and the measurement mode of SIR. In the standby/preparation mode SIR is ready for receiving parameters that control the planned measurements. The power consumption of SIR is approx. 4.1 W (+1 W for heater if activated). No data from SIR is sent to the mass memory in this stage except if the HK data acquisition was activated. SIR should be powered only when the instrument is cold enough (below –20 °C at sensor thermistor) for starting spectral measurements (TBC).

5.5.6.3.2 Measurement Mode

This mode is the most important one. The parameters selected in standby/preparation mode will be executed. The mode is entered after sending the G003C command. An interruption is

possible by sending a standby or preparation command. The total power consumption is 4.1 W (+ 1 W if the SIR heater is powered) a bit depending on the temperatures of the sensor-head and the E-Box. The mode is scientifically only relevant if the sensor temperature is approx. below –20 °C (TBC). Powering of SIR in phases where sunlight is entering the O-Box or illuminating the radiator shall be avoided. During the measurement mode SIR is sending continuously data via the CAN bus to the mass memory. The highest data rate reaches 47.4 Kbit/s. Due to SIR's small field of view it is essential to have the highest possible tracking and pointing capability during the measurement mode.

5.5.7 Nominal and Contingency Operations Procedures

5.5.7.1 Industry Procedures/Flight Control Procedures

For last version of Industry Procedures see [RD25]. The FCPs are annexed to the present document (updates of these FCPs will be found on the ESTEC server).

5.5.7.2 Pre-Commissioning and Commissioning

The pre-commissioning and the commissioning procedure are detailed in chapter 5.5.5. Further information is included in the flight control procedures.

5.5.7.3 In-flight Calibration

The main goals of the in-flight calibration in the earth escape phase are the first spectra of a standard star and the alignment verification between SIR and AMIE.

Sequence for alignment verification:

1. Nominal starting procedure of SIR

2. Start S/C slewing to scan across the lunar disk (use commissioning experience)

3. Start sequence "alignment verification" (TBD, for summarize see [RD10], [RD2] and Note on "In flight alignment verification between SIR and AMIE via time tagged commands"). Goal is the verification of the alignment of the optical axes of SIR and AMIE by targeting the Moon limb.

4. Power OFF SIR

The results of the alignment verification will be needed to point SIR to standard stars.

Standard-star spectra taking (to be performed after alignment verification, but before reaching the lunar orbit):

1. Nominal starting procedure of SIR

2. Pointing of SIR (with the help of AMIE) to bright standard stars and Jupiter

3. First burst spectra of standard stars (field search method). See also [RD10], [RD2] and note on "In flight alignment verification between SIR and AMIE via time tagged commands".

5.5.7.4 Second Commissioning in Lunar Orbit

See chapter 5.5.5.

5.5.7.5 Contingency Recovery

In case of a malfunction the latest obtained SIR data should be analyzed. The instrument shall be powered OFF in this phase. A restart of the instrument could resolve the problem. If not software patching could be tried. Since the instrument is operated via time tagged commands and without TM analysis by ESOC a recovery would need support by MPAe.

5.5.8 Summary of Telemetry and Telecommand Data

5.5.8.1 List of Dangerous Commands

Powering of instrument outside the restrictions (constraints) must be avoided (see section 5.5.5.1).

5.5.8.2 Summary of Telemetry and Telecommands (Version 5.3)

All **telecommand** data is in acc. to EID-A and uses "Big Endian" format, i.e. MSBs are sent first.

Common packet header for all SIR telecommand packets:

Packet Header								Packet Data Field	
Packet ID				Packet Source Control			Packet Length	Application Data	
Version Number	Type	Data Field Header	APID	Sequence Flags	Source ID	Sequence Count		Structure Identifier	Parameters
3	1	1	11	2	2	12	16	8	n * 8
000	1	0	APID	11	SID	Counter	Octets in Packet Data Field – 1	STID	

Supported APIDs (only APID 1001d will be used by SIR):

APID	Description
01111101001 (1001d)	SIR
00000000000 (0d)	Time Packet
11111111111 (2047d)	Idle Packet

Supported SIDs:

SID	Description
00	Ground all sources
01	Time Tag Commands
10	Reserved
11	Other on-board source

Supported application data:

Mnemonic	Description	Application Data Field	
		STID	Parameters (Number of letters in <> corresponds to bit sizes)
G000C	NOP (for I/F test only)	00h	–
G001C	Standby Mode	01h	–
G002C	Preparation Mode	02h	–
G003C	Measurement Mode	03h	–
G004C	Set Measurement Parameters	04h	G040M= <eee> <mmmmm> ***Exposure Time*** Calculation using exponent & mantissa as follows (time in [ms]): $(Exp = 0):\ T_{EXP} = \frac{Mant \cdot 262144}{f_{CLK}}$ $(Exp > 0):\ T_{EXP} = \frac{(32 + Mant) \cdot 2^{(Exp-1)} \cdot 262144}{f_{CLK}}$ f_{CLK} is derived from G0007C
			Default: 0x32 = 3.277 ms
			G041M = <sssssssssssssss> ***Number of Spectra*** 0d = off (→ stand-by mode) 1d – 65534d = number of spectra 65535d = infinite burst (for test)
			Default: 0 = off
			G042M = <iiiiiiii> ***Measurement Interval Time*** 0d = 1d 1d – 255d = interval time in [5 ms] units **Note:** The "Telemetry Interval Time" is this time multiplied by the ***Number of Spectra for Mean*** (see G007C below)
			Default: 0x14 = 100 ms
G005C	Set HK Parameters	05h	G050M = <pppppppp> ***H/K Acquisition Period*** 0d = off (→ stand-by mode) 1d – 255d = period in [s] units
			Default: 0d = off
G006C	Set Heater Parameters	06h	G060M = <aaaaaaaaaaaaaaaa> ***Deactivation Temperature*** 1d – 65534d = activation temperature (See temperature table)
			Default: 60265d = –72.9 °C

Mnemonic	Description	Application Data Field	
		STID	Parameters (Number of letters in <> corresponds to bit sizes)
			G061M = <dddddddddddddddd>[1] ***Activation Temperature*** 1d – 65534d = deactivation temperature (See temperature table) When both parameters are set to: 0d = heater on 65535d = heater off
			Default: 60280d = –73.0 °C
G007C	Set Averaging Parameters	07h	G070M = <mmm><cc><aaa>
			<mmm> ***Number of Spectra for Mean*** 0d – 7d = 2^N, 1 … 128 spectra
			Default: 0d = 1 spectrum
			<cc> ***ADC Clock Mode*** 0d = reserved (6 MHz, not operable) 1d = 4 MHz 2d = 3 MHz 3d = 2 MHz
			Default: 1d = 4 MHz
			<aaa> ***Multiple ADC Sampling*** 0d – 4d = 2^N, 1 … 16 samples 5d – 7d = 16 samples 3d = default $T_{sample} = N_{steps} * 64 *(256+7) / f_{clk}$
			Default: 3d = 8 sample
G008C	Memory Load	08h	G080M = <aaaaaaaaaaaaaaaa> ***First Memory Address*** 0d – 65535d = memory address
			G081M = <llllllll> ***Memory Length*** 0d = 256 bytes 1d – 255d = number of bytes to load
			G082M = <dddddddd/0> ... <dddddddd/n-1> ***Memory Data*** 0d – 255d data pattern
G009C	Memory Dump	09h	G080M = <aaaaaaaaaaaaaaaa> ***First Memory Address*** 0d – 65535d = memory address

[1] The G041M Parameter shall be update soon in DB.

Mnemonic	Description	Application Data Field	
		STID	Parameters (Number of letters in <> corresponds to bit sizes)
			G081M = <llllllll> ***Memory Length*** 0d = 256 bytes 1d – 255d = number of bytes to dump
G010C	Memory Check	0Ah	G080M = <aaaaaaaaaaaaaaaa> ***First Memory Address*** 0d – 65535d = memory address
			G081M = <llllllll> ***Memory Length*** 0d = 256 bytes 1d – 255d = number of bytes to check
G011C	Reset Instrument (for W/D test only)	0Bh	Not applicable for (P)FM

All **telemetry data** is in acc. to EID-A and uses Big Endian format, i.e. MSBs are sent first.

Common packet header for all SIR telemetry packets:

Packet Header							Packet Data Field
Packet ID				Packet Source Control		Packet Length	Source Data
Version Number	Type	Data Field Header	APID	Segmentation Flags	Sequence Count		Data
3	1	1	11	2	14	16	n * 8
000	0	0	1001d – 1004d (See below)	11	Counter	Octets in Packet Data Field – 1	

Supported APIDs:

Mnemonic	Description	APID	Application Data Field (Number of letters in <> corresponds to bit sizes)
MSIR0001	HK	1001d	<hhhhhhhh/0> ... <hhhhhhhh/24> ***SIR H/K Data*** 25 octets H/K data (see table below)
MSIR0002	Science	1002d	<ssssssssssssssss/0> ... <ssssssssssssssss/255> ***SIR Spectral Data*** 256 pixels, 16 bits each

Mnemonic	Description	APID	Application Data Field (Number of letters in <> corresponds to bit sizes)
MSIR0004	Memory Dump	1003d	<aaaaaaaaaaaa> ***First Memory Address*** 0d – 65535d = memory address
			<llllllll> ***Memory Length*** 0d = 256 bytes 1d – 255d = number of dumped bytes
			<dddddddd/0> ... <dddddddd/n-1> ***Memory Data*** 0d – 255d data pattern

Mnemonic	Description	APID	Application Data Field (Number of letters in <> corresponds to bit sizes)
MSIR0005	Memory Check	1004d	<aaaaaaaaaaaa> ***First Memory Address*** 0d – 65535d = memory address
			<llllllll> ***Memory Length*** 0d = 256 bytes 1d – 255d = number of checked bytes
			<cccccccccccccccc> ***Memory Checksum*** 0d – 65535d = checksum (acc. to CRC-16)

HK data:

Description	Number of Octets	Range	Resolution
Start of exposure	5	SCET	2^{-8} s (2^{-5} s internal)
W/D reset counter	1	0d … 255d	–
Exposure time	1	See corresponding telecommand	–
Detector temperature[16]	2	See Annex A	
YSI temperature[17]	2	See Annex A	
E–box temperature	2	See Annex A	
+5V voltage	2	0.0 … 6.76 V	~ 103 µV
+3.3V voltage	2	0.0 … 4.36 V	~ 66 µV
+5V E-Box current	2	-60 … 1509 mA	~ 24 µA
+5V sensor head current	2	-9 … 324 mA	~ 5.1 µA
CAN RX overruns	1	0d … 255d	–
CAN TX errors	1	0d … 255d	–
µ-Controller processing load	1	0 … 100 %	0.39 %
Averaging parameters	1	See corresponding telecommand	–
Total	25		

[16] Measured on test unit, PFM offset to be applied
[17] Measured on PFM Instrument unit with commercial E-Box, PFM E-Box correction to be applied

5.5.8.3 Summary of Telemetry and Telecommand parameters

See previous section.

5.5.8.4 Summary of Software parameters

See 5.5.8.2

5.5.9 Data Operations Handbook

5.5.9.1 Telecommand Function Definitions (extraction from DB, see official released DB for updates).

CCA Table

CCA_NUMBR	CCA_DESCR	CCA_ENGFMT	CCA_RAWFMT	CCA_RADIX	CCA_UNIT	CCA_NCURVE	CCA_SOURCE
7100	SIR Exposure	U	U	D	ms	2	S1-SIR-DCN-3001 1.0
7101	SIR H/K Acq.	U	U	D	s	2	S1-SIR-DCN-3001 1.0
7102	SIR	R	U	D	°C	20	S1-SIR-DCN-3001 1.0
7103	SIR Interval	R	U	D	ms	3	S1-SIR-DCN-3001 1.0

The use of the units ms, s, °C, is needless (data is RAW).

CCF Table

CCF_CNAME	CCF_DESCR	CCF_DESCR2	CCF_CTYPE	CCF_CRITICAL	CCF_PKTID	CCF_TYPE	CCF_STYPE	CCF_APID	CCF_NPARS	CCF_PLAN	CCF_EXEC	CCF_ILSCOPE	CCF_ILSTAGE	CCF_SUBSYS	CCF_HIPRI	CCF_MAPID	CCF_DEFSET	CCF_RAPID	CCF_ACK	CCF_CONSTR
G000C	SIR NOP	SIR NOP (for I/F test only)		N	PAYLOAD			1001	1	N	Y	N	C	18	N	63			1	
G001C	SIR Standby Mode	SIR Standby Mode		N	PAYLOAD			1001	1	N	Y	N	C	18	N	63			1	
G002C	SIR Preparation Mode	SIR Preparation Mode		N	PAYLOAD			1001	1	N	Y	N	C	18	N	63			1	
G003C	SIR Measurement Mode	SIR Measurement Mode		N	PAYLOAD			1001	1	N	Y	N	C	18	N	63			1	
G004C	SIR Meas. Parameters	SIR Meas.Parameters		N	PAYLOAD			1001	4	N	Y	N	C	18	N	63			1	
G005C	SIR HK Parameters	SIR H/K Parameters		N	PAYLOAD			1001	2	N	Y	N	C	18	N	63			1	
G006C	SIR Heater Parameters	SIR Heater Parameters		N	PAYLOAD			1001	3	N	Y	N	C	18	N	63			1	
G007C	SIR Averaging Parameters	SIR Averaging Parameter		N	PAYLOAD			1001	2	N	Y	N	C	18	N	63			1	
G008C	SIR Memory Load	SIR Memory Load		N	PAYLOAD			1001	4	N	Y	N	C	18	N	63			1	
G009C	SIR Memory Dump	SIR Memory Dump		N	PAYLOAD			1001	3	N	Y	N	C	18	N	63			1	
G010C	SIR Memory Check	SIR Memory Check		N	PAYLOAD			1001	3	N	Y	N	C	18	N	63			1	
G011C	SIR Reset	SIR W/D Reset		N	PAYLOAD			1001	1	N	Y	N	C	18	N	63			1	

CDF Table

CDF_CNAME	CDF_ELTYPE	CDF_DESCR	CDF_ELLEN	CDF_BIT	CDF_GRPSIZE	CDF_PNAME	CDF_INTER	CDF_VALUE	CDF_TMID
G000C	F	Structure ID	8	0		G030M	R	00	
G001C	F	Structure ID	8	0		G030M	R	01	
G002C	F	Structure ID	8	0		G030M	R	02	
G003C	F	Structure ID	8	0		G030M	R	03	
G004C	F	Structure ID	8	0		G030M	R	04	
G005C	F	Structure ID	8	0		G030M	R	05	
G006C	F	Structure ID	8	0		G030M	R	06	
G007C	F	Structure ID	8	0		G030M	R	07	
G008C	F	Structure ID	8	0		G030M	R	08	
G009C	F	Structure ID	8	0		G030M	R	09	
G010C	F	Structure ID	8	0		G030M	R	0A	
G011C	F	Structure ID	8	0		G030M	R	0B	

G030M parameter defined by SSC

5.5.9.2 Telecommand Parameter Definition

CPC Table

CPC_PNAME	CPC_DESCR	CPC_PTC	CPC_PFC	CPC_DISPFMT	CPC_RADIX	CPC_UNIT	CPC_CATEG	CPC_PRFREF	CPC_CCAREF	CPC_PAFREF	CPC_INTER	CPC_DEFVAL
G030M	SIR Structure ID	3	4	U	H		N				R	0
G040M	SIR Exposure Time	3	4	U	D	ms	C		7100		E	100
G041M	SIR Number of Spectra	3	12	U	D		N				R	65535
G042M	SIR Interval Time	3	4	U	D	ms	C		7103		E	100
G050M	SIR H/K Acq. Period (s)	3	4	U	D	s	C		7101		E	1
G060M	SIR Deactv.Temp (°C)	3	12	R	D	°C	C		7102		E	-72.9
G061M	SIR Actv. Temperature	3	12	R	D	°C	C		7102		E	-73.0
G070M	SIR Averaging	3	4	U	D		N				R	0
G080M	SIR Memory Address	7	2	U	H		N				R	
G081M	SIR Memory Length	7	1	U	H		N				R	
G082M	SIR Memory Data	7	6	U	H		N				R	

