SPIRE

SUBJECT: SPIRE Data ICD

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Glossary

APID	Application ID
DPU	Digital Processing Unit
OBS	On-Board Software
SID	Structure ID
SPIRE	Spectral and Photometric Imaging REceiver
SVM	Service Module

1. INTRODUCTION

Control of the SPIRE instrument is handled by the Digital Processing Unit (DPU) part of the instrument electronics, which contains the On-Board Software (OBS). This unit is mounted on the spacecraft Service Module (SVM) and interfaces directly to the CDMS bus of the Herschel spacecraft for the purpose of transferring commands to, and collection of telemetry data from the instrument.

All data passing between the instrument and the spacecraft is transferred in the form of telemetry and telecommand packets conforming to the ESA packet standards (RD01 and RD02). The ESA Packet Utilisation Standard (RD03) defines the types of service that may be provided by units on board ESA spacecraft, but the set of supported packet types within the Herschel project is restricted. This restricted set is defined in the Herschel Packet Structure ICD (AD01) and is the minimum set necessary to meet the satellite operational requirements given in AD02.

The current issue of this document is based on Issue 0.5 of the DRCU ICD. Until that document is at Issue 1.0 the contents of this document are subject to change. Items likely to be updated in the future are marked in blue text.

1.1 Scope

This document defines the packet types and their contents that will be accepted and generated by the SPIRE instrument during all operations. These packets conform to the formats given in the Packet Structure ICD (AD01) and the Ground Segment to Instruments ICD (AD03). They also provide for the instrument functionality described in the instrument Operating Modes document (RD04) and elaborated in the instrument operating document (RD04)

1.2 Structure of the Document

Section 2 describes the packet interface between the instrument and the spacecraft. This includes the general format of the packets used by the SPIRE instrument for telecommanding and telemetry (from AD01), the allocation of Application IDs used by the instrument and the functionality of the packet transfer protocol of the instrument/spacecraft interface (from AD01, appendix 9) that is used by the instrument.

Section 3 defines the format and content of each of the telecommand packets accepted by the instrument. Section 4 defines the corresponding information for the telemetry packets generated by the instrument. A description of how these packets are handled by the instrument is given in RD05.

Section 5 defines, in detail, the parameters used in the telecommand and telemetry packets.

1.3 Documents

1.3.1 Applicable Documents

AD01 Herschel/Planck Packet Structure Interface Control Document. Issue 2.0 (draft2)
AD02 Herschel/Planck Operations Interface Requirements Document, Issue 2.0 (draft3)
AD03 Herschel Science Ground Segment to Instruments Interface Control Document, Issue 1.0

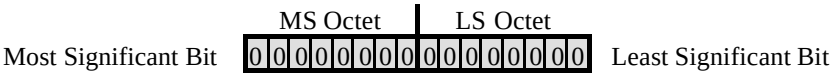
1.3.2 Reference Documents

RD01 Packet Telemetry Standard (ESA PSS-04-106), Issue 1, 1998
RD02 Packet Telecommand Standard (ESA PSS-04-107), Issue 2, 1992
RD03 Telemetry and Telecommand Packet Utilisation Standard (ECSS-E-70/41) Draft 04, April 1999
RD04 Operating Modes of the SPIRE Instrument (SPIRE-RAL-PRJ-000320)
RD05 Operating the SPIRE Instrument (SPIRE-RAL-PRJ-000???)
RD06 DRCU Interface Control Document (SAp-SPIRE-CCa-25-00) Issue 0.5, 17th October 2001

2. THE PACKET INTERFACE

2.1 Packet Structures

The following packet structures are shown as a set of 16 bit words, contained in two consecutive octets in the packet structure (all packets are composed of an even number of octets). The most significant octet of each word comes before the least significant in the packet. The least significant bit of each word is on right of each field:



2.1.1 Fields

Within a field (of any length) the most significant bit is designated bit (0), the least significant bit is bit (length-1).

2.1.2 Telecommand Packets

The following figure gives the general structure of a SPIRE TC Packet (after AD01)

Packet Header	Packet ID	0 0 0 1 1 APID
	Sequence Control	1 1 Src Count
	Length	Length
Data Field	Data Field Header	0 0 0 0 Ack 1 Type Sub-Type 0 0 0 0 0 0 0 0
	Source Data	D A T A
	Error Control	Checksum

Src,Count, Length, TIME and Checksum are defined in AD01
Ack is the most significant 3 bits of Ack as defined in AD01
Type and Sub-Type define the packet type and are also defined in AD01

2.1.3 Telemetry Packets

The following figure gives the general structure of a SPIRE TM Packet (after AD01)

Packet Header	Packet ID	0 0 0 0 1 APID
	Sequence Control	1 1 Count
	Length	Length
Data Field	Data Field Header	0 0 0 0 0 0 0 0 Type
		Sub-Type 0 0 0 0 0 0 0 0
		TIME
	Source Data	DATA
	Error Control	Checksum

Count, Length, TIME and Checksum are defined in AD01
Type and Sub-Type define the packet type and are also defined in AD01

2.2 APIDs

The Application ID is used to identify the source or destination of a telemetry packet. Herschel uses different APIDs for different types of packet (see AD1) as well as for different instruments. The APIDS to be used by SPIRE are given in the following table:

ID	Telemetry types	APID (hex)
APID1	SPIRE Telecommands, Telecommand Verification and Events	500
APID2	SPIRE Periodic Housekeeping	502
APID3	SPIRE Photometer Science Data	504
APID4	SPIRE Spectrometer Science Data	505
APID5	SPIRE Mechanism Science Data	506

2.3 Packet Transfer Protocol

- No asynchronous events are used
- The instrument time is synchronised using the time information included in subframe 33 each second. The Time Management service (9) is not used for this purpose.

3. SPIRE TELECOMMAND PACKETS

This section defines all the telecommand packets accepted by the SPIRE instrument

3.1 Telecommand Packet Types

The Packet Structure ICD (AD1) defines many types of service that can be provided by an Application. The following table shows the telecommand packet types that will be accepted by the SPIRE instrument.

Description	Service Type	Service Sub-Type	Comments
Telecommand Verification Service	1		N/A
Device Command Distribution	2		Not Used
Housekeeping and Diagnostic Data Reporting			
Define New HK Parameter Report	3	1	
Define New Diagnostic Parameter Report	3	2	
Clear HK Parameter Report Definitions	3	3	
Clear Diagnostic Parameter Report Definitions	3	4	
Report HK Parameter Report Definitions	3	9	
Report Diagnostic Parameter Report Definitions	3	11	
Event Reporting	5		N/A
Memory Management			
Load Memory Using Absolute Addresses	6	2	
Dump Memory Using Absolute Addresses	6	5	
Check Memory Using Absolute Addresses	6	9	
Function Management			
Start Function	8	1	
Stop Function	8	2	
Perform Activity of Function	8	4	
Report Function Status	8	5	
Time Management			
Synchronise User	9	3	Not Used
Enable Time Synchronisation	9	4	Not Used (TBC)
Time Code	9	5	Not Used (TBC)
Verify User Time	9	6	Not Used
Enable Time Verification	9	7	
Synchronise Central Time Reference	9	10	Not Used
On-Board Scheduling	11		Not Used
On-Board Monitoring			
Enable Monitoring of Parameters	12	1	
Disable Monitoring of Parameters	12	2	
Clear Monitoring List	12	4	
Modify Monitoring List	12	5	
Delete Parameters from Monitoring List	12	6	
Report Current Monitoring List	12	8	
Packet Transmission Control			
Enable Generation of Telemetry Packets	14	1	
Disable Generation of Telemetry Packets	14	2	
Report Enabled Telemetry Packets	14	3	
On-Board Storage and Retrieval	15		Not Used
On-Board Traffic Management	16		Not Used
Test Service			
Perform Connection Test	17	1	
On-Board Control procedures	18		Not Used
Action/Event Service	19		Not Used
Information Distribution Service			

Enable Distribution of Information TC Packets	20	1	
Disable Distribution of Information TC Packets	20	2	
Report Distributed Information Packets	20	3	
Information Telecommand	20	4	
Science Data	21		N/A
Context Saving Service			TBD
Report Context	22	1 (TBC)	

3.2 Telecommand Packet Definition

3.2.1 Telecommand Verification Service

Not Applicable

3.2.2 Device Command Distribution

Not Used

3.2.3 Housekeeping and Diagnostic Data Reporting

The periodic Housekeeping and Diagnostic Data is reported, at fixed time intervals, in packets with a fixed format. A maximum of 4 (TBC) different housekeeping reports are available for use, each allocated a different HK_Packet_ID. Associated with each HK_Packet_ID is a sampling interval and an on-board table, which contains the definition of the contents of the report.

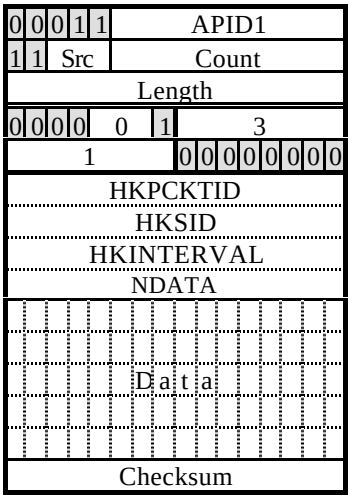
The following reports are defined in the OBS by default:

HK_Packet_ID	Report	Table_ID	Sampling Interval
0	Default Housekeeping Report	0	1 sec
1	---- Undefined ----	1	---- Undefined ----
2	---- Undefined ----	2	---- Undefined ----
3	---- Undefined ----	3	---- Undefined ----

The contents are described in the Housekeeping Parameter Report (Service 3,25).

3.2.3.1 Define New Housekeeping Parameter Report (Service 3,1)

This command is used to define/redefine housekeeping reports.



Parameters

Name	Comments
HKPCKTID	
HKSID	
HKINTERVAL	
NDATA	
Data	

Note: The parameter is placed in the least significant bits of the16 bit 'parameter' field and the most significant bits are padded with zeros.

Note: the maximum length of a report defined in this way is restricted by the maximum length of a telecommand packet to 115 parameters and it is currently impossible to define a new HK report longer than this! Therefore a different mechanism is used to define the reports:

- An on-board table is loaded with the definition of the report using one or more 'Load Table' commands. The format of the table contents is TBD.

- A 'Define New Housekeeping Parameter Report' is used to associate the table containing the report definition with the HK_Packet_ID and the sampling interval. In this case:
  - HK_SID contains, in its least significant octet, the Table_ID of the on-board table containing the report definition: i.e. HK_SID = 0x03nn where nn = the Table_ID of the table
  - N = 0

Possible Errors

Error	TM Service	Error Code	Description
Illegal_HK_Packet_ID	(1,8)	0x0301	HK_Packet_ID Out of Range
Illegal_HK_SID	(1,8)	0x0302	HK_SID MSB not 0x03
Illegal_Table_ID	(1,8)	0x0303	HK_SID LSB not a valid table ID
Illegal_HK_Sampling Interval	(1,8)	0x0304	HK_Sampling Interval is less than the absolute limit (10, TBC)
Bad_Ndata	(1,8)	0x0305	Ndata does not agree with length of data field
Undefined_Table	(1,8)	0x0306	Table number given as part of the HK_SID is not defined

3.2.3.2 Define New Diagnostic Parameter Report (Service 3,2)

TBW

3.2.3.3 Clear Housekeeping Parameter Report Definitions (Service 3,3)

TBW

3.2.3.4 Clear Diagnostic Parameter Report Definitions (Service 3,4)

TBW

3.2.3.5 Report Housekeeping Parameter Report Definitions (Service 3,9)

TBW

3.2.3.6 Report Diagnostic Parameter Report Definitions (Service 3,11)

TBW

3.2.4

Not Available

3.2.5 Event Reporting

Not Applicable

3.2.6 Memory Management

These commands allow access to the contents of memory locations. Three areas of memory have been identified:

- Program Memory (RAM)
- Data memory (RAM)
- EEPROM

When accessing memory the address is specified in terms of the number of Single Addressable Units (SAUs) from the start of the memory area. The SPIRE SAU is always 16bit words.

