Title: **Sentinel-2 Packet Utilization Standard**

CI - No: 000000

DRL Refs : SY-27

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Change Record

ISSUE	DATA	SHEET	DESCRIPTION
1	22.05.2008	all	First issue
2	08.08.2008	all	Updates based on ESA and Astrium review comments as communicated per ASD e-mail "S2-PUS Meeting" by S.Bursch dated 31.7.2008. • Split "Core PUS" and "Annex A" into separate Document GS2.STD.ASD.SY.00001 and GS2.STD.ASD.SY.00002
3	10.10.2008	all	Updates based on ESA and Astrium review comments as per "S2-PUS Meeting" GS2.MN.ASD.SY.00091 09.09.2008 and "S2-PUS telecon" GS2.MN.ASD.SY.00094. • Combined PUS volumes as described in this document with o Header-Part-Document (this) o Volume A: former "Core PUS" (GS2.STD.ASD.SY.00001) o Volume B: former "Annex A" (GS2.STD.ASD.SY.00002) • Document GS2.STD.ASD.SY.00002 no longer supported.
4	12.12.2008	all	Updates based on S-1; S-2; S3 review comments in the frame of the GPSR comunallity. As concluded in S3-MN-TAF-GN-00440 dated 04.12.2008.
5	27.02.2009	all	Document Change Note GS2.DN.ASD.SY.00020 • Sentinel-2 Packet Utilization Standard update after System PDR. For details see change log of each individual Volume as listen in §3.
6	31.07.2009	all	Sentinel-2 Packet Utilization Standard update: • issue number and date changed of the referenced Volumes in §3 • update after clarification from Operations Meetings • refinement of services • refinement of project specific definitions For details see change log of each individual Volume as listen in §3.
7	12.01.2010	all	Sentinel-2 Packet Utilization Standard: • update of issue number and date of the referenced Volumes in §3 • update after clarification from Operations Meetings • refinement of services • refinement of project specific definitions For details see change log of each individual Volume as listen in §3.
8	12.05.2010	all	Sentinel-2 Packet Utilization Standard: • update of issue number and date of the referenced Volumes in §3 • update after CSW V2 SRR • refinement of services in Volume A • refinement of project specific definitions in Volume B For details see change log of each individual Volume as listed in §3.

ISSUE	DATA	SHEET	DESCRIPTION
9	22.10.2010	all	Sentinel-2 Packet Utilization Standard: • update after CSW V2 PDR • update based on red-marked S2-PUS as generated during the working meeting GS2.MN.ASD.SY.00524 date 7.10.2010. • update of issue number and date of the referenced Volumes in §3 • refinement of services in Volume A • refinement of project specific definitions in Volume B For details see change log of each individual Volume as listed in §3.
10	22.03.2011	all	Sentinel-2 Packet Utilization Standard update after System CDR • §2.2: Added reference to CCSDS 732.0-B-1 • §3: update of PUS issue number/date of the referenced Volumes • refinement of services in Volume A • refinement of project specific definitions in Volume B For details see change log of each individual Volume as listed in §3.
11	21.10.2011	all	Sentinel-2 Packet Utilization Standard update after CSW V3 PDR • §3: update of PUS issue number/date of the referenced Volumes • refinement of services in Volume A • refinement of project specific definitions in Volume B For details see change log of each individual Volume as listed in §3.
12	25.05.2012	all	Sentinel-2 Packet Utilization Standard update for CSW V3 DDR • §3: update of PUS issue number/date of the referenced Volumes • refinement of services in Volume A • refinement of project specific definitions in Volume B For details see change log of each individual Volume as listed in §3.
13	15.11.2012	all	Sentinel-2 Packet Utilization Standard clean-up. • §3: update of PUS issue number/date of the referenced Volumes • refinement of services **in Volume A** • refinement of project specific definitions **in Volume B** For details see **change log** of **each** individual **Volume** as listed in §3.

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1. INTRODUCTION

1.1 Scope of the Document

This document is in response to the Sentinel-2 Operations Interface Requirements Document (OIRD) to provide a specific tailoring of the ECSS Packet Utilisation Standard ECSS-E70-41A [ND-154].

In order to maximise the application of a heritaged tailoring approach for the ECSS Packet Utilization Standard, the following documentation approach has been adopted. The document will consist of :

- a “Header part” with the generic information (this document) like introduction and applicable docs and a table ***listing the volumes and there valid issue***
- Volume A - the generic PUS
  It details the definitions of PUS-Service/Sub-services and their data structures, which are intended to be applied across applications. It defines the TC- and TM-format and it contains the applicable generic annexes of ECSS-70-41-A [ND-154]. The core PUS is basically the answer to the OIRD.
- Volume B – the project specific part
  It contains the definition of the project specifc process identfiers (PRID), source and destination ID, common failure ID's (FID) and event ID's (EID) as well as applicability matrix of the individual PUS-Service/Sub-service for the individual on-board applications. Volume B basically reflects the general application hierarchy and distribution of on-board services.
- Volume C – the project specific CSW part
  It details the private PUS-Service/Sub-services of the Central Software (CSW).

Volume A & B & C are identified by the same document number as the “Header part”.
They have there own change record, but they do not have signatures on the front page.
They do not have the chapters §1 “Introduction” and §2 “Documents”, as all of these items are covered in the "header part".

PUS specific functional requirements are called up in the Software System Specification or the respective Unit Specifications.

The unit specific PUS (i.e. STR, GPSR, MMFU, etc) will be covered by dedicated TM/TC ICDs for each unit. The subcontractor will generate this ICD and keep it under configuration.

1.2 Definitions

None.

1.3 Abbreviations

General Sentinel-2 abbreviations are in [RD-1].

2. DOCUMENTS

Applicable Documents:
All dokuments which are contractually binding and configuration controlled exchanged between contractual partners (change prozess). Ideally these documents are refered to in the contract.

Normative Documents:
All normative / standards wihich are referenziert in the documents and which are required for the generation of the document respectively which provide additional guidance (no change prozess).

Reference Documents:
All other documents wihich are referenziert in the documents and which are required for the generation of the document respectively which provide additional guidance (no change prozess).

2.1 Applicable Documents

ID	TITLE	DOCUMENT-REFERENCE
	none	

Table 2-1: Applicable Documents

2.2 Normative Documents

Normative Documents are …

ID	TITLE	DOCUMENT-REFERENCE
[ND-104]	Packet Telemetry	CCSDS-102.0-B-5
[ND-111]	Telecommand Part 1 – Channel Service, Blue Book, June 2000	CCSDS-201.0-B-3
[ND-112]	Telecommand Part 2 – Data Routing Service, Blue Book, June 2001	CCSDS-202.0-B-3
[ND-113]	Telecommand Part 2.1 – Command Operation Procedures, Blue Book, June 2001	CCSDS-202.1-B-2
[ND-114]	Telecommand Part 3 – Data Management Service, Blue Book, June 2001	CCSDS-203.0-B-2
[ND-115]	Time Code Formats	CCSDS-301.0-B-3
[ND-117]	Advanced Orbiting Systems Space Data Links Protocols	CCSDS 732.0-B-1
[ND-152]	Space Engineering - Space Segment Operability	ECSS-E-70-11A
[ND-154]	Ground systems and operations - Telemetry and telecommand packet utilization	ECSS-E-70-41A

Table 2-2: Normative Documents

2.3 Reference Documents

Reference Documents are …

ID	TITLE	DOCUMENT-REFERENCE
[RD-1]	List of Abbreviations and Acronyms	GS2.LI.ASD.SY.00001
[RD-2] **OIRD**	GMES SENTINEL-2 Operations Interface Requirements Document	S2-RS-ESA-SY-0006
[RD-4]	SENTINEL-123 GPSR Command and HK Data IF Specification	S1-IF-AAE-SC-0001
[RD-5]	SENTINEL-2 Mass Memory Formating Unit TM/TC ICD	GS2-IF-ASG-MMFU-0003
[RD-6]	SENTINEL-2 Startracker PUS ICD	GS2.ICD.JOP.STR.02402
[RD-7]	SENTINEL-2 LCT PUS Services List	SEN2-TESAT-LCT-TNO-0025
[RD-8]	SENTINEL-2 OBC HW/SW ICD	GS2.ICD.RSE.OBC.00002

Table 2-3: Reference Documents

3. APPLICABLE VOLUMES

The Sentinel-2 Packet Utilization Standard is composed of the following volumes:

VOLUME NUMBER	TITLE	APPLICABLE ISSUE	APPLICABLE DATE
Volume A	Generic Services	issue 13	**15.11.2012**
Volume B	Common Data Tables	issue 13	**15.11.2012**

Title: **Sentinel-2 Packet Utilisation Standard**

- Volume A: Generic Services

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Change Record

Issue	Date	Sheet	Description of Change
1	22.05.2008	all	first issue
2	08.08.2008	all	see related issue
3	10.10.2008	all	see related issue
4	27.02.2009	all	see related issue
5	31.07.2009	all	see related issue
6	-	all	Not issued
7	12.01.2010	all	see related issue
8	12.05.2010	all	Volume A updated after CSW V2 SRR. see related issue.
9	22.10.2010	All	Update based on red-marked S2-PUS as generated during the working meeting GS2.MN.ASD.SY.00524 date 07.10.2010
10	22.03.2011	all	Volume A updated after System CDR and CSW V3 SRR. see related issue.
11	18.10.2011	all	Volume A updated after CSW V3 PDR.
12	25.05.2012	All	Volume A updates for CSW V2 CDR
13	**15.11.2012**	**All**	**Sentinel-2 Packet Utilization Standard Volume A clean-up. All changes are marked by change bars.**
		§2.4.1	• Updated Table 2.4 2: Sub-Services with bandwidth limitation for S3, S6, S148 as per **GS2-MN.ASD.SY.00919-13** • Typo TM(1,8) corrected • Text corrected wrt. TM(5,132)*, TM(5,134)
		§4.5	• Updated description and details of SystemLog. • Updated Table 4.5-7 range parameters for TC(5,128)
.		§4.7	• Added TM(8,128)
		§4.8	• Updated Table 4.8-11 range prameters for TC(9,1)
		§4.9	• Updated Table 4.9-22 range of parameter N for TC(11,10) • Updated FIDs for PUS-4646, 12169, 4802, 4876, 4955, 5010, 5080, 5249, 5320, 5496, 5582
		§4.10	• Updated service 12 description • Updated Table 4.10-5 Structure of TC(12,5) • Updated range description of NOL and NOE • Updated FIDs for PUS-5995, 12370

Issue	Date	Sheet	Description of Change
		§4.12	• Updated description • Updated Table 4.12-6 range description of N1 of TC(12,2)
		§4.13	• Updated description of TC(15,9), TC(15,129), TM(15,143) • Added remark to TM(15,146) • Updated FIDs for PUS-7962, 8084
		§4.16	• Added remark to TM(19,7)
		§4.17	• Updated description • Updated Table 4.17-9 parameter description of TC(140,4) BYTE_ARRAY type included as per **GS2-MN.ASD.SY.00919-8**. • Updated FIDs for PUS-10062
		§4.18	• Updated Table 4.18-1 “Service 142 sub-services” • Updated description of service 142 • Updated Figure 4.18-1 “Functional Monitoring definitions and status” • Updated Table 4.18-8 Timeout Parameter of TC(142,5) • Updated Table 4.18-12 “Structure of the Source data TM(142,9)” • Updated Table 4.18-14+17 FMON Protection, Status and Timeout Parameter of TM(142,9)+TM(142,11) • Updated FIDs for PUS-12708, 12858, 12919,
		§4.20	• Updated Table 4.20-7 parameters for TM(148,9) • Updated Table 4.20-9 parameter for TM(148,11) • Corrected note for TC(148,128) • Updated Table 4.20-17 parameter for TM(148,131) • Updated Table 4.20-20 Structure of TC(148,133)
		§4.22	• Updated Table 4.22-22 Range of Parameter N for TC(151,10) • Updated Table 4.22-31 Structure of TC(151,14) • Updated FIDs for PUS-10397, 10418, 10490, 10562, 10672, 10757, 10817, 10887, 11059, 11131, 11309, 11398,

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TABLES

FIGURES

1 TELECOMMAND STRUCTURE

This chapter describes the telecommand structures to be used for AstroBUS-L projects

The telecommand structure definitions have to be consistent over all AstroBUS-L System Elements (platform and payloads).

1.1 CLTU Structure

PUS-4//

The CLTU structure shall be as showed below:

CLTU - Command Link Transmission Unit					
Start Sequence EB90 (hex)	1st Codeblock	2nd Codeblock	----------------------------------	n-th Codeblock	Tail Sequence
16 bit	8 byte	8 byte		8 byte	8 byte

Figure 1.1-1: CLTU Structure

PUS-7//

The Codeblock structure shall be as showed below:

Codeblock – one out of n	
TC Data 7 Bytes	Error Control 7 Parity Bits | 1 Filler Bit
56 bit	8 bit

Figure 1.1-2: CLTU Codeblock

PUS-10//

The Tail sequence shall be as showed below according to ECSS-E-50-04

Tail sequence:
0xC5 - 0xC5 -0xC5 - 0xC5 - 0xC5 -0xC5 - 0xC5 - 0x79

1.2 TC Transfer Frame

PUS-17//

The TC Transfer Frame structure shall be as showed below:

TC Transfer Frame		
Frame Header	TC Frame Data Unit = 1 TC Segment	TC Frame Error Control (CRC)
5 byte	variable length - 249 byte max.	2 byte

Figure 1.2-1: TC Transfer Frame

PUS-20//

The Frame Header structure shall be as showed below:

Frame Header							
Version (=00)	Bypass Flag	Control Cmd Flag	Spare (=00)	Spacecraft ID	Virtual Channel ID	Frame Length	Frame Sequence Number
2	1	1	2	10	6	10	8
2 byte					2 byte		1 byte

Figure 1.2-2: TC Transfer Frame Header

Aggregation:
OFF: n=1 / single TC Packet in Segment Data Field (n … number of TC packets per Transfer Frame)
ON: n>1 / multiple TC Packet in Segment Data Field **Segment Data Field filled up by integral number of packets** (n … number of TC packets per Transfer Frame)

Note:

Aggregation will not be supported neither by CPDU nor by Authentication Unit (i.e. no aggregation of MAP ID 0 & 63)

Parameter	Description	Range or value		
Version	Transfer Frame Version Number	"00"		
Bypass Flag / Control Command Flag	Flags used to control the PTD operation	0	0	Type-AD. Frame Data Field carries TC data (e.g., Packets or Segments), subject to acceptance check under control of the FARM. These Frames use the Sequence-Controlled (or AD) Service of the COP.
		0	1	Reserved
		1	0	Type-BD. Frame Data Field carries TC data (e.g., Packets or Segments), with all frame acceptance checks bypassed under control of the FARM. These Frames use the Expedited (or BD) Service of the COP.
		1	1	Type-BC. Frame Data Field carries FARM Control Commands, with all frame acceptance checks bypassed under control of the FARM. These Frames control the Sequence-Controlled Service of the COP.
Spare		"00"		

Parameter	Description	Range or value
Spacecraft ID	These ten bits carry the identification code for the spacecraft being commanded. The Secretariat of the CCSDS assigns the SPACECRAFT IDENTIFIER to each vehicle within a particular mission	See volume B
Virtual Channel ID	VC Id Identifier used to address a single physical channel to be logically multiplexed on a frame-by-frame basis.	See volume B.
Frame Length	This 10-bit field contains a length count "C" which equals one fewer than the total octets in the TC Transfer Frame. The count is measured from the first bit of the FRAME HEADER to the last bit of the FRAME ERROR CONTROL FIELD (if present), or the last bit of the FRAME DATA FIELD if the error control is omitted. The size of this field limits the maximum length of a TC Transfer Frame to 1024 octets. The length count "C" is expressed as: C = (Total Number of Octets) -1	6..255 bytes
Frame Sequence Number	up-counting binary number which is assigned to each TC Frame by the TC Transfer layer,	0 .. 2^8-1
TC Frame Error Control	Provides frame error control information (CRC)	CRC over complete frame (as specified in [ND-112])

Table 1.2-1: TC Transfer Frame Structure

1.3 TC Frame Data (= Segments)

PUS-90//

The TC Segment structure shall be as showed below:

TC Segment					
Segment Header		Segment Data Field			Segment Trailer
Sequence Flags	MAP ID	Packet #1		Packet #n	Only present, when authentication is ON
2	6				
1 byte		variable length - 226 byte max.			22 byte

Figure 1.3-1: TC Segment

Description of the "TC Segment" elements

Parameter	Description	Range or Value
Sequence Flags	Inidicates the sequential position of the Segment relative to the complete user data unit.	Note 1)
MAP ID	Identification of the Multiplexed Access Point	See Volume B
Packet #	One or more TC Packets included in the TC segment	
Segment Trailer	Authentication Tail	Only present when the authentication is ON See note 2)

Table 1.3-1: TC Segment

Note 1)

Sequence Flag should be set to 11 (i.e. no command packet segmentation)

Note 2)

The detailsof the segment are described in GS2.TN.RSE.OBC.00101 "Authentication Unit User Manual".

For command segments of some MAP ID’s it is possible to aggregate or include several command packets within the same segment such that they are all encoded and transmitted in the same transfer frame. After unpacking the command segment, all command packets contained therein shall be sent for execution in the same order as contained in the segment. For MAP ID supporting aggregation besides the maximum segment length, the only restriction is that all commands aggregated in the same segment are destined to the same map id and the commands need to be sent in the same transmission mode (ad / bd).

In Volume B it is identified which MAP ID’s are supporting aggregation andwhich ones are not supporting aggregation

1.4 CPDU Specific TC Source Packet

PUS-94//

The TC source packets shall conform to the structure defined in ESA PSS 04-151 and showed below.

TC Source Packet		
Packet Header	Packet Data Field	
	Application Data > **Command Data** <	Packet Error Control (CRC)
6 byte	variable length - 218 byte max.	2 byte

Figure 1.4-1: TC source packet

PUS-97//

The TC Packet Header structure shall be as showed below:

Packet Header							
Packet ID					Packet Sequence Control		Pkt Length
Version (=000)	Type (=1)	DFH Flag	APID		Sequence Flags (=11)	Sequence Count	Packet Data Field Length
			PRID	PCAT			
3	1	1	7	4	2	14	16
2 byte					2 byte		2 byte

Figure 1.4-2: TC source packet Header

Parameter		Description	Range or value
Version Number	MSB b_0-b_2	CCSDS Version Number	Must be set to 0 for all commands
Type	b_3	Packet type (0 = telemetry, 1 = telecommand)	Must be set to 1 for all telecommands
Data Field Header Flag	b_4	Indicates the presence of a data field header (when set to 1)	0: No secondary header present
APID *PRID*	b_5-b_{11}	Process ID (part of the APID)	Must be set to a value according to the PRID Table in volume B of this document
PCAT	b_{12}-b_{15}	Packet category	Must be 12.
Sequence Flag	b_{16}-b_{17}		Must be set to 11 bin (stand alone TC packet)
Sequence Count	b_{18}-b_{31}	Wrap around counter (per APID)	0 to 2^{14} - 1, Note: not verified, only telemetered back to ground.

Parameter		Description	Range or value
Packet Length	b_{32}-b_{47}	Number of bytes contained in the packet data field minus 1	Max. 219 bytes ⌠ (application data 218 bytes, packet error control 2 bytes) minus 1 Note: The packet length field has to be an odd number to ensure the TC packet has an even number of bytes.

Table 1.4-1: TC Packet Header

1.5 TC Source Packet

PUS-151//

The TC source packets shall conform to the structure defined in [ND-113], except those addressed to the Command Pulse Distribution Unit (CPDU). Packets addressed to the CPDU do not contain a Packet Data Field Header.

TC Source Packet			
	Packet Data Field		
Packet Header	Data Field Header	Application Data > **Command Data** <	Packet Error Control (CRC)
6 byte	4 byte	variable length - 214 byte max.	2 byte

Figure 1.5-1: TC source packet

PUS-154//

The TC Packet Header shall be as showed below:

Packet Header							
Packet ID					Packet Sequence Control		Pkt Length
Version (=000)	Type (=1)	DFH Flag	APID		Sequence Flags (=11)	Sequence Count	Packet Data Field Length
			PRID	PCAT			
3	1	1	7	4	2	14	16
2 byte					2 byte		2 byte

Figure 1.5-2: TC source packet Header

Parameter		Description	Range or value
Version Number	MSB b_0-b_2	CCSDS Version Number	Must be set to 0 for all commands
Type	b_3	Packet type (0 = telemetry, 1 = telecommand)	Must be set to 1 for all telecommands

Parameter			Description	Range or value
Data Field Header Flag		b_4	Indicates the presence of a data field header (when set to 1)	0: No secondary header present 1: secondary header present Note: for MAP ID 0 the secondary header flag shall be 0; for all other MAP IDs the secondary header flag shall be 1
APID	*PRID*	b_5-b_{11}	Process ID (part of the APID)	Must be set to a value according to the PRID Table in volume B of this document
	PCAT	b_{12}-b_{15}	Packet category	Must be set to 12 (this is the only packet category for telecommands)
Sequence Flag		b_{16}-b_{17}		Must be set to 11 bin (stand alone TC packet)
Sequence Count		b_{18}-b_{31}	Wrap around counter (per APID)	0 to 2^{14}-1, Note: No TC is rejected due to SSC discontinuity
Packet Length		b_{32}-b_{47}	Number of bytes contained in the packet data field minus 1	See Note 1)

Table 1.5-1: TC Packet Header

Note 1)

Max. 219 bytes ⌠ (header 4 bytes, application data 214 bytes, packet error control 2 bytes) minus 1

1.6 TC Packet Data Field Header

PUS-208//

The TC Data Field Header shall conform to the structure as defined in [ND-154]. The structure is shown here below.

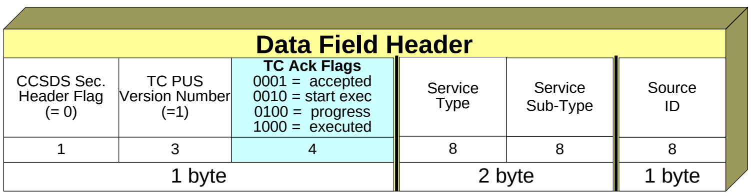


Figure 1.6-1: TC Packet Data Field Header

Parameter	Description	Range or value
CCSDS Secondary Header Flag	As required by CCSDS 203.1 -- B -- 1	Must be set to 0 (for non-CCSDS defined secondary header)
TC PUS Version Number		1
Acceptance	Indicates if acknowledgement is required for TC acceptance	0 = acceptance report (TM(1,1)) not requested 1 = acceptance report (TM(1,1)) requested
Start of Execution	Indicates if acknowledgement is required for TC Start of Execution	Not supported. Note: The flag can have any value [0,1] it will be ignored
Progress of Execution	Indicates if acknowledgement is required for TC Progress of Execution	Not supported. Note: The flag can have any value [0,1] it will be ignored
Execution Completion	Indicates if acknowledgement is required after TC Execution Completion	0 = completion report (TM(1,7)) not requested 1 = completion report (TM(1,7)) requested
Service Type	Indicates the service to which the packet relates	Defined in each "Structure" Definition in the Service chapters
Service Subtype	Indicates the service subtype to which the packet relates	Defined in each "Structure" Definition in the Service chapters
Source ID	Identification of the command source issuing the TC packet	See Volume B.
TC Packet Error Control	Provides frame error control information (CRC)	CRC over complete packet (as specified in [ND-112])

Table 1.6-1: TC Packet Data Field Header

PUS-257//

The two ACK flags to be used shall be usable in any combination, i.e. 0000 bin, 0001 bin, 1000 bin, 1001 bin. etc.

1.7 Eligibility for Nested Telecommands

From the packet sizes and header layouts detailed in this section it can be seen that the maximum size of a Telecommand Application Data area plus data field header is given as **218** bytes.

However, this only applies to a generic packet. The standard implements Services 11, 18, 19 and 151 which all have the ability to contain a full telecommand packet within their packet structure as Application Data.

In effect this allows nesting of telecommands and so introduces some additional constraints, both operational and physical, in terms of a reduced Application Data area.

The operational constraints are required to prevent recursive nesting of telecommands and are in the form of a set of rules stating what telecommands may be contained within the four Services mentioned.

	Containing		
TC	**(11,4)** (151,4)	(19,1)	**All other**
(11,4)		Y	Y
(151,4)		Y	Y
(148,128)			Y
(19,1)			Y

Table 1.7-1: Eligibility for Nested Commands

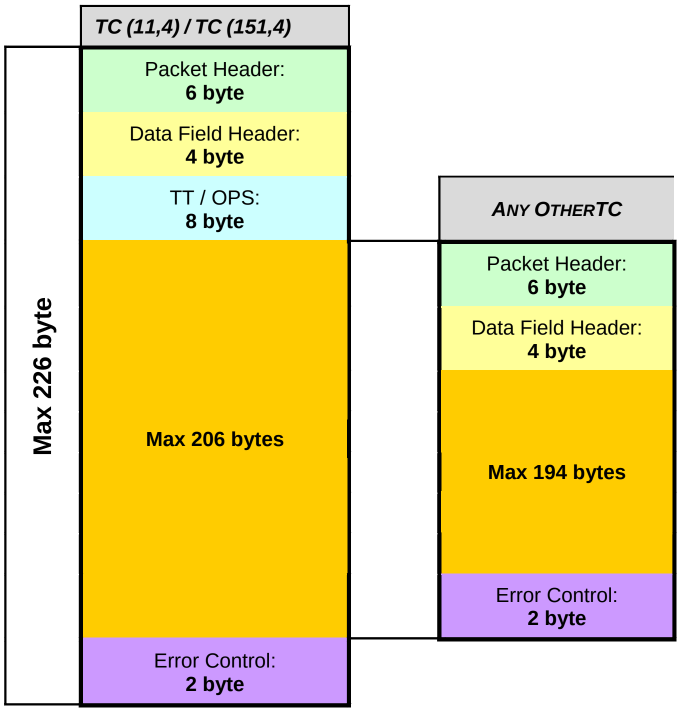


Figure 1.7-1: Worst Case Nested Telecommands Packet Size

Note:

For TC's embedded in TC(148,128) and TC(19,1) additional length constraints do apply in case these TC's would be sent time tagged.

2 TELEMETRY STRUCTURE

This chapter describes the telemetry structures to be used for the AstroBUS-L Platform.

The information given in this chapter shall not be referenced from elsewhere.

2.1 TM Transfer Frame (S-Band)

PUS-305//

The CADU structure shall be as showed below:

CADU		
Attached Sync. Marker 1ACFFC1D	Reed-Solomon Codeblock	
	Data Space	Check Symbols
32 bits	8920 bits	1280 bits
4 byte	1275 byte = 1115 byte + 160 byte	

Figure 2.1-1: CADU (S-Band)

PUS-308//

The TM Transfer Frame structure shall be as showed below:

TM Transfer Frame		
Frame Header	Frame Data Field	Frame Trailer
6 byte	1103 byte	6 byte

Figure 2.1-2: TM Transfer Frame (S-Band)

PUS-311//

The Frame Header shall be as showed below:

Frame Header											
	Frame Identification						Frame Data Field Status				
Version (=00)	Spacecraft ID	Virtual Channel Id	Op Ctrl Flag	Master Channel Frame Count	Virtual Channel Frame Count	SH Flag (=0)	Sync Flag (=0)	Pkt Order Flag (=0)	Segment Length ID (=11)	First Header Pointer
2	10	3	1			1	1	1	2	11
2 byte				1 byte	1 byte	2 byte				

Figure 2.1-3: TM Transfer Frame Header

Parameter	Description	Range or value
Version	Transfer Frame Version Number	"00"

Parameter	Description	Range or value
Spacecraft ID	These ten bits carry the identification code for the spacecraft itself or for the physical link uset to transmit the transfer frame. The Secretariat of the CCSDS assigns the SPACECRAFT IDENTIFIER to each vehicle within a particular mission	Refer to Spacecraft ID Table in Volume B
Virtual Channel ID	VC Id Identifier used to address a single physical channel to be logically multiplexed on a frame-by-frame basis.	VC0 to VC7
Operational Control Flag	Indicates the presence or absence of the OPERATIONAL CONTROL FIELD.	**0** : OPERATIONAL CONTROL FIELD **NOT** present; **1** : OPERATIONAL CONTROL FIELD present This is the project default
Master Channel Frame Count	Contains an 8-bit sequential counter (Modulo 256) of each transfer frame transmitted. The counter must be left frree-running, that is, it shall not be short-cycled.	
Virtual Channel Frame Count	Contains an 8-bit sequential counter (Modulo 256) of each transfer frame transmitted through a specific virtual channel. The counter must be left frree-running, that is, it shall not be short-cycled.	
Secondary Header Flag	contains the TRANSFER FRAME SECONDARY HEADER FLAG	**0** : SECONDARY HEADER **NOT** present **1** : SECONDARY HEADER present
Sync Flag	signals the type of data which are inserted into the TRANSFER FRAME DATA FIELD.	**0** : byte synchronised and forwarded SOURCE PACKETs or idle data **1** : PRIVATELY DEFINED DATA
Packet Order Flag	In conjunction with *Sync Flag* , Reserved for future use	Always "0"

Parameter	Description	Range or value
Segment Length Id	In conjunction with *Sync Flag*	**"11"** : if *Sync Flag = 0* **Undefined:** if Sync Flag = 1
First Header Pointer	If the *SYNC FLAG* is set to "0", the FIRST HEADER POINTER shall contain information on the position of the first SOURCE PACKET within the TRANSFER FRAME DATA FIELD.	**"11111111111":** no PACKET PRIMARY HEADER starts in the TRANSFER FRAME DATA FIELD **"11111111110":** TRANSFER FRAME DATA FIELD contains idle data any other value between 0 and 1102 indicates the start address of a new source packet
Operational Control Field Data	See Figure 2.1-4 (TM Transfer Frame Trailer (S-Band))	
TM Frame Error Control	Provides frame error control information (CRC)	CRC over complete Frame (as specified in [ND-112])

Table 2.1-1: TM Transfer Frame Structure (S-Band)

PUS-372//

The Transfer Frame Trailer shall be as showed below:

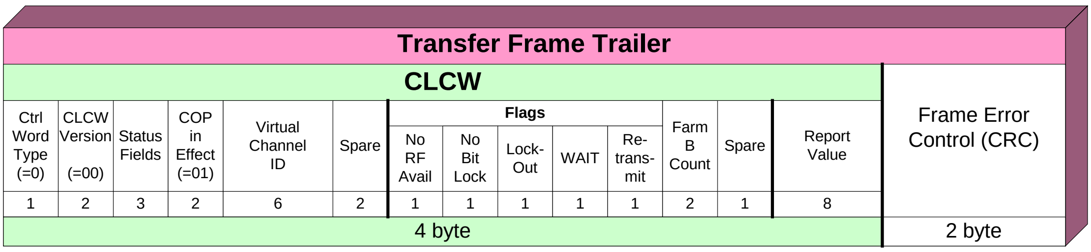


Figure 2.1-4: TM Transfer Frame Trailer (S-Band)

Field		Size and Meaning	Fixed
CWT	MSB b_0	1-bit ,**Control Word Type** specifies that the structure is a CLCW	0b
VN	b_1-b_2	2-bit field ,**Version Number**, reserved by CCSDS	00b
SF	b_3-b_5	3-bit field, **Status Field**, reserved by CCSDS	000b
COP	b_6-b_7	2-bit field, **COP in Effect** is used to indicate which of the CCSDS-defined COP (Command Operation Procedure) is in use, in this standard only COP-1 is specified, which corresponds to COP=**01**	01b
VCID	b_8-b_{13}	6-bit field, **Virtual Channel Identifier** contains the TC Virtual Channel number. Only the 3 least bits (b_{20}-b_{18}) are used for coding.	-

Field		Size and Meaning	Fixed
RES	b_{14}-b_{15}	2-bit field, **Reserved Field** and is set to **00**	00
NRFF	b_{16}	1-bit , **No RF Available Flag** represents the status of RF system, which corresponds to NRFF=**1** (RF not available) and NRFF=**0** (RF available)	-
NBLF	b_{17}	1-bit, **No Bit Lock Flag** monitors the presence of the S/C demodulation, if NBLF=**1** all TC Active Signals (0 to 5) are zero at the PTD inout pins, and if NBLF=**0** one of the TC Active signals is set to 1	-
LOF	b_{18}	1-bit, **LockOut Flag** indicates, if LOF=1 , that the FARM-1 is in the „Lockout" state	-
WF	b_{19}	1-bit, **Wait Flag** indicates, if WF=1 , that the FARM-1 is in the „Wait" state	-
RTMF	b_{20}	1-bit, **Retransmit Flag** indicates, if RTMF =1 , that a frame was lost in transmission or has been discarded because there was no buffer space available	-
FBC	b_{21}-b_{22}	2-bit field, **FARM-B Counter** field contains a wraparound up-counter (modulo 4) of each TC frame of type BC or BD	-
REPT	b_{23}	1-bit, **Report Type** is always set to REPT=**0**	0b
REPV	b_{24}-b_{31}	8-bit field, **Report Value** field is maintained by the FARM-1 and contains the next expected frame sequence number V(R)	-
TM Frame Error Control		Provides frame error control information (CRC) (as specified in [ND-112])	

Table 2.1-2: CLCW parameters

2.2 TM Transfer Frame (X-Band)

Moved to annex B.

2.3 Idle TM Frames (S-Band)

Whenever there is not enough data in the external buffer memory of the major frame building HW Idle Transfer Frames will be generated. An Idle Transfer Frame is treated as a normal telemetry transfer frame as defined in the previous section.

As given in Table 2.1-1 it is distinguished by its First Header Pointer value.

•The first header pointer value of Idle Transfer Frames is $111\_1111\_1110_{bin}$.

•A dedicated virtual channel is allocated for Idle Frames. The Virtual Channel ID for an Idle Transfer Frame is 111bin = 7 dec.

The Frame Generator will generate the correct flags and counter values, and provide a fill pattern for the Data Field. The fill pattern of the frame data field is generated by a pseudo-randomiser with the generator polynomial $x^9 + x^4 + 1$.

The randomiser is only active when the Data Field of an Idle Telemetry Frame is being output and it is systematically preset when VC Frame Counter value is zero. This ensures that the pseudo-random pattern generation is deterministic.

2.4 TM Source Packet (S-Band)

PUS-460//

Telemetry source packets shall conform to the structure defined in [ND-104] except Time, High Priority and Idle Packets. The structure is shown here below.

TM Source Packet			
Packet Header	Packet Data Field		
	Data Field Header	Source Data > **Telemetry Data** <	Packet Error Control (CRC)
6 byte	12 byte	variable length	2 byte
65536 + 6 Byte max.			