5.5.9.3 Telemetry Packet Definition

PID Table

PID_TYPE	PID_STYPE	PID_APID	PID_PI1_VAL	PID_PI2_VAL	PID_SPID	PID_DESCR	PID_UNIT	PID_TPSD	PID_DFHSIZE	PID_TIME	PID_INTER	PID_VALID	PID_LONG_DESCR
1	1	1001	0	-1	9301	ROUTE_SIR1_ACCEPTANCE_SUCCESS		-1	10	N		Y	
0	0	1001	0	-1	91001	SIR Housekeeping (MSIR0001)		-1	10	N		Y	Used
1	2	1001	8	-1	9031	ROUTE_SIR1_SYNTAX_ERROR		-1	10	N		Y	
5	2	1001	10	-1	9001	RouteSIR1CountGap		100	10	N		Y	Error
1	2	1001	14	-1	9061	ROUTE_SIR1_INVALID_PARAMETER		-1	10	N		Y	
1	2	1001	18	-1	9091	ROUTE_SIR1_REQUEST_NOT_COMPLET		-1	10	N		Y	
1	2	1001	25	-1	9121	ROUTE_SIR1_COMMAND_DELETED		-1	10	N		Y	
1	2	1001	26	-1	9151	ROUTE_SIR1_UNABLE_TO_DEPOSIT_CO		-1	10	N		Y	
1	2	1001	27	-1	9181	ROUTE_SIR1_SUBSCHEDULE_DISABLED		-1	10	N		Y	
1	2	1001	38	-1	9211	ROUTE_SIR1_INVALID_COMMAND_ID		-1	10	N		Y	
1	2	1001	39	-1	9241	ROUTE_SIR1_INVALID_DATA_LENGTH		-1	10	N		Y	
1	2	1001	41	-1	9271	ROUTE_SIR1_RESOURCE_NOT_AVAILAB		-1	10	N		Y	
1	1	1002	0	-1	9302	ROUTE_SIR2_ACCEPTANCE_SUCCESS		-1	10	N		Y	
0	0	1002	0	-1	91002	SIR Spectral Data (MSIR0002)		-1	10	N		Y	Used
1	2	1002	8	-1	9032	ROUTE_SIR2_SYNTAX_ERROR		-1	10	N		Y	
5	2	1002	10	-1	9002	RouteSIR2CountGap		110	10	N		Y	Error
1	2	1002	14	-1	9062	ROUTE_SIR2_INVALID_PARAMETER		-1	10	N		Y	
1	2	1002	18	-1	9092	ROUTE_SIR2_REQUEST_NOT_COMPLET		-1	10	N		Y	
1	2	1002	25	-1	9122	ROUTE_SIR2_COMMAND_DELETED		-1	10	N		Y	
1	2	1002	26	-1	9152	ROUTE_SIR2_UNABLE_TO_DEPOSIT_CO		-1	10	N		Y	
1	2	1002	27	-1	9182	ROUTE_SIR2_SUBSCHEDULE_DISABLED		-1	10	N		Y	
1	2	1002	38	-1	9212	ROUTE_SIR2_INVALID_COMMAND_ID		-1	10	N		Y	
1	2	1002	39	-1	9242	ROUTE_SIR2_INVALID_DATA_LENGTH		-1	10	N		Y	
1	2	1002	41	-1	9272	ROUTE_SIR2_RESOURCE_NOT_AVAILAB		-1	10	N		Y	
1	1	1003	0	-1	9303	ROUTE_SIR3_ACCEPTANCE_SUCCESS		-1	10	N		Y	
0	0	1003	0	-1	91003	SIR Memory Dump (MSIR0003)		-1	10	N		Y	Used
1	2	1003	8	-1	9033	ROUTE_SIR3_SYNTAX_ERROR		-1	10	N		Y	
5	2	1003	10	-1	9003	RouteSIR3CountGap		120	10	N		Y	Error
1	2	1003	14	-1	9063	ROUTE_SIR3_INVALID_PARAMETER		-1	10	N		Y	
1	2	1003	18	-1	9093	ROUTE_SIR3_REQUEST_NOT_COMPLET		-1	10	N		Y	
1	2	1003	25	-1	9123	ROUTE_SIR3_COMMAND_DELETED		-1	10	N		Y	
1	2	1003	26	-1	9153	ROUTE_SIR3_UNABLE_TO_DEPOSIT_CO		-1	10	N		Y	
1	2	1003	27	-1	9183	ROUTE_SIR3_SUBSCHEDULE_DISABLED		-1	10	N		Y	
1	2	1003	38	-1	9213	ROUTE_SIR3_INVALID_COMMAND_ID		-1	10	N		Y	
1	2	1003	39	-1	9243	ROUTE_SIR3_INVALID_DATA_LENGTH		-1	10	N		Y	
1	2	1003	41	-1	9273	ROUTE_SIR3_RESOURCE_NOT_AVAILAB		-1	10	N		Y	
1	1	1004	0	-1	9304	ROUTE_SIR4_ACCEPTANCE_SUCCESS		-1	10	N		Y	
0	0	1004	0	-1	91004	SIR Memory Check (MSIR0004)		-1	10	N		Y	Used

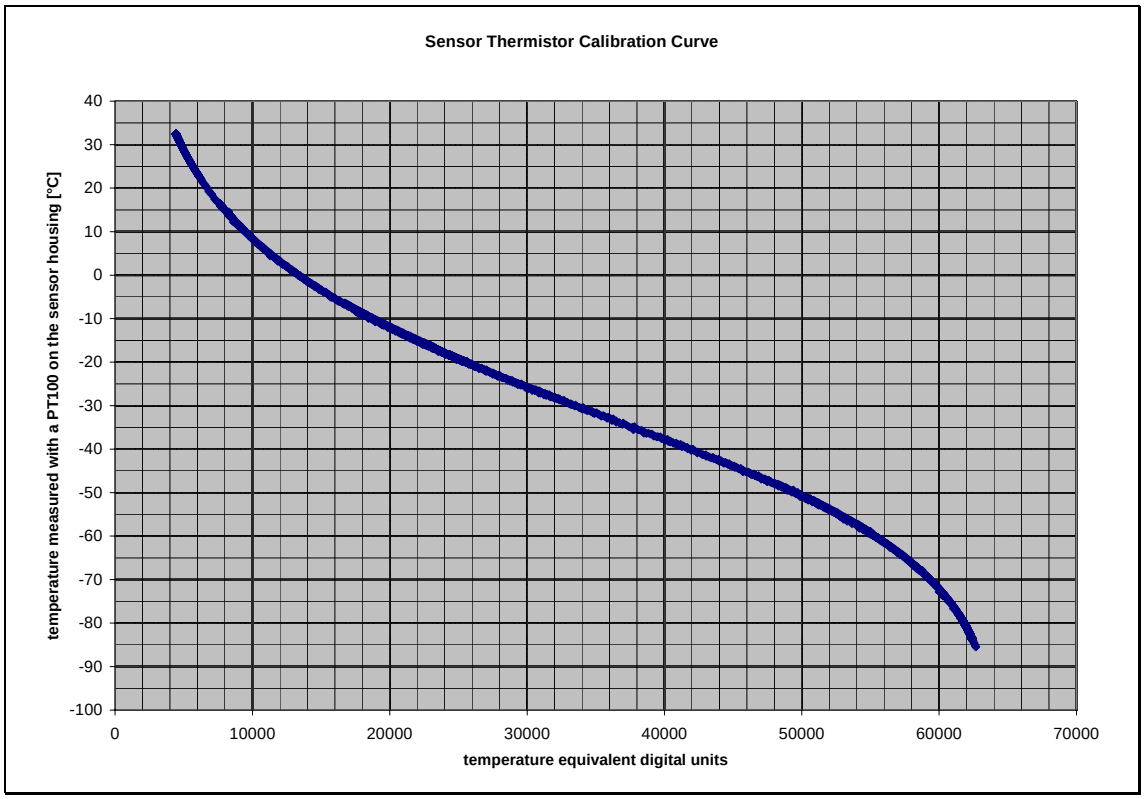
1	2	1004	8	-1	9034	ROUTE_SIR4_SYNTAX_ERROR		-1	10	N		Y	
5	2	1004	10	-1	9004	RouteSIR4CountGap		130	10	N		Y	Error
1	2	1004	14	-1	9064	ROUTE_SIR4_INVALID_PARAMETER		-1	10	N		Y	
1	2	1004	18	-1	9094	ROUTE_SIR4_REQUEST_NOT_COMPLET		-1	10	N		Y	
1	2	1004	25	-1	9124	ROUTE_SIR4_COMMAND_DELETED		-1	10	N		Y	
1	2	1004	26	-1	9154	ROUTE_SIR4_UNABLE_TO_DEPOSIT_CO		-1	10	N		Y	
1	2	1004	27	-1	9184	ROUTE_SIR4_SUBSCHEDULE_DISABLED		-1	10	N		Y	
1	2	1004	38	-1	9214	ROUTE_SIR4_INVALID_COMMAND_ID		-1	10	N		Y	
1	2	1004	39	-1	9244	ROUTE_SIR4_INVALID_DATA_LENGTH		-1	10	N		Y	
1	2	1004	41	-1	9274	ROUTE_SIR4_RESOURCE_NOT_AVAILAB		-1	10	N		Y	

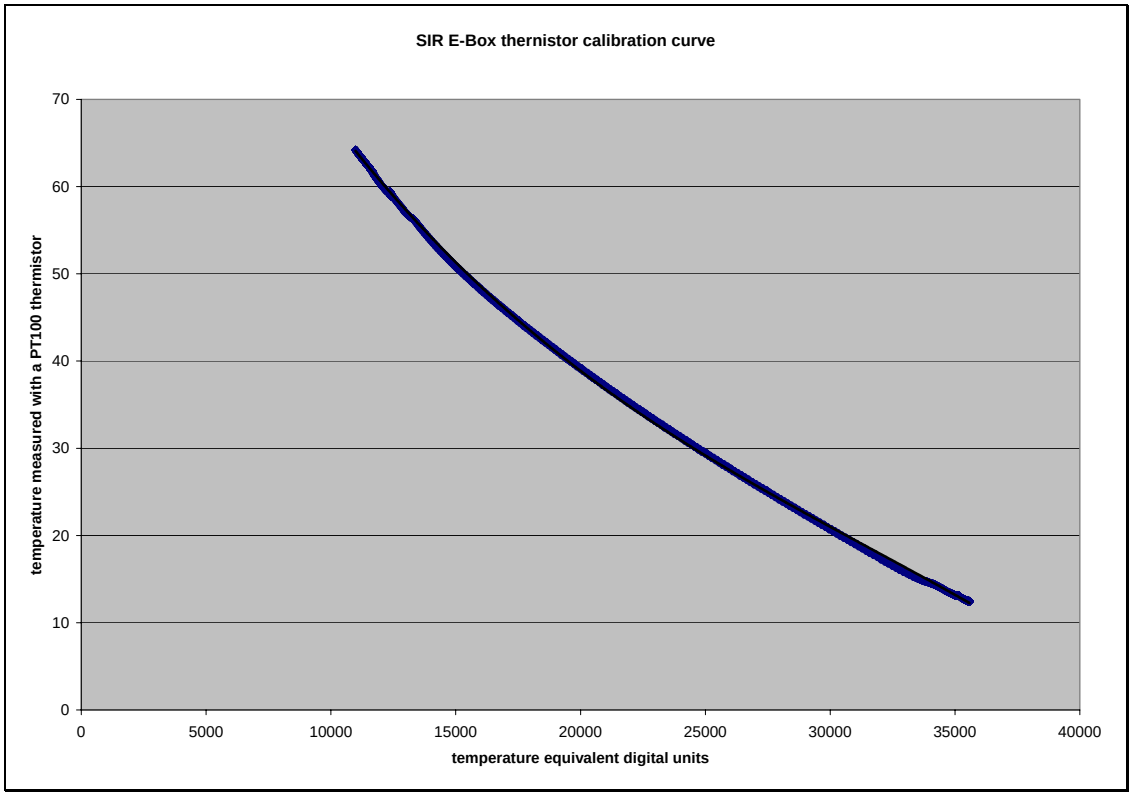
All telemetry data is in acc. to EID-A and uses Big Endian format, i.e. MSBs are sent first.

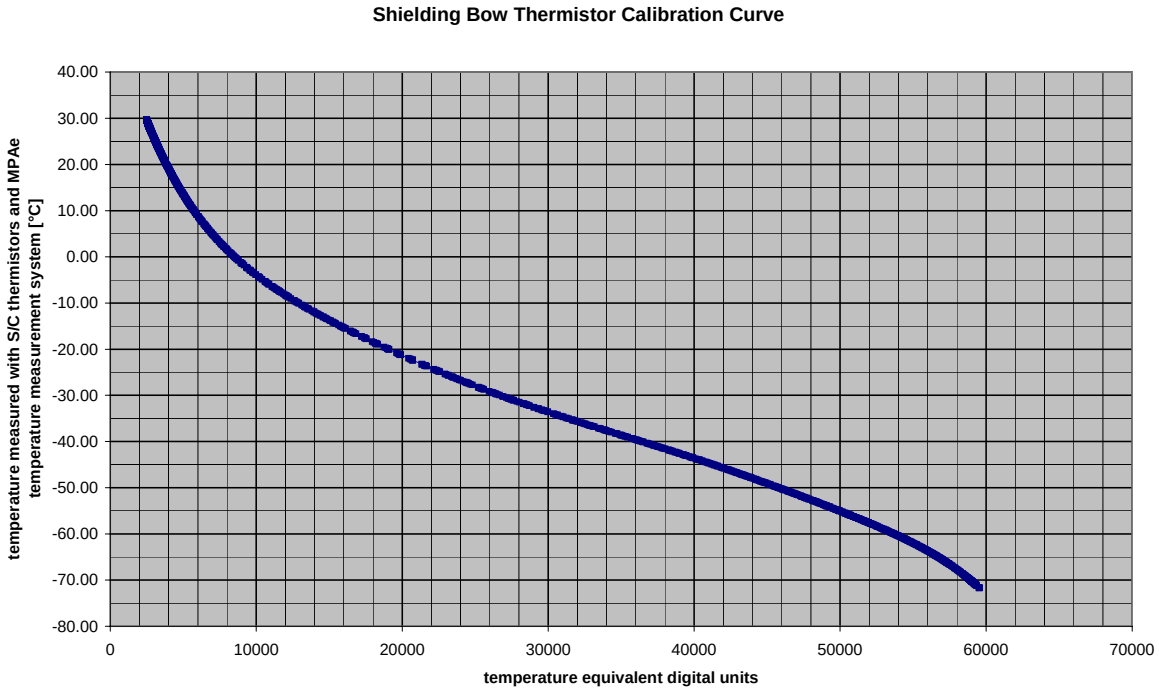
Common packet header for all SIR telemetry packets:

Packet Header							Packet Data Field
Packet ID				Packet Source Control		Packet Length	Source Data
Version Number	Type	Data Field Header	APID	Segmentation Flags	Sequence Count		Data
3	1	1	11	2	14	16	n * 8
000	0	0	1001d – 1004d	11	Counter	Octets in Packet Data Field – 1	

5.5.10 Annex A: Mathematical Models




SIR E-Box thernistor calibration curve
temperature measured with a PT100 thermistor
70
60
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
30000
35000
40000
temperature equivalent digital units


Shielding Bow Thermistor Calibration Curve
temperature measured with S/C thermistors and MPAe temperature measurement system [°C]
40.00
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
0
10000
20000
30000
40000
50000
60000
70000
temperature equivalent digital units

Sensor thermistor conversion table[19]

digital value		temperature [°C]
0x0000	0	51.1
0x0100	256	49.8
0x0200	512	48.5
0x0300	768	47.3
0x0400	1024	46.0
0x0500	1280	44.8
0x0600	1536	43.6
0x0700	1792	42.4
0x0800	2048	41.2
0x0900	2304	40.1
0x0A00	2560	38.9
0x0B00	2816	37.8
0x0C00	3072	36.6
0x0D00	3328	35.5
0x0E00	3584	34.4
0x0F00	3840	33.3
0x1000	4096	32.3
0x1100	4352	31.2
0x1200	4608	30.2
0x1300	4864	29.1
0x1400	5120	28.1
0x1500	5376	27.1
0x1600	5632	26.1
0x1700	5888	25.2
0x1800	6144	24.2
0x1900	6400	23.2
0x1A00	6656	22.3
0x1B00	6912	21.4
0x1C00	7168	20.5
0x1D00	7424	19.6
0x1E00	7680	18.7
0x1F00	7936	17.8
0x2000	8192	16.9
0x2100	8448	16.1
0x2200	8704	15.2
0x2300	8960	14.4
0x2400	9216	13.6
0x2500	9472	12.8
0x2600	9728	12.0
0x2700	9984	11.2
0x2800	10240	10.4
0x2900	10496	9.6
0x2A00	10752	8.9
0x2B00	11008	8.1
0x2C00	11264	7.4
0x2D00	11520	6.7
0x2E00	11776	6.0
0x2F00	12032	5.2
0x3000	12288	4.6
0x3100	12544	3.9
0x3200	12800	3.2
0x3300	13056	2.5
0x3400	13312	1.9
0x3500	13568	1.2
0x3600	13824	0.6
0x3700	14080	0.0
0x3800	14336	-0.6
0x3900	14592	-1.3
0x3A00	14848	-1.9
0x3B00	15104	-2.4
0x3C00	15360	-3.0
0x3D00	15616	-3.6
0x3E00	15872	-4.2
0x3F00	16128	-4.7
0x4000	16384	-5.3
0x4100	16640	-5.8
0x4200	16896	-6.4
0x4300	17152	-6.9
0x4400	17408	-7.4
0x4500	17664	-7.9
0x4600	17920	-8.4
0x4700	18176	-8.9
0x4800	18432	-9.4
0x4900	18688	-9.9
0x4A00	18944	-10.3
0x4B00	19200	-10.8
0x4C00	19456	-11.3
0x4D00	19712	-11.7
0x4E00	19968	-12.2
0x4F00	20224	-12.6
0x5000	20480	-13.0
0x5100	20736	-13.5
0x5200	20992	-13.9
0x5300	21248	-14.3
0x5400	21504	-14.7
0x5500	21760	-15.1
0x5600	22016	-15.5
0x5700	22272	-15.9
0x5800	22528	-16.3
0x5900	22784	-16.7
0x5A00	23040	-17.1
0x5B00	23296	-17.4
0x5C00	23552	-17.8
0x5D00	23808	-18.2
0x5E00	24064	-18.5
0x5F00	24320	-18.9
0x6000	24576	-19.2
0x6100	24832	-19.5
0x6200	25088	-19.9
0x6300	25344	-20.2
0x6400	25600	-20.6
0x6500	25856	-20.9
0x6600	26112	-21.2
0x6700	26368	-21.5
0x6800	26624	-21.8
0x6900	26880	-22.1
0x6A00	27136	-22.4
0x6B00	27392	-22.8
0x6C00	27648	-23.1
0x6D00	27904	-23.4
0x6E00	28160	-23.6
0x6F00	28416	-23.9
0x7000	28672	-24.2
0x7100	28928	-24.5
0x7200	29184	-24.8
0x7300	29440	-25.1
0x7400	29696	-25.4
0x7500	29952	-25.6
0x7600	30208	-25.9
0x7700	30464	-26.2
0x7800	30720	-26.5
0x7900	30976	-26.7
0x7A00	31232	-27.0
0x7B00	31488	-27.3
0x7C00	31744	-27.5
0x7D00	32000	-27.8
0x7E00	32256	-28.1
0x7F00	32512	-28.3

