Interface Control Document

CIXS/XSM DATA HANDLING ICD

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RAL Server	x	x	x	x				
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C. Erd		x	x					

CHANGE RECORD

Date	Iss/Rev	Section	Comments
01/03/2006	1	All	Created from S1-CIX-ICD-3002 issue 13.
29/09/2006	2	1	removed reference to EID-B
		2.1.1	Packet ID confirmed.
		2.1.4	Updated command list
		2.2.3	Added s/w parameters
		2.3	Updated figure
		3.1.1	APID = 1006
		3.2.1	Added Data types 10, 11 and 12, deleted types 3 and 7.
		3.3.4	Deleted data type
		3.3.5	XSM integration time now adjustable using a software parameter.
		3.3.7.2	Corrected number of bytes
		3.3.8	Deleted data type
		3.3.11, 3.3.12, 3.3.13	Sections added for new data types
		4	Table 4.2 updated RESTING mode added
		4.2	Data volumes added to the table
		5	Data rate added
		6	Mass memory figure added

27/03/2008	3	3.3.9, 3.3.10	Revised Aux and Means packet formats for C1XS. (COBS 3.7)
		2.1.4.7	Added EMERGENCY_OFF telecommand
		2.2	Updated parameter tables
		3.3	Corrected HK packet details
22/06/2009	4	1	MSB defined
		2.1, 2.1.2	Maximum number of bytes now 48
		2.1.4.1	Patch and dump command updated
		2.1.4.4	XSM on command added
		2.1.4.5	Max event rate command deleted
		2.1.4.7	EEP_Prot command description improved. BB_Cal command deleted Boot command details and description added
		2.2.1	Note added, parameter values updated.
		2.2.2	Note added.
		2.2.3	Parameter values updated
		2.2.5	Parameter values updated
		2.2.6	Parameter values updated
		3.3.1	Telemetry parameter descriptions updated
		3.3.2	Note added
		3.3.3	Corrected number of ADC channles used in each bin.
		3.3.10	Added notes and table detailing conversion values from type 9 zero data to all other data formats
		3.3.11	Changed title to single pixel data
		3.3.13	Changed text to indicate that HRLCS mode uses sthe FPGA in single pixel mode.

CONTENTS

1. INTRODUCTION

The C1XS/XSM command and telemetry data are described.
The data structures for the telemetry and on-board CAN BUS are defined. The different packet sizes and transmission periods which can arise for the different experiment modes/states are listed and cross-referenced with the mission phase.

NOTE: Throughout this document the MSB (most significant bit) is defined as bit 0.

2. COMMANDS

2.1 Command Definitions

A C1XS command packet has the following structure:

Packet Header [Sect 2.1.1]	Command Data Field [sect 2.1.2]					
	Command Type	Qualifier	Register address / Function	Data	Further data as required Max 48 bytes	Packet Error Control CRC [sect 2.1.3]
0…….5	6	7	8...9	10…….11	12….	2 bytes

2.1.1 Packet Header

Length: 6 bytes

Format:

Packet ID				Packet sequence control		Packet length
Version number 3bits	Type 1 bit	Data Field header Flag 1 bit	Application Process 11bits	Segmentation Flags 2 bits	Source Sequence Count 14bits	16bits
000	1	0	011 1110 1110	11	Variable	Variable

The packet ID is 0x13EE.

2.1.2 Packet Command Data Field

Length: 6 bytes, or longer for patches and table loads.

See section 2.1.4

Command Byte Number	Size in bytes	Function
6	1	Command type
7	1	Qualifier
8-9	2	Register address / Function
10-11	2	Data
12…	N = Maximum 48	further data if required

2.1.3 Packet Error Control

Byte Number	Size in bytes	Function
12+N,12+N+1	2	A CRC code will be used for error control.

2.1.3.1 CRC 'C' Routine

```
      /*
crc.c - routine to perform CRC check on a block of data. The CRC is the one
        commonly used in space systems and processed the most significant
        bit first

Calling sequence: crc(buf,len,ocrc)  where:

  buf    is the name of the array holding the data to check
  len    is the length of the data in 16 bit words
  oldcrc is the running total if multiple calls are used
*/
crc(buf,len,oldcrc)
  int buf[],len,oldcrc;
  {
  unsigned i,ax,bx,cx,dx;

  bx=oldcrc;
  for(i=0;i<len;i++)               /* do for each word in buffer */
    {
    dx=buf[i];                     /* fetch word from buffer */
    cx=16;                         /* count of bits */
    do{
      ax=bx^dx;
      dx<<= 1;
      bx<<= 1;
      if(ax>0x7fff)bx^= 4129;
      }while(--cx>0);
    }
    return(bx);
  }
```

2.1.4 Command Formats

2.1.4.1 System Diagnostics and repair

Name/ Database ID	**Command Type (decimal)**	**Qualifier**	**Address /Function**	**Data**	**Further Data**	**Instrument Mode Validity**	**Description/ Verification**
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
DUMMY X001C	1	Fixed 00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Dummy command which only causes increment of command counter VERIFICATION: HK Packet TC Accepted - Byte 16 incremented
PATCH X100C 8bytes X101C 16bytes X102C 32bytes X103C 38bytes	2	Page Number 0 – 15, 16 & 17	Patch Address	Actual Patch Length	Patch Data	Emergency Mode STANDBY OPERATING	Patch of processor RAM or EEPROM pages 0 to 15. A value of 16 or 17 is used to patch the waveform generator memory in either FPGA 1 or 2. Use fixed length command X100C…..X105C of appropriate size and fill with zeroes as required. The on-board software 'actual patch length' only to determine how much data is to be loaded. VERIFICATION: DUMP from same location

Name/ Database ID	**Command Type (decimal)**	**Qualifier**	**Address /Function**	**Data**	**Further Data**	**Instrument Mode Validity**	**Description/ Verification**
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
DUMP X003C	3	Page Number 0 – 15, 16, 17, 32 – 41, 64 - 73	Dump Address	Dump Length	Not used	Emergency Mode STANDBY OPERATING	Dump of 0-15: page of RTX RAM, PROM or EEPROM 16, 17 : WG memory 32-41: Dump RAM table 64-73: Dump EEPROM table VERIFICATION: Not applicable
GOTO X004C	4	Page Number 0 – 15	Goto Address	Fixed 0000h	Not used	Emergency Mode	Run on-board software from specified address VERIFICATION: Not applicable

2.1.4.2 Operating Mode selection

Name/ Database ID	**Command Type (decimal)**	**Qualifier**	**Address/ Function**	**Data**	**Further Data**	**Instrument Mode Validity**	**Description/ Verification**
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
EMODE X005C	5	Fixed 00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Force transition to emergency mode VERIFICATION: Not applicable
OPERATING X006C	6	Fixed 00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY	Go to Operating Mode VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11 Mode - Byte 25 bit 0-3 =
STANDBY X007C	7	Fixed 00h	Fixed 0000h	Fixed 0000h	Not used	OPERATING	Go to Standby Mode VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11 Mode - Byte 25 bit 0-3 =
DELETED X008C							

2.1.4.3 C1XS Science Data Processing Mode

Name/ Database ID	Command Type (decimal)	Qualifier	Address/ Function	Data	Further Data	Instrument Mode Validity	Description
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
SCI_SUBMODE X009C	9	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Select C1XS Science Submode with Fixed Time-Tagged Events VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11 Mode - Byte 25 bits 4-7 = 0000
	9	01h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Select C1XS Science Submode with Low Count Spectra VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11 Mode - Byte 25 bits 4-7 = 0001
	9	02h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Submode not used
	9	03h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Select C1XS Science Submode with Autoformat VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11 Mode - Byte 25 bits 4-7 = 00011

Name/ Database ID	Command Type (decimal)	Qualifier	Address/ Function	Data	Further Data	Instrument Mode Validity	Description
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
	9	04h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Select C1XS Science Submode with Compressed low count spectra VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11 Mode - Byte 25 bits 4-7 = 0100
	9	05h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Select C1XS Science Submode with Time tagged, 3 pixel event data VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11 Mode - Byte 25 bits 4-7 = 0101
	9	06h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Select C1XS Science Submode with Time tagged summed pixel data VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11 Mode - Byte 25 bits 4-7 = 0110

Name/ Database ID	Command Type (decimal)	Qualifier	Address/ Function	Data	Further Data	Instrument Mode Validity	Description
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
	9	07h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Select C1XS Science Submode with High resolution low count spectra VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11 Mode - Byte 25 bits 4-7 = 0111
	9	08h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Select C1XS Science Submode with Autoformat-2 VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11 Mode - Byte 25 bits 4-7 = 1000

2.1.4.4 Instrument On/Off Commands

These commands enable the XSM and C1XS instruments to be operated independently

Name/ Database ID	**Command Type (decimal)**	**Qualifier**	**Address/ Function**	**Data**	**Further Data**	**Instrument Mode Validity**	**Description**
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
C1XS_ON X010C	10	00h	Fixed 0000h	Fixed 0000h	Not used	OPERATING	Turns on C1XS instrument SCD FPGA power and Science TM VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 – 61 = TC bytes 6 -11
C1XS_OFF X011C	11	00h	Fixed 0000h	Fixed 0000h	Not used	OPERATING	Turns off C1XS instrument SCD FPGA power and Science TM VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 – 61 = TC bytes 6 -11
XSM_ON X012C	12	00h	Fixed 0000h	Fixed 0000h	Not used	OPERATING	Turns on XSM instrument 12V, 5V and TM VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 - 61 = TC bytes 6 -11