Figure 2.4-1: TM Source Packet

PUS-463//

The Packet Header shall be as showed below:

Packet Header								
Packet ID					Packet Sequence Control		Pkt Length	
Version (=000)	Type (=0)	DFH Flag	APID		Grouping Flags	Sequence Count	Packet Data Field Length	
			PRID	PCAT				
3	1	1	7	4	2	14	16	
2 byte					2 byte		2 byte	

Figure 2.4-2: TM Source Packet Header

Parameter	Description	Range or value
Version Number	CCSDS Version Number	Must be set to 0 for all TM source packets
Type	Packet type (0 = telemetry, 1 = telecommand)	Must be set to 0 for all TM source packets
Data Field Header Flag	Indicates the presence of a secondary (data field) header (when set to 1)	Must be set to 1 for all TM source packets, Exceptions: must be set to 0 for Time Packets, HPTM Packets and Idle Packets
PRID	Process ID (part of the APID)	Must be set to a value according to the PRID Table in Volume B

Parameter	Description	Range or value
PCAT	Packet category	Must be set to a value according to the PRID Table in Volume B
Grouping Flags	Indicates the grouping of TM source packets	- 01 bin first packet of a group of packets - 00 bin continuation packet - 10 bin last packet of a group of packets - 11 bin Standalone (default for HPTM) Note: all TM packets are Standalone (i.e. no segmentation allowed)
Source Sequence Count	Wrap around counter used to count each TM packet from a certain *APID.* For each *APID* a separate *Sequence Counter* is maintained.	Must be set to 0 for first packet, increments up to 214-1, wrap around to 0
Packet Length	Number of bytes contained in the packet data field minus 1 (even **and** odd values are allowed)	The max. number contained in the packet data field is project dependent (see Note 1)
Source Data	This field contains the data of the TM source packet.	
TM Packet Error Control	Provides packet error control information (CRC)	CRC over complete packet (as specified in [ND-112])

Table 2.4-1: TM Source Packet

Note 1)

For **S-Band**: **1 .. 2047**

For **X-Band**: **1 .. 65535**

2.4.1 Bandwidth adjustment

The goal of bandwith adjustment is to control the data flow of on-request TM report packets potentially producing a data flow burst. The concept shall be applied to TM packets which embedd to repeated group parameters potentially allowing to produce large data amounts. The purpose is to avoid instantaeous as well as long term flooding of the data transfer links by large and/or too many TM packets. Therefore those sub-services which might generate large amount of data shall be limited according to the following bandwidth adjustment concept:

- Each *PRID* maintains a global parameter called *Maximum Transmission Unit* called *MTU.*
- The *MTU* is the maximum amount of bytes allowed for the *Source Data Field* within one *Packet Data Field.*
- Only one TM packet per second shall be allowed/generated per sub-service
- The TM packet content shall be aligned to logical data structures, wherever possible
- This mechanism shall be applicable **only for selected** TM sub-services which are marked accordingly.
- The global parameter *MTU* can be adjusted by means of Service TC(140,1 (Set N parameter)
- In case a new TC is received requesting the generation of TM packets for a subservice which is still on-going from a previous received TC, this on-going TM generation process shall be terminated, a TM(1,8) to the original request shall be sent and the generation of the requested TM sub-service shall be started with the new parameter values (if any). For potential long duration commands this allows to abort their execution by sending a new request with modified parameter settings.

Note: in case the MTU value is modified while the PRID is reporting a group of packets subject to the MTU limitation there is no interruption of the report. The updated value of the MTU will become effective only at start of the next TC request of report.

- If a TM packet is split the *Grouping Flags* shall be set accordingly albeit only indicating that these packets have been subject to MTU Limitation. The packets themselves are complete stand-alone packets.
- TC's generating bandwidth limited TM packets are execution acknowledged after successful completion of the TM generation process. TM(1,7), if requested by TC ACK flag settings of the originating TC, is generated after the last TM of the actual request.
- The min/Max values for the MTU are given by the TM packet definition in 2.4.

Those TM packets for which this function shall be applicable are marked with:

> "Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfil the request. The bandwidth adjustment mechanism is applicable for this TM."

The TM service sub-types affected by the bandwidth adjustment mechanism are listed below together with the TC service sub-types which shall abort the on-going TM generation process upon arrival of another TC requesting the generation of the same type and subtype TM packets.

The following TM sub-services will make use of this feature:

Service ID	List of MTU affected TM packets	TC superseeding previous request
Service 2	TM(2,133)	N/A
Service 3	TM(3,10)*, TM(3,12)*, TM(3,129)*	TC (3,9)*, TC(3,11)*,TC(3,128)*, TC(3,131)*
Service 5	TM(5,132)*, TM(5,134)	TC(5,133)

Service ID	List of MTU affected TM packets	TC superseeding previous request
Service 6	TM(6,6)	TC(6,5)
Service 8	TM(8,145)	TC(8,144)
Service 11	TM(11,10); TM(11,13)	TC(11,9);TC(11,11);TC(11,12);TC(11,14)
Service 12	TM(12,9); TM(12,11)	TC(12,8); TC(12,10)
Service 14	TM(14,8); TM(14,12); TM(14,129); TM(14,131)	TC(14,7), TC(14,11); TC(14,128); TC(14,130)
Service 15	TM(15,146)	TC(15,145)
Service 19	TM(19,7)	TC(19,6)
Service 140	TM(140,3)	TC(140,2)
Service 142	TM(142,9) TM(142,11)	TC(142,8), TC(142,10)
Service 148	TM(148,9); TM(148,11); TM(148,131)	TC(148,10); TC(148,8); TC(148,130)
Service 149	TM(149,5); TM(149,8)	TC(149,4), TC(149,7)
Service 151	TM(151,10); TM(151,13)	TC(151,9);TC(151,11);TC(151,12);TC(151, 14)

Table 2.4-2: Sub-Services with bandwidth limitation

*) applicable for CSW only.

Example:

At T_0 the Ground sends TC(11,9) "Report Subset of Command Schedule in Detailed Form", it is assumed that at least 3 TM(11,10) packets are needed to fulfil the request.

The OBC accepts the TC and generates TM(1,1)

The OBC generates the first TM(11,10), with grouping flags set to 01_{bin}.

Cycle T_0+1s starts

The OBC generates the 2nd TM(11,10), with grouping flags set to 00_{bin}.

Cycle T_0+2s starts

The Ground sends another TC(11,9), superseding the previous one

The OBC accepts the new TC and generates TM(1,1)

The OBC generates TM(1,8), to indicate the cancellation of the old request.

The OBC generates the first TM(11,10) of the new request, with grouping flags set to 01_{bin}.

Cycle T_0+3s starts

The OBC generates the 2nd TM(11,10), with grouping flags set to 00_{bin}.

Cycle T_0+4s starts

The OBC generates the last TM(11,10), with grouping flags set to 10_{bin}.

The OBC reports "execution success" for the new TC and generates TM(1,7)

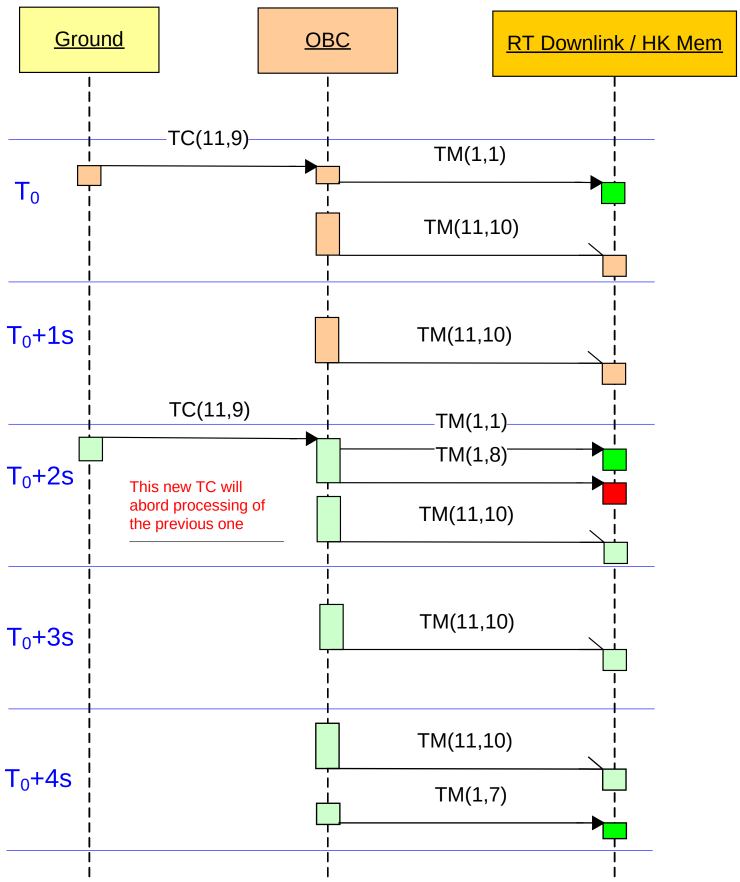


Figure 2.4-3: TM Handling with Bandwidth limitation

2.4.2 TM Packet Secondary (Data Field) Header

PUS-584//

The TM Packet Data Field Header shall conform to the structure defined in [ND-154]. The structure is shown here below.

Data Field Header								
						Time (CUC format)		
Filler (=0)	PUS Version Number (=001)	Filler (=0)	Service Type	Service Sub-Type	Destination ID	T-Field (Coarse Time)	T-Field (Fine Time)	Synch/ Time Quality
1	3	4	8	8	8	32	24	8
1 byte			2 byte		1 byte	8 byte		

Figure 2.4-4: TM Packet Data Field Header

Parameter	Description	Range or value

Parameter	Description	Range or value
Spare 1	Not used	Must be set to 0 for all TM source packets
TM Source Packet PUS Version Number		Must be 1 for EGSE C&C is no restriction.
Spare 2	Filler to complete the byte	Must be set to 0 for all TM source packets
Service Type	Indicates the service to which the packet relates	Defined in each "Structure" Definition in the Service chapters
Service Subtype	Indicates the service subtype to which the packet relates	Defined in each "Structure" Definition in the Service chapters
Destination ID	Indicates the destination of the packet	Solicited = *Source ID* of related TC Unsolicited = GROUND If a TM packet has been generated automatically, i.e. not on specific TC request, its *Source Id* shall be set to 0 (GROUND) See Volume B.
Time	Onboard time (OBT)	For structure and range see Table 4.8-14 **(Parameters of the Source data for** TM(9,2))
Sync Time Quality	OBT status flag	For structure and range see Table 4.8-14 (**Parameters of the Source data for** TM(9,2))

Table 2.4-3: TM Packet Data Field Header.

2.5 Time Source Packet

Refer to Section 4.8.2 **(TM(9, 2): Time/OP Report**).

2.6 Idle Source Packet

Idle Source Packets are used to fill transfer frames in case a transfer frame has to be submitted and the presently available source packets do not yet complete the transfer frame. The length of idle source packets is fixed. The structure of the idle source packet is shown here below.

Packet Header	Packet Data Field
6 bytes	See Note 1)

Figure 2.6-1: Idle Source Packet

Note 1)

The length is fixed to 8 bytes.

The Packet Header structure is identical for all TM Source Packets. The details are defined in Section 2.4

For parameters of the Packet Header not listed here below see Section 2.4

Parameter	Description	Range or value
Data Field Header Flag	Indicates the presence of a data field header (when set to 1)	Must be set to 0
PRID	Process ID (part of the APID)	Must be set to 1111111 bin
PCAT	Packet category	Must be set to 1111 bin
Packet Data Field	Fixed length	See Note 1)

Table 2.6-1: Idle Source Packet

Note 1)

Pseudo Random Data (as per GS2.TN.RSE.OBC.00015 "OBC User Manual")

2.7 High Priority Packets

The HPTM packet structure is identical to the one described in Section 2.4, but HPTM packet will have neither a Data Field Header nor a Packet Error Control field. The detailed format description is part of volume B.

3 DEFINITION OF PUS SERVICES

3.1 Applicability Matrix

Service Type	Name	Applicability
1	Service 1: Telecommand Verification	Basic
2	Service 2: Device Command Distribution	Specific
3	Service 3: Housekeeping and Diagnostic Data Reporting	Basic
4	Service 4: Parameter Statistics Reporting	Specific
5	Service 5: Event Reporting	Basic
6	Service 6: Memory Management	Specific
7	Not used	
8	Service 8: Function Management	Basic
9	Service 9: Time Management	Specific
10	Not used	
11	Service 11: On Board Operations Scheduling	Specific
12	Service 12: On Board Parameter Monitoring	Specific
13	Service 13: Large Data Transfer	Specific
14	Service 14: Packet Forwarding Control	Specific
15	Service 15: On Board Storage and Retrieval	Specific
16	Not used	
17	Service 17: Test	Basic
18	Service 18: On Board Operations Procedures	Specific
19	Service 19: Event/Action	Specific
140	Service 140: Parameter Management	Basic
142	Service 142: Functional Monitoring	Specific
145	Service 145: S/C State vector Management	Specific
148	Service 148 : On-board Macro Procedures	Specific
149	Service 149: Thermal Control	Specific
151	Service 151: Orbit Position Schedule (OPS)	Specific
152	Service 152: TC File Management	Specific

Table 3.1-1: Applicability of PUS Services (Overview)

The column “Applicability” in the table above shall be interpreted as follows:

- All services marked with *“Basic”* will be supported by all on-board packet terminals;
- i.e. by all PRID's.
- All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

3.2 Deviations from the Standard ECSS-E-70-41A

The following services deviate from the standard:

Service 2:

Deviation:

The minimum capability set required in ECSS-E-70-41 (Low Level ON/OFF Switching & Register Access) is provided by private service sub-type allowing to abstract the HW architecture by provision of access to the low level IO interface for corresponding activities.

Service (2,3) is extended to provide access to the sub-set of CPDU commands accessible via on-board SW.

Affected sub-services: 1,2,3

Justification:

The ECSS-E-70-41 standard identifies service (2,1) and Service (2,2) as minimum service capability. However these services do have a specific HW architecture as background, which supports low level commanding via register address settings. This HW architecture is not used in the mission. The minimum service capability is provided by private service sub-types.

The extension of service (2,3) is justified by the fact that direct HW decoded CPDU Commands are pure CCSDS TC source packets, which do not have a secondary TC header and thus do not carry service type/sub-type information. These CPDU commands are handled according to the dedicated chapter of this document

Service 11:

Deviation:

In case sub-schedules are supported the ECSS-E-70-41 PUS standard requires management of process ID as a child / sub-group of the sub-schedule. Within this tailored PUS sub-schedule and process ID is treated on the same level, i.e. the settings for one process ID is valid in all sub-schedules.

Affected sub-services: 6,8, 9, 10, 11, 13, 14, 17 and 19

Justification:

Customer request to support simplified operations

Service 12:

Deviation:

The PUS standard requires a parameter ID to define a monitoring on a certain parameter. In deviation to this approach an addition key called monitoring ID has been added to allow identification a one certain monitoring specification.

Affected sub-services: 1,2,5,6,7, 9 and 11

Justification:

The PUS-standard uses the parameter ID to control the monitoring of a parameter. In deviation from the standard, the project uses the monitoring ID to control the different monitoring. This approach helps to reduce the complexity of this service, for both the ASW and the operations:

With the current implementation, an identification (monitoring id) is assigned to each parameter check, so the ASW can autonomously update the list of checks to be applied using only the validity parameter (no need of additional level of control like the check selection parameter of the ECSS version) and the ground keeps full control by enabling/disabling checks individually (in ECSS version, ground can only enable or disable all checks related to one parameter).

Service 14:

Deviation:

The service implementation is based on routing tables requiring only the knowledge of deviations from default settings of the next higher level defaults. If all packets of one process ID are routed in the same default manner one entry is sufficient for the complete routing definition.

In addition in all report sub-types defined for the services, the additional parameter *FSTAT* is inserted which indicates the actual forwarding status of the associated TM source packet (enabled or disabled) on the different levels (PRID, SID, EID) as applicable for the report to be generated.

Affected sub-services: 8, 12, 128, 131

Justification:

The service 14 (and service 15 as well) offer to the operations a high flexibility for the control of the TM packets routing (using four levels from PRID/TYPE/SUBTYPE to SID/EID). To limit information redundancy and streamline the data handling the routing root is the application process ID (PRID) and not the complete APID as defined in the ECSS. packet forwarding and routing. The service implementation is based on a routing tree principle minimizing the dependencies of the routing service from a-priori knowledge of packets to be routed/forwarded. The routing definitions are based on a minimum of one default routing for all packets of each on-board PRID. In addition dedicated routing paths for packets identfied by above 4 criterias are possible to define, having on each level the capability to define a default for all lower level criterias. With the current approach, default routing rules can be defined in the Application SW providing this service based on simple criteria (e.g. PRID only) but full flexibility is granted to the ground to change it on the fly (e.g. to include only one particular Payload TM packet in one service 15 packet store or suppressing the forwarding of one particular EID to the ground).

Service 15:

Deviation:

The service implementation is based on routing and storage selection tables requiring only the knowledge of deviations from default settings of the next higher level defaults. If all packets of one process ID are routed in the same default manner one entry is sufficient for the complete routing definition.

For the report defined in ECSS-E-70-41- for services TM 15,6 (Storage Selection Report) additional parameters Store-Id are inserted for each level. The function of this service subtype is provided as private service sub-type TM(15,146) which is requested by private service sub-type TM(15,145) .

Justification:

See justification for service 14.

Service 18:

Deviation:

The OBCP function is provided as On-board macro procedure service 148.

Justification:

Service 148 implementation is strictly oriented towards an operational service to most effeciently support in-flight operations but also FDIR definition and functional verification as well as AIT. The advantage of the chosen approach is that there is a clear distinction between OBCP/OBMP's and on-board SW which makes the use of OBMP's more robust, while still a high degree of freedom for operational and FDIR detailed design is ensured as it relies on a composition of well verified and validated SW functions. The OBMP service embeds the capability to upload OBCPs from user to the on-board SW avoiding other mechanism or service.

3.3 Alignment Conventions

The following conventions have been applied for definition of the PUS data structures:

- Date types shall byte aligned
- The smallest data entity is 8 bit (1byte)
- Smaller data types will be right aligned
- filler bits are always set to zero
- The overall packet length can be odd or even number of bytes
- When used, deduced parameter shall be right aligned or purely deduced

Note: TC's with parameters of type deduced need to be imlemented in the database by parameter type specific TC instatiations.

4 DETAILED DEFINITIONS OF PUS SERVICES

4.1 Service 1: Telecommand Verification Service

Service Summary

Service, Subservic e	TM/TC	Description	Applicability
(1,1)	TM	Telecommand Acceptance Report - Success	Basic
(1,2)	TM	Telecommand Acceptance Report - Failure	Basic
(1,3)	TM	Telecommand Execution Started Report - Success	n/a
(1,4)	TM	Telecommand Execution Started Report - Failure	n/a
(1,5)	TM	Telecommand Execution Progress Report - Success	n/a
(1,6)	TM	Telecommand Execution Progress Report - Failure	n/a
(1,7)	TM	Telecommand Execution Completion Report - Success	Basic
(1,8)	TM	Telecommand Execution Completion Report - Failure	Basic

Table 4.1-1: Service 1 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with *“Basic”* will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Objective:

This service allows the command source to verify identified commands at acceptance and/or execution by asking the addressed application to generate service type 1 reports in the telemetry stream.

Description:

The command source can set two bits in the command packet header, one asks for an acceptance report; the other an execution report, the two bits can be set to any value. Application SW uses these bits to generate the required reports; No systematic on-board check is done on the report this may be done by the command sender if required. An acceptance report is generated immediately after completion of checks on validity of the packet header; an execution report after internal verification of TC execution. In case of TC acceptance or execution check failures only one TC acknowledge failure report packet will be generated reporting the first identified failure in below defined sequence of checks.

Service 1 is used to verify that the addressed application has received and executed the packet telecommand addressed to it. The type of response required is coded in the Acknowledge field contained in the telecommand packet header. The response required is restricted to:

No positive acceptance/execution response (acceptance / execution success acknowledge report not required, not applicable to acceptance and execution failure)

Acceptance Success or Failure (service report sub-type 1 or 2 required)

Execution Success or Failure (service report sub type 7 or 8 required)

The type of response required for each command depends on the function of the command and is coded with the command definition in the Spacecraft Data Base.

Notes:

PUS-875//

Each TC packet received shall be submitted to the Static Acceptance checks defined here below (independently from the ACK flags settings). In case any one of the following check fails the TC shall be rejected in total

Static Acceptance Checks (eventually issuing a Telecommand Acceptance Report):

Check the constant fields in the packet header (version number, type, data field header flag, and sequence flag) and data field header (PUS version)

Check the indicated length of the TC(5_{DEC} ≤ value of parameter "Packet Length" ≤ $MAX\_PCK\_LEN_{DEC}$)

Check the indicated length w.r.t. the number of received bytes (see note below)

- Compute packet error control word and check w.r.t. received packet error control word
- Check the *PRID* w.r.t. the assigned *PRID* number(s)
- Check the field *PCAT* (always 12 for TC)
- Check whether Service Type/Subtype is supported (result may depend from actual context e.g. unit mode or actually running software).

PUS-885//

Each TC packet received shall be submitted to the Execution Completion checks defined here below (independently from the ACK flags settings). In case any one of the following check fails the TC shall be rejected in total

Consistency Checks (eventually issuing a Telecommand Execution Completion Report):

- Check the actual TC length w.r.t. expected TC length associated with actual service type and service subtype.
- Check whether parameters included in the Application Data Field are within their defined range (specific for a Service type/subtype).

Notes: TC consistency checks shall only be performed after all static checks have been passed successfully. TC execution shall only start after all consistency checks have been passed successfully.

In addition to the consistency checks execution success checks (specific for a Service type/subtype, e.g. read back written data from H/W) may be performed, before eventually a Telecommand Execution Completion Report is issued.

TM(1,2) and TM(1,8) shall always be generated independent from the settings of the ACK flags.

For several reasons it might not be possible to detect an incorrect actual length. If no mechanism guarantees that only single TC packets are transmitted/processed, an incorrect actual length may appear as an incorrect checksum.

Explanation: Depends on HW/SW I/F, if TC's are received on-block without separation, there are errors possible which do not allow to determine the start of the packet correctly hence also the field interpretation may fail.

In case more than one independent parameter or parameter sets are supplied by a TC, the complete TC shall be rejected if there is an error on one or more of the parameter/parameter sets.

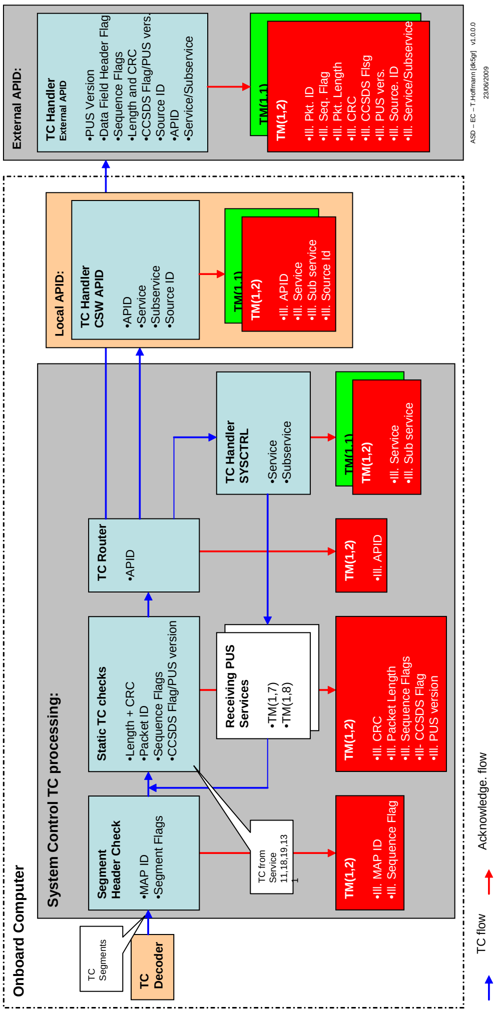


Figure 4.1-1: TC Acknowledge

4.1.1 TM(1,1) Telecommand Acceptance Report - Success

4.1.1.1 Description

This report shall be generated if the corresponding ACK flag was set in the TC. The report informs the TC source about the successful acceptance of the TC by the receiving onboard application (PRID).

4.1.1.2 Structure

PUS-902//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 1 (acknowledge)

Service Type : Must be set to 1

Service Subtype : Must be set to 1

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

TC Packet ID	TC Packet Sequence Control
Unsigned integer	Unsigned integer
2 bytes	2 bytes

Table 4.1-2: Structure of the Source data TM(1,1)

4.1.1.3 Parameter Definition & Range

PUS-920//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
TC Packet ID	This is a copy of the 16 bits of the TC Packet ID contained in the TC Packet Header	Identical to the value of the *Packet ID* parameter of the received TC
TC Packet Sequence Control	This is a copy of the 16 bits of the TC Packet Sequence Control contained in the TC Packet Header	Identical to the value of the *Packet Sequence Control* parameter of the received TC

Table 4.1-3: Parameters of the Source data for TM(1,1)

4.1.2 TM(1,2) Telecommand Acceptance Report - Failure

4.1.2.1 Description

This report shall be generated if the acceptance check of a TC failed. Each application process shall provide

TC acceptance failure report independent from the ACK flag settings.

The actual failure cause can be determined *by the FID* and the attached parameters. Dedicated details are given in the unit specific volumes of this documents.

4.1.2.2 Structure

PUS-940//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 1 (acknowledge)

Service Type : Must be set to 1

Service Subtype : Must be set to 2

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

TC Packet ID	TC Packet Sequence Control	Fault ID (FID)	Parameters
Unsigned integer	Unsigned integer	Unsigned integer	Any
2 bytes	2 bytes	2 bytes	variable

Table 4.1-4: Structure of the Source data TM(1,2)

4.1.2.3 Parameter Definition & Range

PUS-964//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
TC Packet ID	This is a copy of the 16 bits of the TC Packet ID contained in the TC Packet Header	Identical to the value of the Packet ID parameter of the received TC
TC Packet Sequence Control	This is a copy of the 16 bits of the TC Packet Sequence Control contained in the TC Packet Header	Identical to the value of the Packet Sequence Control parameter of the received TC
FID	Fault Identification Code	See Volume B
Parameters	Complementary information	See Volume B

Table 4.1-5: Parameters of the Source data for TM(1,2)

4.1.3 TM(1,7) Telecommand Execution Completion Report - Success

4.1.3.1 Description

This report shall be generated if the corresponding ACK flag was set in the TC. The report informs the TC source about the successful completion of the TC by the receiving onboard application (PRID)

4.1.3.2 Structure

PUS-991//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 1 (acknowledge)

Service Type : Must be set to 1

Service Subtype : Must be set to 7

The structure of the *Source Data* field within the TM *Packet Data Field* is identical with the one specified for the service TM(1,1). See Table 4.1-2 (Structure of the Source data TM(1,1))

4.1.4 TM(1,8) Telecommand Execution Completion Report - Failure

4.1.4.1 Description

This report shall be generated if the execution of a TC failed. Each application process shall provide TC execution failure report independent from the ACK flag settings.

4.1.4.2 Structure

PUS-1001//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 1 (acknowledge)

Service Type : Must be set to 1

Service Subtype : Must be set to 8

The structure of the *Source Data* field within the TM *Packet Data Field* is identical with the one defined for the service TM(1,2). See Table 4.1-4 (Structure of the Source data TM(1,2))

4.2 Service 2: Device Command Distribution Service

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(2,1)	TC	Distribute ON/OFF Commands (HPC1)	n/a
(2,2)	TC	Distribute Register Load Commands	Specific
(2,3)	TC	Distribute CPDU Commands (HPC3)	Specific

Service, Subservice	TM/TC	Description	Applicability
(2,128)	TC	Distribute MIL-1553 Low-Level Command	Specific
(2,129)	TM	MIL-1553 Low-Level Command Response	Specific
(2,132)	TC	Direct I/O	Specific
(2,133)	TM	Direct I/O response	Specific

Table 4.2-1: Service 2 sub-services

The column "Applicability" in the table above shall be interpreted as follows:

•All services marked with *"Basic"* will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *"Specific"* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Objectives

The device command distribution service provides the capability for the distribution of:

- Command Pulse Distribution Unit (CPDU) commands for reconfiguration of vital unit functions.
- 1553 bus command messages
- The service will provide a simple interface to the API software for debug and checkout purposes

Note: Service TC(2,1) will serve as a placeholder for so called MAP_ID 0 commands, which are executed directly by the TC decoder.These commands have a non PUS structure.

4.2.1 TC(2,2): Distribute register load commands

4.2.1.1 Description

TC(2,2) request for the distribution of register load commands.

Note: Access to internal OBC registers will be provided via TC(2,132) using the HDSW I/O driver interface.

4.2.1.2 Structure

PUS-1079//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 2

Service Subtype : Must be set to 2

The structure of the *Application Data* field within the *TM Packet Data* field is defined here below.

N	Filler	Register Address	Register Data
Unsigned integer		Unsigned integer	Unsigned integer
1 byte	5 bits	3 bits	2 byte
	<----- Repeat N times ------>		

Table 4.2-2: Structure of the Application data TC(2,2)

4.2.1.3 Parameter Definition & Range

PUS-1099//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N	The number of Register Load commands to follow	0 ......N_MAX[1)]
Address	The HW Address to which the ON-OFF command shall be routed	
Register Data	register data value	0 ... 2^{16}-1

Table 4.2-3: Parameters of the Application Data for TC(2,2)

Note 1)

N_MAX = 64 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.2.1.4 TC Verification

PUS-1115//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-1117//

TM(1,8): TC Execution Completion Report - Failure shall be generated

- if one of the consistency checks according to Section 4.1 failed

4.2.2 TC(2,3): Distribute CPDU commands

4.2.2.1 Description

TC(2,3) provides the capability to address each CPDU. In that case, the TC decoder routes the telecommand to the Central Software.

Deleted.

4.2.2.2 Structure

PUS-1124//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 2

Service Subtype : Must be set to 3

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

CommandNo	Filler	PulseLength
Enumerated		Unsigned integer
1 byte	5bit	3bit

Table 4.2-4: Structure of the Application data TC(2,3)

4.2.2.3 Parameter Definition & Range

PUS-1146//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
CommandNo	Number of CPDU command	See relevant unit ICDs
PulseLength	Pulse length (3 bits) determines the length of the CPDU pulse.	See relevant unit ICDs

Table 4.2-5: Parameters of the Application Data for TC(2,3)

4.2.2.4 TC Verification

PUS-1162//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-1164//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if the *CommandNo* is not in the allowed range

4.2.3 TC(2,128): Distribute MIL-1553 Low-Level Command

4.2.3.1 Description

This command allows issuing a low level mil-bus command on the OBC MIL-Bus. It will be used for troubleshooting purposes only.

4.2.3.2 Structure

PUS-1172//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 2

Service Subtype : Must be set to 128

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

BUS	***BUSCOUPLER***	***N***	***RT ADDRESS***	***RECEIVE BIT***	***SA / MODE FIELD***	***DATA WORD COUNT / MODE CODE***	***M***	***DATA WORDS***
Enumerated	Enumerated	Unsigned Integer	Unsigned integer	Boolean	Unsigned integer	Unsigned Integer	Unsigned Integer	Unsigned integer
1 byte	1 byte	1 byte	5 bit	1 bit	5 bits	5 bits	1 byte	2 bytes
			1553 command word					← *M* times →
			← *N* times →					

Table 4.2-6: Structure of the Application data TC(2,128)

4.2.3.3 Parameter Definition & Range

PUS-1180//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Bus	Identifier for the addressed MIL-BUS;	Platform Bus = 0b Payload Bus = 1b
BusCoupler	Selected Bus Coupler for the selected bus	MIL-Bus A = 01b MIL-BUS B = 10b

Parameters of Application Data Field	Description	Range or value
N	Number of command words to follow	1.... N_MAX[1)]
RT Address	The MIL-Bus terminal address / sub-address where the command shall be sent to	
Receive Bit	Flag indicating the remote terminal RT to receive or transmit a message:	0=RT to receive; 1=RT to transmit
SA / Mode Field	Used for RT Subaddress or identification of Mode Commands	
Data Word Count / Mode Code	Number of Data Words to be either received or sent out or the Mode Code	00000b or 11111b identifies mode code.
M	M-Count: number of repeated Data Word(s) field(s),	if no data words: M = 0 the value of *M* is equal to the value of '*Data Word Count*' except *M* = 32 when 'Data Word Count'=0.
Data Words	The data words of the mil-bus message	

Table 4.2-7: Parameters of the Application Data for TC(2,128)

Note 1)

N_MAX =

4.2.3.4 TC Verification

PUS-1225//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-1228//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•In case of I/O error on Mil-bus command execution

4.2.3.5 Remarks

Operational Constraint:

A new TC(2,128) must be uplinked only after the TC acknowledge for the previous TC has been produced.

4.2.4 TM(2,129): MIL-1553 Low-Level Command Response

4.2.4.1 Description

TM(2,129) is the response to TC(2,128).

4.2.4.2 Structure

PUS-1237//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 1(acknowledge)

Service Type : Must be set to 2

Service Subtype : Must be set to 129

The structure of the *Source Data* field within the TM Packet Data field is defined here below.

BUS	MIL- 1553 Command Word	BUS Coupler	BCStatus Word	RTStatus Word	N	Data Words
Enumerated	Unsigned integer	Enumerated	Unsigned integer	Unsigned integer	Unsigned integer	Unsigned integer
1 byte	2 byte	1 byte	2 byte	2 byte	1 bytes	2 bytes
						< -- repeat *N* times -- >

Table 4.2-8: Structure of the Source data TM(2,129)

4.2.4.3 Parameter Definition & Range

PUS-1273//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
Bus	Identifier for the addressed MIL-BUS;	Platform Bus = 0b Payload Bus = 1b
MIL-1553 Command Word	Command word sent by the BC comprising: •RT ADDRESS •RECEIVE BIT •SA/MODE FIELD •DATA WORD COUNT/MODE COUNT	

Parameters of Source Data Field	Description	Range or value
BusCoupler	Selected Bus Coupler for the selected bus	MIL-Bus A = 01b MIL-BUS B = 10b
BC Status Word	Status Word (BC)	Note: Provision and content of the BC status word is not in scope of the MIL-1553 standard, rather than depending on special controller implementations.
RT Status Word	Status Word (RT response)	Note: Provision and content of the BC status word is not in scope of the MIL-1553 standard, rather than depending on special controller implementations.
N	Number of received data words	0 … 32
Data Words	The data words of the mil-bus message	Data Words

Table 4.2-9: Parameters of the Source data for TM(2,129)

4.2.5 TC(2,130): Distribute SpW-1355 Low-Level Command

This service subtype is not applicable

4.2.6 TM(2,131): SpW-1355 Low-Level Command Reply

This service subtype is not applicable

4.2.7 TC(2,132): Direct I/O

4.2.7.1 Description

TC(2,132) is the direct interface to a units API driver software interface. It allows calling any function provided by the API without any restriction including data transfer via external interfaces. The ON-OFF commanding capability, usually provided by TC(2,1), is fully covered by this sub-service.

Since preconditions are not checked and constraints are not respected, the user is in charge to resolve possible conflicts caused by direct API access.

An API function is uniquely identified by its *Device*, *Channel* and *Command* Identifier. Details will be provided with the units ICD control document for API driver software. The IDs for the OBC will be given in volume B of this document.

Further, the TC structure provides 3 generic 4byte parameters, allowing passing function arguments, i.e. register values. If this is not sufficient, there can be a Data field attached, containing additional user data. Even complex structures can be passed to an API function using the scheme.

During execution of TC(2,132) the interface software will generate a unique *Request ID* (4byte wrap around counter). This *ID* will be used as identifier for the related response TM(2,133).

As response TM(2,133) will be generated.