[19] PFM offset to be applied

0x8000	32768	-28.6
0x8100	33024	-28.8
0x8200	33280	-29.1
0x8300	33536	-29.4
0x8400	33792	-29.6
0x8500	34048	-29.9
0x8600	34304	-30.1
0x8700	34560	-30.4
0x8800	34816	-30.6
0x8900	35072	-30.9
0x8A00	35328	-31.2
0x8B00	35584	-31.4
0x8C00	35840	-31.7
0x8D00	36096	-31.9
0x8E00	36352	-32.2
0x8F00	36608	-32.4
0x9000	36864	-32.7
0x9100	37120	-33.0
0x9200	37376	-33.2
0x9300	37632	-33.5
0x9400	37888	-33.8
0x9500	38144	-34.0
0x9600	38400	-34.3
0x9700	38656	-34.6
0x9800	38912	-34.8
0x9900	39168	-35.1
0x9A00	39424	-35.4
0x9B00	39680	-35.7
0x9C00	39936	-36.0
0x9D00	40192	-36.2
0x9E00	40448	-36.5
0x9F00	40704	-36.8
0xA000	40960	-37.1
0xA100	41216	-37.4
0xA200	41472	-37.7
0xA300	41728	-38.0
0xA400	41984	-38.3
0xA500	42240	-38.6
0xA600	42496	-38.9
0xA700	42752	-39.2
0xA800	43008	-39.5
0xA900	43264	-39.8
0xAA00	43520	-40.2
0xAB00	43776	-40.5
0xAC00	44032	-40.8
0xAD00	44288	-41.2
0xAE00	44544	-41.5
0xAF00	44800	-41.8
0xB000	45056	-42.2
0xB100	45312	-42.6
0xB200	45568	-42.9
0xB300	45824	-43.3
0xB400	46080	-43.6
0xB500	46336	-44.0
0xB600	46592	-44.4
0xB700	46848	-44.8
0xB800	47104	-45.2
0xB900	47360	-45.6
0xBA00	47616	-46.0
0xBB00	47872	-46.4
0xBC00	48128	-46.8
0xBD00	48384	-47.2
0xBE00	48640	-47.6
0xBF00	48896	-48.0
0xC000	49152	-48.5
0xC100	49408	-48.9
0xC200	49664	-49.4
0xC300	49920	-49.8
0xC400	50176	-50.3
0xC500	50432	-50.8
0xC600	50688	-51.2
0xC700	50944	-51.7
0xC800	51200	-52.2
0xC900	51456	-52.7
0xCA00	51712	-53.2
0xCB00	51968	-53.7
0xCC00	52224	-54.2
0xCD00	52480	-54.8
0xCE00	52736	-55.3
0xCF00	52992	-55.9
0xD000	53248	-56.4
0xD100	53504	-57.0
0xD200	53760	-57.5
0xD300	54016	-58.1
0xD400	54272	-58.7
0xD500	54528	-59.3
0xD600	54784	-59.9
0xD700	55040	-60.5
0xD800	55296	-61.1
0xD900	55552	-61.8
0xDA00	55808	-62.4
0xDB00	56064	-63.0
0xDC00	56320	-63.7
0xDD00	56576	-64.4
0xDE00	56832	-65.1
0xDF00	57088	-65.7
0xE000	57344	-66.4
0xE100	57600	-67.1
0xE200	57856	-67.9
0xE300	58112	-68.6
0xE400	58368	-69.3
0xE500	58624	-70.1
0xE600	58880	-70.8
0xE700	59136	-71.6
0xE800	59392	-72.4
0xE900	59648	-73.2
0xEA00	59904	-74.0
0xEB00	60160	-74.8
0xEC00	60416	-75.6
0xED00	60672	-76.5
0xEE00	60928	-77.3
0xEF00	61184	-78.2
0xF000	61440	-79.0
0xF100	61696	-79.9
0xF200	61952	-80.8
0xF300	62208	-81.7
0xF400	62464	-82.6
0xF500	62720	-83.6
0xF600	62976	-84.5
0xF700	63232	-85.5
0xF800	63488	-86.5
0xF900	63744	-87.4
0xFA00	64000	-88.4
0xFB00	64256	-89.4
0xFC00	64512	-90.5
0xFD00	64768	-91.5
0xFE00	65024	-92.5
0xFF00	65280	-93.6

E-Box thermistor conversion table

digital value		temperature [°C]
0x0000	0	115.1
0x0100	256	113.6
0x0200	512	112.1
0x0300	768	110.6
0x0400	1024	109.1
0x0500	1280	107.6
0x0600	1536	106.2
0x0700	1792	104.8
0x0800	2048	103.4
0x0900	2304	102.0
0x0A00	2560	100.6
0x0B00	2816	99.3
0x0C00	3072	98.0
0x0D00	3328	96.6
0x0E00	3584	95.3
0x0F00	3840	94.1
0x1000	4096	92.8
0x1100	4352	91.5
0x1200	4608	90.3
0x1300	4864	89.1
0x1400	5120	87.9
0x1500	5376	86.7
0x1600	5632	85.5
0x1700	5888	84.3
0x1800	6144	83.2
0x1900	6400	82.1
0x1A00	6656	80.9
0x1B00	6912	79.8
0x1C00	7168	78.7
0x1D00	7424	77.7
0x1E00	7680	76.6
0x1F00	7936	75.5
0x2000	8192	74.5
0x2100	8448	73.5
0x2200	8704	72.5
0x2300	8960	71.5
0x2400	9216	70.5
0x2500	9472	69.5
0x2600	9728	68.6
0x2700	9984	67.6
0x2800	10240	66.7
0x2900	10496	65.8
0x2A00	10752	64.9
0x2B00	11008	64.0
0x2C00	11264	63.1
0x2D00	11520	62.2
0x2E00	11776	61.3
0x2F00	12032	60.5
0x3000	12288	59.7
0x3100	12544	58.8
0x3200	12800	58.0
0x3300	13056	57.2
0x3400	13312	56.4
0x3500	13568	55.6
0x3600	13824	54.8
0x3700	14080	54.1
0x3800	14336	53.3
0x3900	14592	52.6
0x3A00	14848	51.8
0x3B00	15104	51.1
0x3C00	15360	50.4
0x3D00	15616	49.7
0x3E00	15872	49.0
0x3F00	16128	48.3
0x4000	16384	47.6
0x4100	16640	47.0
0x4200	16896	46.3
0x4300	17152	45.7
0x4400	17408	45.0
0x4500	17664	44.4
0x4600	17920	43.8
0x4700	18176	43.1
0x4800	18432	42.5
0x4900	18688	41.9
0x4A00	18944	41.3
0x4B00	19200	40.7
0x4C00	19456	40.2
0x4D00	19712	39.6
0x4E00	19968	39.0
0x4F00	20224	38.5
0x5000	20480	37.9
0x5100	20736	37.4
0x5200	20992	36.8
0x5300	21248	36.3
0x5400	21504	35.8
0x5500	21760	35.2
0x5600	22016	34.7
0x5700	22272	34.2
0x5800	22528	33.7
0x5900	22784	33.2
0x5A00	23040	32.7
0x5B00	23296	32.2
0x5C00	23552	31.7
0x5D00	23808	31.3
0x5E00	24064	30.8
0x5F00	24320	30.3
0x6000	24576	29.9
0x6100	24832	29.4
0x6200	25088	28.9
0x6300	25344	28.5
0x6400	25600	28.1
0x6500	25856	27.6
0x6600	26112	27.2
0x6700	26368	26.7
0x6800	26624	26.3
0x6900	26880	25.9
0x6A00	27136	25.4
0x6B00	27392	25.0
0x6C00	27648	24.6
0x6D00	27904	24.2
0x6E00	28160	23.8
0x6F00	28416	23.4
0x7000	28672	22.9
0x7100	28928	22.5
0x7200	29184	22.1
0x7300	29440	21.7
0x7400	29696	21.3
0x7500	29952	20.9
0x7600	30208	20.5
0x7700	30464	20.1
0x7800	30720	19.7
0x7900	30976	19.3
0x7A00	31232	18.9
0x7B00	31488	18.5
0x7C00	31744	18.1
0x7D00	32000	17.7
0x7E00	32256	17.4
0x7F00	32512	17.0
0x8000	32768	16.6
0x8100	33024	16.2
0x8200	33280	15.8
0x8300	33536	15.4
0x8400	33792	15.0
0x8500	34048	14.6

0x8600	34304	14.2
0x8700	34560	13.8
0x8800	34816	13.4
0x8900	35072	13.0
0x8A00	35328	12.6
0x8B00	35584	12.2
0x8C00	35840	11.8
0x8D00	36096	11.4
0x8E00	36352	11.0
0x8F00	36608	10.6
0x9000	36864	10.2
0x9100	37120	9.7
0x9200	37376	9.3
0x9300	37632	8.9
0x9400	37888	8.5
0x9500	38144	8.1
0x9600	38400	7.6
0x9700	38656	7.2
0x9800	38912	6.8
0x9900	39168	6.3
0x9A00	39424	5.9
0x9B00	39680	5.4
0x9C00	39936	5.0
0x9D00	40192	4.5
0x9E00	40448	4.1
0x9F00	40704	3.6
0xA000	40960	3.2
0xA100	41216	2.7
0xA200	41472	2.2
0xA300	41728	1.7
0xA400	41984	1.2
0xA500	42240	0.7
0xA600	42496	0.2
0xA700	42752	-0.3
0xA800	43008	-0.8
0xA900	43264	-1.3
0xAA00	43520	-1.8
0xAB00	43776	-2.3
0xAC00	44032	-2.9
0xAD00	44288	-3.4
0xAE00	44544	-3.9
0xAF00	44800	-4.5
0xB000	45056	-5.0
0xB100	45312	-5.6
0xB200	45568	-6.2
0xB300	45824	-6.8
0xB400	46080	-7.3
0xB500	46336	-7.9
0xB600	46592	-8.5
0xB700	46848	-9.1
0xB800	47104	-9.8
0xB900	47360	-10.4
0xBA00	47616	-11.0
0xBB00	47872	-11.7
0xBC00	48128	-12.3
0xBD00	48384	-13.0
0xBE00	48640	-13.6
0xBF00	48896	-14.3
0xC000	49152	-15.0
0xC100	49408	-15.7
0xC200	49664	-16.4
0xC300	49920	-17.1
0xC400	50176	-17.8
0xC500	50432	-18.6
0xC600	50688	-19.3
0xC700	50944	-20.1
0xC800	51200	-20.8
0xC900	51456	-21.6
0xCA00	51712	-22.4

0xCB00	51968	-23.2
0xCC00	52224	-24.0
0xCD00	52480	-24.8
0xCE00	52736	-25.6
0xCF00	52992	-26.4
0xD000	53248	-27.3
0xD100	53504	-28.1
0xD200	53760	-29.0
0xD300	54016	-29.9
0xD400	54272	-30.8
0xD500	54528	-31.7
0xD600	54784	-32.6
0xD700	55040	-33.5
0xD800	55296	-34.5
0xD900	55552	-35.4
0xDA00	55808	-36.4
0xDB00	56064	-37.4
0xDC00	56320	-38.4
0xDD00	56576	-39.4
0xDE00	56832	-40.4
0xDF00	57088	-41.4
0xE000	57344	-42.5
0xE100	57600	-43.5
0xE200	57856	-44.6
0xE300	58112	-45.7
0xE400	58368	-46.8
0xE500	58624	-47.9
0xE600	58880	-49.1
0xE700	59136	-50.2
0xE800	59392	-51.4
0xE900	59648	-52.5
0xEA00	59904	-53.7
0xEB00	60160	-54.9
0xEC00	60416	-56.1
0xED00	60672	-57.4
0xEE00	60928	-58.6
0xEF00	61184	-59.9
0xF000	61440	-61.2
0xF100	61696	-62.5
0xF200	61952	-63.8
0xF300	62208	-65.1
0xF400	62464	-66.5
0xF500	62720	-67.8
0xF600	62976	-69.2
0xF700	63232	-70.6
0xF800	63488	-72.0
0xF900	63744	-73.4
0xFA00	64000	-74.9
0xFB00	64256	-76.3
0xFC00	64512	-77.8
0xFD00	64768	-79.3
0xFE00	65024	-80.8
0xFF00	65280	-82.4

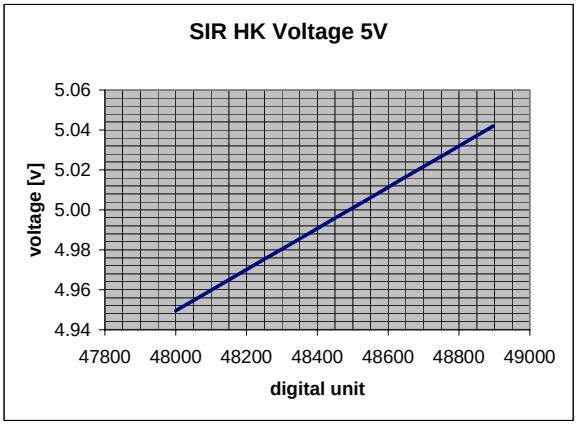
Conversion table for "shielding bow thermistor" (YSI)[20]

digital value		temperature [°C]
0x0000	0	54.9
0x0100	256	51.8
0x0200	512	48.8
0x0300	768	45.9
0x0400	1024	43.1
0x0500	1280	40.5
0x0600	1536	38.0
0x0700	1792	35.6
0x0800	2048	33.3
0x0900	2304	31.2
0x0A00	2560	29.1
0x0B00	2816	27.1
0x0C00	3072	25.2
0x0D00	3328	23.4
0x0E00	3584	21.7
0x0F00	3840	20.1
0x1000	4096	18.5
0x1100	4352	17.0
0x1200	4608	15.6
0x1300	4864	14.2
0x1400	5120	12.9
0x1500	5376	11.7
0x1600	5632	10.5
0x1700	5888	9.4
0x1800	6144	8.3
0x1900	6400	7.2
0x1A00	6656	6.2
0x1B00	6912	5.2
0x1C00	7168	4.3
0x1D00	7424	3.4
0x1E00	7680	2.6
0x1F00	7936	1.7
0x2000	8192	1.0
0x2100	8448	0.2
0x2200	8704	-0.5
0x2300	8960	-1.3
0x2400	9216	-2.0
0x2500	9472	-2.6
0x2600	9728	-3.3
0x2700	9984	-3.9
0x2800	10240	-4.5
0x2900	10496	-5.1
0x2A00	10752	-5.7
0x2B00	11008	-6.2
0x2C00	11264	-6.8
0x2D00	11520	-7.3
0x2E00	11776	-7.8
0x2F00	12032	-8.4
0x3000	12288	-8.9
0x3100	12544	-9.4
0x3200	12800	-9.8
0x3300	13056	-10.3
0x3400	13312	-10.8
0x3500	13568	-11.2
0x3600	13824	-11.7
0x3700	14080	-12.2
0x3800	14336	-12.6
0x3900	14592	-13.0
0x3A00	14848	-13.5
0x3B00	15104	-13.9
0x3C00	15360	-14.3
0x3D00	15616	-14.7
0x3E00	15872	-15.1
0x3F00	16128	-15.5
0x4000	16384	-16.0
0x4100	16640	-16.4
0x4200	16896	-16.8
0x4300	17152	-17.1
0x4400	17408	-17.5
0x4500	17664	-17.9
0x4600	17920	-18.3
0x4700	18176	-18.7
0x4800	18432	-19.1
0x4900	18688	-19.5
0x4A00	18944	-19.8
0x4B00	19200	-20.2
0x4C00	19456	-20.6
0x4D00	19712	-20.9
0x4E00	19968	-21.3
0x4F00	20224	-21.7
0x5000	20480	-22.0
0x5100	20736	-22.4
0x5200	20992	-22.8
0x5300	21248	-23.1
0x5400	21504	-23.5
0x5500	21760	-23.8
0x5600	22016	-24.1
0x5700	22272	-24.5
0x5800	22528	-24.8
0x5900	22784	-25.2
0x5A00	23040	-25.5
0x5B00	23296	-25.8
0x5C00	23552	-26.2
0x5D00	23808	-26.5
0x5E00	24064	-26.8
0x5F00	24320	-27.1
0x6000	24576	-27.5
0x6100	24832	-27.8
0x6200	25088	-28.1
0x6300	25344	-28.4
0x6400	25600	-28.7
0x6500	25856	-29.0
0x6600	26112	-29.3
0x6700	26368	-29.6
0x6800	26624	-29.9
0x6900	26880	-30.2
0x6A00	27136	-30.5
0x6B00	27392	-30.8
0x6C00	27648	-31.1
0x6D00	27904	-31.4
0x6E00	28160	-31.6
0x6F00	28416	-31.9
0x7000	28672	-32.2
0x7100	28928	-32.5
0x7200	29184	-32.8
0x7300	29440	-33.0
0x7400	29696	-33.3
0x7500	29952	-33.6
0x7600	30208	-33.8
0x7700	30464	-34.1
0x7800	30720	-34.4
0x7900	30976	-34.6
0x7A00	31232	-34.9
0x7B00	31488	-35.1
0x7C00	31744	-35.4
0x7D00	32000	-35.7
0x7E00	32256	-35.9
0x7F00	32512	-36.2
0x8000	32768	-36.4
0x8100	33024	-36.7
0x8200	33280	-36.9

[20] correction for PFM E-Box to be applied.