Name/ Database ID	Command Type (decimal)	Qualifier	Address/ Function	Data	Further Data	Instrument Mode Validity	Description
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
XSM_OFF X013C	13	00h	Fixed 0000h	Fixed 0000h	Not used	OPERATING	Turns off XSM instrument 12V, 5V and TM VERIFICATION: HK Packet TC Accepted - Byte 16 incremented HK Bytes 56 – 61 = TC bytes 6 -11

2.1.4.5 Processor Commands

Name/ Database ID	**Command Type (decimal)**	**Qualifier**	**Address/ Function**	**Data**	**Further Data**	**Instrument Mode Validity**	**Description**
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
RAM_TABLE X110C 8bytes X111C 16bytes X112C 32bytes X113C 38bytes	14	Table ID 00h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 00h Load WGA Length Table Fill with zeroes to fixed length as required
	14	Table ID 01h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 01h Load WGA Vector Table Fill with zeroes to fixed length as required
	14	Table ID 02h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 02h Load WGA tables Table Fill with zeroes to fixed length as required
	14	Table ID 03h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 03h Load WGA Registers Table Fill with zeroes to fixed length as required
	14	Table ID 04h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 04h Load BB registers Table Fill with zeroes to fixed length as required
	14	Table ID 05h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 05h Load FPGA Table Fill with zeroes to fixed length as required
	14	Table ID 06h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 06h Load Software Parameter Table Fill with zeroes to fixed length as required
DELETED X014C							

Name/ Database ID	**Command Type (decimal)**	**Qualifier**	**Address/ Function**	**Data**	**Further Data**	**Instrument Mode Validity**	**Description**
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
EEP_TABLE X110C 8bytes X111C 16bytes X112C 32bytes X113C 38bytes	15	Table ID 00h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 00h Load WGA Length Table Fill with zeroes to fixed length as required
	15	Table ID 01h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 01h Load WGA Vector Table Fill with zeroes to fixed length as required
	15	Table ID 02h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 02h Load WGA tables Table Fill with zeroes to fixed length as required
	15	Table ID 03h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 03h Load WGA Registers Table Fill with zeroes to fixed length as required
	15	Table ID 04h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 04h Load BB registers Table [Section 2.2.1] Fill with zeroes to fixed length as required
	15	Table ID 05h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 05h Load FPGA Table [Section 2.2.2] Fill with zeroes to fixed length as required
	15	Table ID 06h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 06h Load Software Parameter Table [Section 2.2.3] Fill with zeroes to fixed length as required
	15	Table ID 07h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 07h Load Analogue HK limits Table [Section 2.2.4] Fill with zeroes to fixed length as required

Name/ Database ID	Command Type (decimal)	Qualifier	Address/ Function	Data	Further Data	Instrument Mode Validity	Description
	15	Table ID 08h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 08h Load Offset/ADC Transfer Function Table [Section 2.2.5] Fill with zeroes to fixed length as required
	15	Table ID 09h	Address Offset	Actual No. of words	Table data	STANDBY OPERATING	Qualifier = Table ID = 09h Load Offset Nulling Reference Table [Section 2.2.6] Fill with zeroes to fixed length as required

Name/ Database ID	Command Type (decimal)	Qualifier	Address/ Function	Data	Further Data	Instrument Mode Validity	Description
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
CPY_TABLE X016C	16	Table ID	Fixed 0000h	Fixed 0000h	Not used	STANDBY	Copy a parameter table from EEPROM to RAM Qualifier Byte 7 identifies Table
	16	FFh	Fixed 0000h	Fixed 0000h	Not used	STANDBY	Table ID = FFh Copies ALL tables

2.1.4.6 Radiation Shield Actuator Commands

Name/ Database ID	Command Type (decimal)	Qualifier	Address/ Function	Data	Further Data	Instrument Mode Validity	Description
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
C1XS_DOOR X017	17	00h	Maximum Steps	Step Size	Not used	STANDBY OPERATING	Full Steps – Ignore tellback – Close
	17	20h	Maximum Steps	Step Size	Not used	STANDBY OPERATING	Full Steps – Ignore tellback – Open
	17	40h	Maximum Steps	Step Size	Not used	STANDBY OPERATING	Full Steps – Observe tellback – Close
	17	60h	Maximum Steps	Step Size	Not used	STANDBY OPERATING	Full Steps – Observe tellback – Open
	17	80h	Maximum Steps	Step Size	Not used	STANDBY OPERATING	Half Steps – Ignore tellback – Close
	17	A0h	Maximum Steps	Step Size	Not used	STANDBY OPERATING	Half Steps – Ignore tellback – Open

Name/ Database ID	Command Type (decimal)	Qualifier	Address/ Function	Data	Further Data	Instrument Mode Validity	Description
	17	C0h	Maximum Steps	Step Size	Not used	STANDBY OPERATING	Half Steps – Observe tellback – Close
	17	E0h	Maximum Steps	Step Size	Not used	STANDBY OPERATING	Half Steps – Observe tellback – Open
XSM_SHUTR X018C	18	Fixed 00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Close XSM Shutter
	18	Fixed 01h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Open XSM Shutter
OPEN_LATCH X019C	19	Fixed 00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY	Open C1XS Radiation Pin-Puller Latch
ENBL_LATCH X020C	20	Fixed D6h	Fixed 0000h	Fixed 0000h	Not used	STANDBY	Enable C1XS Radiation Pin-Puller Latch Circuit
	20	Fixed 00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY	Disable C1XS Radiation Pin-Puller Latch Circuit

2.1.4.7 Direct Commands

**********THESE COMMANDS ARE FOR EMERGENCY DIAGNOSTIC USE ONLY*********

Name	**Command Type (decimal)**	**Qualifier**	**Address/ Function**	**Data**	**Further Data**	**Instrument Mode Validity**	**Description**
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
XSM_DATA X021C	21	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	STOP acquisition of XSM data
	21	01h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	START acquisition of XSM data
SET_PELTIER X022C	22	00h	Fixed 0000h	data	Not used	STANDBY OPERATING	Set target temperature for Peltier cooler
ENBL_BIAS X023C	23	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Disable the XSM HV bias
	23	01h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Enable the XSM HV bias
PELTIER_PWR X024C	24	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Switch Peltier cooler OFF
	24	01h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Switch Peltier cooler ON
BIAS_OVERRIDE X025C	25	00h	Fixed 0000h	data	Not used	STANDBY OPERATING	Load pattern in XSM bias override register
XSM_THRES X026C	26	00h	Fixed 0000h	data	Not used	STANDBY OPERATING	Set threshold for XSM photon events
XSM_12V X027C	27	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	XSM 12V power OFF

Name	Command Type (decimal)	Qualifier	Address/ Function	Data	Further Data	Instrument Mode Validity	Description
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
	27	01h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	XSM 12V power ON
SCD_BANK1 X028C	28	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	C1XS SCD Bank 1 OFF
	28	01h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	C1XS SCD Bank 1 ON
SCD_BANK2 X029C	29	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	C1XS SCD Bank 2 OFF
	29	01h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	C1XS SCD Bank 2 ON
WGA_COMMAND X030C	30	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	STOP SCD Readout Waveform Generator
	30	01h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	START SCD Readout Waveform Generator
LOAD_FPGA X031C	31	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Load SCD FPGA device from table
LOAD_3D+ X032C	32	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Load SCD 3D+ device from table
LOAD_WGA X033C	33	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING	Load SCD WGA device from table and start it running
CKSUM X034C	34	Page 00-0Fh	Address	Length in words	Not used	STANDBY	Calculate checksum over memory area given
EEP_PROT X035C	35	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY	Disable EEPROM writing

Name	Command Type (decimal)	Qualifier	Address/ Function	Data	Further Data	Instrument Mode Validity	Description
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
	35	01h	Fixed 0000h	Fixed 0000h	Not used	STANDBY	Enable EEPROM writing. Note that the EEPROM must be enabled for reading too.
	35	02h	Fixed 0000h	Fixed 0000h	Not used	STANDBY	Disable EEPROM completely
	35	03h	Fixed 0000h	Fixed 0000h	Not used	STANDBY	Enable EEPROM for reading.
DELETED X036C	36						
XSM_ANL_ON X037C	37	00h	Fixed 0000h	Fixed 0000h	Not used	OPERATING	XSM Annealing ON
XSM_ANL_OFF X038C	38	00h	Fixed 0000h	Fixed 0000h	Not used	OPERATING	XSM Annealing OFF
DELETED X039C							
DELETED X040C							
DELETED X041C							
XSM_CALIB X042C	42	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY	XSM Calibration

Name	**Command Type (decimal)**	**Qualifier**	**Address/ Function**	**Data**	**Further Data**	**Instrument Mode Validity**	**Description**
	Byte 6	**Byte 7**	**Bytes 8-9**	**Bytes 10-11**	**Bytes 12 …**		
BOOT X043C	43	Page Number 0 – 15	Address	Fixed 0000h	Not used	Emergency Mode	Run on-board software from specified address having first checked the checksum over the image. If the checksum is correct then run the software otherwise increment the page number and try a checksum over that page's software. If the checksum on the second page fails remain in Emergency Mode. VERIFICATION: Not applicable
EMERGENCY _OFF X044C	44	00h	Fixed 0000h	Fixed 0000h	Not used	STANDBY OPERATING RESTING	Emergency shut down command