4.2.7.2 Structure

PUS-1418//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 2

Service Subtype : Must be set to 132

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

Device	Channel	Command	Mode	Ipar[0]	Ipar[1]	Ipar[2]	DSize	Data
Uint8	Unit8	Unit8	Uint8	Uint32	Uint32	Uint32	Uint32	Uint8
1 byte	1 byte	1 byte	1 Byte	4 Byte	4 Byte	4 Byte	4 Byte	DSize Bytes
								<- DSize ->

Table 4.2-10: Structure of the Application data TC(2,132)

4.2.7.3 Parameter Definition & Range

PUS-1457//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Device	Device ID	No generic definition, details will be given in dediacted ICDs/UMs
Channel	Channel ID	No generic definition, details will be given in dediacted ICDs/UMs
Command	Command	No generic definition, details will be given in dediacted ICDs/UMs
Mode	Not used	Fixed to 1
IPAR[0,1,2]	IN parameter for the I/O Transfer	No generic definition, details will be given in dediacted ICDs/UMs
DSize	Size of Data Area	

Parameters of Application Data Field	Description	Range or value
Data	Data Area	No generic definition, details will be given in dediacted ICDs/UMs

Table 4.2-11: Parameters of the Application data for TC(2,132)

4.2.7.4 TC Verification

PUS-1493//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-1495//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

4.2.7.5 Remarks

Operational Constraint:

PUS-1499//

A new TC(2,132) shall be uplinked only after the TC acknowledge for the previous TC has been produced.

Note: TC(2,132) is considered to be successful after successful TC check and transfer to the I/O system. A full check needs to be performed on ground by evaluation of the TC response TM(2,133) !

4.2.8 TM(2,133): Direct I/O Response

4.2.8.1 Description

TM(2,133) is the response to TC(2,132).

4.2.8.2 Structure

PUS-1505//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 1(acknowledge)

Service Type : Must be set to 2

Service Subtype : Must be set to 133

The structure of the *Source Data* field within the TM Packet Data field is defined here below.

IOTdef	RequestId	Status	IO_Stat	Opar[0]	Opar[1]	Opar[2]	DSize	Data

IOTdef	RequestId	Status	IO_Stat	Opar[0]	Opar[1]	Opar[2]	DSize	Data
Uint32	Uni32	Unit32	Uint32	Uint32	Uint32	Uint32	Uint32	Uint8
4 bytes	4 bytes	4 bytes	4 Bytes	4 Byte	4 Byte	4 Byte	4 Byte	DSize Bytes

Table 4.2-12: Structure of the Source data TM(2,133)

4.2.8.3 Parameter Definition & Range

PUS-1544//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
IOTdef	Predefined value of an I/O-Transaction definition.	Any valid I/O Transaction definition.
RequestID	ID of the I/O transaction request	
Status	Return Status of the I/O transaction	0x00 = IO_SUCCESSFUL 0x06 = IO_TIMEOUT 0x1B = IO_IO_ERROR
Io_stat	Detailed error description	See Valume B
Opar[0,1,2]	This structure contains output data from the I/O transaction.	H/W depended, see related ICD's !
DSize	Size of Data Area	0 … [MAX]
data	If indicated by *out_para* this structure contains output data from the I/O transaction.	

Table 4.2-13: Parameters of the Source data for TM(2,133)

4.2.8.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfil the request. The bandwidth adjustment mechanism is applicable for this TM.

4.3 Service 3: Housekeeping and Diagnostic Data Reporting Service

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(3,1)	TC	Define new HK Parameter Report	Specific
(3,2)	TC	Define new Diagnostic Parameter Report	Specific
(3,3)	TC	Clear HK Parameter Report Definitions	Specific
(3,4)	TC	Clear Diagnostic Parameter Report Definitions	Specific
(3,5)	TC	Enable HK Parameter Report Generation	Basic
(3,6)	TC	Disable HK Parameter Report Generation	Basic
(3,7)	TC	Enable Diagnostic Parameter Report Generation	Specific
(3,8)	TC	Disable Diagnostic Parameter Report Generation	Specific
(3,9)	TC	Report HK Parameter Report Definitions	Basic
(3,10)	TM	HK Parameter Report Definitions Report	Basic
(3,11)	TC	Report Diagnostic Parameter Report Definitions	Specific
(3,12)	TM	Diagnostic Parameter Report Definitions Report	Specific
(3,13)	TC	Report HK Parameter Sampling-Time Offset	n/a
(3,14)	TC	Report Diagnostic Parameter Sampling-Time Offset	n/a
(3,15)	TM	HK Parameter Sampling-Time Offset Report	n/a
(3,16)	TM	Diagnostic Parameter Sampling-Time Offset Report	n/a
(3,17)	TC	Select Periodic HK Param. Report Generation Mode	n/a
(3,18)	TC	Select Periodic Diag. Param. Report Generation Mode	n/a
(3,19)	TC	Select Filtered HK Parameter Report Generation Mode	n/a
(3,20)	TC	Select Filtered Diag. Param. Report Generation Mode	n/a
(3,21)	TC	Report Unfiltered Housekeeping Parameters	n/a

Service, Subservice	TM/TC	Description	Applicability
(3,22)	TC	Report Unfiltered Diagnostic Parameters	n/a
(3,23)	TM	Unfiltered Housekeeping Parameters Report	n/a
(3,24)	TM	Unfiltered Diagnostic Parameters Report	n/a
(3,25)	TM	Housekeeping Parameter Report	Basic
(3,26)	TM	Diagnostic Parameter Report	Specific
(3,128)	TC	Report HK/Diag Parameter Report Definitions in Summary Form	Specific
(3,129)	TM	HK/Diag Parameter Report Definitions Report in Summary Form	Specific
(3,130)	TC	Define HK Parameter Report Collection Interval	Specific
(3,131)	TC	Define Diagnostic Parameter Report Collection Interval	Specific
(3,136)	TC	Request HK Parameter Report	Specific
(3,138)	TC	Add HK Parameters to existing HK Parameter Report	Specific
(3,139)	TC	Request Snapshot HK Parameter Anomaly Report	Specific

Table 4.3-1: Service 3 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with *“Basic”* will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Objective

This service controls the generation of report packets from the Data pool via the Application software. This service, along with the parameter statistics reporting and event reporting services, provides for the reporting to the ground of all information of operational significance that is not explicitly provided within the reports of another service. The service consists of two independent sub-services which cover, respectively, the requirements for:

- housekeeping data reporting (both periodic and non-periodic);
- diagnostic data reporting.

Any number of on-board application processes may provide a single instance of the housekeeping and diagnostic data reporting service.

Description

Generation start, stop, frequency and content of housekeeping report packets are controlled by this service.

Housekeeping

The housekeeping data reporting sub-service samples sets of housekeeping parameters in accordance with a set of reporting definitions stored onboard. There will be a pre-defined set of such definitions onboard as deemed appropriate for the housekeeping monitoring of the mission. However, these definitions may be modified, deleted and new definitions may be added by the ground at any time.

A Structure Identification (SID) is associated with each distinct reporting definition and associated housekeeping report packet. The SID will be used on the ground, together with the Application Process ID and knowledge of the nature of the packet (i.e. that it is a housekeeping packet, as opposed to a diagnostic packet), Service Type and Sub-type to identify the housekeeping report packet and to interpret its content. The SID shall be unique to a given service implementation and packet nature (i.e. housekeeping or diagnostic), however different instances of the service within different application processes can use the same values of SID.

Diagnostic service concept

The diagnostic data reporting sub-service shall be functionally identical to the housekeeping data reporting sub-service. Different service subtypes shall be used, however, primarily for the purposes of distinguishing the diagnostic parameter reports for routing and (ground) processing.

A means to disable the generation of certain diagnostic parameter reports (whose definitions can remain on-board for intermittent use, for example, when a particular anomaly occurs) shall be provided. Because of the nature of diagnostic mode, it is anticipated that the parameter reports contain a predominance of fixed-length arrays corresponding to parameters sampled at very high rates, many times per report.

SIDs allocated to the housekeeping and Diagnostic data are defined in volume B.

The service supports Houskeeping-, Diagnostic- and Supercommutated reports. HK packets are used for nominal operations. The service can be configured to the needs of different mission phases. The diagnostic sub-services shall be used for error investigation and other exceptional cases, requiring access to a dedicated set of HK parameters. Supercommutation is supported for the diagnostic subservice.

Data Collection

Each reporting definition has an associated data collection interval, which is the time interval over which the housekeeping parameters are sampled. Parameters within a reporting definition may be either simply commutated (sampled once per collection interval) or supercommutated.

In addition, the data sampling, data collection and parameter-report-generation activities for a housekeeping parameter report may be temporarily disabled (e.g. to reduce the on-board processing load).

> Note: For HK TM(3,25) and Diagnostic Reports TM(3,26) the” generation mode” shall always be periodic with one exception: the HK Report requested using TC(3,136) shall be generated only once.

HK SID State Diagram

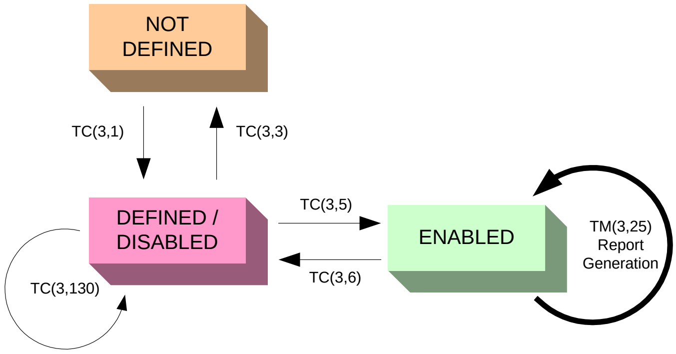


Figure 4.3-1: HK SID State Diagram

For diagnostic SID's the TC and TM names of Figure 4.3-1 need to be adapted according to their definitions. The diagram itself remains unchanged.

4.3.1 TC(3,1): Define new HK Parameter Report

4.3.1.1 Description

Upon reception of TC(3,1) a new HK Report Definition is created in the onboard system. A corresponding "*Report Generation Flag*" is created and set to "disabled". TM(3,25) for this new defined HK Parameter Report has to be enabled with TC(3,5).

Note:

They may use the SID number range from 1 .. 127.

4.3.1.2 Structure

PUS-1790//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

SID	Collection Interval	NPAR	Parameter ID
Unsigned integer	Unsigned integer	Unsigned integer	Unsigned integer
1 byte	2 bytes	1 byte	4 bytes
			< ------ repeat NPAR times ------ >

Table 4.3-2: Structure of the Application data TC(3,1)

4.3.1.3 Parameter Definition & Range

PUS-1819//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
SID	Structure ID	See Volume B
Collection Interval	generation period for this HK TM packet expressed in number of cycles.	1…65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10)
NPAR	number of cumulated parameters in the definition	1 … NPAR_MAX[1)]
Parameter ID	Number uniquely identifying a parameter out of a list	See Volume B.

Table 4.3-3: Parameters of the Application Data for TC(3,1)

Note 1) NPAR_MAX = 52 for full TC packet length

NPAR_MAX = 47 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.3.1.4 TC Verification

PUS-1843//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-1845//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] SID is outside the range specified above	FID_INVALID_SID
[3] Collection Interval is outside the range specified above	FID_INVALID_COLL_INT
[4] NPAR is outside the range specified above (=0)	FID_INVALID_NPAR
[5] SID is already defined and is enabled	FID_SID_ENABLED
[6] The maximum number of defined Housekeeping SIDs is already reached for that PID	FID_MAX_HK_NB_EXCEEDED
[7] The maximum total number of defined SIDs is already reached	FID_MAX_TOTAL_SID_NB
[8] NPAR is inconsistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[9] At least one of the Parameter IDs is not defined	FID_INVALID_PAR_ID
[10] Housekeeping structure exceeds HK TM size (*)	FID_TM_SIZE_EXCEEDED

4.3.2 TC(3,2): Define new Diagnostic Parameter Report

4.3.2.1 Description

Upon reception of TC(3,2) a new Diagnostic Report Definition is created in the onboard system. A corresponding "Report Generation Flag" is created and set to "disabled". TM(3,26) for this new defined Diagnostic Parameter Report has to be enabled with TC(3,7).

Note:

They may use the SID number range from 128 .. 255.

4.3.2.2 Structure

PUS-1859/*/*

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 2

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

SID	***Collection Interval***	***NPAR1***	***Parameter ID***	
Unsigned integer	Unsigned integer	Unsigned integer	Unsigned integer	
1 byte	2 bytes	1 byte	4 bytes	
			< ------ repeat *NPAR* times ------ >	

	NFA	***NREP***	***NPAR2***	***Parameter ID***
	Unsigned integer	Unsigned integer	Unsigned integer	Unsigned integer
	1 byte	1 byte	1 byte	4 bytes
				< ------ repeat *NPAR2* times ------ >
		< ------ repeat *NFA* times ------ >		

Table 4.3-4: Structure of the Application data TC(3,2)

4.3.2.3 Parameter Definition & Range

PUS-1867/*/*

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
SID	Structure ID	See Volume B

Parameters of Application Data Field	Description	Range or value
Collection Interval	generation period for this HK TM packet expressed in number of cycles.	1…65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10)
NPAR1	The number of parameters in the definition that are sampled once per collection interval.	0 … NPAR_MAX[1)]
Parameter ID	Number uniquely identifying a parameter out of a list	See Volume B.
NFA	The number of fixed-length arrays	0 or 1.
NREP	The number of values to be sampled for each parameter within this fixed length array.	NREP_MAX[1)]
NPAR2	The number of different parameters within this fixed-length array, each of which shall be sampled "*NREP*" times per collection interval.	NPAR2_MAX[1)]
Parameter ID	Number uniquely identifying a parameter out of a list	See Volume B.

Table 4.3-5: Parameters of the Application Data for TC(3,2)

Note 1)

NPAR1_MAX = 47 (if NFA=0 and TC nested in TC(11,4) or TC(151,4))

NPAR2_MAX = 46 (if NPAR1=0 and TC nested in TC(11,4) or TC(151,4))

NREP_MAX is defined per application and must fulfill the condition that Collection Interval / NREP is an integer value

4.3.2.4 TC Verification

PUS-1907//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1   failed

PUS-1909//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	SID is outside the range specified above	FID_INVALID_SID
[3]	Collection Interval is outside the range specified above	FID_INVALID_COLL_INT
[4]	N2 is outside the range specified above (=0)	FID_INVALID_NPAR
[5]	SID is already defined and is enabled	FID_SID_ENABLED
[6]	The maximum number of defined Diagnostic SIDs is already reached for that PID	FID_MAX_DIAG_NB_EXCEEDED
[7]	The maximum total number of defined SIDs is already reached	FID_MAX_TOTAL_SID_NB
[8]	(N1,N2) is inconsistent with the real length of the packet data field	FID_N1_N2_LENGTH_DISCREP
[9]	At least one of the Parameter IDs is not defined	FID_INVALID_PAR_ID
[10]	Diagnostic structure exceeds TM size	FID_TM_SIZE_EXCEEDED
[11]	NREP is incompatible with Collection Interval parameter	FID_NREP_INCO_INTERVAL
[12]	NFA is outside the range specified above	FID_INVALID_NFA

4.3.3 TC(3,3): Clear HK Parameter Report Definitions

4.3.3.1 Description

Upon reception of TC(3,3) the HK Report Definition specified by the SID number is removed from the onboard system. All related flags (Report Generation Flag) shall be cleared. This TC can only be sent if the associated report generation for this *SID* has been disabled before.

4.3.3.2 Structure

PUS-1926//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 3

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

SID
Unsigned integer
1 byte

Table 4.3-6: Structure of the Application data TC(3,3)

4.3.3.3 Parameter Definition & Range

PUS-1941//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
SID	Structure ID of HK Report Definition to be cleared	See Volume B

Table 4.3-7: Parameters of the Application Data for TC(3,3)

4.3.3.4 TC Verification

PUS-1953//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-1955//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The SID is out of the range specified above	FID_INVALID_SID
[3]	The SID is not defined	FID_UNKNOWN_SID
[4]	The SID is enabled	FID_SID_ENABLED

4.3.4 TC(3,4): Clear Diagnostic Parameter Report Definitions

4.3.4.1 Description

Upon reception of TC(3,4) the Diagnostic Report Definition specified by the SID number is removed from the onboard system. All related flags (Report Generation Flag) shall be cleared. This TC can only be sent if the associated report generation for this *SID* has been stopped before.

4.3.4.2 Structure

PUS-1963//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 4

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

SID
Unsigned integer
1 byte

Table 4.3-8: Structure of the Application data TC(3,4)

4.3.4.3 Parameter Definition & Range

PUS-1978//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
SID	Structure ID of Diagnostic Report Definition to be cleared	See Volume B

Table 4.3-9: Parameters of the Application Data for TC(3,4)

4.3.4.4 TC Verification

PUS-1990//

TM(1,2): TC Acceptance Report - shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-1992//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The SID is out of the range specified above	FID_INVALID_SID
[3]	The SID is not defined	FID_UNKNOWN_SID
[4]	The SID is enabled	FID_SID_ENABLED

4.3.5 TC(3,5): Enable HK Parameter Report Generation

4.3.5.1 Description

Upon reception of TC(3,5) the HK Report Definition specified by the SID number is enabled.

4.3.5.2 Structure

PUS-1999//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 5

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

SID
Unsigned integer
1 byte

Table 4.3-10: Structure of the Application data TC(3,5)

4.3.5.3 Parameter Definition & Range

PUS-2014//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value

Parameters of Application Data Field	Description	Range or value
SID	Structure ID of HK Report Definition	See Volume B

Table 4.3-11: Parameter of the Application Data for TC(3,5)

4.3.5.4 TC Verification

PUS-2026//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-2028//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if the *SID* is not in the allowed range

•if the *SID* has no definition assigned (i.e. empty structure)

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The SID is out of the range specified above	FID_INVALID_SID
[3]	The SID is not defined	FID_UNKNOWN_SID

4.3.5.5 Remarks

Note:

They may use the SID number range from 1 .. 127.

4.3.6 TC(3,6): Disable HK Parameter Report Generation

4.3.6.1 Description

Upon reception of TC(3,6) the HK Report Definition specified by the SID number is disabled.

4.3.6.2 Structure

PUS-2038//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 6

The structure of the *Application Data* field within the TC Packet Data field is identical with the one defined for TC(3,5). See Table 4.3-10 (Structure of the Application data TC(3,5))

4.3.6.3 TC Verification

PUS-2045//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-2047//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The SID is out of the range specified above	FID_INVALID_SID

4.3.7 TC(3,7): Enable Diagnostic Parameter Report Generation

4.3.7.1 Description

Upon reception of TC(3,7) the Diagnostics Report Definition specified by the SID number is enabled.

4.3.7.2 Structure

PUS-2054//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 7

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

SID
Unsigned integer
1 byte

Table 4.3-12: Structure of the Application data TC(3,7)

4.3.7.3 Parameter Definition & Range

PUS-2069//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
SID	Structure ID of Diagnostic Report Definition	See Volume B

Table 4.3-13: Parameter of the Application Data for TC(3,7)

4.3.7.4 TC Verification

PUS-2081//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-2083//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The SID is out of the range specified above	FID_INVALID_SID
[3]	The SID is not defined	FID_UNKNOWN_SID

4.3.7.5 Remarks

Note:

They may use the SID number range from 128 .. 255.

4.3.8 TC(3,8): Disable Diagnostic Parameter Report Generation

4.3.8.1 Description

Upon reception of TC(3,8) the Diagnostics Report Definition specified by the SID number is disabled.

4.3.8.2 Structure

PUS-2093//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 8

The structure of the Application Data field within the TC Packet Data field is identical with the one defined for TC(3,7). See Table 4.3-12 (Structure of the Application Data TC(3,7))

4.3.8.3 TC Verification

PUS-2100//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-2102//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The SID is out of the range specified above	FID_INVALID_SID

4.3.9 TC(3,9): Report HK Parameter Report Definition

4.3.9.1 Description

Upon reception of TC(3,9) the HK Parameter Report Definition Report TM(3,10) specified by the SID number shall be generated.

4.3.9.2 Structure

PUS-2109//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 9

The structure of the Application Data field within the TC Packet Data field is identical with the one defined for TC(3,7). See Table 4.3-12 (Structure of the Application Data TC(3,7))

4.3.9.3 TC Verification

PUS-2116//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-2118//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The SID is out of the range specified above	FID_INVALID_SID
[3]	The SID is not defined	FID_UNKNOWN_SID
[4]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.3.10 TM(3,10): HK Parameter Report Definitions Report

4.3.10.1 Description

TM(3,10) is the response to TC(3,9).

4.3.10.2 Structure

PUS-2125//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 3

Service Subtype : Must be set to 10

The structure of the *Source Data* field within the TM Packet Data field is defined here below.

SID	Collection Interval	NPAR	Parameter ID
Unsigned integer	Unsigned integer	Unsigned integer	Unsigned integer
1 byte	2 bytes	1 byte	4 bytes
			< -- repeat *NPAR* times - >

Table 4.3-14: Structure of the Source data TM(3,10)

4.3.10.3 Parameter Definition & Range

PUS-2152//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
SID	Structure ID of the HK Report Definition to be reported	A valid and existing *SID*
Collection Interval	generation period for this HK TM packet expressed in number of cycles.	1…65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10)
NPAR	number of cumulated parameters in the definition	0 … N_MAX
Parameter ID	Number uniquely identifying a parameter out of a list	Any valid value of the list of predefined parameters See dedicated volumes.

Table 4.3-15: Parameters of the Source data for TM(3,10)

Note 1)

N_MAX = 110 (MAX_HK_PARAM_NB)

4.3.11 TC(3,11): Report Diagnostic Parameter Report Definitions

4.3.11.1 Description

Upon reception of TC(3,11) the Diagnostic Parameter Report Definition Report specified by the SID number shall be generated.

4.3.11.2 Structure

PUS-2179/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 11

The structure of the *Application Data* field within the TC Packet Data field is identical with the one defined for TC(3,7). See Table 4.3-12 (Structure of the Application Data TC(3,7))

4.3.11.3 TC Verification

PUS-2186/I

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-2188/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The SID is out of the range specified above	FID_INVALID_SID
[3]	The SID is not defined	FID_UNKNOWN_SID
[4]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.3.12 TM(3,12): Diagnostic Parameter Report Definitions Report

4.3.12.1 Description

TM(3,12) is the response to TC(3,11).

4.3.12.2 Structure

PUS-2195/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 3

Service Subtype : Must be set to 12

The structure of the *Source Data* field within the TM Packet Data field is defined here below.

SID	***COLLECTION INTERVAL***	***NPAR1***	***PARAMETER ID***
Unsigned integer	Unsigned integer	Unsigned integer	Unsigned integer
1 byte	2 bytes	1 byte	4 bytes
			< ----- repeat *NPAR1* times ------ >

	NFA	***NREP***	***NPAR2***	***PARAMETER ID***
	Unsigned integer	Unsigned integer	Unsigned integer	Unsigned integer
	1 byte	1 byte	1 byte	4 bytes
				< ------ repeat *NPAR2* times ------ >
		< ------ repeat *NFA* times ------ >		

Table 4.3-16: Structure of the Source data TM(3,12)

4.3.12.3 Parameter Definition & Range

PUS-2203//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
SID	Structure ID of the HK Report Definition to be reported	A valid and existing SID
Collection Interval	generation period for this HK TM packet expressed in number of cycles.	1…65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10)
NPAR1	The number of parameters in the definition that are sampled once per collection interval.	0 … NPAR1_MAX [1)]
Parameter ID	Number uniquely identifying a parameter out of a list	Any valid value of the list of predefined parameters See Volume B..
NFA	The number of fixed-length arrays	0 or 1
NREP	The number of values to be sampled for each parameter within this fixed-length array.	1 … NREP_MAX [1)]

Parameters of Source Data Field	Description	Range or value
NPAR2	The number of different parameters within this fixed-length array, each of which shall be sampled "*NREP*" times per collection interval.	1 … NPAR2_MAX [1)]
Parameter ID	Number uniquely identifying a parameter out of a list	See Volume B.

Table 4.3-17: Parameters of the Source data for TM(3,12)

Note 1)

NPAR1_MAX = 47 (if NFA = 0 - see TC(3,2))

NPAR2_MAX = 46 (if NPAR1 = 0 - see TC(3,2))

NREP_MAX is defined per application and must fulfill the condition that Collection Interval / NREP is an integer value

4.3.13 TM(3,25): Housekeeping Parameter Report

4.3.13.1 Description

This report shall be generated if the corresponding flags are set appropriately. The flag "Report Generation Flag" must read "enabled".

4.3.13.2 Structure

PUS-2246//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B

PCAT : Must be set to a value according to the Packet Category Table TM in Volume B

Service Type : Must be set to 3

Service Subtype : Must be set to 25

The structure of the *Source Data* field within the TM Packet Data field is defined here below.

SID	Parameter 1	………	Parameter N
Unsigned integer	Any		Any
1 byte	Variable		Variable

Table 4.3-18: Structure of the Source data TM(3,25)

4.3.13.3 Parameter Definition & Range

PUS-2270//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
SID	The structure ID of the HK Report	An existing SID value
Parameter 1 to Parameter N	Parameter meaning according to the definition of this HK Report	A valid value for this parameter

Table 4.3-19: Parameters of the Source data for TM(3,25)

4.3.14 TM(3,26): Diagnostic Parameter Report

4.3.14.1 Description

This report shall be generated if the corresponding flags are set appropriately. The flag “Report Generation Flag” must read “enabled” .

4.3.14.2 Structure

PUS-2289//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B.

PCAT : Must be set to a value according to the Packet Category Table TM in Volume B

Service Type : Must be set to 3

Service Subtype : Must be set to 26

The structure of the *Source Data* field within the TM Packet Data field is defined here below.

Note: conceptually is the same structure of the TM(3,25) (i.e. what is reported is a SID and the parameters included in this SID). The difference is that there could be one or more parameters (supercommutated) whose values are reported more than one time (i.e. NREP times).

SID	Parameter 1	………	Parameter M	Parameter N	......	Parameter P
Unsigned integer	Any		Any			
1 byte	Variable		Variable			
				<---------- repeated NREP times ---------->		

Table 4.3-20: Parameters of the Source data for TM(3,26)

4.3.15 TC(3,128): Report HK/Diag Parameter Report Definitions in Summary Form

4.3.15.1 Description

Upon reception of TC(3,128) the HK/Diagnostic Parameter Report Definition Report TM(3,129) shall be generated.

4.3.15.2 Structure

PUS-2299//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 128

TC(3,128) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.3.15.3 TC Verification

PUS-2306/ /

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-2308/ /

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.3.16 TM(3,129): HK/Diag Parameter Report Definitions Report in Summary Form

4.3.16.1 Description

TM(3,129) is the response to TC(3,128).

4.3.16.2 Structure

PUS-2315/ /

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 3

Service Subtype : Must be set to 129

The structure of the *Source Data* field within the TM Packet Data field is defined here below.

NPAR	SID	Status	Collection Interval
Unsigned integer	Unsigned integer	Enumerated	Unsigned integer
1 byte	1 byte	1 byte	2 bytes
	< ------ repeat *NPAR* times ------ >		

Table 4.3-21: Structure of the Source data TM(3,129)

4.3.16.3 Parameter Definition & Range

PUS-2342//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
NPAR	number of SID's	1....NPAR_MAX[1)]
SID	Structure ID of the HK/Diag Report Definition to be reported	A valid and existing SID for HK and Diag. Reports
Status	Report generation status	1 = Enabled / 0 = Disabled
Collection Interval	generation period for this HK TM packet expressed in number of cycles.	1…65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10)

Table 4.3-22: Parameters of the Source data for TM(3,129)

Note 1)

NPAR_MAX = 255 (max value due to the 1 byte length of the NPAR parameter)

4.3.17 TC(3,130): Define HK Parameter Report Collection Interval

4.3.17.1 Description

Upon reception of TC(3,130), the collection interval for the specified HK Parameter Report shall be changed. The HK Parameter Report Generation for the specified SID must be disabled in order to fulfill the request.

4.3.17.2 Structure

PUS-2369//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 130

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

SID	Collection Interval
Unsigned integer	Unsigned integer
1 byte	2 bytes

Table 4.3-23: Structure of the Application data TC(3,130)

4.3.17.3 Parameter Definition & Range

PUS-2387//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
SID	Structure ID	See Volume B
Collection Interval	generation period for this HK TM packet expressed in number of cycles.	1…65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10)

Table 4.3-24: Parameters of the Application Data for TC(3,130)

4.3.17.4 TC Verification

PUS-2403//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-2405//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	SID is outside the range specified above	FID_INVALID_SID
[3]	Collection interval is outside the range specified above	FID_INVALID_COLL_INT
[4]	SID is not defined	FID_UNKNOWN_SID
[5]	SID is enabled	FID_SID_ENABLED

4.3.18 TC(3,131): Define Diagnostic Parameter Report Collection Interval

4.3.18.1 Description

Upon reception of TC(3,131), the collection interval for the specified Diagnostic Parameter Report shall be changed. The Diagnostic Parameter Report Generation for the specified SID must be disabled in order to fulfil the request.

4.3.18.2 Structure

PUS-2414/I/

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 131

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

SID	Collection Interval
Unsigned integer	Unsigned integer
1 byte	2 bytes

Table 4.3-25: Structure of the Application data TC(3,131)

4.3.18.3 Parameter Definition & Range

PUS-2432/I/

The parameters of the Application Data field shall be inserted according to the following table:

Parameters of Application Data Field	Description	Range or value
SID	Structure ID	See Volume B
Collection Interval	generation period for this HK TM packet expressed in number of cycles.	1…65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10)

Table 4.3-26: Parameters of the Application Data for TC(3,131)

4.3.18.4 TC Verification

PUS-2448//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-2450//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] SID is outside the range specified above	FID_INVALID_SID
[3] Collection interval is outside the range specified above	FID_INVALID_COLL_INT
[4] SID is not defined	FID_UNKNOWN_SID
[5] SID is enabled	FID_SID_ENABLED
[6] Collection Interval not consistent with defined NREP (Collection Interval/NREP is not an integer value)	FID_NREP_INCO_INTERVAL

4.3.19 TC(3,136): Request HK Parameter Report

4.3.19.1 Description

Upon reception of TC(3,136), TM(3,25) specified by the SID number is generated only once.

4.3.19.2 Structure

PUS-2460//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 136

The structure of the *Application Data* field within the TC Packet Data field is identical with the one defined for TC(3,5). See Table 4.3-10 (Structure of the Application Data TC(3,5))

4.3.19.3 TC Verification

PUS-2467//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-2469//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] The SID is out of the range specified above	FID_INVALID_SID
[3] The SID is not defined	FID_UNKNOWN_SID

4.3.20 TC(3,138): Add HK Parameters to existing HK Parameter Report

4.3.20.1 Description

TC(3,138) is used to add additional HK parameter to an already defined HK Report. TM(3,25).

4.3.20.2 Structure

PUS-2541//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 138

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

SID	NPAR	Parameter ID
Unsigned integer	Unsigned integer	Unsigned integer
1 byte	1 byte	4 bytes
		< ------ repeat NPAR times ------ >

Table 4.3-27: Structure of the Application data TC(3,138)

4.3.20.3 Parameter Definition & Range

PUS-2566//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
SID	Structure ID	See Volume B
NPAR	number of appended parameters in the definition	1 … NPAR_MAX[1)]
Parameter ID	Number uniquely identifying a parameter out of a list	See Volume B.

Table 4.3-28: Parameters of the Application Data for TC(3,138)

Note 1) NPAR_MAX = 53 for full TC packet length

NPAR_MAX = 48 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.3.20.4 TC Verification

PUS-2586//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-2588//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The SID is out of the range specified above	FID_INVALID_SID
[3]	The SID is not defined	FID_UNKNOWN_SID
[4]	The SID is enabled	FID_SID_ENABLED
[5]	NPAR is inconsistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[6]	At least one of the Parameter IDs is not defined	FID_INVALID_PAR_ID
[7]	HK structure exceeds HK TM size (*)	FID_TM_SIZE_EXCEEDED
[8]	The final number of parameters of the SID definition -including the append- would exceed the number of parameters per SID (MAX_SID_PARAM_NB)	FID_TOTAL_NPAR_EXCEEDED

4.3.21 TC(3,139): Request Snapshot HK Parameter Anomaly Report

4.3.21.1 Description

Upon reception of TC(3,139), one TM(5,x) event report with a severity corresponding to the given EID and the SID and all parameters of the HK resp. FDIR SID definition in the parameter field of the event report.

4.3.21.2 Structure

PUS-17342/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 3

Service Subtype : Must be set to 139

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

EID	SID
Unsigned integer	Unsigned integer
2 bytes	1 byte

Table 4.3-29: Structure of the Application data TC(3,139)

4.3.21.3 Parameter Definition & Range

PUS-17364/I

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
EID	Event Identifier	See Volume B
SID	Structure ID	See Volume B

Table 4.3-30: Parameters of the Application Data for TC(3,139)

Note:

Diagnostic SID can not be used.

4.3.21.4 TC Verification

PUS-17386//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-17388//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	EID is not defined ((PID,EID) combination is not valid)	FID_SID_UNKNOWN_EID
[3]	The SID is out of the range specified above	FID_INVALID_SID
[4]	The SID is not defined	FID_UNKNOWN_SID

4.3.21.5 Remarks

The parameter field defined for the TM(5,x) generated by TC(3,139) contains the same information as provided in TM(3,25) for the same SID. The parameter field of TM(5,x) generated by TC(3,139) is defined as follows:

The structure of the *Parameter* field within the TM Packet Data field of TM(5,x) generated by TC(3,139) is defined here below.

SID	Parameter 1	………	Parameter N
Unsigned integer	Any		Any
1 byte	Variable		Variable

Table 4.3-31: Structure of the Parameter Data Field of TM(5,x) generated from TC(3,139)

PUS-17412//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
SID	The structure ID of the HK Report	An existing SID value
Parameter 1 to Parameter N	Parameter meaning according to the definition of this HK Report	A valid value for this parameter

Table 4.3-32: Parameters of the Parameter Data Field of TM(5,x) generated from TC(3,139)

4.4 Service 4: Parameter Statistics Reporting Service

This Service is not applicable

4.5 Service 5: Event Reporting Service

Service Summary

Service, Subservic e	TM/TC	Description	Applicability
(5,1)	TM	Normal/Progress Report	Basic
(5,2)	TM	Error/Anomaly Report -- Low Severity	Basic
(5,3)	TM	Error/Anomaly Report - Medium Severity	Basic
(5,4)	TM	Error/Anomaly Report - High Severity	Basic
(5,5)	TC	Enable Event Packet Generation	Basic
(5,6)	TC	Disable Event Packet Generation	Basic
(5,128)	TC	Clear System Log	Specific
(5,129)	TC	Downlink System Log	Specific
(5,130)	TM	System Log Event occurance table Report	Specific
(5,133)	TC	Report Disabled EID's	Specific
(5,134)	TM	Disabled EID's Report	Specific

Table 4.5-1: Service 5 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with *“Basic”* will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Note: Service 19 ”Event/Action Service” will be able to monitor all TM(5,1..4) packets

Note: An EVENT ID's is unique within its APID.

Objective

This service provides for the reporting to the service user of information of operational significance which is not explicitly provided within the provider-initiated reports of another service. The service covers the requirements for event reporting, i.e.:

- reporting of failures or anomalies detected on-board;
- reporting of autonomous on-board actions;
- reporting of normal progress of operations and activities, e.g. detection of events which are not anomalous (such as payload events), reaching of predefined steps in an operation.

Some reports can combine more than one of these events.

EXAMPLE A report can declare that “Unit X has been switched off because its temperature was detected as 31 ºC, where the currently defined limit is 30 ºC”.

Any number of on-board application processes may provide a single instance of the event reporting service.

