MANUAL

C1XS FLIGHT OPERATIONS MANUAL

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1. INTRODUCTION

This document describes the commanding required by C1XS in the post-launch, commissioning and lunar operation phases. Copies of the telecommand files are contained in the appendix.

As the C1XS commanding is dependant on events the telecommand files have been created assuming a start date of 1 Jan 2008, duration of 1 day and a start time of 00:00:00. The following sections describe the commanding in detail and also state which event they are expected to be run from. In addition all the command files assume that:

a) C1XS is powered on 30 seconds before the command file is sent
b) The CAN bus is enabled by the BDH.
c) The spacecraft SSR is collecting C1XS data.

2. ABBRIEVIATIONS

BDH	Baseband Data Handling (unit)
CAN	Controller Area Network (data bus)
C1XS	Chandrayaan-1 X-ray Spectrometer
EEPROM	Electrically Erasable Programmable Read Only Memory
SSR	Solid State Recorder
TC	Telecommand
TLM	Telemetry
XSM	X-ray Solar Monitor

3. POST LAUNCH

3.1 Rationale

During launch there is a possibility that the XSM shutter may open. The shutter protects the detector from protons during the spacecraft transit from the Earth to the Moon and so it is essential that the C1XS instrument be powered on briefly to allow the XSM shutter to be closed.

3.2 Timing

As soon as practical after launch the C1XS instrument should be switched on and the command file sent to the instrument.

3.3 Command File

Filename:	c1xs_XSMshuter_v1.txt
Version:	1
Duration:	60 seconds
Depends:	Instrument power on and CAN communications for >30 seconds
Completed State:	Instrument in standby, power off after 30 seconds
Description:	The instrument housekeeping rate is increased to one packet every 4 seconds, the XSM instrument is powered on, the shutter close command sent and then the XSM power is switched off.

4. COMMISSIONING

4.1 Rationale

Before science operations can take place the C1XS door catch has to be released.

4.2 Timing

This command file should be run during the C1XS instrument commissioning phase.

4.3 Command File

Filename:	c1xs_openHOP_v1.txt
Version:	1
Duration:	12.5 minutes
Depends:	Instrument power on and CAN communications for >30 seconds. The instrument temperature should be <20 ˚C and the SCD radiator should be < -30˚C.
Completed State:	Instrument in standby, power off after 30 seconds
Description:	The instrument housekeeping rate is increased to one packet every 4 seconds, the door latch time-out is increased to 3 minutes and the latch drive circuit is enabled. The open latch command is sent and the script waits for 5 minutes to ensure that the latch has opened and cooled down. The door is then opened and closed to check that the latch has correctly withdrawn. To verify that the rest of the instrument is working correctly it is put into operating mode for 5 minutes to collect data from the calibration sources.

5. LUNAR OPERATIONS

5.1 Rationale

Under normal operations the C1XS instrument requires very little commanding, 5 command files in total; on, operating, standby, calibrate and off.

The instrument should be left powered on, in standby mode, while the spacecraft is flying over the dark side of the Moon.

Once per day the instrument door needs to be closed so that the calibration sources can be used to monitor the degradation of the X-ray detectors.

5.2 Timing

The C1XS instrument only collects data while flying over the sunlit side of the Moon. Therefore the operating and standby command need to occur just before / just after the terminator is crossed. To maximise the collection of scientific data the on, off and calibration files should be run whilst the spacecraft is over the dark side.

5.3 Command Files

5.3.1 On

Filename:	c1xs_on_v1.txt
Version:	1
Duration:	21.5 minutes
Depends:	Instrument power on and CAN communications for >30 seconds
Completed State:	Instrument in standby mode, C1XS door open.
Description:	After power on the instrument runs the software located in PROM, an update was made to the on-board software during final test and this is located in EEPROM. Therefore the first two commands cause the software to reboot and run the latest version held in EEPROM. Ten minutes of calibration data is taken by commanding operating mode, after this time standby mode is requested and the C1XS door is opened.

5.3.2 Operating

Filename:	c1xs_operating_v1.txt
Version:	1
Duration:	10 seconds
Event:	300 seconds before dark to sun-lit terminator crossing.
Depends:	Instrument in standby mode, C1XS door open
Completed State:	Instrument in operating mode
Description:	The instrument is commanded into operating mode.

5.3.3 Standby

Filename:	c1xs_standby_v1.txt
Version:	1
Duration:	10 seconds
Event:	Terminator crossing, sun-lit to dark
Depends:	Instrument in operating mode
Completed State:	Instrument in standby mode.
Description:	The instrument is commanded into standby mode.

5.3.4 Off

Filename:	c1xs_off_v1.txt.txt
Version:	1
Duration:	20.5 minutes
Depends:	Instrument in standby
Completed State:	Instrument in standby, C1XS door closed, power off after 30 seconds
Description:	The C1XS door is closed, operating mode is commanded to collect 10 minutes of calibration data, then the instrument is returned to standby mode ready for power off.

