SPIRE INSTRUMENT

DRCU / DPU

INTERFACE CONTROL DOCUMENT

SPIRE-SAP-PRJ-001364

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List of Acronyms

ADC	Analog to Digital Converter
AMUX	Analog Multiplexer
BSM	Beam Steering Mirror
DAC	Digital to Analog Converter
DCE	Detector Control Electronics
DCU	Detector Control Unit
DMUX	Digital Multiplexer
DPU	Data Processing Unit
DRCU	Detector Readout & Control Unit
FPU	Focal Plane Unit
FTS	Fourier Transform Spectrometer
JFET	Junction Field Effect Transistor
LIA	Lock-in amplifier
LPF	Low Pass Filter
MCE	Mechanisms Control Electronics
MCU	Mechanisms Control Unit
NA	Not Applicable
NC	Not connected
OEP	Optical Encoder Preamplifier
PDU	Power Distribution Unit
PSU	Power Supply Unit
S/S	Sub-System
S/W	Software
SCE	Sub-system Control Electronics
SCU	Sub-system Control Unit
SMEC	Spectrometer Mechanism Control
SMPS	Switching Mode Power Supply
SNR	Signal over Noise Ratio
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
WIH	Warm Interconnect Harnesses

Table of Contents

1. Introduction

1.1. Purpose

The purpose of this document is to provide a description of all the DRCU units' electrical interfaces to the DPU. Along with the "DRCU ICD" and the "MCU/DPU Command List ICD" this document shall allows a complete overview of the DRCU units in terms of interfaces.

1.2. Scope

The scope of this document includes all the DRCU units external interfaces low-level description including electrical and low level protocol and connector pin-out.

1.3. Reference Documents

RD1	Note IFSI : *DPU/DRCU Interfaces*	SP-RCI-18.5.00
RD2	Efficient Shift Registers, and Long Pseudo-Random Sequence Generators	XILINX XAPP 052
RD3	MCU interconnections list	LAM/ELE/FTS/NTT/010314 - issue 2.0
RD4	A Generic DPU Interface for SPIRE DRCU Subsystems	CEA internal note

1.4. Applicable Documents

AD1	Herschel/Planck IID part A	SCI-PT-IIDA-04624
AD2	MCU/DPU Command List ICD	LAM/ELE/SPI/011011 issue 2.0

2. Electrical interfaces with the DPU

The DRCU has two kinds of interface with the DPU: one is devoted to low level command transmission (to the DRCU) for H/W configuration and housekeeping/status parameters reporting while the second is in turn devoted to data transfer from the DRCU to the DPU for further packing activities.
While the low-level command interface is slow (312kps) bi-directional with word-based protocol the data transfer interface is fast (up to 2.5 Mbps) unidirectional with frame-based protocol.

2.1. Command interface

2.1.1. General Information

The command interface goal is manifold:

• Passing of commands from the DPU to the DRCU subsystems.
• Setting of DRCU Subsystems parameters.
• DRCU Subsystems synchronisation.

Physically it consists in 3 sets of bi-directional point-to-point links between the DPU and the DRCU (one link per DRCU subsystem except PSU: DCU MCU & SCU). The protocol is master-slave based, the DPU being the master.
It allows operating independently the 3 DRCU sub-units.

All commands being sent simultaneously to the 3 DRCU subsystems each subsystem recognising its own commands by means of a address inserted into the command word. In addition a broadcast address allows sending the same (broadcast) command simultaneously to the 3 DRCU sub-units.

The command format is fixed and consists in a 32-bit word with 3 fields:

• a DRCU sub-unit address field.
• a command identifier field.
• a parameter field.

DRCU subsystems, if addressed individually reply with a response word with the following format:

• a field for reporting interface error (in place of the sub-unit address),
• a field echoing the command identifier,
• a data field which contains, either the echo of the command parameter, or a data requested by the command (housekeeping parameter).

In the case of broadcast command, no acknowledgement is sent back by the DRCU subsystems. If the DPU requires acknowledgement it has to be carried out by sending successive acknowledgement request (specific command) to the DRCU sub-units.

2.1.2. Interface Overall Diagrams

The Command Interface diagram is given in figure 2.1-a.: main and redundant interfaces are shown.

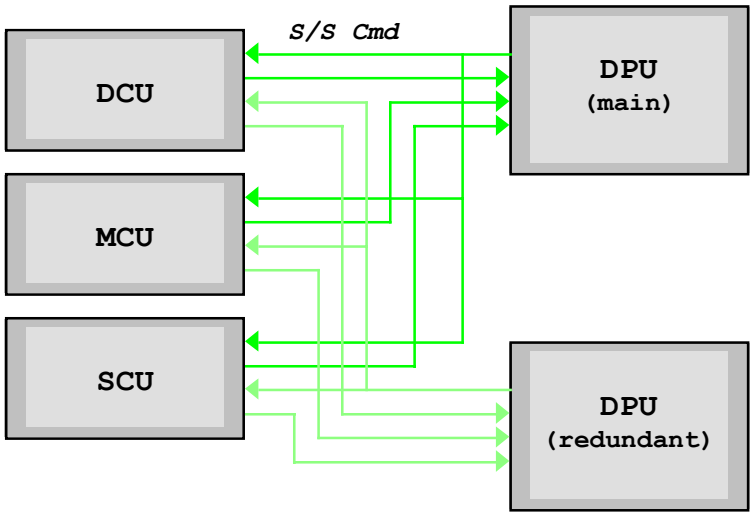


Figure 2.1-a

2.1.3. Interface Circuit

Each interface is defined by the following signals:

- a command (CMD) line - from DPU to DRU, MCU, SCU sub-units
- a response (RES) line - from each sub-unit to DPU
- a clock (CLK) line for bit synchronisation and S/S format time clock- from the DPU to DRU, MCU, SCU sub-units.

Each sub-unit implements a complete set of the above interface signals: that is the DPU implements 3 electrically independent “Command Interfaces” each having 2 transmitters + 1 receiver. However all those signals are interconnected type by type inside the DPU. In particularly the 3 RES signals are mixed according to the sub-unit address previously sent.

The interface uses the balanced lines RS422 electrical standard based on 26C31 and 26C32 transmitter and receiver types.

Complete interface functional and electrical diagrams are given figures 2.1-b and 2.1-c.

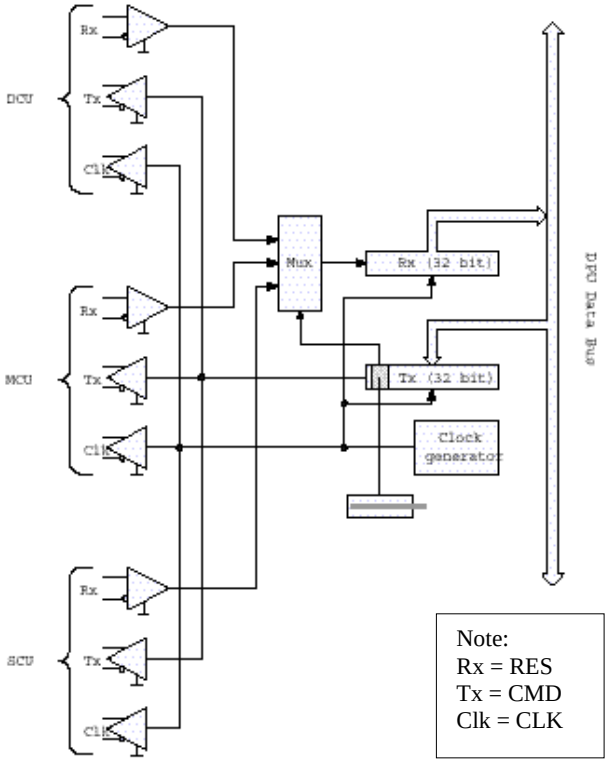


Figure 2.1-b - DPU Low Speed Interface Functional Diagram

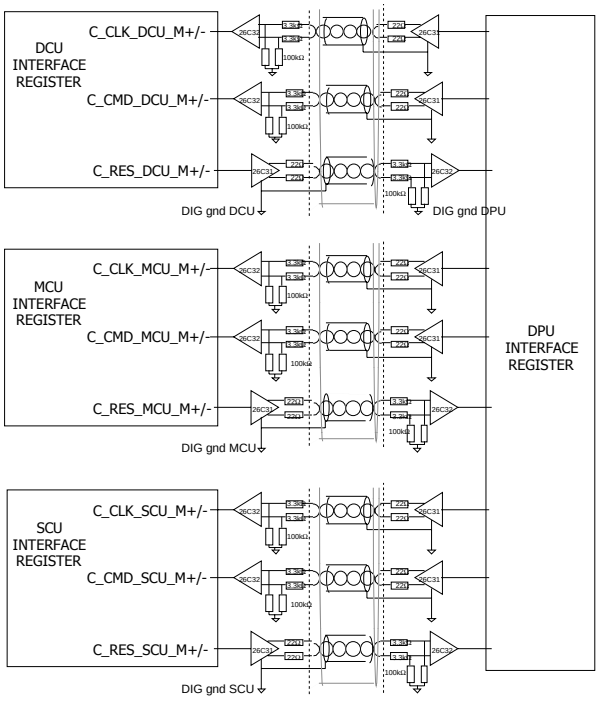


Figure 2.1-c - Electrical configuration

2.1.4. Protocol definition

2.1.4.1. Command Word

At any time after completion of a previous command/response exchange the DPU can send command words to the DRCU subsystems on the CMD line.
The 32-bit command word is divided into 5 fields as defined bellow:

- a 2-bit sync pattern: see table 2.1-a for details,
- a 2-bit sub-unit address: see table 2.1-b for details,
- a 12-bit command identifier: see table 2.1-c for details,
- a 16-bit parameter when applicable*.

*: Filled with zero if the command does not require any parameter.

These 4 fields are concatenated as follow to form the 32-bits word:

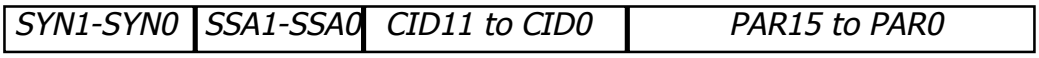


Figure 2.1-d - Command Word Field Structure

SYN1 - SYN0 : sync. pattern
SSA1 - SSA0 : subsystem address
CID11 to CID0 : command identifier
PAR15 to PAR0 : command parameter*
*: filled with zero if no used

Note : • MSB is transmitted first
• SYN1 = MSB
• PAR0 = LSB

SYN1	SYN0	Response
1	0	Yes
1	1	No

Table 2.1-a - Sync Pattern definition

SSA1	SSA0	Subsystem Name
0	0	DCU
0	1	MCU
1	0	SCU
1	1	Broadcast Command

Table 2.1-b - Subsystem address allocation

Bit 11 of the Command IDentifier determines the type of the command between Read (or Get) and Write (or Set). The following table explicits the R/W bit definition:

CID11	CID10--CID0	Command Type
1	X	Read
0	X	Write

Table 2.1-c - Command Identifier Structure

Note: the subsystems do not include any command buffering. If a subsystem is unable for any reason to execute a command it will reply with a negative acknowledge and the last command is definitively lost.

2.1.4.2. Response Word

The response line (RES) enables command verification and DRCU sub-system housekeeping parameters reading by the DPU.

When a "Set_*parameter*" command is received the subsystem responds to the DPU by transferring a command acknowledge word (positive or negative) on the response line. The positive acknowledgement is normally required for further command transfer after specific critical commands.
When a "get_parameter" command is received the subsystem responds to the DPU by transferring the requested housekeeping parameter. (SPIRE housekeeping parameter polling is running typically at 1Hz).

The sub-system shall respond (leading bit of the response word) within a maximum delay of N clock periods as shown table 2.1-e. The DPU S/W shall include a time-out in order to recover from a lack of response and then report such anomaly.

The 32-bit command response is divided into 4 fields, which are:

- a 2-bit sync pattern (SYN0 & SYN1),
- a 2-bit acknowledge code word (ACK0 & ACK1),
- a 12-bit command or parameter address echo (CID11 to CID0),
- a 16-bit parameter (PAR15 to PAR0) echo or requested housekeeping.

Note : • MSB is transmitted first
• SYN1 = MSB
• PAR0 = LSB

These 4 fields are concatenated as follow to form the 32-bits word:

SYN1-SYN0	ACK1-ACK0	CID11 to CID0	PAR15 to PAR0

If the subsystem address corresponds to the broadcast address the subsystems do not generate any response word to avoid collision at the DPU end.

Along with the "synchro. Pattern", Command Id field and the Parameter field an acknowledge word is in place of the sub-system address field of the received command. While normally the ACK field will content a null character (00 binary) provision for "negative" acknowledge has been introduced to enable sub-system reporting in case of anomaly.
A "negative" acknowledge may result from the following reasons:

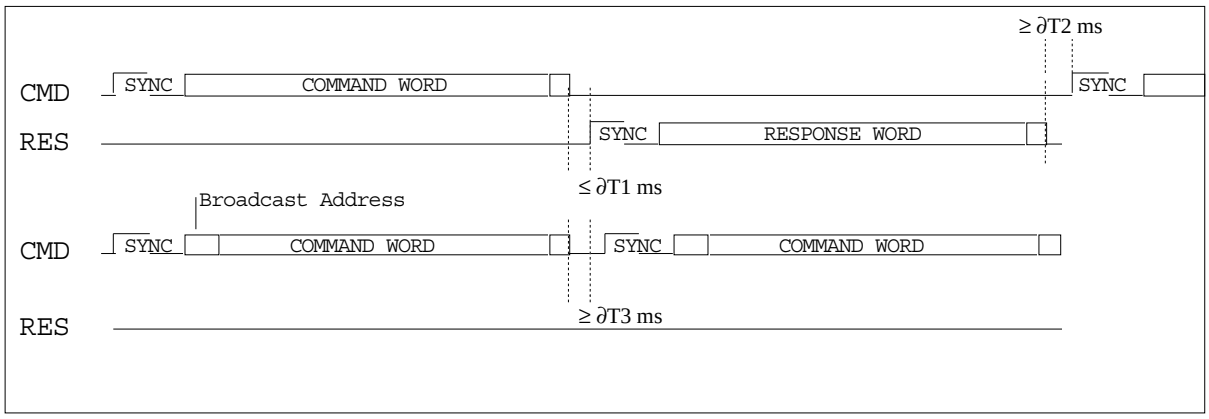
• a transmission error occurred: receiver does not recognise command identifier,
• a command is not allowed in a specific subsystem status (e.g. modification of FTS scan length when mechanism is scanning): return ACK code = CID forbidden,
• the S/S H/W does not respond to the I/F H/W within a given delay: return ACK code = S/S time-out.