Description

Classification	Description
Normal/Progress	Report on the normal progress of long lasting onboard processes.
Low Severity	Errors or anomalies of *low severity* are **warnings** which are worth to be reported, but do not yet initiate any autonomous on board action.
Medium Severity	Errors or anomalies of *medium severity* are all those of operational significance which might require an action to be started, but if so the **action need to be started by ground**.
High Severity	Errors or anomalies of *high severity* are be all those which require an **autonomous on-board action** to be started

Table 4.5-2: Classification of Event Severity

Event reports will be one of the prime methods used to control day to day operations during the mission both to report normal progress, warnings, errors requiring ground action or autonomous actions performed on-board.

The generic PUS defines commands to enable and disable event report generation as well as one TC to request the TM generation and a TM defining the enabled events.

Once generated, events are:

- filtered and recorded in the Safe Guard Memory (SGM),
- forwarded toward ground and recorded in the Mass Memory Unit (MMU).

When recorded in the SGM, the System Log allows to record anomaly or error reporting for service 5 medium and high severity event reports (TM(5,3), TM(5,4) as well as TC acknowledgement error reports (TM(1,2) and TM(1,8) in a combination of a linear and a circular buffer. The linear buffer contains the 'm' first events generated (the oldest ones) and the circular buffer the 'n' last events generated (the youngest ones).

In an ordinary case, the full size of the System log allows to record up to 'm + n' events. In case of burst of events, the 'm' first events and the 'n' last events are recorded in the System Log and a counter of occurrences for 'p' high severity events (TM5,4) is available in order to keep the trace of the first ‘p‘ high severity events, which may get overwritten, even in the case the circular buffer is not large enough to record the whole sequence of events.

In case of linear buffer overflow a dedicated medium severity TM(5,3) is raised, while a high severity event TM(5,4) signals the circular buffer overflow. It is ensured that the latest occurred instance of each of these events is stored in the system log.

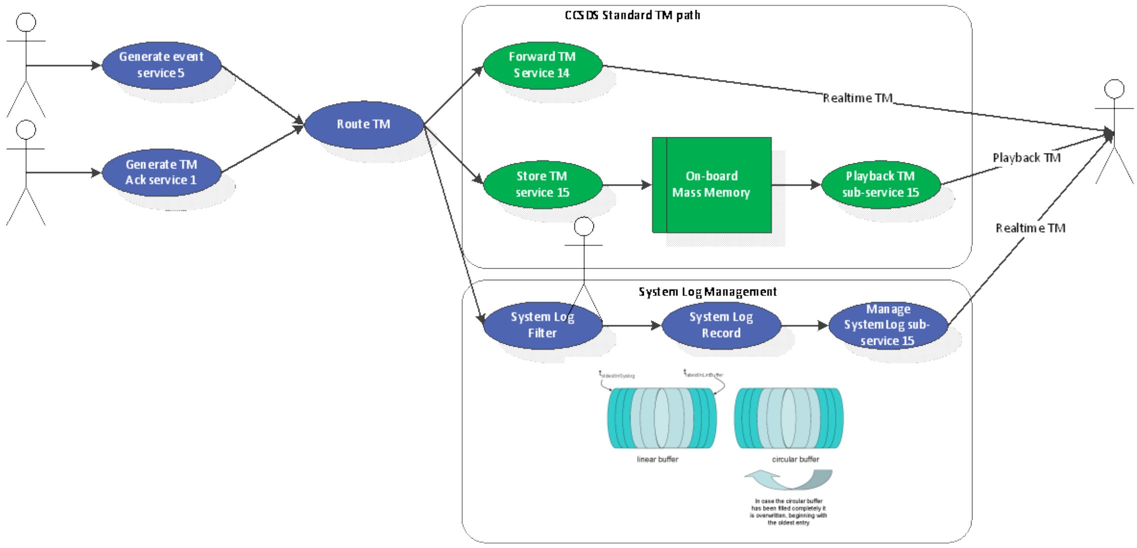
In the exceptional case that both buffers are completely filled no new events will be written to the circular buffer (system log) if the system log downlink process downlinks packets stored in the circular buffer.

The beginning and the end of the system log downlink process is identified via dedicated normal progress events (TM(5,1) in addition to the TC acknowledgment report packets..

The following packets will be stored into the *System Log:*

TM(1,2); TM(1,8)

TM(5,3); TM(5,4)



Service 5 provides the telecommand to:

- Read the Logs and the table. This telecommand may produces several TM as result (TM for the circular buffer, TM for linear buffer and TM for event occurrence table)
- Clear the Logs and the table (1 single TC as this insures the coherency between the three entities).

4.5.1 TM(5,1) Normal/Progress Report

4.5.1.1 Description

TM(5,1) shall be generated to report the normal progress of an on board action that does not relate to a fault condition.

4.5.1.2 Structure

PUS-3156/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 7 (event)

Service Type : Must be set to 5

Service Subtype : Must be set to 1

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

EID	Parameter
Enumerated	Any
2 bytes	variable

Table 4.5-3: Structure of the Source data TM(5,1)

4.5.1.3 Parameter Definition & Range

PUS-3172//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
EID	Event Identifier	See Volume B
Parameter	this field provides complementary information about the event. The structure and the length of this field are uniquely identified by the combination of *APID* and *EID*.	

Table 4.5-4: Parameters of the Source data for TM(5,1)

4.5.2 TM(5,2) Error/Anomaly Report -- Low Severity

4.5.2.1 Description

This report shall be generated to report the errors or anomalies of low severity.

4.5.2.2 Structure

PUS-3191//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 7 (event)

Service Type : Must be set to 5

Service Subtype : Must be set to 2

The structure of the *Source Data* field within the TM *Packet Data Field* is identical with the one defined for TM(5,1). See Table 4.5-3 (Structure of the Source Data TM(5,1))

4.5.3 TM(5,3) Error/Anomaly Report -- Medium Severity

4.5.3.1 Description

This report shall be generated to report the errors or anomalies of medium severity.

4.5.3.2 Structure

PUS-3199//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 7 (event)

Service Type : Must be set to 5

Service Subtype : Must be set to 3

The structure of the *Source Data* field within the TM *Packet Data Field* is identical with the one defined for TM(5,1) See Table 4.5-3 (Structure of the Source Data TM(5,1))

4.5.4 TM(5,4) Error/Anomaly Report -- High Severity

4.5.4.1 Description

This report shall be generated to report the errors or anomalies of high severity.

4.5.4.2 Structure

PUS-3207//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 7 (event)

Service Type : Must be set to 5

Service Subtype : Must be set to 4

The structure of the *Source Data* field within the TM *Packet Data Field* is identical with the one defined for TM(5,1) See Table 4.5-3 (Structure of the Source Data TM(5,1))

4.5.5 TC(5,5): Enable Event Packet Generation

4.5.5.1 Description

Upon reception of TC(5,5) the Event Packet generation specified by the *EID* number is enabled.

4.5.5.2 Structure

PUS-3215//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 5

Service Subtype : Must be set to 5

PUS-3218//

The structure of the Source Data *field within the* TM Packet Data *field is defined here below.*

NEID	EID
Unsigned Ineteger	Enumerated
1 byte	2 byte
	< ------ repeat *NEID* times ------ >

Table 4.5-5: Structure of the Application data TC(5,5)

4.5.5.3 Parameter Definition & Range

PUS-3234//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
NEID	Number of EID's	1 … NEID_MAX[1)]
EID	Event Packet Structure Identifier	Any valid *EID* See Volume B.

Table 4.5-6: Parameters of the Application Data for TC(5,5)

Note 1)

NEID_MAX = 96 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.5.5.4 TC Verification

PUS-3250//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3252//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	NEID is inconsistent with the real length of the packet data field	FID_NEID_LEN_DISCREP
[3]	NEID is outside the range specified above	FID_INVALID_NEID
[4]	At least one of the EIDs does not exist	FID_UNKNOWN_EID

4.5.6 TC(5,6): Disable Event Packet Generation

4.5.6.1 Description

Upon reception of TC(5,6) the Event Packet generation specified by the *EID* number is disabled.

4.5.6.2 Structure

PUS-3261/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 5

Service Subtype : Must be set to 6

The structure of the *Application Data field within the TC Packet Data* field is identical with the one defined for TC(5,5). See Table 4.5-5 (Structure of the Application Data TC(5,5))

4.5.6.3 TC Verification

PUS-3266/I

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-3268/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	NEID is inconsistent with the real length of the packet data field	FID_NEID_LEN_DISCREP
[3]	NEID is outside the range specified above	FID_INVALID_NEID
[4]	At least one of the EIDs does not exist	FID_UNKNOWN_EID

4.5.7 TC(5,128):Clear System Log

4.5.7.1 Description

This telecommand clears the defined number of or all entries of the buffers of the System Log as well as in case of a complete clear the event occurrence table.

On reception of this TC, the number of entries starting from the oldest entry in the system log will be cleared. In case that all entries contained in the linear and circular buffers of the System Log shall be cleared, the number of entries contained in the system log at command acceptance shall be cleared as well as the occurrence table of the System Log.

If the number of requested packets to delete exceeds the number of entries in the linear and circular buffers, then only the number of entries in the buffers at the time of command reception will be deleted, i.e. new entries available for storage into the system log after the command is received will not be deleted.

Partial clear is only possible as long as the circular buffer is not in use.

Note that the System Log in both the SGMs are cleared by this telecommand.

4.5.7.2 Structure

PUS-3277/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 5

Service Subtype : Must be set to 128

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

NoOfEntries
Unsigned integer
2 byte

Table 4.5-7: Structure of the Application data TC(5,128)

4.5.7.3 Parameter Definition & Range

PUS-3290//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or Value
NoOFENtries	Number of system log entries to be deleted If the specified number is greater or equal than the number of log entries, all entries will be deleted.	0 - complete clear of all entries 1...2^{16}-1 - partial clear of given number of entries

Table 4.5-8: Parameters of the Application Data for TC(5,128)

4.5.7.4 TC Verification

PUS-3302//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3304//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if a system log downlink is on-going

•if partial clear (NoOfEntries >0) is requested and circular buffer is in use

4.5.8 TC(5,129) Downlink the System Log

4.5.8.1 Description

Upon reception of TC(5,129) the System Log will be downlinked i.e. all stored TM packets in the linear and the circular System Log buffers. The downlink is started at the position of the oldest packet in the system log. In addition TM(5,130) will be generated.

It allows the ground to request the downlink of the system-log maintained in the SGM (Safeguard memory of the OBC). The entries of the system log are maintained in chronological order of reception. The content of the system-log is put into the real-time telemetry s-band downlink as telemetry packets in chronological order. The bandwidth consumption of the system log downlink is limited by the downlink process. The limit is configurable.

No content of the system log will be deleted by execution of this TC.

4.5.8.2 Structure

PUS-3311//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 5

Service Subtype : Must be set to 129

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

SGM ID
Unsigned Integer
1 byte

Table 4.5-9: Structure of the Application data TC(5,129)

4.5.8.3 Parameter Definition & Range

PUS-13992//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameter of Application Data Field	Description	Range or Value
SGM ID	SGM Identifier	01_{bin} = SGM_A 10_{bin} = SGM_B 11_{bin} = SGM A & B

Table 4.5-10: Parameters of the Application Data for TC(5,129)

4.5.8.4 TC Verification

PUS-3316//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3318//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if a system log clearing is on-going

4.5.9 TM(5,130) System Log Event occurrence table Report

4.5.9.1 Description

TM(5,130) is the response to TC(5,129).

The event occurence table contains the number of occurences of high severity event ID's which may have been overwritten in System Log . The event occurence table is an extension of the normal system log particularly covering the case that single event packets are filling up the system log. It contains only entries in case overwriting of the system log has started.

4.5.9.2 Structure

PUS-14011//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 5

Service Subtype : Must be set to 130

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

SGM ID	NEID	Filler	PRID	EID	Occurence
Unsigned Integer	Unsigned Integer		Enumerated	Enumerated	Unsigned Integer
1 byte	2 byte	1 bit	7 bits	2 byte	2 byte
		< ------ repeat *NEID* times ------ >			

Table 4.5-11: Structure of the Source data for TM(5,130)

4.5.9.3 Parameter Definition & Range

PUS-14028//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
SGM ID	SGM Identifier	01_{bin} = SGM_A 10_{bin} = SGM_B
NEID	Number of EID's following	no EIDs in SKET: Range: 0....NEID_MAX[1)]
PRID	Process ID	Process ID of the generating application
EID	Event Packet Structure Identifier	
Occurence	Number of times the event EID has occurred since start of circular buffer writing	1 .... 2^16-^1

Table 4.5-12: Parameters of the Source data for TM(5,130)

Note 1)

NEID_MAX = 16

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.5.10 TC(5,133) Report Disabled EID's

4.5.10.1 Description

Upon reception of TC(5,133) the report TM(5,134) shall be generated.

4.5.10.2 Structure

PUS-3324//

The Packet Header shall have the following structure:

PRID: Must be set to a value according to the PRID Table in Volume B

PCAT: Must be set to 12 (telecommand)

Service Type: Must be set to 5

Service Subtype: Must be set to 133

TC(5,133) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.5.10.3 TC Verification

PUS-3329//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3331//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if the request could not be completed, since superseded by new request.

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.5.11 TM(5,134) Disabled EID's Report

4.5.11.1 Description

TM(5,134) is the response to TC(5,133).

4.5.11.2 Structure

PUS-3338//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 5

Service Subtype : Must be set to 134

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

NEID	EID
Unsigned Integer	Enumerated
2 byte	2 byte
	<------ repeat NEID times --------->

Table 4.5-13: Structure of the Source data TM(5,134)

4.5.11.3 Parameter Definition & Range

PUS-3357//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
NEID	Number of EID's following	0 … NEID_MAX
EID	Event Packet Structure Identifier	Any valid EID See Volume B.

Table 4.5-14: Parameters of the Source data for TM(5,134)

Note1)

NEID_MAX = INT((MTU-14)/2) i.e. 1016 for MTU=2047, resp.

4.5.11.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfil the request. The bandwidth adjustment mechanism is applicable for this TM.

4.6 Service 6: Memory Management Service

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(6,1)	TC	Load Memory using Base plus Offsets	n/a
(6,2)	TC	Load Memory using Absolute Addresses	Basic
(6,3)	TC	Dump Memory using Base plus Offsets	n/a
(6,4)	TM	Memory Dump using Base plus Offsets Report	n/a
(6,5)	TC	Dump Memory using Absolute Addresses	Basic
(6,6)	TM	Memory Dump using Absolute Addresses Report	Basic
(6,7)	TC	Check Memory using Base plus Offsets	n/a
(6,8)	TM	Memory Check using Base plus Offsets Report	n/a
(6,9)	TC	Check Memory using Absolute Addresses	Basic

Service, Subservice	TM/TC	Description	Applicability
(6,10)	TM	Memory Check using Absolute Addresses Report	Basic

Table 4.6-1: Service 6 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with *“Basic”* will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Service 6 uses a *Memory ID* to uniquely identify the different memory blocks.

The *memory ID* allocations for dedicated units are given in the relevant annexes. The selected addressing scheme shall be “Absolute Addresses” throughout the entire service 6.

Memory sizes are counted by so called SAU’s (**S**mallest **A**ddressable **U**nit)

Objective

This service relates to the management of the various memory areas (e.g. RAM or EEPROM) which exist on-board the satellite. The service provides the capability for loading, dumping and checking the contents of either a contiguous memory area or of several non-contiguous memory areas.

.

*Note***:** non- contiguous memory areas are not supported within a single TC

Any number of on-board application processes may provide a single instance of the memory management service; however, the number of instances shall ensure that all on-board changeable memory areas can be loaded and that all on-board memory areas can be dumped.

Description

The memory management service provides basic dump, load and check facilities.

A “Memory ID” uniquely identifies each on-board memory block.

The addressing technique used for memory load, dump and check requests and reports is the absolute addressing. This allows the user to specify a real address to start loading or dumping from. The address is expressed in Smallest Addressable Unit (SAU) corresponding to the one of the selected memory ID. See volume B for details.

4.6.1 TC(6,2): Load Memory using Absolute Addresses

4.6.1.1 Description

TC(6,2) shall load any data or code to the memory on-board identified by the relevant parameters of the TC. No scattered Memory Load is foreseen.

4.6.1.2 Structure

PUS-3450//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 6

Service Subtype : Must be set to 2

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Memory ID	Start Address	Length	Data
Enumerated	Unsigned integer	Unsigned integer	Unsigned integer
2 bytes	4 bytes	4 bytes	Variable

Table 4.6-2: Structure of the Application data TC(6,2)

4.6.1.3 Parameter Definition & Range

PUS-3472//

The parameters of the Application Data Field *shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Memory ID	Identification Number of the on board memory block	Must be set according to a valid memory ID See Volume B.
Start Address	Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero) within the memory block for loading the data	A valid address of the memory addressed by *Memory ID.*
Length	Length of data block (in **S**mallest **A**ddressable **U**nits, with count starting from 1)	1 …. MAXSAU (MAXSAU is application depending, see Volume B) And Limited by size of TC Application Data field. Start Address + Length - 1 must be within the physical limits of the memory.
Data	The data to be loaded	Data must be arranged in increasing order of SAU.

Table 4.6-3: Parameters of the Application Data for TC(6,2)

Note: In case the amount of data to be uploaded exceeds the capacity of a TC Source Packet, as many source packets as required shall be generated, each with consistent parameters.

4.6.1.4 TC Verification

PUS-3497//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3499//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if the *Memory ID* is invalid

•if the addressed memory is not accessible (i.e. if *Start Address* + *Length exceeds* the physical memory)

•if physical access is not possible (i.e. EEPROM access failed, time out, write protection etc.)

• if the length value is inconsistent with the number of memory data

4.6.2 TC(6,5): Dump Memory using Absolute Addresses

4.6.2.1 Description

TC(6,5) requests a dump of any data or code from the memory onboard identified by the relevant parameters of the TC. No scattered Memory Dump is foreseen.

4.6.2.2 Structure

PUS-3508//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 6

Service Subtype : Must be set to 5

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Memory ID	Start Address	Length
Enumerated	Unsigned integer	Unsigned integer
2 bytes	4 bytes	4 bytes

Table 4.6-4: Structure of the Application data TC(6,5)

4.6.2.3 Parameter Definition & Range

PUS-3526/I

The parameters of the Application Data Field *shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Memory ID	Identification Number of the on board memory block	Must be set according to a valid memory ID See Volume B.
Start Address	Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero) within the memory block for loading the data	A valid address of the memory addressed by *Memory ID.*
Length	Number of **SAU**'s to be dumped	1 …. MAXSAU (MAXSAU is application depending; details are provided in the APID specific annexes of this document.) Start Address + Length - 1 must be within the physical limits of the memory.

Table 4.6-5: Parameters of the Application Data for TC(6,5)

4.6.2.4 TC Verification

PUS-3546/I

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3548/I

TM(1,7): TC Execution Completion Report - Success shall be generated when the last packet of the requested dump has been released

PUS-3549/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if the *Memory ID* is invalid

•if the addressed memory is not accessible (i.e. if *Start Address* + *Length exceeds* the physical memory)

•if the request could not be completed, since superseded by new request.

4.6.3 TM(6,6): Memory Dump using Absolute Addresses Report

4.6.3.1 Description

TM(6,6) is the response to TC(6,5).

In case the amount of data to be down linked exceeds the max. size of a TM(6,6), as many TM(6,6) packets as requested by TC(6,5) shall be generated. Each of these TM packets will be self-contained, i.e. Start Address and Length of dump are consistent with the dumped data presented in the related TM dump packet. The bandwidth for the amount of TM(6,6) packets may be reduced (bandwidth adjustment mechanism).

4.6.3.2 Structure

PUS-3558//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 9 (dump)

Service Type : Must be set to 6

Service Subtype : Must be set to 6

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

Memory ID	Start Address	Length	Data
Enumerated	Unsigned integer	Unsigned integer	Unsigned Integer
2 bytes	4 bytes	4 bytes	Variable

Table 4.6-6: Structure of the Source data TM(6,6)

4.6.3.3 Parameter Definition & Range

PUS-3580//

The parameters of the Source Data Field *shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
Memory ID	Identification Number of the on board memory block	SeeVolume B.
Start Address	Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero)	Address of the memory addressed by *Memory ID.*
Length	Length of data block (in **S**mallest **A**ddressable **U**nits, with count starting from one)	The maximum value is limited by size of TM Source Packet and may be further restricted by the individual APID
Data	dump data	Data are arranged in increasing order of SAU.

Table 4.6-7: Parameters of the Source data for TM(6,6)

4.6.3.4 Remarks

Note: The ‘Data’ field shall contain data referring to memory addresses which are contiguous i.e. increasing without gaps (e.g. page boundaries shall be taken into account such that several dump packets are generated if the dump request goes across them).

The meaning of Length field shall be the same as for the load command TC(6,2).

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.6.4 TC(6,9): Check Memory using Absolute Addresses

4.6.4.1 Description

TC(6,9) allows for requesting a checksum report.

4.6.4.2 Structure

PUS-3611//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 6

Service Subtype : Must be set to 9

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Memory ID	Start Address	Length
Enumerated	Unsigned integer	Unsigned integer
2 bytes	4 bytes	4 bytes

Table 4.6-8: Structure of the Application data TC(6,9)

4.6.4.3 Parameter Definition & Range

PUS-3630//

The parameters of the Application Data Field *shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Memory ID	Identification Number of the on board memory block	Must be set according to a valid memory ID See Volume B.

Parameters of Application Data Field	Description	Range or value
Start Address	Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero)	A valid address of the memory addressed by *Memory ID.*
Length	Length of data block (in **S**mallest **A**ddressable **U**nits, with count starting from one)	Start Address + Length - 1 must be within the physical limits of the memory.

Table 4.6-9: Parameters of the Application Data for TC(6,9)

4.6.4.4 TC Verification

PUS-3650//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3652//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if the *Memory ID* is invalid

•if the addressed memory is not accessible (i.e. if *Start Address + Length exceeds* the physical memory) or cross the boundary of the memory block

4.6.5 TM(6,10): Memory Check using Absolute Addresses Report

4.6.5.1 Description

TM(6,10) is the response to TC(6,9).

4.6.5.2 Structure

PUS-3660//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (Table)

Service Type : Must be set to 6

Service Subtype : Must be set to 10

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

Memory ID	Start Address	Length	Checksum
Enumerated	Unsigned integer	Unsigned integer	Unsigned integer
2 bytes	4 bytes	4 bytes	2 bytes

Table 4.6-10: Structure of the Source data TM(6,10)

4.6.5.3 Parameter Definition & Range

PUS-3682//

The parameters of the Source Data Field *shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
Memory ID	Identification Number of the on board memory block	See Volume B.
Start Address	Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero)	Address of the memory addressed by *Memory ID.*
Length	Length of data block (in **S**mallest **A**ddressable **U**nits, with count starting from one)	Limited by size of addressed Memory
Checksum	CRC 16 bit checksum (according to [ND-154])	

Table 4.6-11: Parameters of the Source data for TM(6,10)

4.7 Service 8: Function Management Service

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(8,1)	TC	Perform Function	Basic
(8,140)	TC	Enable Function Execution	Specific
(8,141)	TC	Disable Function Execution	Specific
(8,142)	TC	Enable Autoreset of Execution Enable Flag	Specific
(8,143)	TC	Disable Autoreset of Execution Enable Flag	Specific
(8,144)	TC	Report Function Status	Basic
(8,145)	TM	Function Status Report	Basic
(8,128)	TM	Service 8 Table Configuration Report	Specific

Table 4.7-1: Service 8 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with *“Basic”* will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

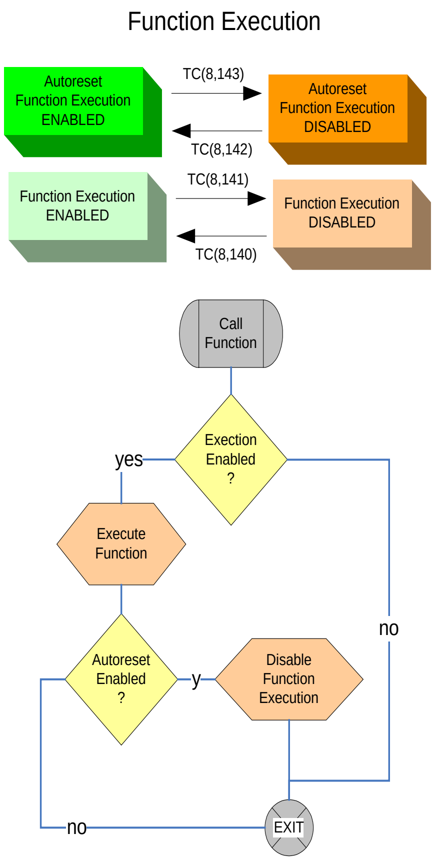


Figure 4.7-1: Function State Diagram

Service 8 implements a two step approach to protect from unwanted function execution. To achieve this, the following principles apply:

•each function ID has two independent status flags, the "execution enabled" flag and the "autoreset" flag.

•the two flags are accessible by dedicated TC's

•in general function execution is allowed if the "execution enabled" flag is set.

•the flag does not change its status unless the "autoreset" flag is activated

•if this is the case, each time after function execution the "execution enabled" flag is set back to "disabled"

•the user has to send "Enable Function Execution" before the function can be called the next time

4.7.1 TC(8,1): Perform Function

4.7.1.1 Description

TC(8,1) performs the function with the specified *Function ID,* if its execution is allowed. i.e. the current status is “enabled”.

4.7.1.2 Structure

PUS-3768//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 8

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Function ID	Parameters
Enumerated	N Parameters of any Type
1 byte	0 .. m byte

Table 4.7-2: Structure of the Application data TC(8,1)

4.7.1.3 Parameter Definition & Range

PUS-3784//

The parameters of the Application Data Field *shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Function ID	Identification number of the function to be activated	0....255
Parameter	Parameter relating to the function to be performed	See APID specific volumes

Table 4.7-3: Parameters of the Application Data for TC(8,1)

4.7.1.4 TC Verification

PUS-3800//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3802//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The Function ID is not defined	FID_UNKNOWN_FUNC_ID
[3]	The "execution status" of the function is "disabled"	FID_FUNCTION_DIS
[4]	Function execution failed	FID_FUNCTION_FAIL

4.7.2 TC(8,140): Enable Function Execution

4.7.2.1 Description

TC(8,140) sets the *execution status* of the function identified by *Function ID* to "Enabled".

4.7.2.2 Structure

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 8

Service Subtype : Must be set to 140

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	Function ID
Unsigned integer	Enumerated
1 byte	1 byte
	< ------ repeat N times ------ >

Table 4.7-4: Structure of the Application data TC(8,140)

4.7.2.3 Parameter Definition & Requirements

PUS-3829//

The parameters of the Application Data Field *shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N	Number of function status values to be set	**N=0:** All functions status values shall be set; 1....NMAX[1)]
Function ID	Identification number of the Function	See APID specific volumes

Table 4.7-5: Parameters of the Application Data for TC(8,140)

Note 1)

NMAX = 193 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.7.2.4 TC Verification

PUS-3845//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3847//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is not consistent with the real length of the packet data field	FID_FUNC_ID_LEN_DISCREP
[3]	N is outside the range specified above	FID_INVALID_N_FUNC_ID
[4]	At least one of the Function IDs is not defined	FID_UNKNOWN_FUNC_ID

4.7.3 TC(8,141): Disable Function Execution

4.7.3.1 Description

TC(8,141) sets the *execution status* of the function identified by *Function ID* to “Disabled”.

4.7.3.2 Structure

PUS-3855//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 8

Service Subtype : Must be set to 141

The structure of the *Application Data* field within the TC *Packet Data* field is identical to the one defined for TC(8,140). See Table 4.7-4 (Structure of the Application Data TC(8,140))

4.7.3.3 TC Verification

PUS-3859//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3861//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is not consistent with the real length of the packet data field	FID_FUNC_ID_LEN_DISCREP
[3]	N is outside the range specified above	FID_INVALID_N_FUNC_ID
[4]	At least one of the Function IDs is not defined	FID_UNKNOWN_FUNC_ID

4.7.4 TC(8,142): Enable Autoreset of Execution Enable Flag

4.7.4.1 Description

TC(8,142) sets the *autoreset status* of the function identified by *Function ID* to "Autoreset Enabled" and the *execution status* to "Disabled". This means the function must be explicitly enabled before it can be executed only once. After execution the function status is set back to "Disabled" automatically.

4.7.4.2 Structure

PUS-3869//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 8

Service Subtype : Must be set to 142

The structure of the *Application Data* field within the TC *Packet Data* field is identical to the one defined for TC(8,140). See Table 4.7-4 (Structure of the Application Data TC(8,140))

4.7.4.3 TC Verification

PUS-3874//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3876//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is not consistent with the real length of the packet data field	FID_FUNC_ID_LEN_DISCREP
[3]	N is outside the range specified above	FID_INVALID_N_FUNC_ID
[4]	At least one of the Function IDs is not defined	FID_UNKNOWN_FUNC_ID

4.7.5 TC(8,143): Disable Autoreset of Execution Enable Flag

4.7.5.1 Description

TC(8,143) sets the *autoreset status* of the function identified by *Function ID* to "Auroreset disabled". The *execution status* is unaffected. With "Autoreset disabled" the *execution status* remains statically at the value set by TC(8,140) and TC(8,141), regardless whether the function has been executed or not.

4.7.5.2 Structure

PUS-3884//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 8

Service Subtype : Must be set to 143

The structure of the *Application Data* field within the TC *Packet Data* field is identical to the one defined for TC(8,140). See Table 4.7-4 (Structure of the Application Data TC(8,140))

4.7.5.3 TC Verification

PUS-3889//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3891//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is not consistent with the real length of the packet data field	FID_FUNC_ID_LEN_DISCREP
[3]	N is outside the range specified above	FID_INVALID_N_FUNC_ID
[4]	At least one of the Function IDs is not defined	FID_UNKNOWN_FUNC_ID

4.7.6 TC(8,144): Report Function Status

4.7.6.1 Description

TC(8,144) requests the Function Status Report TM(8,145).

4.7.6.2 Structure

PUS-3899//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 8

Service Subtype : Must be set to 144

The structure of the *Application Data* field within the TC *Packet Data* field is identical to the one defined for TC(8,140). See Table 4.7-4 (Structure of the Application Data TC(8,140))

4.7.6.3 TC Verification

PUS-3904//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-3906//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is not consistent with the real length of the packet data field	FID_FUNC_ID_LEN_DISCREP
[3]	N is outside the range specified above	FID_INVALID_N_FUNC_ID
[4]	At least one of the Function IDs is not defined	FID_UNKNOWN_FUNC_ID
[5]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.7.7 TM(8,145) Function Status Report

4.7.7.1 Description

TM(8,145) is the response to TC(8,144).

4.7.7.2 Structure

PUS-3915//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 8

Service Subtype : Must be set to 145

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N	Function Id	Filler	Execution Status	Filler	Autoreset Status
Unsigned Integer	Enumerated		Boolean		Boolean
1 byte	1 byte	7 bit	1 bit	7 bit	1 bit
	< ------ repeat N times ------ >				

Table 4.7-6: Structure of the Source data TM(8,145)

4.7.7.3 Parameter Definition & Range

PUS-3949//

The parameters of the Source Data Field *shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
N	Number of *Function IDs* to follow	1 .. N_MAX[1)]

Parameters of Source Data Field	Description	Range or value
Function ID	Identification number of the Function	See APID specific volumes
Execution Status	Defines whether the execution of the function is enabled or disabled	0 = Disabled 1 = Enabled
Autoreset Status	Defines whether the autoreset mechanism of the function is enabled or disabled	0 = Disabled 1 = Enabled

Table 4.7-7: Parameters of the Source data for TM(8,145)

Note 1)

N_MAX = 255 (max value due to the 1 byte length of the N parameter)

4.7.7.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.7.8 TM(8,128) Downlink Service 8 Table Report

4.7.8.1 Description

TM(8,128) is the response to a specific TC(8,1) function ID , which requests this table dump.

4.7.8.2 Structure

PUS-18732//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 8

Service Subtype : Must be set to 128

The generic structure of the *Source Data* field within the *TM Packet Data* field is defined here below. The detailed layout depends on the related Service 8 table ID

Table ID	Table Data
Enumerated	Byte
1 byte	variable length

Table 4.7-8: Structure of the Source data TM(8,128)

4.7.8.3 Parameter Definition & Range

PUS-18762//

The parameters of the Source Data Field *shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
Table ID	Unique indentifier of Service 8 table	see volume B
Table Data	Content of identified table	Individual structure with vaiable length Size 1 .. 2033 Byte

Table 4.7-9: Parameters of the Source data for TM(8,128)

4.8 Service 9: Time Management Service

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(9,1)	TC	Change Time Report Generation Rate	Specific
(9,2)	TM	Time/OP Report	Specific
(9,128)	TC	Set Central OBT	Specific
(9,130)	TC	Set Orbit Number	Specific
(9,133)	TC	Enable Synchronization of GPS to OBC time	Specific
(9,134)	TC	Disable Synchronization of GPS to OBC time	Specific
(9,135)	TC	Trigger Time Synchronization Verification	Specific
(9,136)	TC	Select Time Synchronization Reference	Specific

Table 4.8-1: Service 9 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with *“Basic”* will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *"Specific"* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

On-board Time System Overview

The on-board time (OBT) system consists of

- An Absolute Time Provider, the GPS/GNSS receiver issuing a synchronization signal identifying the GPS time system 1 second roll-over and a GPS time message either as dedicated TM packet or as part of the PVT solution

- A Central On-board Time (COBT) master e.g. as part of the on-board computer, also call On-board Time Reference (OBTR), mastering time used across the satellite by distribution on-board time synchronization messages and signals

- An on-board time reporting capability from space segment to ground segment providing the COBT relation to transmission start of selected transfer frames, thus allowing a correlation of the space segment COBT with the ground segment time reference.

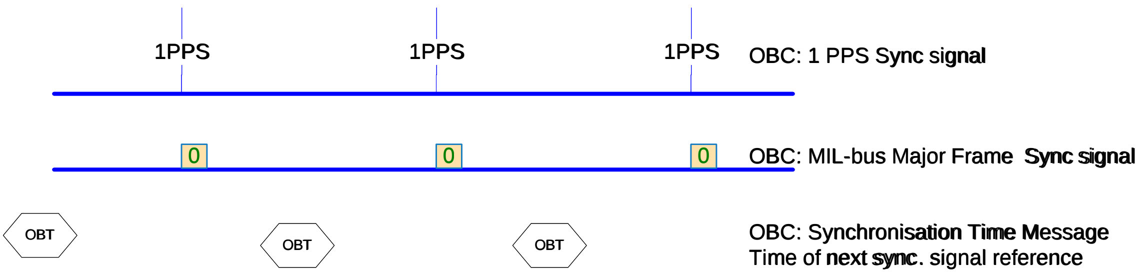
- A number of datation users, each comprising a Local On-board Time (LOBT) function for standalone operation, which is to be synchronized to the COBT to ensure consistent and full performance operation.

- There are two classes of datation users defined depending on the accuracy of the synchronized operation:

  - Class A datation users will be synchronized by dedicated HW line, the 1 PPS signal

  - Class B datation users will be synchronized by communication protocol embedded synchronization reference, which is the start of the major frame of the MIL-Bus Protocol.