0x8300	33536	-37.2
0x8400	33792	-37.4
0x8500	34048	-37.7
0x8600	34304	-37.9
0x8700	34560	-38.2
0x8800	34816	-38.4
0x8900	35072	-38.7
0x8A00	35328	-38.9
0x8B00	35584	-39.2
0x8C00	35840	-39.4
0x8D00	36096	-39.7
0x8E00	36352	-39.9
0x8F00	36608	-40.2
0x9000	36864	-40.4
0x9100	37120	-40.7
0x9200	37376	-41.0
0x9300	37632	-41.2
0x9400	37888	-41.5
0x9500	38144	-41.7
0x9600	38400	-42.0
0x9700	38656	-42.2
0x9800	38912	-42.5
0x9900	39168	-42.8
0x9A00	39424	-43.0
0x9B00	39680	-43.3
0x9C00	39936	-43.6
0x9D00	40192	-43.8
0x9E00	40448	-44.1
0x9F00	40704	-44.4
0xA000	40960	-44.6
0xA100	41216	-44.9
0xA200	41472	-45.2
0xA300	41728	-45.4
0xA400	41984	-45.7
0xA500	42240	-46.0
0xA600	42496	-46.3
0xA700	42752	-46.6
0xA800	43008	-46.8
0xA900	43264	-47.1
0xAA00	43520	-47.4
0xAB00	43776	-47.7
0xAC00	44032	-48.0
0xAD00	44288	-48.3
0xAE00	44544	-48.6
0xAF00	44800	-48.9
0xB000	45056	-49.2
0xB100	45312	-49.4
0xB200	45568	-49.7
0xB300	45824	-50.0
0xB400	46080	-50.3
0xB500	46336	-50.6
0xB600	46592	-50.9
0xB700	46848	-51.2
0xB800	47104	-51.5
0xB900	47360	-51.9
0xBA00	47616	-52.2
0xBB00	47872	-52.5
0xBC00	48128	-52.8
0xBD00	48384	-53.1
0xBE00	48640	-53.4
0xBF00	48896	-53.7
0xC000	49152	-54.0
0xC100	49408	-54.3
0xC200	49664	-54.7
0xC300	49920	-55.0
0xC400	50176	-55.3
0xC500	50432	-55.6
0xC600	50688	-55.9
0xC700	50944	-56.3
0xC800	51200	-56.6
0xC900	51456	-56.9
0xCA00	51712	-57.3
0xCB00	51968	-57.6
0xCC00	52224	-57.9
0xCD00	52480	-58.3
0xCE00	52736	-58.6
0xCF00	52992	-59.0
0xD000	53248	-59.4
0xD100	53504	-59.7
0xD200	53760	-60.1
0xD300	54016	-60.5
0xD400	54272	-60.8
0xD500	54528	-61.2
0xD600	54784	-61.6
0xD700	55040	-62.0
0xD800	55296	-62.5
0xD900	55552	-62.9
0xDA00	55808	-63.3
0xDB00	56064	-63.8
0xDC00	56320	-64.2
0xDD00	56576	-64.7
0xDE00	56832	-65.2
0xDF00	57088	-65.7
0xE000	57344	-66.3
0xE100	57600	-66.8
0xE200	57856	-67.4
0xE300	58112	-68.0
0xE400	58368	-68.6
0xE500	58624	-69.2
0xE600	58880	-69.9
0xE700	59136	-70.6
0xE800	59392	-71.3
0xE900	59648	-72.1
0xEA00	59904	-72.9
0xEB00	60160	-73.7
0xEC00	60416	-74.5
0xED00	60672	-75.5
0xEE00	60928	-76.4
0xEF00	61184	-77.4
0xF000	61440	-78.5
0xF100	61696	-79.6
0xF200	61952	-80.7
0xF300	62208	-81.9
0xF400	62464	-83.2
0xF500	62720	-84.6
0xF600	62976	-86.0
0xF700	63232	-87.4
0xF800	63488	-89.0
0xF900	63744	-90.7
0xFA00	64000	-92.4
0xFB00	64256	-94.2
0xFC00	64512	-96.1
0xFD00	64768	-98.1
0xFE00	65024	-100.2
0xFF00	65280	-102.5

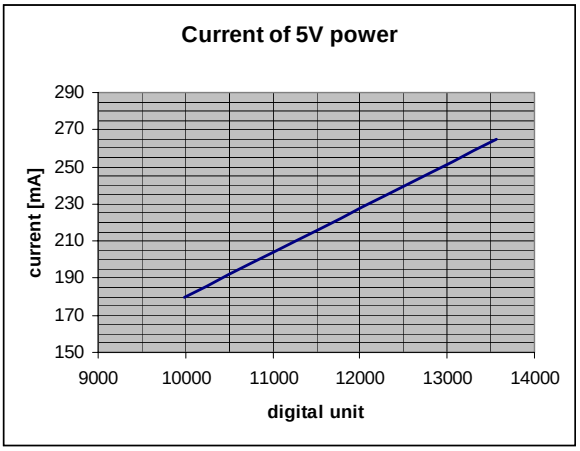
5V HK Value



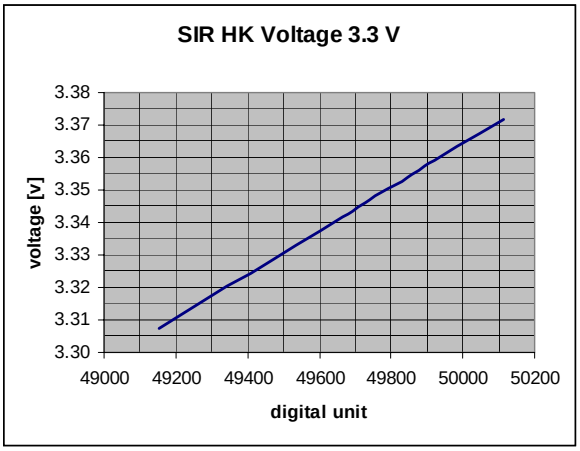
digital value		voltage [V]
0xC000	49152	3.31
0xC040	49216	3.31
0xC080	49280	3.32
0xC0C0	49344	3.32
0xC100	49408	3.32
0xC140	49472	3.33
0xC180	49536	3.33
0xC1C0	49600	3.34
0xC200	49664	3.34
0xC240	49728	3.35
0xC2C0	49856	3.35
0xC300	49920	3.36
0xC340	49984	3.36
0xC380	50048	3.37
0xC3C0	50112	3.37

digital value		voltage [V]
0xBB80	48000	4.95
0xBBC0	48064	4.96
0xBC00	48128	4.96
0xBC40	48192	4.97
0xBC80	48256	4.98
0xBCC0	48320	4.98
0xBD00	48384	4.99
0xBD40	48448	5.00
0xBD80	48512	5.00
0xBDC0	48576	5.01
0xBE00	48640	5.02
0xBE40	48704	5.02
0xBE80	48768	5.03
0xBEC0	48832	5.04
0xBF00	48896	5.04

Current (5V power) HK Value

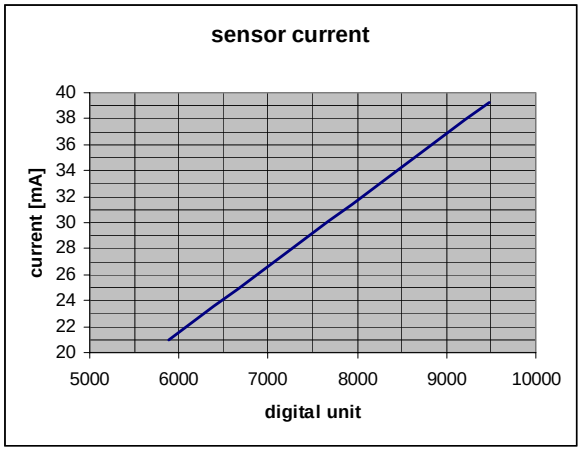


3.3 V HK Value



digital value		current [mA]
0x2700	9984	179
0x2800	10240	185
0x2900	10496	192
0x2A00	10752	198
0x2B00	11008	204
0x2C00	11264	210
0x2D00	11520	216
0x2E00	11776	222
0x2F00	12032	228
0x3000	12288	235
0x3100	12544	241
0x3200	12800	247
0x3300	13056	253
0x3400	13312	259
0x3500	13568	265

Sensor Current HK Value



digital value		current [mA]
0x1700	5888	21
0x1800	6144	22
0x1900	6400	24
0x1A00	6656	25
0x1B00	6912	26
0x1C00	7168	27
0x1D00	7424	29
0x1E00	7680	30
0x1F00	7936	31
0x2000	8192	33
0x2100	8448	34
0x2200	8704	35
0x2300	8960	37
0x2400	9216	38
0x2500	9472	39

5.5.11 Annex B: Pointing and special requirements

Nominal measurement mode is “nadir pointing”. “Off nadir” pointing with surface feature tracking is sometimes desired (scientific target list). High precision tracking of ground spot desired.

5.5.12 Annex C: Auxiliary processing Data Requirements

S/C HK data, timing and ground spot position needed.

5.5.13 Annex D: List of Abbreviations

ADC: Analog Digital Converter
A/D: Analog Digital Conversion
CAN: Controller Area Network
EGSE: Electronic Ground Support Equipment
E-Box: Electronics Box
NIR: Near Infrared
O-Box: Optical Box
PDA: Photo Diode Array
PCB: Printed Circuit Board
PFM: Proto Flight Model
QM: Qualification Model
S/C: Spacecraft
S/W: Software
TM: Telemetry

5.5.14 Annex E: Instrument Contact Points

A. Nathues, MPAe, Tel. 0049 5556 979 433, nathues@linmpi.mpg.de
A. Dannenberg, MPAe, Tel. 0049 5556 979 359, dannenberg@linmpi.mpg.de
H. Perplies, MPAe, Tel. 0049 5556 979 374, perplies@linmpi.mpg.de
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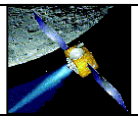
H.U. Keller, MPAe, Tel. 0049 5556 979 419, keller@linmpi.mpg.de

5.5.15 FCP of SIR (following pages)

SIR to STANDBY Mode
File: FC-PL-001.01-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

Sets SIR to STANDBY Mode to allow the setting of measurement parameters

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR ON

End of Procedure

No change

Reference File(s)

Input Command Sequences

Output Command Sequences

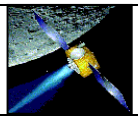
G00101ZA

Referenced Displays

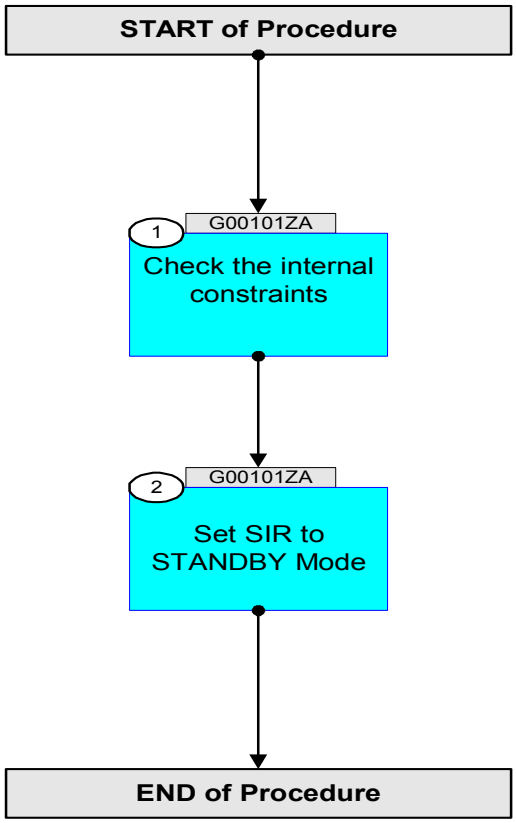
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/07/03		1	Created	Rblake	
25/02/03		2	Porting to MOIS5	admin-s1	
26/02/03		3	Added duration & updated seq. Flags	Cpullig-s1	
28/02/03		4	Display MPS information	Rblake	
14/03/03		5	Fix typographic errors	Rblake	

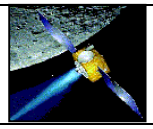


Procedure Flowchart Overview



SIR to STANDBY Mode
File: FC-PL-001.01-G.xls
Author: Rblake

SMART-1

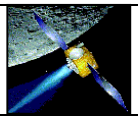


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00101ZA	Beginning of Sequence **SIR to STANDBY Mode** Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check the internal constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Set SIR to STANDBY Mode**		Next Step: -> **END**
	ET=TR+00.00.00	**Execute Telecommand** **G001C SIR Standby Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	G00101ZA	End of Sequence		
End of Procedure				

SIR switch ON (Nominal)
File: FC-PL-005.11-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure performs a nominal power ON of the SIR payload,
using FDIR commands

Summary of Constraints

1. No eclipse.

Spacecraft Configuration

Start of Procedure

1. AOCS Mode in Science.
2. SIR OFF.

End of Procedure

1. SIR ON.

Reference File(s)

Input Command Sequences

Output Command Sequences

G00511ZA

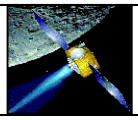
Referenced Displays

ANDs	GRDs	SLDs
AZ7001		
AP7005		

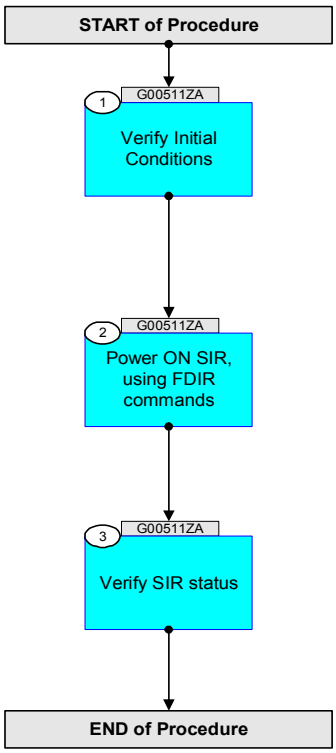
Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
17/06/02		1	Created	Malonso	
25/06/02	Draft 1.0	2	FC procedure for SVT1-1	Malonso	
30/07/02		3	Generate the TC again due to significant changes in the new DB. Please refer to Jurriaan for more info on this.□ Add delta relative time for the execution time of the TC in the sequence.□ Generate sequence again.	Malonso	
22/10/02	Draft 2.0	4	None	Malonso	
13/12/02		5	Updated to use FDIR commands	Rblake	
18/12/02		6	Update to use FDIR commands. Additional TM checks.	Rblake	
18/12/02	1	7	Updated FOP title	Rblake	
25/02/03		8	Porting to MOIS5	admin-s1	
26/02/03		9	Added duration & updated seeq. Flags□ Verify TM: P681T lower limit changed to >=0.08mA (from 0.09)	Cpullig-s1	
27/02/03		10	Second TC time changed to Time Relative.	Cpullig-s1	
28/02/03		11	Correct MPS mode usage	Rblake	
21/03/03		12	Extend duration to ensure 10 seconds delay after power ON	Rblake	

Status : Version 12 - Updated
Last Checkin: 21/03/03

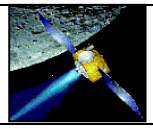


Procedure Flowchart Overview



SIR switch ON (Nominal)
File: FC-PL-005.11-G.xls
Author: Rblake

SMART-1

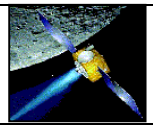


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
		Beginning of Procedure		
	G00511ZA	Beginning of Sequence **SIR ON (Nominal)** Time tag flag : NAY--1 Precondition: SIR_OFF Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.12		
1		**Verify Initial Conditions**		Next Step: -> **2**
		Verify that the S/C is in Science Mode		
		Verify Telemetry **A627T** AocCurrentMode **= Science**		AND=AZ7001
		Verify that the S/C is not in eclipse		
		Verify Telemetry **P760T** PowCurrentMode **= Sun**		AND=AZ7001
		Verify that SIR is switched OFF. If SIR is switched OFF, it will be flagged by the Solid State Power Controller (SSPC) as OFF and the current between the PCDU and SIR will be 0 amps		
		Verify Telemetry **P680T** SSPC31SIRON **= OFF**		AND=AP7005
		Verify Telemetry **P681T** SSPC31SIRcurr **= .00 A**		AND=AP7005
2		**Power ON SIR, using FDIR commands**		Next Step: -> **3**

SIR switch ON (Nominal)
File: FC-PL-005.11-G.xls
Author: Rblake

SMART-1



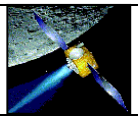
esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.00.00	**Execute Telecommand** **F028C F_Cmd_SIR** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **W011M** ENFORCING_1 **= 1 <dec>**		
	ET=TR+00.00.01	**Execute Telecommand** **F028C F_Cmd_SIR** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **W011M** ENFORCING_1 **= 0 <dec>**		
3		**Verify SIR status**		Next Step: -> **END**
		Verify that SIR is switched ON. If SIR is switched ON, it will be flagged by the Solid State Power Controller (SSPC) as ON and a current will be detected between the PCDU and the SIR payload		
		Verify Telemetry **P680T** SSPC31SIRON **= ON**		AND=AP7005
		Verify Telemetry **P681T** SSPC31SIRcurr **>= 0.08 A** **<= 0.10 A**		AND=AP7005
	G00511ZA	End of Sequence		

End of Procedure

SIR -Health check with H/K every 10sec
File: FC-PL-004.02-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure defines and starts H/K data acquisition for
monitoring the SIR H/K data every 10 seconds for 1 minute

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR Powered On.