ACK	Command Status
00	OK
01	CID unknown
10	CID forbidden
11	S/S Time-out

Table 2.1-d

2.1.4.3. Word level protocol

The following figure illustrates the command interface protocol for the possible modes of operation (a "set_parameter" / "get_parameter" command and a "broadcast command").



2.1.5. Interface Timing

2.1.5.1. Low-level Timing

The CMD signal is switched on the falling edge of the CLK signal. This signal shall be sampled by the DRCU subsystem on the next rising edge of the CLK signal. To validate the command the subsystem shall identify the word sync pattern ("10" or "11") and then check the subsystem address. If one of these conditions is not fulfilled the subsystem input logic shall stay in the "wait for command" status.
The RES signal shall by modified on the rising edge of the CLK signal and being sampled by the DPU on the next falling edge of the CLK signal.

For detailed interface timing see AD1.

2.1.5.2. Command timing

The following table gives interval timing value for the delay shown in §2.6.

Parameters	S/S	Symbols	Limits (µs)	
			Min	Max
Command to response delay	DCU	∂T1	3.2	100
	MCU		3.2	500
	SCU		3.2	100
Response to next command delay	DCU/SCU	∂T2	3.2	-
or Command to next command delay	MCU		3.2	See "SetDPUPollingTime" command (AD2)

Table 2.1-e Command interface high-level timing constraints

2.1.5.3. Command Rate

The NRZ data rate being fixed at 312.5 kbit per second the absolute maximum command rate can be computed. The command rate including both command word transmission and command response word transmission is:

$$\text{Max. Command rate} = 1 / ((3.2\ \mu s \times 32) \times 2 + \partial T2_{min}) \leq 4883 \text{ commands per second.}$$

This value gives the maximum rate supported by the protocol. Real rates will have to take into account the DPU software performance.

2.2. Command lists

2.2.1. DRCU generic command list summary

2.2.1.1. Command and parameter mapping

The following table shows respectively the bit mapping for CID and PAR field of a low-level command for the DRCU.

CID11	CID10 to CID0	PAR15 to PAR0
R/W	Command Code	Parameter(s)

Note: These list refer to commands common to the 3 DRCU S/S. The execution of those commands is supported by the DRCU to DPU (CmdIF) interface H/W only.

2.2.1.2. Write only commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
SetTStampRst	NA	NA	Ack. code	

2.2.1.3. Read only commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
GetCmdIfStat	CmdIfStat	NA	NA	
GetSubSDelay	SubSDelay	0 to 511	NA	

2.2.1.4. Read/Write Commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
Set/GetCmdIfCtrl	CmdIfCtrl	NA	Get… cmd	

2.2.2. DRCU command description

2.2.2.1. CmdIfStat

Command	Unit	Code	Description
GetCmdIfStat	DCU	800	Get the S/S interface status
Returned Parameter(s)	Location	Length	
CmdIfStat	0	6	Bit 5-4: LastCmdStatus Bit 3: SubSystemTimeout Bit 2: ForbiddenRead Bit 1: ForbiddenBroacast Bit 0: CommandOverlapped

2.2.2.2. CmdIfCtrl

Command	Unit	Code	Description
SetCmdIfCtrl	DCU	001	Set the S/S command IF control word.
Parameters	Location	Length	
CmdIfCtrl	0	3	Bit 2: StatusRst Bit 1 : SubSystemRst Bit 0: DataIfReset

Command	Unit	Code	Description
GetCmdIfCtrl	DCU	801	Get the S/S command IF control word.
Returned Parameter(s)	Location	Length	
CmdIfCtrl	0	3	Bit 2: StatusRst Bit 1 : SubSystemRst Bit 0: DataIfReset

2.2.2.3. SubSDelay

Command	Unit	Code	Description
GetSubSDelay	DCU	802	Get the S/S maximum predefined response time expressed in low-level command interface clock periods
Returned Parameter(s)	Location	Length	
SubSDelay	0	9	Bit 8 to 0: Register preset -

2.2.2.4. TstampRst

Command	Unit	Code	Description
SetTstampRst	DRCU	003	Reset the 32-bit counter inserted in the S/S output data format.
Parameters	Location	Length	
NA	NA	NA	PAR15 to PAR00 = 00 hexa

2.2.3. DRCU parameter description

Name	Type	Size	Conversion	Limits	Description
LastCmdStatus	Discrete	2	See ACK definition table 2.1-d		
SubSystemTimeout	Discrete	1	1=last command time out error		
ForbiddenRead	Discrete	1	1=last read command forbidden		
ForbiddenBroacast	Discrete	1	1=last broadcast command forbidden		
CommandOverlapped	Discrete	1	1=successive command overlap		
StatusRst	Discrete	1	0=reset the CmdIfStat register		
SubSystemRst	Discrete	1	0=reset S/S		
DataIfReset	Discrete	1	0=reset S/S IF logic		
SubSDelay	Digital	9	Delay between command reception & response transmission = SubSDelay/319 488		

2.2.4. DRCU typical commanding scenarios

2.2.5. DCU specific command list summary

2.2.5.1. Command and parameter mapping

The following table shows respectively the bit mapping for CID and PAR field of a low-level command for the DCU.

CID11	CID10 to CID0	PAR15 to PAR9	PAR8 to PAR0
R/W	Command Code	Channel id.	Parameter(s)

Note: for the SetPhotoOffset and SetSpetroOffset commands the *parameter* field is in turn divided into two sub-fields has described bellow.

PAR8 to PAR4	PAR3 to PAR0
Channel Number	Offset Value

2.2.5.2. Photometer write/read commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
Set/GetPhotoSampFreq	Channel id Bias freq divider	NA 000 to 255	Get... cmd	
Set/GetPhotoBiasFreq	Channel id. Frequency divider	NA 064 to 511	Get... cmd	
Set/GetPhotoDemodPh	Ref. Channel id PSD Phase	00 to 03 000 to 255	Get... cmd	
Set/GetPhotoBiasMode	Channel id Bias gene mode	NA 000 to 255	Get... cmd	
Set/GetPhotoBiasAmpl	Bias Channel id. Sine amplitude	00 to 03 000 to 255	Get... cmd	
Set/GetPhotoJfetVss	Channel id. Vss voltage	00 to 11 000 to 255	Get... cmd	
Set/GetPhotoHeaterBias	Channel id. Bias current	NA 000 to 255	Get... cmd	
SetGetPhotoJfetPwr	Channel id On/Off word	00 to 01 NA	Get... cmd	
SetGetPhotoOffset	Channel id. Channel number Offset value	00 to 08 00 to 32 00 to 15	Get... cmd	

2.2.5.3. Spectrometer write/read commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
Set/GetSpectroSampFreq	Channel id Bias freq divider	NA 000 to 255	Get_... cmd	
Set/GetSpectroBiasFreq	Channel id. Frequency divider	NA 064 to 511	Get_... cmd	
Set/GetSpectroDemodPh	Channel id PSD Phase	00 to 01 000 to 255	Get_... cmd	
Set/GetSpectroBiasMode	Channel id Bias gene mode	NA 000 to 255	Get_... cmd	
Set/GetSpectroBiasAmpl	Channel id. Sine amplitude	00 to 01 000 to 255	Get_... cmd	
Set/GetSpectroHeaterPwr	Channel id. Bias current	NA 000 to 255	Get_... cmd	
Set/GetSpectroJfetVss	Channel id. Vss voltage	00 to 02 000 to 255	Get_... cmd	
Set/GetSpectroJfetPwr	Channel id On/Off word	00 to 01 NA	Get_... cmd	
Set/GetSpectroOffset	Channel id. Channel number Offset value	00 to 02 00 to 32 00 to 15	Get_... cmd	

2.2.5.4. Photometer / spectrometer common write/read commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
Set/GetDataMode	Channel id. Mode id.	NA See xx	Get... cmd TBC	
Set/GetFrameNber	Channel id Nber of frames	NA 000 to 255	Get... cmd TBC	
Set/GetStartFrame	Channel id Run/Stop code	NA 000 / 255	Get... cmd TBC	

2.2.5.5. Read only commands

Command Name	Argument(s)	Execution Delay
GetHKChannel	HK Channel id.	See §2.2.5.6

2.2.5.6. DCU housekeeping identifier list

The following table explicits the *HK Channel id* to be transmitted as an argument of the *GetHKChannel* command.

Parameter Name	Word size (bits)	Comments	HK Channel id (hex)	Delay To Transmit
T/C_1	16	16-bit ADC (Offset=0)	00	
T/C_2	16	16-bit ADC (Offset=0)	01	
T/C_3	16	16-bit ADC (Offset=0)	02	
BIAS_BDA_1	8	Ph. Bolo. Bias 1 ampl. setting	03	
BIAS_BDA_2	8	Ph. Bolo. Bias 2 ampl. setting	04	
BIAS_BDA_3	8	Ph. Bolo. Bias 3 amplitude setting	05	
BIAS_BDA_4	8	Sp. Bolo. Bias 1 amplitude setting	06	
BIAS_BDA_5	8	Sp. Bolo. Bias 2 amplitude setting	07	
BIAS_TEMP_5	8	T/C. Bias 1 ampl. Setting	08	
F_BIAS_PH/TC	8	Ph. & T/C Bias Freq div. setting	09	
F_BIAS_SP	8	Sp. Bias Freq div. setting	0A	
JFET_VSS_PLW_1	8	PLW_1 JFET VSS setting	0B	
JFET_VSS_PLW_2	8	PLW_2 JFET VSS setting	0C	
JFET_VSS_PMW_1	8	PMW_1 JFET VSS setting	0D	
JFET_VSS_PMW_2	8	PMW_2 JFET VSS setting	0E	
JFET_VSS_PMW_3	8	PMW_3 JFET VSS setting	0F	
JFET_VSS_PMW_4	8	PMW_4 JFET VSS setting	10	
JFET_VSS_PSW_1	8	PSW_1 JFET VSS setting	11	
JFET_VSS_PSW_2	8	PSW_2 JFET VSS setting	12	
JFET_VSS_PSW_3	8	PSW_3 JFET VSS setting	13	
JFET_VSS_PSW_4	8	PSW_4 JFET VSS setting	14	
JFET_VSS_PSW_5	8	PSW_5 JFET VSS setting	15	
JFET_VSS_PSW_6	8	PSW_6 JFET VSS setting	16	
JFET_VSS_SLW_1	8	SLW_1 JFET VSS setting	17	
JFET_VSS_SSW_1	8	SSW_1 JFET VSS setting	18	
JFET_VSS_SSW_2	8	SSW_2 JFET VSS setting	19	
LIA_B1_TEMP	16	LIA board 1 temperature	1A	
LIA_B2_TEMP	16	LIA board 2 temperature	1B	
LIA_B3_TEMP	16	LIA board 3 temperature	1C	
LIA_B4_TEMP	16	LIA board 4 temperature	1D	
LIA_B5_TEMP	16	LIA board 5 temperature	1E	
LIA_B6_TEMP	16	LIA board 6 temperature	1F	
LIA_B7_TEMP	16	LIA board 7 temperature	20	
LIA_B8_TEMP	16	LIA board 8 temperature	21	
LIA_B9_TEMP	16	LIA board 9 temperature	22	
LIA_B10_TEMP	16	LIA board 10 temperature	23	
LIA_B11_TEMP	16	LIA board 11 temperature	24	
LIA_B12_TEMP	16	LIA board 12 temperature	25	
BIAS_TEMP	16	BIAS board temperature	26	
DAQ_IF_TEMP	16	DAQ_IF board temperature	27	
PWR_STATUS	12	LIA 1 to LIA 12 +5V/+9V/-9V status	28	

2.2.6. DCU command description

2.2.6.1. Photometer

2.2.6.1.1. PhotoSampFreq

Command	Unit	Code	Description
SetPhotoSampFreq	DCU	000	Set the photometer & T/C bolometer sampling frequency division from the photometer bias clock
Parameters	Location	Length	
PhotoBiasDiv	0	8	

Command	Unit	Code	Description
GetPhotoSampFreq	DCU	800	Get the photometer & T/C bolometer sampling frequency division from the photometer bias clock
Returned Parameters	Location	Length	
PhotoBiasDiv	0	8	

2.2.6.1.2. PhotoBiasFreq

Command	Unit	Code	Description
SetPhotoBiasFreq	DCU	001	Set the photometer & T/C bolometer sine bias frequency division from the master clock
Parameters	Location	Length	
PhotoMClkDiv	0	9	Min 64; Max 511

Command	Unit	Code	Description
GetPhotoBiasFreq	DCU	801	Get the photometer & T/C bolometer sine bias frequency division from the master clock
Returned Parameters	Location	Length	
PhotoMClkDiv	0	9	Min 64; Max 511

2.2.6.1.3. PhotoBiasMode

Command	Unit	Code	Description
SetPhotoBiasMode	DCU	006	Set the photometer & T/C bolometer sine bias mode
Parameters	Location	Length	
PhotoBiasMode	0	8	FF=run ; 00=stop ; 01 to FE = discrete values