2.2 Parameter Tables

2.2.1 Table 4 Burr-Brown ADC Parameters

Note the actual values being used by the software are given in the Type 8 telemetry packet.

```
0x0,        /* 00 Bank1 chan A-C configuration */
  0x2d0,    /* 01 Bank1 chan A Det  0 offset */
  0x2d0,    /* 02 Bank1 chan B Det  4 offset */
  0x2a1,    /* 03 Bank1 chan C Det  8 offset */
  0x00,     /* 04 Bank1 chan A Det  0 Det  0 gain */
  0x00,     /* 05 Bank1 chan B Det  4 Det  0 gain */
  0x00,     /* 06 Bank1 chan C Det  8 Det  0 gain */
  0x0,      /* 07 Bank1 chan D-F configuration */
  0x2d0,    /* 08 Bank1 chan D Det  1 offset */
  0x2d0,    /* 09 Bank1 chan E Det  5 offset */
  0x2a1,    /* 0A Bank1 chan F Det  9 offset */
  0x00,     /* 0B Bank1 chan D Det  1 Det  0 gain */
  0x00,     /* 0C Bank1 chan E Det  5 Det  0 gain */
  0x00,     /* 0D Bank1 chan F Det  9 Det  0 gain */
  0x0,      /* 0E Bank1 chan G-I configuration */
  0x2e0,    /* 0F Bank1 chan G Det  2 offset */
  0x2e0,    /* 10 Bank1 chan H Det  6 offset */
  0x2d0,    /* 11 Bank1 chan I Det 10 offset */
  0x00,     /* 12 Bank1 chan G Det  2 gain */
  0x00,     /* 13 Bank1 chan H Det  6 gain */
  0x00,     /* 14 Bank1 chan I Det 10 gain */
  0x0,      /* 15 Bank1 chan J-L configuration */
  0x2d0,    /* 16 Bank1 chan J Det  3 offset */
  0x2d0,    /* 17 Bank1 chan K Det  7 offset */
  0x2b7,    /* 18 Bank1 chan L Det 11 offset */
  0x00,     /* 19 Bank1 chan J Det  3 gain */
  0x00,     /* 1A Bank1 chan K Det  7 gain */
  0x00,     /* 1B Bank1 chan L Det 11 gain */
  0x0,      /* 1C Bank2 chan A-C configuration */
  0x2c0,    /* 1D Bank2 chan A Det 12 offset */
  0x2c0,    /* 1E Bank2 chan B Det 16 offset */
  0x2c0,    /* 1F Bank2 chan C Det 20 offset */
  0x00,     /* 20 Bank2 chan A Det 12 gain */
  0x00,     /* 21 Bank2 chan B Det 16 gain */
  0x00,     /* 22 Bank2 chan C Det 20 gain */
  0x0,      /* 23 Bank2 chan D-F configuration */
  0x2c0,    /* 24 Bank2 chan D Det 13 offset */
  0x2a7,    /* 25 Bank2 chan E Det 17 offset */
  0x2c0,    /* 26 Bank2 chan F Det 21 offset */
  0x00,     /* 27 Bank2 chan D Det 13 gain */
  0x00,     /* 28 Bank2 chan E Det 17 gain */
  0x00,     /* 29 Bank2 chan F Det 21 gain */
  0x0,      /* 2A Bank2 chan G-I configuration */
```

```
0x291,      /* 2B Bank2 chan G Det 14 offset */
0x291,      /* 2C Bank2 chan H Det 18 offset */
0x291,      /* 2D Bank2 chan I Det 22 offset */
0x00,       /* 2E Bank2 chan G Det 14 gain */
0x00,       /* 2F Bank2 chan H Det 18 gain */
0x00,       /* 30 Bank2 chan I Det 22 gain */
0x0,        /* 31 Bank2 chan J-L configuration */
0x2c0,      /* 32 Bank2 chan J Det 15 offset */
0x2c0,      /* 33 Bank2 chan K Det 19 offset */
0x2c0,      /* 34 Bank2 chan L Det 23 offset */
0x00,       /* 35 Bank2 chan J Det 15 gain */
0x00,       /* 36 Bank2 chan K Det 19 gain */
0x00        /* 37 Bank2 chan L Det 23 gain */
```

2.2.2 Table 5 Detector FPGA Parameters

The figures given below are the default values on transition to operating mode, the software then recalculates these limits based upon the position of the 'zero energy' peak. The thresholds being used by the software are given in the Type 9 telemetry packet and the other information in the type 8 packet.

```
900,        /* 00 00 Bank1 channel A high threshold */
900,        /* 01 01 Bank1 channel B high threshold */
900,        /* 02 02 Bank1 channel C high threshold */
900,        /* 03 03 Bank1 channel D high threshold */
900,        /* 04 04 Bank1 channel E high threshold */
900,        /* 05 05 Bank1 channel F high threshold */
900,        /* 06 06 Bank1 channel G high threshold */
900,        /* 07 07 Bank1 channel H high threshold */
900,        /* 08 08 Bank1 channel I high threshold */
900,        /* 09 09 Bank1 channel J high threshold */
900,        /* 10 0A Bank1 channel K high threshold */
900,        /* 11 0B Bank1 channel L high threshold */
800,        /* 12 0C Bank1 channel A low threshold */
800,        /* 13 0D Bank1 channel B low threshold */
800,        /* 14 0E Bank1 channel C low threshold */
800,        /* 15 0F Bank1 channel D low threshold */
800,        /* 16 10 Bank1 channel E low threshold */
800,        /* 17 11 Bank1 channel F low threshold */
800,        /* 18 12 Bank1 channel G low threshold */
800,        /* 19 13 Bank1 channel H low threshold */
800,        /* 20 14 Bank1 channel I low threshold */
800,        /* 21 15 Bank1 channel J low threshold */
800,        /* 22 16 Bank1 channel K low threshold */
800,        /* 23 17 Bank1 channel L low threshold */
0x3f00,     /* 24 18 Bank1 event reject level */
0x0007,     /* 25 19 Bank1 discriminator mode - use 1st 3 samples */
-1,         /* 26 1A Bank1 Data for Burr-Brown register write */
0x0067,     /* 27 1B Bank1 OD DAC  72->67                  *v2.1*/
0x008A,     /* 28 1C Bank1 RD DAC  62->8A                  *v2.1*/
0x07,       /* 29 1D Bank1 power control (all on)  0xF->7      *v1.9*/
900,        /* 30 1E Bank2 channel A high threshold */
900,        /* 31 1F Bank2 channel B high threshold */
900,        /* 32 20 Bank2 channel C high threshold */
900,        /* 33 21 Bank2 channel D high threshold */
900,        /* 34 22 Bank2 channel E high threshold */
900,        /* 35 23 Bank2 channel F high threshold */
900,        /* 36 24 Bank2 channel G high threshold */
900,        /* 37 25 Bank2 channel H high threshold */
900,        /* 38 26 Bank2 channel I high threshold */
```

```
900,        /* 39 27 Bank2 channel J high threshold */
900,        /* 40 28 Bank2 channel K high threshold */
900,        /* 41 29 Bank2 channel L high threshold */
800,        /* 42 2A Bank2 channel A low threshold */
800,        /* 43 2B Bank2 channel B low threshold */
800,        /* 44 2C Bank2 channel C low threshold */
800,        /* 45 2D Bank2 channel D low threshold */
800,        /* 46 2E Bank2 channel E low threshold */
800,        /* 47 2F Bank2 channel F low threshold */
800,        /* 48 30 Bank2 channel G low threshold */
800,        /* 49 31 Bank2 channel H low threshold */
800,        /* 50 32 Bank2 channel I low threshold */
800,        /* 51 33 Bank2 channel J low threshold */
800,        /* 52 34 Bank2 channel K low threshold */
800,        /* 53 35 Bank2 channel L low threshold */
0x3f00,     /* 54 36 Bank2 event reject level */
0x0007,     /* 55 37 Bank2 discriminator mode use last 3 smpls */
-1,         /* 56 38 Bank2 data for Burr-Brown register write */
0x00c5,     /* 57 39 Bank2 Output gate 9d->c5              *v2.1*/
0x0076,     /* 58 3A Bank2 Substrate d0-> 76              *v2.1*/
0x07        /* 59 3B Bank2 power control (all on)  0xF->7      *v1.9*/
```

