Solar-B EIS

MULLARD SPACE SCIENCE LABORATORY
UNIVERSITY COLLEGE LONDON **Author: A M James**

PM software test procedures for the Solar-B EIS instrument

Version 4

Document Number: MSSL/SLB-EIS/SP019.04
18 June 2001

Distribution:

NRL	G Doschek	
	C Korendyke	
	S Myers	
	C Brown	
	K Dere	
	J Mariska	
NAOJ	H Hara	✓
	T Watanabe	
RAL	J Lang	
	B Kent	
	D Pike	
UiO	V Hansteen	✓
	O Wikstøl	✓
Mullard Space Science Laboratory	J L Culhane	
	A Smith	
	A Dibbens	✓
	L Harra	
	A McCalden	✓
	C McFee	
	R Chaudery	✓
	P Thomas	
	R Card	
	B Winter	
	P Coker	
	R Gowen	
	K Al Janabi	✓
	K Rees	
	M Whillock	✓
SLB-EIS Project Office	A James	Orig

Author: Date:

Authorised By Date:

Distributed: Date:

Change Record

ISSUE	DATE	PAGES CHANGED	COMMENTS
01	12 Feb 2001	All New	
02	15 Mar 2001	All New	
03	14 Jun 2001		Change of Title (added word 'software') Change of Scope – doesn't cover hardware tests Modified memory table Ids. Modified sequence testing to allow increased flexibility The above two changes agreed with the J-side (meeting at MSSL 26-28/3/2001) Minor error corrections
04	18 Jun 2001	 In tests 4 to 10 Page 32 Page 23 Page 6	Updates based on comments from Hiro (e-mail on 18/6): In line with new Telecommanding Structure SP016.02, 11/6/01 , the mode enable command (MODE ENA) changed from 0x2001 (the 01 was originally a dummy byte) to 0x20. Line list 1: Window x lengths corrected. Clear explanation of command parameters to uplink new compression parameters (in table) Add note on aborting operations

Contents

1 Scope

This documents describes the purpose and requirements of the prototype model (PM) testing, as prescribed by the system side, the necessary functionality of the PM ICU needed to meet these requirements and a detailed procedure for the tests. By defining test procedures now it is envisaged that any testing that is performed at ISAS during spacecraft PM testing would have already been performed and analysed at MSSL prior to delivery. However, to allow for flexibility during the system testing at ISAS a number of tests are described which allow some freedom in defining the operations performed by the ICU i.e. different number of exposures, turning compression on or off etc.

WARNING: This document assumes that the hardware integration and tests described in the 'PM hardware test procedures document' (MSSL/SLB-EIS/SP024.01) have been successfully completed.

2 Applicable Documents

[1] MSSL/SLB-EIS/SP006	EIS ICU Software Architectural Design
[2] MSSL/SLB-EIS/SP016	EIS Telecommanding Structure
[3] MSSL/SLB-EIS/SP017	EIS Status
[4] MSSL/SLB-EIS/SP018	EIS Mission data structure
[5] NAO/SLB-EIS/SP/MDP001	MDP ICU interface document
[6] MSSL/SLB-EIS/SP013	EIS Mode definition
[7] NAO/SLB-EIS/MN?	PM System Test Plan (T.I.M., ISAS, Dec 2000)

3 Purpose and Requirements

The following list is taken from the 'PM System Test Plan' as presented at the Technical interchange Meeting (T.I.M.) held at ISAS in December 2000 [7].

Purpose of PM System Test:

- To verify interface of power / signal line between Payload and Bus System
- To verify signal interface between Payload and MDP
- To verify validity of command sequence for each payload by using H/K telemetry
- To verify validity of mission data (in high rate packet)

The same document states:

- Purpose of subsystem/component test conducted by payload side is to verify interface related to other components and performance of its own operation.
- Purpose of system test is to verify end to end (S/C control system-DHU-MDP-Payloads) interface using bus components (DHU) and S/C control system

4 Functionality Requirements

The 'PM System Test Plan' [7] describes 3 tests:

Integration & Test

- Primary power line interface (consumed power, voltage ripple, transient current etc.)
- Telemetry command interface (waveform, timing etc. on interface between DHU and PIM, DHU and MDP)
- Signal interface (interface between MDP and each payload: interface specification shall be defined by MDP side)

Functional Test (for each payload)

- Send command to set **each** payload to **observation mode** and verify corresponding telemetry by using command sequence required by payload side.
- Verify validity of Mission data (evaluation is conducted by payload side)

5 Format of Tests

In each test description below there is a test number and short title. Following that is a brief description of the test and a table outlining the timing of events. The table contains 6 columns:

1. Time of event (see following note)
2. Description of event; nominally a s/c or EIS command (see applicable document [2])
3. Command associated with event if it is an EIS command (does not show s/c commands).
4. Notes, generally a brief description of the event.
5. Mission data; a description of the data returned (only used if mission data is expected).

Following this is a list of key status parameters that have changed during the event or as a result of the event. Only key status parameters are shown and only after what are key events within the test (explanatory notes are given after the event table). Underlined statements show details of where the user needs to do something in addition to what is in the table, normally this will be checking of status parameters or data.