Command	Unit	Code	Description
GetPhotoBiasMode	DCU	806	Get the photometer & T/C bolometer sine bias mode
Parameters	Location	Length	
PhotoBiasMode	0	8	FF=run ; 00=stop ; 01 to FE= test values

2.2.6.1.4. PhotoDemodPh

Command	Unit	Code	Description
SetDemodPh	DCU	002	Set the P250 bolometer demodulation phase shift
Parameters	Location	Length	
PhotoPhaseShift	0	8	
PhotoBiasChannel	9 *	2	0=P250, 1=P350, 2=P500, 3=TC

Command	Unit	Code	Description
GetDemodPh	DCU	802	Set bolometer group demodulation phase shift
Parameters	Location	Length	
PhotoBiasChannel	9 *	2	0=P250, 1=P350, 2=P500, 3=TC
Returned Parameters			
PhaseShift	0	8	

2.2.6.1.5. PhotoBiasAmpl

Command	Unit	Code	Description
SetPhotoBiasAmpl	DCU	007	Set bolometer group sine bias amplitude
Parameters	Location	Length	
PhotoBiasAmpl	0	8	
PhotoBiasChannel	9 *	2	0=P250, 1=P350, 2=P500, 3=TC

Command	Unit	Code	Description
GetPhotoBiasAmpl	DCU	807	Set bolometer group sine bias amplitude
Parameters	Location	Length	
PhotoBiasChannel	9 *	2	0=P250, 1=P350, 2=P500, 3=TC
Returned Parameters	Location	Length	
PhotoBiasAmpl	0	8	

2.2.6.1.6. PhotoHeaterPwr

Command	Unit	Code	Description
SetPhotoHeaterBias	DCU	00B	Set the photometer heater bias voltage
Parameters	Location	Length	
PhotoHeaterBias	0	8	

Command	Unit	Code	Description
GetPhotoHeaterBias	DCU	80B	Get the photometer heater bias voltage
Parameters	Location	Length	
PhotoHeaterBias	0	8	

2.2.6.1.7. PhSWJfetVSS

Command	Unit	Code	Description
SetPhSWJfetVSS	DCU	00C	Set P250 JFET source voltage
Parameters	Location	Length	
PSW_VSS (Ampl)	0	8	Analogue value $=VSS_{max}\frac{Ampl}{255}$ with $0 \le Ampl \le 255$
VSSChannelID	9 *	3	000=VSS1, 001=VSS2, 010=VSS3, 011=VSS4, 100=VSS5, 101=VSS6

Command	Unit	Code	Description
GetPhSWJfetVSS	DCU	80C	Get P250 JFET source voltage
Parameters	Location	Length	
VSSChannelID	9 *	3	000=VSS1, 001=VSS2, 010=VSS3, 011=VSS4, 100=VSS5, 101=VSS6
Returned Parameters			
PSW_VSS	0	8	

2.2.6.1.8. PhMWJfetVSS

Command	Unit	Code	Description
SetPhSWJfetVSS	DCU	012	Set P350 JFET source voltage
Parameters	Location	Length	
PMW_VSS (Ampl)	0	8	
VSSChannelID	9 *	2	00=VSS1, 01=VSS2, 10=VSS3, 11=VSS4,

Command	Unit	Code	Description
GetPhMWJfetVSS	DCU	812	Get P350 JFET source voltage
Parameters	Location	Length	
VSSChannelID	9 *	2	00=VSS1, 01=VSS2, 10=VSS3, 11=VSS4
Returned Parameters			
PMW_VSS	0	8	

2.2.6.1.9. PhLWJfetVSS

Command	Unit	Code	Description
SetPhLWJfetVSS	DCU	016	Set JFET source voltage
Parameters	Location	Length	
PLW_VSS (Ampl)	0	8	
VSSChannelID	9 *	1	0=VSS1, 1=VSS2

Command	Unit	Code	Description
Get_P500_JFET_VSS1	DCU	816	Get JFET source voltage
Parameters	Location	Length	
VSSChannelID	9 *	1	0=VSS1, 1=VSS2
Returned Parameters			
PLW_VSS	0	8	

2.2.6.2. PhSWJfetPwr

Command	Unit	Code	Description
SetPhSWJFfetBias	DCU	018	Switch the P250 JFETs drain voltage on/off
Parameters	Location	Length	
P250_JFET_1	0	1	
P250_JFET_2	1	1	
P250_JFET_3	2	1	
P250_JFET_4	3	1	
P250_JFET_5	4	1	
P250_JFET_6	5	1	

Command	Unit	Code	Description
GetPhSWJFfetBias	DCU	818	Get the P250 JFETs drain voltage status
Parameters	Location	Length	
P250_JFET_1	0	1	
P250_JFET_2	1	1	
P250_JFET_3	2	1	
P250_JFET_4	3	1	
P250_JFET_5	4	1	
P250_JFET_6	5	1	

2.2.6.3. PhMLWJfetPwr

Command	Unit	Code	Description
SetPhMLWJfetBias	DCU	019	Switch the P350 & P500 JFETs drain voltage on/off
Parameters	Location	Length	
P350_JFET_1	0	1	
P350_JFET_2	1	1	
P350_JFET_3	2	1	
P350_JFET_4	3	1	
P500_JFET_1	4	1	
P500_JFET_2	5	1	

Command	Unit	Code	Description
GetPhMLWJfetBias	DCU	819	Get the P350 & P500 JFETs drain voltage status
Parameters	Location	Length	
P350_JFET_1	0	1	
P350_JFET_2	1	1	
P350_JFET_3	2	1	
P350_JFET_4	3	1	
P500_JFET_1	4	1	
P500_JFET_2	5	1	

2.2.6.3.1. SetLIAPxOffset

Command	Unit	Code	Description
SetLIAP1Offset	DCU	020	Set one LIA_P1 channel offset value
Parameters	Location	Length	
Offset_ P1	0	4	
Channel_P1	4	5	

Command	Unit	Code	Description
SetLIAP2Offset	DCU	821	Set one LIA_P2 channel offset value
Parameters	Location	Length	
Offset_ P2	0	4	
Channel_P2	4	5	

Command	Unit	Code	Description
SetLIAP3Offset	DCU	822	Set one LIA_P3 channel offset value
Parameters	Location	Length	
Offset_ P3	0	4	
Channel_P3	4	5	

Command	Unit	Code	Description
SetLIAP4Offset	DCU	823	Set one LIA_P4 channel offset value
Parameters	Location	Length	
Offset_ P4	0	4	
Channel_P4	4	5	

Command	Unit	Code	Description
SetLIAP5Offset	DCU	824	Set one LIA_P5 channel offset value
Parameters	Location	Length	
Offset_ P5	0	4	
Channel_P5	4	5	

Command	Unit	Code	Description
SetLIAP6Offset	DCU	825	Set one LIA_P6 channel offset value
Parameters	Location	Length	
Offset _P6	0	4	
Channel_P6	4	5	

Command	Unit	Code	Description
SetLIAP7Offset	DCU	826	Set one LIA_P7 channel offset value
Parameters	Location	Length	
Offset _P7	0	4	
Channel_P7	4	5	

Command	Unit	Code	Description
SetLIAP8Offset	DCU	827	Set one LIA_P8 channel offset value
Parameters	Location	Length	
Offset _P8	0	4	
Channel_P8	4	5	

Command	Unit	Code	Description
SetLIAP9Offset	DCU	828	Set one LIA_P9 channel offset value
Parameters	Location	Length	
Offset_P9	0	4	
Channel_P9	4	5	

- see 2.2.5.1: [PAR8;PAR0]

2.2.6.4. LIA_P channel/Bolometer number cross table (to be completed)

Board Id																	
LIAP1		LIAP2		LIAP3		LIAP4		LIAP5		LIAP6		LIAP7		LIAP8		LIAP9	
Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number
1		1		1		1		1		1		1		1		1	
2		2		2		2		2		2		2		2		2	
3		3		3		3		3		3		3		3		3	
4		4		4		4		4		4		4		4		4	
5		5		5		5		5		5		5		5		5	
6		6		6		6		6		6		6		6		6	
7		7		7		7		7		7		7		7		7	
8		8		8		8		8		8		8		8		8	
9		9		9		9		9		9		9		9		9	
10		10		10		10		10		10		10		10		10	
11		11		11		11		11		11		11		11		11	
12		12		12		12		12		12		12		12		12	
13		13		13		13		13		13		13		13		13	
14		14		14		14		14		14		14		14		14	
15		15		15		15		15		15		15		15		15	
16		16		16		16		16		16		16		16		16	
17		17		17		17		17		17		17		17		17	
18		18		18		18		18		18		18		18		18	
19		19		19		19		19		19		19		19		19	
20		20		20		20		20		20		20		20		20	
21		21		21		21		21		21		21		21		21	
22		22		22		22		22		22		22		22		22	
23		23		23		23		23		23		23		23		23	
24		24		24		24		24		24		24		24		24	
25		25		25		25		25		25		25		25		25	
26		26		26		26		26		26		26		26		26	
27		27		27		27		27		27		27		27		27	
28		28		28		28		28		28		28		28		28	
29		29		29		29		29		29		29		29		29	
30		30		30		30		30		30		30		30		30	
31		31		31		31		31		31		31		31		31	
32		32		32		32		32		32		32		32		32	

2.2.6.5. Spectrometer

2.2.6.5.1. SpectroSampFreq

Command	Unit	Code	Description
SetSpectroSamplfreq	DCU	030	Set the spectrometer bolometer sampling frequency division from the spectrometer bias clock
Parameters	Location	Length	
SpectroBiasDiv	0	8	

Command	Unit	Code	Description
GetSpectroSamplFreq	DCU	830	Get the photometer & T/C bolometer sampling frequency division from the photometer bias clock
Parameters	Location	Length	
SpectroBiasDiv	0	8	

2.2.6.5.2. SpectroBiasFreq

Command	Unit	Code	Description
SetSpectroBiasFreq	DCU	031	Set the spectrometer bolometer sine bias frequency division from the master clock
Parameters	Location	Length	
SpectroMClkDiv	0	9	Min 64; Max 511

Command	Unit	Code	Description
GetSpectroBiasFreq	DCU	831	Get the spectrometer bolometer sine bias frequency division from the master clock
Parameters	Location	Length	
SpectroMClkDiv	0	9	Min 64; Max 511

2.2.6.5.3. SpectroBiasMode

Command	Unit	Code	Description
SetSpectroBiasMode	DCU	034	Set the spectrometer bolometer sine bias mode
Parameters	Location	Length	
SpectroBiasMode	0	8	FF=run ; 00=stop ; 01 to FE = test values

Command	Unit	Code	Description
GetSpectroBiasMode	DCU	834	Get the spectrometer bolometer sine bias mode
Parameters	Location	Length	
SpectroBiasMode	0	8	FF=run ; 00=stop ; 01 to FE = test values

2.2.6.5.4. SpectroDemodPh

Command	Unit	Code	Description
SetSpectroDemodPh	DCU	032	Set the S-SW bolometer demodulation phase shift
Parameters	Location	Length	
SpectroPhaseShift	0	8	
SpectroBiasChannel	9 *	1	0=SW, 1=LW

Command	Unit	Code	Description
GetSpectroDemodPh	DCU	832	Get the S-SW bolometer demodulation phase shift
Parameters	Location	Length	
SpectroBiasChannel	9 *	1	
Returned Parameters			
SpectroPhaseShift	0	8	

2.2.6.5.5. SpectroBiasAmpl

Command	Unit	Code	Description
SetSpectroBiasAmpl	DCU	035	Set bolometer group sine bias amplitude
Parameters	Location	Length	
SpectroBiasAmpl	0	8	
SpectroBiasChannel	9 *	1	0=SW, 1=LW

Command	Unit	Code	Description
GetSpectroBiasAmpl	DCU	835	Set bolometer group sine bias amplitude
Parameters	Location	Length	
SpectroBiasChannel	9 *	1	0=SW, 1=LW
Returned Parameters	Location	Length	
SpectroBiasAmpl	0	8	

2.2.6.5.6. SpectroHeaterPwr

Command	Unit	Code	Description
SetSpectroHeaterBias	DCU	038	Set the spectrometer heater bias voltage
Parameters	Location	Length	
SpectroHeaterBias	0	8	

Command	Unit	Code	Description
GetSpectroHeaterBias	DCU	838	Set the spectrometer heater bias voltage
Parameters	Location	Length	
SpectroHeaterBias	0	8	

2.2.6.5.7. SpSWJfetVSS

Command	Unit	Code	Description
SetSpSWJfetVSS	DCU	039	Set S-SW JFET source voltage
Parameters	Location	Length	
SSW_VSS (Ampl)	0	8	
VSSChannelID	9 *	1	0=VSS1, 1=VSS2

Command	Unit	Code	Description
GetSpSWJfetVSS	DCU	839	Get S-SW JFET source voltage
Parameters	Location	Length	
VSSChannelID	9 *	1	0=VSS1, 1=VSS2
Returned Parameters			
SSW_VSS	0	8	

2.2.6.5.8. SpLWJfetVSS

Command	Unit	Code	Description
GetSpLWJfetVSS	DCU	03A	Get L-SW JFET source voltage
Parameters	Location	Length	
SLW_VSS	0	8	

Command	Unit	Code	Description
SetSpLWJfetVSS	DCU	83A	Set L-SW JFET source voltage
Returned Parameters	Location	Length	
SLW_VSS	0	8	

2.2.6.5.9. SpSLWJfetPwr

Command	Unit	Code	Description
SetSpSLWJfetBias	DCU	03B	Switch the spectrometer JFETs drain voltage on/off
Parameters	Location	Length	
SLW_JFET1	0	1	
SSW_JFET1	1	1	
SSW_JFET2	2	1	

Command	Unit	Code	Description
GetSpSLWJfetBias	DCU	83B	Get the spectrometer JFETs drain voltage status
Parameters	Location	Length	
SLW_JFET1	0	1	
SSW_JFET1	1	1	
SSW_JFET2	2	1	