2.2.3 Table 6 Software Parameters

```
3,          /* 00 HK packet gen interval 3-> every 64s */
4,          /* 01 activation period for latch heater in seconds */
0x6940,     /* 02 Software options flags:  6900->6940 (ISRO time)  *v3.4*/
                /*    bit 15  1-> enable test CAN pkts 0 -> disable */
                /*    bit 14  1-> CRC in TM, 0-> no CRC in TM */
                /*    bit 13  1-> use XSM in sci mode 0-> no XSM */
                /*    bit 12  1-> keep XSM shtr closed until open TC 230902 */
            /*    bit 11  1-> do XSM cal 0-> no XSM calibration */
                /*    bit 10  1-> switch off XSM after anneal 0-> restart */
                /*    bit 09  1-> enable BB_CAL at start up */
            /*    bit 08  1-> enable servo for SS/OG/RD/OD DACs */
            /*    bit 07  1-> use alternate WGA table */
            /*    bit 06  1-> expect ISRO-format time distribution  *v2.0*/
8,          /* 03 integration time/s for C1XS spectra */
180,        /* 04 max event count for time tagged format */
150,        /* 05 min event count to stay in lunar spectrum fmt */
0,          /* 06 SCD1 detectors to omit from spectra Det0 in bit 0 */
0,          /* 07 SCD2 detectors to omit from spectra Det 12 in bit 0 */
1024,       /* 08 Total event count threshold for disabling detectors */
17000,      /* 09 limit for change in rad_mon5 (v.high) 17000 impos.*v3.4*/
17000,      /* 10 limit for change in rad_mod4 (high) 1700 impos.   *v3.4*/
```

```
0x400,      /* 11 number of (half) steps for autonomous door movement */
0x1403,     /* 12 stepsize,flags for autonomous door movements */
0x1400,     /* 13 target stepsize, decrement, for auton. door mv */
32,         /* 14 Delay from offset cal to detector check */
0x0,        /* 15 Patch ID - included when patches added in EEPROM */
0x07,       /* 16 pixel select bits for non-summing processing 1->7 *v2.1*/
0x12,       /* 17 pixel select bits for summed processing 17->12    *v3.1*/
0xffff,     /* 18 Min. number of minutes to keep door shut */
256,        /* 19 Interval, in seconds at which to adjust thresholds */
5298,       /* 20 SS monitor target ADC reading (1.6V) */
4960,       /* 21 OG monitor target ADC reading () */
7140,       /* 22 RD monitor target ADC reading () */
4814,       /* 23 OD monitor target ADC reading () */
20,         /* 24 SS monitor tolerance (6.1mV) */
8,          /* 25 OG monitor tolerance (2.44mV) */
32,         /* 26 RD monitor tolerance (9.8mV) */
80,         /* 27 OD monitor tolerance (24.4mV */
800,        /* 28 Uppr lmt at which switch from Summed TT to HR Spect */
740,        /* 29 Lowr lmt at which switch from HR Spect to Summed TT */
320,        /* 30 Uppr lmt at which switch from NS TT to Summed TT */
280,        /* 31 Lowr lmt at which switch from Summed TT to NS TT */
120,        /* 32 XSM default Peltier Target Tempr DAC o/p (-15C)   *v3.5*/
24,         /* 33 XSM default Discriminator Threshold (.5V) */
35,         /* 34 XSM max. det tempr to keep HV bias on (0 deg C) */
4,          /* 35 XSM total count thres. for spectrum transmission */
9,          /* 36 XSM delta lkge crrnt thres. to anneal (7.2pA)    */
16,         /* 37 XSM max expctd lkge currnt at end calib (12.8pA) */
60,         /* 38 XSM leakage current settling time in seconds     */
2,          /* 39 XSM number shutter pulses for autonomous activation */
41,         /* 40 XSM max safe PIN tempr for bias switch-on (-2C)  */
400,        /* 41 XSM calibration integration time in seconds      */
3,          /* 42 XSM number of times to try shuttr open/close2->3 *v3.0*/
7,          /* 43 XSM Delta Lkge crrnt in no annealing case (5.4pA) */
2,          /* 44 XSM margin for excess lkge crrnt in calib (1.6pA) */
18000,      /* 45 XSM annealing period in seconds 16->18000         */
128,        /* 46 XSM leakge currnt settling time(s) for annealing  */
0,          /* 47 XSM spare */
1,          /* 48 increment for shut-door integrator */
3,          /* 49 decrement for shut-door integrator */
3,          /* 50 limit for shut-door integrator */
6048,       /* 51 Start-rest temperature (-5C) */
6290,       /* 52 end-rest temperature (-8C) */
16,         /* 53 integration period for XSM spectra */
17000,      /* 54 limit for change in rad_mon3(medium) 17000 impos.*v3.4*/
0x0a72,     /* 55 variable HK entry */
0x0,        /* 56 ITL ID (set by ground command) */
0x0,        /* 57 Boot page (for EEPROM boots, patched with page */
```

```
120,          /* 58 POT reading below which door considered closed   *v3.5*/
4000,         /* 59 POT reading above which door considered open     *v3.5*/
5,            /* Value to write to SCD reg 29 after 3D+ power up */
```

2.2.4 Table 7 Analogue HK limits

Parameter	Lower	Upper	Action
00 XSM prm 0: PSU_TEMP	-32767	32767	None
02 XSM prm 1: +12 volt monitor	-32767	32767	None
04 XSM prm 2: -12 volt monitor	-32767	32767	None
06 XSM prm 3: PIN detector temperature	-32767	32767	None
08 XSM prm 4: Detector box temperature	-32767	32767	None
0A XSM prm 5: HV bias voltage	-32767	32767	None
0C XSM prm 6: Leakage current	-32767	32767	None
0E XSM prm 7: not used	-32767	32767	None
10 prm 0: PSU_TEMP – glued to ART2812	-32767	32767	None
12 prm 1: CAN_TEMP – on CAN card	-32767	32767	None
14 prm 2: -Yplate_TEMP – backplane face	2862	32767	Go to STANDBY Mode
16 prm 3: VIDEO_TEMP – digital video tempr	-32767	32767	None
18 prm 4: VIDEO1_TEMP – 3D+ bank 1 tempr	1165	32767	Go to STANDBY Mode
1A prm 5: VIDEO2_TEMP – 3D+ bank 2 tempr	1165	32767	Go to STANDBY Mode
1C prm 6: SCD1_TEMP – SCD column B tempr	2862	32767	Go to STANDBY Mode
1E prm 7: SCD2_TEMP – SCD column E tempr	2862	32767	Go to STANDBY Mode
20 prm 8: 12V – 12 volt rail voltage	-32767	32767	None
22 prm 9: 5V - 5 volt rail voltage	-32767	32767	None
24 prm 10: 3.3V – 3.3 volt rail voltage	-32767	32767	None
26 prm 11: PELTIER_V – Peltier supply volts	-32767	32767	None
28 prm 12: -12V - -12 volt rail voltage	-32767	32767	None
2A prm 13: -5V - -5 volt rail voltage	-32767	32767	None
2C prm 14: MTR_P1 – motor phase 1 voltage	-32767	32767	None
2E prm 15: MTR_P2 – motor phase 2 voltage	-32767	32767	None
30 prm 16: SS_VMON – SCD substrate voltage	-32767	32767	None
32 prm 17: OG_VMON – SCD o/p gate voltage	-32767	32767	None
34 prm 18: RSTD_VMON – SCD reset drain volts	-32767	32767	None
36 prm 19: OPD_VMON – SCD o/p drain voltage	-32767	32767	None
38 prm 20: 32V_MON – 32 V supply voltage	-32767	32767	None
3A prm 21: 0V – spare input connected to 0V	-32767	32767	None
3C prm 22: DOOR_POSN - analogue door posn	-32767	32767	None
3E prm 23: RAD_MON_1 very low gain	-32767	32767	None
40 prm 24: RAD_MON_2 low gain	-32767	32767	
42 prm 25: RAD_MON_3 med. gain	-32767	32767	
44 prm 26: RAD_MON_4 high gain	-32767	32767	
46 prm 27: RAD_MON_+12V RAD mon 12V mon	3000	32767	Reset current trip
48 prm 28: RAD_MON 5 very high gain	-32767	32767	

2.2.5 Table 8 noise rejection threshold addition factors

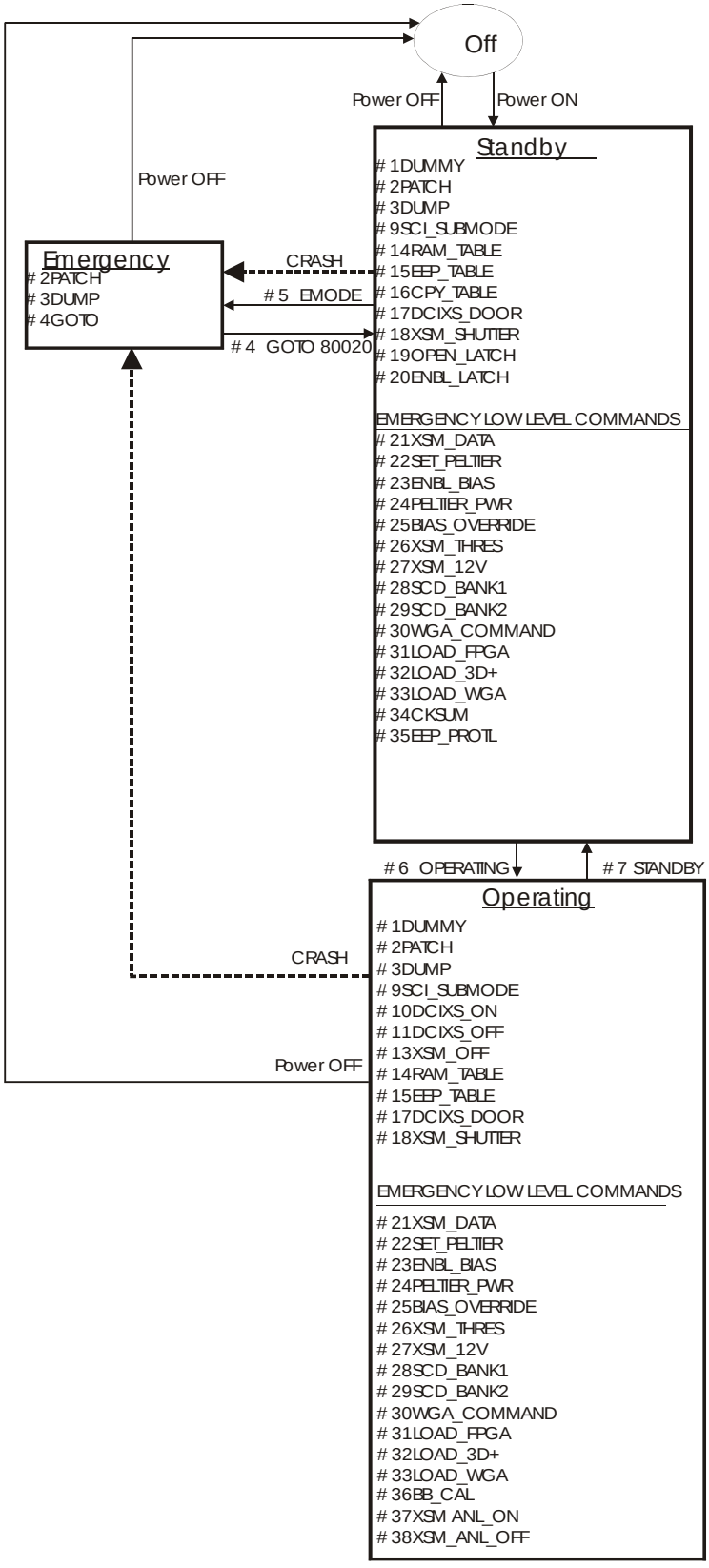
det 00	176
det 01	200
det 02	180
det 03	200
det 04	176
det 05	200
det 06	200
det 07	200
det 08	200
det 09	200
det 10	200
det 11	200
det 12	169
det 13	200
det 14	200
det 15	180
det 16	180
det 17	200
det 18	200
det 19	200
det 20	124
det 21	200
det 22	132
det 23	152