The tests are split into certain sections:
Test 1 – simple instrument on test
Test 2 – Uplink/Downlink tests using Program Memory
Test 3 – Uplink/Downlink tests using Data Memory
Test 4 to 6 – Predefined Sequence tests
Test 7 to 10 – User defined Sequence tests

Tests 1,2 and 3 will be used during the **integration tests** in ISAS.
All the tests will be used during the **functional tests** and **system performance tests** in ISAS.

Each test is started on a new page of this document.

TEST	DESCRIPTION
1	Switch on test
2	Uplink / Downlink from Program Memory
3	Uplink / Downlink from Data Memory
4	Operations test using sequence 0 (default 1 exposure)
5	Operations test using sequence 1 (default 1 exposure)
6	Operations test using sequence 0 and 1
7	Operations test changing exposure number (example: setting exposure number to 2 in sequence 0)
8	Operations test changing compression setting (example: selecting compression in schedule 1)
9	Operations test sequence recursive call (example: calling sequence 1 recursively)
10	Operations test multi-sequence recursive call (example: calling seq. 0 from seq. 1 and then calling seq. 1 from seq, 0)

Table 1, Summary of Solar B EIS PM tests

5.1 A note on timing

Within the event tables the timings are all **TBD** at present. During the initial integration and functional tests at ISAS, after every command is sent, status parameters would be carefully checked by both the system team and the EIS team. In this case the timing of the next command is dependent not on any hardware or software timings but on the agreement that the command was successfully received and interpreted. For later testing it may be more useful to test timed commands. Timing for these commands, however, will be derived from the actual recorded times of events during the integration and functional testing phases. The timing column is left in such that these timings can be added at ISAS during the testing.

5.2 A note on compression

When performing the sequence tests it is possible for the user to define the MDP compression schemes. When no data compression is used, the CCD pixels are sent as 16bit words (14bit 'energy' + 2bits 'side flag'). However, if data compression is used, then only the pixel energies (14 LS bits in the 16bit word) are sent. The 2 MS bits are set to 00 in this case.

The side flag, which occupies the 2 MS bits are as follows:

CCD 0 side L = 00(b)
CCD 0 side R = 01(b)
CCD 1 side L = 10(b)
CCD 1 side R = 11(b)

N.B.
CCD 0 represents the physical CCD A (long λ detector)
CCD 1 represents the physical CCD B (short λ detector)

5.3 A note on sequences

Tests 4 to 8 are fully predetermined tests that have been performed successfully at MSSL during sub-system testing. They use 2 predefined sequences 0 and 1 which are described, with their corresponding line lists, in Appendix A. Tests 9 to 12 show examples of how the user can select different number of exposures, using compression, perform sequence recursive calls and perform multi-sequence recursive calls. These tests involve making changes to the predefined sequences 0 and 1, however, sequences 0 and 1 are initialised every time the software is started (re-boot) so any changes will be removed and the original sequences will again be available. Commands are also given to return the sequences to their original states at the end of these tests.

5.4 A note on aborting operations

Please note that the time required to abort a sequence is Mission Data dependent. A sequence can only be aborted after the completion of the current mission data packet send. When running a "nominal EIS raster" with for example 4 lines (32X512 pixel), as in sequence 1, then the sequence is aborted in 2 to 3 seconds (worst case). However, when transmitting a full CCDs data (as in sequence 0), then aborting the sequence can take up to 40 seconds.

6 Description of Tests

Test 1 – Switch on test

In this test the instrument is switched on by the spacecraft and responds to status requests whilst in STANDBY mode (this is the default mode after a switch on). At some later time it is switched off again.

Sequence of events:

Time	Event	Command	Notes
T=0	Power On	N/A	Spacecraft power up of EIS
	Power Off	N/A	Spacecraft power down of EIS

Whilst in the 'ON' state, the MDP request status packets (1 status packet every 2 seconds):

Status Byte	Name and value	
0	ICU_SW_ID	10 (V 1, REV 0)
1	EIS_MODE	1
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+ (Increments)
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	0
10 & 11	TC_EXC_PKTC	Not used
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
16	XRT_FF_STAT	2
16	EIS_FF_STAT	2
16	H_MONI_STAT	2 (PM)
16	AEC_STAT	2
17	MEM_DMP_STAT	2
17	SEQ_STAT	2
17	XRT_FF_REC	NK
18	XRT_X_COR	NK
19	XRT_Y_COR	NK
20	SEQ_I	0
21	SEQ_P	0
22	LL_I	0
23	MD_BUF_STAT	0
24 & 25	EXPOSURE_NO	0
26 & 27	FINE_M_POS	0
28	ICU_VF	1
28	PSU_VF	1
28	CAM_VF	2
28	MHC_VF	2
64 to 67	CMD_LOG	0 (see note 1 below)

NK: Not Known. This depends on what is received from MDP

Note 1: These are 4 bytes which logs the parameters of the last command received (BC's 1 to 3 and the command length)

Test 2a – Acquire small block from Program Memory

In this test the instrument is switched on by the spacecraft and responds to status requests. The initial Status parameters are as shown for test 1 on previous page.
Whilst in the STANDBY mode a memory uplink or downlink is performed and the next test is performed without switching the instrument off. Only when all the tests in this section are performed is the instrument switched off again (after test 2f).

