HERSCHEL DPUs/ICU

CARLO GAVAZZI SPACE SpA

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Titolo : *Title :* HERSCHEL DPUs/ICU BOOT SW TELEMETRY / TELECOMMANDS PACKETS USER MANUAL

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REGISTRAZIONE DELLE MODIFICHE / *CHANGE RECORD*			
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1	10/04/2006		First Issue
2	10/01/2006		Added description to Boot Software functionality
3	10/04/2006		

LISTA DELLE PAGINE VALIDE / *LIST OF VALID PAGES*

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TABLE OF CONTENT

1. SCOPE

Scope of the document is to support the user of the Herschel Boot Software and define the Telemetry packets to be transmitted by the DPU Boot program during the Application Software uploading, when a Data memory, Program Memory, EEPROM memory error is detected.

The Boot program is in charge of uploading the Application program. The Application Program can be uploaded in two way; the nominal way is from EEPROM, the non-nominal way is by means the 1553 line. The Boot program will send a telemetry message to the CDMS via 1553 after an error detection.

Two categories of telemetry message have been designed to manage possible errors as follow:

- Telemetry events
- Telecommands acknowledge

Besides additional sections has been included to list the possible telecommands the Boot Software could accept.

In this document, the packet details are reported. For each telemetry packet a table packet format is presented. It is composed of four column. The first field is the field description according to the [AD 5] document. The second is the number of bits required. The third is the value of the related field. The fourth field includes comments and remarks about the current field.

2. DOCUMENTS

2.1 APPLICABLE DOCUMENTS

#	Document Number	Issue	Date	Name
AD1	SCI-PT-IIDA-04624	3.1	12/02/2004	Herschel/Planck IID Part A
AD2	SCI-PT-IIDB-02126	3.2	02/03/2004	Herschel/Planck IID Part B Instrument PACS
AD3	SCI-PT-IIDB-02125	3.2	13/10/2003	Herschel/Planck IID Part B Instrument "HIFI"
AD4	SCI-PT-IIDB-02124	3.2	01/03/2004	Herschel/Planck IID Part B Instrument "SPIRE"
AD5	SCI-PT-ICD-07527	4	07/11/2003	Packet Structure –Interface Control Document
AD6	IFSI/ICU/PL/2000-001	1.1	02/04/2001	DPU/ICU OBS PA Plan
AD7	IFSI/OBS/SP/2000-001	1.4	14/01/2005	HIFI ICU/OBS User Requirements Document
AD8	SPIRE-IFS-PRJ-000444	1.4	10/11/2004	SPIRE DPU/OBS User Requirements Document
AD9	PACS-CR-RD-001	2.5	01/12/2004	Herscel PACS DPU/OBS User Requirements Document
AD10	ECSS Q-80	Rev.B	10/10/03	Software product assurance
AD11	ECSS E-40	Rev.B	28/11/03	Software – Part 1 : Principles and Requirements. Tailored according to BSCC(96) Issue 1
AD12	HERS-GEN-SQ-CGS-001	2	9/07/2005	HERSCHEL DPUs/ICU Boot Software User requirements
AD13	HERS-GEN-SQ-CGS-002	1	10/7/2005	HERSCHEL DPUs/ICU Boot Software Specification Document

Table 2-1 Applicable Documents

2.2 REFERENCE DOCUMENTS

#	Document Number	Issue	Date	Name
RD1	BSSC(96)2			Guide to applying the ESA software engineering standards to small software projects

Table 2-2 Reference Documents

2.3   ACRONYMS

AD#	Applicable Document number #
BSP	Board Support Package
DPU	Data Processing Unit
DPU BSW	DPU Basic S/W
DM	Data Memory
DPR	Dual Port Ram
DSP	The 21020 DSP microprocessor
EDAC	Error Detector And Corrector
EEPROM	Electrically Erasable Programmable Read Only Memory
EM	Engineering Model
EPROM	Erasable Programmable Read Only Memory
EQM	Engineering Qualification Model
FIRST	Far Infra-Red and Sub-millimeter Telescope
FM	Flight Model
FS	Flight Spare
HIFI	Heterodyne Instrument for First
IFSI	Istituto per la Fisica dello Spazio Interplanetario
I/F	Interface
OBDH	On Board Data Handling
OBS	On Board Software
PA	Product Assurance
PACS	Photoconductor Array Camera and Spectrometer
PM	Program Memory
PROM	Programmable Read Only Memory
PL	Payload
RAM	Random Access Memory
RD#	Reference Document number #
SEU	Single Event Upset
S/C	Spacecraft
SPIRE	Spectral and Photometric Imaging Receiver
TC	Telecommand
TCGEN	Telecommand Generator

3. BOOT SOFTWARE GENERAL DESCRIPTION

The Boot Software is a stand-alone software resident in PROM in charge of uploading and running the On Board Software in the DSP Program Memory. The Boot Software has the capability to upload On-Board Software from EEPROM memory on the board or by means of 1553 interface with specific memory management telecommands. See Figure 3-1 and Figure 3-2 for the flowchart representing the main procedure of the Boot Software.
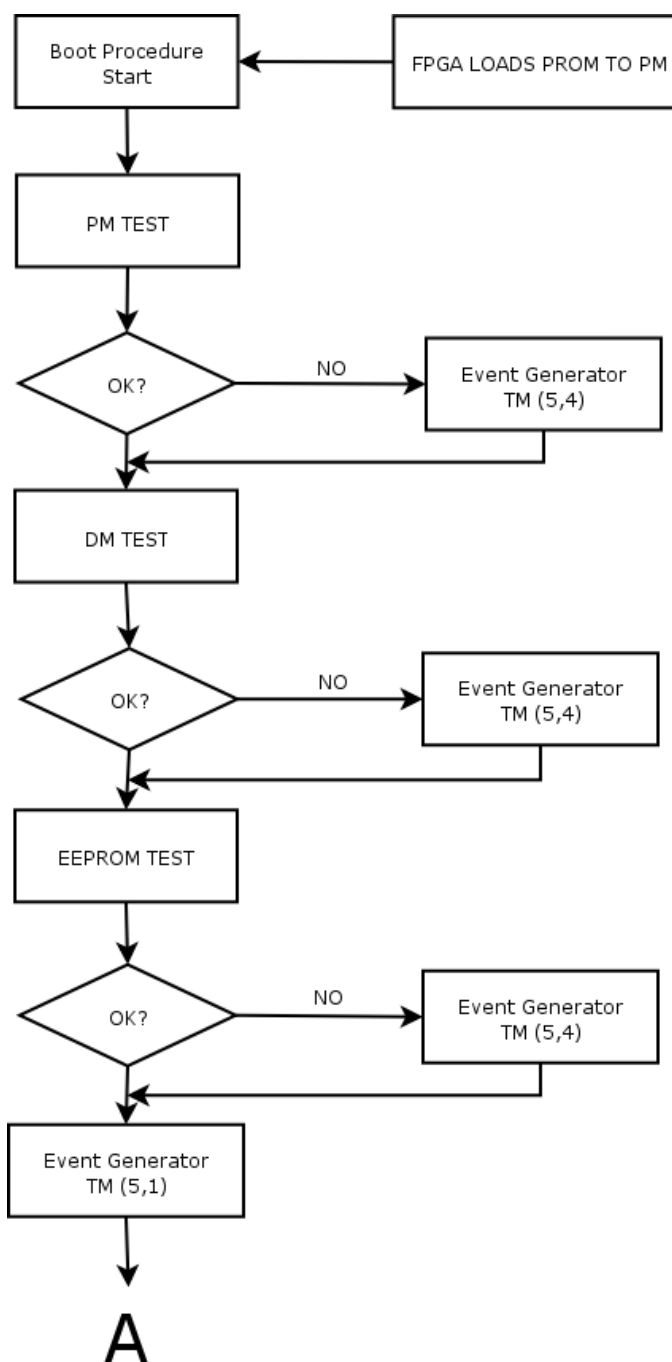