The COBT is distributed as part of the communication via the on-board time synchronization message, which is provided well before the next synchronization reference signal and which contains the OBT of the next synchronization reference. For Class A users this is the 1 PPS signal from the OBC, for Class B users this is the major frame start of the MIL-Bus Protocol as depicted in following figure



The time format shall be CUC with Agency defined epoch with Coarse Time (seconds) using 4 bytes and 3 bytes for fine time. Type and Format code are as follows: PTC=9; PFC=18[1)]

Note 1):

(See Table "Parameter Type Definition" in Volume B)

PTC: Parameter Type Code

PFC: Parameter Format Code

The P-Field shall be: ***0010_1111bin***.

p-field code:
Bit 0 = extension bit (0=no extension)
Bit 1-3 = Time code Id (010 - Agency defined epoch)
Bit 4-5 = NbOf bytes of coarse time - 1
Bit 6-7 = NbOf bytes of fine time

Table 4.8-2: p-codes

<u>Reporting of Onboard Time:</u>

The rate control sub-service shall maintain the *generation rate* (16, 32, 64, 128 or 256) of the time report. It shall also have means of communicating this generation rate to the time reporting sub-service.

The time reporting sub-service shall have access to the satellite time reference which is a free running counter from a given epoch (i.e. absolute time). The satellite time reference shall be sampled at the instant of occurrence of the leading edge of the first bit of the attached synchronization marker of the telemetry transfer frame of Virtual Channel 0 that has a virtual channel frame count of “0” and for each subsequent frame for which: virtual channel frame count modulo (*generation rate*) = 0.

The synchronisation state of the on-board time system is reported in the *Time Sync/Quality field* of the related report as well as in the corresponding field in the data field header of each TM source packet.

The time reporting sub-service shall then downlink this satellite time reference in a spacecraft time source packet at any time before the satellite time reference is next sampled. When a new generation rate is requested, the time reporting sub-service shall use this new generation rate from the next telemetry transfer frame that meets the above criterion.

Calculation of Time Period between two TM(9,2) packets:

The s-band downlink budget for VC0 is, for example, 12 Kbps = 1500 bytes / sec the length of a VC0 transfer frame is 1115 bytes, thus appr. 1.35 VC0 frames are generated in one second in average. Assuming the *generation rate* has been set to 32, a TM(9,2) would be generated with a period of **23.7secs**.

Nominally, the Ground segment performs the first on-board time initialisation by using PUS Service TC(9,128) “Set Central OBT” (see [RD2]). The TC(9,128) parameter contains:

•an *absolute time* value (set new OBT action in TC) in order to set the coarse time in CUC-Format (i.e. seconds) that will be valid at the time of the next OBC PPS;

•a *relative time* value (add/subtract delta time from OBT action in TC) in order to set both the coarse and fine time in CUC-Format that will be used to adjust the current COBT at the time of the next OBC PPS.

In case of a *relative time* value, the CSW shall synchronise both the coarse and fine time of the COBT with the provided relative time correction using a smooth synchronisation algorithm:

•**add delta time**: adjust Master TTRM OBT NCO to *accelerate* clock;

•**subtract delta time**: adjust Master TTRM OBT NCO to *decelerate* clock.

Reference Cases for Sync Time Quality Setting in the data field header of TM source packets

Note: The listed cases are examplary and non-exhaustive

Before first COBT synchronisation or TC based COBT setting has been performed the contents of the "Time/Sync Quality" byte for **COBT master** based TM packets will read.

Bit	**Description**	**Value**
3	Time Type	0 = SCET
4	Sync Source	0 = Internal
5	Sync Method	1 = 1Hz Pulse
6	Sync Status	0 = NoSync i.e not synchronised with GPST
7	Sync Ena/Dis	0 = Disabled

Table 4.8-3: Initial COBT "Time/Sync Quality" byte contents before synchronisation/time setting for COBT master **based TM packets**

In case the COBT is set by TC(9,128) but COBT synchronisation is not yet enabled the contents of the "Time/Sync Quality" byte for **COBT master** based TM packets will read.

Bit	**Description**	**Value**
3	Time Type	1 = OBT
4	Sync Source	0 = Internal
5	Sync Method	1 = 1Hz Pulse
6	Sync Status	0 = NoSync i.e not synchronised with GPST
7	Sync Ena/Dis	0 = Disabled

Table 4.8-4: COBT "Time/Sync Quality" byte contents before synchronisation but after time setting for COBT master **based TM packets**

In case of successful COBT synchronisation to GPST the contents of the "Time/Sync Quality" byte for **COBT master** based TM packets will read.

Bit	**Description**	**Value**
3	Time Type	1 = OBT
4	Sync Source	1 = External
5	Sync Method	1 = 1Hz Pulse
6	Sync Status	1 = InSync i.e synchronised with GPST
7	Sync Ena/Dis	1 = Enabled

Table 4.8-5: COBT "Time/Sync Quality" byte contents after synchronisation with GPST for COBT master **based TM packets**

After the LOBT is synchronised to COBT, the contents of the "Time/Sync Quality" byte for **Class A LOBT users** will read.

Bit	**Description**	**Value**

3	Time Type	1 = OBT
4	Sync Source	1 = External
5	Sync Method	1 = 1Hz Pulse / 1_PPS
6	Sync Status	1 = InSync i.e synchronised with COBT
7	Sync Ena/Dis	1 = Enabled

Table 4.8-6: LOBT "Time/Sync Quality" byte contents after synchronisation with COBT for Class A LOBT users

In case of a missing time broadcast message or a missing PPS signal, the contents of the "Time/Sync Quality" byte for **Class A LOBT users** will read:

Bit	**Description**	**Value**
3	Time Type	1 = OBT
4	Sync Source	0 = Internal
5	Sync Method	1 = 1Hz Pulse / 1_PPS
6	Sync Status	0 = NoSync
7	Sync Ena/Dis	1 = Enabled

Table 4.8-7: LOBT "Time/Sync Quality" byte contents after loss of synchronisation for Class A LOBT users

In case of no synchronisaton can be achieved after power up, the contents of the "Time/Sync Quality" byte for **Class A LOBT users** will read:

Bit	**Description**	**Value**
3	Time Type	0 = SCET
4	Sync Source	0 = Internal
5	Sync Method	1 = 1Hz Pulse / 1_PPS
6	Sync Status	0 = NoSync
7	Sync Ena/Dis	1 = Enabled

Table 4.8-8: LOBT "Time/Sync Quality" byte contents after loss of synchronisation for Class A LOBT users

After the LOBT is synchronised to COBT, the contents of the "Time/Sync Quality" byte for **Class B LOBT users** will read.

Bit	**Description**	**Value**
3	Time Type	1 = OBT
4	Sync Source	1 = External
5	Sync Method	0 = MIL-Bus Major Frame
6	Sync Status	1 = InSync i.e synchronised with COBT

7 Sync Ena/Dis 1 = Enabled

Table 4.8-9: LOBT "Time/Sync Quality" byte contents after synchronisation with COBT for Class B LOBT users

4.8.1 TC(9,1): Change the Time Report Generation Rate

4.8.1.1 Description

TC(9,1) is used to change the reference VC0 Transfer Frame Counter ID for which a time report packet TM (9,2) will be generated. It sets the generation rate in terms of number of VC0 transfer frames used to sample and downlink the satellite time packet TM(9,2).

4.8.1.2 Structure

PUS-4057/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 9

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Rate
Unsigned integer
1 byte

Table 4.8-10: Structure of the Application data TC(9,1)

4.8.1.3 Parameter Definition & Range

PUS-4072/I

The parameters of the Application Data Field *shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Rate	This parameter determines the generation rate used to sample and downlink the satellite time. Its value shall be in the range 0 to 8 inclusive. The corresponding generation rate is equal to once every 2^{Rate} telemetry transfer frames.	In range 0....8 operationaly used range: 4 ... 8

Table 4.8-11: Parameters of the Application Data for TC(9,1)

4.8.1.4 TC Verification

PUS-4084//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-4086//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if the rate is not in the specific range

4.8.2 TM(9, 2): Time/OP Report

4.8.2.1 Description

TM(9,2) is used to report the spacecraft time as well as the orbit position to the ground, which is correlated to the last VC0 TM frame with frame counter 0.

4.8.2.1.1 Structure

PUS-4092//

The parameters of the TM Packet Header (being not defined in Section 2) shall be inserted according to the following table.

Parameter	Description	Range or value
Data Field Header Flag	Indicates the presence of a data field header (when set to 1)	Must be set to 0
PRID	Process ID (part of the APID)	Must be set to 0
PCAT	Packet category	Must be set to 0
Packet Length	Number of bytes contained in the packet data field minus 1	Must be set to 18 (2 byte CRC need to be respected)

Table 4.8-12: TM Packet Header for TM(9,2)

S-Field	P-Field	Satellite Time		TimeSync /Quality	Orbit Position		OPSStatus
		Integer Second	Sub-seconds		Orbit Number	Orbit Angle	
Unsigned Integer	Unsigned Integer	Unsigned integer	Unsigned integer	Enumerated	Unsigned integer	Unsigned integer	Enumerated
1 byte	1 byte	4 bytes	3 bytes	1 byte	4 bytes	2 bytes	1 byte

Table 4.8-13: Structure of the Source data TM(9,2)

4.8.2.2 Parameter Definition & Range

PUS-4144//

The parameters of the Data Field *shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
On-board Time	Coarse Time field	In range 0 .. 2^{32} - 1
Subseconds	Fine Time LSB = 1/2^{24} sec	In range 0 .. 2^{24} - 1
Time Sync/Quality	This shall give the status of the time reporting sub-service, i.e. current PPS source and whether synchronization is enabled	**Bit 3 :** Time Type 0 = S/C ElapsedTime (SCET ; after boot); 1 = OBT **Bit 4 :** Sync. Source 0 = internal; 1 = external **Bit 5 :** Sync. Method 1 = 1Hz Pulse; 0 = MIL-Bus Major Frame **Bit 6 :** Sync. Status 0 = NoSync; 1 = InSync **Bit 7 :** …Synchronization Enabled/Disabled 0 = Disabled; 1 = Enabled
Orbit Number	Number of orbit. The orbit number is increased at each ascending equator crossing.	In range 0 .. 2^{32} - 1
Orbit Angle	Orbit Angle	The angle in [radians] x 10000. Angle = 0 corresponds to at each ascending equator crossing.

Parameters of Source Data Field	Description	Range or value
OPSStatus	This shall give the status of the orbit position reporting sub-service, i.e. current orbit position source and whether orbit position is valid	**Bit 5 :** GPS_PVT status Valid/Invalid 0 = Valid; 1 = Invalid **Bit 6 :** orbit position source 0 = AOC_OOP; 1 = GPS_PVT **Bit 7 :** …orbit position validity status Valid/Invalid 0 = Valid; 1 = Invalid

Table 4.8-14: Parameters of the Source data for TM(9,2)

4.8.2.3 Remarks

Note: The satellite time in On-board Time (OBT) time format is referenced to 00:00:00 UT on January 6th, 1980.

4.8.3 TC(9,128): Set Central OBT

4.8.3.1 Description

TC(9,128) is used to set the Central OBT of the datation master of the on-board time system. The service sub-type supports setting of an absolute time value as well as setting of delta time.

4.8.3.2 Structure

PUS-4183//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 9

Service Subtype : Must be set to 128

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Action	Satellite Time	
Enumerated	Integer Second	Sub-seconds
	Unsigned integer	Unsigned integer
1byte	4 bytes	3 bytes

Table 4.8-15: Structure of the Application data TC(9,128)

4.8.3.3 Parameter Definition & Range

PUS-4207//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Action	Definition of time set operation	0 … set new OBT 1 … add delta time to OBT 2 ... subtract delta time from OBT
Integer Second	GPS Time or SCET	In range 0 .. 2^{32} - 1
Subseconds	Fine Time LSB = $1/2^{24}$ sec	Must be set to zero in case of "Action"=00

Table 4.8-16: Parameters of the Application Data for TC(9,128)

4.8.3.4 TC Verification

PUS-4227//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-4229//

TM(1,8): TC Execution Completion Report - Failure shall be generated

- if one of the consistency checks according to Section 4.1 failed
- if the synchronization with GPS time is enabled
- in case of over-/underflow check failure

4.8.4 TC(9,130): Set Orbit Number

4.8.4.1 Description

TC(9,130) is used to set Orbit Number which is used in the Orbit Position Scheduling service.The service sub-type supports setting of an absolute orbit number as well as subtracting or adding an orbit number.

4.8.4.2 Structure

PUS-4238//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 9

Service Subtype : Must be set to 130

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Action	OrbitNumber
Enumerated	Unsigned integer
1 byte	4 bytes

Table 4.8-17: Structure of the Application data TC(9,130)

4.8.4.3 Parameter Definition & Range

PUS-4256/I

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Action	Definition of orbit set operation	0 … set new orbit 1 ... add delta to current orbit 2 … subtract delta from current orbit
Orbit Number	Number of orbit. The orbit number is increased at each ascending equator crossing.	In range 0 .. 2^{32} - 1

Table 4.8-18: Parameters of the Application Data for TC(9,130)

4.8.4.4 TC Verification

PUS-4272/I

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-4274/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

- if one of the consistency checks according to Section 4.1 failed

4.8.5 TC(9,133): Enable Synchronization of GPS / OBC time

4.8.5.1 Description

Upon reception of TC(9,133) the datation master will start permanently synchronizing the COBT with the time received from the absolute time provider i.e. the GPS receiver. The 1 Hz cycle and the 1 Hz clock output will be synchronized as well.

4.8.5.2 Structure

PUS-4280/I/

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 9

Service Subtype : Must be set to 133

TC(9,133) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.8.5.3 TC Verification

PUS-4287/I/

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-4289/I/

TM(1,8): TC Execution Completion Report - Failure shall be generated

- if one of the consistency checks according to Section 4.1 failed

4.8.6 TC(9,134): Disable Synchronization of GPS to OBC time

4.8.6.1 Description

Upon reception of TC(9,134) the datation master will stop permanently synchronizing the OBC time with the time received from the absolute time provider i.e. the GPS receiver.

4.8.6.2 Structure

PUS-4295/I/

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 9

Service Subtype : Must be set to 134

TC(9,134) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.8.6.3 TC Verification

PUS-4302/I

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-4304/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

- if one of the consistency checks according to Section 4.1 failed

4.8.7 TC(9,135): Trigger Time Synchronization Verification

4.8.7.1 Description

Upon reception of TC(9,135) the receiving application shall generate at reception of the next synchronisation reference and distribute

in case of successful synchronisation an event report packet TM(5,1) containing

- Info 1 parameter: LOBT at reception of this TC
- Info 2 parameter: received OBT for next synchronization reference
- Info 3 parameter: new LOBT at synchronization reference
- Info 4 parameter: original LOBT at synchronisation reference

Note:

The difference (Info 3 parameter - Info 4 parameter) yields the drift of the LOBT in between 2 synchronisation references.

in case of unsuccessful synchronisation an event report packet TM(5,3) containing

- Info 1 parameter: LOBT at reception of this TC
- Info 2 parameter: received OBT for next synchronization reference
- Info 3 parameter: new LOBT at synchronization reference
- Info 4 parameter: original LOBT at synchronisation reference

4.8.7.2 Structure

PUS-4318/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 9

Service Subtype : Must be set to 135

TC(9,135) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.8.7.3 TC Verification

PUS-4325//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-4327//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

4.8.8 TC(9,136): Select Time Synchronization Reference

4.8.8.1 Description

TC(9,136) is used to select the synchronization reference for external datation users. This can be either PPS main, PPS red or none.

4.8.8.2 Structure

PUS-4335//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 9

Service Subtype : Must be set to 136

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Filler	SyncRef
Unsigned integer	Unsigned integer
6 bit	2 bit

Table 4.8-19: Structure of the Application data TC(9,136)

4.8.8.3 Parameter Definition & Range

PUS-4353//

The parameters of the Application Data Field *shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
SyncRef	Identifies the current synchronization reference	0 … none 1 ... PPS main 2 …PPS red

Table 4.8-20: Parameters of the Application Data for TC(9,136)

4.8.8.4 TC Verification

PUS-4369//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-4371//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

4.9 Service 11: On Board Operations Scheduling

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(11,1)	TC	Enable Release of Telecommands	Specific
(11,2)	TC	Disable Release of Telecommands	Specific
(11,3)	TC	Reset Command Schedule	Specific
(11,4)	TC	Insert Telecommands in Command Schedule	Specific
(11,5)	TC	Delete Telecommands	Specific
(11,6)	TC	Delete Telecommands over Time Period	Specific
(11,7)	TC	Time-Shift selected Telecommands	Specific
(11,8)	TC	Time-Shift selected Telecommands over Time Period	Specific
(11,9)	TC	Report Subset of Command Schedule in Detailed Form	Specific
(11,10)	TM	Detailed Schedule Report	Specific
(11,11)	TC	Report Subset of Command Schedule in Detailed Form over Time Period	Specific
(11,12)	TC	Report Subset of Command Schedule in Summary Form	Specific
(11,13)	TM	Summary Schedule Report	Specific
(11,14)	TC	Report Subset of Command Schedule in Summary Form over Time Period	Specific

Service, Subservice	TM/TC	Description	Applicability
(11,15)	TC	Time-Shifting all Time Tagged Telecommands	Specific
(11,16)	TC	Report Command Schedule in Detailed Form	Specific
(11,17)	TC	Report Command Schedule in Summary Form	Specific
(11,18)	TC	Report Status of Command Schedule	Specific
(11,19)	TM	Command Schedule Status Report	Specific

Table 4.9-1: Service 11 sub-services

The column "Applicability" in the table above shall be interpreted as follows:

•All services marked with *"Basic"* will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *"Specific"* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Objective

The on-board operations scheduling service provides the capability to command on-board application processes using telecommands pre-loaded on-board the satellite and released at their due time. To achieve this, the service maintains an on-board command schedule and ensures the timely execution of telecommands contained therein.

Description

General

The on-board operations scheduling service shall maintain a command schedule which contains telecommand packets and their associated scheduling information.

The service user(s) can request the following activities:

- Enable the scheduling of all, or a subset of, the telecommands in the command schedule (e.g. those to be sent to specified application processes).
- Disable the scheduling of all, or a subset of, the telecommands in the command schedule.
- Add telecommands to the command schedule.
- Delete or time shift all, or a subset of, the telecommands in the command schedule (e.g. the telecommands becoming due for release within a specified time period).
- Report on all, or a subset of, the telecommands in the command schedule.
- Report the status of the command schedule.

The command schedule

The on-board operations scheduling service maintains a command schedule consisting of telecommand packets together with their scheduling attributes. The scheduling attributes of a telecommand indicate the following:

- The sub-schedule with which the telecommand is associated. A sub-schedule is a grouping mechanism for telecommands that enables them to be controlled together with others in the same group (see point b. below).

Absolute times shall be expressed in the format PTC = 9; PFC = 17[1)] for the on-board operations scheduling service.

Note 1)

(See Table "Parameter Type Definition" in Volume B)

PTC = Parameter Type Code

PFC = Parameter Format Code

Telecommand release status

The on-board operations scheduling service shall maintain appropriate information to determine whether a telecommand should be released or not at its due time.

The release status of a telecommand shall be affected by the user requests to enable or disable the release of all or a subset of the telecommands in the command schedule. The telecommand release status shall be either “disabled” or “enabled”.

The release status of a telecommand shall be “enabled” if the release of telecommands is enabled from the command schedule, from the sub-schedule to which the telecommand belongs and from the destination application process of the telecommand.

The release status shall be “disabled” in all other cases.

Conceptually, this is as if each telecommand has three independent controlling attributes (at schedule level, at sub-schedule level and at destination application process level) whose values determine the release status of the telecommand in accordance with Table 4.9-2

The release status will be managed according to Table 4.9-2:

Schedule	Sub-schedule	PRID	Release Status
D(isabled)	E(nabled)	E	D
D	D	E	D
D	E	D	D
D	D	D	D
E	E	E	E
E	D	E	D for TC's of any PRID in disabled sub-schedule
E	E	D	D for TC's of disabled PRID in all sub-schedules
E	D	D	D

Table 4.9-2: Release status decision table

<u>Auxiliary information</u>

The on-board operations scheduling service shall also have access to other information needed for the proper execution of its activities. This includes:

- The maximum number of entries or maximum size of the command schedule.
- The maximum number of sub-schedules which can be simultaneously managed.
- The list of sources from which the service can receive telecommand packets to be scheduled.
- The list of on-board application processes to which the service can release telecommand packets.

The service shall use this information for error detection and reporting.

<u>The scheduling activity</u>

The processing of a telecommand packet whose release time is due shall always be performed (even if the command schedule is disabled).

The corresponding service activity shall be:

- The telecommand shall not be released if the telecommand release status is “disabled”
- Otherwise, the telecommand shall be released.
- **<u>Note</u>:** in case a TC is due to be executed, but the release status is “disabled”, the TC shall be removed from the command schedule. In this case a TM(5,2) Error/Anomaly Report - Low Severity shall be generated.

4.9.1 TC(11,1): Enable Release of Telecommands

4.9.1.1 Description

TC(11,1) is used to enable the release of Telecommands..

4.9.1.2 Structure

PUS-4537//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N1	Sub-schedule ID	N2	Filler	PRID
Unsigned	Enumerated	Unsigned	Boolean	Enumerated
1 byte	1 byte	1 byte	1bit	7bits
			< ----- repeat *N2* times ---->	
	< ----- repeat *N1* times ---->			

Table 4.9-3: Possible Combination of Sub-schedules and PRID's

N1	Sub-schedule ID	N2	PRID	Description
0		0		Affect the MTL-schedule control bit
1	0	0		Apply to all Sub-schedules
N1 >= 1	[i], [j], [k]...	0		Apply to the N1 Sub-schedules i, j, k,...
1	0	N2 >= 1	[a], [b], [c]...	Apply to the N2 PRID's a, b, c, ...
1	SSID <> 0	N2 >= 1	[a], [b], [c]...	Not allowed combination of SSID and PRID

Table 4.9-4: Possible Combinations of Sub-schedules and PRID's

Note:PRID=0 is not allowed in this service.

4.9.1.3 Parameter Definition & Range

PUS-4571//

The parameters of the Application Data Field *shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N1	Number of Sub-schedule IDs which follow	*N1* = 0, the command will effect the schedule control bit. *N* 1> 0, *N* 2= 0 the command will effect the sub-schedule level controlling attribute of the telecommands with the specified sub-schedule ID N1=1, N2>0 and SubScheduled=0 the application process level controlling attribute of the telecommands with the specified destination application processes will be affected. Note that the PRID status and SubSchedule statuses are completely independent from each other. This means in particular that when a given PRID is disabled, no TC of this PRID will be released at all, whatever the subschedule.

Parameters of Application Data Field	Description	Range or value
Sub-schedule ID	The identification of the sub-schedule(s) to be enabled or disabled.	By convention, the value 0 for Sub-schedule ID shall mean “all sub-schedules”. 0 … 32
N2	Number of PRID combinations which follow	See N1 row
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Table 4.9-5: Parameters of the Application Data for TC(11,1)

4.9.1.4 TC Verification

PUS-4644//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-4646//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	(N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTLOPS_INVALID_SUBSET
[3]	At least one of the Sub-schedule IDs is out of the range specified	FID_MTLOPS_INVALID_SSID

4.9.2 TC(11,2): Disable Release of Telecommands

4.9.2.1 Description

TC(11,2) is used to disable the release of Telecommands..

4.9.2.2 Structure

PUS-4655//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 2

The structure of the *Application Data field within the TC Packet Data* field is identical with the one defined for TC(11,1). See Table 4.9-3 (Structure of the Application Data TC(11,1))

4.9.2.3 TC Verification

PUS-12167//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-12169//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	(N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTLOPS_INVALID_SUBSET
[3]	At least one of the Sub-schedule IDs is out of the range specified	FID_MTLOPS_INVALID_SSID

4.9.3 TC(11,3): Reset Command Schedule

4.9.3.1 Description

Upon reception of TC(11,3) the service provider shall reset the sub-schedule and PRID enabled state of the command schedule to its initial values and clear all entries from the schedule.

After TC execution the global MTL state is disabled.

The release of telecommand needs to be globally disabled by TC(11,2) before execution of the command.

4.9.3.2 Structure

PUS-4670//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 3

TC(11,3) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.9.3.3 TC Verification

PUS-4677//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-4679//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	MTL is enabled at service level	FID_MTLOPS_SERVICE_ENABL

4.9.4 TC(11,4): Insert Telecommands in Command Schedule

4.9.4.1 Description

Upon reception of TC(11,4) the TC specified by the field Telecommand Packet is inserted in the command schedule. TC's in the command schedule are reordered with increasing time tag. TC's with identical time tag are sorted in the sequence they are received. The resolution of the Time Tags is given by their fomat code (PTC/PFC). However, the execution accuracy of the TC's might be less than the Time Tag resolution itself.

Note: TC Packet Header and TC Packet Data Field may be stored separately in order to minimise CPU time for reordering the command schedule.

4.9.4.2 Structure

PUS-4687//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 4

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Sub-schedule ID	N	Time Tag	TC Packet
Unsigned Integer	Unsigned Integer	Onboard time format PTC = 9; PFC = 17	Byte String
1 bytes	1 byte	6 bytes	See Section 1.7
		<------ ------ repeat N times -------- ---------->	

Table 4.9-6: Structure of the Application data TC(11,4)

4.9.4.3 Parameter Definition & Range

The parameters of the *Application Data Field* shall be inserted according to the following table.

Parameters of Application Data Field	Description	Range or value
Sub-schedule ID	The identification of the sub-schedule to which the execution time command is assigned.	See Note 2)
N	Number of TCs to add in the Sub-schedule	See Note 1)
Time Tag	Absolute release time for the TC	Any valid spacecraft time in the specified format
TC packet	Complete TC packet	See Section 1.7

Table 4.9-7: Parameters of the Application Data for TC(11,4)

Note 1)

N shall be a constant equal to 1 in Data Base definition.

Note 2)

SSID = [1 .. 32]

4.9.4.4 TC Verification

PUS-4727//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-4729//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Sub Schedule ID is out of the range specified above (= 0)	FID_MTLOPS_INVALID_SSID
[3] N is out of the range specified above (= 0)	FID_INVALID_NPAR
[4] At least one of the Time Tags is < current OBT + MTL_INSERT_TIME_MARGIN	FID_MTLOPS_TAG_EXPIRED
[5] The command cannot be inserted in the command schedule (no more control block in MTL)	FID_MTLOPS_SCH_OVERFLOW
[6] TC length is not consistent with the headers of the included TCs	FID_TC_LENGTH_DISCREP
[7] TC to be inserted is either TC(11,4) or TC(OPS,4)	FID_MTLOPS_FORBIDDEN_TC
[8] deleted	
[9] Not enough space in TC pool	FID_TC_POOL_OVERFLOW

4.9.5 TC(11,5): Delete Telecommands

4.9.5.1 Description

Upon reception of TC(11,5) all TC's which satisfy the selection criteria defined by the PRID, Sequence Count and the Number of TC's shall be deleted.

4.9.5.2 Structure

PUS-4741//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 5

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	Filler	PRID	Filler	Sequence Count	Number of TC's
Unsigned integer		Enumerated		Unsigned integer	Unsigned integer
1 byte	1 bit	7 bits	2 bits	14 bits	1 byte
	< ----- repeat *N* times ---->				

Table 4.9-8: Structure of the Application data TC(11,5)

Note: Destination PRID and Sequence Number correspond to the Packet Header Definition in Section 1.5 .

4.9.5.3 Parameter Definition & Range

PUS-4776//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N	Number of TC areas to be deleted ("scattered delete")	1 .. N_MAX[1)]
PRID	Destination PRID of the TC to be deleted	Must be set to a value according to the PRID Table in Volume B Value is a copy of the corresponding field of the TC Packet Header of the TC's to be deleted from the command schedule
Sequence Count	The sequence number of the first TC to be deleted	An existing *Sequence Count*, value is a copy of the corresponding field of the TC Packet Header of the first TC to be deleted from the command schedule
Number of TC's	Number of successive TC's to be deleted	All TC's with given PRID between Sequence Count and Sequence Count + *Number of TC' s* - 1 shall be deleted.

Table 4.9-9: Parameters of the Application Data for TC(11,5)

Note 1)

N_MAX = 48 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.9.5.4 TC Verification

PUS-4800//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-4802//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if the expected length based on N is not consistent with the real length of the packet data field

•if the 1st TC to be deleted is not found in the command schedule. (for one parameter set)

•if the PRID is not known/registered

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	merged with [3]	
[3]	N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[4]	"Nb of SSCs" is out of the range specified above (=0)	FID_MTLOPS_INVALID_NB_SSC
[5]	SSC overflow (Start SSC + Nb of SSCs - 1> 0x3FFF)	FID_MTLOPS_SSC_OVERFLOW
[6]	deleted	

4.9.5.5 Remarks

Note: If the Number of Telecommands exceeds the total number of commands that satisfy the selection criteria, then all commands that satisfy the selection criteria shall be deleted.

4.9.6 TC(11,6): Delete Telecommands over Time Period

4.9.6.1 Description

Upon reception of TC(11,6) the TC's specified shall be removed from the command schedule. TC's in the command schedule are reordered with increasing time tag.

4.9.6.2 Structure

PUS-4813//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 6

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

RANGE	***TIME TAG-1***	***TIME TAG-2***	***N1***	***SUB-SCHEDULE ID***	***N2***	***FILLER***	***PRID***
Enumerated	Onboard time format PTC = 9; PFC = 17	Onboard time format PTC = 9; PFC = 17	Unsigned integer	Enumerated	Unsigned integer		enumerated
1 byte	6 bytes	6 bytes	1 byte	1 byte	1 byte	1 bit	7 bits
						< ----- repeat *N2* times ---->	
				< ----- repeat *N1* times ---->			

Table 4.9-10: Structure of the Application data TC(11,6)

4.9.6.3 Parameter Definition & Range

PUS-4821//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Range	Parameter for interpretation of the period given by Time Tags	see Table 4.9-13
Time Tag 1 & 2	Absolute Satellite Time	A valid time
N1	Number of Sub-schedules follow	see Table 4.9-12
Sub-schedule ID	The identification of the sub-schedule(s)	*see* Table 4.9-12, see Note 1)
N2	Number of PRID combinations to follow	see Table 4.9-12
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Table 4.9-11: Parameters of the Application Data for TC(11,6)

Note 1)

SSID = 0 all sub-schedules

SSID = [1 .. 32]

N1	Sub-schedule ID	N2	PRID	Description
0	-	-	-	the command will apply to TC's for any PRID in all sub-schedules.
>= 1	[i], [j],[k]...	0	-	the command will apply to TC's of all PRID's in the identified sub-schedules
1	0	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in all sub-schedules.
1	[i]	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedule.
>= 1	[i], [j],[k]...	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedules.

Table 4.9-12: Possible Combination of Sub-schedules and PRID's

The meaning and presence of the Time Tag parameters is according following table.

Range	Time Tag 1	Time Tag 2
0 (ALL)	n/a	n/a

Range	Time Tag 1	Time Tag 2
1 (between)	Earliest absolute time	Latest absolute time
2 (before)	Latest absolute time	n/a
3 (after)	Earliest absolute time	n/a

Table 4.9-13: Time Tag Parameters

4.9.6.4 TC Verification

PUS-4876//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-4878//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Range Type is out of the range specified above	FID_MTLOPS_INVALID_RANGE_
[3]	Time tag parameters are inconsistent (BETWEEN, Tag1>Tag2)	FID_MTLOPS_INVALID_TAG_RA
[4]	(N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTLOPS_INVALID_SUBSET
[5]	Deleted	
[6]	At least one of the Sub-schedule IDs is out of the range specified	FID_MTLOPS_INVALID_SSID

4.9.7 TC(11,7): Time-shifting selected telecommands

4.9.7.1 Description

This is a request to time-shift a selected subset of telecommands in the command schedule.

4.9.7.2 Structure

PUS-4888//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 7

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Time Offset	N	Filler	PRID	Filler	Sequence Count	Number of TC's
Relative Time	Unsigned integer		Enumerated		Unsigned integer	Unsigned integer
6 bytes	1 byte	1 bit	7 bits	2 bits	14 bits	1 byte
		< ----- repeat *N* times ---->				

Table 4.9-14: Structure of the Application data TC(11,7)

Note: Destination PRID and Sequence Number correspond to the Packet Header Definition in Section 1.5 .

4.9.7.3 Parameter Definition & Range

PUS-4925//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Time Offset	A positive or negative interval of time expressed in the length and format of relative OBT defined for the service or mission (since it is the relative time between the new and the old values of release time).	The format shall be identical to the Satellite Time format (see volume B)
N	Number of TC areas to be shifted ("scattered shifting")	1... N_MAX[1)]
PRID	Destination PRID of the TC to be time-shifted	Must be set to a value according to the PRID Table in Volume B Value is a copy of the corresponding field of the TC Packet Header of the TC's to be time-shifted the command schedule
Sequence Count	The sequence number of the first TC to be time-shifted	An existing *Sequence Count*, value is a copy of the corresponding field of the TC Packet Header of the first TC to be time-shifted in the command schedule
Number of TC's	Number of successive TC's to be time-shfted	All TC's with given PRID between Sequence Count and Sequence Count + *Number of TC' s* - 1 shall be time-shifted.

Table 4.9-15: Parameters of the Application Data for TC(11,7)

Note 1)

N_MAX = 46 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.9.7.4 TC Verification

PUS-4953//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-4955//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Deleted	
[3] N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[4] "Nb of SSCs" is out of the range specified above (=0)	FID_MTLOPS_INVALID_NB_SSC
[5] SSC overflow (Start SSC + Nb of SSCs - 1> 0x3FFF)	FID_MTLOPS_SSC_OVERFLOW
[6] No TC in the range defined by "Start SSC" and "Nb of SSCs"	FID_MTLOPS_NO_TC_FOUND
[7] At least one of the new computed Time Tags is < current OBT + MTL_INSERT_TAG_MARGIN	FID_MTLOPS_TAG_EXPIRED
[8] Time Offset is out of the range specified above (overflow) for at least one TC Time tag	FID_MTLOPS_TAG_OVERFLOW

4.9.8 TC(11,8): Time-shifting selected telecommands over a time period

4.9.8.1 Description

This request time-shift selected telecommands over a time period.

4.9.8.2 Structure

PUS-4963//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 8

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

RANGE	TIME TAG-1	TIME TAG-2	TIME OFFSET	N1	SUB-SCHEDULE ID	N2	FILLER	PRID
Enumerated	Onboard time format PTC = 9; PFC = 17	Onboard time format PTC = 9; PFC = 17	Relative Time	Unsigned integer	Enumerated	Unsigned integer		Enumerated
1 byte	6 bytes	6 bytes	6 bytes	1 byte	1 byte	1 byte	1 bit	7 bits
							< ---- repeat *N2* times ---->	
					< ----- repeat *N1* times ---->			

Table 4.9-16: Structure of the Application data TC(11,8)

Note: Destination PRID and Sequence Number correspond to the Packet Header Definition in Section 1.5

4.9.8.3 Parameter Definition & Range

PUS-4972//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Range	Parameter for interpretation of the period given by Time Tags	Range = 0: complete command schedule Range = 1: shift between time tags Range = 2: shift before Time Tag 1 Range = 3: shift after Time Tag 1
Time Tag 1 & 2	Absolute Satellite Time	Onboard time value
Time Offset	A positive or negative interval of time expressed in the length and format of relative OBT defined for the service or mission (since it is the relative time between the new and the old values of release time).	The format shall be compatible with the Satellite Time format (see volume B)
N1	Number of Sub-schedules IDs which follow	see Table 4.9-18
Sub-schedule ID	The identification of the sub-schedule	see Table 4.9-18 and note 1)
N2	Number of PRID's which follow	see Table 4.9-18
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Table 4.9-17: Parameters of the Application Data for TC(11,8)

Note 1)

SSID = 0 all sub-schedules

SSID = [1 .. 32]

N1	Sub-schedule ID	N2	PRID	Description
0	-	-	-	the command will apply to TC's for any PRID in all sub-schedules.
>= 1	[i], [j],[k]...	0	-	the command will apply to TC's of all PRID's in the identified sub-schedules
1	0	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in all sub-schedules.
1	[i]	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedule.
>= 1	[i], [j],[k]...	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedules.