Sequence of events:

Time	Event	Command	Notes
T=0	Power On	N/A	Spacecraft power up of EIS
	Memory Downlink	CMD-ID = 0x05 Address = 0x000C00 Length = 100	

Following the send of this TC, monitor the following status parameters:

Status Byte	Name	Value
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	+
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	MEM_DMP_STAT	Should change from 2 to 1 and back to 2. Please note that this test runs for a very short duration and the changes may be missed
64, 65, 66, 67	CMD_LOG	5, 7, 0 and 7

Check the content of memory dump data against EIS memory map (provided as part of PM delivery).

Test 2b – Acquire a large block from Program memory

Sequence of events:

Time	Event	Command	Notes
	Memory Downlink	CMD-ID = 0x05 Address = 0x000C00 Length = 20480	

Following the send of this TC, monitor the following status parameters (change from power on status):

Status Byte No.	Name	Value
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	+
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	MEM_DMP_STAT	Should change from 2 to 1 and back to 2.
64, 65, 66, 67	CMD_LOG	5, 7, 0 and 7

Check the content of memory dump data against EIS memory map (provided as part of PM delivery).

Test 2c – Uplink to Program memory

Sequence of events:

Time	Event	Command	Notes
	Uplink command	CMD_ID = 0xE5 Address = 0x060000 Length = 100	0X60000 is an empty portion of EIS program memory Length = 100 byte. The uplink data can be selected by the system size (suggest incremental values of 1 to 100)

Following the send of this TC, monitor the following status parameters (change from power on status):

Status Byte	Name	Value
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	+
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	MEM_DMP_STAT	2
64, 65, 66, 67	CMD_LOG	0xE5, 6, 0 and 105

Test 2d – Downlink from Program memory

Sequence of events:

Time	Event	Command	Notes
	Downlink command	CMD-ID = 0x05 Address = 0x060000 Length = 100	0X60000 is an empty portion of EIS program memory Length = 100 byte.

Following the send of this TC, monitor the following status parameters:

Status Byte	Name	Value
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	+
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	MEM_DMP_STAT	2
64, 65, 66, 67	CMD_LOG	5, 7, 6 and 7

Compare downlinked memory data with uplinked data in test 2c.

Test 2e – Uplink 2 bytes to Program memory

N.B. (EIS program memory is 6 bytes wide)

Sequence of events:

Time	Event	Command	Notes
	Uplink command	CMD_ID = 0xE5 Address = 0x060007 Length = 2 Uplink data: 0x21 and 0x45	0X60007 is an empty portion of EIS program memory Length = 2 bytes. 0x21 and 0x45 are random values.

Following the send of this TC, monitor the following status parameters:

Status Byte	Name and value	
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	+
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	MEM_DMP_STAT	2
64, 65, 66, 67	CMD_LOG	0xE5, 6, 0 and 7

Test 2f – Downlink from Program memory

Sequence of events:

Time	Event	Command	Notes
	Downlink command	CMD_ID = 0x05 Address = 0x060007 Length = 2	0X60000 is an empty portion of EIS program memory Length = 2 byte.

Following the send of this TC, monitor the following status parameters:

Status Byte	Name	Value
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	+
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	MEM_DMP_STAT	2
64, 65, 66, 67	CMD_LOG	5, 6, 0 and 7

6.1.1.1 Compare down linked memory data with uplinked data in test E

Test 3a – Uplink a new sequence to Data Memory

Note that some uplinks will overwrite some existing sequences; nevertheless these sequences should be restored by the next re-boot (power-on)

Sequence of events: Send 3 consecutive commands to fill sequence 0 (48 × 256 byte sequences are currently available)

Time	Event	Command	Notes
T=0	Memory uplink to sequence 0	CMD_ID = 0xE7 Address = 0x070000 Length = 100 CMD_ID = 0xE7 Address = 0x070064 Length = 100 CMD_ID = 0xE7 Address = 0x0700C8 Length = 56	0X070000 is the ICU start address of the sequence table. Each sequence is 256 bytes.

Following the send of these TCs, monitor the following status parameters:

Status Byte	Name	Value
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	+
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ ID	0
15	CMD_BUF_STAT	0
17	MEM_DMP_STAT	2
64, 65, 66, 67	CMD_LOG	0xE7, 7, 0 and 61

Test 3b – Dump the new sequence

Sequence of events:

Time	Event	Command	Notes
	Memory downlink from sequence 0	CMD_ID = 0x07 Address = 0x070000 Length = 256	0X070000 is the ICU start address of the sequence table. Each sequence is 256 bytes.