3.2.6.1 Load Memory Using Absolute Addresses (Service 6,2)

0	0	0	1	1	APID1										
1	1	Src			Count										
Length															
0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
MEMORYID															
STARTADDR															
0	0	0	0	0	0	0	0	NSAU							
Data															
CRC															
Checksum															

Parameters

Name	Comments
MEMORYID	
STARTADDR	Start Address in SAUs
NSAU	Number of SAUs to be loaded
DATA	Data to be loaded
CRC	CRC Checksum of data field

Possible Errors

Error	TM Service	Error Code	Description
Illegal_Memory_ID	(1,8)	0x0601	Not a valid memory ID
Illegal_Start_Address	(1,8)	0x0602	Start address outside valid range
Illegal_Nsau	(1,8)	0x0603	Length will place data outside valid address range
Bad_Nsau	(1,8)	0x0604	Length does not agree with size of data field
Bad_CRC	(1,8)	0x0605	CRC in command does not agree with calculated checksum over data in command
Bad_Load	(1,8)	0x0606	CRC in command does not agree with calculated checksum over data in memory

3.2.6.2 Dump Memory Using Absolute Addresses (Service 6,5)

0	0	0	1	1	APID1											
1	1	Src			Count											
Length																
0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	
0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
MEMORYID																
STARTADDR																
NSAU																
Checksum																

Parameters

Name	Value and Comments
MEMORYID	
STARTADDR	Start Address in SAUs
NSAU	Number of SAUs to be dumped

Possible Errors

Error	TM Service	Error Code	Description
Illegal_Memory_ID	(1,8)	0x0601	Not a valid memory ID
Illegal_Start_Address	(1,8)	0x0602	Start address outside valid range
Illegal_Nsau	(1,8)	0x0603	Length will read data outside valid address range

3.2.6.3 Check Memory Using Absolute Addresses (Service 6,9)

0	0	0	1	1	APID1											
1	1	Src			Count											
Length																
0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	
0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	
MEMORYID																
STARTADDR																
NSAU																
Checksum																

Parameters

Name	Value and Comments
MEMORYID	
STARTADDR	Start Address in SAUs
NSAU	Number of SAUs to be checked

Possible Errors

Error	TM Service	Error Code	Description
Illegal_Memory_ID	(1,8)	0x0601	Not a valid memory ID
Illegal_Start_Address	(1,8)	0x0602	Start address outside valid range
Illegal_Nsau	(1,8)	0x0603	Length will read data outside valid address range

3.2.7

Not Available

3.2.8 Function Management

All command packets of this type may give rise to the following Errors:

Error	TM Service	Error Code	Description
Illegal_Function_ID	(1,2)	0x0801	Function_ID not known

3.2.8.1 Start Function (Service 8,1)

These commands allow functions that are not started automatically when the OBS runs to be started.

3.2.8.1.1 Function 0x01: Table Management

Always available - cannot be started

3.2.8.1.2 Function 0x02: Cooler Control: Start Cooler Control

Starts thermal control of the Cooler. If thermal control is already operational, thermal control is stopped while the control parameters are updated and then restarted.

0 0 0 1 1	APID1
1 1 Src	Count
Length = 25	
0 0 0 0 0 0 0 1	0 0 0 0 1 0 0 0
0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0
FUNCTIONID	NPARMS
SID	
COOLS	
COOLKP	
COOLKI	
COOLKD	
COOLDT	
COOLN	
COOLPM	
COOLPC	
Checksum	

Parameters

Name	Value and Comments
FUNCTIONID	0x02
NPARMS	1
SID	0x0801
COOLS	Required Temperature (Raw Value)
COOLKP	Proportional Gain
COOLKI	Integral Gain
COOLKD	Differential Gain
COOLN	Number of samples to integrate
COOLDT	Sample Interval
COOLPM	Measurement Parameter
COOLPC	Control Parameter

Possible Errors

Error	TM Service	Error Code	Description
Bad_Nparms	(1,8)	0x0801	Number of parameters not as expected
Illegal_Sampling_Interval	(1,8)	0x0802	Sampling Interval is less than the absolute limit (10, TBC)
Illegal_Parameter	(1,8)	0x0803	Parameter PM or PC is not a valid DRCU parameter
Illegal_SID	(1,8)	0x0804	SID MSB not 0x08

3.2.8.1.3 Function 0x03: SCAL Control: Start SCAL Control

Starts thermal control of the SCAL. If thermal control is already operational, thermal control is stopped while the control parameters are updated and then restarted.

0 0 0 1 1	APID1
1 1 Src	Count
Length = 25	
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0	
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0	
FUNCTIONID	NPARMS
SID	
SCALS	
SCALKP	
SCALKI	
SCALK	
SCALDT	
SCALN	
SCALPM	
SCALPC	
Checksum	

Parameters

Name	Value and Comments
FUNCTIONID	0x03
NPARMS	1
SID	0x0801
SCALS	Required Temperature (Raw Value)
SCALKP	Proportional Gain
SCALKI	Integral Gain
SCALKD	Differential Gain
SCALDT	Sample Interval
SCALN	Number of samples to integrate
SCALPM	Measurement Parameter
SCALPC	Control Parameter

Possible Errors

Error	TM Service	Error Code	Description
Bad_Nparms	(1,8)	0x0801	Number of parameters not as expected
Illegal_Sampling_Interval	(1,8)	0x0802	Sampling Interval is less than the absolute limit (10, TBC)
Illegal_Parameter	(1,8)	0x0803	Parameter PM or PC is not a valid DRCU parameter
Illegal_SID	(1,8)	0x0804	SID MSB not 0x08

3.2.8.1.4 Function 0x04: 300mK Control: Start 300mK Control

Starts thermal control of the 300mK system. If thermal control is already operational, thermal control is stopped while the control parameters are updated and then restarted.

0 0 0 1 1	APID1
1 1 Src	Count
Length = 25	
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0	
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0	
FUNCTIONID	NPARMS
SID	
300MKS	
300MKKP	
300MKKI	
300MKKD	
300MKDT	
300MKN	
300MKPM	
300MKPC	
Checksum	

Parameters

Name	Value and Comments
FUNCTIONID	0x04
NPARMS	1
SID	0x0801
300MKS	Required Temperature (Raw Value)
300MKKP	Proportional Gain
300MKKI	Integral Gain
300MKKD	Differential Gain
300MKDT	Sample Interval
300MKN	Number of samples to integrate
300MKPM	Measurement Parameter
300MKPC	Control Parameter

Possible Errors

Error	TM Service	Error Code	Description
Bad_Nparms	(1,8)	0x0801	Number of parameters not as expected
Illegal_Sampling_Interval	(1,8)	0x0802	Sampling Interval is less than the absolute limit (10, TBC)
Illegal_Parameter	(1,8)	0x0803	Parameter PM or PC is not a valid DRCU parameter
Illegal_SID	(1,8)	0x0804	SID MSB not 0x08

3.2.8.1.5 Function 0xC0: Operations

Always Available - cannot be started

3.2.8.1.6 Function 0xC1: Observations

Always Available - cannot be started

3.2.8.1.7 Function 0xCA: DPU

Always Available - cannot be started

3.2.8.2 Stop Function (Service 8,2)

3.2.8.2.1 Function 0x001: Table Management

Always available - cannot be stopped

3.2.8.2.2 Function 0x02: Cooler Control: Stop Cooler Control

0	0	0	1	1	APID1										
1	1	Src	Count												
Length = 7															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
FUNCTIONID								0	0	0	0	0	0	0	0
Checksum															

Parameters

Name	Value
FUNCTIONID	0x02

3.2.8.2.3 Function 0x03: SCAL Control: Stop SCAL Control

0	0	0	1	1	APID1										
1	1	Src	Count												
Length = 7															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
FUNCTIONID								0	0	0	0	0	0	0	0
Checksum															

Parameters

Name	Value
FUNCTIONID	0x03

3.2.8.2.4 Function 0x04: 300mK Control: Stop 300mK Control

0	0	0	1	1	APID1										
1	1	Src	Count												
Length = 7															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
FUNCTIONID								0	0	0	0	0	0	0	0
Checksum															

Parameters

Name	Value
FUNCTIONID	0x04

3.2.8.2.5 Function 0xC0: Operations

Always Available - cannot be stopped

3.2.8.2.6 Function 0xC1: Observations

Always Available - cannot be stopped

3.2.8.2.7 Function 0xCA: DPU

Always Available - cannot be stopped

3.2.8.3 Perform Activity of a Function (Service 8,4)

All command packets of this type and subtype may give rise to the following Errors:

Error	TM Service	Error Code	Description
Illegal_Activity_ID	(1,2)	0x0802	Activity_ID not known

3.2.8.3.1 Function 0x01 Table Management, Activity 0x01: Load Table

0 0 0 1 1	APID1
1 1 Src	Count
Length	
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0	
0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0	
FUNCTIONID	ACTIVITYID
SID	
TABLEID	
INDEX	
DATATYPE	
NDATA	
DATA	
Checksum	

Parameters

Name	Value and Comments
FUNCTIONID	0x01
ACTIVITYID	0x01
SID	0x0802
TABLEID	
INDEX	
DATATYPE	
NDATA	
DATA	NDATA words

Possible Errors

Error	TM Service	Error Code	Description
Illegal_SID	(1,8)	0x0804	SID MSB not 0x08
Illegal_Table_ID	(1,8)	0x0805	Not a valid table ID
Illegal_Table_Index	(1,8)	0x0806	Index outside valid range
Illegal_Table_Data_Type	(1,8)	0x0807	Data Type not a recognised value
Bad_Data	(1,8)	0x0808	Ndata does not agree with length of data field
Table_Space_Full	(1,8)	0x0809	Not enough space available in table buffer to create new table

3.2.8.3.2 Function 0x01 Table Management, Activity 0x02: Report Table

0	0	0	1	1	APID1										
1	1	Src			Count										
Length = 17															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								AC TIVITYID							
SID															
TABLEID															
INDEX															
DATATYPE															
NDATA															
Checksum															

Parameter

Name	Value and Comments
FUNCTIONID	0x01
ACTIVITYID	0x02
SID	0x0803
TABLEID	
INDEX	
DATATYPE	
NDATA	

Possible Errors

Error	TM Service	Error Code	Description
Illegal_SID	(1,8)	0x0804	SID MSB not 0x08
Illegal_Table_ID	(1,8)	0x0805	Not a valid table ID
Illegal_Table_Index	(1,8)	0x0806	Index outside valid range
Illegal_Table_Data_Type	(1,8)	0x0807	Data Type not a recognised value

3.2.8.3.3 Function 0x01 Table Management, Activity 0x03: Update Table

0	0	0	1	1	APID1										
1	1	Src			Count										
Length															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID							
SID															
TABLEID															
INDEX															
DATATYPE															
NDATA															
DATA															
Checksum															

Parameters

Name	Value and Comments
FUNCTIONID	0x01
ACTIVITYID	0x03
SID	0x0804
TABLEID	
INDEX	
DATATYPE	
NDATA	
DATA	NDATA words

Possible Errors

Error	TM Service	Error Code	Description
Illegal_SID	(1,8)	0x0804	SID MSB not 0x08
Illegal_Table_ID	(1,8)	0x0805	Not a valid table ID
Illegal_Table_Index	(1,8)	0x0806	Index outside valid range
Illegal_Table_Data_Type	(1,8)	0x0807	Data Type not a recognised value
Bad_Data	(1,8)	0x0808	Ndata does not agree with length of data field
Table_Space_Full	(1,8)	0x0809	Not enough space available in table buffer to create new table

3.2.8.3.4 Function 0xC0 Operations, Activity 0x01: Execute Command List

0	0	0	1	1	APID1										
1	1	Src			Count										
Length															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID							
SID															
NDATA															
DATA															
Checksum															

Parameters

Name	Value and Comments
FUNCTIONID	0xC0
ACTIVITYID	0x01
SID	0x0805
NDATA	
DATA	NDATA * 32 bit data words

Possible Errors

Error	TM Service	Error Code	Description
Illegal_SID	(1,8)	0x0804	SID MSB not 0x08
Bad_Data	(1,8)	0x0808	Ndata does not agree with length of data field

3.2.8.3.5 Function 0xC0 Operations, Activity 0x02: Start Command List

0	0	0	1	1	APID1										
1	1	Src			Count										
Length															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID							
SID															
TABLEID															
INDEX															
N															
Parameters															
Checksum															

Parameters

Name	Value and Comments
FUNCTIONID	0xC0
ACTIVITYID	0x02
SID	0x0806
TABLEID	Table_ID of list to execute
INDEX	Index within Table at which to start
N	Number of parameters
Parameters	N * 32 bit data words

Possible Errors

Error	TM Service	Error Code	Description
Illegal_SID	(1,8)	0x0804	SID MSB not 0x08
Illegal_Table_ID	(1,8)	0x0805	Not a valid table ID
Illegal_Table_Index	(1,8)	0x0806	Index outside valid range
Bad_Table_Data_Type	(1,8)	0x0807	Data Type not valid for a command list
Bad_Data	(1,8)	0x0808	Nparms does not agree with length of data field

3.2.8.3.6 Function 0xC0 Operations, Activity 0x03: Stop Command List

0	0	0	1	1	APID1										
1	1	Src	Count												
Length = 7															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID							
Checksum															

Parameters

Name	Value
FUNCTIONID	0xC0
ACTIVITYID	0x03

Possible Errors

Error	TM Service	Error Code	Description
No_Command_List	(1,8)	0x080A	Command List Not Running

3.2.8.3.7 Function 0xC0 Operations, Activity 0x04: Peak Up

Possible parameters to this command are TBD but could include definition of the Photometer array to use to find the peak and the pixel defined to be the centre of the array.