End of Procedure

SIR in Standby Mode

Reference File(s)

Input Command Sequences

Output Command Sequences

G00402ZA

Referenced Displays

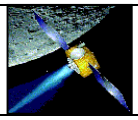
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
20/02/03		2	Changed sequence flag SOURCES to All	Cpullig-s1	
25/02/03		3	Porting to MOIS5	admin-s1	
27/02/03		4	Changed TM checks, updated seq. Flags, added duration	Cpullig-s1	
28/02/03		5	Display MPS information	Rblake	
14/03/03		6	Fixed typographic errors and added flowchart	Rblake	

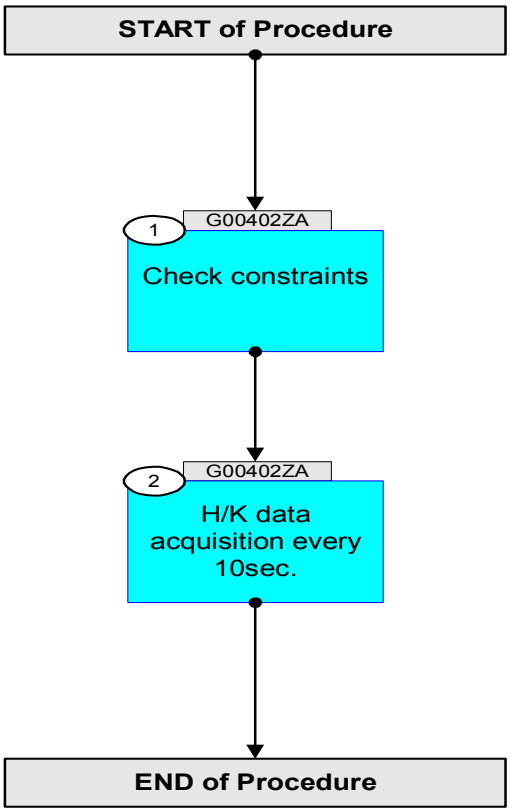
SIR -Health check with H/K every 10sec
File: FC-PL-004.02-G.xls
Author: Rblake

SMART-1



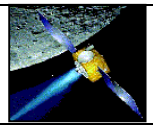
esa

Procedure Flowchart Overview



SIR -Health check with H/K every 10sec
File: FC-PL-004.02-G.xls
Author: Rblake

SMART-1

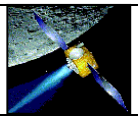


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00402ZA	Beginning of Sequence **Health check H/K 10s** *SIR - Health check with H/K every 10sec* Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.01.01		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**H/K data acquisition every 10sec.**		Next Step: -> **END**
	ET=TR+00.00.00	**Execute Telecommand** **G005C SIR HK Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G050M** SIR H/K Acq. Period (s) **= 10 <dec>**		
	ET=TR+00.01.01	**Execute Telecommand** **G005C SIR HK Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G050M** SIR H/K Acq. Period (s) **= 0 <dec>**		
	G00402ZA	End of Sequence		
End of Procedure				

SIR: Health Check Commissioning_2
File: FC-PL-004.01-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure takes several burst spectra with different parameters to check the basic functionality of SIR.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR ON

End of Procedure

No change

Reference File(s)

Input Command Sequences

Output Command Sequences

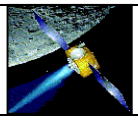
G00401ZA

Referenced Displays

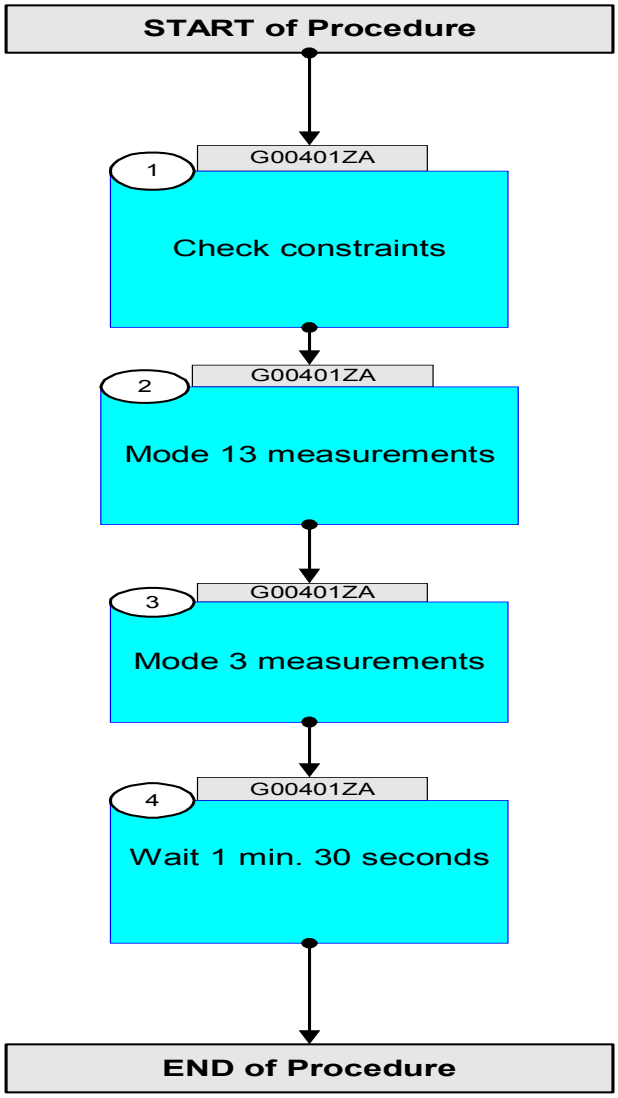
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
28/01/03	2	1	Created	Cpullig-s1	
25/02/03		2	Porting to MOIS5	admin-s1	
27/02/03		3	Changed TM checks, updated seq. Flags, added duration	Cpullig-s1	
28/02/03		4	Display MPS information	Rblake	
14/03/03		5	Fixed typographic errors and flowchart formatting	Rblake	

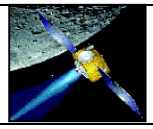


Procedure Flowchart Overview



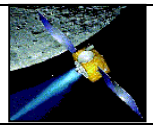
SIR: Health Check Commissioning_2
File: FC-PL-004.01-G.xls
Author: Rblake

SMART-1

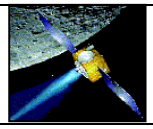


esa

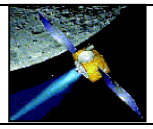
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
		Beginning of Procedure		
	G00401ZA	Beginning of Sequence **SIR: Health Check C2** Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.03.05		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Mode 13 measurements**		Next Step: -> **3**
		For each case 100 spectra, with 2, 10, 50, 100 and 150 ms integration time. The read-out frequency is changed from 4 MHz with spectral averanging OFF and the ADC sample rate of 1 to 2 MHz with a sample rate of 16.		
	ET=TR+00.00.00	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= 8 <dec>**		
	ET=TR+00.00.01	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 31 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		



Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.00.02	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.00.13	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 102 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.00.14	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.00.25	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 176 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.00.26	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.00.37	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 208 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 23 <dec>**		



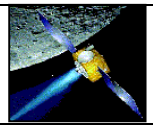
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.00.38	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.00.51	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 228 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 32 <dec>**		
	ET=TR+00.00.52	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
3		**Mode 3 measurements**		Next Step: -> **4**
		The read-out frequency is set to 2MHz while the ADC sampling is set to 16 times.		
	ET=TR+00.01.09	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= 28 <dec>**		
	ET=TR+00.01.10	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 16 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 30 <dec>**		



Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.01.11	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.01.27	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 71 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 32 <dec>**		
	ET=TR+00.01.28	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.01.45	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 144 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 40 <dec>**		
	ET=TR+00.01.46	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.02.07	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 176 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 50 <dec>**		

SIR: Health Check Commissioning_2
File: FC-PL-004.01-G.xls
Author: Rblake

SMART-1

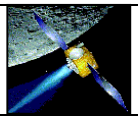


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.02.08	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.02.34	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 196 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 60 <dec>**		
	ET=TR+00.02.35	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
4		**Wait 1 min. 30 seconds**		Next Step: -> **END**
	G00401ZA	End of Sequence		
End of Procedure				

SIR: Commissioning_1
File: FC-PL-003.01-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure takes several burst spectra with different parameters for analysing the instrument behaviour and selected target observation.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR ON

End of Procedure

No change

Reference File(s)

Input Command Sequences

Output Command Sequences

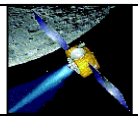
G00301ZA

Referenced Displays

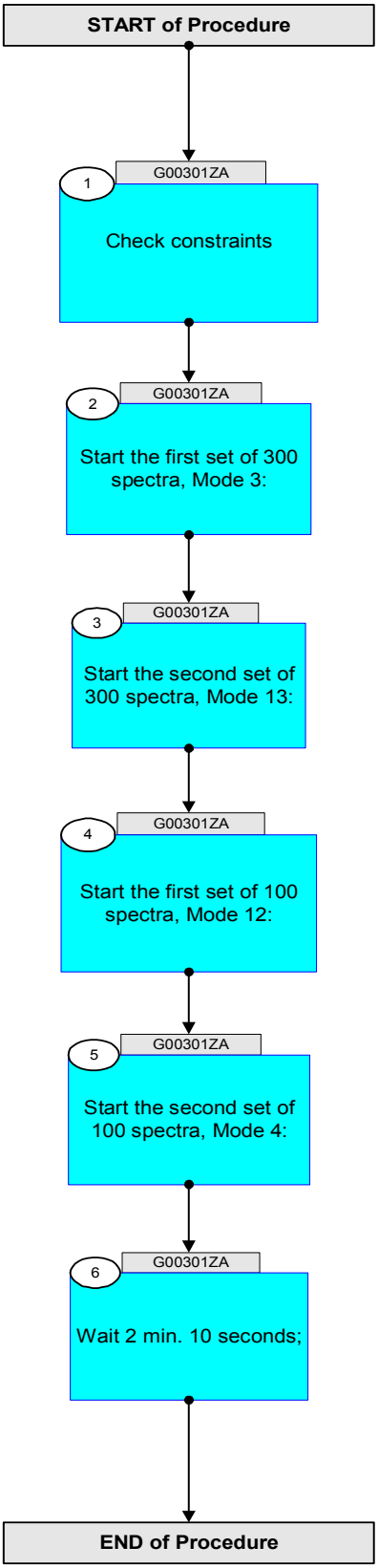
ANDs **GRDs** **SLDs**

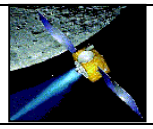
Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
28/01/03		1	Created	Cpullig-s1	
28/01/03	2	2	Added TM checks, step 1	Cpullig-s1	
02/06/03		3	Only cover: completed the Internal Constraints	Cpullig-s1	
25/02/03		4	Porting to MOIS5	admin-s1	
27/02/03		5	Changed TM checks, updated seq. Flags, added duration	Cpullig-s1	
28/02/03		6	Display MPS information	Rblake	
14/03/03		7	Fixed typographic errors and flowchart formatting	Rblake	

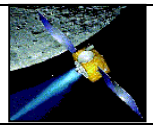


Procedure Flowchart Overview

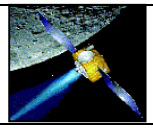




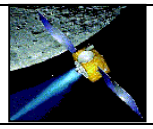
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
		Beginning of Procedure		
	G00301ZA	Beginning of Sequence **SIR: Commissioning_1** Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.40.14		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Start the first set of 300 spectra, Mode 3:**		Next Step: -> **3**
		The read-out frequency is set to 2MHz with non-activated spectral averanging while the ADC sampling is set to 16 times.The selected parameter values allow an increased measurement accuracy but a reduced measurement rate compared to the next data set.		
	ET=TR+00.00.00	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= 28 <dec>**		
	ET=TR+00.00.01	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 4 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 30 <dec>**		



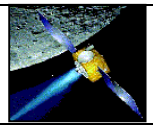
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.00.02	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.00.48	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 8 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 30 <dec>**		
	ET=TR+00.00.49	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.01.35	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 38 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 32 <dec>**		
	ET=TR+00.01.36	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.02.25	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 70 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 32 <dec>**		



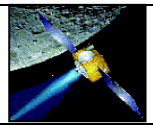
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.02.26	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.03.15	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 144 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 40 <dec>**		
	ET=TR+00.03.16	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.04.17	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 176 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 50 <dec>**		
	ET=TR+00.04.18	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.05.34	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 196 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 60 <dec>**		



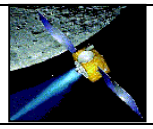
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.05.35	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
3		**Start the second set of 300 spectra, Mode 13:**		Next Step: -> **4**
		Faster achieving mode. The integration times are similar as before but the clock frequency is increased to 4MHz and the ADC sampling is reduced to 1 time.		
	ET=TR+00.07.06	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= 8 <dec>**		
	ET=TR+00.07.07	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 8 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.07.08	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		



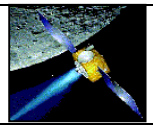
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.07.39	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 16 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.07.40	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.08.11	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 70 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.08.12	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.08.43	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 102 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.08.44	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		



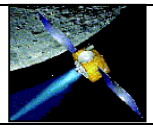
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.09.15	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 176 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.09.16	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.09.47	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 208 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 22 <dec>**		
	ET=TR+00.09.48	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.10.22	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 228 <dec>** **G041M** SIR Number of Spectra **= 300 <dec>** **G042M** SIR Interval Time **= 32 <dec>**		
	ET=TR+00.10.23	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		



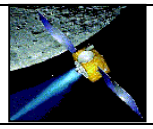
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
4		**Start the first set of 100 spectra, Mode 12:**		Next Step: -> **5**
		Mode that uses a spectral averaging of 8 spectra. These settings allow considerably increased measurement accuracy: 2MHZ, 16z sampling of ADC. The data rate is lower.		
	ET=TR+00.11.12	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= 124 <dec>**		
	ET=TR+00.11.13	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 4 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 30 <dec>**		
	ET=TR+00.11.14	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.13.15	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 8 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 30 <dec>**		



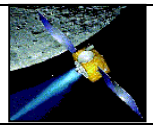
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.13.16	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.15.17	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 38 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 32 <dec>**		
	ET=TR+00.15.18	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.17.27	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 70 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 32 <dec>**		
	ET=TR+00.17.28	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.19.37	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 144 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 40 <dec>**		



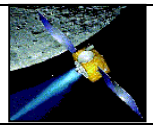
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.19.38	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.22.19	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 176 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 50 <dec>**		
	ET=TR+00.22.20	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.25.41	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 196 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 60 <dec>**		
	ET=TR+00.25.42	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
5		**Start the second set of 100 spectra, Mode 4:**		Next Step: -> **6**
		This mode uses fast data archieving parameter values (4MHz and 1 sampling of ADC) and spectral averaging of 8 spectra.		



Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.29.43	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= 104 <dec>**		
	ET=TR+00.29.44	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 8 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.29.45	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.31.06	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 16 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.31.07	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.32.28	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 70 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		



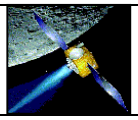
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.32.29	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.33.50	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 102 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.33.51	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.35.12	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 176 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 20 <dec>**		
	ET=TR+00.35.13	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.36.34	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 208 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 22 <dec>**		



Step	Label/Time	Activity/Remarks	CK	Display/ Branch
	ET=TR+00.36.35	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	ET=TR+00.38.04	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= 228 <dec>** **G041M** SIR Number of Spectra **= 100 <dec>** **G042M** SIR Interval Time **= 32 <dec>**		
	ET=TR+00.38.05	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
6		**Wait 2 min. 10 seconds;**		Next Step: -> **END**
	G00301ZA	End of Sequence		
End of Procedure				

SIR - Mode 4 Averaging Parameter 8_4_1
File: FC-PL-002.05-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure sets the "fast mode"for quick sensor readout. The frequency is 4 MHz and the ADC sampling is 1.Each send spectrum is now an average of 8 spectra. The averaging reduces the data rate compared to non averaging.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR Powered On.

End of Procedure

SIR in Standby Mode

Reference File(s)

Input Command Sequences

Output Command Sequences

G00205ZA

Referenced Displays

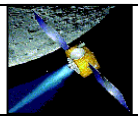
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
25/02/03		2	Porting to MOIS5	admin-s1	
27/02/03		3	Changed TM checks, updated seq. Flags, added duration	Cpullig-s1	
28/02/03		4	Display MPS information	Rblake	
14/03/03		5	Fixed typograhpic errors and added flowchart	Rblake	

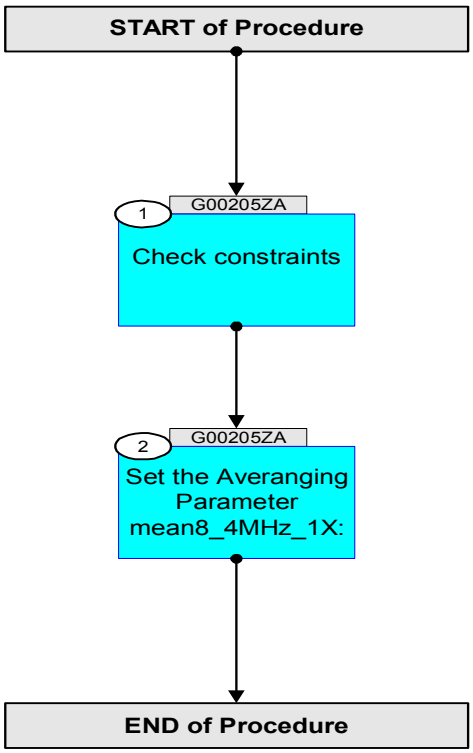
SIR - Mode 4 Averaging Parameter 8_4_1
File: FC-PL-002.05-G.xls
Author: Rblake

SMART-1



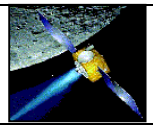
esa

Procedure Flowchart Overview



SIR - Mode 4 Averaging Parameter 8_4_1
File: FC-PL-002.05-G.xls
Author: Rblake

SMART-1

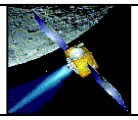


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00205ZA	Beginning of Sequence **Set Aver Param8_4_1** *SIR - Mode 4 Averaging Parameter 8_4_1* Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Set the Averanging Parameter mean8_4MHz_1X:**		Next Step: -> **END**
	ET=TR+00.00.00	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= 104 <dec>**		
	G00205ZA	End of Sequence		
End of Procedure				

SIR - Mode 13 Averaging Parameter 1_4_1
File: FC-PL-002.04-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure sets the "fast mode"for a quick sensor readout without spectral averaging . The frequency is 4 MHz and the ADC sampling is 1.

Summary of Constraints

FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR Powered On.

End of Procedure

SIR in Standby Mode

Reference File(s)

Input Command Sequences

Output Command Sequences

G00204ZA

Referenced Displays

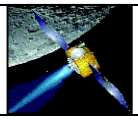
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
25/02/03		2	Porting to MOIS5	admin-s1	
27/02/03		3	Changed TM check, updated seq. Flags, added duration	Cpullig-s1	
28/02/03		4	Display MPS information	Rblake	
14/03/03		5	Fixed typographic errors and added flowchart	Rblake	

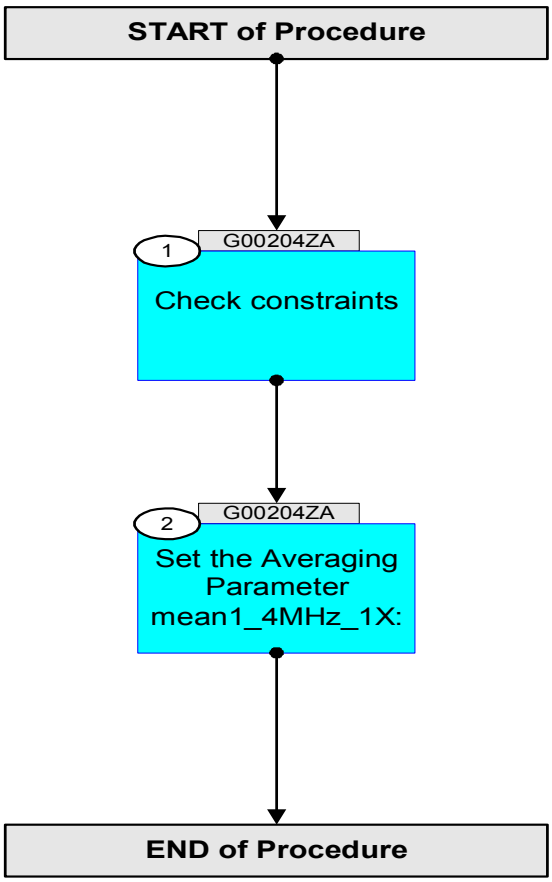
SIR - Mode 13 Averaging Parameter 1_4_1
File: FC-PL-002.04-G.xls
Author: Rblake

SMART-1



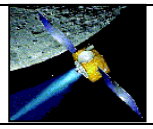
esa

Procedure Flowchart Overview



SIR - Mode 13 Averaging Parameter 1_4_1
File: FC-PL-002.04-G.xls
Author: Rblake

SMART-1

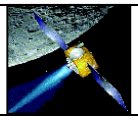


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00204ZA	Beginning of Sequence **Set Aver Param1_4_1** *SIR - Mode 13 Averaging Parameter 1_4_1* Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Set the Averaging Parameter mean1_4MHz_1X:**		Next Step: -> **END**
	ET=TR+00.00.00	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= 8 <dec>**		
	G00204ZA	End of Sequence		
End of Procedure				

SIR - Mode 12 Averaging Parameter 8_2_16
File: FC-PL-002.03-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure sets the "slow mode" for low noise readout of the sensor with averanging = 8 (8 spectra will be averaged to one and sent to the mass memory of the S/C). The frequency is 2 MHz and the ADC sampling is 16.

The data accuracy is high but the data acquisition duration is quite long.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR Powered On.

End of Procedure

SIR in Standby Mode

Reference File(s)

Input Command Sequences

Output Command Sequences

G00203ZA

Referenced Displays

ANDs **GRDs** **SLDs**

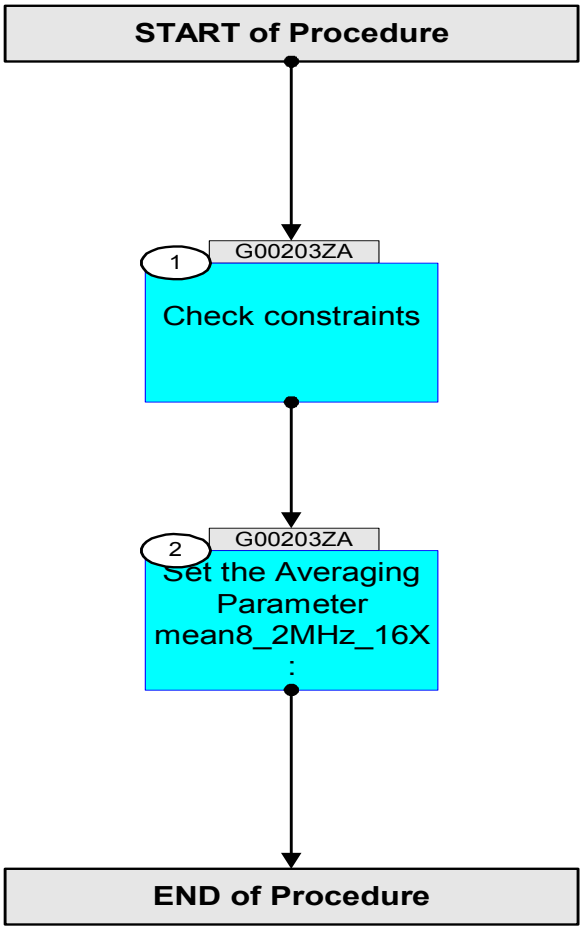
Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
25/02/03		2	Porting to MOIS5	admin-s1	
27/02/03		3	Changed TM checks, updated seq. Flags, added duration	Cpullig-s1	
28/02/03		4	Display MPS information	Rblake	
14/03/03		5	Fixed typograhpic errors and added flowchart	Rblake	

SIR - Mode 12 Averaging Parameter 8_2_16
File: FC-PL-002.03-G.xls
Author: Rblake

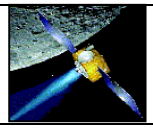
SMART-1

Procedure Flowchart Overview



SIR - Mode 12 Averaging Parameter 8_2_16
File: FC-PL-002.03-G.xls
Author: Rblake

SMART-1

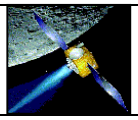


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00203ZA	Beginning of Sequence **Set Aver Param8_2_16** *SIR - Mode 12 Averangingr Parameter 8_2_16* Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Set the Averaging Parameter mean8_2MHz_16X:**		Next Step: -> **END**
	ET=TR+00.00.00	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= 124 <dec>**		
	G00203ZA	End of Sequence		
End of Procedure				

SIR - Mode 3 Averaging Parameter 1_2_16
File: FC-PL-002.02-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure sets the "slow mode" for low noise readout of the sensor without averaging. The frequency is 2 MHz and the ADC sampling is 16.

This allows data acquisition with higher accuracy and without time loss due to averaging.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR Powered On.

End of Procedure

SIR in Standby Mode

Reference File(s)

Input Command Sequences

Output Command Sequences

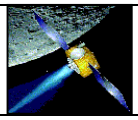
G00202ZA

Referenced Displays

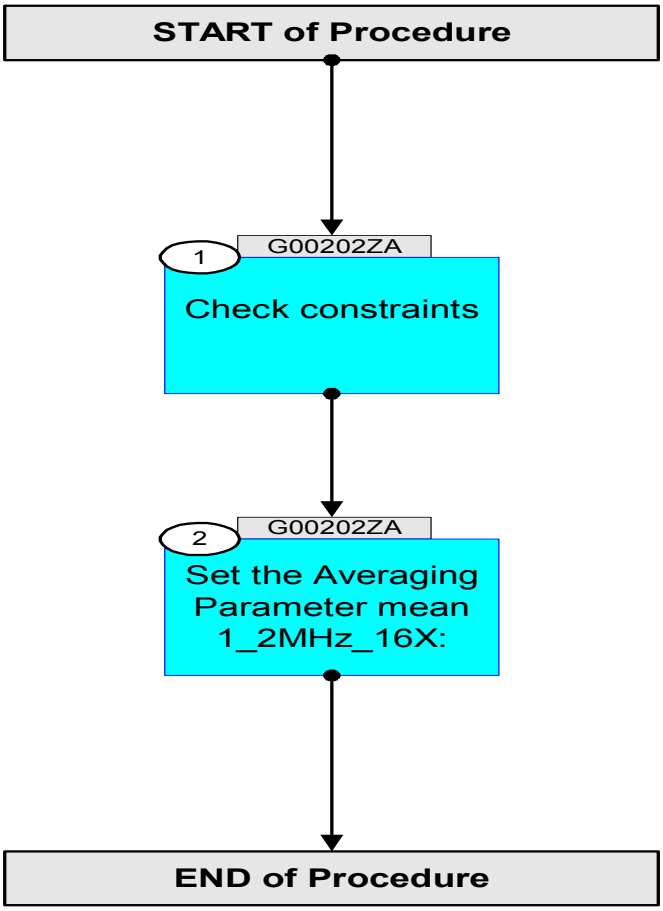
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
25/02/03		2	Porting to MOIS5	admin-s1	
27/02/03		3	Changed TM checks, updated seq. Flags, added duration	Cpullig-s1	
28/02/03		4	Display MPS information	Rblake	
14/03/03		5	Fixed typographic errors and added flowchart	Rblake	

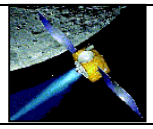


Procedure Flowchart Overview



SIR - Mode 3 Averaging Parameter 1_2_16
File: FC-PL-002.02-G.xls
Author: Rblake

SMART-1

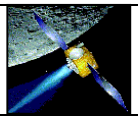


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00202ZA	Beginning of Sequence **Set Aver Param1_2_16** *SIR - Mode 3 Averaging Parameter* Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Set the Averaging Parameter mean 1_2MHz_16X:**		Next Step: -> **END**
	ET=TR+00.00.00	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= 28 <dec>**		
	G00202ZA	End of Sequence		
End of Procedure				

SIR - Set and Start Measurement
File: FC-PL-002.01-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure sets the measurement parameters and starts immediately a burst measurement for data acquisition.

Note: the averaging parameters must have been set before.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR Powered On

End of Procedure

SIR in Standby Mode

Reference File(s)

Input Command Sequences

Output Command Sequences

G00201ZA

Referenced Displays

ANDs **GRDs** **SLDs**

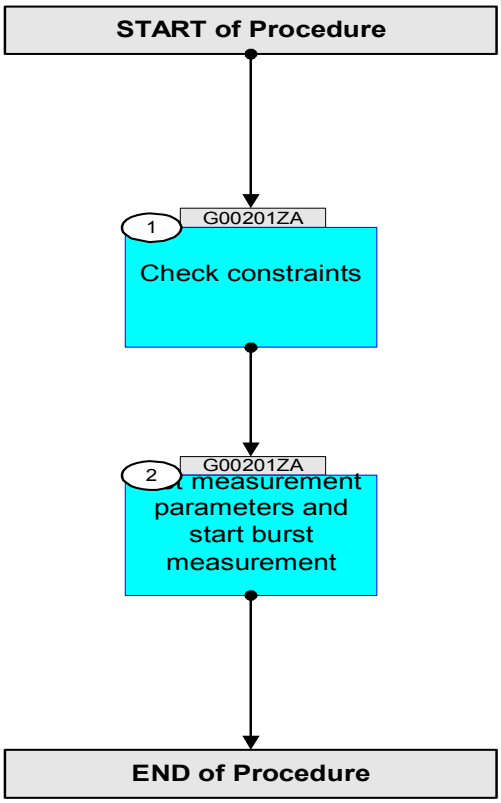
Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
21/02/03		2	Changed the formal parameter name(s) to GxxxF.□	Cpullig-s1	
25/02/03		3	Porting to MOIS5	admin-s1	
27/02/03		4	Changed TM checks, updated seq. Flags, added duration	Cpullig-s1	
28/02/03		5	Display MPS information	Rblake	
14/03/03		6	Fixed typographic errors and added flowchart	Rblake	
26/03/03		7	Remove control character from command sequence name	Rblake	

SIR - Set and Start Measurement
File: FC-PL-002.01-G.xls
Author: Rblake

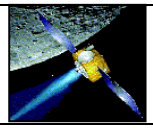
SMART-1

Procedure Flowchart Overview



SIR - Set and Start Measurement
File: FC-PL-002.01-G.xls
Author: Rblake

SMART-1

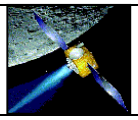


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00201ZA	Beginning of Sequence **Start Measurement** **Formal Parameters** G040F as = ms G041F as = <dec> G042F as = ms Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Set measurement parameters and start burst measurement**		Next Step: -> **END**
	ET=TR+00.00.00	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= G040F** **G041M** SIR Number of Spectra **= G041F** **G042M** SIR Interval Time **= G042F**		
	ET=TR+00.00.01	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	G00201ZA	End of Sequence		
End of Procedure				

SIR Basic Command: Memory Check
File: FC-PL-001.10-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

Calculates a CRC16 checksum over a specified address range and
writes the result to the memory.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR ON

End of Procedure

SIR Standby MODE

Reference File(s)

Input Command Sequences

Output Command Sequences

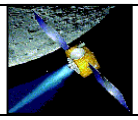
G00110ZA

Referenced Displays

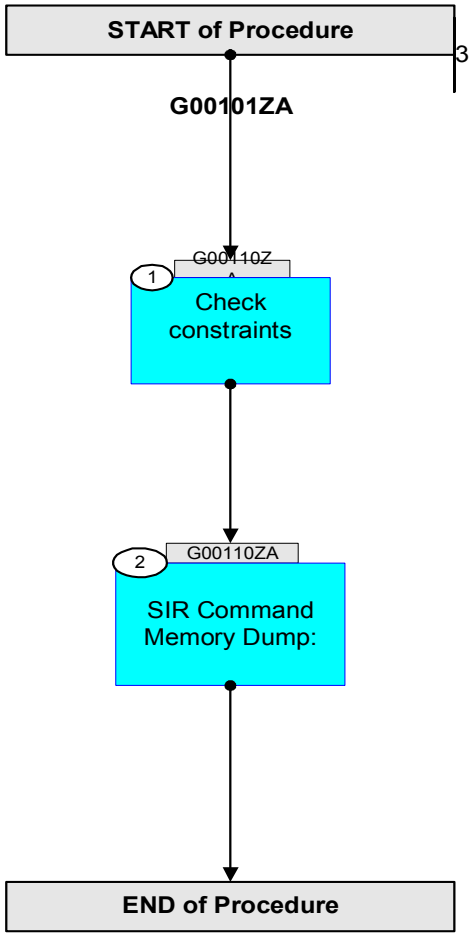
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
27/02/03		1	Created	Cpullig-s1	
28/02/03		2	Display MPS information	Rblake	
14/03/03		3	Fixed flowchart and typos	Rblake	