Following the send of this TC, monitor the following status parameters:

Status Byte	Name	Value
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	+
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	MEM_DMP_STAT	2
64, 65, 66, 67	CMD_LOG	7, 7, 7 and 7

Compare the uplinked data

Test 3c – Edit sequence 0: Change the contents of 2 bytes of sequence 0

Note that some uplinks will overwrite existing sequences; these will be restored by the next re-boot (power-on).

Sequence of events: Send 3 consecutive commands

Time	Event	Command	Notes
	Memory uplink to sequence 0	CMD_ID = 0xE7 Address = 0x070001 Length = 1 Data = 0xAA CMD_ID = 0xE7 Address = 0x070008 Length = 0xBB	0X070000 is the ICU start address of the sequence table. Each sequence is 256 bytes.

Following the send of this TC, monitor the following status parameters:

Status Byte	Name	Value
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	+
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	MEM_DMP_STAT	2
64, 65, 66, 67	CMD_LOG	0xE7, 7, 0 and 6

Test 3d – Dump the new sequence

Note that some uplinks will overwrite existing sequences; these will be restored by the next re-boot (power-on). After the downlink of this sequence EIS is turned off.

Sequence of events:

Time	Event	Command	Notes
	Memory downlink to sequence 0	CMD_ID = 0x07 Address = 0x070000 Length = 256	0X070000 is the ICU start address of the sequence table. Each sequence is 256 bytes.
	Power Off	N/A	Spacecraft Power Off EIS (after downlink completed)

Following the send of the Downlink TC, monitor the following status parameters:

Status Byte	Name	Value
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	+
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	MEM_DMP_STAT	2
64, 65, 66, 67	CMD_LOG	7, 7, 7 and 7

Compare with the uplinked data

Test 4 – Operations test using sequence 0

In this test the instrument is switched on by the spacecraft and responds to status requests. Whilst in the STANDBY mode the instrument is commanded to MANUAL mode and a sequence selected. The ICU is then commanded to AUTO mode and the sequence started. At some later time EIS commanded to MANUAL mode, then STANDBY and the instrument is switched off again.

Sequence structure:
This sequence performs a single exposure and a full CCDs readout (CCDs 0 and 1). Window dimensions are (2048 × 512), for each CCD. No MDP compression.

Sequence of events:

Time	Event	Command	Notes	Mission Data
T=0	Power On	N/A	Spacecraft power up of EIS	No
	Mode enable	MODE_EN (0x20 00)	Enables mode transitions	No
	Mode change	MODE (0x21 02)	Change from STANDBY to MANUAL	No
	Sequence Select	SEL_SEQ (0x83 00)	Select sequence 0 to run	No
	Mode change	MODE (0x21 03)	Change from MANUAL to AUTO, sequence starts automatically	Yes
	Mode change	MODE (0x21 02)	Change from AUTO to MANUAL	**See note below**
	Mode change	MODE (0x21 01)	Change from MANUAL to STANDBY	No
	Power Off	N/A	Spacecraft power down of EIS	

Note: Command EIS **back** to MANUAL (from AUTO) after byte 17 (SEQ_STAT) changes from 1 (RUNNING) to 2 (STOPPED). Sequence stopped indicates the completion of the sequence. However, the last exposure MD may be still transmitted.

Following mode transition command to Auto, EIS status should be as follows:

Status Byte	Name	Value
0	ICU_SW_ID	10
1	EIS_MODE	3
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	4
10 & 11	TC_EXC_PKTC	Not used
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ ID	0
15	CMD_BUF_STAT	0
17	SEQ_STAT	1 (running)
20	SEQ_I	0
21	SEQ_P	+
22	LL_I	0
23	MD_BUF_STAT	+
24 & 25	EXPOSURE_NO	1
26 & 27	FINE_M_POS	1
28	ICU_VF	1
28	PSU_VF	1
28	CAM_VF	1
28	MHC_VF	1
64 to 67	CMD_LOG	0x21, 3, 0 and 2

Perform the following checks:
1 – Check mission data header area parameters.
2 – Check mission data pixels

Test 5 – Operations test using sequence 1

In this test the instrument is switched on by the spacecraft and responds to status requests. Whilst in the STANDBY mode the instrument is switched to MANUAL mode and a sequence selected. The ICU is then commanded to AUTO mode and the sequence started. At some later time EIS commanded to MANUAL mode, then STANDBY and the instrument is switched off again.

Sequence structure:
This sequence performs 1exposures and partial CCD readout (CCDs 0 and 1). Window dimensions are for typical spectral line (32 X 512). No MDP compression.

Sequence of events:

Time	Event	Command	Notes	Mission Data
T=0	Power On	N/A	Spacecraft power up of EIS	No
	Mode enable	MODE_EN (0x20 00)	Enables mode to be changed	No
	Mode change	MODE (0x21 02)	Change from STANDBY to MANUAL	No
	Sequence Select	SEL_SEQ (0x83 01)	Select sequence 1 to run	No
	Mode change	MODE (0x21 03)	Change from MANUAL to AUTO, sequence starts automatically	Yes
	Mode change	MODE (0x21 02)	Change from AUTO to MANUAL	**See note below**
	Mode change	MODE (0x21 01)	Change from MANUAL to STANDBY	No
	Power Off	N/A	Spacecraft power down of EIS	No

Note: Command EIS **back** to MANUAL (from AUTO) after byte 17 (SEQ_STAT) changes from 1 (RUNNING) to 2 (STOPPED). Sequence stopped indicates the completion of the run.