Figure 3-1: Boot Software Flow Chart 1/2
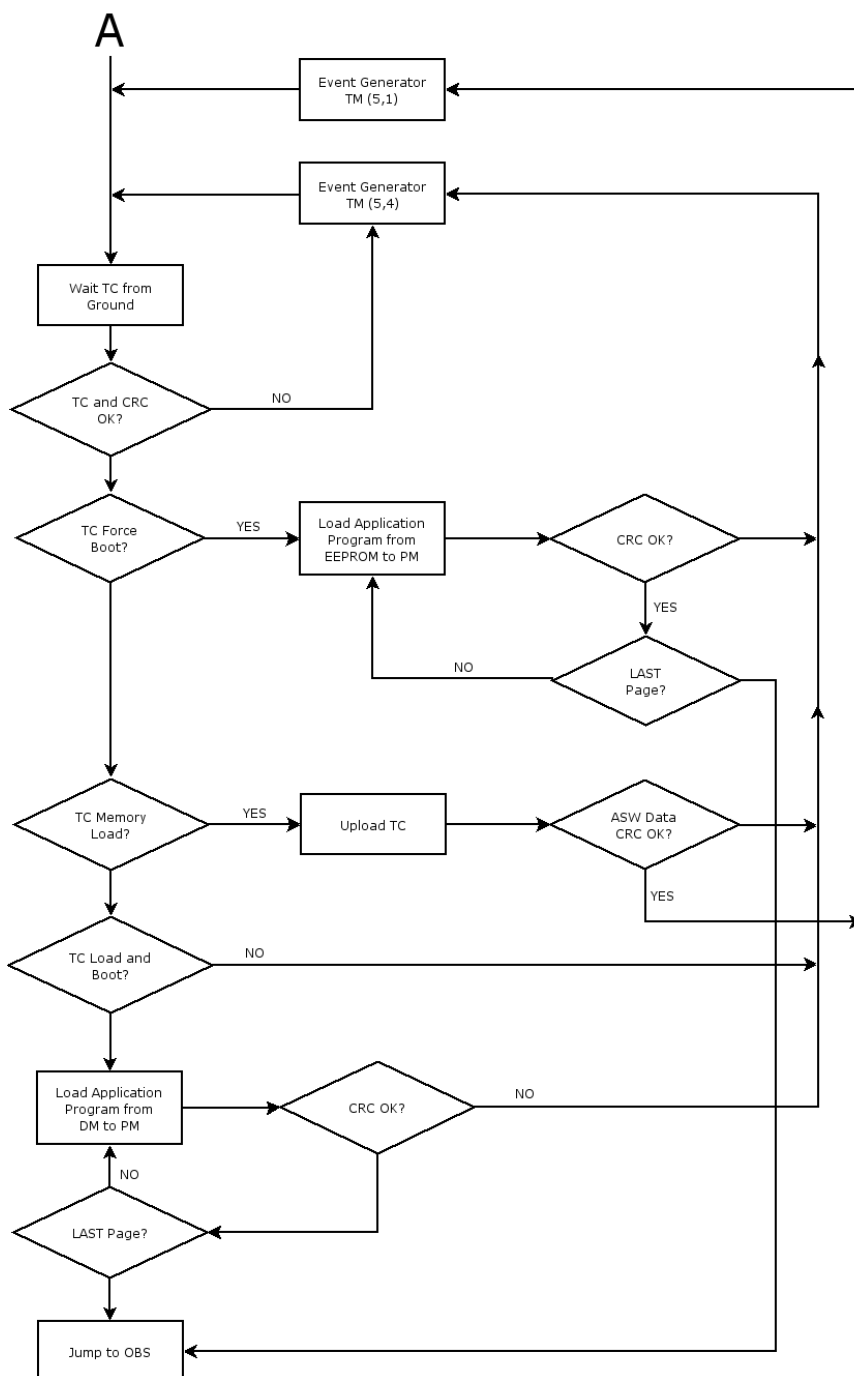
Figure 3-2: Boot Software Flow Chart 2/2

3.1 DPUS/ICU SWITCH ON AND INITIAL TESTS

When the DPUs/ICU has been switched on the Boot Software perform some tests to check the integrity of the Program Memory (PM), Data Memory (DM) and EEPROM Memory, see Figure 3-1
If all the memory tests were performed without errors the procedure generates a Telemetry Event Packet (5,1) detailed in section 7.7 .
Otherwise if one or more tests fails the procedure generates a Telemetry Event Packet containing mainly the indication of the type (PM, DM or EEPROM) of the on-board memory where the check failed;
The possible failure are:

- *Program Memory test fail*: The Telemetry Event Packet (5,4) format is detailed in section 7.1 and indicate that one ore more Program Memory location are corrupted; only the number of pages containing the corrupted location are detailed in bytes 31-32 of the packet and the address list of the related pages failed starts from the byte 33.

- *Data Memory test fail*: The Telemetry Event Packet (5,4) format is detailed in section 7.2 and indicate that one or more Data Memory location are corrupted: only the number of pages containing the corrupted location are detailed in bytes 31-32 of the packet and the address of the list of the related pages failed starts from the byte 33. If the Boot Software report this type of error on Data Memory the user can generate, with Telecommand Generator program, a set of Memory Management telecommands that jumps this pages to avoid the error.

- *EEPROM Memory test fail*: Telemetry Event Packet (5,4) format is detailed in section 7.3 and indicate that one or more EEPROM pages are corrupted; the number of pages corrupted are detailed in bytes 31-32 of the packet and the address list of the related pages failed starts from byte 33.

The Boot Software repeat the last Telemetry Message every 10 seconds if no telecommands has been received.

3.2 BOOT SOFTWARE TELECOMMANDS

At the end of the three tests described in section 3.1 , if no errors are detected the procedure generate a Telemetry Message packet (5,1) described in section 7.7 and starts waiting for a telecommand (TC) from the ground. When a telecommand has been received and processed correctly by the Boot Software the procedure generate a Telemetry Event Packet Message (5,1) detailed in section 8.1
If the telecommand is not recognized due to an error a Telemetry Event Packet Message (5,4) has been received. The possible error are:
- *Telecommand FCS Error:* The telecommand packet contains a wrong CRC in the last field of the packet. The Telemetry Event Packet format is detailed in section 8.2
- *Telecommand APID Error:* The telecommand packet contains a wrong APID into the packet, the possible APID should be (0x480 for PACS, 0x400 for HIFI and 0x500 for SPIRE). The Telemetry packet format is detailed in section 8.3
- *Telecommand Function ID Error:* The telecommand packet contains a wrong Function ID into the packet. The Telemetry Packet format is detailed in section 8.4
- *Telecommand Activity ID Error:* The telecommand packet contains has a wrong Activity ID into the packet. The Telemetry Packet format is detailed in section 8.5
- *Telecommand Packet Type Error:* The telecommand packet contains a wrong Packet Type into the packet. The Telemetry Packet format is detailed in section 8.6

- *Telecommand Packet Subtype Error:* The telecommand packet contains a wrong Packet Subtype into the packet. The Telemetry Packet format is detailed in section 8.7

The Boot Software repeat the last Telemetry Message every 10 seconds if no telecommands has been received.