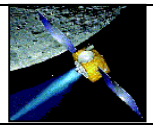


Procedure Flowchart Overview



SIR Basic Command: Memory Check
File: FC-PL-001.10-G.xls
Author: Rblake

SMART-1

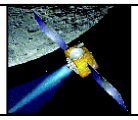


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00110ZA	Beginning of Sequence **SIR Memory Check** *SIR Memory Check* **Formal Parameters** G080F as = <hex> G081F as = <hex> Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: ->
		Perform procedure FC-PL-501.01-G.		
2		**SIR Command Memory Dump:**		
		- G080F = First Memory Address - G081F = Memory Length		
	ET=TR+00.00.00	**Execute Telecommand** **G010C SIR Memory Check** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G080M** SIR Memory Address **= G080F** **G081M** SIR Memory Length **= G081F**		
	G00110ZA	End of Sequence		
End of Procedure				

SIR Basic Command: Memory Dump
File: FC-PL-001.09-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

Downloading a program segment from SIR does not change any part of the SIR s/w.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR ON

End of Procedure

SIR Standby MODE

Reference File(s)

Input Command Sequences

Output Command Sequences

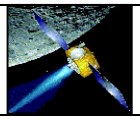
G00109ZA

Referenced Displays

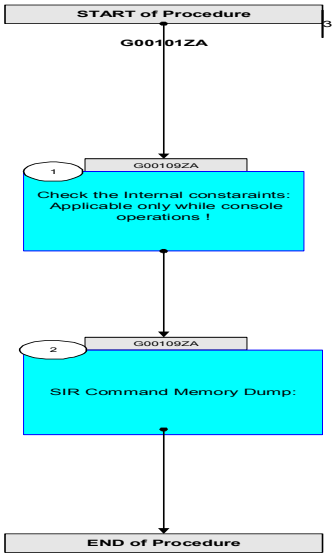
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
27/02/03		1	Created	Cpullig-s1	
28/02/03		2	Display MPS information	Rblake	
14/03/03		3	Fixed typographic error	Rblake	

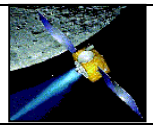


Procedure Flowchart Overview



SIR Basic Command: Memory Dump
File: FC-PL-001.09-G.xls
Author: Rblake

SMART-1

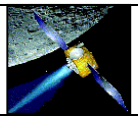


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00109ZA	Beginning of Sequence **SIR Memory Dump** *SIR Memory Dump* **Formal Parameters** G080F as = <hex> G081F as = <hex> Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: ->
		Perform procedure FC-PL-501.01-G.		
2		**SIR Command Memory Dump:**		
		- G080F = First Memory Address - G081F = Memory Length		
	ET=TR+00.00.01	**Execute Telecommand** **G009C SIR Memory Dump** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G080M** SIR Memory Address **= G080F** **G081M** SIR Memory Length **= G081F**		
	G00109ZA	End of Sequence		
End of Procedure				

SIR Basic Command: Memory Load
File: FC-PL-001.08-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure implements a new s/w segment in the SIR on board software.

The command allows changing of the SIR s/w (expanding of the p/l features).

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR ON

End of Procedure

SIR Standby MODE

Reference File(s)

Input Command Sequences

Output Command Sequences

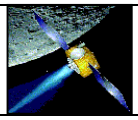
G00108ZA

Referenced Displays

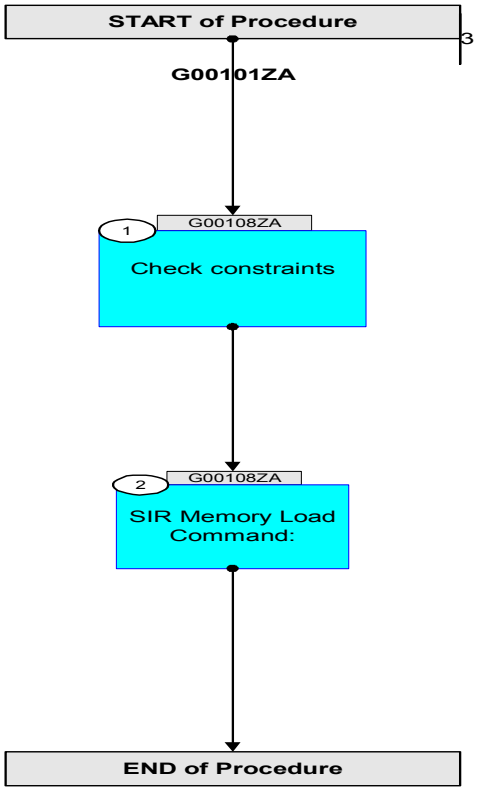
ANDs **GRDs** **SLDs**

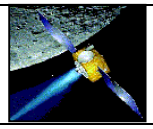
Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
21/02/03		2	Changed the formal parameter name(s) to GxxxF.□ Added timeline (10sec)	Cpullig-s1	
25/02/03		3	Porting to MOIS5	admin-s1	
27/02/03		4	Changed step1 TM checks, updated seq. Flags, added duration.	Cpullig-s1	
28/02/03		5	Display MPS information	Rblake	
14/03/03		6	Fixed typographic errors and formatted flowchart	Rblake	



Procedure Flowchart Overview

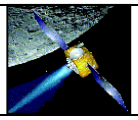




Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00108ZA	Beginning of Sequence **SIR Memory Load** *SIR Memory Load Command* **Formal Parameters** G080F as = <hex> G081F as = <hex> G082F as = <hex> Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: ->
		Perform procedure FC-PL-501.01-G.		
2		**SIR Memory Load Command:**		
	ET=TR+00.00.00	**Execute Telecommand** **G008C SIR Memory Load** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G080M** SIR Memory Address **= G080F** **G081M** SIR Memory Length **= G081F** **G082M** SIR Memory Data **= G082F**		
	G00108ZA	End of Sequence		
End of Procedure				

SIR - Set Averaging Parameters
File: FC-PL-001.07-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure sets the averaging parameters.

The parameters defined by the procedure are important for the scientific results: the upper three bits (5 to 7) define the multiple reads of the sensors, and the lower three bits (0 to 2) the multiple reads of the ADC converter.The bits 3 and 4 define the clock frequency. All combinations are allowed.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR Powered On.

End of Procedure

SIR in Standby Mode

Reference File(s)

Input Command Sequences

Output Command Sequences

G00107ZA

Referenced Displays

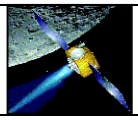
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
21/02/03		2	Changed the formal parameter name(s) to GxxxF.□	Cpullig-s1	
25/02/03		3	Porting to MOIS5	admin-s1	
27/02/03		4	Updated seq. Flags and added duration.	Cpullig-s1	
28/02/03		5	Display MPS information	Rblake	
14/03/03		6	Fixed typographic errors and add flowchart	Rblake	

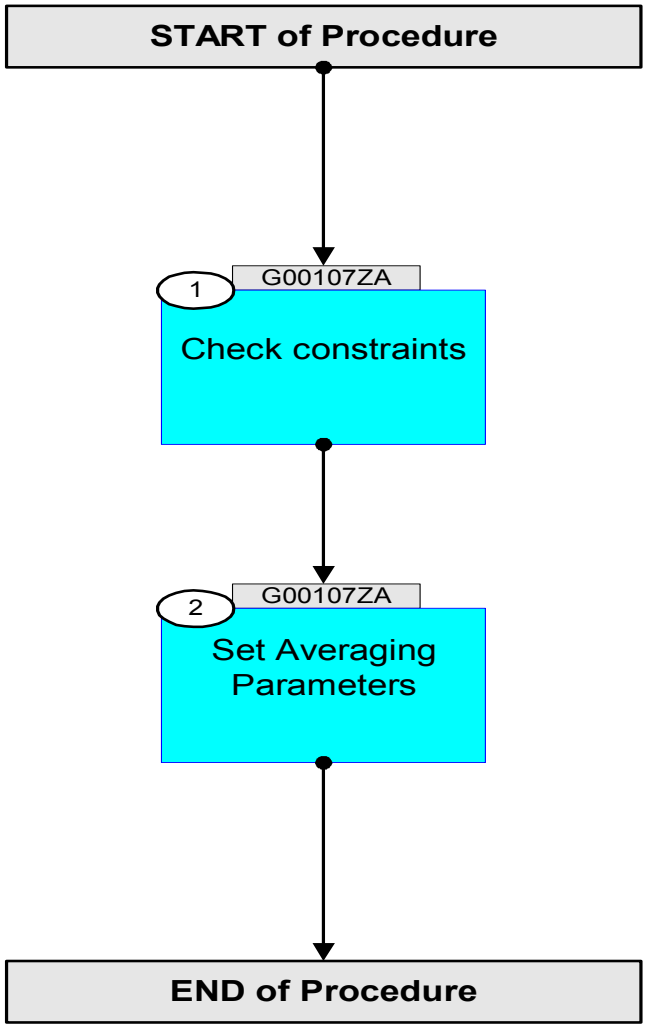
SIR - Set Averaging Parameters
File: FC-PL-001.07-G.xls
Author: Rblake

SMART-1



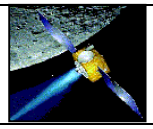
esa

Procedure Flowchart Overview



SIR - Set Averaging Parameters
File: FC-PL-001.07-G.xls
Author: Rblake

SMART-1

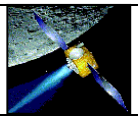


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
		Beginning of Procedure		
	G00107ZA	Beginning of Sequence **Set Avrging Params** *SIR - Sets Averaging Parameter* **Formal Parameters** G070F as = <dec> Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Set Averaging Parameters**		Next Step: -> **END**
		- The number of spectra that will be averanging internally to one spectrum (bits 5 & 7) - The value of the clock frequency (bits 3 & 4) - The multiple read of the ADC （bits 0 & 2)		
	ET=TR+00.00.00	**Execute Telecommand** **G007C SIR Averaging Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G070M** SIR Averaging **= G070F**		
	G00107ZA	End of Sequence		
		End of Procedure		

SIR - Set Heater Parameters
File: FC-PL-001.06-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure changes the heater parameters for T stabilisation of the sensor. It sets the temperature limits between which the SIR interval heater is switched OFF and ON again.

The first parameter (G060F) defines the deactivation and the second (G061F) the activation temperature.The deactivation temperature has to be always lower than the activation temperature. Note: A higher temperature has a lower parameter value.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR Powered On.

End of Procedure

SIR in Standby Mode

Reference File(s)

Input Command Sequences

Output Command Sequences

G00106ZA

Referenced Displays

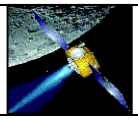
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
25/02/03		2	Porting to MOIS5	admin-s1	
26/02/03		3	Added duration & updated seq. Flags□ Added Formal Param. G061F	Cpullig-s1	
27/02/03		4	Flowchart corrected	Cpullig-s1	
28/02/03		5	Display MPS information	Rblake	
28/02/03		6	Remove redundant commentary	Rblake	
14/03/03		7	Fix typos and flowchart	Rblake	

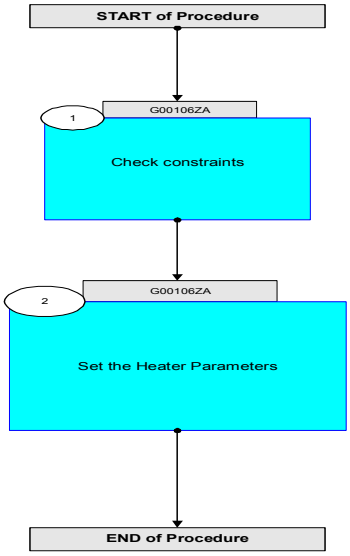
SIR - Set Heater Parameters
File: FC-PL-001.06-G.xls
Author: Rblake

SMART-1



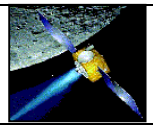
esa

Procedure Flowchart Overview



SIR - Set Heater Parameters
File: FC-PL-001.06-G.xls
Author: Rblake

SMART-1

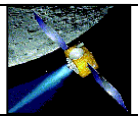


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00106ZA	Beginning of Sequence **Set Heater Paramet** *SIR - Sets Heater Parameters* **Formal Parameters** G060F as = °C G061F as = °C Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Set the Heater Parameters**		Next Step: -> **END**
		The deactivation temperature has to be always lower than the activation temperature. Note: A higher temperature has a lower parameter value.		
	ET=TR+00.00.00	**Execute Telecommand** **G006C SIR Heater Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G060M** SIR Deactv.Temp (°C) **= G060F** **G061M** SIR Actv. Temperature **= G061F**		
	G00106ZA	End of Sequence		
End of Procedure				

SIR - Set the H/K Parameter
File: FC-PL-001.05-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure defines the time interval (in sec.,G050F), in which H/K data are taken.
Note: In the Measurement Mode H/K data will be achieved with each spectrum.

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR Powered On.

End of Procedure

SIR in Standby Mode

Reference File(s)

Input Command Sequences

Output Command Sequences

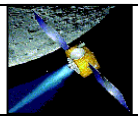
G00105ZA

Referenced Displays

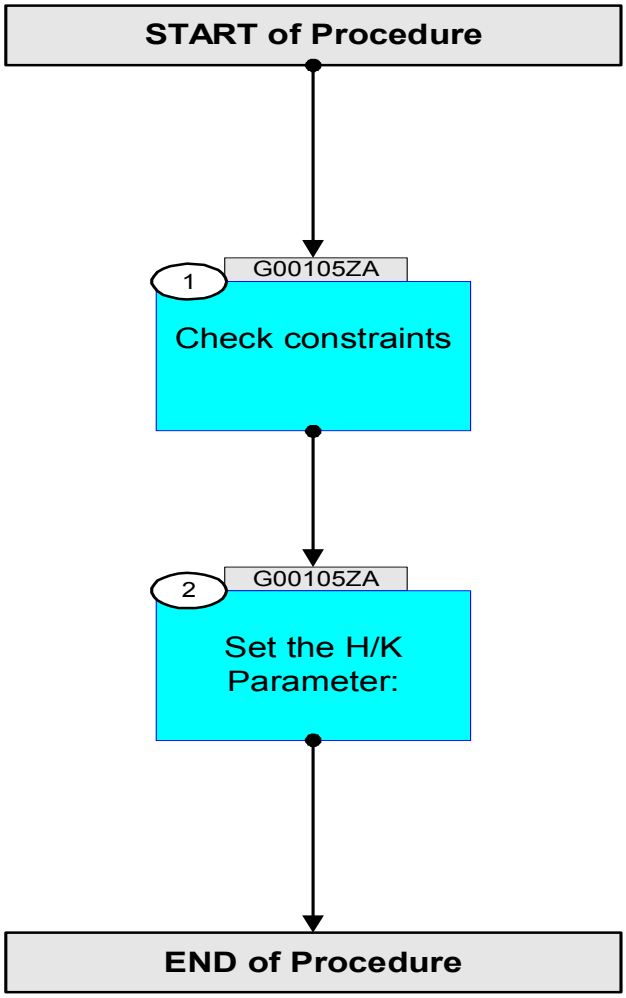
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
21/02/03		2	Changed the formal parameter name(s) to GxxxF.□	Cpullig-s1	
25/02/03		3	Porting to MOIS5	admin-s1	
26/02/03		4	Added duration & updated seq. Flags□ Added new Formal Param. G061F	Cpullig-s1	
26/02/03		5	The previous Description of Modification is incorrect: there is NO Formal Param. G061F added or needed for this sequence	Cpullig-s1	
28/02/03		6	Display MPS information	Rblake	
14/03/03		7	Fixed typographic errors and added flowchart	Rblake	

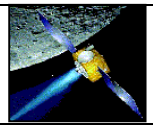


Procedure Flowchart Overview



SIR - Set the H/K Parameter
File: FC-PL-001.05-G.xls
Author: Rblake

SMART-1

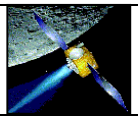


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00105ZA	Beginning of Sequence **Set the H/K Paramet** *SIR - Sets the H/K Parameter* **Formal Parameters** G050F as = s Time tag flag : NAY--1 Precondition: SIR_OFF Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Set the H/K Parameter:**		Next Step: -> **END**
	ET=TR+00.00.00	**Execute Telecommand** **G005C SIR HK Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G050M** SIR H/K Acq. Period (s) **= G050F**		
	G00105ZA	End of Sequence		
End of Procedure				