Following mode transition command to Auto, EIS status should be as follows:

Status Byte	Name	Value
0	ICU_SW_ID	10
1	EIS_MODE	3
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	4
10 & 11	TC_EXC_PKTC	Not Used
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	SEQ_STAT	1 (running)
20	SEQ_I	1
21	SEQ_P	+
22	LL_I	1
23	MD_BUF_STAT	+
24 & 25	EXPOSURE_NO	1
26 & 27	FINE_M_POS	1
28	ICU_VF	1
28	PSU_VF	1
28	CAM_VF	1
28	MHC_VF	1
64 to 67	CMD_LOG	0x21, 3, 0 and 2

Perform the following checks:
1 – Check mission data header area parameters.
2 – Check mission data pixels

Test 6 – Operations test using sequence 0 and 1

In this test the instrument is switched on by the spacecraft and responds to status requests. Whilst in STANDBY mode the instrument is switched to MANUAL mode and sequence 0 selected. The ICU is then commanded to AUTO mode and the sequence started. Once completed the ICU is returned to MANUAL mode and sequence 1 is selected. The ICU is again commanded to AUTO mode and the sequence started. At some later time later EIS commanded to MANUAL mode, then STANDBY and the instrument is switched off again.

Sequence of events:

Time	Event	Command	Notes	Comments
T=0	Power On	N/A	Spacecraft power up of EIS	
	Mode enable	MODE_EN (0x20 00)	Enables mode to be changed	
	Mode change	MODE (0x21 02)	Change from STANDBY to MANUAL	
	Seq. Select	SEL_SEQ (0x83 00)	Select sequence 0 to run	
	Mode change	MODE (0x21 03)	Change from MANUAL to AUTO, sequence starts automatically	**See note below**
	Mode change	MODE (0x21 02)	Change from AUTO to MANUAL	
	Seq. Select	SEL_SEQ (0x83 01)	Select sequence 1 to run	
	Mode change	MODE (0x21 03)	Change from MANUAL to AUTO, sequence starts automatically	**See note below**
	Mode change	MODE (0x21 02)	Change from AUTO to MANUAL	
	Mode change	MODE (0x21 01)	Change from MANUAL to STANDBY	
	Power Off	N/A	Spacecraft power off of EIS	

Note: Command EIS **back** to MANUAL (from AUTO) after byte 17 (SEQ_STAT) changes from 1 (RUNNING) to 2 (STOPPED). Sequence stopped indicates the completion of the run.

Following **2nd** mode transition command to Auto, EIS status should be as follows:

Status Byte	Name	Value
0	ICU_SW_ID	10
1	EIS_MODE	3
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	7
10 & 11	TC_EXC_PKTC	Not Used
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ID	0
15	CMD_BUF_STAT	0
17	SEQ_STAT	1 (running)
20	SEQ_I	1
21	SEQ_P	+
22	LL_I	1
23	MD_BUF_STAT	+
24 & 25	EXPOSURE_NO	1
26 & 27	FINE_M_POS	1
28	ICU_VF	1
28	PSU_VF	1
28	CAM_VF	1
28	MHC_VF	1
64 to 67	CMD_LOG	0x21, 3, 0 and 2

Perform the following checks:
1 – Check mission data header area parameters.
2 – Check mission data pixels

Test 7 – Operations test – changing exposure number

In this test the instrument is switched on by the spacecraft and responds to status requests. Whilst in the STANDBY mode a memory uplink to the data memory is performed to change the number of exposures from the default 1 to 2 in sequence 0. This change is then verified using memory download before the instrument is commanded to MANUAL mode and the sequence selected. The ICU is then commanded to AUTO mode and the sequence started. At some later time EIS commanded to MANUAL mode, then STANDBY and the instrument is switched off again.

N.B. Sequence 0 will be initialised every time the software is started and revert to the default sequence shown in Appendix A.

Sequence structure:
This sequence performs **2** exposures and a full CCDs readout (CCDs 0 and 1). Window dimensions are (2048 × 512), for each CCD. No MDP compression.

Sequence of events:

Time	Event	Command	6.1.1.1.1 Notes	Mission Data
T=0	Power On	N/A	Spacecraft power up of EIS	No
	Memory uplink to sequence 0 to set exposure number to 2	CMD_ID = 0xE7 Address = 0x07000A Length = 2 Parameters=0x00,02	0x07000A is the ICU address of the sequence table parameter which controls the number of exposures.	No
	Memory downlink from sequence 0	CMD_ID = 0x07 Address = 0x070000 Length = 256	0x070000 is the ICU start address of the sequence table.	No
	Mode enable	MODE_EN (0x20 00)	Enables mode transitions	No
	Mode change	MODE (0x21 02)	Change from STANDBY to MANUAL	No
	Sequence Select	SEL_SEQ (0x83 00)	Select sequence 0 to run	No
	Mode change	MODE (0x21 03)	Change from MANUAL to AUTO, sequence starts automatically	Yes
	Mode change	MODE (0x21 02)	Change from AUTO to MANUAL	**See note below**
	Mode change	MODE (0x21 01)	Change from MANUAL to STANDBY	No
	Power Off	N/A	Spacecraft power down of EIS	

Note: Command EIS **back** to MANUAL (from AUTO) after byte 17 (SEQ_STAT) changes from 1 (RUNNING) to 2 (STOPPED). Sequence stopped indicates the completion of the sequence. However, the last exposure MD may be still transmitted.