2.2.6.5.10. SetLIASxOffset

Command	Unit	Code	Description
SetLIAS1Offset	DCU	03C	Set one LIA_S1 channel offset value
Parameters	Location	Length	
Offset _S1	0	4	
Channel_S1	4	5	

Command	Unit	Code	Description
SetLIAS2Offset	DCU	03D	Set one LIA_S2 channel offset value
Parameters	Location	Length	
Offset _S2	0	4	
Channel_S2	4	5	

Command	Unit	Code	Description
SetLIAS3Offset	DCU	03E	Set one LIA_S3 channel offset value
Parameters	Location	Length	
Offset _S3	0	4	
Channel_S3	4	5	

2.2.6.6. LIA_S channel/Bolometer number cross table (to be completed)

Board Id																	
LIAS1		LIAS2		LIAS3		LIAS1		LIAS2		LIAS3		LIAS1		LIAS2		LIAS3	
Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number	Channel Number	Bolometer Number
1		1		1		9		9		9		17		17		17	
2		2		2		10		10		10		18		18		18	
3		3		3		11		11		11		19		19		19	
4		4		4		12		12		12		20		20		20	
5		5		5		13		13		13		21		21		21	
6		6		6		14		14		14		22		22		22	
7		7		7		15		15		15		23		23		23	
8		8		8		16		16		16		24		24		24	

2.2.6.7. Photometer & Spectrometer common commands

2.2.6.7.1. SetDataMode

Command	Unit	Code	Description
SetDataMode	DCU	029	Set mode
Parameters	Location	Length	

DataMode	0	5	Bit 4: 0=acquisition ; 1=offset Bit 3: 0=normal ; 1=test Bit 2 to 0: 0=photometer ; 1=P250 ; 2=P350&T/C ; 3=P500 4=spectrometer ; 5=S-LW ; 6=S-SW

Command	Unit	Code	Description
GetDataMode	DCU	829	Get mode
Parameters	Location	Length	
DataMode	0	5	

2.2.6.7.2. SetFrameNber

Command	Unit	Code	Description
SetFrameCount	DCU	02A	Set photometer frames acquisition mode
Parameters	Location	Length	
FrameCount	0	8	0=continuous; 1 to 255 =number of frames

Command	Unit	Code	Description
GetFrameCount	DCU	82A	Get photometer frames acquisition mode
Parameters	Location	Length	
FrameCount	0	8	0=continuous; 1 to 255 =number of frames

2.2.6.7.3. StartFrame

Command	Unit	Code	Description
SetStartFrame	DCU	02B	
Parameters	Location	Length	
StartFrame	0	1	1=run ; 0=stop

Command	Unit	Code	Description
GetStartFrame	DCU	82B	
Parameters	Location	Length	
Startframe	0	1	1=run ; 0=stop

* see 2.2.5.1: [PAR8;PAR0]

2.2.7. DCU parameters description

2.2.7.1. Photometer

Name	Type	Size	Conversion	Limits	Description
PhotoDivBias	Analogue	8	$F_{sampl}=\frac{F_{bias}}{2.(Div\_photo\_sampl)}$	0 to 255	
PhotoMClkDiv	Analogue	9	$F_{BIAS}=\frac{xxMHz}{2.256.(Div\_photo\_bias)}$	64 to 511	
Mode_photo_bias	Discrete	8	FF=run sine 00 to FE= DC level	0 to 254	
PhotoPhaseShift	Analogue	8	$Ph_{xx}=\frac{360°(Phase\_shift\_xx)}{255}$	0 to 255	
PhotoBiasAmpl	Analogue	8	$Vb_{xx}=\frac{Vb\max.(Ampl\_xx)}{255}$	0 to 255	
PhotoHeaterBias	Analogue	8	$Vh_{xx}=\frac{Vh\max.(Ampl\_xx)}{255}$	0 to 255	
PSW_VSS	Analogue	8	$VSS_{xx}=\frac{VSS\max.(Ampl\_xx)}{255}$	0 to 255	
PMW_VSS	Analogue	8	$VSS_{xx}=\frac{VSS\max.(Ampl\_xx)}{255}$	0 to 255	
PLW_VSS	Analogue	8	$VSS_{xx}=\frac{VSS\max.(Ampl\_xx)}{255}$	0 to 255	
P250_JFET_1	Discrete	1	0=off ; 1=on		
P250_JFET_2	Discrete	1	0=off ; 1=on		
P250_JFET_3	Discrete	1	0=off ; 1=on		
P250_JFET_4	Discrete	1	0=off ; 1=on		
P250_JFET_5	Discrete	1	0=off ; 1=on		
P250_JFET_6	Discrete	1	0=off ; 1=on		
P350_JFET_1	Discrete	1	0=off ; 1=on		
P350_JFET_2	Discrete	1	0=off ; 1=on		
P350_JFET_3	Discrete	1	0=off ; 1=on		
P350_JFET_4	Discrete	1	0=off ; 1=on		
P500_JFET_1	Discrete	1	0=off ; 1=on		
P500_JFET_2	Discrete	1	0=off ; 1=on		
Channel_P1	Discrete	5	Channel 1 to 32 of LIA_P1		
Channel_P2	Discrete	5	Channel 1 to 32 of LIA_P2		
Channel_P3	Discrete	5	Channel 1 to 32 of LIA_P3		
Channel_P4	Discrete	5	Channel 1 to 32 of LIA_P4		
Channel_P5	Discrete	5	Channel 1 to 32 of LIA_P5		
Channel_P6	Discrete	5	Channel 1 to 32 of LIA_P6		
Channel_P7	Discrete	5	Channel 1 to 32 of LIA_P7		
Channel_P8	Discrete	5	Channel 1 to 32 of LIA_P8		
Channel_P9	Discrete	5	Channel 1 to 32 of LIA_P9		
Offset_P1	Analogue	4			
Offset_P2	Analogue	4			
Offset_P3	Analogue	4			
Offset_P4	Analogue	4			

Offset_P5	Analogue	4			
Offset_P6	Analogue	4			
Offset_P7	Analogue	4			
Offset_P8	Analogue	4			
Offset_P9	Analogue	4			

2.2.7.2. Spectrometer

Name	Type	Size	Conversion	Limits	Description
SpectroBiasDiv	Analogue	8	$F_{sampl}=\frac{F_{bias}}{2.(Div\_photo\_sampl)}$	0 to 255	
SpectroMClkDiv	Analogue	9	$F_{BIAS}=\frac{xxMHz}{2.256.(Div\_photo\_bias)}$	64 to 511	
SpectroBiasMode	Discrete	8	FF=run sine 00 to FE= DC level	0 to 254	
SpectroPhaseShift	Analogue	8	$Ph_{xx}=\frac{360°(Phase\_shift\_xx)}{255}$	0 to 255	
SpectroBiasAmpl	Analogue	8	$Vb_{xx}=\frac{Vb\max.(Ampl\_xx)}{255}$	0 to 255	
SpectroHeaterBias	Analogue	8	$Vh_{xx}=\frac{Vh\max.(Ampl\_xx)}{255}$	0 to 255	
SLW_VSS	Analogue	8	$VSS_{xx}=\frac{VSS\max.(Ampl\_xx)}{255}$	0 to 255	
SSW_VSS	Analogue	8	$VSS_{xx}=\frac{VSS\max.(Ampl\_xx)}{255}$	0 to 255	
SLW_JFET1	Discrete	1	0=off ; 1=on		
SSW_JFET1	Discrete	1	0=off ; 1=on		
SSW_JFET2	Discrete	1	0=off ; 1=on		
Channel_S1	Discrete	5	Channel 1 to 24 of LIA_S1		
Channel_S2	Discrete	5	Channel 1 to 24 of LIA_S2		
Channel_S3	Discrete	5	Channel 1 to 24 of LIA_S3		
Offset_S1	Analogue	4	Offset_S1		
Offset_S2	Analogue	4	Offset_S2		
Offset_S3	Analogue	4	Offset_S3		

2.2.7.3. Photometer & Spectrometer

Name	Type	Size	Conversion	Limits	Description
DataMode	Discrete	5	00= acquisition photometer 01= acquisition P250 02= acquisition P350 03= acquisition P500 04= acquisition Spectrometer 05= acquisition S-SW 06= acquisition S-LW 08= Test Pattern photometer 0C= Test Pattern Spectrometer 10= Automatic offset photometer set 14= Automatic offset spectrometer set 18= Get offset photometer 1C= Get offset spectrometer Other = do nothing		
FrameCount	Discrete	8	0=continuous; 1 to 255 = number of frames		
StartFrame	Discrete	1	1=run ; 0=stop		

2.2.8. DCU typical commanding scenarios

2.2.8.1. DCU Configuration

Steps	Command	Parameters	Comment
1	SetPhotoBiasFreq	Div_photo_bias	With a 10 MHz master clock for a photometer bias frequency of 199,3Hz; Div_photo_sampl = 98
2	SetPhotoSampFreq	Div_photo_sampl	For a photometer sampling frequency of 15,3Hz; Div_photo_sampl=13
3	SetPhotoDemodPh	P250 Phase_shift_P250	The optimised phases shift for each possible bias frequency must be set in a table during the ground calibration (447cases of each type of BDA)
4	SetPhotoDemodPh	P350 Phase_shift_P350	
5	SetPhotoDemodPh	P500 Phase_shift_P500	
6	SetPhotoDemodPh	T/C Phase_shift_T/C	
7	SetPhotoBiasAmpl	P250 Ampl_P250	Optimised amplitude could be determine during the ground calibration
8	SetPhotoBiasAmpl	P350 Ampl_P350	
9	SetPhotoBiasAmpl	P500 Ampl_P500	
10	SetPhotoBiasAmpl	T/C Ampl_T/C	
11	SetPhSWJfetVSS	VSS1 Ampl_P250_VSS1	Optimised amplitude could be determined during the ground calibration
12	SetPhSWJfetVSS	VSS2 Ampl_P250_VSS2	
13	SetPhSWJfetVSS	VSS3 Ampl_P250_VSS3	
14	SetPhSWJfetVSS	VSS4 Ampl_P250_VSS4	
15	SetPhSWJfetVSS	VSS5 Ampl_P250_VSS5	
16	SetPhSWJfetVSS	VSS6 Ampl_P250_VSS6	
17	SetPhMWJfetVSS	VSS1 Ampl_P350_VSS1	
18	SetPhMWJfetVSS	VSS2 Ampl_P350_VSS2	
19	SetPhMWJfetVSS	VSS3 Ampl_P350_VSS3	
20	SetPhMWJfetVSS	VSS4 Ampl_P350_VSS4	
21	SetPhLWJfetVSS	VSS1 Ampl_P500_VSS1	

22	SetPhLWJfetVSS	VSS2 Ampl_P500_VSS2	
23	SetSWJfetPwr	P250_JFET	All JFET on (P250_JFET=111111)
24	SetMLWJfetPwr	P350&500_JFET	All JFET on (P350&500_JFET=111111)
25	SetPhotoBiasMode	Mode_photo_bias	Mode = EF
26	SetPhotoHeaterBias	Ampl_photo_heater	Start heat the photometer JFET modules Set Ampl_photo_heater with xx
	Wait xx ms		
27	SetPhotoHeaterBias	Ampl_photo_heater	Stop heat the photometer JFET modules Set Ampl_photo_heater with 00

Steps	Command	Parameters	Comment
28	SetSpectroBiasFreq	Div_spectro_bias	With a 10 MHz master clock for a photometer bias frequency of 160,1Hz; Div_photo_sampl=122
29	SetSpectroSamplFreq	Div_spectro_sampl	For a photometer sampling frequency of 80 Hz; Div_photo_sampl=2
30	SetSpectroDemodPh	SW Phase_shift_S-SW	The optimised phases shift for each possible bias frequency must be set in a table during the ground calibration (447cases of each type of BDA)
31	SetSpectroDemodPh	LW Phase_shift_S-LW	
32	SetSpectroBiasAmpl	SW Ampl_S-SW	Optimised amplitude could be determine during the ground calibration
33	SetSpectroBiasAmpl	LW Ampl_S-LW	
34	SetSpLWJfetVSS	VSS1 Ampl_S-LW_VSS1	Optimised amplitude could be determine during the ground calibration
35	SetSpSWJfetVSS	VSS1 Ampl_S-SW_VSS1	
36	SetSpSWJfetVSS	VSS2 Ampl_S-SW_VSS2	
37	SetSpectroJfetPwr	S-LW&S-SW_JFET	All JFET on (S-LW&S-SW_JFET =111111)
38	SetSpectroBiasMode	Mode_spectro_bias	Mode = EF
39	SetSpectroHeaterBias	Ampl_spectro_heater	Start heat the spectrometer JFET modules Set Ampl_spectro_heater with xx
	Wait xx ms		
40	SetSpectroHeaterBias	Ampl_spectro_heater	Stop heat the spectrometer JFET modules Set Ampl_spectro_heater with 00

So after all those steps the spectrometer and the photometer JFETs are running. All the sine bias parameters and acquisition parameters are loaded and the bolometers biases receive a differential 0V.
Next step: start running the spectrometer or the photometer.