SIR - Set Measurement Parameter
File: FC-PL-001.04-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure sets the Measurement Mode parameters which will be used for the following burst
or single spectra measurement

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR in Standby Mode

End of Procedure

SIR in Standby Mode

Reference File(s)

Input Command Sequences

Output Command Sequences

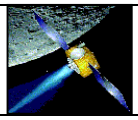
G00104ZA

Referenced Displays

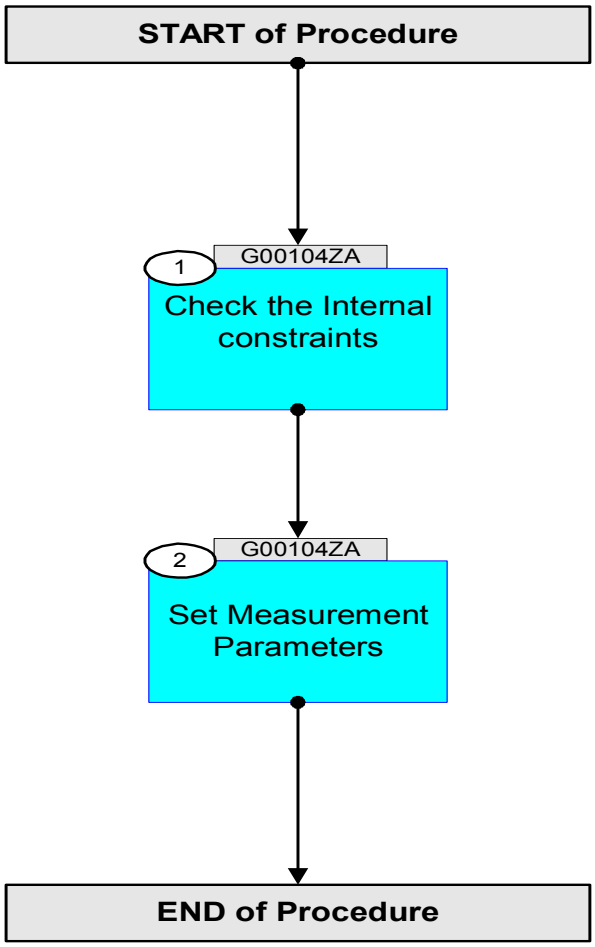
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
21/02/03		2	Changed the formal parameter name(s) to GxxxF.	Cpullig-s1	
25/02/03		3	Porting to MOIS5	admin-s1	
26/02/03		4	Added duration & updated seq. Flags	Cpullig-s1	
28/02/03		5	Display MPS information	Rblake	
14/03/03		6	Fixed typographical errors and added flowchart	Rblake	

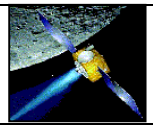


Procedure Flowchart Overview



SIR - Set Measurement Parameter
File: FC-PL-001.04-G.xls
Author: Rblake

SMART-1

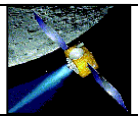


esa

Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00104ZA	Beginning of Sequence **Measurement Paramet** *SIR - Set Measurement Parameter* **Formal Parameters** G040F as = ms G041F as = <dec> G042F as = ms Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check the Internal constraints**		Next Step: -> **2**
		Perform procedure FC-PL-501.01-G.		
2		**Set Measurement Parameters**		Next Step: -> **END**
	ET=TR+00.00.00	**Execute Telecommand** **G004C SIR Meas. Parameters** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **G040M** SIR Exposure Time (ms) **= G040F** **G041M** SIR Number of Spectra **= G041F** **G042M** SIR Interval Time **= G042F**		
	G00104ZA	End of Sequence		
End of Procedure				

SIR: To Measurement Mode
File: FC-PL-001.03-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

Sets SIR in Measurement Mode

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR ON

End of Procedure

SIR Standby MODE

Reference File(s)

Input Command Sequences

Output Command Sequences

G00103ZA

Referenced Displays

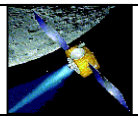
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
25/02/03		2	Porting to MOIS5	admin-s1	
26/02/03		3	Added duration & seq. Flags	Cpullig-s1	
28/02/03		4	Display MPS information	Rblake	
14/03/03		5	Fixed typograhpical errors and flowchart formatting	Rblake	

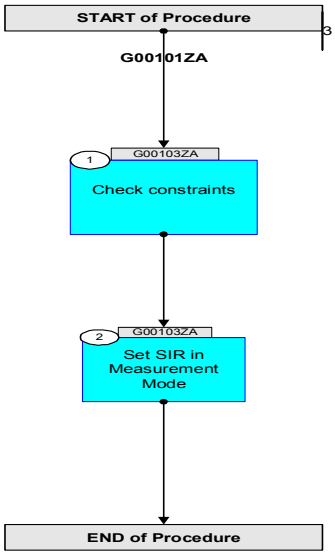
SIR: To Measurement Mode
File: FC-PL-001.03-G.xls
Author: Rblake

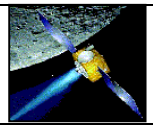
SMART-1



esa

Procedure Flowchart Overview

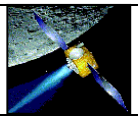




Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00103ZA	Beginning of Sequence **SIR Measurement Mode** *SIR to Measurement Mode* Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: ->
		Perform procedure FC-PL-501.01-G.		
2		**Set SIR in Measurement Mode**		
	ET=TR+00.00.00	**Execute Telecommand** **G003C SIR Measurement Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	G00103ZA	End of Sequence		
End of Procedure				

SIR: To Preparation Mode
File: FC-PL-001.02-G.xls
Author: Rblake

SMART-1



esa

Procedure Summary

Objectives

This procedure puts SIR in Preparation mode to allow parameter setting

Summary of Constraints

See FC-PL-501.01-G

Spacecraft Configuration

Start of Procedure

SIR ON

End of Procedure

SIR Preparation / Standby MODE

Reference File(s)

Input Command Sequences

Output Command Sequences

G00102ZA

Referenced Displays

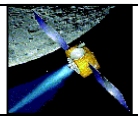
ANDs **GRDs** **SLDs**

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
02/06/03		1	Created	Cpullig-s1	
25/02/03		2	Porting to MOIS5	admin-s1	
26/02/03		3	Added duration & updated seq. Flags	Cpullig-s1	
28/02/03		4	Display MPS information	Rblake	
14/03/03		5	Fix flowchart and typographical errors	Rblake	

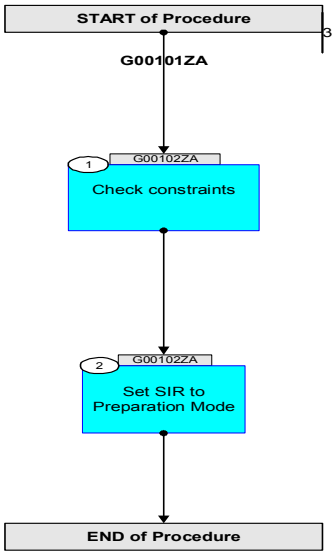
SIR: To Preparation Mode
File: FC-PL-001.02-G.xls
Author: Rblake

SMART-1



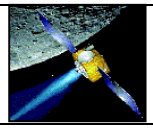
esa

Procedure Flowchart Overview



SIR: To Preparation Mode
File: FC-PL-001.02-G.xls
Author: Rblake

SMART-1



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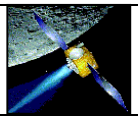
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00102ZA	Beginning of Sequence **SIR Preparation Mode** *SIR to Preparation Mode* Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.00.01		
1		**Check constraints**		Next Step: ->
		Perform procedure FC-PL-501.01-G.		
2		**Set SIR to Preparation Mode**		
	ET=TR+00.00.00	**Execute Telecommand** **G002C SIR Preparation Mode** TC Control Flags: GBM IL DSE **--Y -- ---**		
	G00102ZA	End of Sequence		
End of Procedure				

SIR switch OFF (Nominal)
File: FC-PL-005.12-G.xls
Author: Rblake

SMART-1



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Procedure Summary

Objectives

This procedure performs a nominal power OFF of the SIR payload, using FDIR commands

Summary of Constraints

No eclipse

Spacecraft Configuration

Start of Procedure

1. AOCS mode in Science.
2. SIR ON

End of Procedure

1. SIR OFF

Reference File(s)

Input Command Sequences

Output Command Sequences

G00512ZA

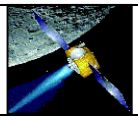
Referenced Displays

ANDs **GRDs** **SLDs**

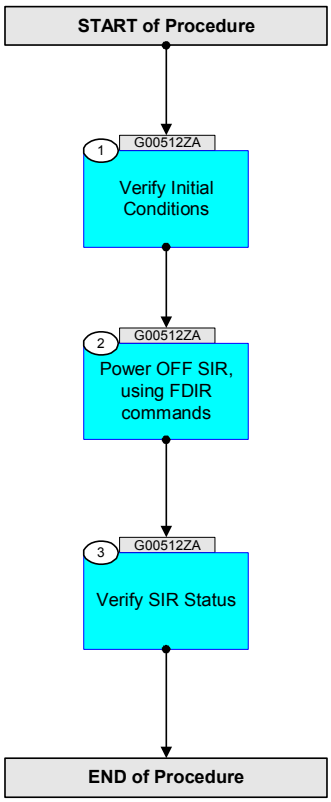
AZ7001
AP7005

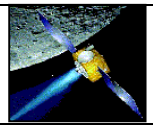
Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
17/06/02		1	Created	Malonso	
25/06/02	Draft 1.0	2	FC procedure for SVT1-1	Malonso	
30/07/02		3	Generate TC again due to significant changes in the new SDB. Refer to Jurriaan De Bruin for more info on this.□ Generate TC sequence again.□ Add delta relative time for the execution time of the TC in the sequence because the request for the TC sequence in the POR will contain an execution time.	Malonso	
22/10/02	Draft 2.0	4	None	Malonso	
13/12/02		5	Updated to use FDIR commands	Rblake	
18/12/02		6	Update to use FDIR commands. Additional TM checks.	Rblake	
18/12/02	1	7	Updated FOP title	Rblake	
25/02/03		8	Porting to MOIS5	admin-s1	
27/02/03		9	Updated seq. Flags, added duration.	Cpullig-s1	
28/02/03		10	Display MPS information	Rblake	
04/04/03		11	Remove check that SIR is ON before powering OFF	Rblake	



Procedure Flowchart Overview

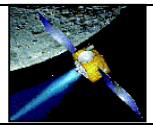




Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G00512ZA	Beginning of Sequence **SIR OFF (Nominal)** Time tag flag : NAY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_OFF Duration: 00.00.01		
1		**Verify Initial Conditions**		Next Step: -> **2**
		Verify that the S/C is in Science Mode		
		Verify Telemetry **A627T** AocCurrentMode **= Science**		AND=AZ7001
		Verify that the S/C is not in eclipse		
		Verify Telemetry **P760T** PowCurrentMode **= Sun**		AND=AZ7001
2		**Power OFF SIR, using FDIR commands**		Next Step: -> **3**
	ET=TR+00.00.00	**Execute Telecommand** **F028C F_Cmd_SIR** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **W011M** ENFORCING_1 **= 2 <dec>**		
	ET=+00.00.01	**Execute Telecommand** **F028C F_Cmd_SIR** TC Control Flags: GBM IL DSE **--Y -- ---** Command Parameters : **W011M** ENFORCING_1 **= 0 <dec>**		

SIR switch OFF (Nominal)
File: FC-PL-005.12-G.xls
Author: Rblake

SMART-1



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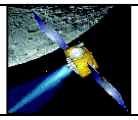
Step	Label/Time	Activity/Remarks	CK	Display/ Branch
3		**Verify SIR Status**		Next Step: -> **END**
		Verify that SIR is switched OFF. If SIR is switched OFF, it will be flagged by the Solid State Power Controller (SSPC) as OFF and the current between the PCDU and SIR will be 0 amps		
		Verify Telemetry **P680T** SSPC31SIRON **= OFF**		AND=AP7005
		Verify Telemetry **P681T** SSPC31SIRcurr **= .00 A**		AND=AP7005
	G00512ZA	End of Sequence		

End of Procedure

SIR Internal Constraints Checks
File: FC-PL-501.01-G.xls
Author: Rblake

SMART-1



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Procedure Summary

Objectives

This is a generic procedure used to perform external and internal constraints checks.

The procedure is normally used as pre-condition for the execution of most other SIR procedures.

Summary of Constraints

Spacecraft Configuration

Start of Procedure

SIR Powered OFF

End of Procedure

SIR Powered ON

Reference File(s)

Input Command Sequences

Output Command Sequences

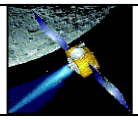
G50101ZA

Referenced Displays

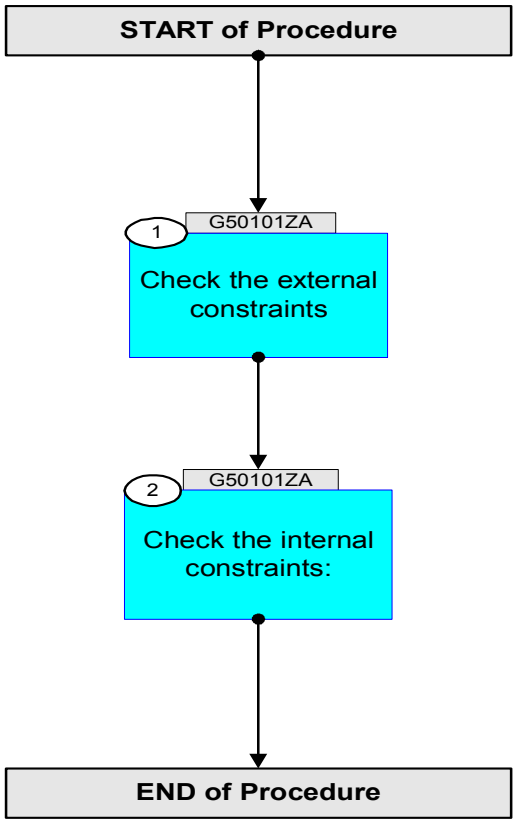
ANDs	GRDs	SLDs
AZ7001		
AE7101		
AP7005		
AU0083		

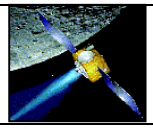
Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
27/02/03		1	Created	Cpullig-s1	
28/02/03		2	Front Page Formatting	Rblake	
28/02/03		3	Display MPS information	Rblake	
14/03/03		4	Fixed typographic error	Rblake	
04/04/03		5	Restructured and added external constraint checks	Rblake	
14/04/03		6	Remove erroneous duplicate current check. Check external constraints first	Rblake	
14/04/03	3	7	Corrected front sheet	Rblake	
23/05/03		8	Updated temperature values in steps 2.3 and 2.4	Rblake	

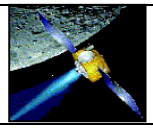


Procedure Flowchart Overview

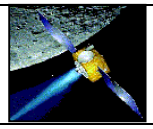




Step	Label/Time	Activity/Remarks	CK	Display/ Branch
Beginning of Procedure				
	G50101ZA	Beginning of Sequence **SIR Constraints Chk** Time tag flag : NNY--1 Precondition: SIR_ON Mode: SIR_ON Postcondition: SIR_ON Duration: 00.02.00		
1		**Check the external constraints**		Next Step: -> **2**
1.1		**Verify spacecraft not in eclipse**		
		Verify Telemetry **P760T** PowCurrentMode **= Sun**		AND=AZ7001
		Note: this constraint is also checked by the ESOC MPS system		
1.2		**Verify EP is OFF**		
		The internal checks confirm that we are in SCIENCE mode so the EP must be OFF anyway. Note: this constraint is also checked by the ESOC MPS system		
		Verify Telemetry **E630T** EpState **= EP OFF**		AND=AE7101
1.3		**Verify that sun is not in Field of View**		



Step	Label/Time	Activity/Remarks	CK	Display/ Branch
		Cannot be verified via telemetry or by the ESOC MPS system. Assumed to be verified by STOC planning system.		
1.4		**Verify that spacecraft not in radiation belts**		
		Cannot be verified by telemetry. Check with Flight Dynamics/STOC.		
2		**Check the internal constraints:**		Next Step: -> **END**
		Note: these constraint checks can only be applied when the procedure is being executed by an engineer on-console.		
2.1		**Verify that the S/C is in Science Mode**		
		Verify Telemetry **A627T** AocCurrentMode **= Science**		AND=AZ7001
2.2		**Verify that SIR is powered ON**		
		Verify Telemetry **P680T** SSPC31SIRON **= ON**		AND=AP7005
2.3		**Verify Instrument Unit (IU) not too warm**		



Step	Label/Time	Activity/Remarks	CK	Display/ Branch
		Verify Telemetry **T572T** SIRopt_At43 **< 14.00 degC**		AND=AU0083
2.4		**Verify Electronics Box (EB) not too warm**		
		Verify Telemetry **T573T** SIRel_At44 **< 40.00 degC**		AND=AU0083
2.5		**Verify SIR voltage in limits**		
		Verify telemetry **P681T** SSPC31SIRcurr **= < 110 mA** **= > 78 mA**		AND=AP7005
	G50101ZA	End of Sequence		

End of Procedure