4. EEPROM FORMAT AND BOOT FROM EEPROM TELECOMMANDS

The On-Board Software (OBS) program is stored in EEPROM Memory area. The EEPROM area containing the OBS program is shared in 256 programmable pages of 1024 x 32 bits and the same page size is used to share the free area in Data Memory for OBS uploading by MilBus 1553 but in this case the available pages are 512. This size of 1024x32bits allows to optimise the Cyclic Redundancy Check Code (Frame Check Sequence) limiting the encoded block of less 32768bits. In this way the FCS has the capabilities to maximize the error detection.

Considering the uploading of the OBS via MilBus 1553, 18 Telecommands packet are required to upload a Data Memory page.

On top of the page is defined a Header of 7 words x32bits. The header contains information for program uploading and the single field will be defined in this section. The page space available to store the OBS program is 1017 words x32bit. In EEPROM space the OBS instruction will be memorized. A DSP instruction size is 48bits and 6bytes are required. In order to save space in EEPROM, two DSP instructions are stored in 3 Data memory cells 32 bits wide.
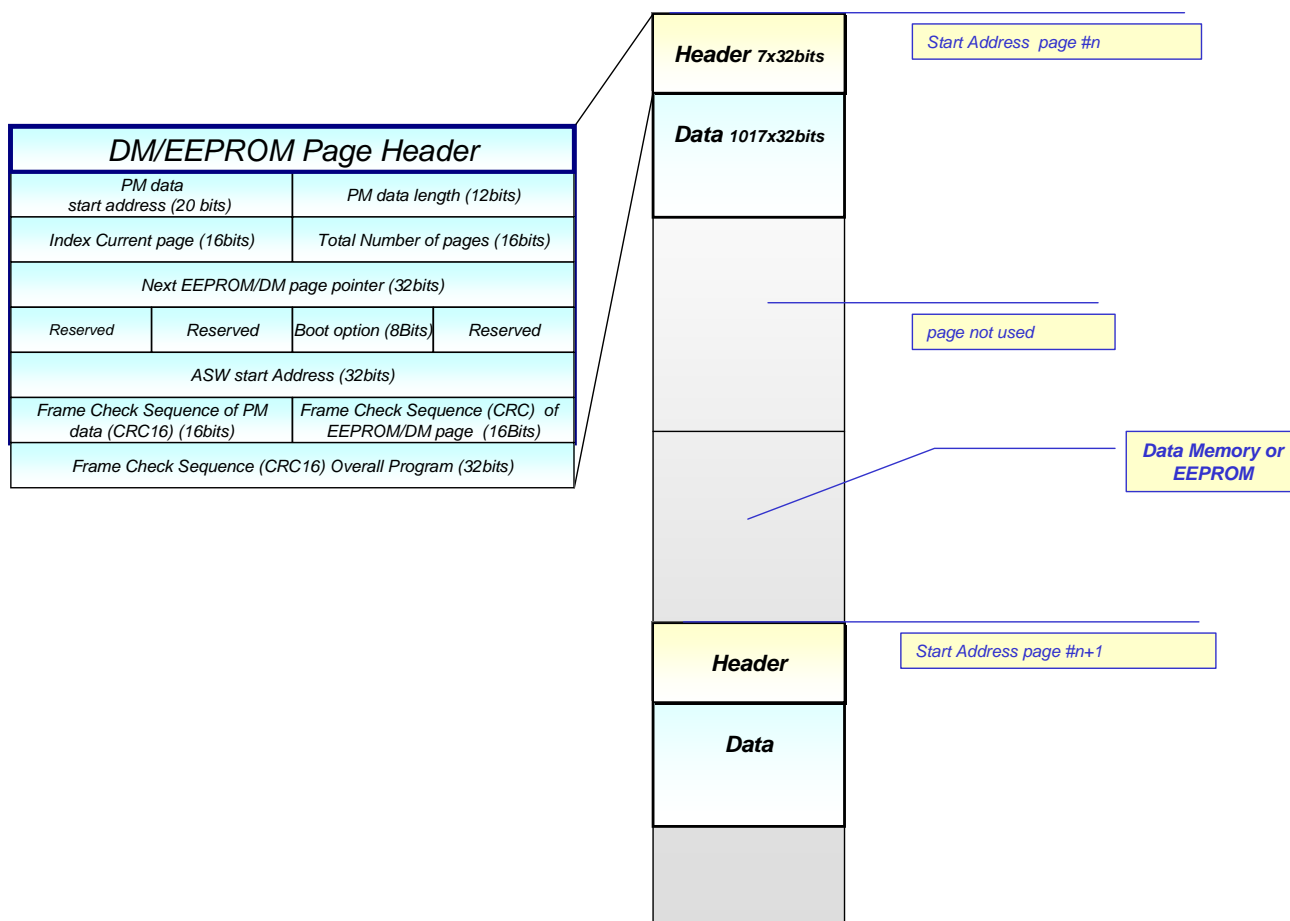
Figure 4-1: EEPROM/DM Pages in the DSP Data Memory space

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The EEPROM / DM header fields shall be as follow:

- *PM segment start address pointer (20bits)*: It is Program memory pointer to copy the OBS data inside the current page to Program memory
- *PM Length (12bits):* Length of the data to be copied in Program memory
- *Index of the current page (16bits):* The OBS program is shared in EEPROM pages numbered in progressive order. This field indicates the number of the current page.
- *Number of Pages (16bits):* It is the total number of the pages required for storing the OBS
- *Next EEPROM / DM page pointer:* It is the address of the next OBS page in the EEPROM or DM. This pointer allows to select the next page in EEPROM / DM to be uploaded in Program Memory
- *Boot Option Flag (8bits):* It allows to select two option: Boot from primary partition or Boot from secondary partition. This filed is read for the first and last pages. In all other pages the filed is ignored.
- *ASW start address (32bits):* Application Software entry point
- *Frame Check Sequence PM page (16bits):* Cyclic redundancy code of the Program memory data in the page
- *Frame Check Sequence EEPROM /DM page:* Cyclic redundancy code of the EEPROM /DM memory page
- *Frame Check Sequence Overall Program (32bits):* Cyclic redundancy code of the OBS program

Byte #4	*Byte #3*	*Byte #2*	*Byte #1*
PM Data start address pointer (20bits)		*PM Data length (12 bits)*	
Index of Current Page (16bits)		*Total Number of Pages (16bits)*	
next EEPROM/DM page pointer (32bits)			
Reserved		*Boot options Byte (8bits)*	*Reserved*
ASW start address (32bits)			
Frame Check sequence of the PM Data (16 bits)		*Frame Check sequence of EEPROM/DM Page (16 bits)*	
0x0000		*Frame Check Sequence Overall Program (CRC16)*	

Table 4-1: EEPROM / DM header (first seven words of each page)