0	0	0	1	1	APID1										
1	1	Src	Count												
Length = 7															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID							
Parameters															
Checksum															

Parameters

Name	Value
FUNCTIONID	0xC0
ACTIVITYID	0x04

Possible Errors

Error	TM Service	Error Code	Description
No_Peak	(1,8)	0x080B	Unable to find Peak

3.2.8.3.8 Function 0xC1 Observations, Activity 0x01: Set Observation ID

0	0	0	1	1	APID1											
1	1	Src			Count											
Length = 11																
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID								
OBSID																
Checksum																

Parameters

Name	Value and Comments
FUNCTIONID	0xC1
ACTIVITYID	0x01
OBSID	Observation ID (32 bits)

3.2.8.3.9 Function 0xC1 Observations, Activity 0x02: Set Building Block ID

0	0	0	1	1	APID1											
1	1	Src			Count											
Length = 11																
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID								
BBID																
Checksum																

Parameters

Name	Value and Comments
FUNCTIONID	0xC1
ACTIVITYID	0x02
BBID	Building Block ID (32 bits)

3.2.8.3.10 Function 0xC1 Observations, Activity 0x03: Set Observing Mode

0	0	0	1	1	APID1											
1	1	Src			Count											
Length = 19																
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID								
MODE																
Checksum																

Parameters

Name	Value and Comments
FUNCTIONID	0xC1
ACTIVITYID	0x03
MODE	Observing Mode

3.2.8.3.11 Function 0xC1 Observations, Activity 0x04: Set Observation Step

0	0	0	1	1	APID1											
1	1	Src			Count											
Length = 19																
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID								
STEP																
Checksum																

Parameters

Name	Value and Comments
FUNCTIONID	0xC1
ACTIVITYID	0x04
STEP	Observation Step

3.2.8.3.12 Function 0xCA DPU, Activity 0x01: Synchronise DRCU Counters

0	0	0	1	1	APID1										
1	1	Src	Count												
Length = 7															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID							
Checksum															

Parameters

Name	Value
FUNCTIONID	0xCA
ACTIVITYID	0x01

3.2.8.3.13 Function 0xCA DPU, Activity 0x02: Flush FIFOs

0	0	0	1	1	APID1										
1	1	Src	Count												
Length = 9															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID							
FIFOFLAGS															
Checksum															

Parameters

Name	Value
FUNCTIONID	0xCA
ACTIVITYID	0x02
FIFOFLAGS	

3.2.8.3.14 Function 0xCA DPU, Activity 0x03: Science Packing

0	0	0	1	1	APID1										
1	1	Src	Count												
Length = 19															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
FUNCTIONID								ACTIVITYID							
NDPU															
NDCU															
NSCU															
NCHOP															
NJIGGLE															
NSMEC															
Checksum															

Parameters

Name	Value and Comments
FUNCTIONID	0xCA
ACTIVITYID	0x03
NDPU	Number of DPU Science Frames per TM packet
NDCU	Number of DCU Science Frames per TM packet
NSCU	Number of SCU Science Frames per TM packet
NCHOP	Number of Chop Science Frames per TM packet
NJIGGLE	Number of Jiggle Science Frames per TM packet
NSMEC	Number of SMEC Science Frames per TM packet

Note: this command is better implemented as part of the Command List interpreter, as it is dependant on the current operational mode. In this case this command will not exist as a separate command.

3.2.8.4 Report Function Status (Service 8,5)

0	0	0	1	1	APID1										
1	1	Src	Count												
Length = 7															
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
FUNCTIONID								0	0	0	0	0	0	0	0
Checksum															

Parameter

Name	Comment
FUNCTIONID	Function to report on

3.2.9 Time Management

3.2.9.1 Enable Time Verification (Service 9,7)

0	0	0	1	1	APID1
1	1	0	0	0	Count
Length = 5					
0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1
0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
Checksum															

3.2.10

Not Available

3.2.11 On-Board Scheduling

Not Used

3.2.12 On-Board Monitoring

TBW

3.2.13

Not Available

3.2.14 Packet Transmission Control

3.2.14.1 Enable Generation of Telemetry Packets (Service 14,1)

TBW

3.2.14.2 Disable Generation of Telemetry Packets (Service 14,2)

TBW

3.2.14.3 Report Enabled Telemetry Packets (Service 14,3)

TBW

3.2.15 On-Board Storage and Retrieval

Not Used

3.2.16 On-Board Traffic Management

Not Used

3.2.17 Test Service

3.2.17.1 Perform Connection Test (Service 17,1)

0	0	0	1	1	APID1										
1	1	0	0	0	Count										
Length = 5															
0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Checksum															

3.2.18 On-Board Control Procedures

Not Used

3.2.19 Action/Event Service

Not Used

3.2.20 Information Distribution Service

3.2.20.1 Enable Distribution of Information TC Packets (Service 20,1)

0	0	0	1	1	APID1										
1	1	0	0	0	Count										
Length = 9															
0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
APID															
SID															
Checksum															

3.2.20.2 Disable Distribution of Information TC Packets (Service 20,2)

0	0	0	1	1	APID1										
1	1	0	0	0	Count										
Length = 9															
0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
APID															
SID															
Checksum															

3.2.20.3 Report Distributed Information Packets (Service 20,3)

0	0	0	1	1	APID1										
1	1	0	0	0	Count										
Length = 5															
0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0
0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Checksum															

3.2.20.4 Information Telecommand (Service 20,4)

This service is used to transfer the following information to the instrument from other spacecraft subsystems (e.g. AOCS)

1. On-target flag
2. Start of Scan

The format is TBC

3.2.20.4.1 On Target Flag Information

0 0 0 1 1	APID1
1 1 0 0 0	Count
Length = 13	
0 0 0 0 0 0 0 1 0 0 0 1 0 1 0	
0 0 0 0 0 1 0 0 0 0 0 0 0 0 0	
INFOTYPE	
OTFTIME	
OTFERROR	
Checksum	

Parameter

Name	Comment
INFOTYPE	Type of information 0 = Off Target 1 = On Target
OTFTIME	On Board Time of Report
OTFERROR	OTF flag is set if pointing is within this value

3.2.20.4.2 Telescope Scan Information

0 0 0 1 1	APID1
1 1 0 0 0	Count
Length = 13	
0 0 0 0 0 0 0 1 0 0 0 1 0 1 0	
0 0 0 0 0 1 0 0 0 0 0 0 0 0 0	
INFOTYPE	
TSFTIME	
Checksum	

Parameter

Name	Comment
INFOTYPE	Type of information 2 = Start of Scan 3 = End of Scan
TSFTIME	On Board Time of Report

3.2.21 Science Data

Not Applicable

3.2.22 Context Saving Service

The use of this service is TBD

4. SPIRE TELEMETRY PACKETS

This section defines all the TM packets that will be produced by SPIRE.

4.1 Telemetry Packet Types

The Packet Structure ICD (AD1) defines many types of service that can be provided by an Application. The following table shows the telemetry packet types that will be produced by the SPIRE.

Description	Service Type	Service Sub-Type	Comments
Telecommand Verification Service			
Telecommand Acceptance Report - Success	1	1	
Telecommand Acceptance Report - Failure	1	2	
Telecommand Execution Report - Started	1	3	
Telecommand Execution Report - Progress	1	5	
Telecommand Execution Report - Completed	1	7	
Telecommand Execution Report - Failure	1	8	
Telecommand Contents Report	1	9	Not Used
Device Command Distribution	2		N/A
Housekeeping and Diagnostic Data Reporting			
HK Parameter Report Definitions Report	3	10	
Diagnostic Parameter Definitions Report	3	12	
Housekeeping Parameter Report	3	25	
Diagnostic Parameter Report	3	26	
Event Reporting			
Event Report	5	1	
Exception Report	5	2	
Error/Alarm Report	5	4	
Memory Management			
Memory Dump, Absolute Addresses	6	6	
Memory Check Report, Absolute Addresses	6	10	
Function Management			
Function Status Report	8	6	
Time Management			
Central Time Reference	9	8	Not Used
Time Verification Report	9	9	
On-Board Scheduling	11		Not Used
On-Board Monitoring			
Current Monitoring List Report	12	9	
Packet Transmission Control			
Enabled Telemetry Packets Report	14	4	
On-Board Storage and Retrieval	15		Not Used
Test Service			
Connection Test Report	17	2	
On-Board Control procedures	18		Not Used (TBC)
Action/Event Service	19		Not Used
Information Distribution Service			
Distributed Information Packets Report	20	5	
Science Data			
Nominal Science Data Report	21	1	
Science Type B Data Report	21	2	
Diagnostic Science Data Report	21	3	
Auxiliary Science Data Report	21	4	
Context Saving Service	22		TBD
Context Report	22	2 (TBC)	

4.2 Telemetry Packet definitions

4.2.1 TC Verification Service

4.2.1.1 Telecommand Acceptance Report - Success (1,1)

0	0	0	0	1	APID1										
1	1	Count													
Length = 15															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
TIME															
TC_Packet_ID															
TC_Packet_Sequence_Control															
Checksum															

4.2.1.2

4.2.1.3 Telecommand Acceptance Report - Failure (1,2)

The structure of this packet depends on the type of error found.

4.2.1.3.1 Packet Control Errors

0	0	0	0	1	APID1										
1	1	Count													
Length = 19															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
TIME															
TC_Packet_ID															
TC_Packet_Sequence_Control															
Failure Code															
Parameter															
Checksum															

Error	*Failure Code*	*Parameter*
Illegal APID	0	TC_Packet_APID
Incomplete Packet or invalid Length	1	TC_Packet_Length
Incorrect Checksum	2	TC_Packet_Checksum
Illegal Packet Type	3	TC_Packet_Type
Illegal Packet Sub-Type	4	TC_Packet_Sub-Type

Note: The parameter is placed in the least significant bits of the16 bit 'parameter' field and the most significant bits are padded with zeros

4.2.1.3.2 Packet Content Error

0	0	0	0	1	APID1										
1	1	Count													
Length															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
TIME															
TC_Packet_ID															
Packet_Sequence_Control															
Failure Code															
Parameters															
Checksum															

Error	*Failure Code*	*Parameters*
Illegal or inconsistent Application Data	5	See Note
Other TBD errors	16-255	See Note
Illegal_Functio_ID	0x0801	See Note
Illegal_Activity_ID	0x0802	See Note

Note: The parameters for each error are TBD, but as a suggestion this field should contain the first 20 words from the 'source data' field of the received telecommand packet, unless this field is less than 20 words in length, in which case all words from the 'source data' field will be included.

4.2.1.4 Telecommand Execution Report - Started (1,3)

0	0	0	0	1	APID1											
1	1	Count														
Length = 15																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
TIME																
TC_Packet_ID																
TC_Packet_Sequence_Control																
Checksum																

4.2.1.5 Telecommand Execution Report - Progress (1,5)

0	0	0	0	1	APID1											
1	1	Count														
Length = 15																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
TIME																
TC_Packet_ID																
TC_Packet_Sequence_Control																
Step_Number																
Checksum																

4.2.1.6 Telecommand Execution Report - Completion (1,7)

0	0	0	0	1	APID1											
1	1	Count														
Length = 15																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
TIME																
TC_Packet_ID																
TC_Packet_Sequence_Control																
Checksum																

4.2.1.7 Telecommand Execution Report - Failure (1,8)

The structure of this packet depends on the type of error found and are currently TBC, but the Telemetry packet will take the following form.