2.2.8.2. Photometer Configuration

Steps	Command	Parameters	Comment
1	SetPhotoBiasMode	Mode_photo_bias	Mode = FF
	Wait xx ms		After this time the system must be stable

2.2.8.3. Photometer offset setting

2.2.8.3.1. Automatic

Steps	Command	Parameters	Comment
1	SetStartFrame	start	Start=0
2	SetPhotoMode	Mode	Mode = 10
3	SetStartFrame	start	Start=1
	Wait xx ms		All the offset are set
4	SetStartframe	start	Start=0
5	SetPhotoMode	Mode	Mode = 18
6	SetStartFrame	start	Start=1
	Wait xx ms		All the offset are send to DPU

2.2.8.3.2. Manual

Steps	Command	Parameters	Comment
1	SetLIAP1Offset	Channel_P1 Offset_P1	Channel_P1=0 Offset_P1=X
-	-	-	-
32	SetLIAP1Offset	Channel_P1 Offset_P1	Channel_P1=31 Offset_P1=X
17	SetLIAP2Offset	Channel_P2 Offset_P2	Channel_P2=0 Offset_P2=X
-	-	-	-
32	SetLIAP2Offset	Channel_P2 Offset_P2	Channel_P2=31 Offset_P2=X
-	-	-	-
-	-	-	-
288	SetLIAP9Offset	Channel_P9 Offset_P9	Channel_P9=31 Offset_P9=X

2.2.8.4. Photometer acquisition

2.2.8.4.1. Continuous

Steps	Command	Parameters	Comment
1	Set_start_mode	start	Start=0
2	Set _mode	Mode	Mode = 00
3	Set_frames_photo	frame	Frame=0
4	Set_start_mode	start	Start=1

2.2.8.4.2. Frame burst

Steps	Command	Parameters	Comment
1	SetStartFrame	start	Start=0
2	SetDataMode	Mode	Mode = 00
3	SetFrameNber	frame	Frame=x (1 to 255 = number of frames)
4	SetStartFrame	start	Start=1

2.2.8.5. Spectrometer Configuration

Steps	Command	Parameters	Comment
1	SetSpectroBiasMode	Mode_Spectro_bias	Mode = FF
	Wait xx ms		After this time the system must be stable

2.2.8.6. Spectrometer offset setting

2.2.8.6.1. Automatic

Steps	Command	Parameters	Comment
1	SetStartFrame	start	Start=0
2	SetSpectroMode	Mode	Mode = 14
3	SetStartFrame	start	Start=1
	Wait xx ms		All the offset are set
4	SetStartFrame	start	Start=0
5	SetSpectroMode	Mode	Mode = 1C
6	SetStartFrame	start	Start=1
	Wait xx ms		All the offset are send to DPU

2.2.8.6.2. Manual

Steps	Command	Parameters	Comment
1	SetLIAS1Offset	Channel_S1 Offset_S1	Channel_S1=0 Offset_S1=X
-	-	-	-
32	SetLIAS1Offset	Channel_S1 Offset_S1	Channel_S1=23 Offset_S1=X
17	SetLIAS2Offset	Channel_S2 Offset_S2	Channel_S2=0 Offset_S2=X
-	-	-	-
32	SetLIAS2Offset	Channel_S2 Offset_S2	Channel_S2=23 Offset_S2=X
-	-	-	-
-	-	-	-
288	SetLIAS3Offset	Channel_S3 Offset_S3	Channel_S3=23 Offset_S3=X

2.2.8.7. Spectrometer acquisition

2.2.8.7.1. Continuous

Steps	Command	Parameters	Comment
1	SetStartFrame	start	Start=0
2	Set DataMode	Mode	Mode = 04
4	SetStartFrame	start	Start=1

2.2.9. MCU specific command list summary

2.2.9.1. Command and parameter mapping

The following table shows respectively the bit mapping for CID and PAR field of a low-level command for the DCU.

CID11	CID10 to CID9	CID9 to CID0	PAR15 to PAR0
R/W	Axis Id	Command Code	Parameter(s)

Axis	Axis Id
All	00
SMEC	01
Chopper	10
Jiggle	11

Axis identifier definition

2.2.9.2. General commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
GetBootStatusRegister	BootStatusRegister	Discrete	NA	
Set/GetDownloadConfig	DownloadParam	Discrete	Get... cmd	
Set/GetDownloadWord	DownloadWord	0 to FFFF hexa	Get... cmd	
GetDownLoadCounter	DownloadCounter	0 to FFFF hexa	NA	
Set/GetUploadConf	UploadParam	Discrete	Get... cmd	
GetUploadWord	UploadWord	0 to FFFF hexa	NA	
GetUploadCounter	UploadCounter	0 to FFFF hexa	NA	
SetBootRam	NA			

2.2.9.3. SMEC commands

2.2.9.3.1. Read/Write Commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
Set/GetSEncoderPwr	SEncoderPwr	0 to 7	Get... cmd A	
Set/GetSLVDTPwr	SLVDTPwr	0/1	Get... cmd	
Set/GetMotorMode	MotorMode	0/1	Get... cmd	
Set/GetSLaunchLatch	SLaunchLatch	0/1	Get... cmd	
Set/GetSLoopMode	SLoopMode	0/1	Get... cmd	

Set/GetSTrajEndPosition	STrajEndPos	-32767/+32768		
Set/GetSTrajStartPosition	STrajStartPos	-32767/+32768		
Set/GetSScanSpeed	SScanSpeed	0 to 65535		
Set/GetSScanNumber	SScanN	0/1 to 65535		
Set/GetSTrajMode	STrajMode	Discrete		
Set/GetSKp	SKp	0 to FFFF hexa		
Set/GetSKd	SKd	0 to FFFF hexa		
Set/GetSDerivFilter	SDerivFilt	0 to FFFF hexa		
Set/GetSKi	SKi	0 to FFFF hexa		
Set/GetSIntegrationLimit	SIntLimit	0 to FFFF hexa		
Set/GetSLVDTFilteringFreq	SLVDTFiltFreq	0 to FFFF hexa		
Set/GetNotchZeroFreq	NotchZeroFreq	0 to FFFF hexa		
Set/GetNotchPoleFreq	NotchPoleFreq	0 to FFFF hexa		
Set/GetNotchZeroDamp	NotchZeroDamp	0 to FFFF hexa		
Set/GetNotchPoleDamp	NotchPoleDamp	0 to FFFF hexa		
Set/GetSFeedForwardGain	SFeedFwdGain	0 to FFFF hexa		
Set/GetSMaxOutput	SMaxOut	0 to FFFF hexa		
Set/GetSMaxSpeed	SMaxSpeed	0 to FFFF hexa		
Set/GetSMaxAcceleration	SMaxAccel	0 to FFFF hexa		
Set/GetMaxTolPositionError	MaxPosError	0 to FFFF hexa		
Set/GetMaxTolSpeedError	MaxSpeedError	0 to FFFF hexa		
Set/GetMinEncoderSignalAmpl	MinEncodSAmpl	0 to FFFF hexa		
Set/GetMaxEncoderSignalBias	MaxEncodSBias	0 to FFFF hexa		

2.2.9.3.2. Read only commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
GetSMECStatus	SMECStatus	Discrete	NA	
GetSEncoderIncrPosition	SEncodIncrPos	0 to FFFF hexa		
GetSEncoderSignal1	SEncodS1	0 to FFFF hexa		
GetSEncoderSignal2	SEncodS2	0 to FFFF hexa		
GetSEncoderSignal3	SEncodS3	0 to FFFF hexa		
GetSLVDTAC	SLVDTAC	0 to FFFF hexa		
GetSLVDTDC	SLVDTDC	0 to FFFF hexa		
GetMeanPositionError	MeanPosError	0 to FFFF hexa		
GetEstimatedOLoopPos	EstOLPos	0 to FFFF hexa		
GetPositionDifference	PosDiff	0 to FFFF hexa		
GetEncoderDeltaT	EncodDT	0 to FFFF hexa		
GetEncoderShift	EncodShift	0 to FFFF hexa		
GetActualVelocity	ActualVel	0 to FFFF hexa		
GetMeanSpeed	MeanSpeed	0 to FFFF hexa		
GetMeanPositionError	MeanPosError	0 to FFFF hexa		
GetSMotorCurrent	SMotorCurrent	0 to FFFF hexa		
GetSBEMF	SBEMF	0 to FFFF hexa		

2.2.9.4. Chop commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
SetCSensorPwr	CSensorPwr	0/1		
SetBSMLaunchLatch1	BSMLaunchLatch1	0/1		
SetChopLoopMode	ChopLoopMode	Discrete		
Set/GetCPosition0	CPosition0	0 to FFFF hexa	Get... cmd	
Set/GetCPosition1	CPosition1	0 to FFFF hexa	Get... cmd	
Set/GetChopPeriod	ChopPeriod	0 to FFFF hexa	Get... cmd	
SetChopMode	ChopMode	0 to 2		
SetChopNumber	ChopNumber	0 to FFFF hexa		
SetCKp	CKp	0 to FFFF hexa		
SetCKd	CKd	0 to FFFF hexa		
SetCKi	Cki	0 to FFFF hexa		
SetCIntegrationThreshold	IntegTh	0 to FFFF hexa		
SetCPositionErrorLimit	CPosErrorLimit	0 to FFFF hexa		
SetCMotorTorqueCst	CMotorTorqueC	0 to FFFF hexa		
SetCRateLoopsf	CRateLoopsf	0 to FFFF hexa		
SetCAccelLoopsf	CAccelLoopsf	0 to FFFF hexa		
SetCAccelLimit	CAccelLimi	0 to FFFF hexa		
SetCRateLimit	CRateLimit	0 to FFFF hexa		
SetCStateCoeff1 to SetCStateCoeff4	CStateCoeffn	0 to FFFF hexa		
SetICnCoeff1 to SetICnCoeff4	ICnCoeffn	0 to FFFF hexa		
SetCOutCoeff1 to SetCOutCoeff4	COutCoeffn	0 to FFFF hexa		
SetCProfileValue1 to SetCProfileValue15	CProfileValuen	0 to FFFF hexa		
GetChopStatus	ChopStatus	Discrete		
GetCPosition	CPosition	0 to FFFF hexa		
GetCMeanPositionError	CMeanPosError	0 to FFFF hexa		
GetCMagnetoResPos1	CMagnetoResPos1	0 to FFFF hexa		
GetCMagnetoResPos2	CMagnetoResPos2	0 to FFFF hexa		
GetCMotorCurrent	CMotorCurrent	0 to FFFF hexa		
GetCBEMF	CBEMF	0 to FFFF hexa		

2.2.9.5. Jiggle commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
SetJSensorPwr	JSensorPwr	0/1		
SetBSMLaunchLatch2	BSMLaunchLatch2	0/1		
SetJigLoopMode	JigLoopMode	Discrete		

Set/GetJPosition0	JPosition0	0 to FFFF hexa	Get... cmd	
Set/GetJPosition1	JPosition1	0 to FFFF hexa	Get... cmd	
Set/GetJigPeriod	JigPeriod	0 to FFFF hexa	Get... cmd	
SetJigMode	JigMode	0 to 2		
SetJigNumber	JigNumber	0 to FFFF hexa		
SetJKp	JKp	0 to FFFF hexa		
SetJKd	JKd	0 to FFFF hexa		
SetJKi	Jki	0 to FFFF hexa		
SetJIntegrationThreshold	JIntegTh	0 to FFFF hexa		
SetJPositionErrorLimit	JPosErrorLimit	0 to FFFF hexa		
SetJMotorTorqueCst	JMotorTorqueC	0 to FFFF hexa		
SetJRateLoopsf	JRateLoopsf	0 to FFFF hexa		
SetJAccelLoopsf	JAccelLoopsf	0 to FFFF hexa		
SetJAccelLimit	JAccelLimi	0 to FFFF hexa		
SetJRateLimit	JRateLimit	0 to FFFF hexa		
SetJStateCoeff1 to SetJStateCoeff4	JStateCoeffn	0 to FFFF hexa		
SetIJnCoeff1 to SetIJnCoeff4	IJnCoeffn	0 to FFFF hexa		
SetJOutCoeff1 to SetJOutCoeff4	JOutCoeffn	0 to FFFF hexa		
SetJProfileValue1 to SetJProfileValue15	JProfileValuen	0 to FFFF hexa		
GetJigStatus	JigStatus	Discrete		
GetJPosition	JPosition	0 to FFFF hexa		
GetJMeanPositionError	JMeanPosError	0 to FFFF hexa		
GetJMagnetoResPos1	JMagnetoResPos1	0 to FFFF hexa		
GetJMagnetoResPos2	JMagnetoResPos2	0 to FFFF hexa		
GetJMotorCurrent	JMotorCurrent	0 to FFFF hexa		
GetJBEMF	JBEMF	0 to FFFF hexa		

2.2.9.6. Telemetry and trace configuration commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
SetTP10SampFreq	TP10SampFreq			
SetTP11SampFreq	TP11SampFreq			
SetTP12SampFreq	TP12SampFreq			
SetTP13SampFreq	TP13SampFreq			
SetTP14SampFreq	TP14SampFreq			
SetTP15SampFreq	TP15SampFreq			
SetTraceSampFreq	TraceSampFreq			
SetTraceBufLength	TraceBufLength			
SetTraceParam1 to SetTraceParam 6	TraceParam1 to SetTraceParam 6			

2.2.9.7. HK and miscellaneous commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
GetMACTemp	MACTemp	0 to FFFF hexa		
GetSMECTemp	SMECTemp	0 to FFFF hexa		
GetBSMTemp	BSMTemp	0 to FFFF hexa		
GetP15V	P15V	0 to FFFF hexa		
GetM15V	M15V	0 to FFFF hexa		
GetP13V	P13V	0 to FFFF hexa		
GetM13V	M13V	0 to FFFF hexa		
GetP5V	P5V	0 to FFFF hexa		
SetDPUPollingTime	DPUPollingT	0 to FFFF hexa		
GetErrorCode	ErrorCode	Discrete		

2.2.10. MCU command description

For MCU full command description please refer to AD2.

2.2.11. MCU parameter description

For MCU full parameter description please refer to AD2.

2.2.12. MCU typical commanding scenarios

For typical commanding scenarios please refer to AD2 chapter 4.

2.2.13. SCU specific command list summary

2.2.13.1. Command and parameter mapping

The following table shows respectively the bit mapping for CID and PAR field of a low-level command for the SCU.