2.2.6 Table 9 event threshold addition factors

det 00	264
det 01	300
det 02	270
det 03	300
det 04	264
det 05	300
det 06	300
det 07	300
det 08	300
det 09	300
det 10	300
det 11	300
det 12	253
det 13	300
det 14	300
det 15	270
det 16	270
det 17	300
det 18	300
det 19	300
det 20	186
det 21	300
det 22	198
det 23	227

2.3 Command Mode Validity

The instrument modes are shown below with each box containing the valid commands and the linking arrows the mode transition commands. The commands are identified by Type no and Name.



2.4 Time-tagged Command Budget

All commands are 14bytes long which includes 6 bytes command and 8 bytes PUS packet header and CRC.
In the event of anomalous operations requiring a memory patch the command length will be longer.

Based on the Smart-1 DCIXS experience the number of commands per orbit will be approximately 20.

3. TELEMETRY

The data is formatted as follows:

Header [Sect 3.1]	Telemetry Data Field [sect 3.2]			
	Packet Time [sect 3.2.1]	Data Type [sect 3.2.1]	Data [sect3.3]	Packet Error Control CRC [sect 3.2.3]
0…….5	6……11	12	13….271	278, 279

3.1 Source Packet Header

Length: 6 bytes

Format:

Packet ID				Packet sequence control		Packet length
Version number 3bits	Type 1 bit	Data Field header Flag 1 bit	Application Process APID 11bits	Segmentation Flags 2 bits	Source Sequence Count 14bits	16bits
000	0	0	0x3EE	11	Variable	Variable

3.1.1 Application IDs

APID	Data Formats
0x3EE 1006	Housekeeping, Science data packets, Auxiliary Data, and memory dump.

3.2 Packet Data Field

C1XS packets are of fixed length with a modified data header for compatibility with existing EGSE.

Data Field Length: 274 bytes.

Sub Fields: Data header: 7 bytes
Data: 265 bytes
Checksum: 2 bytes

3.2.1 Data Header

Length: 7 bytes

Format:

Packet Time	6 bytes
Data Type	1 byte

Time definition:

Spacecraft Time in Seconds (4bytes)	1/65536 sec units (2bytes)

Data Type definition:

Value	Data Type
0	Housekeeping
1	C1XS Time tagged events
2	C1XS Low Count Spectrum
3	not used
4	XSM sensor
5	Memory Dump
6	C1XS Compressed Low Count Spectrum
7	not used
8	C1XS Auxiliary Data
9	C1XS Auxiliary Data - Detector Means
10	C1XS Time tagged events
11	C1XS Time tagged, 3 pixel event data
12	C1XS High resolution Low Count Spectrum

3.2.2 Data

Length: 265 bytes

C1XS system has 6 possible data gathering states each with a different data packet format; data types 1, 2, 6, 10, 11 and 12.

The XSM system has one format (type 4).

3.2.3 Packet Error Control

Length: 2 bytes

A CRC code or checksum will be used for error control.

3.3 Data Formats

3.3.1 Data Type 0: Housekeeping Data [APID=1006]

The housekeeping data is collected and transmitted every 64s.

The experiment housekeeping packet will be of standard length and of the following form.

	Start Byte	Length	Bit	ID	Comment/Calibration
Header	0	6		Header	
	6	6		Packet Time	
	12	1		Data Type	
	13	1		HK Packet Count	
Software Status	14	1		TC error flags	
	15	1		Software Version	
	16	1		TCs Accepted Count	
	17	1		TCs rejected Count	
	18	1		TC Error Code	
	19	1		**Software Flags, low byte**	
			0	XSM processing	
			1	DCIXS processing	
			2	Door radiation status	
			3	Door radiation movement	
			4	XSM shutter status	
			5	XSM entering annealing	
			6	XSM on for >1s	
			7	XSM switched on	
	20	2		Received CRC from last TC packet with bad CRC	
	22	2		Calculated CRC from last TC packet with bad CRC	
	24	1		Door State	
	25		0 - 3	Mode	0: Standby

	Start Byte	Length	Bit	ID	Comment/Calibration
					1: Operating
					2: Test
					3: Calibrate
					4: Resting
	25		4-7	Submode	0: Time tagged (DCIXS mode)
					1: Low count Spectrum
					2: not used
					3: DCIXS automatic mode
					4: Compressed
					5: Time tagged, 3 pixel
					6: Time tagged
					7: High resolution low count spectrum
					8: C1XS auto mode
	26	2		Max CAN packets in Output queue this HK period	
	28	2		Last calculated time adjustment (MS)	
	30	2		Last calculated time adjustment (NMS)	
	32	2		Last calculated time adjustment (LS)	
	34	2		Worst background elapsed time this HK period	
	36	2		Worst idle loop count this HK period	
	38	2		Count of times CAN TX not ready	
	40	2		Count of lost TM PUS packets	
	42	1		Return Stack pointer	
	43	1		Parameter stack pointer	
	44	2		EEPROM write retries	
	46	2		EEPROM write failures	
	48	4		Seconds remaining of minimum door closed interval	
	52	1		**Software flags, high byte**	
			0	Not used	
			1	Not used	

	Start Byte	Length	Bit	ID	Comment/Calibration
			2	Not used	
			3	Not used	
			4	XSM Cal sequence	
			5	XSM annealing heater	
			6	TC XSM anneal start Rxd	
			7	TC XSM anneal stop Rxd	
	53	1		Door close integrator count.	
	54	2		Seconds since last calibration.	
	56	1		Last TC Type	
	57	1		Last TC qualifier	
	58	2		Last TC Address/function	
	60	2		Last TC first data word	
	62	1		Last but 1 TC Type	
	63	1		Last but 1 TC qualifier	
	64	2		Last but 1 TC Address/function	
	66	2		Last but 1 TC first data word	
C1XS Detector Status	68	1		Sensor 16-23 inhibit	'1' = inhibit '0' = enabled
	69	1		Sensor 8-15 inhibit	'1' = inhibit '0' = enabled
	70	1		Sensor 0-7 inhibit	'1' = inhibit '0' = enabled
	71	1		Power monitor	
	72	2		BANK 1 Channel A Event Count	
	74	2		BANK 1 Channel B Event Count	
	76	2		BANK 1 Channel C Event Count	
	78	2		BANK 1 Channel D Event Count	
	80	2		BANK 1 Channel E Event Count	
	82	2		BANK 1 Channel F Event Count	
	84	2		BANK 1 Channel G Event Count	
	86	2		BANK 1 Channel H Event Count	
	88	2		BANK 1 Channel I Event Count	

	Start Byte	Length	Bit	ID	Comment/Calibration
	90	2		BANK 1 Channel J Event Count	
	92	2		BANK 1 Channel K Event Count	
	94	2		BANK 1 Channel L Event Count	
	96	2		BANK 2 Channel A Event Count	
	98	2		BANK 2 Channel B Event Count	
	100	2		BANK 2 Channel C Event Count	
	102	2		BANK 2 Channel D Event Count	
	104	2		BANK 2 Channel E Event Count	
	106	2		BANK 2 Channel F Event Count	
	108	2		BANK 2 Channel G Event Count	
	110	2		BANK 2 Channel H Event Count	
	112	2		BANK 2 Channel I Event Count	
	114	2		BANK 2 Channel J Event Count	
	116	2		BANK 2 Channel K Event Count	
	118	2		BANK 2 Channel L Event Count	
XSM Analogue HK	120	2		XSM +5V monitor	Volts = Count *****10/256
	122	2		XSM +12V monitor	Volts = Count *****14.968/255
	124	2		XSM -12V monitor	Volts = -(Count +1.606)/20.08
	126	2		XSM PIN detector temperature	Temp C = - Count*0.21875
	128	2		XSM Detector Box temperature	Temp C = Count * 3.90625 - 273
	130	2		XSM HV Bias Voltage	Volts = Count *1.5625
	132	2		XSM Leakage Current	pA = Count * 0.78125
C1XS Analogue HK	134	2		DC Converter Temperature	See section 3.3.1.1
	136	2		CAN/HK PCB Temperature	See section 3.3.1.1
	138	2		-Y plate Temperature	See section 3.3.1.1
	140	2		Video Digital PCB temperature	See section 3.3.1.1
	142	2		VIDEO1 3D+ temperature	See section 3.3.1.1
	144	2		VIDEO2 3D+ temperature	See section 3.3.1.1
	146	2		SCD column B temperature	See section 3.3.1.1