0	0	0	0	1	APID1										
1	1	Count													
Length															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
TIME															
TC_Packet_ID															
TC_Packet_Sequence_Control															
Failure Code															
Parameters															
Checksum															

The following error Codes have been defined with the parameters to be provided in the TM packet:

Error	***Failure Code***	***Parameters***
Illegal_HK_Packet_ID	0x0301	HK_Packet_ID
Illegal_HK_SID	0x0302	HK_SID
Illegal_Table_ID	0x0303	HK_SID
Illegal_HK_Sampling Interval	0x0304	HK_Sampling_Interval
Bad_Ndata	0x0305	Length Ndata
Undefined_Table	0x0306	HK_SID
Illegal_Memory_ID	0x0601	Memory_ID
Illegal_Start_Address	0x0602	Memory_ID Start Adress
Illegal_Nsau	0x0603	Memory_ID Start_Address Nsau
Bad_Nsau	0x0604	Length Nsau
Bad_CRC	0x0605	CRC Calculated Checksum
Bad_Load	0x0606	CRC Calculated Checksum
Bad_Nparms	0x0801	Length Nparms
Illegal_Sampling_Interval	0x0802	Sample Interval
Illegal_Parameter	0x0803	Parameter
Illegal_SID	0x0804	SID
Illegal_Table_ID	0x0805	Table_ID
Illegal_Table_Index	0x0806	Table Index
Illegal_Table_Data Type	0x0807	Data_Type

Bad_Ndata	0x0808	Length Ndata
Table_Space_Full	0x0809	Table_ID Data_Type Ndata
No_Command_List	0x080a	-------

4.2.2 Device Command Distribution

Not Used

4.2.3 Housekeeping and Diagnostic Data Reporting

4.2.3.1 Housekeeping Parameter Report (Service 3,25)

The general packet structure is shown below. The Structure ID identifies the housekeeping packet type.

0 0 0 0 1	APID2
1 1	Count
Length	
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 1 1 0 0 1 0 0 0 0 0 0 0 0	
TIME	
SID	
Parameters	
Checksum	

SID	Packet type	Default Period (msec)
0x0300	Nominal Housekeeping Report	1000

4.2.3.2 Nominal Housekeeping Report (SID=0x0300)

The following table lists the field to be found in this report

Location (msb) octet	Location (msb) bit	Field Length (bits)	Parameter Name
18	0	32	OBSID
22	0	32	BBID
26	0	16	MODE
28	0	16	STEP
30	0	48	THSK
36	0	48	TSYNC
42	0	16	TCRECV
44	0	16	TCRECN
46	0	16	TCEXEC
48	0	16	TCEXEN
50	0	16	OTF
52	0	48	OTFTIME
58	0	16	OTFERROR
60	0	16	TSF
62	0	48	TSFTIME
68	0	32	OBSLEN
72	0	32	RATE
76	0	48	MEMCHK
82	0	16	MONFLAGS
84	0	16	DCUFLAGS
86	0	16	SCUFLAGS
88	0	16	MCUFLAGS
90	0	16	DPUI
92	0	16	DPU5V

94	0	16	DPU15V
96	0	16	DPU15VN
98	0	16	DPUTEMP
100	0	16	DPUSPARE1
102	0	16	DPUSPARE2
104	0	16	DPUSPARE3
106	0	8	DCUDATAMODE
107	0	8	DCUDATAFRMS
108	0	8	DCUDATASTAT
109	0	8	PHOTSAMPFREQ
110	0	8	PHOTBIASMODE
111	0	8	spare
112	0	16	PHOTBIASFREQ
114	0	8	PSWBIAS
115	0	8	PMWBIAS
116	0	8	PLWBIAS
117	0	8	TCBIAS
118	0	8	PSWPHSE
119	0	8	PMWPHSE
120	0	8	PLWPHSE
121	0	8	TCPHSE
122	0	8	PSWJFETSTAT
123	0	8	PMLWJFETSTAT
124	0	8	PSWJFET1V
125	0	8	PSWJFET2V
126	0	8	PSWJFET3V
127	0	8	PSWJFET4V
128	0	8	PSWJFET5V
129	0	8	PSWJFET6V
130	0	8	PMWJFET1V
131	0	8	PMWJFET2V
132	0	8	PMWJFET3V
133	0	8	PMWJFET4V
134	0	8	PLWJFET1V
135	0	8	PLWJFET2V
136	0	8	PHOTHTRV
137	0	8	spare
138	0	8	SPECSAMPFREQ
139	0	8	SPECBIASMODE
140	0	16	SPECBIASFREQ
142	0	8	SSWBIAS
143	0	8	SLWBIAS
144	0	8	SSWPHSE
145	0	8	SLWPHSE
146	0	8	SPECJFETSTAT
147	0	8	SSWJFET1V
148	0	8	SSWJFET2V
149	0	8	SLWJFET1V
150	0	8	SPECHTRV
151	0	8	spare
152	0	32	TC1TEMP
156	0	32	TC2TEMP
160	0	32	TC3TEMP
164	0	8	LIA01TEMP
165	0	8	LIA02TEMP

166	0	8	LIA03TEMP
167	0	8	LIA04TEMP
168	0	8	LIA05TEMP
169	0	8	LIA06TEMP
170	0	8	LIA07TEMP
171	0	8	LIA08TEMP
172	0	8	LIA09TEMP
173	0	8	LIA010TEMP
174	0	8	LIA11TEMP
175	0	8	LIA12TEMP
176	0	8	BIASTEMP
177	0	8	DAQTEMP
178	0	8	SMECOENCPWR
179	0	8	SMECLVDTPWR
180	0	8	SMECLOOPMODE
181	0	8, TBC	SMECINITSTAT
182	0	8	SMECLAT1STAT
183	0	8	SMECLAT2STAT
184	0	16	SCANSTART
186	0	16	SCANSPEED
188	0	8	SCANSTAT
189	0	8	SCANMODE
190	0	16	SCANS
192	0	16	SMECKPHIGH
194	0	16	SMECKPLOW
196	0	16	SMECKDHIGH
198	0	16	SMECKDLOW
200	0	16	SMECFILTHIGH
202	0	16	SMECFILTLOW
204	0	16	SMECKIHIGH
206	0	16	SMECKILOW
208	0	16	SMECSATNLIM
210	0	16	SMECPERRLIM
212	0	16	SMECNOTCHIGH
214	0	16	SMECNOTCHLOW
216	0	16	SMECSTAT
218	0	16	SMECPOSN
220	0	16	SMECVEL
222	0	16	SMECMEANVEL
224	0	16	SMECMEANPERR
226	0	8	CHOPSENSPWR
227	0	8, TBC	CHOPLOOPMODE
228	0	8, TBC	CHOPLATSTAT
229	0	8	spare
230	0	16	CHOPPOSN0
232	0	16	CHOPPOSN1
234	0	16	CHOPPERIOD
236	0	8	CHOPMODE
237	0	8	spare
238	0	16	CHOPS
240	0	16	CHOPKPHIGH
242	0	16	CHOPKPLOW
244	0	16	CHOPKDHIGH
246	0	16	CHOPKDLOW
248	0	16	CHOPFILTHIGH

250	0	16	CHOPFILTLOW
252	0	16	CHOPKIHIGH
254	0	16	CHOPKILOW
256	0	16	CHOPSATNLIM
258	0	16	CHOPPERRLIM
260	0	16	CHOPSTAT
262	0	16	CHOPPOSN
264	0	16	CHOPMEANPERR
266	0	8	JIGGSENSPWR
267	0	8, TBC	JIGGLOOPMODE
268	0	8, TBC	JIGGLATSTAT
269	0	8	spare
270	0	16	JIGGPOSN0
272	0	16	JIGGPOSN1
274	0	16	JIGGPERIOD
276	0	8	JIGGMODE
279	0	8	spare
280	0	16	JIGGLES
282	0	16	JIGGKPHIGH
284	0	16	JIGGKPLOW
286	0	16	JIGGKDHIGH
288	0	16	JIGGKDLOW
290	0	16	JIGGFILTHIGH
292	0	16	JIGGFILTLOW
294	0	16	JIGGKIHIGH
296	0	16	JIGGKILOW
298	0	16	JIGGSATNLIM
300	0	16	JIGGPERRLIM
302	0	16	JIGGSTAT
304	0	16	JIGGPOSN
306	0	16	JIGGMEANPERR
308	0	16	MCUTELSTAT
310	0	16	MCUTELSAMP
312	0	16	TRACEPERIOD
314	0	16	TRACESIZE
316	0	16	TRACEPARM1
318	0	16	TRACEPARM2
320	0	16	TRACEPARM3
322	0	16	TRACEPARM4
324	0	16	TRACEPARM5
326	0	16	TRACEPARM6
328	0	16	MCUTIMEOUT
330	0	16	SCUCMDSTAT
332	0	16	SCUDELAY
334	0	8	SCUSTAT
335	0	8	spare
336	0	16	SCUDATAFREQ
338	0	16	SCUFRAMES
340	0	16	SCUTEMPSTAT
342	0	16	SCUSUBKFREQ
344	0	8	SCUSUBSSTAT
345	0	8	spare
346	0	16, TBC	SCULHTR1V
348	0	16, TBC	SCULHTR2V
350	0	16, TBC	SCULHTR3V

352	0	16, TBC	SCUHHTRV
354	0	16, TBC	SCUCAL1V
356	0	16, TBC	SCUCAL2V
358	0	16, TBC	SCUCAL3V
360	0	16, TBC	SCUCAL1I
362	0	16, TBC	SCUCAL2I
364	0	16, TBC	SCUCAL3I
366	0	16, TBC	SCU5V
368	0	16, TBC	SCU9V
370	0	16, TBC	SCU9VN
372	0	16, TBC	PHOTBIAS9V
374	0	16, TBC	PHOTBIAS9VN
376	0	16, TBC	SPECBIAS9V
378	0	16, TBC	SPECBIAS9VN
380	0	16, TBC	DAQBIAS5V
382	0	16, TBC	DAQ9V
384	0	16, TBC	DAQ9VN
386	0	16, TBC	PHOTLIA5V
388	0	16, TBC	PHOTLIA9V
390	0	16, TBC	PHOTLIA9VN
392	0	16, TBC	SPECLIA5V
394	0	16, TBC	SPECLIA9V
396	0	16, TBC	SPECLIA9VN
398	0	16, TBC	TEMP01
400	0	16, TBC	TEMP02
402	0	16, TBC	TEMP03
404	0	16, TBC	TEMP04
406	0	16, TBC	TEMP05
408	0	16, TBC	TEMP06
410	0	16, TBC	TEMP07
412	0	16, TBC	TEMP08
414	0	16, TBC	TEMP09
416	0	16, TBC	TEMP10
418	0	16, TBC	TEMP11
420	0	16, TBC	TEMP12
422	0	16, TBC	TEMP13
424	0	16, TBC	TEMP14
426	0	16, TBC	TEMP15
428	0	16, TBC	TEMP16
430	0	16, TBC	SUBKTEMP
432	0	16, TBC	CCUTEMP
434	0	16, TBC	TCUTEMP
436	0	16, TBC	DCUTEMP
438	0	16, TBC	PSUTEMP
440	0	16, TBC	SCUSPARE

4.2.4

Not Available

4.2.5 Event Reporting

4.2.5.1 Event Report (5,1)

4.2.5.1.1 New Step Report

0 0 0 0 1	APID1
1 1	Count
Length = 25	
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1	
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0	
TIME	
SID = 0x0501	
OBSID	
BBID	
MODE	
STEP	
Checksum	

4.2.5.1.2 On Target Report

0 0 0 0 1	APID1
1 1	Count
Length = 25	
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1	
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0	
TIME	
SID = 0x0502	
OBSID	
BBID	
OTF	
OTFTIME	
OTFERROR	
Checksum	

Parameter	Comment
OTF	Copy of INFOTYPE from command 0 = Off Target 1 = On Target

4.2.5.1.3 Telescope Scan Report

0	0	0	0	1	APID1														
1	1	Count																	
Length = 25																			
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1				
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0				
TIME																			
SID = 0x0503																			
OBSID																			
BBID																			
TSF																			
TSFTIME																			
Checksum																			

Parameter	Comment
TSF	Copy of INFOTYPE from command 2 = Start Scan 3 = End Scan

4.2.5.1.4 Peak Up Report

0	0	0	0	1	APID1														
1	1	Count																	
Length = 25																			
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1				
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0				
TIME																			
SID = 0x0504																			
OBSID																			
BBID																			
Parameters																			
Checksum																			

Parameter	Comment
Parameters	TBD, but will contain information for the AOCS to offset to bring the peak on to the required pixel

Possible more Events:

Command_Response_Error: Response from DRCU subsystem to command is not correct. Parameters: copy of command to DRCU