CID11	CID10 to CID0	PAR15 to PAR0
R/W	Command Code	Parameter(s)

2.2.13.2. Write/read commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
Set/GetFrameConf	Frame type Frame Rate	0/1 0 to 255	Get... cmd	
Set/GetSeqLength	Frame Number	0 to 15	Get... cmd	
Set/GetTempOnOff	On/Off Word	NA	Get... cmd	
Set/GetSubKOnOff	On/Off bit	0/1	Get... cmd	
Set/GetDRelOnOff	On/Off Word	NA	Get... cmd	
Set/GetSPHSHeatB	Heater Current (Set) Heater Voltage (Get)	0 to 4095 0 to 65354	Get... cmd	
Set/GetEVHSHeatB	Heater Current (Set) Heater Voltage (Get)	0 to 4095 0 to 65354	Get... cmd	
Set/GetTCHeaterB	Heater Current (Set) Heater Voltage (Get)	0 to 4095 0 to 65354	Get... cmd	
Set/GetSPHeaterB	Heater Current (Set) Heater Voltage (Get)	0 to 4095 0 to 65354	Get... cmd	
Set/GetPhCalBias	Heater Current (Set) Heater Voltage (Get)	0 to 4095 0 to 65354	Get... cmd	
Set/GetSCal4Bias	Heater Current (Set) Heater Voltage (Get)	0 to 4095 0 to 65354	Get... cmd	
Set/GetSCal2Bias	Heater Current (Set) Heater Voltage (Get)	0 to 4095 0 to 65354	Get... cmd	

2.2.13.3. Read only commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
GetScuStatus	ScuStatus	0 to FFFF hexa		
GetCsuTempRd	CsuTemp	0 to FFFF hexa		
GetTsuTempRd	TsuTemp	0 to FFFF hexa		
GetPsuTempRd	PsuTemp	0 to FFFF hexa		
GetScuCHTp05	ScuCHTp05	0 to FFFF hexa		
GetScuCHTp09	ScuCHTp09	0 to FFFF hexa		
GetScuCHTn09	ScuCHTn09	0 to FFFF hexa		
GetFpuTemp01 to GetFpuTemp16	FpuTemp01 to FpuTemp16	0 to FFFF hexa		
GetSubKTempP	SubKTemp	0 to FFFF hexa		
GetPhCalVolt	PhCalVolt	0 to FFFF hexa		
GetSCal4Volt	SCal4Volt	0 to FFFF hexa		
GetSCal2Volt	SCal2Volt	0 to FFFF hexa		

2.2.13.4. Write only commands

Command Name	Argument(s)	Ranges List	Command verification	Execution Delay
SetFrRequest	NA			
FrameStop	NA			

2.2.14. SCU command description

2.2.14.1. Read/Write commands

2.2.14.1.1. FrameConf

Command	Unit	Code	Description
SetFrameConf	SCU	083	Set frame rate and type (normal/test pattern)
Parameters	Location	Length	
FrameConf	0	16	Bit 15: Type Bit 07 to 00: Frame Rate

Command	Unit	Code	Description
GetFrameConf	SCU	883	Return frame rate and type (normal/test pattern)
Returned Parameters	Location	Length	
FrameConf	0	16	Bit 15: Type Bit 14 to 08: null Bit 07 to 00: Frame Rate

2.2.14.1.2. SeqLength

Command	Unit	Code	Description
SetSeqLength	SCU	084	Set number of frame per sequence (0 for infinite)
Parameters	Location	Length	
SeqLength	0	4	Bit 3 to 0: frame number

Command	Unit	Code	Description
GetFramRate	SCU	884	Return number of frame per sequence (0 for infinite)
Returned Parameters	Location	Length	
SeqLength	0	4	

2.2.14.1.3. TempOnOff

Command	Unit	Code	Description
SetTempOnOff	SCU	085	Set standard FPU temperature probes bias on/off
Parameters	Location	Length	
TempOnOff	0	16	Bit 15 to 0: 16 bits on/off word

Command	Unit	Code	Description
GetTempOnOff	SCU	885	Return standard FPU temperature probes bias on/off
Returned Parameters	Location	Length	
TempOnOff	0	16	Bit 15 to 0: 16 bits on/off word

2.2.14.1.4. SubKOnOff

Command	Unit	Code	Description
SetSubKOnOff	SCU	086	Set sub K temperature probe bias on/off
Parameters	Location	Length	
SubKOnOff	0	1	Bit 0: on/off flag

Command	Unit	Code	Description
GetSubKpOnOff	SCU	886	Return sub K temperature probe bias on/off
Returned Parameters	Location	Length	
SubKpOnOff	0	1	Bit 0: on/off flag

2.2.14.1.5. DRelOnOff

Command	Unit	Code	Description
SetDRelOnOff	SCU	087	Set DCDC on/off command word
Parameters	Location	Length	
DRelOnOff	0	3	Bit 2 to 0: on/off flags

Command	Unit	Code	Description
GetDRelOnOff	SCU	887	Return DCDC on/off command word
Returned Parameters	Location	Length	
DRelOnOff	0	3	Bit 2 to 0: on/off flags

2.2.14.1.6. SPHSHeatB

Command	Unit	Code	Description
SetSPHSHeatB	SCU	0C0	Set value of current applied to Low Power Heater 1
Parameters	Location	Length	
SPHSHeatB	0	12	Current value

Command	Unit	Code	Description
GetSPHSHeatB	SCU	8C0	Get voltage across Low Power Heater 1
Returned Parameters	Location	Length	
SPHSHeatB	0	16	Heater voltage analog value

2.2.14.1.7. EVHSHeatB

Command	Unit	Code	Description
SetEVHSHeatB	SCU	0C1	Set value of current applied to Low Power Heater 2
Parameters	Location	Length	
EVHSHeatB	0	12	Current value

Command	Unit	Code	Description

GetEVHSHeatB	SCU	8C1	Get voltage across Low Power Heater 2
Returned Parameters	Location	Length	
EVHSHeatB	0	16	Heater voltage analog value

2.2.14.1.8. TCHeaterB

Command	Unit	Code	Description
SetTCHeaterB	SCU	0C2	Set value of current applied to Low Power Heater 3
Parameters	Location	Length	
TCHeaterB	0	12	Current value

Command	Unit	Code	Description
GetTCHeaterB	SCU	8C2	Get voltage across Low Power Heater 3
Returned Parameters	Location	Length	
TCHeaterB	0	16	Heater voltage analog value

2.2.14.1.9. SPHeaterB

Command	Unit	Code	Description
SetSPHeaterB	SCU	0C3	Set value of current applied to High Power Heater 4 (Sorption Pump)
Parameters	Location	Length	
SPHeaterB	0	12	Current value

Command	Unit	Code	Description
GetSPHeaterB	SCU	8C3	Get voltage across High Power Heater 4 (Sorption Pump)
Returned Parameters	Location	Length	
SPHeaterB	0	16	Heater voltage analog value

2.2.14.1.10. PhCalBias

Command	Unit	Code	Description
SetPhCalBias	SCU	0C4	Set value of current applied to Stimulus Source PCal
Parameters	Location	Length	
PhCalBias	0	12	Current value

Command	Unit	Code	Description
GetPhCalBias	SCU	8C4	Get current in Stimulus Source 1 PCal
Returned Parameters	Location	Length	
PhCalBias	0	16	Stimulus source current analog value

2.2.14.1.11. SCal4Bias

Command	Unit	Code	Description
SetSCal4Bias	SCU	0C5	Set value of current applied to Stimulus Source SCal 4%
Parameters	Location	Length	

SCal4Bias	0	12	Current value

Command	Unit	Code	Description
GetSCal4Bias	SCU	8C5	Get current in Stimulus Source SCal 4%
Returned Parameters	Location	Length	
SCal4Bias	0	16	Stimulus source current analog value

2.2.14.1.12. SCal2Bias

Command	Unit	Code	Description
SetSCal2Bias	SCU	0C6	Set value of current applied to Stimulus Source SCal 2%
Parameters	Location	Length	
SCal2Bias	0	12	Current value

Command	Unit	Code	Description
GetSCal2Bias	SCU	8C6	Get current in Stimulus Source SCal 2%
Returned Parameters	Location	Length	
SCal2Bias	0	16	Stimulus source current analog value

2.2.14.2. Write only commands

2.2.14.2.1. FrRequest

Command	Unit	Code	Description
SetFrRequest	SCU	081	Initiate frame sequence transfer
Parameters	Location	Length	
NA			

2.2.14.2.2. FrameStop

Command	Unit	Code	Description
SetFrameStop	SCU	082	Initiate frame sequence transfer
Parameters	Location	Length	
NA			

2.2.14.3. Read only commands

2.2.14.3.1. ScuStatus

Command	Unit	Code	Description
GetScuStatus	SCU	880	Get SCU electronics status
Parameters	Location	Length	
ScuStatus	0	--	--

2.2.14.3.2. PhCalVolt

Command	Unit	Code	Description
GetPhCalVolt	SCU	8D0	Get voltage across Stimulus Source PCal
Parameters	Location	Length	
PhCalVolt	0	16	Voltage analog value

2.2.14.3.3. SCal4Volt

Command	Unit	Code	Description
GetSCal4Volt	SCU	8D1	Get voltage across Stimulus Source SCal4
Parameters	Location	Length	
SCal4Volt	0	16	Voltage analog value

2.2.14.3.4. SCal2Volt

Command	Unit	Code	Description
GetSCal2Volt	SCU	8D2	Get voltage across Stimulus Source SCal2
Parameters	Location	Length	
SCal2Volt	0	16	Voltage analog value

2.2.14.3.5. ScuCHTp05

Command	Unit	Code	Description
GetScuCHTp05	SCU	8C7	Return value of +05V of SCU/CCHK&TEMP
Returned Parameter(s)	Location	Length	
ScuCHTp05	0	16	Voltage analog value

2.2.14.3.6. ScuCHTp09

Command	Unit	Code	Description
GetScuCHTp09	SCU	8D3	Return value of +09V of SCU/CCHK&TEMP
Returned Parameter(s)	Location	Length	
ScuCHTp09	0	16	Voltage analog value

2.2.14.3.7. ScuCHTn09

Command	Unit	Code	Description
GetScuCHTn09	SCU	8D7	Return value of -09V of SCU/CCHK&TEMP
Returned Parameter(s)	Location	Length	
ScuCHTn09	0	16	Voltage analog value

2.2.14.3.8. FpuTemp01

Command	Unit	Code	Description
GetFpuTemp01	SCU	8E0	Return FPU temperature probe 01 current value (pr_name)
Returned Parameter(s)	Location	Length	
	0	16	Probe current analog value (function of the temperature)

2.2.14.3.9. FpuTemp02

Command	Unit	Code	Description
GetFpuTemp02	SCU	8E1	Return FPU temperature probe 02 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp02	0	16	Probe current analog value (function of the temperature)

2.2.14.3.10. FpuTemp03

Command	Unit	Code	Description
GetFpuTemp03	SCU	8E2	Return FPU temperature probe 03 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp03	0	16	Probe current analog value (function of the temperature)

2.2.14.3.11. FpuTemp04

Command	Unit	Code	Description
GetFpuTemp04	SCU	8E3	Return FPU temperature probe 04 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp04	0	16	Probe current analog value (function of the temperature)

2.2.14.3.12. FpuTemp05

Command	Unit	Code	Description
GetFpuTemp05	SCU	8E4	Return FPU temperature probe 05 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp05	0	16	Probe current analog value (function of the temperature)

2.2.14.3.13. FpuTemp06

Command	Unit	Code	Description
GetFpuTemp06	SCU	8E5	Return FPU temperature probe 06 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp06	0	16	Probe current analog value (function of the temperature)

2.2.14.3.14. FpuTemp07

Command	Unit	Code	Description
GetFpuTemp07	SCU	8E6	Return FPU temperature probe 07 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp07	0	16	Probe current analog value (function of the temperature)

2.2.14.3.15. FpuTemp08

Command	Unit	Code	Description
GetFpuTemp01	SCU	8E7	Return FPU temperature probe 01 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp01	0	16	Probe current analog value (function of the temperature)

2.2.14.3.16. FpuTemp09

Command	Unit	Code	Description
GetFpuTemp01	SCU	8E8	Return FPU temperature probe 01 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp01	0	16	Probe current analog value (function of the temperature)

2.2.14.3.17. FpuTemp10

Command	Unit	Code	Description
GetFpuTemp01	SCU	8E9	Return FPU temperature probe 01 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp01	0	16	Probe current analog value (function of the temperature)

2.2.14.3.18. FpuTemp11

Command	Unit	Code	Description
GetFpuTemp01	SCU	8EA	Return FPU temperature probe 01 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp01	0	16	Probe current analog value (function of the temperature)

2.2.14.3.19. FpuTemp12

Command	Unit	Code	Description
GetFpuTemp01	SCU	8EB	Return FPU temperature probe 01 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp01	0	16	Probe current analog value (function of the temperature)

2.2.14.3.20. FpuTemp13

Command	Unit	Code	Description
GetFpuTemp01	SCU	8EC	Return FPU temperature probe 01 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp01	0	16	Probe current analog value (function of the temperature)

2.2.14.3.21. FpuTemp14

Command	Unit	Code	Description
GetFpuTemp01	SCU	8ED	Return FPU temperature probe 01 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp01	0	16	Probe current analog value (function of the temperature)

2.2.14.3.22. FpuTemp15

Command	Unit	Code	Description
GetFpuTemp01	SCU	8EE	Return FPU temperature probe 01 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp01	0	16	Probe current analog value (function of the temperature)

2.2.14.3.23. FpuTemp16

Command	Unit	Code	Description
GetFpuTemp01	SCU	8EF	Return FPU temperature probe 01 current value (pr_name)
Returned Parameter(s)	Location	Length	
FpuTemp01	0	16	Probe current analog value (function of the temperature)

2.2.14.3.24. SubKTempP

Command	Unit	Code	Description
GetSubKTempP	SCU	8F0	Return subK temperature probe voltage value (pr_name)
Returned Parameter(s)	Location	Length	
SubKTempP	0	16	Probe voltage analog value (function of the temperature)