	Start Byte	Length	Bit	ID	Comment/Calibration
	148	2		SCD column E temperature	See section 3.3.1.1
	150	2		12V regulated supply	Volts = Count * 5.525*0.0003052
	152	2		5V regulated supply	Volts = Count * 2.361*0.0003052
	154	2		3.3V regulated supply	Volts = Count * 2*0.0003052
	156	2		XSM Peltier supply voltage	Volts = Count *0.0003052
	158	2		-12V regulated supply	Volts = - (65536-Count) * 5.525*0.0003052
	160	2		-5V regulated supply	Volts = - (65536-Count) * 2.361*0.0003052
	162	2		Motor Phase 1 voltage	
	164	2		Motor Phase 2 voltage	
	166	2		SCD Substrate Voltage Monitor [SS_VMON]	Volts = Count * 5.545*0.0003052
	168	2		SCD Output Gate Voltage Monitor [OG_VMON]	Volts = Count * 2*0.0003052
	170	2		SCD Reset Drain Voltage Monitor [RSTD_VMON]	Volts = Count * 7.818*0.0003052
	172	2		SCD Output Drain Voltage Monitor [OPD_VMON]	Volts = Count * 20.545*0.0003052
	174	2		39V supply voltage [39V_VMON]	Volts = Count * 20.545*0.0003052
	176	2		0V	
	178	1		**Door Mechanism Status**	
			bit 0	not used	
			bit 1	Launch Lock Latch Enabled	'1' = enabled
			bit 2	Launch Lock Bypass Enabled	'1' = enabled
			bit 3	Launch Lock Latch Open = 1 [SW1]	'1' = true
			bit 4	Launch Lock Latch Closed = 1 [SW2]	'1' = true
			bit 5	Door Motor Running	'1' = true
			bit 6	Not used	
			bit 7	Not used	
	179	1		Spare	
	180	2		Door Motor Step Count	
	182	1		**XSM Control Status**	

	Start Byte	Length	Bit	ID	Comment/Calibration
			bit 0 MSB	Not used	
			bit 1	Not used	
			bit 2	Peltier On/Off	1 = On 0 = Off
			bit 3	Peltier mode heat/cool	1 = Heat 0 = Cool
			bit 4	Shutter mode	1 = Open 0 = Closed
			bit 5	HV Bias on/off :	1= on 0 = off
			bit 6	HV Override Enable:	'1' = enabled '0' = Disabled
			bit 7 LSB	FIFO write Enable:	'1' = enabled '0' = Disabled
	183	1		**XSM Status**	
			bit 0 MSB	Not used	
			bit 1	Not used	
			bit 2	Not used	
			bit 3	Not used	
			bit 4	Not used	
			bit 5	Detector Overtemp HV should be switched down	
			bit 6	HV bias overvoltage HV should be switched down	
			bit 7 LSB	ADC Conversion complete	
	184	1		XSM DAC 0 (last value written to DAC)	
	185	1		XSM DAC 1 (last value written to DAC)	
	186	1		XSM State	
	188	2		XSM second counter	
	190	1		Software Patch ID	
	191	1		Boot Page number	
3D+	192	2		SS DAC Monitor Average	
	194	2		OG DAC Monitor Average	
	196	2		RD DAC Monitor Average	
	198	2		OD DAC Monitor Average	
	200	1		SS DAC demand	
	201	1		OG DAC demand	

	Start Byte	Length	Bit	ID	Comment/Calibration
	202	1		RD DAC demand	
	203	1		OD DAC demand	
	204	2		Spare	
	206	2		Spare	
	208	2		Most events/sec this period	
	210	4		Memory checksums	
	214	2		Data in address pointed to by table 6 param 55.	
	216	2		ITL ID table 6 parameter 56.	
	218	2		Latest XSM Total counts	
	220	2		Spare	
	222	2		Spare	
	224	2		Spare	
	226	2		XSM Spectra Count	
	228	2		XSM RICA FIFO port 2 register contents	
	230	2		XSM RICA FIFO port 3 register contents	
	232	2		XSM RICA software control register contents	
	234	4		XSM_FIFO_ERR1	
	238	4		XSM_FIFO_ERR2	
	242	2		HK_DOOR_POSN	
	244	2		HK_RAD_MON_1	Volts = Count * 0.00061
	246	2		HK_RAD_MON_2	Volts = Count * 0.00061
	248	2		HK_RAD_MON_3	Volts = Count * 0.00061
	250	2		HK_RAD_MON_4	Volts = Count * 0.00061
	252	2		HK_RAD_MON_12V	Volts = Count * 0.001686
	254	2		HK_RAD_MON_5	Volts = Count * 0.00061
	---	-		Spare	
	278	2		CRC	
Total	280				

3.3.1.1 C1XS Thermistor Calibration

°C	Counts
-80	8174
-79	8172
-78	8171
-77	8169
-76	8167
-75	8165
-74	8162
-73	8160
-72	8157
-71	8154
-70	8151
-69	8148
-68	8144
-67	8140
-66	8136
-65	8132
-64	8127
-63	8122
-62	8116
-61	8110
-60	8104
-59	8097
-58	8090
-57	8082
-56	8074
-55	8065
-54	8056
-53	8046
-52	8035
-51	8023
-50	8011
-49	7998
-48	7985
-47	7970
-46	7955
-45	7938
-44	7921
-43	7903
-42	7883
-41	7863
-40	7841
-39	7818
-38	7794
-37	7769
-36	7742
-35	7714
-34	7684
-33	7654
-32	7621
-31	7587
-30	7551
-29	7513
-28	7474
-27	7433
-26	7390
-25	7346
-24	7300
-23	7251
-22	7201
-21	7149
-20	7095
-19	7039
-18	6980
-17	6920
-16	6858
-15	6794
-14	6728
-13	6660
-12	6590
-11	6518
-10	6444
-9	6368
-8	6290
-7	6211
-6	6130
-5	6048
-4	5963
-3	5878
-2	5791
-1	5702
0	5613
1	5522
2	5429
3	5337
4	5243
5	5149
6	5055
7	4959
8	4863
9	4766
10	4670
11	4574
12	4478
13	4381
14	4286
15	4190
16	4095
17	4001
18	3907
19	3814
20	3722
21	3630
22	3540
23	3451
24	3363
25	3276
26	3191
27	3106
28	3023
29	2942
30	2862
31	2783
32	2706
33	2630
34	2557
35	2484
36	2414
37	2344
38	2277
39	2211
40	2146
41	2083
42	2022
43	1962
44	1904
45	1847
46	1792
47	1738
48	1686
49	1635
50	1586
51	1538
52	1491
53	1446
54	1402
55	1359
56	1318
57	1278
58	1239
59	1202
60	1165
61	1129
62	1095
63	1061
64	1030
65	998
66	968
67	938
68	910
69	883
70	856
71	830
72	805
73	781
74	758
75	735
76	713
77	692
78	671
79	652
80	632
81	614
82	596
83	578
84	562
85	545
86	529
87	514
88	499
89	485
90	471
91	458
92	445
93	432
94	420
95	408
96	397
97	385
98	375
99	364
100	354
101	345
102	335
103	326
104	317
105	308
106	300
107	292
108	284
109	277
110	269
111	262
112	255
113	248
114	242
115	236
116	230
117	224
118	218
119	212
120	207
121	201
122	196
123	191
124	187
125	182
126	177
127	173
128	169
129	164
130	160

3.3.2 Data type 1: C1XS Time-Tagged Events [APID=1006]

Each X-ray event detected by any of the 24 detectors is time-tagged and the energy (signal count) measured. These data and the detector channel number are stored for 64 events and transmitted in one packet.

The event times are relative to the Start Time which is the full 6 byte on-board clock time of the first event in the packet.

Relative time is 12 bits split between two bytes and the LS bit = 1/16s

The data gathering time will vary according to event rate.

The longest time before the relative time counter rolls over is 256s

Each X-ray event is a 12 bit number, i.e. 4095 max.

Start Byte.Bit	Length	ID
0	6	Header
6	6	Packet Time
12	1	Data Type
13	1	Not used
14	4 bytes	Event Start Time
18	1 byte	Spare
19	1 byte	Number of events in packet
20.0	5 bits	Detector Channel Number
20.6	3 bits	RICA Error Flags
21.0	1	Event Time in seconds
22.0	4 bits	Event Time 1/16seconds
22.4	12 bits	Detector Signal Count
24.0	5 bits	Detector Channel Number
24.6	3 bits	RICA Error Flags
25.0	1	Event Time in seconds
26.0	4 bits	Event Time 1/16seconds
26.4	12 bits	Detector Signal Count
~	~	~
272.0	5 bits	Detector Channel Number
273.0	3 bits	RICA Error Flags
272.6	1	Event Time in seconds
274.0	4 bits	Event Time 1/16seconds
274.4	12 bits	Detector Signal Count
276	2 bytes	Not used
278	2 bytes	Checksum
280	Data bytes	

3.3.3 Data type 2: C1XS Low Count Spectrum [APID=1006]

Energy spectra are formed from each detector covering the full energy range. The spectrum is formed by grouping 16 adjacent A/D conversion levels to give 256 energy bands.

The maximum expected count in each band is 255

For each integration period which is commandable 24 'type 2' packets will be transmitted 1 packet for each spectrum.

Start Byte	Length	Parameter
0	6	Header
6	6	Packet Time
12	1	Data Type
13.0	3 bits	Not Used
13.3	5 bits	Detector Number
14	4	Integration Start time (seconds)
18	2	Not used
20	2	Integration Time (seconds)
22	256	Spectrum data
278	2	Checksum

280 Data bytes

3.3.4 Data type 3: C1XS High Count Spectrum

Packet type not produced by C1XS.