Frame_Error: when copying data frames from the FIFO to the internal science data buffer, the frame structure is not correct. Parameters: copy of Frame Data

4.2.5.2 Exception Report (5,2)

0	0	0	0	1	APID1										
1	1	Count													
Length															
0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
TIME															
SID															
OBSID															
BBID															
Parameters															
Checksum															

TBW

4.2.5.3 Error/Alarm Report (5,4)

0	0	0	0	1	APID1										
1	1	Count													
Length															
0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
TIME															
SID															
OBSID															
BBID															
Parameters															
Checksum															

TBW

4.2.6 Memory Management

TBW

4.2.7

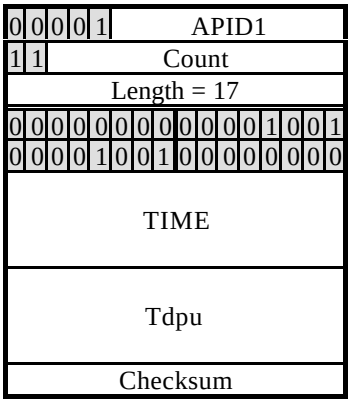
Not Available

4.2.8 Function Management

TBW

4.2.9 Time Management

4.2.9.1 Time Verification Report



4.2.10

Not Available

4.2.11 On Board Scheduling

Not Used

4.2.12 On Board Monitoring

TBW

4.2.13

Not Available

4.2.14 Packet Transmission Control

TBW

4.2.15 On Board Storage and Retrieval

Not Used

4.2.16 On Board Traffic Management

Not Used

4.2.17 Test Service

TBW

4.2.18 On Board Control Procedures

Not Used

4.2.19 Action/Event Service

Not Used

4.2.20 Information Distribution Service

4.2.20.1 Distributed Information Packets Report (Service 20,5)

0 0 0 0 1	APID1
1 1	Count
Length = 17	
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1	
0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0	
NPKT	
$APID_1$	
SID_1	
:	
:	
:	
$APID_{NPKT}$	
SID_{NPKT}	
Checksum	

4.2.21 Science Data

4.2.21.1 Nominal Science Data Report (21,1)

0	0	0	0	1	APID											
1	1	Count														
Length																
0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
TIME																
SID																
OBSID																
BBID																
Parameters																
Checksum																

The reports available are identified by the APID (APID3 = Photometer, APID4 = Spectrometer) and the SID (composed of the Frame Structure (MSByte) and FrameID (LSByte)):

APID	SID	Report
APID3	0x0200	Photometer Full Array
APID4	0x0201	Spectrometer Full Array
APID5	0x0410	SMEC Scan
APID5	0x0612	Chop
APID5	0x0713	Jiggle
APID5	0x1020	SCU
APID5	0x8080	DPU

The *parameters* field contains one or more blocks of science data all of the same type. The possible block types are as follows:

4.2.21.1.1 Photometer Full Array Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Ndcu times but when the DCU FIFO is flushed this may result in a packet with less than Ndcu blocks.

Frame_Time (32 bits)
PSW Array (144 Words)
PMW Array (96 Words)
PLW Array (48 Words)
ADC_Flags
Checkword

This structure is TBC

4.2.21.1.2 Spectrometer Full Array Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Ndcu times but when the DCU FIFO is flushed this may result in a packet with less than Ndcu blocks.

Frame_Time (32 bits)
SSW Array (42 Words)
SLW Array (24 Words)
ADC_Flags
Checkword

This structure is TBC

4.2.21.1.3 SMEC Scan Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Nsmec times, but when the MCU FIFO is flushed this may result in a packet with less than Nsmec blocks.

Crossing_Time (32 bits)
Crossing Count
Mean_Velocity
DC_LVDT
Checkword

This structure is TBC

4.2.21.1.4 Chop Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Nchop times, but when the MCU FIFO is flushed this may result in a packet with less than Nchop blocks.

Frame_Time
Chop_Position
Chop_Error
Checkword

This structure is TBC

4.2.21.1.5 Jiggle Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Njiggle times, but when the MCU FIFO is flushed this may result in a packet with less than Njiggle blocks.

This structure is TBC

4.2.21.1.6 SCU Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Nscu times, but when the SCU FIFO is flushed this may result in a packet with less than Nscu blocks.

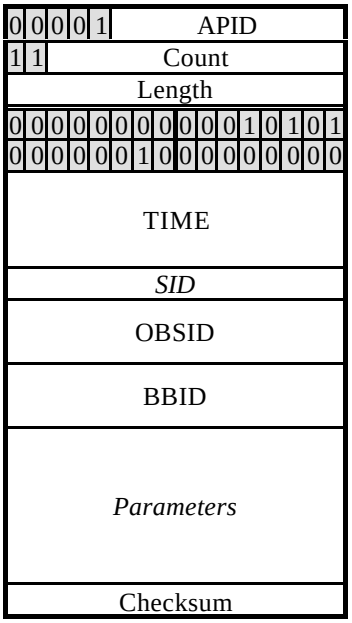
This structure is TBC

4.2.21.1.7 DPU Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Ndpu times, but when the telemetry buffers are flushed this may result in a packet with less than Ndpu blocks.

This structure is TBC

4.2.21.2 Science Type B Data Report (21,2)



The reports available are identified by the APID (APID3 = Photometer, APID4 = Spectrometer) and the SID (composed of the Frame Structure (MSByte) and FrameID (LSByte)):

APID	SID	Report
APID3	0x0102	PSW Array
APID3	0x0103	PMW Array
APID3	0x0104	PLW Array
APID4	0x0105	SSW Array
APID4	0x0106	SLW Array
APID5	0x0511	SMEC Step

The *parameters* field contains one or more blocks of science data all of the same type. The possible block types are as follows:

4.2.21.2.1 PSW Array Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Ndcu times but when the DCU FIFO is flushed this may result in a packet with less than Ndcu blocks.

Frame_Time (32 bits)
PSW Array (144 Words)
T/C (4 words, TBC)
ADC_Flags
Checkword

This structure is TBC

4.2.21.2.2 PMW Array Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Ndcu times but when the DCU FIFO is flushed this may result in a packet with less than Ndcu blocks.

Frame_Time
PMW Array (96 Words)
ADC_Flags
Checkword

This structure is TBC

4.2.21.2.3 PLW Array Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Ndcu times but when the DCU FIFO is flushed this may result in a packet with less than Ndcu blocks.

Frame_Time
PLW Array (48 Words)
T/C (4 words, TBC)
ADC_Flags
Checkword

This structure is TBC

4.2.21.2.4 SSW Array Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Ndcu times but when the DCU FIFO is flushed this may result in a packet with less than Ndcu blocks.

Frame_Time (32 bits)
SSW Array (42 Words)
ADC_Flags
Checkword

This structure is TBC

4.2.21.2.5 SLW Array Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Ndcu times but when the DCU FIFO is flushed this may result in a packet with less than Ndcu blocks.

Frame_Time (32 bits)
SLW Array (24 Words)
ADC_Flags
Checkword

This structure is TBC

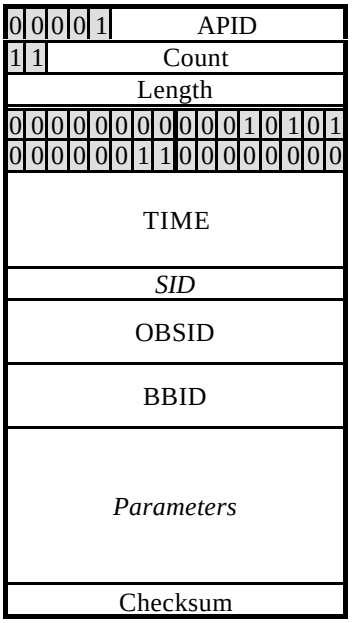
4.2.21.2.6 SMEC Step Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Nsmec times but when the MCU FIFO is flushed this may result in a packet with less than Nsmec blocks.

Frame_Time (32 bits)
SMEC_Position
Position_Error
AC_LVDT
DC_LVDT
Checkword

This structure is TBC

4.2.21.3 Diagnostic Science Report (21,3)



The reports available are identified by the APID (APID3 = Photometer, APID4 = Spectrometer) and the SID (composed of the Frame Structure (MSByte) and FrameID (LSByte)):

APID	SID	Report
APID3	0x0307	DCU Test Pattern
APID5	0x0814	MCU Trace
APID5	0x0915	MCU Test Pattern
APID5	0x1121	SCU Test Pattern

The *parameters* field contains one or more blocks of science data all of the same type. The possible block types are as follows:

4.2.21.3.1 DCU Test Pattern Structure

TBD

4.2.21.3.2 MCU Trace Structure

TBD

4.2.21.3.3 MCU Test Pattern Structure

TBD

4.2.21.3.4 SCU Test Pattern Structure

TBD

4.2.21.4 Auxiliary Science Data Report (21,4)

0	0	0	0	1	APID											
1	1	Count														
Length																
0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
TIME																
SID																
OBSID																
BBID																
Parameters																
Checksum																

The reports available are identified by the APID (APID3 = Photometer, APID4 = Spectrometer) and the SID (composed of the Frame Structure (MSByte) and FrameID (LSByte)):

APID	SID	Report
APID3	0x0208	Photometer Offsets
APID4	0x0209	Spectrometer Offsets

The *parameters* field contains one or more blocks of science data all of the same type. The possible block types are as follows:

4.2.21.4.1 Photometer Offsets Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Ndcu times but when the DCU FIFO is flushed this may result in a packet with less than Ndcu blocks.

Frame_Time (32 bits)
PSW Offsets (144 Words)
PMW Offsets (96 Words)
PLW Offsets (48 Words)
Checkword

This structure is TBC

4.2.21.4.2 Spectrometer Offsets Structure

This block of data is inserted in the *Parameter* field a multiple number of times ,nominally Ndcu times but when the DCU FIFO is flushed this may result in a packet with less than Ndcu blocks.

Frame_Time (32 bits)
SSW Offsets (42 Words)
SLW Offsets (24 Words)
Checkword

4.2.22 Context Saving Service

TBW

5. PARAMETERS

5.1 TC Parameters

5.1.1 Parameter Definition

Parameter Name	Service Reference	Type	Size (bits)	Conversion Curve	Constraint Table	Comments
300MKDT	(8,1)	Unsigned Integer	16	None	Period	Time between successive executions of the control loop, in milliseconds
300MKKD	(8,1)	Integer	16, TBC	None	TBD	Differential gain in control loop
300MKKI	(8,1)	Integer	16, TBC	None	TBD	Integral gain in control loop
300MKKP	(8,1)	Integer	16, TBC	None	TBD	Proportional gain in control loop
300MKN	(8,1)	Integer	16	None	NSamples	Number of samples to integrate
300MKPC	(8,1)	Integer	16	None	None	Parameter to use as the control variable. Expressed as the most significant 16 bits of the DRCU command word to be sent to set the housekeeping value, TBC
300MKPM	(8,1)	Integer	16	None	None	Parameter to use as the measurement variable. Expressed as the most significant 16 bits of the DRCU command word to be sent to get the housekeeping value, TBC
300MKS	(8,1)	Integer	32	None	HskValue	Required set point - value of the measurement variable to be maintained
Activity_ID	(8,4)	Integer	8	None	None	
APID	(20,1) (20,2)	Integer	11	None	None	Application ID
BBID	(8,4)		32			Field is split into 3 parts:

BBINTR BBTYPE BBCOUNT		Constant Integer Integer	2 14 16	None None None	None None None	Location: Bits 0-1 Value: 2 Location: Bits 2-15 Location: Bits 16-31
COOLDT	(8,1)	Unsigned Integer	16	None	Period	Time between successive executions of the control loop, in milliseconds
COOLKD	(8,1)	Integer	16, TBC	None	TBD	Differential gain in control loop
COOLKI	(8,1)	Integer	16, TBC	None	TBD	Integral gain in control loop
COOLKP	(8,1)	Integer	16, TBC	None	TBD	Proportional gain in control loop
COOLN	(8,1)	Integer	16	None	NSamples	Number of samples to integrate
COOLPC	(8,1)	Integer	16	None	None	Parameter to use as the control variable. Expressed as the most significant 16 bits of the DRCU command word to be sent to set the housekeeping value, TBC
COOLPM	(8,1)	Integer	16	None	None	Parameter to use as the measurement variable. Expressed as the most significant 16 bits of the DRCU command word to be sent to get the housekeeping value, TBC
COOLS	(8,1)	Integer	32	None	Hsk_Value	Required set point - value of the measurement variable to be maintained
CRC	(6,2)	Unsigned Integer	16	None	None	Cyclic Redundancy Check - algorithm TBD
Data	(6,2) (8,4)					Variable length field of any data type. Must be an integer number of 16 bits in length
DATATYPE	(8,4)	Integer	2	Data_Type	Bit2	Type of data loaded in a table
FIFOFLAGS FIFODPU FIFODCU FIFOSCU FIFOMCU	(8,4)	 Integer Integer Integer Integer	16 1 1 1 1	 Flush Flush Flush Flush	 None None None None	Flags indicating the FIFO(s) to flush Location: bit 15: DPU science buffer Location: bit 14: DCU FIFO Location: bit 13: SCU FIFO Location: bit 12: MCU FIFO
FUNCTIONID	(8,1) (8,2) (8,4) (8,5)	Integer	8	Func_ID	None	