5.3.5 Calibration

Filename:	c1xs_calibrate_v1.txt
Version:	1
Duration:	11.5 minutes
Event:	Once per day, spacecraft over Moon's dark side.
Depends:	Instrument in standby, C1XS door open.
Completed State:	Instrument in standby, C1XS door open.
Description:	The script closes the C1XS door, commands operating mode and 10 minutes later goes back to standby mode. The door is then re-opened ready for the next science observation.

6. ABNORMAL OPERATIONS

In the case of any problems with the C1XS instrument or command files please contact:

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APPENDIX – COMMAND FILES

c1xs_calibrate_v1.txt

```
0000  ISRO  CH-1  CXS  01-Jan-2008  1  01-Jan-2008   01-Jan-2008  0000  0005

0001  01-Jan-2008  00:00:00  STANDBY                                  14  13EEC0000007070000000000C562
0002  01-Jan-2008  00:00:30  DCIXS_DOOR 3 400 20                      14  13EEC00100071103019000140BCE
0003  01-Jan-2008  00:01:00  OPERATING                                14  13EEC00200070600000000000046A5
0004  01-Jan-2008  00:11:00  STANDBY                                  14  13EEC00300070700000000000E826
0005  01-Jan-2008  00:11:30  DCIXS_DOOR 7 400 20                      14  13EEC00400071107019000014F504
```

c1xs_off_v1.txt

```
0000  ISRO  CH-1  CXS  01-Jan-2008  1  01-Jan-2008   01-Jan-2008  0000  0004

0001  01-Jan-2008  00:00:00  STANDBY                                  14  13EEC0000007070000000000C562
0002  01-Jan-2008  00:10:00  DCIXS_DOOR 3 400 20                      14  13EEC00100071103019000140BCE
0003  01-Jan-2008  00:10:30  OPERATING                                14  13EEC00200070600000000000046A5
0004  01-Jan-2008  00:20:30  STANDBY                                  14  13EEC00300070700000000000E826
```

c1xs_on_v1.txt

```
0000  ISRO  CH-1  CXS  01-Jan-2008  1  01-Jan-2008   01-Jan-2008  0000  0005

0001  01-Jan-2008  00:00:00  EMODE                                    14  13EEC00000070500000000004E22
0002  01-Jan-2008  00:00:30  BOOT 5 0X8000                            14  13EEC00100072B0580000000EEC5
0003  01-Jan-2008  00:01:30  OPERATING                                14  13EEC00200070600000000046A5
0004  01-Jan-2008  00:11:30  STANDBY                                  14  13EEC00300070700000000E826
0005  01-Jan-2008  00:21:30  DCIXS_DOOR 7 400 20                      14  13EEC00400071107019000014F504
```

c1xs_openHOP_v1.txt

```
0000  ISRO  CH-1  CXS  01-Jan-2008  1  01-Jan-2008  01-Jan-2008  0000  0008

0001  01-Jan-2008  00:00:00  HKRATE 1                                 16  13EEC00000090E06000000010001090F
0002  01-Jan-2008  00:00:10  RAM_TABLE 6 1 180                        16  13EEC00100090E060001000100B48C69
0003  01-Jan-2008  00:00:20  ENBL_LATCH 0XD6                          14  13EEC002000714D6000000002D06
0004  01-Jan-2008  00:00:30  OPEN_LATCH                               14  13EEC00300071300000000000F403
0005  01-Jan-2008  00:05:30  DCIXS_DOOR 7 400 20                      14  13EEC00400071107019000014F504
0006  01-Jan-2008  00:06:30  DCIXS_DOOR 3 400 20                      14  13EEC00500071103019000149721
0007  01-Jan-2008  00:07:30  OPERATING                                14  13EEC00600070600000000000DA4A
0008  01-Jan-2008  00:12:30  STANDBY                                  14  13EEC00700070700000000000074C9
```

c1xs_operating_v1.txt

```
0000  ISRO  CH-1  CXS  01-Jan-2008  1  01-Jan-2008   01-Jan-2008  0000  0001

0001  01-Jan-2008  00:00:00  OPERATING                                14  13EEC00000070600000000000080C2
```

c1xs_standby_v1.txt

```
0000  ISRO  CH-1  CXS  01-Jan-2008  1  01-Jan-2008   01-Jan-2008  0000  0001

0001  01-Jan-2008  00:00:00  STANDBY                                  14  13EEC000000707000000000C562
```

c1xs_XSMshuter_v1.txt

```
0000  ISRO  CH-1  CXS  01-Jan-2008  1  01-Jan-2008   01-Jan-2008  0000  0004

0001  01-Jan-2008  00:00:00  HKRATE 1                                 16  13EEC00000090E06000000010001090F
0002  01-Jan-2008  00:00:10  XSM_12V 1                                14  13EEC00100071B01000000009577
0003  01-Jan-2008  00:00:20  XSM_SHUTR 0                              14  13EEC00200071200000000005A80
0004  01-Jan-2008  00:00:50  XSM_12V 0                                14  13EEC00300071B0000000000F941
```