2.2.14.3.25. CsuTempRd

Command	Unit	Code	Description
GetCsuTempRd	SCU	8C4	Return CCHK board temperature sensor value
Returned Parameter(s)	Location	Length	

CsuTempRd	0	16	Probe current analog value (function of the temperature)

2.2.14.3.26. TsuTempRd

Command	Unit	Code	Description
GetTsuTempRd	SCU	8C5	Return TEMP board temperature sensor value
Returned Parameter(s)	Location	Length	
TsuTempRd	0	16	Probe current analog value (function of the temperature)

2.2.14.3.27. PsuTempRd

Command	Unit	Code	Description
GetPsuTempRd	SCU	8C6	Return PSU board temperature sensor value
Returned Parameter(s)	Location	Length	
PsuTempRd	0	16	Probe current analog value (function of the temperature)

2.2.15. SCU parameters description (to be completed)

Name	Type	Size	Conversion	Limits	Description
FrameRate	Analogue	8		0 to 255	
SeqLength	Discrete				
TempOnOff	Discrete				
DRelOnOff	Discrete				
SPHSHeatB	Analogue				
EVHSHeatB	Analogue				
TCHeaterB	Analogue				
SPHeaterB	Analogue				
PhCalBias	Analogue				
SCal4Bias	Analogue				
SCal2Bias	Analogue				
PhCalVolt	Analogue				
SCal4Volt	Analogue				
SCal2Volt	Analogue				
ScuCHTp05	Analogue				
ScuCHTp09	Analogue				
ScuCHTn09	Analogue				
FpuTemp01	Analogue				
FpuTemp02	Analogue				
FpuTemp03	Analogue				
FpuTemp04	Analogue				
FpuTemp05	Analogue				
FpuTemp06	Analogue				
FpuTemp07	Analogue				
FpuTemp08	Analogue				
FpuTemp09	Analogue				
FpuTemp10	Analogue				
FpuTemp11	Analogue				
FpuTemp12	Analogue				
FpuTemp13	Analogue				
FpuTemp14	Analogue				
FpuTemp15	Analogue				
FpuTemp16	Analogue				
SubKTempP	Analogue				
CcuTempRd	Analogue				
TcuTempRd	Analogue				
PsuTempRd	Analogue				

2.2.16. SCU typical commanding scenarios

TBW

2.3. Data Interface

2.3.1. General Information

The Data Interface is dedicated to data transfer from subsystem to DPU. Three independent "Data Interface" are required allowing simultaneous DRCU data transfer.
This interface is unidirectional: data are transferred from the DRCU sub-units to the DPU acquisition electronics. Fixed data packets are defined according to sub-unit operating mode.
This data packet contents both scientific data (i.e. bolometer signal) and/or housekeeping parameters.

2.3.2. Overall Interface Diagram

The Command Interface diagram is given in figure 2.3-a Prime and Redundant interfaces are shown.

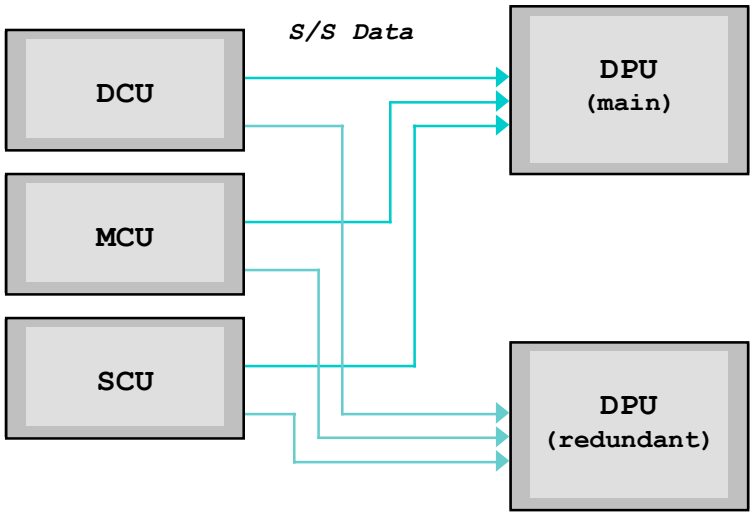


Figure 2.3-a

2.3.3. Interface Circuit

The interface is a synchronous serial link based on one data line (DTA) associated to a clock line (CLK) for bit synchronisation and a gate line (GAT) for word synchronisation. Each sub-unit implements a complete set of signals: that is the DPU implements 3 totally independent Data interfaces each having 3 receivers (as shown by figure 2.3-b).
The interface uses the balanced line RS422 electrical standard based on 26C31 and 26C32 transmitter and receiver type respectively.

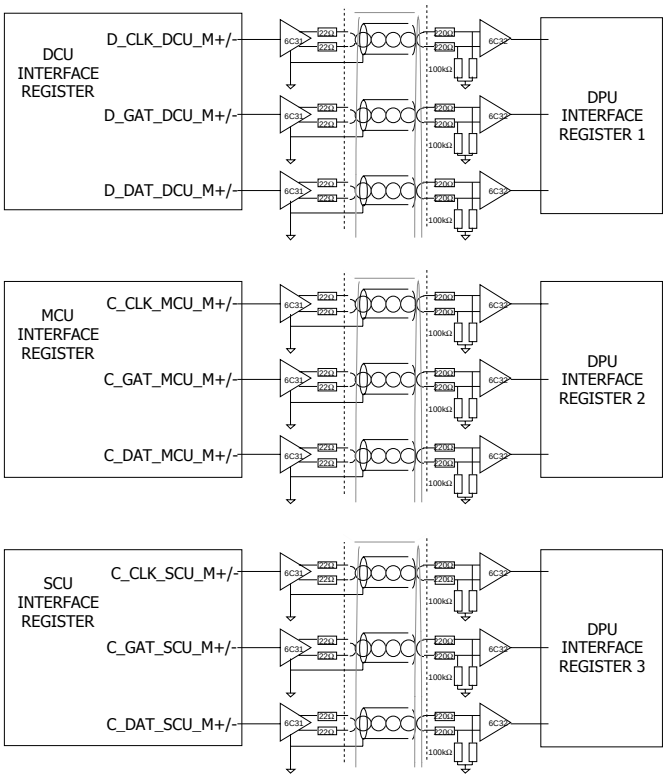


Figure 2.3-b - Electrical configuration

2.3.4. Word definition

Word definition is subsystem dependent. Data are currently 16-bit encoded and correspond to bolometer signal, mechanisms motion parameters, instrument temperature and all other housekeeping channels.
In order to deal with the latch-up effect of the analogue to digital converters (see RD01), which cause the generation of wrong data until the converter recovers full performances, a specific “invalid” data identifier is defined. This avoids the DRCU to transfer unpredictable packet length following a cosmic ray impact on the converter and later on-ground misanalysis.

These data words are defined as follow:

DAT15 to DAT0

Figure 3.4-a - Data Word Definition

DAT15 to DAT0: data

Note: • MSB (DAT15) is transmitted first

2.3.5. General Frame Definition

Data frame length and structure are defined regarding the DRCU sub-unit and its mode of operation. The sub-systems data structures are encapsulated into a common frame structure as described bellow (except two MCU modes).

The frame is composed of:

- a length word (1 word)
- a frame ID (1 word)
- a data structure (n words)
- a frame time (2 words)
- a check word (1 word)

2.3.5.1. Length

The “length” field (16 bits) is placed at the head of the frame. It indicates the number of 16-bit words of the frame (including all the fields). Along with the “frame ID” and “check word” fields this field allows frame consistency checking by the receiver unit.

2.3.5.2. Frame ID

The “frame ID” field is a 16-bit word following the “length” word. Along with the “length” field and the “check” word it allows data consistency checking. In case the check fails the DPU takes action to resynchronise with the data stream.
The purpose of the frame ID is to enable identifying to frame after packing by the DPU. A specific code is allocated for each frame type of each DRCU S/S. The following table shows the identifier allocation:

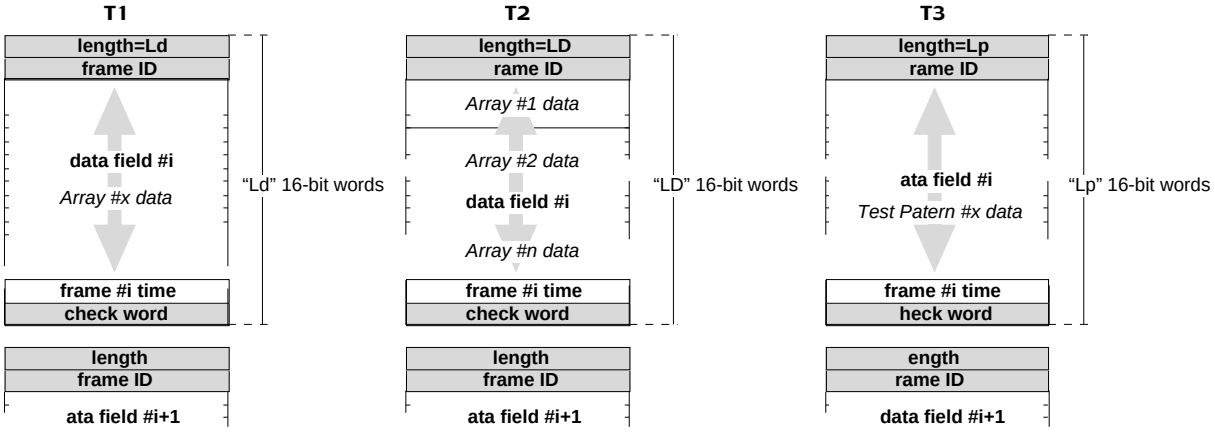
UNIT	Frame Type	Frame ID (hex)
DCU	Ph Full Array	00
DCU	Sp Full array	01
DCU	P-SW	02
DCU	P-MW	03
DCU	P-LW	04
DCU	S-SW	05
DCU	S-LW	06
DCU	Ph Test Pattern	07
DCU	Ph Offset	08
DCU	Sp Offset	09
DCU	Sp Test Pattern	0A
DCU	Not Allocated	0B-0F
MCU	SMEC scan	10
MCU	SMEC Step	11

UNIT	Frame Type	Frame ID (hex)
MCU	Chop	12
MCU	Jiggle	13
MCU	Trace	14
MCU	Test Pattern	15
MCU	Not Allocated	16-1F
SCU	HSK	20
SCU	Test Pattern	21
SCU	Not Allocated	22-2F

2.3.5.3. Data structure

2.3.5.3.1. DCU Frames Definition

The four frame structures of the DCU are defined as follow:



The following cross table shows the corresponding Frame ID for each DCU configuration status:

DCU Configuration	Frame ID	Frame Format	Length
Photometer Full Array	00	T2	294
Spectrometer Full Array	01	T2	78
Photometer SW	02	T1	150
Photometer MW	03	T1	102
Photometer LW	04	T1	54
Spectrometer SW	05	T1	54
Spectrometer LW	06	T1	30
Photometer Test Pattern	07	T3	294
Photometer Offset	08	T2	294
Spectrometer Offset	09	T2	78
Spectrometer Test Pattern	0A	T2	78

Remind: the DCU data interface configuration is configured by means of the "SetDataMode" command.