Table 4.9-18: Possible Combination of Sub-schedules and PRID's

4.9.8.4 TC Verification

PUS-5008//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5010//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Range Type is out of the range specified above	FID_MTLOPS_INVALID_RANGE_
[3]	Time tag parameters are inconsistent (BETWEEN, Tag1>Tag2)	FID_MTLOPS_INVALID_TAG_RA
[4]	(N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTLOPS_INVALID_SUBSET
[5]	Deleted	
[6]	At least one of the new computed Time Tags is < current OBT + MTL_INSERT_TAG_MARGIN	FID_MTLOPS_TAG_EXPIRED
[7]	Time Offset is out of the range specified above (overflow) for at least one TC Time tag	FID_MTLOPS_TAG_OVERFLOW

4.9.9 TC(11,9): Report Subset of Command Schedule in Detailed Form

4.9.9.1 Description

Upon reception of TC(11,9) the report TM(11,10) shall be generated.

4.9.9.2 Structure

PUS-5019//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 9

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	Filler	PRID	Filler	Sequence Count	Number of TC's
Unsigned integer		Enumerated		Unsigned integer	Unsigned integer
1 byte	1 bit	7 bits	2 bits	14 bits	1 byte
	< ----- repeat *N* times ---->				

Table 4.9-19: Structure of the Application data TC(11,9)

Destination PRID and Sequence Number correspond to the Packet Header Definition in Section 1.5

If there are less TC's in the command schedule than requested, the related TM(11,10) will just contain the matching TC's. No further notification is given.

4.9.9.3 Parameter Definition & Range

PUS-5054//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N	Number of TC areas to be reported ("scattered report")	1 … N_MAX[1)]
PRID	Destination PRID of the TC to be reported	Must be set to a value according to the PRID Table in Volume B Value is a copy of the corresponding field of the TC Packet Header of the TC's to be reported from the command schedule
Sequence Count	The sequence number of the first TC to be reported	An existing *Sequence Count*, value is a copy of the corresponding field of the TC Packet Header of the first TC to be reported from the command schedule
Number of TC's	Number of successive TC's to be reported	All TC's with given PRID between Sequence Count and Sequence Count + *Number of TC' s* - 1 shall be reported.

Table 4.9-20: Parameters of the Application Data for TC(11,9)

Note 1)

N_MAX = 48 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.9.9.4 TC Verification

PUS-5078//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5080//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	merged with [3]	
[3]	N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[4]	"Nb of SSCs" is out of the range specified above (=0)	FID_MTLOPS_INVALID_NB_SSC
[5]	SSC overflow (Start SSC + Nb of SSCs - 1> 0x3FFF)	FID_MTLOPS_SSC_OVERFLOW
[6]	Deleted	
[7]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.9.10 TM(11,10): Detailed Schedule Report

4.9.10.1 Description

TM(11,10) is the response to TC(11,9), TC(11,11) or TC(11,16).

4.9.10.2 Structure

PUS-5088//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 11

Service Subtype : Must be set to 10

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N	Sub-schedule ID	Subschedule Status	PRID Status	Time Tag	TCData
Unsigned Integer	Enumerated	Unsigned Integer	Unsigned Integer	Onboard time format PTC = 9; PFC = 17	Unsigned Integer
2 bytes	1 byte	1 byte	1 byte	6 bytes	Variable
	< ----- repeat *N* times ---->				

Table 4.9-21: Structure of the Source data TM(11,10)

4.9.10.3 Parameter Definition & Range

PUS-5117//

The parameters of the Source Data Field *shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
N	Number of *Time Tag* + *TC Packets* to follow	0 - No TC in requested range 1 … N_MAX[1)]

Parameters of Source Data Field	Description	Range or value
Sub-schedule ID	The identification of the sub-schedule	
Sub-schedule Status	Sub-schedule enable status	1 = Enabled 0 = Disabled
PRID Status	(TC Packet destination) PRID enabled status	1 = Enabled 0 = Disabled
Time Tag	Absolute release time for the TC	Copy of the time tag of the TC in the command schedule
TCData	TC raw data	Variable

Table 4.9-22: Parameters of the Source data for TM(11,10)

Note 1)

N_MAX = 88 (in case of minimum "TCData" length of 12 - see Note 2)

Note 2)

Min: 12 bytes

Max: 206 bytes

4.9.10.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.9.11 TC(11,11): Report Subset of Command Schedule in Detailed Form over Time Period

4.9.11.1 Description

Upon reception of TC(11,11) the report TM(11,10) shall be generated.

4.9.11.2 Structure

PUS-5150//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 11

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Range	Time Tag-1	Time Tag-2	N1	Sub-schedule ID	N2	Filler	PRID
Enumerated	Onboard time format PTC = 9; PFC = 17	Onboard time format PTC = 9; PFC = 17	Unsigned integer	Enumerated	Unsigned integer		Enumerated
1 byte	6 bytes	6 bytes	1 byte	1 byte	1 byte	1 bit	7 bits
						< -- repeat *N2* times ---->	
				< ----- repeat *N1* times ---->			

Table 4.9-23: Structure of the Application data TC(11,11)

4.9.11.3 Parameter Definition & Range

PUS-5192//

The parameters of the Source Data Field *shall be inserted according to the following table*

Parameters of Application Data Field	Description	Range or value
Range	Parameter for interpretation of the period given by Time Tags	Range = 0: complete command schedule Range = 1: report between time tags Range = 2: report before Time Tag 1 Range = 3: report after Time Tag 1
Time Tag 1 & 2	Absolute Satellite Time	A valid time
N1	Number of Sub-schedule IDs which follow	see Table 4.9-25
Sub-schedule ID	The identification of the sub-schedule	*see* Table 4.9-25 see note 1)
N2	Number of PRID's which follow	see Table 4.9-25
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Table 4.9-24: Parameters of the Application Data for TC(11,11)

Note 1)

SSID = 0 all sub-schedules

SSID = [1 .. 32]

N1	Sub-schedule ID	N2	PRID	Description
0	-	-	-	the command will apply to TC's for any PRID in all sub-schedules.
>= 1	[i], [j],[k]...	0	-	the command will apply to TC's of all PRID's in the identified sub-schedules
1	0	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in all sub-schedules.
1	[i]	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedule.
>= 1	[i], [j],[k]...	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedules.

Table 4.9-25: Possible Combination of Sub-schedules and PRID's

The meaning and presence of the Time Tag parameters is according following table.

Range	Time Tag 1	Time Tag 2
0 (ALL)	n/a	n/a
1 (between)	Earliest absolute time	Latest absolute time
2 (before)	Latest absolute time	n/a
3 (after)	Earliest absolute time	n/a

Table 4.9-26: Time Tag Parameters

4.9.11.4 TC Verification

PUS-5247//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5249//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Range Type is out of the range specified above	FID_MTLOPS_INVALID_RANGE_
[3]	Time tag parameters are inconsistent (BETWEEN, Tag1>Tag2)	FID_MTLOPS_INVALID_TAG_RA
[4]	(N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTLOPS_INVALID_SUBSET
[5]	Deletded	
[6]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.9.12 TC(11,12): Report Subset of Command Schedule in Summary Form

4.9.12.1 Description

Upon reception of TC(11,12) the report TM(11,13) shall be generated.

4.9.12.2 Structure

PUS-5260//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 12

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	Filler	PRID	Filler	Sequence Count	Number of TC's
Unsigned integer		Enumerated		Unsigned integer	Unsigned integer
1 byte	1 bit	7 bits	2 bits	14 bits	1 byte
	< ----- repeat *N* times ---->				

Table 4.9-27: Structure of the Application data TC(11,12)

Note: Destination PRID and Sequence Number correspond to the Packet Header Definition in Section 1.5

4.9.12.3 Parameter Definition & Range

PUS-5294//

The parameters of the Application Data Field shall be inserted according to the following table:

Parameters of Application Data Field	Description	Range or value
N	Number of TC areas to be reported ("scattered report")	1 …N_MAX[1)]
PRID	Destination PRID of the TC to be reported	Must be set to a value according to the PRID Table in Volume B Value is a copy of the corresponding field of the TC Packet Header of the TC's to be reported from the command schedule

Parameters of Application Data Field	Description	Range or value
Sequence Count	The sequence number of the first TC to be reported	An existing *Sequence Count*, value is a copy of the corresponding field of the TC Packet Header of the first TC to be reported from the command schedule
Number of TC's	Number of successive TC's to be reported	All TC's with given PRID between Sequence Count and Sequence Count + *Number of TC' s* - 1 shall be reported.

Table 4.9-28: Parameters of the Application Data for TC(11,12)

Note 1)

N_MAX = 48 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.9.12.4 TC Verification

PUS-5318//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5320//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	merged with [3]	
[3]	N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[4]	"Nb of SSCs" is out of the range specified above (=0)	FID_MTLOPS_INVALID_NB_SSC
[5]	SSC overflow (Start SSC + Nb of SSCs - 1> 0x3FFF)	FID_MTLOPS_SSC_OVERFLOW
[6]	Deleted	FID_MTLOPS_NO_TC_FOUND
[7]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.9.13 TM(11,13): Summary Schedule Report

4.9.13.1 Description

TM(11,13) is the response to TC(11,12) , TC(11,14) and TC(11,17).

4.9.13.2 Structure

PUS-5329//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 11

Service Subtype : Must be set to 13

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N	Sub-schedule ID	Sub-schedule Status	PRID Status	Time Tag	TC Packet Header	TC Data Field Header
Unsigned integer	Enumerated	Enumerated	Enumerated	Onboard time format PTC = 9; PFC = 17	Unsigned Integer	
2 bytes	1 byte	1 byte	1 byte	6 bytes	6 bytes	4 bytes
	< -------- Repeat *N* times ------ >					

Table 4.9-29: Structure of the Source data TM(11,13)

4.9.13.3 Parameter Definition & Range

PUS-5364//

The parameters of the Source Data *Field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
N	Number of TC's reported in this TM Source Packet	0....N_MAX[1)]
Sub-schedule ID	The identification of the sub-schedule	
Sub-schedule Status	Status of the Sub-schedule	1 = enabled 0 = disabled
PRID Status	Status of the PRID	1 = enabled 0 = disabled
Time Tag		Copy of the time tag of the TC as in the command schedule
TC Packet Header	TC Packet Header	defined in Section 1.5
TC Data Field Header	TC Data Field Header	defined in Section 1.5

Table 4.9-30: Parameters of the Source data for TM(11,13)

Note 1)

N_MAX = 106

4.9.13.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.9.14 TC(11,14): Report Subset of Command Schedule in Summary Form over Time Period

4.9.14.1 Description

Upon reception of TC(11,14) the report TM(11,13) shall be generated.

4.9.14.2 Structure

PUS-5397//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 14

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Range	Time Tag-1	Time Tag-2	N1	Sub-schedule ID	N2	Filler	PRID
Enumerated	Onboard time format PTC = 9; PFC = 17	Onboard time format PTC = 9; PFC = 17	Unsigned integer	Enumerated	Unsigned integer		Enumerated
1 byte	6 bytes	6 bytes	1 byte	1 byte	1 byte	1 bit	7 bits
						< ----- repeat *N2* times --->	
				< ----- repeat *N1* times ---->			

Table 4.9-31: Structure of the Application data TC(11,14)

4.9.14.3 Parameter Definition & Range

PUS-5439//

The parameters of the Source Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Range	Parameter for interpretation of the period given by Time Tags	Range = 0: complete command schedule Range = 1: report between time tags Range = 2: report before Time Tag 1 Range = 3: report after Time Tag 1

Parameters of Application Data Field	Description	Range or value
Time Tag 1 & 2	Absolute Satellite Time	A valid time
N1	Number of Sub-schedule IDs which follow	see Table 4.9-33
Sub-schedule ID	The identification of the sub-schedule	*see* Table 4.9-33 see Note 1)
N2	Number of PRID's which follow	see Table 4.9-33
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Table 4.9-32: Parameters of the Application Data for TC(11,14)

Note 1)

SSID = 0 all sub-schedules

SSID = [1 .. 32]

N1	Sub-schedule ID	N2	PRID	Description
0	-	-	-	the command will apply to TC's for any PRID in all sub-schedules.
>= 1	[i], [j],[k]...	0	-	the command will apply to TC's of all PRID's in the identified sub-schedules
1	0	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in all sub-schedules.
1	[i]	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedule.
>= 1	[i], [j],[k]...	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedules.

Table 4.9-33: Possible Combination of Sub-schedules and PRID's

The meaning and presence of the Time Tag parameters is according following table.

Range	Time Tag 1	Time Tag 2
0 (ALL)	n/a	n/a
1 (between)	Earliest absolute time	Latest absolute time
2 (before)	Latest absolute time	n/a

Range	Time Tag 1	Time Tag 2
3 (after)	Earliest absolute time	n/a

Table 4.9-34: Time Tag Parameters

4.9.14.4 TC Verification

PUS-5494//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5496//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Range Type is out of the range specified above	FID_MTLOPS_INVALID_RANGE_
[3]	Time tag parameters are inconsistent (BETWEEN, Tag1>Tag2)	FID_MTLOPS_INVALID_TAG_RA
[4]	(N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTLOPS_INVALID_SUBSET
[5]	Deleted	
[6]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.9.15 TC(11,15): Time-shifting all Time Tagged Telecommands

4.9.15.1 Description

The request to time-shift all telecommands in the command schedule.

4.9.15.2 Structure

PUS-5507//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 15

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Time Offset
Relative Time
6 bytes

Table 4.9-35: Structure of the Application data TC(11,15)

4.9.15.3 Parameter Definition & Range

PUS-5522//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Time Offset	A positive or negative interval of time expressed in the length and format of relative OBT defined for the service or mission (since it is the relative time between the new and the old values of release time).	The format shall be identical to the Satellite Time format (see volume B)

Table 4.9-36: Parameters of the Application Data for TC(11,15)

4.9.15.4 TC Verification

PUS-5534//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5536//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] At least one of the new computed Time Tags is < current OBT + MTL_INSERT_TAG_MARGIN	FID_MTLOPS_TAG_EXPIRED
[3] Time Offset is out of the range specified above (overflow) for at least one TC Time tag	FID_MTLOPS_TAG_OVERFLOW

4.9.16 TC(11,16): Report Command Schedule in Detailed Form

4.9.16.1 Description

Upon reception of TC(11,16) TM(11,10) shall be generated.

4.9.16.2 Structure

PUS-5543//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 16

TC(11,16) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.9.16.3 TC Verification

PUS-5550//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5552//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.9.17 TC(11,17): Report Command Schedule in Summary Form

4.9.17.1 Description

Upon reception of TC(11,17) TM(11,13) shall be generated.

4.9.17.2 Structure

PUS-5558//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 17

TC(11,17) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.9.17.3 TC Verification

PUS-5565//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5567//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.9.18 TC(11,18): Report Status of Command Schedule

4.9.18.1 Description

Upon reception of TC(11,18) TM(11,19) shall be generated.

4.9.18.2 Structure

PUS-5573/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 11

Service Subtype : Must be set to 18

TC(11,18) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.9.18.3 TC Verification

PUS-5580/I

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5582/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.9.19 TM(11,19): Command Schedule Status Report

4.9.19.1 Description

TM(11,19) is the response to TC(11,18).

4.9.19.2 Structure

PUS-5588/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 11

Service Subtype : Must be set to 19

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N1	Sub-schedule ID	Status	N2	Filler	PRID	Status
Unsigned integer	Enumerated	Enumerated	Unsigned integer		Enumerated	Enumerated
1 bytes	1 byte	8 bit	1 bytes	1 bit	7 bits	8 bit

N1	Sub-schedule ID	Status	N2	Filler	PRID	Status
				< -------- Repeat *N2* times ------ >		
	<------- Repeat *N1* times -------->					

Table 4.9-37: Structure of the Source data TM(11,19)

4.9.19.3 Parameter Definition & Range

PUS-5627//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
N1	Repetition counter for subschedule related information	1...N1_MAX[1)] Note that the PRID status and SubSchedule statuses are completely independent from each other. This means in particular that when a given PRID is disabled, no TC of this PRID will be released at all, whatever the subschedule.
Sub-schedule ID	The identification of the sub-schedule	see Note 2)
Status	The status of the corresponding *sub-schedule*	0… disabled 1… enabled
N2	Repetition counter for PRID related information	1.... N2_MAX[1)] for SSID = 0; 0 for SSID > 0
PRID	PRID of the TC	Must be set to a value according to the PRID Table in Volume B. Value is a copy of the corresponding field of the TC Packet Header.
Status	The status of the corresponding *PRID*	0… disabled 1… enabled

Table 4.9-38: Parameters of the Source data for TM(11,19)

Note 1)

N1_MAX = 33 with SSID = 0 giving the global status of the service as well as the PRID status and 1 <=SSID=>32 usable subschedules.

N2_MAX = number of on-board processe ID's (in any cas <=127)

Note 2)

SSID = 0 all sub-schedules

SSID = [1 .. 32]

4.10 Service 12: On Board Parameter Monitoring

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(12,1)	TC	Enable Monitoring of Parameters	Specific
(12,2)	TC	Disable Monitoring of Parameters	Specific
(12,3)	TC	Change Maximum Reporting Delay	n/a
(12,4)	TC	Clear Monitoring List	Specific
(12,5)	TC	Add/Modify Parameters to/in Monitoring List	Specific
(12,6)	TC	Delete Parameters from Monitoring List	Specific
(12,7)	TC	Modify Parameter Checking Information	Specific
(12,8)	TC	Report Current Monitoring List	Specific
(12,9)	TM	Current Monitoring List Report	Specific
(12,10)	TC	Report Current Parameters Out-of-limit List	Specific
(12,11)	TM	Current Parameters Out-of-limit List Report	Specific
(12,12)	TM	Check Transition Report	n/a

Table 4.10-1: Service 12 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with *“Basic”* will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Note:

This Service will only support Limit Checks and Expected Value checks. It will not support Delta checks. Only one check definition of a certain type is supported per parameter

Objective:

Parameter monitoring allows a single parameter contained in the on-board data pool to be monitored against a limit set or an expected status value and react with a specified event report, if the parameter gets out-of-limit. To achieve this, the Service maintains a parameter monitoring list, which checks the parameters according to the defined monitoring constraints and the related filtering rule.

Description:

A **Parameter Monitoring List** is maintained which contains the parameter monitoring information, drives the parameter monitoring activity and the generation of Out-of-Limit Reports.

The ground segment can modify or report the contents of the Parameter Monitoring List using Service requests to:

- reset the monitoring list;
- add parameters to, or delete parameters from, the monitoring list;
- modify the monitoring information of parameters in the monitoring list;
- enable or disable the monitoring of parameters in the monitoring list;
- report the monitoring information for all parameters in the monitoring list;
- report the set of parameters which are currently out-of-limits.

The ground system can also modify an attribute of the on-board monitoring service which determines whether the monitoring of parameters is enabled or disabled at service level.

Note: In case a Functional Monitoring Service is also implemented, there will be an additional operational constraint. The Monitoring ID's that are associated to a Functional Monitoring ID can be deleted or enabled or disabled or modified ONLY IF the related Functional Monitoring ID is disabled and unproceted.

The Monitoring List:

The Onboard Monitoring Service maintains static monitoring check information for each parameter to be monitored, which is provided by the ground by means of Service Requests.

The parameter monitoring information shall specify:

- the identification of the on-board parameter to be monitored;
- whether the monitoring of the parameter is enabled or disabled;
- the associated validity parameter (if any); this is a Boolean parameter whose value determines whether the parameter is monitored;
- the monitoring interval for the parameter.

The parameter monitoring information shall also include a set of check definitions. A check definition shall provide the information to check a sample of the parameter against either one pair of limits or one expected value.

A check definition shall indicate:

- The nature of the check to be performed. This can be a limit-check or an expected-value-check.
    - For a limit-check, a low-limit value and a high-limit value shall be specified.
    - For an expected-value-check, an expected value shall be specified.

Note: Only one of the two check types (i.e. low/high limit or expected value) can be applied for each parameter.

- A “number of repetitions (#REP)” which indicates the number of successive samples of the parameter that fail (or succeed) the check before establishing a new checking status for the parameter.

- The identifier (RID) of an event report that shall be generated if the corresponding check fails.

<u>The Checking Activity and the Check State:</u>

The Onboard Parameter Monitoring Service maintains a **check state** corresponding to each check definition for each parameter to be monitored.

The check state includes information about the previous and current checking statuses of the parameter for the given check definition (see check filter above) and the time at which the transition to that checking status occurred. This information is downlinked when the ground requests a report of the checks which currently report an out-of- limit condition.

A check definition is "**enabled**” and used for checking a parameter when all the following conditions are set:

- the monitoring of parameters is enabled at service-level,

- the monitoring of the parameter is enabled,

- the parameter is valid (check validity parameter value = “TRUE”)

Otherwise the check definition is “**disabled**” and is not used for checking the parameter.

Whenever a sample of the parameter is available for checking, the service shall perform the following checking activity independently for each parameter check definition (and update its check state accordingly):

- If the check definition is “disabled” then the new checking status shall immediately become either “Unchecked” or “Invalid” depending on whether the checking of the parameter is disabled or the parameter is invalid. By default, the initial current checking status of a parameter with respect to the check definition shall be “Unchecked” when the parameter is added to the monitoring list or when a new check definition for the parameter is added at a later time.

If the check definition is “enabled” then the parameter sample is a valid sample for checking. It shall be checked against the limit pair (or expected value) if sufficient consecutive valid samples have been accumulated. For a limit-check or expected-value-check, if the last #REP successive valid samples of the parameter (including the current one) have consistently failed (or consistently passed) the check, then the parameter shall be assigned a new checking status. The new checking status shall be equal to the result of the check of the current sample, i.e. either “Below low limit”, “Above high limit”, “Within limits”, “Unexpected value” or “Expected value”. When the previously determined checking status of a parameter with respect to a limit-check was “Within limits”, and when successive samples are alternately “Below low limit” and “Above high limit”, these earn the parameter a new checking status. In the special case of samples values oscillating between "Above High limit" and "Below Low limit", to avoid too fast check status changes, it is required that starting from one of this two possible check status, a change to the other out-of-limit check status will occur ONLY after a minimun number of samples

- Having elaborated a new checking status for the parameter, a comparison between the previous and new checking statuses shall be performed. If they differ, then a check transition shall be recorded (conceptually this is recorded in a transition reporting list).

- When a check transition is detected, the transition time shall be recorded in the corresponding check state. This is the sampling time of the first parameter sample which was used to establish the new checking status and of the associated event for the applicable cases. If a check transition occurs for which the check definition identifies an associated event report, a telemetry packet of type 5 and subtype in line with EID associated severity shall be generated, containing the specified report identifier (RID) with auxiliary parameters that are the ones recorded in the transition report. The check transitions concerned are those where the checking status changes to “Below low limit”, “Above high limit”, “Unexpected value”, (depending on the parameter and check type) where it was previously something different.

The current checking status and associated transition times can be reported to the ground system on request.

The event reports, which are reported in case of transition to "in limit", "out of limit" or "un-expected state", will have the following details in the parameters field as complementary information part of the report:

Monitoring ID	Parameter ID	Mask	Parameter Value	Limit crossed	Previous checking status	Current checking status	Transition Time
Unsigned Integer	Enumerated	Unsigned Integer	Deduced	Deduced	Enumerated	Enumerated	Satellite Time (see Section 4.8)
1 byte	4 bytes	4 bytes	8 byte	8 bytes	1 byte	1 byte	6 bytes

Table 4.10-2: Structure of the Application data for Monitoring Events Report

It is assumed that the on-board monitoring service has access to other information used for the detection of errors in the processing of service requests. This includes the following:

- The maximum number of entries of the monitoring list.
- The list of parameters which can be accessed, and can thus be monitored, by the application process.
- The type(s) of check for each parameter which can be monitored (limit-check or expected-value-check).
- The list of Boolean on-board parameters which can be accessed by the application process and can be used as validity parameter.

the mnemonics appearing in the transition types "expected values" mean:

EV: Expected Value US: UnSelected (not used)

U: Unchecked UV: Unexpected Value

I: Invalid

the mnemonics appearing in the transition types "limit checks" mean:

WL: Within Limits US: UnSelected (not used)

U: Unchecked BL: Below Low Limit

I: Invalid AL: Above High Limit

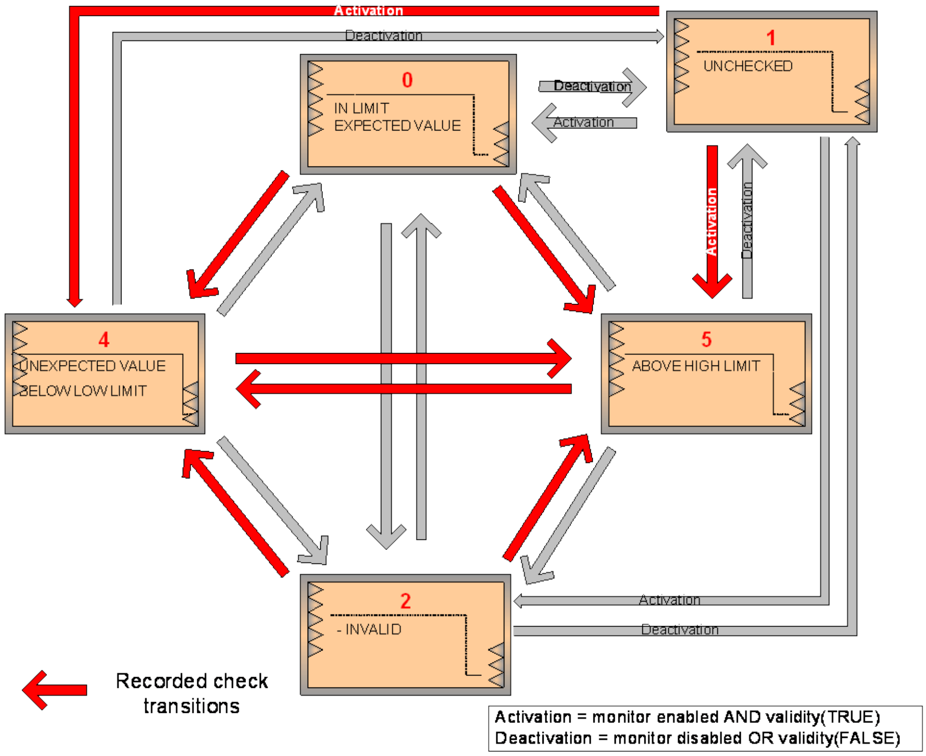


Figure 4.10-1: Check Status Transitions

Following rules shall be implemented for the following special out-of-limit scenarios:

If the current checking status is NOT “Within Limits” (for example, “Above high limit”) then a sequence which exceeds the number of repetitions limit, of consecu-tive samples of the other “out of limit” (in the example “Below low limit”) is needed before a new checking status shall be assigned having elaborated a new checking status for the parameter, a comparison between the previous and new checking status is performed. If they differ, then a check transition is recorded (conceptually this is recorded in a Transition Reporting List, see below).

4.10.1 TC(12,1): Enable Monitoring of Parameters

4.10.1.1 Description

Upon reception of TC(12,1) the monitoring of the specified parameters shall be enabled.

4.10.1.2 Structure

PUS-5826//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 12

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	Monitoring Id
Unsigned integer	Unsigned Integer
1 bytes	1 byte
	< ------- repeat *N* times ------ >

Table 4.10-3: Structure of the Application data TC(12,1)

4.10.1.3 Parameter Definition & Range

PUS-5847//

The parameters of the Application Data *Field shall be inserted according to the following table.´*

Parameters of Application Data Field	Description	Range or value
N	Number of Monitoring ID's following	0 .. N_MAX[1)] ***N* = 0:** The monitoring on service level shall be set to "ENABLED/DISABLED" each individual entry will stay in its current state. ***N* > 0:** Each parameter in the request shall be processed in turn and the individual monitoring shall be set to "ENABLED/DISABLED"
Monitoring Id	Identification of a monitoring control table entry	1 … 255

Table 4.10-4: Parameters of the Application Data for TC(12,1)

Note 1)

N_MAX = 193 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

Note: For TC(12,1) with N = 0 the monitoring service shall be enabled at service level. In this case, the monitoring service shall start to monitor all parameters with individual monitoring being set to “enable”. It shall not change the individual monitoring of parameters..

4.10.1.4 TC Verification

PUS-5864//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5866//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is : either not consistent with the real length of the packet data field OR out of the range specified above	FID_MON_ID_LEN_DISCREP
[3]	At least one of the Monitoring IDs is not defined	FID_UNKNOWN_MON_ID
[4]	At least one of the Monitoring IDs is protected	FID_MON_PROTECTED_ID

4.10.2 TC(12,2): Disable Monitoring of Parameters

4.10.2.1 Description

Upon reception of TC(12,2) the monitoring of the specified parameters shall be disabled.

4.10.2.2 Structure

PUS-5874//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 12

Service Subtype : Must be set to 2

The structure of the *Application Data field within the TC Packet Data* field is identical with the one defined for TC(12,1). See Table 4.10-3 (Structure of the Application data TC(12,1))

Note: For TC(12,2) with N = 0 the monitoring service shall be disabled at service level. In this case, the monitoring service shall stop to monitor. The individual monitoring of parameters shall not be changed.

4.10.2.3 TC Verification

PUS-5882//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-5884//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is : either not consistent with the real length of the packet data field OR out of the range specified above	FID_MON_ID_LEN_DISCREP
[3]	At least one of the Monitoring IDs is not defined	FID_UNKNOWN_MON_ID
[4]	At least one of the Monitoring IDs is protected	FID_MON_PROTECTED_ID
[5]	Monitoring service is locked	FID_MON_LOCKED_SERVICE

4.10.3 TC(12,3) Change Maximum Reporting Delay

This service subtype is not applicable

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP

4.10.4 TC(12,4): Clear Monitoring List

4.10.4.1 Description

Upon reception of TC(12,4) the service provider shall act as follows:

•clear all entries of the monitoring list

•clear all entries of the transition reporting list

The TC will be rejected if the monitoring service has not been globally disabled before.

4.10.4.2 Structure

PUS-5895//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 12

Service Subtype : Must be set to 4

TC(12,4) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.10.4.3 TC Verification

PUS-5902//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5904//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The service is enabled at service level	FID_MON_SERVICE_ENABLED
[3]	At least one of the Monitoring IDs is used	FID_MON_USED_ID

4.10.5 TC(12,5): Add/Modify Parameters to/in Monitoring List

4.10.5.1 Description

Upon reception of TC(12,5) the specified record shall be added to / modified in the monitoring list. If the *Monitoring ID* already exists the new record shall replace the old one.

4.10.5.2 Structure

PUS-5911//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 12

Service Subtype : Must be set to 5

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	*Monitoring ID*	*Parameter ID*	*& Validity Parameter*	*Parameter Monitoring Interval*
Unsigned Integer	Unsigned Integer	Enumerated	Enumerated	Unsigned Integer
1 byte	1 byte	4 bytes	4 bytes	2 byte
	< ----- repeat *N* times ------ >			

Rep	*Monitoring Status*	*NOL*	*Limit Monitoring Criteria*	*NOE*	*Expected Value Monitoring Criteria*
Unsigned Integer	Enumerated	Unsigned Integer	Enumerated	Unsigned Integer	Enumerated
1 byte	1byte	1 byte	20 byte	1 byte	10 byte
< ----- repeat *N* times ------ >					

Table 4.10-5: Structure of the Application data TC(12,5)

Format of the Monitoring Criteria Field:

For monitoring against Low and/or High limits	*Limit Monitoring Criteria*			
	Low Limit	*EID*	*High Limit*	*EID*
	deduced	Unsigned Integer	deduced	Unsigned Integer
	8 byte	2 byte	8 byte	2 byte

For monitoring against Expected Values	*Expected Value Monitoring Criteria*		
	Mask	*Expected Value*	*EID*
	Unsigned Integer	Deduced	Unsigned Integer
	4 byte	4 byte	2 byte

Figure 4.10-2: Monitoring Criteria for TC(12,5)

4.10.5.3 Parameter Definition & Range

PUS-5921//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	Repetition of the following fields	1 … N_MAX [1)]
Monitoring ID	ID of Monitoring Control Table Entry	1…255
Parameter ID	Unique identification of the parameter to monitor	See Volume B
Validity Parameter	A *Parameter ID* whose value determines whether a parameter to be monitored is valid or not.	By convention, if the validity ParameterID is 0, the corresponding parameter is always valid (i.e. it shall always be checked).
Parameter Monitoring Interval	Defines the number of cycles in between two subsequent monitorings	1…65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10)
Rep	Repetition Interval; The number of successive samples of the parameters to establish a new checking status for an expected-value-check or a limit-check.	1 .. 255
Monitoring Status	The Boolean parameter whose value determines whether monitoring of this entry is applied.	0 - disabled 1 - enabled
NOL	Presence of limit check definition	0 - no limit check definition, mandatory if NOE=1 1 - limit value check, mandatory if NOE=0 Note: If NOL = 0 the Limit Monitoring Criteria field exists but its content will not be used.
Low Limit	Low limit	Limit value, right aligned if not the complete field length is required

Parameters of Application Data Field	Description	Range or value
EID	Event ID associated with the low limit of the monitoring description	Any valid *EID* (see Volume B)
High Limit	High limit	Limit value, right aligned if not the complete field length is required
EID	Event ID associated with the high limit of the monitoring description	Any valid *EID* (see Volume B)
NOE	Presence of expected value check definition	0 - no expected value check, mandatory if NOL=1 1 - expected value check, mandatory if NOL=0 Note: If NOE = 0 the Expected Value Monitoring Criteria field exists but its content will not be used.
Mask	Bit mask used to monitor only selected bits from a composite parameter.	bit pattern (1_{BIN} means 'use')
Expected Value	Expected value	Limit value, right aligned if not the complete field length is required
EID	Event ID associated with the monitoring description	Any valid *EID* (see Volume B)

Table 4.10-6: Parameters of the Application Data for TC(12,5)

Note 1)

N_MAX = 5 (TC nested in TC(11,4) or TC(151,4) and in case of low/high limit check)

4.10.5.4 TC Verification

PUS-5993//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-5995//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length (includes case N=0)	FID_LENGTH_DISCREP
[2] At least one of the Monitoring IDs is outside the range specified above (=0)	FID_INVALID_MON_ID
[3] At least one of the REPs is outside the range specified above (=0)	FID_INVALID_REP_INTERVAL
[4] NOL or NOE is outside its range or they have the same value	FID_MON_INVALID_CHECK
[5] At least one of the Monitoring Status is outside the range specified above	FID_MON_STAT_INVALID
[6] At least one of the Parameter IDs is not defined	FID_UNKNOWN_MON_PAR_ID
[7] At least one of the Validity Parameter ID is not a defined Parameter ID	FID_UNKNOWN_VAL_PAR
[8] Monitoring List is already full (capacity overflow)	FID_MON_LIST_OVERFLOW
[9] At least one of the EIDs is not defined	FID_UNKNOWN_MON_EID
[10] N is not consistent with the real length of the packet data field	FID_MON_ID_LEN_DISCREP
[11] At least one of the Intervals is outside the range specified above (=0)	FID_INVALID_MON_INTERVAL
[12] At least one of the Monitoring IDs is already defined and is protected	FID_MON_PROTECTED_ID
[13] Expected Value Check is not allowed on a 64-bit float parameter (NOE=1 and Parameter ID's type is float 64-bit)	FID_MON_FLOAT64_INVALID
[14] At least one of the Limits or the Expected Value is expected as a float but is not a number (NAN).	FID_INVALID_DATA
[15] At least one of the Monitoring IDs is already defined and enabled	FID_MON_ACTIVE

4.10.6 TC(12,6): Delete Parameters from Monitoring List

4.10.6.1 Description

Upon reception of TC(12,6) the specified parameter shall be deleted from the monitoring list, provided the parameters monitoring is not "ENABLED".