PM start address and PM length of segment fields utilization
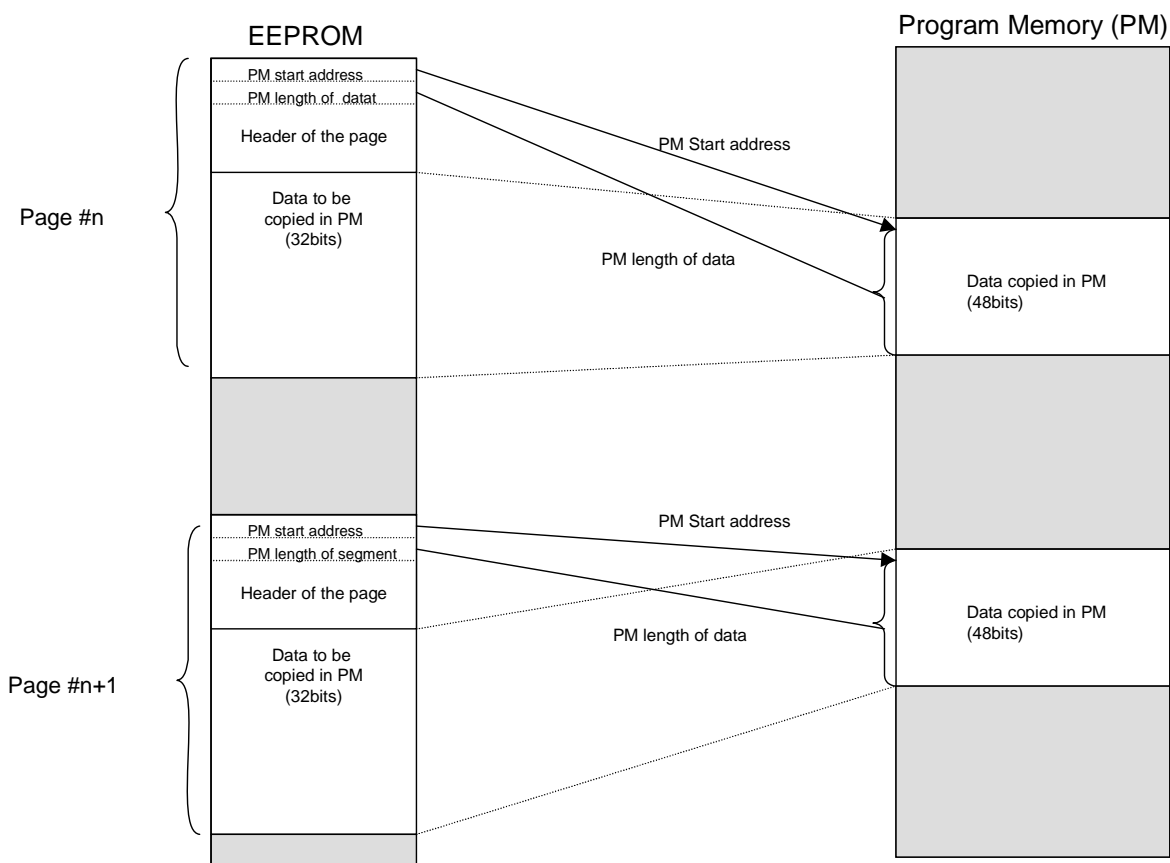
Figure 4-2: PM Start Address and PM Length header fields utilization

EEPROM pointer to the next page field utilization
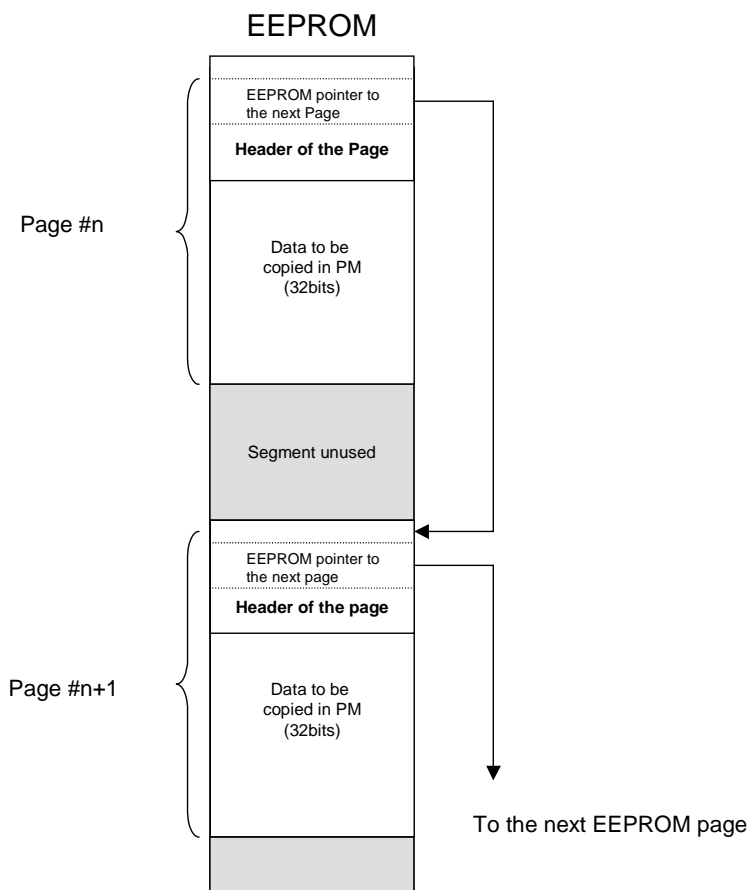
Figure 4-3: : "Pointer to the next EEPROM page" header filed utilization

PM FCS e EEPROM FCS fields utilization
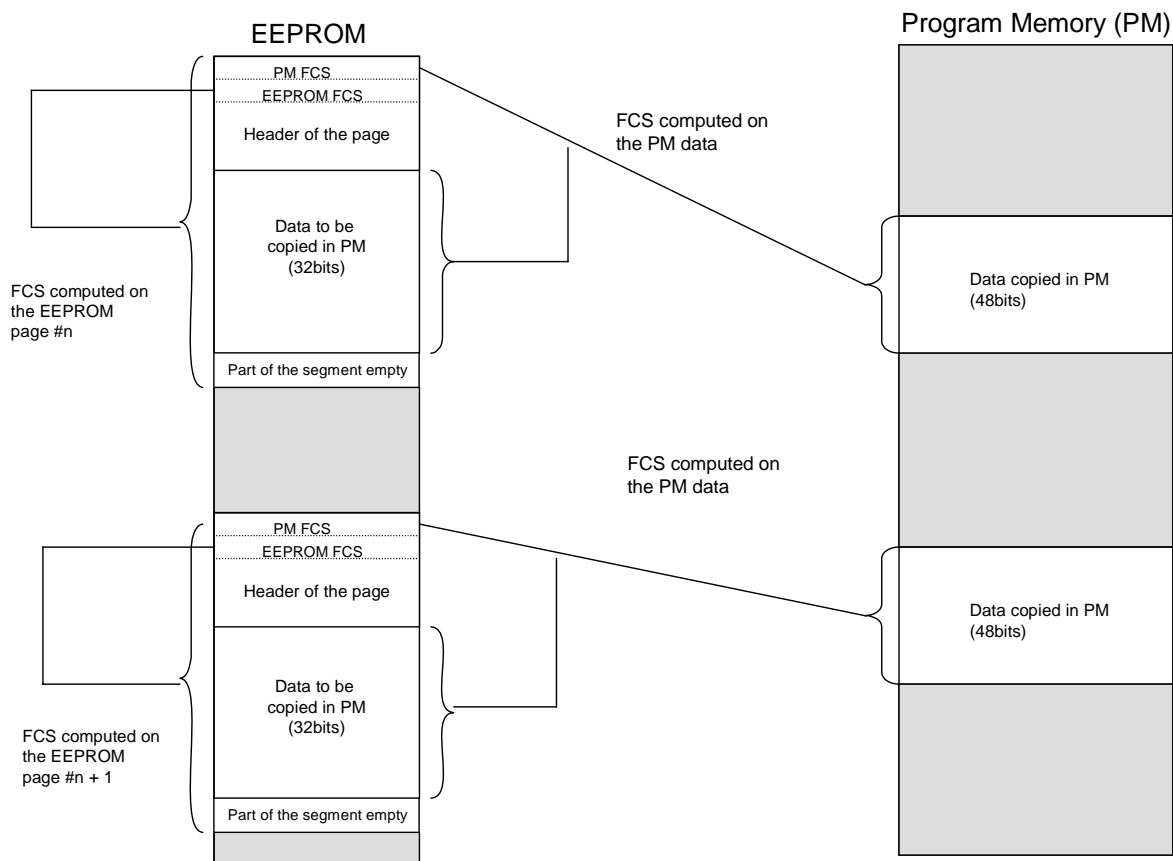
Figure 4-4: : FCS Header field utilization: The Boot software check the FCS of the EEPROM page and the FCS of the data to be write in Program memory