HKPCKTID	(3,1)	Integer	16	None	Hsk_ID	Identifies housekeeping packets 0 = default packet 1 to 3 indicates additional packets
HKSID	(3,1)	Unsigned Integer	16	None	None	Unique identifier for parameter list Value = 0x03nn where nn = the Table_ID of the table containing the report definition
HKINTERVAL	(3,1)	Unsigned Integer	16	None	Period	Time between each packet generated, in milliseconds
INDEX	(8,4)	Unsigned Integer	16	None	None	Offset into a table(in octets)
INFOTYPE	(20,4)	Unsigned Integer	16	Info_Type	None	Type of information Packet
Length	(6,2) (6,5) (6,9)	Unsigned Integer	16	None	None	
MEMORYID	(6,2) (6,5) (6,9)	Integer	16	Mem_ID	None	ID of Memory Area to be addressed
MODE	(8,4)	Unsigned Integer	16	None	None	Observing Mode
N	(8,4)	Unsigned Integer	16	None	N32	
NCHOP	(8,4)	Integer	16	None	TBD	Number of Chop science data frames to combine into one Chop Science TM Packet
NDATA	(8,2)	Unsigned Integer	16	None	N16	
NDCU	(8,4)	Integer	16	None	TBD	Number of DCU science data frames to combine into one Chop Science TM Packet
NDPU	(8,4)	Integer	16	None	TBD	Number of DPU science data frames to combine into one Chop Science TM Packet
NJIGGLE	(8,4)	Integer	16	None	TBD	Number of Jiggle science data frames to combine into one Chop Science TM Packet
NPARMS	(8,1)	Integer	8	None	None	Number of parameter to follow
NSAU	(6,2) (6,5) (6,9)	Integer	16	None	None	Number of SAUs to transfer

NSCU	(8,4)	Integer	16	None	TBD	Number of SCU science data frames to combine into one Chop Science TM Packet
NSMEC	(8,4)	Integer	16	None	TBD	Number of SMEC science data frames to combine into one Chop Science TM Packet
OBSID	(8,4)	Unsigned Integer	32	None	None	Observation ID
OTFTIME	(20,4)	Time	48	None	None	Time of OTF change
OTFERROR	(20,4)	TBD	TBD	TBD	TBD	Maximum position error to be on target
Parameters	(8,4)					Variable length field of 32 data words.
SCALDT	(8,1)	Unsigned Integer	16	None	Period	Time between successive executions of the control loop, in milliseconds
SCALKD	(8,1)	Integer	16, TBC	None	TBD	Differential gain in control loop
SCALKI	(8,1)	Integer	16, TBC	None	TBD	Integral gain in control loop
SCALKP	(8,1)	Integer	16, TBC	None	TBD	Proportional gain in control loop
SCALN	(8,1)	Integer	16	None	NSamples	Number of samples to integrate
SCALPC	(8,1)	Integer	16	None	None	Parameter to use as the control variable. Expressed as the most significant 16 bits of the DRCU command word to be sent to set the housekeeping value, TBC
SCALPM	(8,1)	Integer	16	None	None	Parameter to use as the measurement variable. Expressed as the most significant 16 bits of the DRCU command word to be sent to get the housekeeping value, TBC
SCALS	(8,1)	Integer	32	None	Hsk_Value	Required set point - value of the measurement variable to be maintained
SID	(8,1) (8,4) (20,1) (20,2)	Unsigned Integer	16	None	None	Unique identifier for parameter list Values are TBD
STARTADDR	(6,2) (6,5) (6,9)	Unsigned Integer	16	None	None	Start address of memory area to be addressed
STEP	(8,4)	Unsigned	16	None	None	Observation Step

		Integer				
TABLEID	(8,4)	Integer	16	None	Tab_ID	Up to 128 tables can be defined
TSFTIME	(20,4)	Time	48	None	None	Time of Telescope Scan start/end

5.1.2 Conversion Curves

Name	Type	Raw Value	Converted Value	Comments
Data_Type	Enumerated	0 1 2 3	8Bits 16Bits 24Bits 32Bits	
Func_ID	Enumerated	0x01 0x02 0x03 0x04 0xC0 0xC1 0xCA	Table Cooler SCAL 300mK Ops Obs DPU	TableManagement CoolerControl SCALControl 300mKControl Operations Observations DPU
Info_Type	Enumerated	0 1 2 3	Off Target On Target Start Scan End Scan	
Mem_ID	Enumerated	TBD	TBD	
Flush	Enumerated	0 1	Do not flush FIFO Flush FIFO	

5.1.3 Constraints

Name	Type	Minimum Value	Maximum Value	Comments
Bit2	Range	0	3	Value held in lowest 2 bits of field
Hsk_ID	Range	0	3	Allows three housekeeping packets other than the default to be defined
Hsk_Value	Range	0x00000000	0x000FFFFF	The value is held in lowest 20 bits of the field
N16	Range	1	112	Number of 16 bit data words held in a command

N32	Range	1	56	Number of 32 bit data words held in a command
Nsamples	Range	1	32	
Period	Range	10	60000	Time period expressed as milliseconds - range is 0.01 to 60 seconds
Tab_ID	Range	0	127	

5.2 TM Parameters

5.2.1 Parameter Definition

Name	DRCU Name	Length (bits)	Conversion	Limits	Description
BBID BBINSTR BBTYPE BBCNT		**32** 2 14 16			**Building Block ID** Instrument (Bits 0,1) BB type (Bits 2-15) BB sequence count (Bits 16-31)
BIASTEMP	BIAS_TEMP	8	TBD		BIAS Board Temperature
CCUTEMP	CcuTempRd	TBD	TBD	TBD	Temperature from sensor on CCHK Board
CHOPKDHIGH	KdHigh	16, TBC			Maximum Derivative Gain of Chop Axis PID Controller?
CHOPKDLOW	KdLow	16, TBC			Minimum Derivative Gain of Chop Axis PID Controller?
CHOPFILTHIGH	DerivFilterHigh	16, TBC			Filtering Time Constant to calculate the derivative term of the Chop PID Controller
CHOPFILTLOW	DerivFilterLow	16, TBC			Filtering Time Constant to calculate the derivative term of the Chop PID Controller
CHOPKIHIGH	KiHigh	16, TBC			Maximum Integral Gain of Chop Axis PID Controller?
CHOPKILOW	KiLow	16, TBC			Minimum Integral Gain of Chop Axis PID Controller?
CHOPKPHIGH	KpHigh	16, TBC			Maximum Proportional Gain of Chop Axis PID Controller?
CHOPKPLOW	KpLow	16, TBC			Minimum Proportional Gain of Chop Axis PID Controller?
CHOPLATSTAT	ChopLaunchLatch	1	LATCH		Chopper Axis Launch Latch Status
CHOPLOOPMODE	ChopLoopMode	2	CLOOPMODE		Chopper Axis Loop Mode

CHOPMEANPERR	MeanPositionError	16, TBC			Mean Position Error over a Chopper movement?
CHOPMODE	ChopMode	2	CHOPMODE		Chopping Mode
CHOPPERIOD	ChopPeriod	16, TBC	PERIOD		Chop Cycle Period
CHOPPERRLIM	PositionErrorLimit	16, TBC			Minimum Value of Chop Position Error that causes a PID error to be reported?
CHOPPOSN	ActualPosition	16, TBC			Last Absolute position of the Chopper
CHOPPOSN0	Position0	16, TBC			Chopper Axis Position 0
CHOPPOSN1	Position1	16, TBC			Chopper Axis Position 1
CHOPS	ChopNumber	16, TBC			Number of Chop Cycles to perform
CHOPSATNLIM	IntegrationLimit	16, TBC			Integration Saturation Limit for the Chop PID Controller?
CHOPSENSPWR	SensorPwr	1	CHOPSENS		Chopper axis sensor power status
CHOPSTAT	ChopStatus	16, TBC	TBD		Contents of Chop Axis Activity Status Register
DAQBIAS5V	DcuDAQp05	TBD	TBD	TBD	Voltage to DAQ Board on +5V line
DAQ9V	DcuDAQp09	TBD	TBD	TBD	Voltage to DAQ Board on +9V line
DAQ9VN	DcuDAQn09	TBD	TBD	TBD	Voltage to DAQ Board on -9V line
DAQTEMP	DAQ_I/F_TEMP	8	TBD		DAQ I/F Board Temperature
DCUDATAFRMS	frame	8	DCUFRMS		Number of DCU data frames to generate
DCUDATAMODE	mode	5	DCUMODE		DCU data collection mode
DCUDATASTAT	start	1	DCUSTAT		Status of DCU data frame generation
DCUFLAGS		16			DCU Status -TBC
DCUTEMP	DcuTempRd	TBD	TBD	TBD	Temperature from sensor on Distribution Board
DPU5V		12	TBD		DPU +5V line voltage
DPU15V		12	TBD		DPU +15V line voltage
DPU15VN		12	TBD		DPU -15V line voltage
DPUI		12	TBD		DPU measured input current
DPU_Spare1		12	TBD		
DPU_Spare2		12	TBD		
DPU_Spare3		12	TBD		
DPUTEMP		12	TBD		DPU DC-DC Converter Temperature
JIGGKDHIGH	KdHigh	16, TBC			Maximum Derivative Gain of Chop Axis PID Controller?
JIGGKDLOW	KdLow	16, TBC			Minimum Derivative Gain of Chop Axis PID Controller?
JIGGFILTHIGH	DerivFilterHigh	16, TBC			Filtering Time Constant to calculate the derivative term of the Chop PID Controller

JIGGFILTLOW	DerivFilterLow	16, TBC			Filtering Time Constant to calculate the derivative term of the Chop PID Controller
JIGGKIHIGH	KiHigh	16, TBC			Maximum Integral Gain of Chop Axis PID Controller?
JIGGKILOW	KiLow	16, TBC			Minimum Integral Gain of Chop Axis PID Controller?
JIGGKPHIGH	KpHigh	16, TBC			Maximum Proportional Gain of Chop Axis PID Controller?
JIGGKPLOW	KpLow	16, TBC			Minimum Proportional Gain of Chop Axis PID Controller?
JIGGLATSTAT	JiggleLaunchLatch	1	LATCH		Jiggle Axis Launch Latch Status
JIGGLOOPMODE	JiggleLoopMode	2	JLOOPMODE		Jiggle Axis Loop Mode
JIGGMEANPERR	MeanPositionError	16, TBC			Mean Position Error over a Jiggle movement?
JIGGMODE	JiggleMode	2	JIGGMODE		Jiggling Mode
JIGGPERIOD	JigglePeriod	16, TBC	PERIOD		Jiggle Cycle Period – TBD if applicable
JIGGPERRLIM	PositionErrorLimit	16, TBC			Minimum Value of Chop Position Error that causes a PID error to be reported?
JIGGPOSN	ActualPosition	16, TBC			Last Absolute position of the Jiggle Axis
JIGGPOSN0	Position0	16, TBC			Jiggle Axis Position 0
JIGGPOSN1	Position1	16, TBC			Jiggle Axis Position 1 – TBD if applicable
JIGGLES	JiggleNumber	16, TBC			Number of Jiggle Cycles to perform – TBD if applicable
JIGGSATNLIM	IntegrationLimit	16, TBC			Integration Saturation Limit for the Chop PID Controller?
JIGGSENSPWR	SensorPwr	1	JIGGSENS		Jiggle Axis sensor power status
JIGGSTAT	JiggleStatus	16, TBC	TBD		Contents of Jiggle Axis Activity Status Register
LIA01TEMP	LIA_B1TEMP	8	TBD		LIA Board 1 Temperature
LIA02TEMP	LIA_B2_TEMP	8	TBD		LIA Board 2 Temperature
LIA03TEMP	LIA_B3_TEMP	8	TBD		LIA Board 3 Temperature
LIA04TEMP	LIA_B4_TEMP	8	TBD		LIA Board 4 Temperature
LIA05TEMP	LIA_B5_TEMP	8	TBD		LIA Board 5 Temperature
LIA06TEMP	LIA_B6_TEMP	8	TBD		LIA Board 6 Temperature
LIA07TEMP	LIA_B7_TEMP	8	TBD		LIA Board 7 Temperature
LIA08TEMP	LIA_B8_TEMP	8	TBD		LIA Board 8 Temperature
LIA09TEMP	LIA_B9_TEMP	8	TBD		LIA Board 9 Temperature
LIA10TEMP	LIA_B10_TEMP	8	TBD		LIA Board 10 Temperature
LIA11TEMP	LIA_B11_TEMP	8	TBD		LIA Board 11Temperature
LIA12TEMP	LIA_B12_TEMP	8	TBD		LIA Board 12 Temperature
MCUFLAGS		16			MCU Status -TBC