Following mode transition command to Auto, EIS status should be as follows:

Status Byte	**Name**	**Value**
0	ICU_SW_ID	10
1	EIS_MODE	3
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	6
10 & 11	TC_EXC_PKTC	Not used
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ ID	0
15	CMD_BUF_STAT	0
17	SEQ_STAT	1 (running)
20	SEQ_I	0
21	SEQ_P	+
22	LL_I	0
23	MD_BUF_STAT	+
24 & 25	EXPOSURE_NO	**2**
26 & 27	FINE_M_POS	+
28	ICU_VF	1
28	PSU_VF	1
28	CAM_VF	1
28	MHC_VF	1
64 to 67	CMD_LOG	0x21, 3, 0 and 2

Perform the following checks:
1 – Check mission data header area parameters.
2 – Check mission data pixels

Test 8 – Operations test – changing data compression setting

In this test the instrument is switched on by the spacecraft and responds to status requests. Whilst in the STANDBY mode a memory uplink to the data memory is performed to change the compression setting from the default 0 (no compression) to 1 (data compression as defined by J-side) in sequence 1. This change is then verified using memory download before the instrument is commanded to MANUAL mode and the sequence selected. The ICU is then commanded to AUTO mode and the sequence started. At some later time EIS commanded to MANUAL mode, then STANDBY and the instrument is switched off again.

N.B. Sequence 1 will be initialised every time the software is started and revert to the default sequence shown in Appendix A.

Sequence structure:
This sequence performs 1 exposure and partial CCD readout (CCDs 0 and 1). Window dimensions are for typical spectral line (32 X 512).

Sequence of events:

Time	**Event**	**Command**	**6.1.1.1.2 Notes**	**Mission Data**
T=0	Power On	N/A	Spacecraft power up of EIS	No
	Memory uplink to sequence 1 to turn compression on	CMD_ID = 0xE7 Address = 0x07010C Length = 2 Parameters= 0xN, 0xM	0x07010C is the ICU address of the sequence table parameter that controls the data compression. N and M are 2 bytes as defined in section 6.4.3 of the MDP-EIS-ICU Electrical Interface Doc (v3.0) and are used to select MDP compression scheme to be used (and associated parameters). No EIS data compression is implemented. **NOTE**: The Compression parameters are to be selected by the system side.	No
	Memory downlink from sequence 1	CMD_ID = 0x07 Address = 0x070100 Length = 256	0x070100 is the ICU start address of the sequence table.	No
	Mode enable	MODE_EN (0x20 00)	Enables mode transitions	No
	Mode change	MODE (0x21 02)	Change from STANDBY to MANUAL	No
	Sequence Select	SEL_SEQ (0x83 01)	Select sequence 1 to run	No
	Mode change	MODE (0x21 03)	Change from MANUAL to AUTO, sequence starts automatically	Yes
	Mode change	MODE (0x21 02)	Change from AUTO to MANUAL	**See Note**
	Mode change	MODE (0x21 01)	Change from MANUAL to STANDBY	No
	Power Off	N/A	Spacecraft power down of EIS	

Note: Command EIS **back** to MANUAL (from AUTO) after byte 17 (SEQ_STAT) changes from 1 (RUNNING) to 2 (STOPPED). Sequence stopped indicates the completion of the sequence. However, the last exposure MD may be still transmitted.

Following mode transition command to Auto, EIS status should be as follows:

Status Byte	**Name**	**Value**
0	ICU_SW_ID	10
1	EIS_MODE	3
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	6
10 & 11	TC_EXC_PKTC	Not Used
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ ID	0
15	CMD_BUF_STAT	0
17	SEQ_STAT	1 (running)
20	SEQ_I	1
21	SEQ_P	+
22	LL_I	1
23	MD_BUF_STAT	+
24 & 25	EXPOSURE_NO	1
26 & 27	FINE_M_POS	1
28	ICU_VF	1
28	PSU_VF	1
28	CAM_VF	1
28	MHC_VF	1
64 to 67	CMD_LOG	0x21, 3, 0 and 2

Perform the following checks:
1 – Check mission data header area parameters.
2 – Check mission data pixels and ensure that the 2 MS bits are not set to 0, except for CCD0 side L.