The EEPROM memory should be formatted in two partition.

Boot Software allows to decrease the risk during OBS maintenance by using the Primary and Secondary partition.

Before of updating the OBS is possible to write only secondary partition and booting the new image OBS; the original image will be unchanged in the primary partition.

New OBS image can be also uploaded via MilBus 1553. In this case if the OBS is bigger then half EEPROM size some of the pages must be shared between the two partitions.
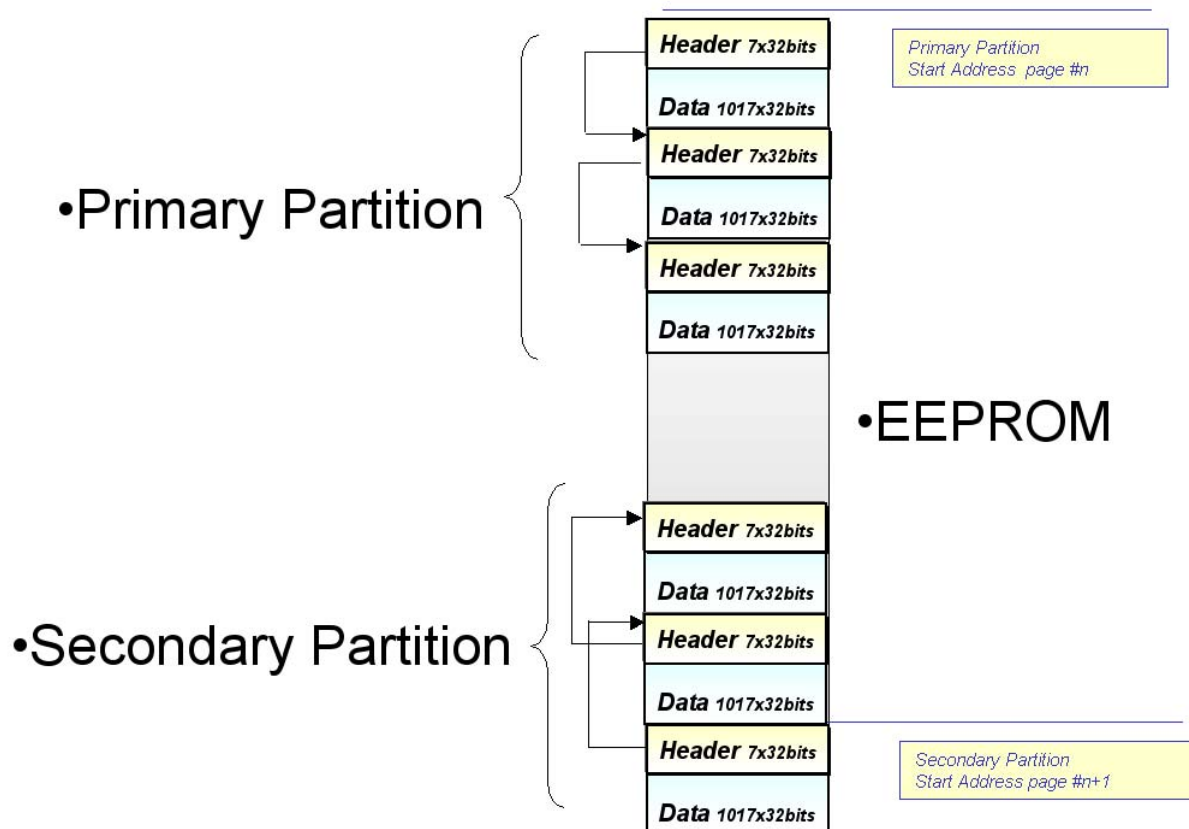
Figure 4-5: EEPROM Primary and Secondary partition

4.1 PROGRAM MEMORY SEGMENTATION

The Program Memory is segmented in 512 segments/pages of 512x48bits in analogue way to the EEPROM and DM. The only difference concerns the words length 48bits instead 32bits. The segmentation allows a more simple test philosophy only. When a single or more memory cells are corrupted the related segment will be declared corrupted and not used. This method avoids to transmit information for all the corrupted cells and the information concerning the segment in failure is only transmitted.

The segmentation don't limit the users management of the Program Memory in term of unused cells. Two or more DM/EEPROM segment could be copied in the same PM segment if the space is available and all the PM space can be utilized.

4.2   FORCE BOOT TELECOMMAND (DEFAULT, PRIMARY AND SECONDARY OPTIONS)

With this telecommand the Boot Software copy the OBS from the EEPROM to PM and launch it. There are three option for this telecommand listed below.

- *Force Boot Default Option:* The packet format of the telecommand is detailed in section 9.2 When this telecommand is sent the Boot Software try to copy the OBS software from EEPROM to PM and launch it. The Boot Software choose automatically which partition of the EEPROM to copy by checking his integrity. If the first partition is corrupted try to copy from the second partition. If both of the partition are corrupted the Boot Software generates a Telemetry Event Packet Message (5,4) described below.

- *Force Boot Primary Partition:* The packet format of the telecommand is detailed in section 9.3 When this telecommand is sent the Boot Software try to copy the OBS from the Primary partition of the EEPROM to PM and launch it. If the procedure of copying the OBS from EEPROM to PM fails the procedure generates a Telemetry Event Packet Message (5,4) described below.

- *Force Boot Secondary Partition:* The packet format of the telecommand is detailed in section 9.3 When this telecommand is sent the Boot Software try to copy the OBS from the Secondary partition of the EEPROM to PM and launch it. If the procedure of copying the OBS from EEPROM to PM fails the procedure generates a Telemetry Event Packet Message (5,4) described below.

If one of this operation fails the Boot Software generates a Telemetry Event Packet Message (5,4) described in section 7.4 The possible error in Error Code field of the packet are:
- Total FCS error (Error Code 0x0800): The computed FCS on the whole program is wrong.
- A Program Memory FCS error (Error Code 0xC000) is detected during the page upload.
- Previous EEPROM Test failed (Error Code 0x1400).
- Overlapping between two Program Memory Pages (Error Code 0x1800).