4.10.6.2 Structure

PUS-6012//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 12

Service Subtype : Must be set to 6

The structure of the Application Data field within the TC Packet Data field is defined here below.

N	Monitoring ID
Unsigned Integer	Unsigned Integer
1 byte	1 byte
	< --- repeat *N* times --- >

Table 4.10-7: Structure of the Application data TC(12,6)

4.10.6.3 Parameter Definition & Range

PUS-6033//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	Number of Parameters follow	1 … N_MAX [1)]
Monitoring ID	ID of Monitoring Control Table Entry	1…255

Table 4.10-8: Parameters of the Application Data for TC(12,6)

Note 1)

N_MAX = 193 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.10.6.4 TC Verification

PUS-6049//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-6051//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length (includes case N=0)	FID_LENGTH_DISCREP
[2] N is not consistent with the real length of the packet data field	FID_MON_ID_LEN_DISCREP
[3] At least one of the Monitoring IDs is not defined	FID_UNKNOWN_MON_ID
[4] At least one of the Monitoring IDs is enabled	FID_MON_ACTIVE
[5] At least one of the Monitoring IDs is used	FID_MON_USED_ID

4.10.7 TC(12,7) Modify Parameter Checking Information

4.10.7.1 Description

This command changes the monitoring criteria of one or several (currently disabled) Monitoring.

4.10.7.2 Structure

PUS-12218//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 12

Service Subtype : Must be set to 7

The structure of the Application Data field within the TC Packet Data field is defined here below.

N	*Monitoring ID*	*NOL*	*Limit Monitoring Criteria*	*NOE*	*Expected Value Monitoring Criteria*
Unsigned Integer	Unsigned Integer	Unsigned Integer	Enumerated	Unsigned Integer	Enumerated
1 byte	1 byte	1 byte	20 byte	1 byte	10 byte
			< ---- repeat *NOL* times --- >		< -- repeat *NOE* times -- >
	< ----- repeat *N* times ------ >				

With the following Monitoring Criteria format:

For monitoring against Low and/or High limits	*Limit Monitoring Criteria*			
	Low Limit	*EID*	*High Limit*	*EID*
	deduced	Unsigned Integer	deduced	Unsigned Integer
	8 byte	2 byte	8 byte	2 byte

For monitoring against Expected Values	*Expected Value Monitoring Criteria*		
	Mask	*Expected Value*	*EID*
	Unsigned Integer	Deduced	Unsigned Integer
	4 byte	4 byte	2 byte

Table 4.10-9: Format of the Monitoring Criteria Field

4.10.7.3 Parameter Definition & Range

PUS-12249//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	Repetition of the following fields	1 … N_MAX [1)]
Monitoring ID	ID of Monitoring Control Table Entry	1…255
NOL	Presence of limit check definition	0 - no limit check definition, mandatory if NOE=1 1 - limit value check, mandatory if NOE=0

Parameters of Application Data Field	Description	Range or value
Low Limit	Low limit	Limit value, right aligned if not the complete field length is required
EID	Event ID associated with the low limit of the monitoring description	Any valid *EID* (see Volume B)
High Limit	High limit	Limit value, right aligned if not the complete field length is required
EID	Event ID associated with the high limit of the monitoring description	Any valid *EID* (see Volume B)
NOE	Presence of expected value check definition	0 - no expected value check, mandatory if NOL=1 1 - expected value check, mandatory if NOL=0
Mask	Bit mask used to monitor only selected bits from a composite parameter.	bit pattern (1_{BIN} means 'use')
Expected Value	Expected value	Limit value, right aligned if not the complete field length is required
EID	Event ID associated with the monitoring description	Any valid *EID* (see Volume B)

Table 4.10-10: Parameters of the Application Data for TC(12,7)

Note 1)

N_MAX = 8 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.10.7.4 TC Verification

PUS-12368//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-12370//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length (includes case N=0)	FID_LENGTH_DISCREP
[2] N is not consistent with the real length of the packet data field	FID_MON_ID_LEN_DISCREP
[3] At least one of the EIDs is not defined	FID_UNKNOWN_MON_EID
[4] At least one of the Monitoring IDs is not defined	FID_UNKNOWN_MON_ID
[5] At least one of the Monitoring IDs is not disabled	FID_MON_ACTIVE
[6] The NOL or NOE are outside their range or have the same value	FID_MON_INVALID_CHECK
[7] At least one of the Monitoring IDs is protected	FID_MON_PROTECTED_ID
[8] Expected Value Check is not allowed on a 64-bit float parameter (NOE=1 and Parameter ID's type is float 64-bit)	FID_MON_FLOAT64_INVALID
[9] At least one of the Limits or the Expected Value is expected as a float but is not a number (NAN).	FID_INVALID_DATA

s

4.10.8 TC(12,8) Report Current Monitoring List

4.10.8.1 Description

Upon reception of TC(12,8) the report TM(12,9) shall be generated.

4.10.8.2 Structure

PUS-12389//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 12

Service Subtype : Must be set to 8

TC(12,8) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.10.8.3 TC Verification

PUS-12396//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-12398//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.10.9 TM(12,9): Current Monitoring List Report

4.10.9.1 Description

TM(12,9) is the response to TC(12,8).

4.10.9.2 Structure

PUS-6076//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 12

Service Subtype : Must be set to 9

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

Monitoring	Maximum Reporting Delay	N	Monitoring ID	Parameter ID	&Validity Parameter	Parameter Monitoring Interval
Enumerated	Unsigned Integer	Unsigned Integer	Unsigned Integer	Enumerated	Enumerated	Unsigned Integer
1 byte	1 byte	1 byte	1 byte	4 bytes	4 bytes	2 bytes
			< ----- repeat *N* times ------ >			

Rep	Monitoring	NOL	Limit Monitoring CrIteria	NOE	Expected Value Monitoring CrIteria
Unsigned Integer	Enumerated	Unsigned Integer	Enumerated	Unsigned Integer	Enumerated
1 byte	1byte	1 byte	20 byte	1 byte	10 byte
< ----- repeat *N* times ------ >					

Table 4.10-11: Structure of the Source data TM(12,9)

Format of the Monitoring Criteria Field:

For monitoring against Low and/or High limits	Limit Monitoring Criteria			
	Low Limit	EID	High Limit	EID
	deduced	Unsigned Integer	deduced	Unsigned Integer
	8 byte	2 byte	8 byte	2 byte

For monitoring against Expected Values	Expected Value Monitoring Criteria		
	Mask	Expected Value	EID
	Unsigned Integer	Deduced	Unsigned Integer
	4 byte	4 byte	2 byte

Figure 4.10-3: Monitoring Criteria for TM(12,9)

4.10.9.3 Parameter Definition & Range

PUS-6139//

The parameters of the Source Data *Field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
Monitoring	Indicates whether the overall monitoring is enabled	(Value = 0) => disabled (Value = 1) => enabled
Maximum Reporting Delay	The maximum reporting delay for the check transition report.	see Note 1
N	Repetition count for the following fields	Depends on MTU
Monitoring ID	ID of Monitoring Control Table Entry	1…255
Parameter ID	Unique identification of the parameter to monitor	See Volume B
&Validity Parameter	A Boolean parameter whose value determines whether a parameter is valid or not.	By convention, if the validity ParameterID is 0, the corresponding parameter is always valid (i.e. it shall always be checked).

Parameters of Source Data Field	Description	Range or value
Parameter Monitoring Interval	Defines the number of cycles in between two subsequent monitorings	1…65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10).
Rep	Repetition Interval; The number of successive samples of the parameters to establish a new checking status for an expected-value-check or a limit-check.	1 .. 255
Monitoring Status	The Boolean parameter whose value determines whether monitoring of this entry is applied.	0 - disabled 1 - enabled
NOL	Presence of limit check definition	0 - no limit check definition, mandatory if NOE=1 1 - limit value check, mandatory if NOE=0 Note: If NOL = 0 the Limit Monitoring Criteria field exists but its content is not relevant.
Low Limit	Low limit	Limit value, right aligned if not the complete field length is required
EID	Event ID associated with the low limit of the monitoring description	Any valid *EID* (see Volume B)
High Limit	High limit	Limit value, right aligned if not the complete field length is required
EID	Event ID associated with the high limit of the monitoring description	Any valid *EID* (see Volume B)

Parameters of Source Data Field	Description	Range or value
NOE	Presence of expected value check definition	0 - no expected value check, mandatory if NOL=1 1 - expected value check, mandatory if NOL=0 Note: If NOE = 0 the Expected Value Monitoring Criteria field exists but its content is not relevant
Mask	Bit mask used to monitor only selected bits from a composite parameter.	bit pattern
Expected Value	Expected value	Limit value, right aligned if not the complete field length is required
EID	Event ID associated with the monitoring description	Any valid *EID* (see Volume B)

Table 4.10-12: Parameters of the Source data for TM(12,9)

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

Note 1: Value = 0 for applications/missions not supporting the Check Transition Report TM(12,12)

4.10.10 TC(12,10): Report Current Parameters Out-of-limit List

4.10.10.1 Description

Upon reception of TC(12,10) the report TM(12,11) shall be generated.

4.10.10.2 Structure

PUS-6223/I/

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 12

Service Subtype : Must be set to 10

TC(12,10) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.10.10.3 TC Verification

PUS-6230//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-6232//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.10.11 TM(12,11): Current Parameters Out-of-limit List Report

4.10.11.1 Description

TM(12,11) is the response to TC(12,10).

4.10.11.2 Structure

PUS-6239//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 12

Service Subtype : Must be set to 11

The structure of the *Source Data* field within the TM Packet Data field is defined here below.

N	Monitoring ID	Parameter ID	Mask	Parameter Value	Limit crossed	Previous checking status	Current checking status	Transition time
Unsigned integer	Unsigned Integer	Enumerated	Unsigned Integer	Deduced	Deduced	Enumerated	Enumerated	Satellite Time (see Section 4.8)
2 bytes	1 byte	4 bytes	4 bytes	8 byte	8 bytes	1 byte	1 byte	6 bytes
	< ----- repeat *N* times ------ >							

Table 4.10-13: Structure of the Source data TM(12,11)

4.10.11.3 Parameter Definition & Range

PUS-6281//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value

Parameters of Source Data Field	Description	Range or value
N	Repetition count for following fields	Number of entries following 1...N_MAX[1)]
Monitoring Id	Identification of a monitoring control table entry	1 … 255
Parameter ID	Number uniquely identifying a parameter out of a list	Any valid value of the list of predefined parameters
Parameter Value	Value of the parameter at last checking status transition	Deduced
Mask	Bit mask used to monitor only selected bits from a composite parameter.	bit pattern
Limit crossed	High or low limit or expected state crossed or violated	Copy of the relevant entry of the monitoring definition
Previous checking status	Checking status of the parameter before the detected transition of the checking status	0 = “in limits” or “expected value” 1 = unchecked 2 = invalid 3 = unselected (not used) 4 = “unexpected value” or “below low limit”, “below low threshold” 5 = “above high limit” or “above high threshold”
Current checking status	Checking status of the parameter after the detected transition of the checking status	Same as above
Transition time	-Time of the transition detection	value at detection of transition of checking status

Table 4.10-14:Parameters of the Source data for TM(12,11)

Note1)

N_MAX = 61

4.10.11.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.10.12 TM(12,12) Check Transition Report

This service subtype is not applicable.

4.11 Service 13: Large Data Transfer Service

This service is not applicable

4.12 Service 14: Packet Forwarding Control Service

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(14,1)	TC	Enable Forwarding of Telemetry Source Packets	Specific
(14,2)	TC	Disable Forwarding of Telemetry Source Packets	Specific
(14,3)	TC	Report Enabled Telemetry Source Packets	n/a
(14,4)	TM	Enabled Telemetry Source Packets Report	n/a
(14,5)	TC	Enable Forwarding of Housekeeping Packets	Specific
(14,6)	TC	Disable Forwarding of Housekeeping Packets	Specific
(14,7)	TC	Report Enabled Housekeeping Packets	Specific
(14,8)	TM	Enabled Housekeeping Packets Report	Specific
(14,9)	TC	Enable Forwarding of Diagnostic Packets	Specific
(14,10)	TC	Disable Forwarding of Diagnostic Packets	Specific
(14,11)	TC	Report Enabled Diagnostic Packets	Specific
(14,12)	TM	Enabled Diagnostic Packets Report	Specific
(14,13)	TC	Enable Forwarding of Event Report Packets	Specific
(14,14)	TC	Disable Forwarding of Event Report Packets	Specific
(14,15)	TC	Report Enabled Event Report Packets	n/a
(14,16)	TM	Enabled Event Report Packets Report	n/a
(14,128)	TC	Report Telemetry Source Packet Forwarding Status	Specific

Service, Subservice	TM/TC	Description	Applicability
(14,129)	TM	Telemetry Source Packet Forwarding Status Report	Specific
(14,130)	TC	Report Event Report Packet Forwarding Status	Specific
(14,131)	TM	Event Report Packet Forwarding Status Report	Specific

Table 4.12-1: Service 14 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with *“Basic”* will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Objective

The packet forwarding control service provides the capability to control the forwarding to the ground of telemetry source packets issued by on-board services.

Description

The packet forwarding control service maintains the knowledge of which packets can be transmitted to the ground system per application process.

Per default the packet forwarding status for all packets of the on-board PRID’s is enabled

For a given application process, the forwarding of packets can be “enabled” and “disabled” at the level of:

- a type of packet
- a subtype of packet
- a housekeeping packet definition, a diagnostic packet definition or an event report definition.

The forwarding of packets with a given type and subtype shall be “enabled” if and only if the packet type and the packet subtype are both enabled (i.e. if the type is in the set of enabled types and the subtype is in the set of enabled subtypes for that type).

In addition, the forwarding of housekeeping (or diagnostic or event report) packets shall be “enabled” if and only if the packet type, the packet subtype and the housekeeping packet definition (or the diagnostic packet definition or the event report definition) are all enabled.

For each packet definition three independent controlling attributes exist (at PRID level, at type level, at subtype level) whose values determine the forwarding of the packet in accordance with the Table 4.12-2 (Forwarding status decision table).

PRID	Type	Subtype	Forwarding Status
D(isabled)	D(isabled)	E(nabled)	D
D	D	D	D
D	E	E	D
D	E	D	D
E	D	E	D
E	D	D	D
E	E	E	E
E	E	D	D

Table 4.12-2: Forwarding status decision table

Telemetry packets of type TM(5,1-4) have the EID as additional packet structure identification level.

Telemetry packets of type TM(3,25) and TM(3,26) have the SID as additional packet structure identification level. The forwarding status is determined according to the table below.

PRID	Type	Subtype	Identification (SID/EID)	Forwarding Status
D(isabled)	D(isabled)	E(nabled)	E	D
D	D	D	E	D
D	D	E	D	D
D	D	D	D	D
D	E	E	E	D
D	E	D	E	D
D	E	E	D	D
D	E	D	D	D
E	D	D	E	D
E	D	E	D	D
E	D	D	D	D
E	D	E	E	D

PRID	Type	Subtype	Identification (SID/EID)	Forwarding Status
E	E	E	E	E
E	E	D	E	D
E	E	E	D	D
E	E	D	D	D

Table 4.12-3: Forwarding status decision table

4.12.1 TC(14,1): Enable Forwarding of Telemetry Source Packets

4.12.1.1 Description

Upon reception of TC(14,1) forwarding of the specified TM Source Packets shall be enabled.

4.12.1.2 Structure

PUS-6966//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 1

The structure of the Application Data field within the TC Packet Data field is defined here below.

N1	Filler	PRID	N2	Type	N3	Subtype
Unsigned integer		Enumerated	Unsigned integer	Enumerated	Unsigned integer	Enumerated
1 byte	1 bit	7 bit	1 byte	1 byte	1 byte	1 byte
						< --- repeat *N3* times --->
				< --- repeat *N2* times --->		
	< ------ repeat *N1* times ------ >					

Table 4.12-4: Structure of the Application data TC(14,1)

4.12.1.3 Parameter Definition & Range

PUS-7011//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value

Parameters of Application Data Field	Description	Range or value
N1	Number of *PRID's* to follow	1 .. MAX_NUMBER_OF_PRID to the PRID Table in Volume B
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B
N2/N3	The number of type definition to follow	**N2 = 0:** all types of telemetry source packets from the corresponding application process shall be placed in the set of enabled types. **N2 > 0, N3 = 0:** the specified types of telemetry source packets from the corresponding application process shall be added to the set of enabled types. **N2 > 0, N3 > 0:** the specified subtypes of telemetry source packets from the corresponding application process shall be added to the set of enabled subtypes for the specified type. Note: If N2 > 1 then there can be a mixture of empty (N3 = 0) and non-empty (N3 > 0) arrays. Note: These requests do not change the forwarding status at the level of the SID/EID.
Type	The telemetry source packet type	Any valid service type of the specified *PRID*.
Subtype	The telemetry source packet service subtype for the specified service type.	Any valid *Subtype* of the specified *Type*

Table 4.12-5: Parameters of the Application Data for TC(14,1)

4.12.1.4 TC Verification

PUS-7039//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7041//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Either N1/N2/N3 are inconsistent with the real length of the packet data field OR N1 is out of the range specified above	FID_FORW_DISCREP
[3] At least one of the Types is outside the range specified above (Type = 0)	FID_FORW_INVALID_TYPE
[4] At least one of the Subtypes is outside the range specified above (Subtype = 0)	FID_FORW_INVALID_SUBTYPE
[5] At least one of the PIDs is not registered	FID_UNKNOWN_FORW_PID
[6] Too many forward control rules commanded	FID_FORW_OVERFLOW

4.12.1.5 Remarks

Note : Since the central software does not have the knowledge about all valid TYPE/SUBTYPE combinations the request will be executed without checking these values. There is in general no problem of having invalid combinations in the packet forwarding table. The erroneously specified rules will never be applied if no corresponding packets exist.

4.12.2 TC(14,2): Disable Forwarding of Telemetry Source Packets

4.12.2.1 Description

Upon reception of TC(14,2) forwarding of the specified TM Source Packets shall be disabled.

4.12.2.2 Structure

PUS-7050//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 2

The structure of the Application Data field within the TC Packet Data field is identical to the one defined for TC(14,1). See Table 4.12-4 (Structure of the Application data TC(14,1)).

4.12.2.3 Parameter Definition & Range

PUS-7057//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N1	Number of *PRID's* to follow	1..MAX_NUMBER_OF_PRID to the PRID Table in Volume B
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Parameters of Application Data Field	Description	Range or value
N2/N3	The number of type definition to follow	**N2 = 0:** all types of telemetry source packets from the corresponding application process shall be removed from the set of enabled types. **N2 > 0, N3 = 0:** the specified types of telemetry source packets from the corresponding application process shall be removed from the set of enabled types. **N2 > 0, N3 > 0:** the specified subtypes of telemetry source packets from the corresponding application process shall be removed from the set of enabled subtypes for the specified type. Note: If N2 > 1 then there can be a mixture of empty (N3 = 0) and non-empty (N3 > 0) arrays. Note: These requests do not change the forwarding status at the level of the SID/EID.
Type	The telemetry source packet type	Any valid service type of the specified *PRID*.
Subtype	The telemetry source packet service subtype for the specified service type.	Any valid *Subtype* of the specified *Type*

Table 4.12-6: Parameters of the Application Data for TC(14,2)

4.12.2.4 TC Verification

PUS-7085//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7087//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Either N1/N2/N3 are inconsistent with the real length of the packet data field OR N1 is out of the range specified above	FID_FORW_DISCREP
[3] At least one of the Types is outside the range specified above (Type = 0)	FID_FORW_INVALID_TYPE
[4] At least one of the Subtypes is outside the range specified above (Subtype = 0)	FID_FORW_INVALID_SUBTYPE
[5] At least one of the PIDs is not registered	FID_UNKNOWN_FORW_PID
[6] Too many forward control rules commanded	FID_FORW_OVERFLOW

4.12.3 TC(14,5): Enable Forwarding of Housekeeping Packets

4.12.3.1 Description

Upon reception of TC(14,5) forwarding of the specified HK Packets shall be enabled.

4.12.3.2 Structure

PUS-7094//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 5

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

N1	Filler	PRID	N2	SID
Unsigned integer		Enumerated	Unsigned integer	Enumerated
1 byte	1bit	7 bit	1 byte	1 byte
				< --- repeat *N2* times --->
	< ------ repeat *N1* times ------ >			

Table 4.12-7: Structure of the Application data TC(14,5)

4.12.3.3 Parameter Definition & Range

PUS-7128//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N1	Repetition count for following fields	Number of entries following
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Parameters of Application Data Field	Description	Range or value
N2	The number of housekeeping packet definitions to be enabled or disabled.	> 0
SID	Structure ID of a housekeeping report definition	SID_HK_RANGE

Table 4.12-8: Parameters of the Application Data for TC(14,5)

4.12.3.4 TC Verification

PUS-7152/I/

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7154/I/

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length (includes case N1=0)	FID_LENGTH_DISCREP
[2] Either N1/N2 are inconsistent with the real length of the packet data field OR N1 and/or N2 is out of the range specified above (case N1=0 excluded)	FID_FORW_DISCREP
[3] At least one of the SIDs is out of the range specified above	FID_FORW_INVALID_RID
[4] At least one of the PIDs is not registered	FID_UNKNOWN_FORW_PID
[5] Too many forward control rules commanded	FID_FORW_OVERFLOW

4.12.4 TC(14,6): Disable Forwarding of Housekeeping Packets

4.12.4.1 Description

Upon reception of TC(14,6) forwarding of the specified HK Packets shall be disabled.

4.12.4.2 Structure

PUS-7161/I/

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 6

The structure of the *Application Data* field within the TC *Packet Data* field is identical to the one defined for TC(14,5). See Table 4.12-7 (Structure of the Application data TC(14,5)).

4.12.4.3 TC Verification

PUS-7168/I/

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7170/I/

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length (includes case N1=0)	FID_LENGTH_DISCREP
[2] Either N1/N2 are inconsistent with the real length of the packet data field OR N1 and/or N2 is out of the range specified above (case N1=0 excluded)	FID_FORW_DISCREP
[3] At least one of the SIDs is out of the range specified above	FID_FORW_INVALID_RID
[4] At least one of the PIDs is not registered	FID_UNKNOWN_FORW_PID
[5] Too many forward control rules commanded	FID_FORW_OVERFLOW

4.12.5 TC(14,7): Report Enabled Housekeeping Packets

4.12.5.1 Description

Upon reception of TC(14,7) the report TM(14,8) shall be generated.

4.12.5.2 Structure

PUS-7177/I/

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 7

TC(14,7) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.12.5.3 TC Verification

PUS-7184/I/

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7186/I/

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.12.6 TM(14,8): Enabled Housekeeping Packets Report

4.12.6.1 Description

TM(14,8) is the response to TC(14,7).

4.12.6.2 Structure

PUS-7193//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 14

Service Subtype : Must be set to 8

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N1	Filler	PRID	N2	SID	FSTAT
Unsigned integer		Enumerated	Unsigned integer	Enumerated	Enumerated
1 byte	1bit	7 bit	1 byte	1 byte	1byte
				< --- repeat *N2* times --->	
	< ------ repeat *N1* times ------ >				

Table 4.12-9: Structure of the Source data TM(14,8)

4.12.6.3 Parameter Definition & Range

PUS-7230//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N1	Repetition count for following fields	1 … N1_MAX[1)]
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B
N2	The number of *SID's*	1 … Depending on *N1*
SID	Structure ID	See Volume B **0 :=** All *HK SID's*
FSTAT	Packet Forewarding Status	**0 :=** DISABLED **1 :=** ENABLED

Table 4.12-10: Parameters of the Source Data for TM(14,8)

Note 1)

depending on MTU and mission specific number of PRIDs acc. Volume B but in any case N1_MAX = 127 (this is the max possible number of PRIDs since it is coded on 7 bits)

4.12.6.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.12.7 TC(14,9): Enable Forwarding of Diagnostic Packets

4.12.7.1 Description

Upon reception of TC(14,9) forwarding of the specified Diagnostic Packets shall be enabled.

4.12.7.2 Structure

PUS-7263//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 9

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

N1	Filler	PRID	N2	SID
Unsigned integer		Enumerated	Unsigned integer	Enumerated
1 byte	1bit	7 bit	1 byte	1 byte
				< --- repeat *N2* times --->
	< ------ repeat *N1* times ------ >			

Table 4.12-11: Structure of the Application data TC(14,9)

4.12.7.2.1 Parameter Definition & Range

PUS-18664//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N1	Repetition count for following fields	Number of entries following

Parameters of Application Data Field	Description	Range or value
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B
N2	The number of housekeeping packet definitions to be enabled or disabled.	> 0
SID	Structure ID of a diagnostic report definition	SID_DIAG_RANGE

Table 4.12-12: Parameters of the Application Data for TC(14,9)

4.12.7.3 TC Verification

PUS-7270/I

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7272/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length (includes case N1=0)	FID_LENGTH_DISCREP
[2] Either N1/N2 are inconsistent with the real length of the packet data field OR N1 and/or N2 are out of the range specified above (case N1=0 excluded)	FID_FORW_DISCREP
[3] At least one of the SIDs is out of the range specified above	FID_FORW_INVALID_RID
[4] At least one of the PIDs is not registered	FID_UNKNOWN_FORW_PID
[5] Too many forward control rules commanded	FID_FORW_OVERFLOW

4.12.8 TC(14,10): Disable Forwarding of Diagnostic Packets

4.12.8.1 Description

Upon reception of TC(14,10) forwarding of the specified Diagnostic Packets shall be disabled.

4.12.8.2 Structure

PUS-7279/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 10

The structure of the Application Data field within the TC Packet Data field is identical to the one defined for

TC(14,9). See Table 4.12-12 (Structure of the Application data TC(14,9)).

4.12.8.3 TC Verification

PUS-7286/I

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7288/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length (includes case N1=0)	FID_LENGTH_DISCREP
[2] Either N1/N2 are inconsistent with the real length of the packet data field OR N1 and/or N2 are out of the range specified above (case N1=0 excluded)	FID_FORW_DISCREP
[3] At least one of the SIDs is out of the range specified above	FID_FORW_INVALID_RID
[4] At least one of the PIDs is not registered	FID_UNKNOWN_FORW_PID
[5] Too many forward control rules commanded	FID_FORW_OVERFLOW

4.12.9 TC(14,11): Report Enabled Diagnostic Packets

4.12.9.1 Description

Upon reception of TC(14,11) the report TM(14,12) shall be generated.

4.12.9.2 Structure

PUS-7295/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 11

TC(14,11) does not have any application data, i.e. the Application Data field within the TC Packet Data field does not exist (length = 0).

4.12.9.3 TC Verification

PUS-7302/I

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7304/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.12.10 TM(14,12): Enabled Diagnostic Packets Report

4.12.10.1 Description

TM(14,12) is the response to TC(14,11).

4.12.10.2 Structure

PUS-7311//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 14

Service Subtype : Must be set to 12

The structure of the Source Data field within the TM Packet Data field is defined here below.

N1	Filler	PRID	N2	SID	FSTAT
Unsigned integer		Enumerated	Unsigned integer	Enumerated	Enumerated
1 byte	1bit	7 bit	1 byte	1 byte	1byte
				< --- repeat *N2* times --->	
	< ------ repeat *N1* times ------ >				

Table 4.12-13: Structure of the Source data TM(14,12)

4.12.10.3 Parameter Definition & Range

PUS-7348//

The parameters of the Source Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N1	Repetition count for following fields	1 … N1_MAX[1)]
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B
N2	The number of *SiD's* to follow	1 … Depending on *N1*
SID	Structure Identifier	See Volume B **0 :=** all diagnostic SIDs
FSTAT	Packet Forwarding Status	**0 :=** DISABLED **1 :=** ENABLED

Table 4.12-14: Parameters of the Source Data for TM(14,12)

Note 1)

depending on MTU and mission specific number of PRIDs acc. Volume B but in any case N1_MAX = 127 (this is the max possible number of PRIDs since it is coded on 7 bits)

4.12.10.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.12.11 TC(14,13): Enable Forwarding of Event Report Packets

4.12.11.1 Description

Upon reception of TC(14,13) forwarding of the specified Event Report Packets shall be enabled.

4.12.11.2 Structure

PUS-7381//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 13

The structure of the Application Data field within the TC Packet Data field is defined here below.

N1	Filler	PRID	N2	EID
Unsigned integer		Enumerated	Unsigned integer	Enumerated
1 byte	1bit	7 bit	1 byte	2 bytes
				< --- repeat *N2* times --->
	< ------ repeat *N1* times ------ >			

Table 4.12-15: Structure of the Application data TC(14,13)

4.12.11.3 Parameter Definition & Range

PUS-7415//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N1	Repetition count for following fields	1 … 56

Parameters of Application Data Field	Description	Range or value
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B
N2	The number of event packet definitions to be enabled or disabled.	Depending on *N1*
EID	Event Identifier	See Volume B

Table 4.12-16: Parameters of the Application Data for TC(14,13)

4.12.11.4 TC Verification

PUS-7439//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7441//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if the Application Data Structure is inconsistent

•if the PRID identifier is invalid

•if there is not enough space to store the TC data

4.12.12 TC(14,14): Disable Forwarding of Event Report Packets

4.12.12.1 Description

Upon reception of TC(14,14) forwarding of the specified Event Report Packets shall be disabled.

4.12.12.2 Structure

PUS-7448//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 14

The structure of the Application Data field within the TC Packet Data field is identical to the one defined for TC(14,13). See Table 4.12-15 (Structure of the Application data TC(14,13)).

4.12.12.3 TC Verification

PUS-7455//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7457//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length (excludes case N1=0)	FID_LENGTH_DISCREP
[2] Either N1/N2 are inconsistent with the real length of the packet data field OR N1 and/or N2 are out of the range specified above (case N1=0 excluded)	FID_FORW_DISCREP
[3] At least one of the EIDs is out of the range specified above	FID_FORW_INVALID_RID
[4] At least one of the PIDs is not registered	FID_UNKNOWN_FORW_PID
[5] Too many forward control rules commanded	FID_FORW_OVERFLOW

4.12.13 TC(14,128): Report Telemetry Source Packet Forwarding Status

4.12.13.1 Description

Upon reception of TC(14,128) the report TM(14,129) shall be generated.

4.12.13.2 Structure

PUS-7464//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 128

TC(14,128) does not have any application data, i.e. the Application Data field within the TC Packet Data field does not exist (length = 0).

4.12.13.3 TC Verification

PUS-7471//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7473//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM	FID_REPORT_ABORTED

4.12.14 TM(14,129): Telemetry Source Packet Forwarding Status

4.12.14.1 Description

TM(14,129) is the response to TC(14,128).

4.12.14.2 Structure

PUS-7480//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 14

Service Subtype : Must be set to 129

The structure of the Source Data field within the TM Packet Data field is defined here below.

N1	FIller	PRID	FSTAT	N2	Type	FSTAT	N3	Subtype	FSTAT
Unsigned integer		Enumerated	Enumerated	Unsigned integer	Enumerated	Enumerated	Unsigned integer	Enumerated	Enumerated
1 byte	1 bit	7 bit	1byte	1 byte	1 byte	1byte	1 byte	1 byte	1byte
								< --- repeat *N3* times --->	
					< --- repeat *N2* times --->				
	< ------ repeat *N1* times ------ >								

Table 4.12-17: Structure of the Source data TM(14,129)

4.12.14.3 Parameter Definition & Range

PUS-7534//

The parameters of the Source Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N1	Number of *PRID's* to follow	Depending on MTU
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Parameters of Application Data Field	Description	Range or value
N2/N3	The number of type/subtype definition to follow	**N2 = 0:** *FSTAT* applies to all types of telemetry source packets from the corresponding application process. **N2 > 0, N3 = 0:** *FSTAT* applies to all subtypes of the given type from the corresponding PRID. **N2 > 0, N3 > 0:** *FSTAT* applies to the specified type/subtype combination from the corresponding PRID. Note: If N2 > 1 then there can be a mixture of empty (N3 = 0) and non-empty (N3 > 0) arrays.
Type	The telemetry source packet type	Any valid service type of the specified *PRID*. **0 :=** All Types
Subtype	The telemetry source packet service subtype for the specified service type.	Any valid *Subtype* of the specified *Type* **0 :=** All Subtypes
FSTAT	Packet Forwarding Status	**0 :=** DISABLED **1 :=** ENABLED

Table 4.12-18: Parameters of the Source data for TM(14,129)

4.12.14.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.12.15 TC(14,130): Report Event Report Packet Forwarding Status

4.12.15.1 Description

Upon reception of TC(14,130) the report TM(14,131) shall be generated.

4.12.15.2 Structure

PUS-7571//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 14

Service Subtype : Must be set to 130

TC(14,130) does not have any application data, i.e. the Application Data field within the TC Packet Data field does not exist (length = 0).

4.12.15.3 TC Verification

PUS-7578//

TM(1,2): TC Acceptance Report - Failure shall be generated

• if one of the static checks according to Section 4.1 failed

PUS-7580//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.12.16 TM(14,131): Event Report Packet Forwarding Status Report

4.12.16.1 Description

TM(14,131) is the response to TC(14,130).

4.12.16.2 Structure

PUS-7587//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 14

Service Subtype : Must be set to 131

The structure of the Source Data field within the TM Packet Data field is defined here below.