Test 9 – Operations test – sequence recursive call

In this test the instrument is switched on by the spacecraft and responds to status requests. Whilst in the STANDBY mode a memory uplink to the data memory (sequence 1) is performed to change the terminate sequence command such that the sequence is started again. This change is then verified using memory download before the instrument is commanded to MANUAL mode and the sequence selected. The ICU is then commanded to AUTO mode and the sequence started. At some later time EIS commanded to MANUAL mode, then STANDBY and the instrument is switched off again.

N.B. Sequence 1 will be initialised every time the software is started and revert to the default sequence shown in Appendix A.

Recursive sequence structure:
This sequence performs 1 exposure and partial CCD readout (CCDs 0 and 1). Window dimensions are for typical spectral line (32 X 512).

Sequence of events:

Time	Event	Command	6.1.1.1.3 Notes	Mission Data
T=0	Power On	N/A	Spacecraft power up of EIS	No
	Memory uplink to sequence 1 to allow recursive calls	CMD_ID = 0xE7 Address = 0x070118 Length = 2 Parameters=0x82,01	0x070118 is the ICU address of the sequence that controls the sequence recursive call	No
	Memory downlink from sequence 1	CMD_ID = 0x07 Address = 0x070100 Length = 256	0x070100 is the ICU start address of the sequence table.	No
	Mode enable	MODE_EN (0x20 00)	Enables mode transitions	No
	Mode change	MODE (0x21 02)	Change from STANDBY to MANUAL	No
	Sequence Select	SEL_SEQ (0x83 01)	Select sequence 1 to run	No
	Mode change	MODE (0x21 03)	Change from MANUAL to AUTO, sequence starts automatically	Yes
	Mode change	MODE (0x21 02)	Change from AUTO to MANUAL	**See note below**
	Mode change	MODE (0x21 01)	Change from MANUAL to STANDBY	No
	Power Off	N/A	Spacecraft power down of EIS	

Note: Command EIS **back** to MANUAL to stop operations.

Following mode transition command to Auto, EIS status should be as follows:

Status Byte	**Name**	**Value**
0	ICU_SW_ID	10
1	EIS_MODE	3
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	6
10 & 11	TC_EXC_PKTC	Not used
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ ID	0
15	CMD_BUF_STAT	0
17	SEQ_STAT	1 (running)
20	SEQ_I	1
21	SEQ_P	+
22	LL_I	1
23	MD_BUF_STAT	+
24 & 25	EXPOSURE_NO	+
26 & 27	FINE_M_POS	1
28	ICU_VF	1
28	PSU_VF	1
28	CAM_VF	1
28	MHC_VF	1
64 to 67	CMD_LOG	0x21, 3, 0 and 2

Perform the following checks:
1 – Check mission data header area parameters.
2 – Check mission data pixels

Test 10 – Operations test – multi-sequence recursive call

In this test the instrument is switched on by the spacecraft and responds to status requests. Whilst in the STANDBY mode a memory uplink to the data memory (sequence 0) is performed to change the number of exposure to 2 and the terminate sequence command such that once completed it would call sequence 1. Then a memory uplink to the data memory (sequence 1) is performed to change the number of exposure to 10 and the terminate sequence command such that once completed it would call sequence 0. These changes are then verified using memory downloads before the instrument is commanded to MANUAL mode and sequence 0 selected. The ICU is then commanded to AUTO mode and the sequence started. At some later time EIS commanded to MANUAL mode, then STANDBY and the instrument is switched off again.

N.B. Sequence 0 and 1 will both be initialised every time the software is started and revert to the default sequences shown in Appendix A.

Recursive sequence structure:
Sequence 0 performs **2** exposures and a full CCDs readout (CCDs 0 and 1). Window dimensions are (2048 × 512), for each CCD. No MDP compression.
Sequence 1 performs **10** exposures and partial CCD readout (CCDs 0 and 1). Window dimensions are for typical spectral line (32 X 512).

Sequence of events:

Time	Event	Command	6.1.1.1.4 Notes	Mission Data
T=0	Power On	N/A	Spacecraft power up of EIS	No
	Memory uplink to sequence 0. Set exposures to 2	CMD_ID = 0xE7 Address = 0x07000A Length = 2 Parameters=0x00,02	Change sequence 0 no. of exposures	No
	Memory uplink to sequence 0. Calls seq 1 at termination	CMD_ID = 0xE7 Address = 0x070018 Length = 2 Parameters=0x82,01	Change sequence 0 to recursive call	No
	Memory uplink to sequence 1. Set exposures to 10	CMD_ID = 0xE7 Address = 0x07010A Length = 2 Parameters=0x00,0A	Change sequence 1 no. of exposures	No
	Memory uplink to sequence 1. Calls seq 0 at termination	CMD_ID = 0xE7 Address = 0x070118 Length = 2 Parameters=0x82,00	Change sequence 1 to recursive call	No
	Memory downlink from both sequences	CMD_ID = 0x07 Address = 0x070000 Length = 512	Dump sequences 0 and 1	No
	Mode enable	MODE_EN (0x20 00)	Enables mode transitions	No
	Mode change	MODE (0x21 02)	Change from STANDBY to MANUAL	No
	Sequence Select	SEL_SEQ (0x83 01)	Select sequence 1 to run	No
	Mode change	MODE (0x21 03)	Change from MANUAL to AUTO, sequence starts automatically	Yes
	Mode change	MODE (0x21 02)	Change from AUTO to MANUAL	**See note below**
	Mode change	MODE (0x21 01)	Change from MANUAL to STANDBY	No
	Power Off	N/A	Spacecraft power down of EIS	

Note: Command EIS **back** to MANUAL to stop operations.