The Boot Software repeat the last Telemetry Event Packet Message (5,4) every 10 seconds if no telecommands has been received.

5. BOOT FROM MILBUS1553 TELECOMMANDS

5.1 MEMORY MANAGEMENT TELECOMMAND

This telecommand is generated by the Telecommand Generator program (see section 6) and the packet format is detailed in section 9.6 .
This set of telecommands must be uploaded using the procedure described in the Boot Software Test Report.

5.2 LOAD AND BOOT TELECOMMAND

This telecommand is detailed in section 9.
This telecommand must be sent before the upload of the OBS via 1553 link. The Boot Software try to copy the OBS from the Data Memory to program memory and launch it.
If the operation fails a Telemetry Message Event (5,4) has been generated. The possible error are:
- *Loading DM to PM error:* This error could occur if one or more page copied has wrong FCS, in this case the Error Code in the packet field should be 0x0C00. Otherwise if there were a overlapping between two program memory pages the Error Code field into the packet should be 0x1800. This packet is detailed in section 7.5 .
- *Program FCS Error during the DM to PM immediate boot:* In this case the FSC of the whole program is wrong. This packet is detailed in section 7.6 .

5.3 LOAD AND WAIT TELECOMMAND

This telecommand is detailed in section 9.4
This telecommand is used to load one or more pages of the OBS and copy them into Data Memory. After the upload of one or more pages, using the 1553 link, the user send this command.

5.4 LOAD AND WAIT BOOT TELECOMMAND

This telecommand is detailed in section 9.5
This telecommand is used to load the last set of Memory Management Telecommands previously uploaded with the Load and Wait Telecommand.

6. PROGRAM TO GENERATE MEMORY MANAGEMENT TELECOMMANDS (TCGEN)

Telecommands Generator program is a tool to supports the automatic Telecommands generation for the On-Board software uploading via MilBus 1553.

Telecommand Generator "Tcgen" is a program that receives in input the compiled On-Board Software "OBS.exe" and it prepares all the required telecommands to be transmitted to the DPU Boot Software for the SPIRE, PACS, HIFI On-Board Software uploading .

The Telecommands are compliant to the ESA packet TC TM SCI-PT-ICD-7527 and the Herschel Boot Software user requirements HERS-GEN-SQ-CGS-001 issue2.

The program splits the On–Board Software in pages as specified in the Boot Software Requirements Document HERS-GEN-SQ-CGS-002 issue1 and finally from each page the telecommands are generated. According to the Data Memory size and the maximum size of data to be uploaded in the Memory Management Telecommand each program page requires 19 telecommands.

6.1   USAGE OF TELECOMMAND GENERATOR

The "Tcgen" command line requires the following parameters

-i	a file name including the kind of segments to be uploaded (seg_rth, seg_init, etc)
-p	a file name including the RAM pages not used during the uploading
-f	the file name with exe extension
-a	the Application Process Identification of APID for the Instrument
-o	the base name for the output files

An example of command line to run the Tcgen is the following

tcgen -i TXT/Segfile.txt -p TXT/pagfile.txt -f DATA/PACS.EXE -a 0x480 -o RESULT/DmPage -m 0

With the –I parameter the user specifies a file containing the name of the program segments to be uploaded. The name of the segment has to be the same name specified in the On-Board Software architecture file. In case of HIFI, SPIRE, PACS architecture file the uploaded segments are the following

seg_rth: it is the interrupt vector table 0xFF size
seg_init : it is the constant initialization segment
seg_pmco: it is the segment that contains the On-Board Software program

the text file has to specify this three segments. An example of Segment file is the following

segfile.txt
seg_rth
seg_init
seg_pmco

With –p parameter the user can specify the Data Memory pages to be skipped during the TCs uploading. This functionality is usefull In case of DPU Boot Software Data Memory Test failure; the Boot Software sends the Telemetry message containing the address of the corrupted Data Memory pages. The user analizing the telemetry message can generate a set of telecommands able to avoid the corrupted Data memory page. In a simple text file the user has to specify the Data Memory page to be skipped considering that the Data memory are is 512 pages wide.

pagfile.txt
3

In this case the page 3 is skipped during the Telecommands uploading (see Figure 6-1)
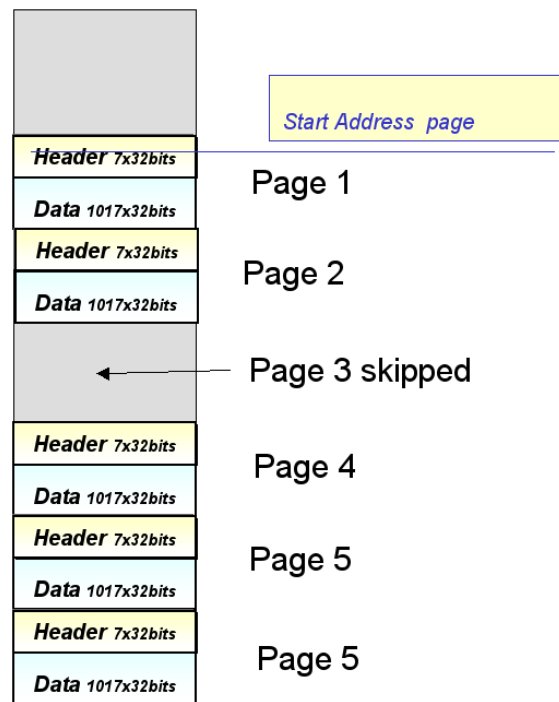
Figure 6-1 Data Memory with page 3 skipped:

With –f parameter the user specifies the executable On-Board Software file. Tcgen read this file for the Telecommands generation.

With –a parameter the user specifies the "APID" to be included in the generated telecommands. (APID=0x400 HIFI, APID=0x480 PACS, APID=0x500 SPIRE).

With –o parameter the user specifies the basename of the generated Telecommands. The Telecommand generator gets this basename and it generates all the telecommands with progressive number starting from 0. In case of 2000 telecommands with base name Foo the name of telecommands are as follow:

Foo00000.dm
Foo00001.dm
Foo00002.dm
……………….
……………….
Foo01999.dm
Foo02000.dm

Set the –m option to 0 in the current version of the Tcgen

Tcgen Outputs: the output of Telecommand generator program are the On-Board Software telecommands as described in the previous point and the Data Memory page of the On-Board software as intermediate result.

In addition the program generates a "c" file containing an array with the interrupt vector table of the program. This functionality will allow to upload the Boot Software from the On-Board software replacing the interrupt vector table of the Boot software with the interrupt vector table of the On-Board software program.

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7. TELEMETRY EVENTS

7.1 PROGRAM MEMORY TEST REPORT

This packet is returned when a failure is detected during the Program Memory check. All the 512 program memory page are controlled and the addresses of failed pages are reported inside the packet.