MCUTIMEOUT	DPU_PollingTime				Maximum Time between commands before an IO error is reported
MCUTELSTAT	Telemetry	TBD	TBD		Define TM packets to be sent
MCUTELSAMP	TelemetrySampling	TBD	TBD		Sampling Rate of Telemetry Packets
MEMCHK		48	TBD		Memory Check Flags
MODE		16	TBD		Instrument Operating Mode
MONFLAGS		16			Subsystem Monitoring Status -TBC
OBSID		32			Observation ID
OBSLEN		32			Time since start of Observation (secs)
OTFERROR		16, TBC	TBD		On Target Flag Error
OTFTIME		48			On Target Flag Time
OTF		1	OTF		On Target Flag
PHOTBIAS9V	DcuBPHp09	TBD	TBD	TBD	Voltage to Photometer Bias Board on +9V line
PHOTBIAS9VN	DcuBPHn09	TBD	TBD	TBD	Voltage to Photometer Bias Board on -9V line
PHOTBIASFREQ	Div_photo_bias	9	BIASFREQ		Photometry Bias frequency
PHOTBIASMODE	Mode_photo_bias	8	BIASMODE		Photometry bias generator mode
PHOTLIA5V	Dc uLPHp05	TBD	TBD	TBD	Voltage to Photometer LIA Board on +5V line
PHOTLIA9V	Dc uLPHp09	TBD	TBD	TBD	Voltage to Photometer LIA Board on +9V line
PHOTLIA9VN	Dc uLPHn09	TBD	TBD	TBD	Voltage to Photometer LIA Board on -9V line
PHOTSAMPFREQ	Div_photo_sampl	8	PSAMPFREQ		Photometry sampling frequency
PHTRV	Ampl_photo_heater	8	HTR		Voltage applied to photometer heaters
PLWBIAS	Ampl_P500	8	BIAS		Amplitude of bias for photometry long wave channels
PLWJFET1V	Ampl_P500_VSS1	8	JFETV		Voltage applied to JFET for photometry long wave channels (group1)
PLWJFET2V	Ampl_P500_VSS2	8	JFETV		Voltage applied to JFET for photometry long wave channels (group2)
PLWPHSE	Phase_shift_P500	8	PHASE		Phase shift for long wave photometry channels demodulation
PMLWJFETSTAT		**6**			
PMWJFET1STAT	P350_JFET_1	1	JFETSTAT		Status of JFET power for photometry medium wave channels (group1) (Bit 7)
PMWJFET2STAT	P350_JFET_2	1	JFETSTAT		Status of JFET power for photometry medium wave channels (group2) (Bit 6)
PMWJFET3STAT	P350_JFET_3	1	JFETSTAT		Status of JFET power for photometry medium wave channels (group3) (Bit 5)
PMWJFET4STAT	P350_JFET_4	1	JFETSTAT		Status of JFET power for photometry medium wave channels (group4) (Bit 4)
PLWJFET1STAT	P500_JFET_1	1	JFETSTAT		Status of JFET power for photometry long wave channels (group1) (Bit 3)
PLWJFET2STAT	P500_JFET_2	1	JFETSTAT		Status of JFET power for photometry long wave channels (group2) (Bit 2)
PMWBIAS	Ampl_P350	8	BIAS		Amplitude of bias for photometry medium wave channels
PMWJFET1V	Ampl_P350_VSS1	8	JFETV		Voltage applied to JFET for photometry medium wave channels (group1)

PMWJFET2V	Ampl_P350_VSS2	8	JFETV		Voltage applied to JFET for photometry medium wave channels (group2)
PMWJFET3V	Ampl_P350_VSS3	8	JFETV		Voltage applied to JFET for photometry medium wave channels (group3)
PMWJFET4V	Ampl_P350_VSS4	8	JFETV		Voltage applied to JFET for photometry medium wave channels (group4)
PMWPHSE	Phase_shift_P350	8	PHASE		Phase shift for medium wave photometry channels demodulation
PSUTEMP	PsuTempRd	TBD	TBD	TBD	PSU Temperature Sensor reading
PSWBIAS	Ampl_P250	8	BIAS		Amplitude of bias for photometry short wave channels
PSWJFET1V	Ampl_P250_VSS1	8	JFETV		Voltage applied to JFET for photometry short wave channels (group1)
PSWJFET2V	Ampl_P250_VSS2	8	JFETV		Voltage applied to JFET for photometry short wave channels (group2)
PSWJFET3V	Ampl_P250_VSS3	8	JFETV		Voltage applied to JFET for photometry short wave channels (group3)
PSWJFET4V	Ampl_P250_VSS4	8	JFETV		Voltage applied to JFET for photometry short wave channels (group4)
PSWJFET5V	Ampl_P250_VSS5	8	JFETV		Voltage applied to JFET for photometry short wave channels (group5)
PSWJFET6V	Ampl_P250_VSS6	8	JFETV		Voltage applied to JFET for photometry short wave channels (group6)
PSWJFETSTAT		**6**			
PSWJFET1STAT	P250_JFET_1	1	JFETSTAT		Status of JFET power for photometry short wave channels (group1) (Bit 7)
PSWJFET2STAT	P250_JFET_2	1	JFETSTAT		Status of JFET power for photometry short wave channels (group2) (Bit 6)
PSWJFET3STAT	P250_JFET_3	1	JFETSTAT		Status of JFET power for photometry short wave channels (group3) (Bit 5)
PSWJFET4STAT	P250_JFET_4	1	JFETSTAT		Status of JFET power for photometry short wave channels (group4) (Bit 4)
PSWJFET5STAT	P250_JFET_5	1	JFETSTAT		Status of JFET power for photometry short wave channels (group5) (Bit 3)
PSWJFET6STAT	P250_JFET_6	1	JFETSTAT		Status of JFET power for photometry short wave channels (group6) (Bit 2)
PSWPHSE	Phase_shift_P250	8	PHASE		Phase shift for short wave photometry channels demodulation
RATE		32			Data Rate (average bits/sec over observation)
SCANMODE	ScanMode	2	SCANMODE		SMEC Scan Mode
SCANS	ScanNumber	16			Number of SMEC Scans to perform TBC
SCANSPEED	ScanSpeed	16			SMEC Scan Speed
SCANSTART	ScanStart	16			SMEC Scan Start Position
SCANSTAT	StartScan	1	SCANSTAT		SMEC Scan Status
SCU5V	ScuCHTp05	12, TBC	TBD		Voltage on SCU 5Vline
SCU9V	ScuCHTp09	12, TBC	TBD		Voltage on SCU+9Vline
SCU9VN	ScuCHTn09	12, TBC	TBD		Voltage on SCU -9Vline
SCUCAL1I	CalibraI1	12, TBC	TBD		Current in Calibrator 1
SCUCAL1V	CalibraV1	12, TBC	TBD		Voltage Applied to Calibrator 1
SCUCAL2I	CalibraI2	12, TBC	TBD		Current in Calibrator 2
SCUCAL2V	CalibraV2	12, TBC	TBD		Voltage Applied to Calibrator 2

SCUCAL3I	CalibraI3	12, TBC	TBD		Current in Calibrator 3
SCUCAL3V	CalibraV3	12, TBC	TBD		Voltage Applied to Calibrator 3
SCUCMDSTAT		TBD	TBD		Command Interface Control Status Word - TBD
SCUDATAFREQ	FrameRate	16,TBC	TBD		Frame Rate
SCUDELAY	SubsDelay	16,TBC	TBD		Subsystem Response Time
SCUFLAGS		16			SCU Status -TBC
SCUFRAMES	SeqLength	16,TBC			Number of frames
SCUHHTRV	HheaterV1	12, TBC	TBD		Voltage Applied to High Power Heater
SCULHTR1V	LHeaterV1	12, TBC	TBD		Voltage Applied to Low Power Heater1
SCULHTR2V	LheaterV2	12, TBC	TBD		Voltage Applied to Low Power Heater2
SCULHTR3V	LheaterV3	12, TBC	TBD		Voltage Applied to Low Power Heater3
SCUSTAT	DRelOnOff	8	TBD		Status of Distribution Board relays
SCUSUBKFREQ	SubKpRate	16,TBC	TBD		Sampling Rate of SubK temperatures
SCUSUBSSTAT	SubStatus	TBD	TBD		Subsystem Status
SCUTEMPSTAT Allocation of bits TBD	TempOnOff	12	TBD		Power on status of temperature probes
SHTRV	Ampl_spectro_heater	8	HTR		Voltage applied to spectrometer heaters
SJFETSTAT		**6**			
SLWJFET1STAT	S-LW_JFET_1	1	JFETSTAT		Status of JFET power for spectrometry long wave channels (Bit 7)
SSWJFET1STAT	S-SW_JFET_1	1	JFETSTAT		Status of JFET power for spectrometry short wave channels (group1) (Bit 6)
SSWJFET2STAT	S-SW_JFET_2	1	JFETSTAT		Status of JFET power for spectrometry short wave channels (group2) (Bit 5)
SLWBIAS	Ampl_S-LW	8	BIAS		Amplitude of bias for spectrometry long wave channels
SLWJFET1V	Ampl_S-LW_VSS1	8	JFETV		Voltage applied to JFET for spectrometry long wave channels
SLWPHSE	Phase_shift_S-LW	8	PHASE		Phase shift for long wave spectrometry channels demodulation
SMECOENCPWR	EncoderPwr	3	TBD		SMEC Optical Encoder LED power
SMECFILTHIGH	DerivFilterHigh	16,TBC			Filtering Time Constant to calculate the derivative term of the SMEC PID Controller
SMECFILTLOW	DerivFilterLow	16,TBC			Filtering Time Constant to calculate the derivative term of the SMEC PID Controller
SMECSATNLIM	IntegrationLimit	16,TBC			Integration Saturation Limit for the SMEC PID Controller?
SMECINITSTAT		TBD			Initialisation Status of SMEC
SMECKDHIGH	KdHigh	16,TBC			Maximum Derivative Gain of SMEC PID Controller?
SMECKDLOW	KdLow	16,TBC			Minimum Derivative Gain of SMEC PID Controller?