3.3.5 Data types 4 : XSM Data [APID=1006]

A 512 channel spectrum is produced for each integration period of 16s. Each channel is stored in a Shift count and Mantissa Format described below.

Four of the following packets are transmitted per integration:

Integration time accuracy <1/64s

Shift count and Mantissa Format:

This format allows unsigned integers from 0 to 134184960 to be represented in a 16 bit number with and accuracy of no worse than one part in 2048 (~0.05%). the number is represented as a 12 bit mantissa an a 4 bit shift count:

bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
	Shift count (0-15)				Mantissa (0-4095)											

The shift count field gives the number of places that the mantissa must be shifted to the left to give the actual value. For numbers in the range 0-4095 the encoded value is the same as the raw value and no precision is lost.

Examples of encoding:

Number	In hex	shift count	Mantissa	Encoded value	Encoded value (hex)	Reconstructed value (hex)
0	0000	0	0	0	0000	0000
4095	0FFF	0	4095	4095	0FFF	0FFF
4096	1000	1	2048	6144	1800	1000

Number	In hex	shift count	Mantissa	Encoded value	Encoded value (hex)	Reconstructed value (hex)
8193	1FFF	1	4095	8193	1FFF	1FFE
32768	8000	4	2048	18432	4800	8000
65535	FFFF	4	4095	20479	4FFF	FFF0
1048575	FFFFF	8	4095	36863	8FFF	FFF00

For counts of less than 4 million the error introduced by encoding is less than the statistical standard deviation.

Start Byte	Length	ID
0	6	Header
6	6	Packet Time
12	1	Data Type
13.0	2bits	Bits = 00 : Channels 0 -127 Bits = 01 : Channels 128 –255 Bits = 10 : Channels 256 -383 Bits = 11 : Channels 384 -511
13.2	1bit	Not used
13.3	1bit	Shutter Open '1' = true
13.4	1bit	Shutter Closed '1' = true
13.5	1bit	Detector Overtemp HV should be switched down
13.6	1bit	HV bias overvoltage HV should be switched down
13.7	1bit	ADC Conversion complete
14	4	Integration Start time (seconds)
18	2	Integration Time (seconds)
20	2	Not used
22	256	XSM Spectrum
278	2	Checksum
280	Data bytes	

3.3.6 Data type 5: Memory Dump Data [APID=1006]

A memory dump packet is generated in response to a memory dump command. The data field is of standard length:

Start Byte	Length	ID
0	6	Header
6	6	Packet Time
12	1	Data Type
13	4	Spare
17	1	Page
18	2	Dump Address
20	2	Length
22	256	Memory Dump Data
278	2	Checksum
280	Data bytes	

3.3.7 Data type 6: C1XS Compressed LC Spectrum [APID=1006]

The compressed low count spectral format is generated by firstly producing a spectrum for each enabled detector and then concatenating up to 24 spectra for a single integration period before run length encoding the data at byte level.

3.3.7.1 The following table lists the spectral bin widths:

Width	Bin Numbers
8	0 to 96
12	97 to 144
16	145 to 176
20	177 to 200
24	201 to 224
32	225 to 244
48	245 to 254
56	255

3.3.7.2 Data format prior to encoding

Each detector shall use a 257 byte structure to contain the detector number and the 255 spectral bins, see following table.

Start Byte	Length	Parameter
0	1	Detector number
1	1	Spectral bin 0
. .	. .	. .
256	1	Spectral bin 255

3.3.7.3 Description of run length encoding

If two consecutive bytes in the data are the same value then a third byte is added to give the number of times that that value occurs again. e.g.

data stream = 00,05,05,05,a0,b0,00,00,00,00,00,00,ff

is encoded to

rle = 00,05,05,01,a0,b0,00,00,04,ff

3.3.7.4 Telemetry Packet Format

The run length encoded data is packed into a sufficient number of telemetry packets, the telemetry packet fields are shown in the following table.

Start Byte	Length	Parameter
0	6	Header
6	6	Packet Time
12	1	Data Type
13	1	Integration time (seconds)
14	4	Integration start time (seconds)

18	2	bits 00:06 – Compressed data packet number (lsb is 0) bits 07:15 – no. bytes of compressed data in pkt
20	258	Compressed spectral data
278	2	Checksum
280	Data bytes	

where:

Integration start time = the time current integration period started.
Integration time = Table 6, parameter 53
Compressed data packet number = sequential number commencing at 0 for this set of compressed data.

3.3.8 Data type 7: C1XS SCD Test

Packet type not produced by C1XS.

3.3.9 Data Type 8: Auxiliary Data [APID=1006]

The detector readout electronics configuration parameters are transmitted in this format.
It will be transmitted on transition to operating mode.
The experiment auxiliary packet will be of standard length and of the following form.

Start Byte	Length	ID
0	6	Header
6	6	Packet Time
12	1	Data Type
13	1	Spare
14	2	SCD 0, 4, 8 configuration
16	2	SCD 0 offset
18	2	SCD 4 offset
20	2	SCD 8 offset
22	2	SCD 0 gain
24	2	SCD 4 gain
26	2	SCD 8 gain
28	2	SCD 1, 5, 9 configuration
30	2	SCD 1 offset
32	2	SCD 5 offset
34	2	SCD 9 offset
36	2	SCD 1 gain
38	2	SCD 5 gain
40	2	SCD 9 gain
42	2	SCD 2, 6, 10 configuration
44	2	SCD 2 offset
46	2	SCD 6 offset
48	2	SCD 10 offset
50	2	SCD 2 gain
52	2	SCD 6 gain

Start Byte	Length	ID
54	2	SCD 10 gain
56	2	SCD 3, 7, 11 configuration
58	2	SCD 3 offset
60	2	SCD 7 offset
62	2	SCD 11 offset
64	2	SCD 3 gain
66	2	SCD 7 gain
68	2	SCD 11 gain
70	2	SCD 12, 16, 20 configuration
72	2	SCD 12 offset
74	2	SCD 16 offset
76	2	SCD 20 offset
78	2	SCD 12 gain
80	2	SCD 16 gain
82	2	SCD 20 gain
84	2	SCD 13, 17, 21 configuration
86	2	SCD 13 offset
88	2	SCD 17 offset
90	2	SCD 21 offset
92	2	SCD 13 gain
94	2	SCD 17 gain
96	2	SCD 21 gain
98	2	SCD 14, 18, 22 configuration
100	2	SCD 14 offset
102	2	SCD 18 offset
104	2	SCD 22 offset
106	2	SCD 14 gain
108	2	SCD 18 gain
110	2	SCD 22 gain
112	2	SCD 15, 19, 23 configuration
114	2	SCD 15 offset
116	2	SCD 19 offset
118	2	SCD 23 offset
120	2	SCD 15 gain
122	2	SCD 19 gain
124	2	SCD 23 gain
126-148	24	Spare
150	2	Bank1 event reject level
152	2	Bank1 pixel processing mode
154	2	Always 0xFFFF
156	2	OD DAC
158	2	RD DAC
160	2	Bank 1 Power control
162	2	Bank2 channel A high threshold

Start Byte	Length	ID
164	2	Bank2 channel B high threshold
166	24	Spare (0)
190	2	Bank2 event reject level
192	2	Bank2 pixel processing mode
194	2	Always 0xFFFF
196	2	OG DAC
198	2	SS DAC
200	2	Bank21 Power control
202	2	Spare
204	2	Spare
206	16	XSM Parameters
222-276	56	Spare (0)
278	2	Checksum
280		Data bytes

3.3.10 Data Type 9: Auxiliary Data – Smoothed noise zero and thresholds [APID=1006]

The detector noise parameters are transmitted in this format. The smoothed noise zero value for each SCD is recorded along with the resulting high and low threshold settings.
It will be transmitted when an threshold adjustment is performed every 256s (nom.).
The smoothed noise zero is given in raw ADC units from the VSP3100. The 14 bit data is limited to a thirteen bit value by and then scaled down by a factor which depends on the data format. The following table shows the scale value for each of the data formats:

Data type	Name	Scaling
1	DCIXS LC spectra	32
2	DCIXS time tagged	4
3	Not used	n/a
6	Compressed LC spectra	16
10	Time tagged, 1 pixel	2
11	Time tagged, 3 pixel	2
12	High resolution LC	8

The scaling figures given for the spectral formats are for the size of the smallest bin in the spectrum.

For example to convert the zero position peak in a high resolution low count spectral packet to the same units as the zero peak value in the type 9 packet then, assuming the peak is in the first 250 bins:

type 9 ‘0’ position = HRLCS ‘0’ position * 16

The packet will be of standard length and of the following form.