Field description	*Number of bits*	*Value*	*Remarks*
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence counter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0	
Fine Time	16	0	
Event ID	16	0x8001	Program memory test packet (when an error is detected at least)
SID	16	0x00FF	Undetermined packet structure
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	0xABAB	
Packet Echo2	16	0xCDCD	
State	16	0xAAAA	
MemType	2	1	Program Memory
Total Number Of pages Failed	14	Range 1-512	Total Number of Page Failed
Addresses of the Pages failed	16	Range 0-512	Addresses of the related pages failed. This field is repeated on the base of the total number of page
CRC/FCS	16	Value	

7.2 DATA MEMORY TEST REPORT

This packet is returned when a failure is detected during the Data Memory check. All the 512 program memory page are controlled and the addresses of failed pages are reported inside the packet.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence counter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0	
Fine Time	16	0	
Event ID	16	0x8002	Data Memory test packet (when an error is detected at least)
SID	16	0x00FF	Undetermined packet structure
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	0xABAB	
Packet Echo2	16	0xCDCD	
State	16	0xAAAA	
MemType	2	2	Data Memory
Number Of pages Failed	14	Range 1-512	Total Number of Page Failed
Addresses of the related Pages failed	16	Range 0-512	Address of the related page failed. This filed is repeated on the base of the total number of page
CRC/FCS	16	Value	

7.3   EEPROM MEMORY TEST REPORT

This packet is returned when a failure is detected during the EEPROM Memory check.
The addresses of the failed page is reported inside the packet. The EEPROM page is declared in failure when the computed FCS on the EEPROM page is different the FCS inside the page header.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0	
Fine Time	16	0	
Event ID	16	0x8003	EEProm memory test packet (when an error is detected at least)
SID	16	0x00FF	Undetermined packet structure
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	0xABAB	
Packet Echo2	16	0xCDCD	
State	16	0xAAAA	
MemType	2	3	EEPROM Memory
Number Of pages Failed	14	Range 1-0xFF	Total Number of Pages Failed ;the check is done comparing the computed FCS on the page to the FCS inside the page header.
Number of the related Page failed	16	Range 0-0xFF	Address of the related page failed. This filed is repeated on the base of the total number of page
		0x101	Next Address out of range: the pointer to the next page is out of eeprom memory range
		0x102	Bad Index in the last page; The index in the last page is different then total number of pages
FCS/CRC	16	Value	

7.4 LOADING EEPROM TO PM

This packet is returned when a failure is detected during the loading of the OBS from EEPROM to Program Memory.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0	
Fine Time	16	0	
Event ID	16	0x8005	
SID	16	0x0001	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	0xABAB	
Packet Echo2	16	0xCDCD	
State	16	0xAAAA	
MemType	2	3	EEPROM Memory
Num Of page Failed	14	0x0001	
Error Code	16	0x0800	Total FCS error. The computed FCS on the whole program is wrong.
		0x0C00	A Program memory FCS error is detected during the page upload.
		0x1400	Previous EEPROM test failed
		0x1800	Overlapping between two program memory pages
FCS/CRC	16	Value	

7.5 LOADING DM TO PM

This packet is returned when a failure is detected during the loading of the OBS from Data Memory to Program Memory.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0	
Fine Time	16	0	
Event ID	16	0x8006	
SID	16	0x0001	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	0xABAB	
Packet Echo2	16	0xCDCD	
Event Type	16	0x0054	
State	16	0xAAAA	
MemType	2	2	DM Memory
Number Of pages Failed	14	0x0001	
Error Code	16	0x0C00	A Program memory FCS error is detected during the page upload.
		0x1800	Overlapping between two program memory pages
FCS/CRC	16	Value	

7.6   PROGRAM FCS ERROR DURING THE DM TO PM IMMEDIATE BOOT

This packet is returned when an FCS error is detected after a Load and Boot command.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0	
Fine Time	16	0	
Event ID	16	0x8007	
SID	16	0x0001	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	0xABAB	
Packet Echo2	16	0xCDCD	
State	16	0xAAAA	
MemType	2	1	
Number Of pages Failed	14	0x0001	
Error Code	16	0x0800	Program FCS error. The computed FCS on the whole program is wrong.
FCS/CRC	16	Value	

7.7 READY TO ACCEPT TELECOMMANDS

This packet is returned when the Boot Software is ready to accept telecommands after all the memory tests are performed successfully.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	1	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0	
Fine Time	16	0	
Event ID	16	0x8008	
SID	16	0x0003	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	0xABAB	
Packet Echo2	16	0xCDCD	
State	16	0xAAAA	Test ok and wait TC
FCS/CRC	16		

8. TELEMETRY PACKETS TC ACKNOWLEDGE

8.1   TELECOMMANDS ACKNOWLEDGE

This packet is returned after the reception of a generic Telecommand.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	1	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0	
Fine Time	16	0	
Event ID	16	0x8111	
SID	16	0x0003	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	Telecommand Packet ID	
Packet Echo2	16	Telecommand Packet Sequence Control	
State	16	0xBBBB	TC upload in progress
		0xCCCC	TC upload performed
FCS/CRC	16	Value	

8.2   TC FCS ERROR

This packet is returned when a telecommand with an FCS error has been received.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flalg	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0	
Fine Time	16	0	
Event ID	16	0x8004	
SID	16	0x0009	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	Telecommand Packet ID	
Packet Echo2	16	Telecommand Packet Sequence Control	
State	16	0xAAAA	
MemType	16	0xAAAA	Not applicable
Error Code	16	0x0008	FCS error
FCS computed	16	Value computed	
FCS read	16	Value read	
Checksum ID	16	0x0002	Type of FCS error: FCS Tele-command error
DmStartAddress	32	0xAAAA AAAA	Not applicable
FCS/CRC	16	Value	

8.3   TC APID COMMAND ERROR

This packet is returned when a telecommand with an incorrect APID has been received.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0x0000	
Fine Time	16	0x0000	
Event ID	16	0x8004	
SID	16	0x0009	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	Telecommand Packet ID	
Packet Echo2	16	Telecommand Packet Sequence Control	
State	16	0xAAAA	
MemType	16	APID Value	APID of the received TC packet
Error Code	16	0x000C	Telecommand APID error
FCS computed	16	0xAAAA	Not Applicable
FCS read	16	0xAAAA	Not Applicable
Checksum ID	16	0xAAAA	Not Applicable
DmStartAddress	32	0xAAAA AAAA	Not applicable
CRC	16	Value	

8.4   TC WRONG FUNCTION ID

This packet is returned when a function management telecommand with an incorrect Function ID has been received.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flalg	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0x0000	
Fine Time	16	0x0000	
Event ID	16	0x8004	
SID	16	0x0009	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	Telecommand Packet ID	
Packet Echo2	16	Telecommand Packet Sequence Control	
State	16	0xAAAA	
MemType	16	Function ID	Function ID of the received TC packet
Error Code	16	0x0010	Telecommand Wrong Function ID
FCS computed	16	0xAAAA	Not Applicable
FCS read	16	0xAAAA	Not Applicable
Checksum ID	16	0xAAAA	Not Applicable
DmStartAddress	32	0xAAAA AAAA	Not applicable
CRC	16	Value	

8.5   TC WRONG ACTIVITY ID

This packet is returned when a function management telecommand with an incorrect Activity ID has been received.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0x0000	
Fine Time	16	0x0000	
Event ID	16	0x8004	
SID	16	0x0009	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	Telecommand Packet ID	
Packet Echo2	16	Telecommand Packet Sequence Control	
State	16	0xAAAA	
MemType	16	Activity ID	Activity ID of the received TC packet
Error Code	16	0x0011	Telecommand Wrong Activity ID
FCS computed	16	0xAAAA	Not Applicable
FCS read	16	0xAAAA	Not Applicable
Checksum ID	16	0xAAAA	Not Applicable
DmStartAddress	32	0xAAAA AAAA	Not applicable
CRC	16	Value	