Following mode transition command to Auto, EIS status should be as follows:

Status Byte	**Name**	**Value**
0	ICU_SW_ID	10
1	EIS_MODE	3
1	TC_FAILED_EC	0
2 & 3	STATUS_PC	+
4, 5, 6 & 7	MDP_TIME	TI+
8 & 9	TC_REC_PKTC	9
10 & 11	TC_EXC_PKTC	Not used
12 & 13	TC_FAILED_PKTC	0
14	TC_FAILED_CMD_ ID	0
15	CMD_BUF_STAT	0
17	SEQ_STAT	1 (running)
20	SEQ_I	1
21	SEQ_P	+
22	LL_I	1
23	MD_BUF_STAT	+
24 & 25	EXPOSURE_NO	+
26 & 27	FINE_M_POS	1
28	ICU_VF	1
28	PSU_VF	1
28	CAM_VF	1
28	MHC_VF	1
64 to 67	CMD_LOG	0x21, 3, 0 and 2

Perform the following checks:
1 – Check mission data header area parameters.
2 – Check mission data pixels

APPENDIX A – Sequences and Line lists

The OBS table starts at location 0x70000 and ending at location 0x7FFFF. Currently, there are 48*256 byte sequences and 48*164 byte line lists (Max. 25 line per list).

Sequence no.	Start address (hex)	End address (hex)
0	70000	700FF
1	70100	701FF
47	72F00	72FFF

Line List no.	Start address (hex)	End address (hex)
0	73000	730A3
1	730A4	70147
47	74E1C	74EBF

Sequence 0:

Sequence command	**Description**
26	Sequence length
0xFA	Sequence ID
0xCE	
0x85	Select line list
0x00	Line list 0
0x86	Run Raster
0xBE	Raster ID
0xEF	
0x00	Initial mirror position
0x00	Position 0
0x00	Loop Counter (one exposure)
0x01	
0x00	Data Compression
0x00	(None)
0x01	OCB X
0x01	OCB Y
0x8d	Start exposure
0x00	Exposure time (unit of 50 ms)
0x28	(2 seconds)
0x87	Step mirror
0x00	Step size (two steps)
0x02	
0x89	Loop back
0x10	To start exposure
0x81	Terminate sequence
0x00	

Sequence 1:

Sequence command	Description
26	Sequence length
0x0A	Sequence ID
0xCE	
0x85	Select line list
0x01	Line list 1
0x86	Run Raster
0xC0	Raster ID
0xDE	
0x00	Initial mirror position
0x04	Position 4
0x00	Loop Counter (one exposure)
0x01	
0x00	Data Compression
0x00	
0x01	OCB X
0x01	OCB Y
0x8D	Start exposure
0x00	Exposure time (unit of 50 ms)
0x28	
0x87	Step mirror
0x00	Step size (one step)
0x01	
0x89	Loop back
0x10	To start exposure
0x81	Terminate sequence
0x00	

Line List 0:

Parameter	Description
38	Length
3	CCD Read-out nodes (L & R)
4	Number of windows
0	Checksum
0x08	CCD Length (2048)
0x00	
0	CCD window X start (0)
0	
0x04	CCD window X length (1024)
0x00	
00	CCD window Y start (0)
00	
0x02	CCD window Y length (512)
0x00	
Software windows	
00	Window 1 header (0)
00	
00	Window 1 X start (0)
00	
0x04	Window 1 X length (1024)
0x00	
00	Window 2 header
01	
0x04	Window 2 X start (1024)
0x00	
0x04	Window 2 X length (1024)
0x00	
00	Window 3 header
02	
00	Window 3 X start (0)
00	
0x04	Window 3 X length (1024)
0x00	
00	Window 4 header
03	
0x04	Window 4 X start (1024)
0x00	
0x04	Window 4 X length (1024)
0x00	

Line List 1:

Parameter	Description
38	Length
3	CCD Read-out nodes (L & R)
4	Number of windows
0	Checksum
0x08	CCD Length (2048)
0x00	
0	CCD window X start (0)
0	
0x04	CCD window X length (1024)
0x00	
00	CCD window Y start (0)
00	
0x02	CCD window Y length (512)
0x00	
Software windows	
00	Window 1 header (0)
00	
00	Window 1 X start (0)
00	
0x00	Window 1 X length (32)
0x20	
00	Window 2 header
01	
0x04	Window 2 X start (1024)
0x00	
0x00	Window 2 X length (32)
0x20	
00	Window 3 header
02	
00	Window 3 X start (0)
00	
0x00	Window 3 X length (32)
0x20	
00	Window 4 header
03	
0x04	Window 4 X start (1024)
0x00	
0x00	Window 4 X length (32)
0x20	