SMECKIHIGH	KiHigh	16,TBC			Maximum Integral Gain of SMEC PID Controller?
SMECKILOW	KiLow	16,TBC			Minimum Integral Gain of SMEC PID Controller?
SMECKPHIGH	KpHigh	16,TBC			Maximum Proportional Gain of SMEC PID Controller?
SMECKPLOW	KpLow	16,TBC			Maximum Proportional Gain of SMEC PID Controller?
SMECLAT1STAT	LaunchLatch1	1	LATCH		SMEC Launch Latch1 Status
SMECLAT2STAT	LaunchLatch2	1	LATCH		SMEC Launch Latch2 Status
SMECLOOPMODE	LoopMode	2	LOOPMODE		SMEC Control Loop Mode
SMECLVDTPWR	LVDTPwr	1	TBD		SMEC LVDT Oscillator On/Off
SMECMEANPERR	MeanPositionError	16,TBC	TBD		Mean SMEC Position Error over scan
SMECMEANVEL	MeanSpeed	16,TBC	TBD		Mean SMEC Speed over scan
SMECNOTCHIGH	NotchParamHigh	16,TBC			TBW
SMECNOTCHLOW	NotchParamLow	16,TBC			TBW
SMECPOSN	ActualPosition	16,TBC			Last Absolute position of the SMEC
SMECPERRLIM	PositionErrorLimit	16,TBC			Minimum Value of SMEC Position Error that causes a PID error to be reported?
SMECSTAT	SmecStatus	16,TBC	TBD		Contents of SMEC Activity Status Register
SMECVEL	ActualVelocity	16,TBC			Instantaneous Velocity (20Hz filtered) of the SMEC
SPECBIAS9V	DcuBSPp09	TBD	TBD	TBD	Voltage to Spectrometer Bias Board on +9V line
SPECBIAS9VN	DcuBSPn09	TBD	TBD	TBD	Voltage to Spectrometer Bias Board on -9V line
SPECBIASFREQ	Div_spectro_bias	9	BIASFREQ		Spectrometry Bias frequency
SPECBIASMODE	Mode_spectro_bias	8	BIASMODE		Spectrometry bias generator mode
SPECLIA5V	DcuLSPp05	TBD	TBD	TBD	Voltage to Spectrometer LIA Board on +5V line
SPECLIA9V	DcuLSPp09	TBD	TBD	TBD	Voltage to Spectrometer LIA Board on +9V line
SPECLIA9VN	DcuLSPn09	TBD	TBD	TBD	Voltage to Spectrometer LIA Board on -9V line
SPECSAMPFREQ	Div_spectro_sampl	8	SSAMPFREQ		Spectrometry sampling frequency
SSWBIAS	Ampl_S-SW	8	BIAS		Amplitude of bias for spectrometry short wave channels
SSWJFET1V	Ampl_S-SW_VSS1	8	JFETV		Voltage applied to JFET for spectrometry short wave channels (group1)
SSWJFET2V	Ampl_S-SW_VSS2	8	JFETV		Voltage applied to JFET for spectrometry short wave channels (group2)
SSWPHSE	Phase_shift_S-SW	8	PHASE		Phase shift for short wave spectrometry channels demodulation
STEP		16			Number of current step in an observation
SUBKTEMP	SubKTempP	TBD	TBD	TBD	Temperature from SubK temperature probe
TRACEPERIOD	TraceSampling		PERIOD		Time period between successive Trace Values

TRACESIZE	TraceBuffer	16, TBC			Trace Buffer Size
TRACEPARM1	TraceParam#1	TBD			Trace Parameter 1
TRACEPARM2	TraceParam#2	TBD			Trace Parameter 2
TRACEPARM3	TraceParam#3	TBD			Trace Parameter 3
TRACEPARM4	TraceParam#4	TBD			Trace Parameter 4
TRACEPARM5	TraceParam#5	TBD			Trace Parameter 5
TRACEPARM6	TraceParam#6	TBD			Trace Parameter 6
TC1TEMP	T/C1	20	TBD		Thermal Control Thermistor #1 value
TC2TEMP	T/C2	20	TBD		Thermal Control Thermistor #2 value
TC3TEMP	T/C3	20	TBD		Thermal Control Thermistor #3 value
TCBIAS	Ampl_T/C	8	BIAS		Amplitude of bias for thermal control channels
TCEXEC		16			Number of telecommand packets executed since switch on
TCEXEN		16			Sequence Control word of last executeded telecommand packet
TCPHSE	Phase_shift_T/C	8	PHASE		Phase shift for thermal control channels demodulation
TCRECN		16			Sequence Control word of last received telecommand packet
TCRECV		16			Number of telecommand packets received since switch on
TCUTEMP	TcuTempRd	TBD	TBD	TBD	Temperature from sensor on Temp Board
TDPU		48			Local DPU On Board Time
TEMP01	FpuTemp01	TBD	TBD	TBD	To be replaced by correct name
TEMP02	FpuTemp02	TBD	TBD	TBD	To be replaced by correct name
TEMP03	FpuTemp03	TBD	TBD	TBD	To be replaced by correct name
TEMP04	FpuTemp04	TBD	TBD	TBD	To be replaced by correct name
TEMP05	FpuTemp05	TBD	TBD	TBD	To be replaced by correct name
TEMP06	FpuTemp06	TBD	TBD	TBD	To be replaced by correct name
TEMP07	FpuTemp07	TBD	TBD	TBD	To be replaced by correct name
TEMP08	FpuTemp08	TBD	TBD	TBD	To be replaced by correct name
TEMP09	FpuTemp09	TBD	TBD	TBD	To be replaced by correct name
TEMP10	FpuTemp10	TBD	TBD	TBD	To be replaced by correct name
TEMP11	FpuTemp11	TBD	TBD	TBD	To be replaced by correct name
TEMP12	FpuTemp12	TBD	TBD	TBD	To be replaced by correct name
TEMP13	FpuTemp13	TBD	TBD	TBD	To be replaced by correct name
TEMP14	FpuTemp14	TBD	TBD	TBD	To be replaced by correct name

TEMP15	FpuTemp15	TBD	TBD	TBD	To be replaced by correct name
TEMP16	FpuTemp16	TBD	TBD	TBD	To be replaced by correct name
THSK		48			DPU Time of start of last housekeeping data collection period
TSFTIME		48			Telescope Scan Time
TSF		1	TSF		Telscope Scan Flag
TSYNC		48			DPU Time of last DRCU Synchronisation
SCUSPARE	Reserved	TBD			

5.2.2 Conversion Curves

Name	Type	Raw Value	Converted Value	Units	Comments
BIAS	Analogue	0 255	0.0 Vbmax	Volts	$Eng = \frac{Vb\max * Raw}{255}$
BIASFREQ	Derived Calculated	*Raw*	*Eng*	Hz	$Eng = \frac{TBD\ MHz}{2 * Raw}$
BIASMODE	Enumerated	0c00 0x01 0x02 …… …… 0xFD 0xFE 0xFF	OFF DC001 DC002 …….. …….. DC253 DC252 SINE		Values 0x01 to 0xFE are test levels
CHOPMODE	Enumerated	0 1 2	STOP STEP TOGGLE		Chopping Stopped Chopping in step mode Chopping in toggle mode
CHOPSENS	Enumerated	0 1	ON OFF		Values TBC
CLOOPMODE	Enumerated	0 1 2	OPEN BEMF SENS		Loop Open Loop closed using Back EMF Loop Closed using Magnetoresistive Sensor
DCUFRMS	Enumerated	0 1 2 ….. ….. 254 255	CONT. 1 2 ….. ….. 254 255		

DCUMODE	Enumerated	0x00 0x01 0x02 0x03 0x04 0x05 0x06 0x08 0x0C 0x10 0x14 0x18 0x1C	PHOT PSW PMW PLW SPEC SSW SLW PTEST STEST POFFSET SOFFSET POFFGET SOFFGET		
DCUSTAT	Enumerated	0 1	OFF RUN		
HTR	Analogue	0 255	0.0 Vhmax	Volts	$Eng = \frac{Vh\,\max * \ Raw}{255}$
JFETSTAT	Enumerated	0 1	OFF ON		
JFETV	Analogue	0 255	0.0 VSSmax	Volts	$Eng = \frac{VSS\,\max * \ Raw}{255}$
JIGGLEMODE	Enumerated	0 1 2	STOP STEP TOGGLE		Jiggling Stopped Jiggling in step mode Jiggling in toggle mode - TBD if applicable
JIGGLESENS	Enumerated	0 1	ON OFF		Values TBC
JLOOPMODE	Enumerated	0 1 2	OPEN BEMF SENS		Loop Open Loop closed using Back EMF Loop Closed using Magnetoresistive Sensor
LATCH	Enumerated	0 1	Engaged Disengaged		Values TBC
LOOPMODE	Enumerated	0	OPEN		Loop Open

		1 2 3	BEMF LVDT OENC		Loop closed using Back EMF Loop Closed using LVDT Loop Closed using Optical Encoder
OTF	Enumerated	0 1	Off Target On Target		
PERIOD				mS	
PHASE	Analogue	0 255	0 360	Degrees	$Eng = \frac{360 * Raw}{255}$
PSAMPFREQ	Derived Calculated	*Raw*	*Eng*	Hz	$Eng = \frac{PHOTBIASFREQ_{Eng}}{2 * Raw}$
SCANMODE	Enumerated	0 1 2 3	STOP STEP SAWTOOTH TRIANGLE		
SCANSTAT	Enumerated	0 1	STOP RUN		
SSAMPFREQ TSF	Derived Calculated Enumerated	*Raw* 2 3	*Eng* Scanning Pointing	Hz	$Eng = \frac{SPECBIASFREQ_{Eng}}{2 * Raw}$

5.2.3 Constraints

Appendix A

This section describes the operation of the On Board Software (OBS) in sufficient detail that the interface can be understood

6. TABLES

Much of the data used by the OBS for operations will be held in tables. These will be used to hold, for example:

- Housekeeping packet parameter lists
- Jiggle position tables
- Command Lists

The OBS will provide for the definition of up to 128 tables, TBC, within a fixed-size memory area and will automatically move data within this memory area in order to allow update of tables, including a change in size.

By default the following table numbers are assigned:

Table ID	Description
00	Default Housekeeping Packet Definition
01- 03	Diagnostic Housekeeping Packet Definitions
04	7 point Jiggle Table
05	64 point Jiggle Table
06	256 point Jiggle Table
07	TBD Jiggle Table
08 - 127	Command Lists

All tables are accessed using a Table_ID and individual locations in the table are accessed by an index, specified as a number of words, offset from the beginning of the table. The word size is determined by the Data_Type of the table:

- Data_Type = 0 : word-size = 8 bits
- Data_Type = 1 : word-size = 16 bits
- Data_Type = 2 : word-size = 24 bits
- Data_Type = 3 : word-size = 32 bits

All tables will be an integer number of 32 bits long

A.1.1 Table Commands

A set of generalised commands related to table management will be used to define and maintain the tables:

6.1.1 Load_Table(Table_ID, Index, Data_Type, Ndata, Data……)

Loads the table with the supplied data, starting from the defined index location. Data consists of Ndata words of the given data type.

Possible Errors (issued as a Command Execution Failure TM packet):

- **Illegal_Table_ID** – not in range 0 to 127
- **Illegal_Table_Data_Type** – not in range 0 to 3
- **Bad_Table_Data** – not Ndata words in Data field
- **Table_Space_Full** – not enough space in table memory area to allow addition of this data to the table

6.1.2 Report_Table(Table_ID, Index, Data_Type, Ndata)

Generate a TM packet containing the Ndata words from the table, starting at the given index location.

If Ndata = 0 report all the words in the table
If Ndata > table_size report all the words in the table

Possible Errors (issued as a Command Execution Failure TM packet):

- **Illegal_Table_ID** – not in range 0 to 127
- **Illegal_Table_Data_Type** – not in range 0 to 3

6.1.3 Update_Table(Table_ID, Index, Data_Type, Ndata, Data….)

Update the table with the supplied data, replacing and/or appending entries, as necessary. No check of the data type held in the table is made.

Possible Errors (issued as a Command Execution Failure TM packet):

- **Illegal_Table_ID** – not in range 0 to 127
- **Illegal_Table_Data_Type** – not in range 0 to 3
- **Bad_Table_Data** – not Ndata words in Data field
- **Table_Space_Full** – not enough space in table memory area to allow addition of this data to the table

Appendix B

7. CONTROL LOOPS

Several control loops are executed by the On-board Software. These are all implemented as PID (Proportional, Integral, Differential) control algorithms, where the control variable (C) is adjusted to maintain the measurement variable (M) at the set point (S). The equation giving this relationship is

$$C_N = C_{N-1} + K_P * (S - M_N) + K_I * \left(S - \frac{\sum_{i=N-n}^{i=N} M_i}{n+1} \right) + K_D * (M_N - M_{N-1})$$

Where:

C_N = Control variable value for sample period N
M_N = Measurement Variable value at sample N
S = Required Set Point of the measurement variable
K_P = Proportional Gain
K_I = Integral Gain
K_D = Differential Gain
n = number of samples in the integral

7.1 Control Loop Parameters

When starting the control loop the following parameters have to be provided

- S = Required Set Point of the measurement variable
- K_P = Proportional Gain
- K_I = Integral Gain
- K_D = Differential Gain
- n = number of samples in the integral (max 32, TBC)
- dt = the time interval between samples
- P_M = The housekeeping parameter to use as the measurement variable
- P_C =The housekeeping parameter to use as the control variable

It is expected that the software shall maintain a buffer containing the last n samples in order to calculate the integral term for each sample period.

If the accuracy of the measurement sampling interval cannot be guaranteed, the software will also need to maintain a buffer containing the time of each of the n samples in order to make a more accurate estimate of the integral and differential terms (the equation above assumes a fixed sampling period).

The software must ensure that the accuracy of the calculation is adequate (e.g. by use of floating point, or fixed point, math functions)

Appendix C

8. COMMAND LIST

This section (TBW) defines the command list entries that are available.