8.6 TC PACKET TYPE ERROR

This packet is returned when a telecommand with an incorrect Packet Type has been received.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0x0000	
Fine Time	16	0x0000	
Event ID	16	0x8004	
SID	16	0x0009	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	Telecommand Packet ID	
Packet Echo2	16	Telecommand Packet Sequence Counter	
State	16	0xAAAA	
MemType	16	Type and Subtype	Type and Subtype of the received TC packet
Error Code	16	0x000E	Telecommand Packet Type error
FCS computed	16	0xAAAA	Not Applicable
FCS read	16	0xAAAA	Not Applicable
Checksum ID	16	0xAAAA	Not Applicable
DmStartAddress	32	0xAAAA AAAA	Not applicable
CRC	16	Value	

8.7 TC PACKET SUBTYPE ERROR

This packet is returned when a telecommand with an incorrect Packet Subtype has been received.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0x0000	
Fine Time	16	0x0000	
Event ID	16	0x8004	
SID	16	0x0009	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	Telecommand Packet ID	
Packet Echo2	16	Telecommand Packet Sequence Counter	
State	16	0xAAAA	
MemType	16	Type and Subtype	Type and Subtype of the received TC packet
Error Code	16	0x000B	Telecommand Packet Subtype error
FCS computed	16	0xAAAA	Not Applicable
FCS read	16	0xAAAA	Not Applicable
Checksum ID	16	0xAAAA	Not Applicable
DmStartAddress	32	0xAAAA AAAA	Not applicable
CRC	16	Value	

8.8 DATA MEMORY PAGE LOST

This packet is returned when during the OBS upload a page has been lost.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0x0000	
Fine Time	16	0x0000	
Event ID	16	0x8004	
SID	16	0x0009	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	Telecommand Packet ID	
Packet Echo2	16	Telecommand Packet Sequence Control	
State	16	0xAAAA	
Mem ID	16	0x0011	
Error Code	16	0x0009	Telecommand PAGE LOST error; when two pages are overlapped
FCS computed	16	0xAAAA	Not Applicable
FCS read	16	0xAAAA	Not Applicable
Checksum ID	16	0xAAAA	Not Applicable
DmStartAddress	32	Value	Start address of the memory page
CRC	16	Value	

8.9   TC APPLICATION DATA FCS ERROR

This packet is returned when a memory management telecommand with an incorrect FCS has been received.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0x0000	
Fine Time	16	0x0000	
Event ID	16	0x8004	
SID	16	0x0009	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	Telecommand Packet ID	
Packet Echo2	16	Telecommand Packet Sequence Control	
State	16	0xAAAA	
Mem ID	16	0x0011	
Error Code	16	0x0008	Telecommand FCS Error
FCS computed	16	Value	Computed on the Data Block
FCS read	16	Value	Read inside the command packet
Checksum ID	16	0x0001	FCS Data Block error in the Telecommand
DmStartAddress	32	Value	Start address of the memory page
FCS/CRC	16	Value	

8.10   TC MEMORY MANAGEMENT DATA MEMORY WRONG FORMAT

This packet is returned when a memory management telecommand with an incorrect format has been received.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Telemetry Type	1	0	
Data Field Secondary header	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Segmentation Flag	2	3	
Source sequence conter	14	Incremented by one evry packet	
Packet Length	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	5	
Packet Subtype	8	4	
Spare	8	0	
Course Time1	16	0x8000	
Course Time2	16	0x0000	
Fine Time	16	0x0000	
Event ID	16	0x8004	
SID	16	0x0009	
Parameter A	64	0	Reserved
Packet Counter	16	Packet Counter	
Packet Echo1	16	Telecommand Packet ID	
Packet Echo2	16	Telecommand Packet Sequence Control	
State	16	0xAAAA	
Mem ID	16	Value	Mem ID into packet
Error Code	16	0x0007	Telecommand WRONG FORMAT
FCS computed	16	0xAAAA	Not Applicable
FCS read	16	0xAAAA	Not Applicable
Checksum ID	16	0xAAAA	Not Applicable
DmStartAddress	32	Value	Start address of memory page
FCS/CRC	16	Value	

9. TELECOMMANDS

9.1   TC LOAD AND BOOT

This telecommand load the OBS from Data Memory to Program Memory and boot.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Type	1	1	
Data Field Header Flag	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Sequence Flags	2	3	
Packet Sequence Counter	14	Incremented by one	
Packet Lenght	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	8	
Packet Subtype	8	4	
Spare	8	0	
Function ID	8	0x70	
Activity ID	8	0x02	
Number of Parameters	16	0	
FCS/CRC	16	Value	

9.2 TC FORCE BOOT DEFAULT OPTION

This telecommand force the boot the OBS from EEPROM. The Boot Software after a check choose to boot from primary or secondary partition.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Type	1	1	
Data Field Header Flag	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Sequence Flags	2	3	
Packet Sequence Counter	14	Incremented by one	
Packet Lenght	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	8	
Packet Subtype	8	4	
Spare	8	0	
Function ID	8	0x70	
Activity ID	8	0x03	
Number of Parameters	16	0	
FCS/CRC	16	Value	

9.3   TC FORCE BOOT PRIMARY/SECONDARY PARTITION

This telecommand force the boot the OBS from EEPROM primary or secondary partition.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Type	1	1	
Data Field Header Flag	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Sequence Flags	2	3	
Packet Sequence Counter	14	Incremented by one	
Packet Lenght	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	8	
Packet Subtype	8	4	
Spare	8	0	
Function ID	8	0x70	
Activity ID	8	0x03	
Number of Parameters	16	1	
Number of partition to boot	16	1=first partition 2=secondary partition	
FCS/CRC	16	Value	

9.4   TC LOAD AND WAIT

This telecommand loads the commands uploaded from DM to PM and wait for other memory management telecommands.

Field Description	*Number of bits*	*Value*	*Remarks*
Version number	3	0	
Type	1	1	
Data Field Header Flag	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Sequence Flags	2	3	
Packet Sequence Counter	14	Incremented by one	
Packet Lenght	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	8	
Packet Subtype	8	4	
Spare	8	0	
Function ID	8	0x70	
Activity ID	8	0x01	
Number of Parameters	16	0	
FCS/CRC	16	Value	

9.5   TC LOAD AND WAIT BOOT

This telecommand loads from Data Memory to Program memory the last set of memory management telecommands.

Field Description	*Number of bits*	*Value*	*Remarks*
Version number	3	0	
Type	1	1	
Data Field Header Flag	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Sequence Flags	2	3	
Packet Sequence Counter	14	Incremented by one	
Packet Lenght	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	8	
Packet Subtype	8	4	
Spare	8	0	
Function ID	8	0x70	
Activity ID	8	0x04	
Number of Parameters	16	0	
FCS/CRC	16	Value	

9.6   TC MEMORY MANAGEMENT

This telecommand loads the On-Board Software in Data memory.

Field Description	Number of bits	Value	Remarks
Version number	3	0	
Type	1	1	
Data Field Header Flag	1	1	
APID	11	PACS=0x480 HIFI =0x400 SPIRE=0x500	
Sequence Flags	2	3	
Packet Sequence Counter	14	Incremented by one	
Packet Lenght	16	Depending on packet length	
Spare	1	0	
PUS Version	3	0	
Spare	4	0	
Packet Type	8	6	
Packet Subtype	8	2	
Spare	8	0	
Mem ID	8	0x11	
Start Address	24	Value	Start address
Spare	8	0	
Length	8	Lenght	Lenght
Data	N*16		
FCS/CRC	16	Value	