2.3.5.3.2. Photometer Full Array pixel arrangement

ADC1	ADC2	ADC3	ADC4	ADC5	ADC6
CH1/LIA_P1	CH16/LIA_P2	CH1/LIA_P4	CH16/LIA_P5	CH1/LIA_P7	CH16/LIA_P8
CH16/LIA_P1	CH1/LIA_P3	CH16/LIA_P4	CH1/LIA_P6	CH16/LIA_P7	CH1/LIA_P9
CH1/LIA_P2	CH16/LIA_P3	CH1/LIA_P5	CH16/LIA_P6	CH1/LIA_P8	CH16/LIA_P9
CH2/LIA_P1	CH17/LIA_P2	CH2/LIA_P4	CH17/LIA_P5	CH2/LIA_P7	CH17/LIA_P8
CH17/LIA_P1	CH2/LIA_P3	CH17/LIA_P4	CH2/LIA_P6	CH17/LIA_P7	CH2/LIA_P9
CH2/LIA_P2	CH17/LIA_P3	CH2/LIA_P5	CH17/LIA_P6	CH2/LIA_P8	CH17/LIA_P9
CH3/LIA_P1	CH18/LIA_P2	CH3/LIA_P4	CH18/LIA_P5	CH3/LIA_P7	CH18/LIA_P8
CH18/LIA_P1	CH3/LIA_P3	CH18/LIA_P4	CH3/LIA_P6	CH18/LIA_P7	CH3/LIA_P9
CH3/LIA_P2	CH18/LIA_P3	CH3/LIA_P5	CH18/LIA_P6	CH3/LIA_P8	CH18/LIA_P9
CH4/LIA_P1	CH19/LIA_P2	CH4/LIA_P4	CH19/LIA_P5	CH4/LIA_P7	CH19/LIA_P8
CH19/LIA_P1	CH4/LIA_P3	CH19/LIA_P4	CH4/LIA_P6	CH19/LIA_P7	CH4/LIA_P9
CH4/LIA_P2	CH19/LIA_P3	CH4/LIA_P5	CH19/LIA_P6	CH4/LIA_P8	CH19/LIA_P9
CH5/LIA_P1	CH20/LIA_P2	CH5/LIA_P4	CH20/LIA_P5	CH5/LIA_P7	CH20/LIA_P8
CH20/LIA_P1	CH5/LIA_P3	CH20/LIA_P4	CH5/LIA_P6	CH20/LIA_P7	CH5/LIA_P9
CH5/LIA_P2	CH20/LIA_P3	CH5/LIA_P5	CH20/LIA_P6	CH5/LIA_P8	CH20/LIA_P9
CH6/LIA_P1	CH21/LIA_P2	CH6/LIA_P4	CH21/LIA_P5	CH6/LIA_P7	CH21/LIA_P8
CH21/LIA_P1	CH6/LIA_P3	CH21/LIA_P4	CH6/LIA_P6	CH21/LIA_P7	CH6/LIA_P9
CH6/LIA_P2	CH21/LIA_P3	CH6/LIA_P5	CH21/LIA_P6	CH6/LIA_P8	CH21/LIA_P9
CH7/LIA_P1	CH22/LIA_P2	CH7/LIA_P4	CH22/LIA_P5	CH7/LIA_P7	CH22/LIA_P8
CH22/LIA_P1	CH7/LIA_P3	CH22/LIA_P4	CH7/LIA_P6	CH22/LIA_P7	CH7/LIA_P9
CH7/LIA_P2	CH22/LIA_P3	CH7/LIA_P5	CH22/LIA_P6	CH7/LIA_P8	CH22/LIA_P9
CH8/LIA_P1	CH23/LIA_P2	CH8/LIA_P4	CH23/LIA_P5	CH8/LIA_P7	CH23/LIA_P8
CH23/LIA_P1	CH8/LIA_P3	CH23/LIA_P4	CH8/LIA_P6	CH23/LIA_P7	CH8/LIA_P9
CH8/LIA_P2	CH23/LIA_P3	CH8/LIA_P5	CH23/LIA_P6	CH8/LIA_P8	CH23/LIA_P9
CH9/LIA_P1	CH24/LIA_P2	CH9/LIA_P4	CH24/LIA_P5	CH9/LIA_P7	CH24/LIA_P8
CH24/LIA_P1	CH9/LIA_P3	CH24/LIA_P4	CH9/LIA_P6	CH24/LIA_P7	CH9/LIA_P9
CH9/LIA_P2	CH24/LIA_P3	CH9/LIA_P5	CH24/LIA_P6	CH9/LIA_P8	CH24/LIA_P9
CH10/LIA_P1	CH25/LIA_P2	CH10/LIA_P4	CH25/LIA_P5	CH10/LIA_P7	CH25/LIA_P8
CH25/LIA_P1	CH10/LIA_P3	CH25/LIA_P4	CH10/LIA_P6	CH25/LIA_P7	CH10/LIA_P9
CH10/LIA_P2	CH25/LIA_P3	CH10/LIA_P5	CH25/LIA_P6	CH10/LIA_P8	CH25/LIA_P9
CH11/LIA_P1	CH26/LIA_P2	CH11/LIA_P4	CH26/LIA_P5	CH11/LIA_P7	CH26/LIA_P8
CH26/LIA_P1	CH11/LIA_P3	CH26/LIA_P4	CH11/LIA_P6	CH26/LIA_P7	CH11/LIA_P9
CH11/LIA_P2	CH26/LIA_P3	CH11/LIA_P5	CH26/LIA_P6	CH11/LIA_P8	CH26/LIA_P9
CH12/LIA_P1	CH27/LIA_P2	CH12/LIA_P4	CH27/LIA_P5	CH12/LIA_P7	CH27/LIA_P8
CH27/LIA_P1	CH12/LIA_P3	CH27/LIA_P4	CH12/LIA_P6	CH27/LIA_P7	CH12/LIA_P9
CH12/LIA_P2	CH27/LIA_P3	CH12/LIA_P5	CH27/LIA_P6	CH12/LIA_P8	CH27/LIA_P9
CH13/LIA_P1	CH28/LIA_P2	CH13/LIA_P4	CH28/LIA_P5	CH13/LIA_P7	CH28/LIA_P8
CH28/LIA_P1	CH13/LIA_P3	CH28/LIA_P4	CH13/LIA_P6	CH28/LIA_P7	CH13/LIA_P9
CH13/LIA_P2	CH28/LIA_P3	CH13/LIA_P5	CH28/LIA_P6	CH13/LIA_P8	CH28/LIA_P9

CH14/LIA_P1	CH29/LIA_P2	CH14/LIA_P4	CH29/LIA_P5	CH14/LIA_P7	CH29/LIA_P8
CH29/LIA_P1	CH14/LIA_P3	CH29/LIA_P4	CH14/LIA_P6	CH29/LIA_P7	CH14/LIA_P9
CH14/LIA_P2	CH29/LIA_P3	CH14/LIA_P5	CH29/LIA_P6	CH14/LIA_P8	CH29/LIA_P9
CH15/LIA_P1	CH30/LIA_P2	CH15/LIA_P4	CH30/LIA_P5	CH15/LIA_P7	CH30/LIA_P8
CH30/LIA_P1	CH15/LIA_P3	CH30/LIA_P4	CH15/LIA_P6	CH30/LIA_P7	CH15/LIA_P9
CH15/LIA_P2	CH30/LIA_P3	CH15/LIA_P5	CH30/LIA_P6	CH15/LIA_P8	CH30/LIA_P9
CH16/LIA_P1	CH31/LIA_P2	CH16/LIA_P4	CH31/LIA_P5	CH16/LIA_P7	CH31/LIA_P8
CH31/LIA_P1	CH16/LIA_P3	CH31/LIA_P4	CH16/LIA_P6	CH31/LIA_P7	CH16/LIA_P9
CH16/LIA_P2	CH31/LIA_P3	CH16/LIA_P5	CH31/LIA_P6	CH16/LIA_P8	CH31/LIA_P9

2.3.5.3.3. Spectrometer Full Array pixel arrangement

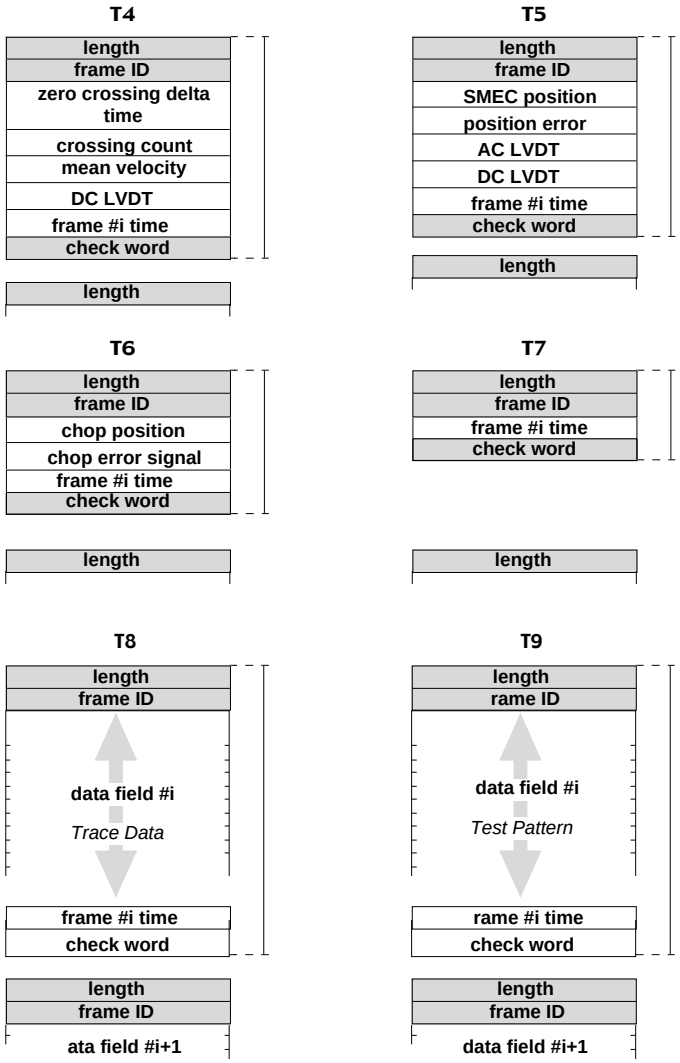
ADC1	ADC2	ADC3	ADC4	ADC5	ADC6
CH1/LIA_S1	CH13/LIA_S1	CH1/LIA_S2	CH13/LIA_S2	CH1/LIA_S3	CH13/LIA_S3
CH2/LIA_S1	CH14/LIA_S1	CH2/LIA_S2	CH14/LIA_S2	CH2/LIA_S3	CH14/LIA_S3
CH3/LIA_S1	CH15/LIA_S1	CH3/LIA_S2	CH15/LIA_S2	CH3/LIA_S3	CH15/LIA_S3
CH4/LIA_S1	CH16/LIA_S1	CH4/LIA_S2	CH16/LIA_S2	CH4/LIA_S3	CH16/LIA_S3
CH5/LIA_S1	CH17/LIA_S1	CH5/LIA_S2	CH17/LIA_S2	CH5/LIA_S3	CH17/LIA_S3
CH6/LIA_S1	CH18/LIA_S1	CH6/LIA_S2	CH18/LIA_S2	CH6/LIA_S3	CH18/LIA_S3
CH7/LIA_S1	CH19/LIA_S1	CH7/LIA_S2	CH19/LIA_S2	CH7/LIA_S3	CH19/LIA_S3
CH8/LIA_S1	CH20/LIA_S1	CH8/LIA_S2	CH20/LIA_S2	CH8/LIA_S3	CH20/LIA_S3
CH9/LIA_S1	CH21/LIA_S1	CH9/LIA_S2	CH21/LIA_S2	CH9/LIA_S3	CH21/LIA_S3
CH10/LIA_S1	CH22/LIA_S1	CH10/LIA_S2	CH22/LIA_S2	CH10/LIA_S3	CH22/LIA_S3
CH11/LIA_S1	CH23/LIA_S1	CH11/LIA_S2	CH23/LIA_S2	CH11/LIA_S3	CH23/LIA_S3
CH12/LIA_S1	CH24/LIA_S1	CH12/LIA_S2	CH24/LIA_S2	CH12/LIA_S3	CH24/LIA_S3

The last word of the data field has a specific meaning: it informs the DPU of occurrence of analog to digital converter latch-up or S/S to DPU interface fault and then of the risk to pack corrupted data. When a flag or more is set the related data of the current frame have to be discarded during on-ground data processing.
The meaning of this word depends on the data interface mode.
See following table for details

DCU Configuration	Frame Format	# of flags
Photo. Array Subset	T1	1
Spectro. Array Subset	T1	1
Photo. Full Array	T2	6
Spectro. Full Array	T2	2
Test Pattern	T3	0
Photo. Offset table	T2	0
Spectro Offset table	T2	0

2.3.5.3.4. MCU Frame Definition

The four frame structures of the MCU are defined as follow:



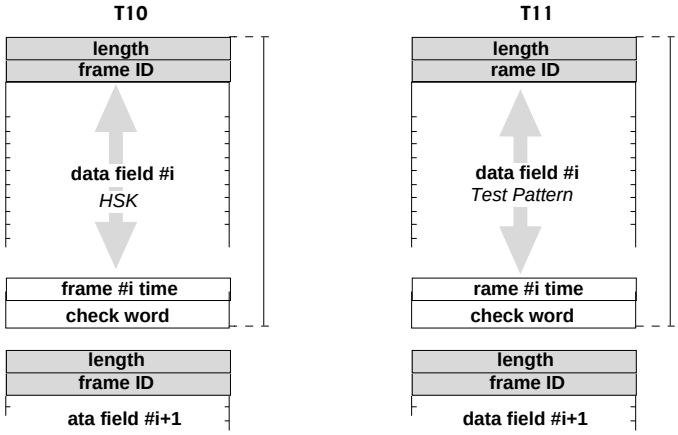
The following cross table shows the corresponding Frame ID for each MCU configuration status:

Configuration Status	Frame ID	Frame Format	Length
SMEC Scan	10	T4	10
SMEC step	11	T5	9
Chop	12	T6	7
Jiggle	13	T7	5
Trace	14	T8	≤ 520

Test Pattern	15	T9	≤ 520

2.3.5.3.5. SCU Frame Definition

The two frame structures of the SCU are defined as follow:



The following cross table shows the corresponding Frame Structure Type for each SCU configuration status:

Configuration Status	Frame Format	Frame ID	Length
HSK	T10	20	30
Test Pattern	T11	21	30

The last word of the data field has a specific meaning: it informs the DPU of occurrence of analog to digital converter latch-up or S/S to DPU interface fault and then of the risk to pack corrupted data. When a flag or more is set the related data of the current frame have to be discarded during on-ground data processing.
The meaning of this word depends on the data interface mode.
See following table for details

SCU Configuration	FST	# of flags
HSK	T8	1
Test Pattern	T9	0

2.3.5.4. Frame time

The “frame time” field follows the data structure area. It is a 32-bit word filled with the contents of the subsystem “time tag” counters. In order to keep data frame synchronisation for the 3 subsystems this counter is driving by a single clock signal and reset by a broadcast

command. The clock is derived from the CLK line of the Command interface and the resolution is then 3.2 µs. The full range of the counter is then above 13740 s (229 min); this means the DPU have to sent the reset command at least every 229 min in order to keep synchronisation between the 3 DRCU sub-systems.
The subsystem time counter shall be effectively reset within 10 (tbc) µs from the command reception and with a maximum skew between subsystems of 3 µs.

2.3.5.5. Check word

The "check" word ends the data frame. Along with the "header" and "length" field it allows frame consistency checking. It is calculated by exclusive or of all frame words.

2.3.6. Test pattern

The purpose of this mode is to generate variable and predictable digital data for test and verification activities. Instead of transmitting a fixed pattern it implements a pseudo random generator.
When in test pattern mode the DRCU interface control logic substitutes the data with a pseudo-random sequence generated by a 16-bit linear feedback shift register (see RD2). The DRCU unit features 3 independent LFSR each corresponding to a data interface. Additionally each LFSR is initialised with a specific vector as show bellow:

V0	Subsystem Name
0000 hexa	DCU
5555 hexa	MCU
AAAA hexa	SCU

2.3.7. Interface Timing

For detailed interface timing see AD01.

2.3.8. Timing Performance

The NRZ data rate is fixed at 1 Mbits per second (max is 2.5 Mbps).

Max data rate = 1 / (1 µs x (16+1)) = 58,823 data per second