Start Byte	Length	ID
0	6	Header
6	6	Packet Time
12	1	Data Type (=9)
13	1	Not used (=0)
14	2	Detector #0 Smoothed noise-zero
16	2	Detector #1 Smoothed noise-zero
18	2	Detector #2 Smoothed noise-zero
20	2	Detector #3 Smoothed noise-zero
22	2	Detector #4 Smoothed noise-zero
24	2	Detector #5 Smoothed noise-zero
26	2	Detector #6 Smoothed noise-zero
28	2	Detector #7 Smoothed noise-zero
30	2	Detector #8 Smoothed noise-zero
32	2	Detector #9 Smoothed noise-zero
34	2	Detector #10 Smoothed noise-zero
36	2	Detector #11 Smoothed noise-zero
38	2	Detector #12 Smoothed noise-zero
40	2	Detector #13 Smoothed noise-zero

Start Byte	Length	ID
42	2	Detector #14 Smoothed noise-zero
44	2	Detector #15 Smoothed noise-zero
46	2	Detector #16 Smoothed noise-zero
48	2	Detector #17 Smoothed noise-zero
50	2	Detector #18 Smoothed noise-zero
52	2	Detector #19 Smoothed noise-zero
54	2	Detector #20 Smoothed noise-zero
56	2	Detector #21 Smoothed noise-zero
58	2	Detector #22 Smoothed noise-zero
60	2	Detector #23 Smoothed noise-zero
62	2	Detector #0 High Threshold
64	2	Detector #1 High Threshold
66	2	Detector #2 High Threshold
68	2	Detector #3 High Threshold
70	2	Detector #4 High Threshold
72	2	Detector #5 High Threshold
74	2	Detector #6 High Threshold
76	2	Detector #7 High Threshold
78	2	Detector #8 High Threshold
80	2	Detector #9 High Threshold
82	2	Detector #10 High Threshold
84	2	Detector #11 High Threshold
86	2	Detector #12 High Threshold
88	2	Detector #13 High Threshold
90	2	Detector #14 High Threshold
92	2	Detector #15 High Threshold
94	2	Detector #16 High Threshold
96	2	Detector #17 High Threshold
98	2	Detector #18 High Threshold
100	2	Detector #19 High Threshold
102	2	Detector #20 High Threshold
104	2	Detector #21 High Threshold
106	2	Detector #22 High Threshold
108	2	Detector #23 High Threshold
110	2	Detector #0 Low Threshold
112	2	Detector #1 Low Threshold
114	2	Detector #2 Low Threshold
116	2	Detector #3 Low Threshold
118	2	Detector #4 Low Threshold
120	2	Detector #5 Low Threshold
122	2	Detector #6 Low Threshold
124	2	Detector #7 Low Threshold
126	2	Detector #8 Low Threshold
128	2	Detector #9 Low Threshold

Start Byte	Length	ID
130	2	Detector #10 Low Threshold
132	2	Detector #11 Low Threshold
134	2	Detector #12 Low Threshold
136	2	Detector #13 Low Threshold
138	2	Detector #14 Low Threshold
140	2	Detector #15 Low Threshold
142	2	Detector #16 Low Threshold
144	2	Detector #17 Low Threshold
146	2	Detector #18 Low Threshold
148	2	Detector #19 Low Threshold
150	2	Detector #20 Low Threshold
152	2	Detector #21 Low Threshold
154	2	Detector #22 Low Threshold
156	2	Detector #23 Low Threshold
158-176	120	Not used (=0)
278	2	Checksum
280		Data bytes

3.3.11 Data Type 10: Time Tagged, single pixel data [APID=1006]

Each X-ray event detected by any of the 24 detectors is time-tagged and the energy (signal count) measured. These data and the event time (4 bits) are stored for 129 events and transmitted in one telemetry packet for each detector. The event times are relative to the Start Time which is the full 4 byte on-board clock time of the first event in the packet.

Relative time is 4 bits with the LS bit = 1/2s

The data gathering time will vary according to the event rate.

The longest time before the relative time counter rolls over is 7.5s

Start Byte.Bit	Length	ID
0	6	Header
6	6	Packet Time
12	1	Data Type
13	1	Detector Number
14	4 bytes	Event Start Time
18	1 byte	Spare
19	1 byte	Number of events in packet
20.0	12 bits	Detector Signal Count
21.4	4 bits	Event Time 1/2seconds
22.0	12 bits	Detector Signal Count
23.4	4 bits	Event Time 1/2seconds
~	~	~
276.0	12 bits	Detector Signal Count
277.4	4 bits	Event Time 1/2seconds
278	2 bytes	Checksum
280		Data bytes

3.3.12 Data Type 11: Time Tagged, 3 pixel event data [APID=1006]

Each X-ray event detected by any of the 24 detectors is time-tagged and the energy (signal count) measured for the SCD pixel that detected the event and one pixel either side of it. These data and the detector channel number are stored for 51 events and transmitted in one telemetry packet for each detector.
The event times are relative to the Start Time which is the full 4 byte on-board clock time of the first event in the packet.
Relative time is 4 bits with the LS bit = 1/2s
The data gathering time will vary according to event rate.
The longest time before the relative time counter rolls over is 7.5s

Start Byte.Bit	Length	ID
0	6	Header
6	6	Packet Time
12	1	Data Type
13	1	Detector Number
14	4 bytes	Event Start Time
18	1 byte	Spare
19	1 byte	Number of events in packet
20.0	12 bits	Pixel 0 Signal Count
21.4	12 bits	Pixel 1 Signal Count
23.0	12 bits	Pixel 2 Signal Count
24.4	4 bits	Event Time 1/2seconds
25.0	12 bits	Pixel 0 Signal Count
26.4	12 bits	Pixel 1 Signal Count
28.0	12 bits	Pixel 2 Signal Count
29.4	4 bits	Event Time 1/2seconds
~	~	~
270.0	12 bits	Pixel 0 Signal Count
271.4	12 bits	Pixel 1 Signal Count
273.0	12 bits	Pixel 2 Signal Count
274.4	4 bits	Event Time 1/2seconds
275	3 bytes	spare
278	2 bytes	Checksum
280	Data bytes	

3.3.13 Data Type 12: High resolution Low Count Spectrum [APID=1006]

Energy spectra are formed from each detector covering the full energy range, the FPGA mode is set to give a single pixel for each X-ray event. The spectrum is formed by grouping adjacent A/D conversion levels to give 512 energy bins, the number of ADC conversion levels (width) that make up each bin is given in the following table.

Width	Bin Numbers
4	0 to 249
8	250 to 387
16	388 to 510
24	511

The maximum expected count in each band is 255

For each integration period which is commandable (>8 secs) 48 'type 12' packets will be transmitted, 2 packets for each spectrum.

Start Byte	Length	Parameter
0	6	Header
6	6	Packet Time
12	1	Data Type
13.0	1 bit	Flag – 0 : Channels 0 to 255 1 : Channels 256 to 511
13.1	2 bits	Not used
13.3	5 bits	Detector Number
14	4	Integration Start time (seconds)
18	2	Not used
20	2	Integration Time (seconds)
22	256	Spectrum data
278	2	Checksum
280	Data bytes	

4. MISSION PHASE DATA RATES

The instrument has three basic conditions OFF STANDBY and 'Operating' which includes a RESTING mode in addition to the OPERATIONAL mode. In STANDBY and RESTING modes the detectors are not being clocked and the solar monitor peltier coolers are off - hence the power is reduced. The transition between OPERATIONAL and RESTING modes is carried out autonomously by the software dependent on the temperature of the SCD.
The OPERATIONAL mode has 7 submodes which correspond to variations in data collection. The contents of the telemetry packets will vary according to mode and state selected.
The modes/states which are likely to be used in the Spacecraft modes are summarised in Table 4-1.
A detailed breakdown is given in section 4.2 for the active operational detector modes.

Table 4-1 Experiment/Spacecraft Mode Correlation – Data rates

Instrument Mode	Spacecraft Mode / Instrument Data Format	Pre-Launch	LEOP	Safe	De-tumble	Observation Lunar Nadir Pointing
OFF		X	X	X	X	X
EMERGENCY	Memory dumps by command only	X				X
STANDBY	Housekeeping	X				X
	Auxiliary Data	X				X
OPERATIONAL	C1XS formats	X				X
	XSM	X				X
	Housekeeping	X				X
	Auxiliary Data	X				X

Table 4-2 Data Format Packet Numbers

Data Type No	Data Format	Packets /Format
0	Housekeeping	1
1	C1XS Time tagged events	1 = 64 events
2	C1XS Low Count Spectrum	24 = 1 spectrum for each detector
3	Not used	
4	XSM sensor	4 = 1 spectrum
5	Memory Dump	1
6	C1XS Compressed Low Count Spectra	24 = 1 spectrum for each detector (poor compression) 10 = 1 spectrum for each detector (typical compression)
7	Not used	
8	C1XS Auxiliary Data – 3D+ Gain and Offset	1
9	C1XS Auxiliary Data – FPGA Thresholds	1
10	Time Tagged, summed pixel data	24 = 3096 events (129 events per detector)
11	Time Tagged, 3 pixel event data	24 = 1224 events (51 events per detector)

12	High resolution Low Count Spectrum	48 = 1 spectrum for each detector

4.1 Inactive modes

STANDBY mode does not have full data collection from the C1XS or XSM detectors. Only housekeeping data is transmitted as one 280 byte packet every 64s.

4.2 Lunar Observations

The event rate is dependent on the state of the sun and the sun/moon/spacecraft geometry.
The average case is given in the table below.

Observation	Data Format	Event Rate /s	Packet /s	Observation Duration (hours)	Total Data Packets /orbit	Mbits
Lunar Geochemistry C1XS	C1XS Time tagged, 3 pixel event data	<306	5.1	0.568	10430	23.4
	C1XS summed pixel data	<774	4.0	0.294	4265	9.6
	C1XS High resolution LC spectrum	>774	3	0.118	1270	2.8
Solar Monitoring	XSM spectrum	n/a	0.25	0.98	1763	3.95
	AUX packet	n/a	0.008	0.98	26	0.06
Housekeeping	HK packet	n/a	0.016	0.98	55	0.12
				Total packets / Mbits per orbit	**16050**	**35.94**

5. CAN WORD DATA RATE

CAN BUS Maximum C1XS/XSM Data transfer rate	40kbps

6. EXPERIMENT SPACECRAFT RESOURCE REQUIREMENTS

Mass memory allocation	400Mbits