N1	Filler	PRID	N2	EID	FSTAT
Unsigned integer		Enumerated	Unsigned integer	Enumerated	Enumerated
1 byte	1bit	7 bit	1 byte	2 bytes	1byte
				< --- repeat *N2* times --->	

N1	Filler	PRID	N2	EID	FSTAT
	< ------ repeat *N1* times ------ >				

Table 4.12-19: Structure of the Source data TM(14,131)

4.12.16.3 Parameter Definition & Range

PUS-7624//

The parameters of the Source Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N1	Repetition count for following fields	
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B
N2	The number of *EID* Packet Forewarding Status values to follow	Depending on *N1*
EID	Event Identifier	See Volume B ! **0 :=** All Events
FSTAT	Packet Forwarding Status	**0 :=** DISABLED **1 :=** ENABLED

Table 4.12-20: Parameters of the Source Data for TM(14,131)

4.12.16.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.13 Service 15: On Board Storage and Retrieval

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(15,1)	TC	Enable Storage in Packet Stores	Specific
(15,2)	TC	Disable Storage in Packet Stores	Specific
(15,3)	TC	Add Packet Types & Sub-Types to Storage Selection Definition	Specific
(15,4)	TC	Remove Packet Types & Sub-Types from Storage Selection Definition	Specific

Service, Subservice	TM/TC	Description	Applicability
(15,5)	TC	Report Storage Selection Definition	covered by (15,145)
(15,6)	TM	Storage Selection Definition Report	covered by (15,146)
(15,7)	TC	Downlink Packet Store Contents for Packet Range	n/a
(15,8)	TM	Packet Store Contents Report	n/a
(15,9)	TC	Downlink Packet Store Contents for Time Period	Specific
(15,10)	TC	Delete Packet Stores Contents (up to Specified Packets)	Specific
(15,11)	TC	Delete Packet Stores Contents up to Specified Storage Time	Specific
(15,12)	TC	Report Catalogues for Selected Packet Stores	n/a
(15,13)	TM	Packet Store Catalogue Report	n/a
(15,128)	TC	Stop Playback of HK Packet Store Contents	Specific
(15,129)	TC	Start Playback of HK Packet Store Contents	Specific
(15,140)	TC	Add SID's to Storage Selection Definition	Specific
(15,141)	TC	Remove SID's from Storage Selection Definition	Specific
(15,142)	TC	Report SID Storage Selection Definition	Specific
(15,143)	TM	SID Storage Definition Report	Specific
(15,145)	TC	Report Storage Routing Definition Table	Specific
(15,146)	TM	Storage Routing Definition Report	Specific
(15,150)	TC	Format Packet Store Memory	Specific
(15,151)	TC	Get Format of Packet Store Memory	Specific
(15,152)	TM	Packet Store Format Report	Specific
(15,153)	TC	Set Packet Store Playback Pointer	Specific
(15,154)	TC	Change Packet Store Attributes	Specific

Table 4.13-1: Service 15 sub-services

The column "Applicability" in the table above shall be interpreted as follows:

•All services marked with *"Basic"* will be supported by all on-board packet terminals;

•i.e. by all PRID's.

•All services marked with *"Specific"* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Description:

The on-board storage and retrieval service is the central service to store in the on board Mass Memory TM packets generated by all on-board applications in order to give the ground system full visibility after the downlink of the stored data. The stored TM packets are selectively routed into different Packet Stores, which per default are configured as specified in the table "Service 15 Packet Store ID Assignment" in Volume B.

The on-board storage and retrieval service consists of three parts:

•packet selection sub-services for routing of telemetry source packets for storage in a dedicated packet store;

•down-link sub-services for playback of telemetry source packets from packet stores to ground.

•storage maintenance sub-services

All Satellite HK are stored in a dedicated Packet Store. They can be replayed during the next period of ground coverage. After start of the Packet Store playback, the TM packets of the first PS are sent in sequential order of storage, when this is emptied, it continues with the next Packet Store until the last Packet Store is emptied. The Packet Store playback is stopped upon command or autonomously when the last packet store is emptied.

One or more packet types and subtypes generated by one or more application processes can be selected for storage in a given packet store.

A packet store is uniquely identified by a "*PS ID*". The definition of the storage selection used by a given packet selection sub-service is predefined, but changeable by ground TC. Packets are stored according to their sequence of arrival at the Packet Store. By design each TM source packet is time stamped by the generating application.

Telemetry source packets stored in a Packet Store can be downlinked on request. The playback sub-service allows specification of a list of Packet Stores, which will be downlinked in the order of the list.

Each packet store provides the following capabilities:

•two playback pointers to indicate the position of the start of the playback

•one write pointer to indicate the position resp. filling of the Packet Store

•parallel writing of data to and down-linking of data from the Packet Store

•an attribute, which defines, whether the storage strategy is circular or bounded

•definition of the storage size and start position for data storage

Service TC(15,12) and TM(15,13) are not implemented, since the provided information will be provided as nominal HK.

4.13.1 TC(15,1): Enable Storage in Packet Stores

4.13.1.1 Description

Upon reception of TC(15,1) the specified Packet Store shall be enabled.

4.13.1.2 Structure

PUS-7795//

The Packet Header shall have the following structure:

Structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

N	Store ID
Unsigned Integer	Enumerated
1 byte	1 byte
	< --- repeat *N* times --->

Table 4.13-2: Structure of the Application data TC(15,1)

4.13.1.3 Parameter Definition & Range

PUS-7817//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	The number of packet stores to be controlled	1.....N_MAX[1)] Note: 0 means all packet stores
Store ID	Identifier for the packet store	See Volume **B**

Table 4.13-3: Parameters of the Application Data for TC(15,1)

Note 1)

N_MAX = 193 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.13.1.4 TC Verification

PUS-7833//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7835//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is : either not consistent with the real length of the packet data field OR out of the range specified above	FID_STORE_DISCREP
[3]	At least one of the Store IDs is not defined	FID_UNKNOWN_STORE_ID

4.13.2 TC(15,2): Disable Storage in Packet Stores

4.13.2.1 Description

Upon reception of TC(15,1) the specified Packet Store shall be disabled.

4.13.2.2 Structure

PUS-7843//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 2

The structure of the *Application Data* field within the TC *Packet Data* field is identical as defined for TC(15,1). See Table 4.13-2 (Structure of the Application Data TC(15,1)).

4.13.2.3 TC Verification

PUS-7850//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-7852//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is : either not consistent with the real length of the packet data field OR out of the range specified above	FID_STORE_DISCREP
[3]	At least one of the Store IDs is not defined	FID_UNKNOWN_STORE_ID

4.13.3 TC(15,3): Add Packets to Storage Selection Definition

4.13.3.1 Description

Upon reception of TC(15,3) the specified packet shall be added to the storage selection definition.

4.13.3.2 Structure

PUS-7860//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 3

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Store ID	N1	Filler	PRID	N2	Type	N3	Subtype
Enumerated	Unsigned integer		Enumerated	Unsigned integer	Enumerated	Unsigned integer	Enumerated
1 byte	1 byte	1bit	7 bit	1 byte	1 byte	1 byte	1 byte
							< --- repeat *N3* --- > times
					< --- repeat *N2* times --->		
		< ------ repeat *N1* times ------ >					

Table 4.13-4: Structure of the Application data TC(15,3)

4.13.3.3 Parameter Definition & Range

PUS-7908//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Store ID	Identifier for the packet store	See Volume **B** Note: value 0 means “No Storage”
N1	Number of *PRID’s* to follow	1 …. [MAX_NOF_PRIDs]
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Parameters of Application Data Field	Description	Range or value
N2/N3	The number of type definition to follow	**N2 = 0:** all types of telemetry source packets from the corresponding application process shall be placed in the set of enabled types to be stored in the specified *Store ID*. **N2 > 0, N3 = 0:** the specified types of telemetry source packets from the corresponding application process shall be added to the set of enabled types to be stored in the specified *Store ID*. **N2 > 0, N3 > 0:** the specified subtypes of telemetry source packets from the corresponding application process shall be added to the set of enabled subtypes for the specified type to be stored in the specified *Store ID*. Note: If N2 > 1 then there can be a mixture of empty (N3 = 0) and non-empty (N3 > 0) arrays.
Type	The telemetry source packet type	Any valid service type of the specified *PRID*.
Subtype	The telemetry source packet service subtype for the specified service type.	Any valid *Subtype* of the specified *Type*

Table 4.13-5: Parameters of the Application Data for TC(15,3)

4.13.3.4 TC Verification

PUS-7940//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7942//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The Store ID is not defined	FID_UNKNOWN_STORE_ID
[3]	Either N1/N2/N3 are inconsistent with the real length of the packet data field OR N1 is out of the range specified above OR there are more definitions than the number of free definitions	FID_STORE_DEF_DISCREP
[4]	At least one of the PIDs is not registered	FID_UNKNOWN_STORE_PID
[5]	Too many storage control rules commanded	FID_STORE_OVERFLOW
[6]	At least one of the Types is outside the range specified above (Type = 0)	FID_STORE_INVALID_TYPE
[7]	At least one of the Subtypes is outside the range specified above (Subtype = 0)	FID_STORE_INVALID_SUBTYPE

4.13.3.5 Remarks

The current content of the packet store shall not be affected by the request.

The request shall have no effect for a packet type which is in the list of packet types to be stored in the specified packet store. (because all its subtypes are already selected for storage).

4.13.4 TC(15,4): Remove Packet from Storage Selection Definition

4.13.4.1 Description

Upon reception of TC(15,4) the specified packet shall be removed from the storage selection definition.

4.13.4.2 Structure

PUS-7953//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 4

The structure of the *Application Data* field within the TC *Packet Data* field is identical to the one defined for TC(15,3). See Table 4.13-4 (Structure of the Application Data TC(15,3)).

4.13.4.3 TC Verification

PUS-7960//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-7962//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The Store ID is not defined	FID_UNKNOWN_STORE_ID
[3]	At least one of the PIDs is not registered	FID_UNKNOWN_STORE_PID
[4]	Either N1/N2/N3 are inconsistent with the real length of the packet data field OR N1 is out of the range specified above OR there are more definitions than the number of free definitions	FID_STORE_DEF_DISCREP
[5]	At least one of the Types is outside the range specified above (Type = 0)	FID_STORE_INVALID_TYPE
[6]	At least one of the Subtypes is outside the range specified above (Subtype = 0)	FID_STORE_INVALID_SUBTYPE

4.13.4.4 Remarks

The current content of the packet store shall not be affected by the request.

The request shall have no effect for a packet type which is not in the list of packet types to be stored in the specified packet store.

4.13.5 TC(15,5): Report Storage Selection Definition

The service subtype is provided as private service sub-type TC(15,145)

4.13.6 TM(15,6): Storage Selection Definition Report

The function of this service subtype is provided as private service sub-type TM(15,146)

4.13.7 TC(15,7): Downlink Packet Store Contents for Packet Range

This service subtype is not applicable

4.13.8 TC(15,9): Downlink Packet Store Contents for Time Period

4.13.8.1 Description

Upon reception of TC(15,9) the content of the specified Packet Store (PS) shall be down linked to the ground. After start of the PS playback, the OBC sends the packets of the requested PSs in chronological order. When the PS empty criteria is reached, it continues with the next PS until the last PS. When the packets within the specified time span and range have been transmitted, the controlling software stops the PS replay. If required, playback can be interrupted using TC (15,128) Stop Playback of Packet Store Contents.

Note:

Neither this subservice nor the Stop Playback of Packet Store Contents subservice influences the position of the playback pointers that are applicable to the Start Playback of Packet Store Contents subservice.

4.13.8.2 Structure

PUS-8184//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 9

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

N	Store ID	TimeSpan	Storage Time 1	Storage Time 2
Unsigned Integer	Enumerated	Enumerated	Onboard time format PTC = 9; PFC = 17	Onboard time format PTC = 9; PFC = 17
1 byte	1 byte	1 byte	6 byte	6 byte
	<---- repeated *N* times ---->			

Table 4.13-6: Structure of the Application data TC(15,9)

TimeSpan	Storage Time 1	Storage Time 2
0	0	0
1	Storage Time 1	Storage Time 2
2	Storage Time 1	0
3	Storage Time 1	0

Table 4.13-7: Combination of the Time parameters values

Note:

In case of TimeSpan = 2 or 3 only the parameter Storage Tme 1 will be checked.

4.13.8.3 Parameter Definition & Range

PUS-8211//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Store ID	Identifier for the packet store	See Volume B
TimeSpan	This indicates how the packet range is specified	0 = the full contents of the packet store shall be downlinked 1 = between Storage Time 1 and Storage Time 2 inclusive 2 = less than or equal to Storage Time 1 3 = greater than or equal to Storage Time 1.
Storage Time 1	Start Time	Any valid spacecraft time in the specified format

Parameters of Application Data Field	Description	Range or value
Storage Time 2	End Time	Any valid spacecraft time in the specified format

Table 4.13-8: Parameters of the Application Data for TC(15,9)

4.13.8.4 TC Verification

PUS-8239//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-8241//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if Packet Store ID is invalid

•if StorageTIme1 and 2 are not consistent with the defined TimeSpan

•if a dump process is already ongoing. (need to be stopped with TC(15,128) before)

4.13.9 TC(15,10): Delete Content of Packet Store

4.13.9.1 Description

Upon reception of TC(15,10) the content of the selected packet store will be deleted.

4.13.9.2 Structure

PUS-7989//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 10

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

N	Store ID
Unsigned Integer	Enumerated
1 byte	1 byte
	< --- repeat *N* times --->

Table 4.13-9: Structure of the Application data TC(15,10)

4.13.9.3 Parameter Definition & Range

PUS-8010//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	The number of packet stores to be controlled	1.....N_MAX[1)] Note: 0 means all packet stores
Store ID	Identifier for the packet store	Value is application dependent. See Volume **B**

Table 4.13-10: Parameters of the Application Data for TC(15,10)

Note 1)

N_MAX = 193 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in section 258)

4.13.9.4 TC Verification

PUS-8026//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-8028//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if N does not correspond to the number of supplied Store ID's

•if Store ID is invalid

•if the request could not be completed, since superseded by new request.

4.13.10 TC(15,11): Delete Content of Packet Store up to specified storage time

4.13.10.1 Description

Upon reception of TC(15,11) the content of the selected packet store up to the specified storage time will be deleted.

4.13.10.2 Structure

PUS-8037//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 11

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

End Time	N	Store ID
Onboard time format PTC = 9; PFC = 17	Unsigned Integer	Enumerated
6 byte	1 byte	1 byte
		< --- repeat *N* times --->

Table 4.13-11: Structure of the Application data TC(15,11)

4.13.10.3 Parameter Definition & Range

PUS-8062//

The parameters of the Application Data *Field shall be inserted according to the following table*

Parameters of Application Data Field	Description	Range or value
EndTIme	The absolute time defining the upper boundary (inclusive) of the packet range to be deleted.	Any valid spacecraft time in the specified format See Note 1)
N	The number of packet stores to be controlled	1.....N_MAX[2)] Note: 0 means all packet stores
Store ID	Identifier for the packet store	Value is application dependent. See Volume **B**

Table 4.13-12: Parameters of the Application Data for TC(15,11)

Note 1)

The resolution of this parameter depends on HW constraints and will be provided in the FOM.

Note 2)

N_MAX = 187 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.13.10.4 TC Verification

PUS-8082//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-8084//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if N does not correspond to the number of supplied Store ID's

•if Store ID is invalid

•if EndTime is less equal than the time of the first valid packet reference in one packet store

•if the request could not be completed, since superseded by new request.

4.13.11 TC(15,128): Stop Playback of Packet Store Contents

4.13.11.1 Description

Upon reception of TC(15,128) the currently executed TC(15,129) or TC(15,9) is stopped. The playback pointers are maintained for the next playback.

4.13.11.2 Structure

PUS-8252//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 128

TC(15,128) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.13.11.3 TC Verification

PUS-8259//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-8261//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

4.13.12 TC(15,129): Start Playback of Packet Store Contents

4.13.12.1 Description

Upon reception of TC(15,129) the content of the specified Packet Store(s) (PS) shall be down linked to the ground. After start of the PS playback, the packets of the first PS is sent in chronological order. When the packet store empty criteria is reached, it continues with the next PS until the last PS. If all data from the last PS are replayed nominally the downlink is autonomously stopped.

The downlink concept is based on the dual playback pointer. The controlling S/W supported by adequate H/W mantains two independent playback pointers in order to support downlink operation. For circular mode buffer stores, data would be overwritten when the store becomes full. The data in bounded mode buffer stores could only be overwritten (perhaps it would be more appropriate to state 'written to the store') after having (successfully) used one of the delete packet store contents commands.

Execution of this command moves the playback pointer(s) for each of the requested packet stores. This value is maintained and used by the next playback operation unless it is modified by TC(15, 153) Set packet Store Playback Pointer.

4.13.12.2 Structure

PUS-8267//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 129

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

N	Store ID	Playback Pointer
Unsigned Integer	Enumerated	Enumerated
1 byte	1 byte	1 byte
	< --- repeat *N* times --->	

Table 4.13-13: Structure of the Application data TC(15,129)

4.13.12.3 Parameter Definition & Range

PUS-8294//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	The number of packet stores to be controlled	1.....N_MAX[1)]

Parameters of Application Data Field	Description	Range or value
Store ID	Identifier for the packet store	Value is application dependent. See Volume **B**
Playback Pointer	Pointer to be used for playback operation	[0,1] 0 .. playback pointer 1 1 .. playback pointer 2

Table 4.13-14: Parameters of the Application Data for TC(15,129)

Note 1)

N_MAX = 96 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.13.12.4 TC Verification

PUS-8318//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-8320//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if N does not correspond to the number of supplied Packet Store ID's

•if Packet Store ID is invalid

4.13.13 TC(15,140): Add SID's to Storage Selection Definition

4.13.13.1 Description

Upon reception of TC(15,140) the *SID's* of the specified *PRID* shall be added to the Storage Selection Definition of the given Packet Store.

4.13.13.2 Structure

PUS-8534//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype: Must be set to 140

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

Store ID	N1	Filler	PRID	N2	SID
Enumerated	Unsigned integer		Enumerated	Unsigned integer	Enumerated
1 byte	1 byte	1bit	7 bit	1 byte	1 byte
					< --- repeat *N2* times --->
		< ------ repeat *N1* times ------ >			

Table 4.13-15: Structure of the Application data TC(15,140)

4.13.13.3 Parameter Definition & Range

PUS-8573/*I*

The parameters of the Application Data *Field shall be inserted according to the following table*

Parameters of Application Data Field	Description	Range or value
Store ID	Identifier for the packet store	See Volume **B** Note: value 0 means “No Storage”
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B
N1/N2	The number of PRID/HK/DG *SID’s* to be added to storage selection definition.	**N1 = 0:** all TM(3,25);TM(3,26) telemetry source packets shall be stored in the specified *Store ID*. **N1 > 0, N2 = 0:** all TM(3,25);TM(3,26) telemetry source packets from the corresponding application process shall be stored in the specified *Store ID*. **N1 > 0, N2 > 0:** the specified *SID’s* of TM(3,25);TM(3,26) telemetry source packets from the corresponding application process shall be stored in the specified *Store ID*.
SID	Structure ID of a Report Definition (HK, Diagnostic)	See Volume B.

Table 4.13-16: Parameters of the Application Data for TC(15,140)

4.13.13.4 TC Verification

PUS-8597//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-8599//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The Store ID is not defined	FID_UNKNOWN_STORE_ID
[3]	At least one of the PIDs is not registered	FID_UNKNOWN_STORE_PID
[4]	Either N1/N2 are inconsistent with the real length of the packet data field OR N1 is out of the range specified above OR there are more definitions than the number of free definitions	FID_STORE_DEF_DISCREP
[5]	Too many storage control rules commanded	FID_STORE_OVERFLOW
[6]	At least one of the SIDs is out of the range specified above (=0)	FID_STORE_INVALID_SID

4.13.13.5 Remarks

The request shall have no effect for HK and diagnostic packets which are in the list of packets to be stored in the specified packet store.

4.13.14 TC(15,141): Remove SID's from Storage Selection Definition

4.13.14.1 Description

Upon reception of TC(15,141) the *SID's* of the specified *PRID* shall be removed to the Storage Selection Definition of the given Packet Store.

4.13.14.2 Structure

PUS-8609//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype: Must be set to 141

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

Store ID	N1	Filler	PRID	N2	SID
Enumerated	Unsigned integer		Enumerated	Unsigned integer	Enumerated
1 byte	1 byte	1bit	7 bit	1 byte	1 byte
					< --- repeat *N2* times --->

Store ID	N1	Filler	PRID	N2	SID
		< ------ repeat *N1* times ------ >			

Table 4.13-17: Structure of the Application data TC(15,141)

4.13.14.3 Parameter Definition & Range

PUS-8648//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Store ID	Identifier for the packet store	See Volume **B** Note: value 0 means “No Storage”
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B
N1/N2	The number of PRID/HK/DG *SID’s* to be deleted from the storage selection definition.	**N1 = 0:** all TM(3,25);TM(3,26) telemetry source packets shall be deleted from storage selection definition of the specified *Store ID*. **N1 > 0, N2 = 0:** all TM(3,25);TM(3,26) telemetry source packets from the corresponding application process shall be deleted from storage selection definition of the specified *Store ID*. **N1 > 0, N2 > 0:** the specified *SID’s* of TM(3,25);TM(3,26) telemetry source packets from the corresponding application process shall be deleted from storage selection definition of the specified *Store ID*.
SID	Structure ID of a Report Definition (HK, Diagnostic)	See Volume B.

Table 4.13-18: Parameters of the Application Data for TC(15,141)

4.13.14.4 TC Verification

PUS-8672//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-8674//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The Store ID is not defined	FID_UNKNOWN_STORE_ID
[3]	At least one of the PIDs is not registered	FID_UNKNOWN_STORE_PID
[4]	Either N1/N2 are inconsistent with the real length of the packet data field OR N1 is out of the range specified above OR there are more definitions than the maximum number of definitions	FID_STORE_DEF_DISCREP
[5]	At least one of the SIDs is out of the range specified above (=0)	FID_STORE_INVALID_SID

4.13.14.5 Remarks

The current content of the packet store shall not be affected by the request.

The request shall have no effect for a packet type which is not in the list of packet types to be stored in the specified packet store.

4.13.15 TC(15,142): Report SID Storage Selection Definition

4.13.15.1 Description

Upon reception of TC(15,142) the report TM(15,143) shall be generated.

4.13.15.2 Structure

PUS-8685//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 142

TC(15,142) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.13.15.3 TC Verification

PUS-8692//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-8694//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.13.16 TM(15,143): SID Storage Selection Definition Report

4.13.16.1 Description

TM(15,143) is the response to TC(15,142).

The TM packet reports the routing definition established for selected SID's. The report is empty if no dedicated routing definitions for single SID's are done. In this case the routing defined by PRID, type and sub-type criterias apply.

For reconstruction of the full ECSS compliant storage selection definition tables the reconstruction scheme given in Volume B is to be applied.

4.13.16.2 Structure

PUS-8700//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 15

Service Subtype : Must be set to 143

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N1	Filler	PRID	N2	SID	Store ID
Unsigned integer		Enumerated	Unsigned integer	Enumerated	Enumerated
1 byte	1bit	7 bit	1 byte	1 byte	1 byte
				< --- repeat *N2* times --->	
	< ------ repeat *N1* times ------ >				

Table 4.13-19: Structure of the Source data TM(15,143)

4.13.16.3 Parameter Definition & Range

PUS-8737//

The parameters of the Application Data *field within the TC* Packet Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value

Parameters of Application Data Field	Description	Range or value
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B
N1/N2	The number of PRID/HK/DG *SID's* to follow.	
SID	Structure ID of a Report Definition (HK, Diagnostic)	A valid *SID* (See Volume B)
Store ID	Identifier for the packet store	See Volume **B** Note: value 0 means "No Storage"

Table 4.13-20: Parameters of the Source data for TM(15,143)

4.13.17 TC(15,145): Report Storage Routing Definition Table

4.13.17.1 Description

Upon reception of TC(15,145) the report TM(15,146) shall be generated.

4.13.17.2 Structure

PUS-7973//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 145

TC(15,145) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.13.17.3 TC Verification

PUS-7980//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-7982//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.13.18 TM(15,146): Storage Routing Definition Report

4.13.18.1 Description

TM(15,146) is the response to TC(15,145) and reports the on-board defined routing table definitions

4.13.18.2 Structure

PUS-8093//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 15

Service Subtype : Must be set to 146

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N1	Filler	PRID	Store ID	N2	Type	Store ID	N3	Subtype	Store ID
Unsigned integer		Enumerated	Enumerated	Unsigned integer	Enumerated	Enumerated	Unsigned integer	Enumerated	Enumerated
1 byte	1bit	7 bit	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte
								< --- repeat *N3* times -->	
					< --- repeat *N2* times --->				
	< ------ repeat *N1* times ------ >								

Table 4.13-21: Structure of the Source data TM(15,146)

4.13.18.3 Parameter Definition & Range

PUS-8147//

The parameters of the Application Data *field within the TC* Packet Data *Field shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
N1	Number of *PRID's* to follow	n/a
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Parameters of Source Data Field	Description	Range or value
N2/N3	The number of type definition to follow	**N2 = 0:** neither type nor subtype of packet from the corresponding application process is selected for storage. **N2 > 0:** the specified types of packet from the corresponding application process are selected for storage. **N3 > 0:** for a type of packet, the specified subtypes of this type from the corresponding application process are selected for storage.
Type	The telemetry source packet type	Any valid service type of the specified *PRID*.
Subtype	The telemetry source packet service subtype for the specified service type.	Any valid *Subtype* of the specified *Type*
Store ID	Identifier for the packet store	See Volume **B** Note: value 0 means "No Storage"

Table 4.13-22: Parameters of the Source data for TM(15,146)

4.13.18.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfil the request. The bandwidth adjustment mechanism is applicable for this TM.

4.13.19 TC(15,150): Format Packet Store Memory

4.13.19.1 Description

The TC(15,150) allows to redefine in-flight the PS allocation : some PS can be kept/repeated, some others can be suppressed and new ones can be added.

After execution of this telecommand, the "old" content of the Mass Memory is lost, even for PS that have been repeated. During execution of this telecommand, the TM packets routed to the HK mass memory will be discarded without notification.

The enabling/disabling status of repeated PS is unchanged by this TC, such as, if the storage was enabled before, the storage will restart immediately after execution of the TC.

The newly created Packet Stores, instead, are disabled and need to be enabled by Ground before data will be written into it.

4.13.19.2 Structure

PUS-8330//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 150

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

N	Store ID	Size
Unsigned Integer	Enumerated	Unsigned Integer
1 byte	1 byte	4 byte
	< --- repeat *N* times --->	

Table 4.13-23: Structure of the Application data TC(15,150)

4.13.19.3 Parameter Definition & Range

PUS-8366//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	The number of packet stores to be allocated	See Note 1)
Store ID	Identifier for the packet store	See Note 1)
Size	Size of buffer in mass memory HW Allocation Units. This parameter is checked so that the end address is within the memory limit.	See Note 1) max HAU defined in Volume B

Table 4.13-24: Parameters of the Application Data for TC(15,150)

Note 1)

For OBC see Volume B

4.13.19.4 TC Verification

PUS-8398//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-8400//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if N does not correspond to the number of supplied Store ID's

•if Store ID is not defined or invalid

•if the size of the packet stores is not compatible with the available mass memory size

•if the storage is enabled

4.13.20 TC(15,151): Get Format of Packet Store Memory

4.13.20.1 Description

TC(15,151) allows retrieving the current Packet Store configuration. TM(15,152) is generated in response to TC(15,151).

4.13.20.2 Structure

PUS-8409//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 151

TC(15,151) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.13.20.3 TC Verification

PUS-8443//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-8445//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

4.13.21 TM(15,152): Packet Store Format Report

4.13.21.1 Description

TM(15,152) is the response to TC(15,151).

4.13.21.2 Structure

PUS-8453//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 15

Service Subtype : Must be set to 152

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N	Store ID	Size	Mode	Virtual Channel
Unsigned Integer	Enumerated	Unsigned Integer	Enumerated	Enumerated
1 byte	1 byte	4 bytes	1 byte	1 byte
	< --- repeat *N* times --->			

Table 4.13-25: Structure of the Source data TM(15,152)

4.13.21.3 Parameter Definition & Range

PUS-8495//

The parameters of the Source Data *field within the TC* Packet Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	Number of packet stores that follow	See Volume B
Store ID	Identifier for the packet store	See Volume B
Size	Packet store size in SAU	
Mode	Packet Store mode of storage. Bounded is used for packet store which stops recording when full, circular type allows overwriting of oldest data with newest ones	0:= Store works as ring (circular) buffer, old data will be overwritten, if store is full 1:= Store works as linear (bounded) buffer, no data will be overwritten in case of overflow
Virtual Channel	Virtual Channel allocated for the downlink.	1....6 (VC1.....VC6)

Table 4.13-26: Parameters of the Source data for TM(15,152)

4.13.22 TC(15,153): Set Packet Store Playback Pointer

4.13.22.1 Description

The TC(15,153) is used to set the playback pointer(s) of a packet store to a TM source packet specified by its coarse generation time, its APID and its SSC. The function will first search for the specified coarse time and will then try to find a packet with a matching APID/SSC combination by moving forward in time.

A subsequent "Start Playback" command for this store will start with the identified packet.

4.13.22.2 Structure

PUS-13245//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 153

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

N	Store ID	PointerID	PktTime	Filler	APID	Filler	SSC
Unsigned Integer	Enumerated	Enumerated	Coarse Time				
1 byte	1 byte	1 byte	4 byte	5 bits	11 bits	2 bit	14bit
	< --- repeat *N* times --->						

Table 4.13-27: Structure of the Application data TC(15,153)

4.13.22.3 Parameter Definition & Range

PUS-13266//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	The number of packet stores for which a Playback Pointer shall be set	See Note 1)
Store ID	Identifier for the packet store	See Note 1)

Parameters of Application Data Field	Description	Range or value
PointerID	Selector which pointer shall be moved	01bin ... PlaybackPointer_01 10bin ... PlaybackPointer_02 11bin ... both
PktTime	Coarse Start Time to look for packet	4 byte coarse time, [sec]
APID	Packet Identification	see volume B
SSC	Source Sequence Count	0 .. 2^{14}-1

Table 4.13-28: Parameters of the Application Data for TC(15,153)

Note 1)

N = 1.... 20 (mission specific)

4.13.22.4 TC Verification

PUS-13287//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-13289//

TM(1,8): TC Execution Completion Report - Failure shall be generated

- if one of the consistency checks according to Section 4.1 failed
- if N does not correspond to the number of supplied Store ID's
- if Store ID is not defined or invalid
- if the packet could not be found in the defined store.

4.13.23 TC(15,154) Change Packet Store Attributes

4.13.23.1 Description

This telecommand specifies, for a packet store, the storage mode and the associated Virtual Channel to be used for downlink.

4.13.23.2 Structure

PUS-17156//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12(telecommand)

Service Type : Must be set to 15

Service Subtype : Must be set to 154

The structure of the *Application Data* field within the *TM Packet Data* field is defined here below.

Store ID	Mode	Virtual Channel
Enumerated	Enumerated	Enumerated
1 byte	1 byte	1 byte

Table 4.13-29: Structure of the Application data TC(15,154)

4.13.23.3 Parameter Definition & Range

PUS-17186/I

The parameters of the Application Data *field within the TC* Packet Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Store ID	Identifier for the packet store	See Volume B
Mode	Packet Store mode of storage. Bounded is used for packet store which stops recording when full, circular type allows overwriting of oldest data with newest ones	0:= Store works as ring (circular) buffer, old data will be overwritten, if store is full 1:= Store works as linear (bounded) buffer, no data will be overwritten in case of overflow
Virtual Channel	Virtual Channel allocated for the downlink.	See Note 1)

Table 4.13-30: Parameters of the Application Data for TC(15,154)

Note 1)

For Sentinel-2 VC = 2 is fixed.

4.13.23.4 TC Verification

PUS-17214/I

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-17216/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if Store ID is not defined or invalid

4.13.24 TC(15,200): Define Storage Cluster

This service subtype is not applicable

N	Number of Store ID's included in this Cluster	1....N_MAX[1)]

4.13.25 TC(15,201): Delete Storage Cluster

This service subtype is not applicable

4.13.26 TC(15,202): Report Storage Cluster Definitions

This service subtype is not applicable

4.13.27 TM(15,203): Storage Cluster Definition Report

This service subtype is not applicable

4.14 Service 17: Test Service

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(17,1)	TC	Perform Connection Test	Basic
(17,2)	TM	Link Connection Report	Basic

Table 4.14-1: Service 17 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with "*Basic*" will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The

detailed assignment for each PRID will be provided in VOLUME B.

Objectives

The test service provides the capability to activate test functions implemented on-board and to report the results of such tests.

Description

The function exercised by the connection test service request shall be the generation of a corresponding one-shot service report by the application process.

The reception on the ground of the service report shall serve to confirm that the routes (uplink and downlink) between itself and the application process are operational and that the application process itself is performing a minimum set of functions (which includes telecommand processing).

4.14.1 TC(17,1): Perform Connection Test

4.14.1.1 Description

TC(17,1) is used to test the end-to-end connection between ground and the onboard application process. The addressed onboard application responds with TM(17,2).

4.14.1.2 Structure

PUS-8791//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 17

Service Subtype : Must be set to 1

TC(17,1) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.14.1.3 TC Verification

PUS-8798//

TM(1,2): TC Acceptance Report - Failure shall be generated

• if one of the static checks according to Section 4.1 failed

PUS-8800//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP

4.14.2 TM(17,2) Link Connection Report

4.14.2.1 Description

The report informs the TC source about the successful reception of the TC by the receiving onboard application (PRID).

4.14.2.2 Structure

PUS-8806//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 1 (acknowledge)

Service Type : Must be set to 17

Service Subtype : Must be set to 2

TM(17,2) does not have any source data, i.e. the *Source Data* field within the *TM Packet Data* field does not exist (length = 0).

4.15 Service 18 : On-board Control Procedures

The on-board control procedure service capability is provided by on-board macro procedures according to Section 4.20

4.16 Service 19: Event/Action Service

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(19,1)	TC	Add Event to the Detection List	Specific
(19,2)	TC	Delete Events from the Detection List	Specific
(19,3)	TC	Clear the Events Detection List	Specific
(19,4)	TC	Enable Actions	Specific
(19,5)	TC	Disable Actions	Specific
(19,6)	TC	Report Event Detection List	Specific
(19,7)	TM	Event Detection List Report	Specific
(19,130)	TC	Report Single Event Detection Entry	Specific
(19,131)	TM	Single Event Detection Entry Report	Specific

Table 4.16-1: Service 19 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with "*Basic*" will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Objective

As an extension to the on-board capability for detecting events and reporting them asynchronously to the ground system, this service provides the capability to define an action that is executed autonomously on-board when a given event is detected. The class of events that can give rise to an action are those that also give rise to an event report and the associated action can be a telecommand of any standard type or any mission-specific telecommand.

Description

The service shall maintain a list of events that can be detected that contains the following information:

- Application Process ID generating the event report;
- Event report ID;
- Associated action (telecommand packet);

- Status of the action - enabled or disabled;

The list shall be updated in accordance with requests from ground and the list information shall be reported to ground on request. The service can be designed to detect event reports (TM(5,[1-4]) generated by one (e.g. its own) or more application process. On reception of an event report, the service shall scan the detection list and if a matching event report is detected and the associated action is enabled, the corresponding telecommand packet shall be sent to the destination application process.

4.16.1 TC(19,1): Add Events to the Detection List

4.16.1.1 Description

Upon reception of TC(19,1) the specified event shall be added. If the PRID/EID combination is already in the detection list the entry shall be updated. The event action status shall be set to “disabled”.

4.16.1.2 Structure

PUS-9601//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 19

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Filler	PRID	E ID	TC
Default 0 bin	Enumerated	Enumerated	Byte String
1 bit	7 bit	2 bytes	Project dependent; See Note 1)

Table 4.16-2: Structure of the Application data TC(19,1)

[Note 1)

Min: 12 bytes

Max: 211 bytes

4.16.1.3 Parameter Definition & Range

PUS-9626//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
PRID	Process ID	See Volume B.

Parameters of Application Data Field	Description	Range or value
EID	Event Identifier	Must be set to a valid *EID* for the given *PRID.* Note: the SW will not check the validity of PRID/EID combinations. The ground is in charge for !
TC	Complete TC packet	A complete stand alone TC packet. Additional details regarding the values for the Source_Id and Source Sequence Counter are specified in section "Source ID of TC Data Field Header" in Volume B.

Table 4.16-3: Parameters of the Application Data for TC(19,1)

4.16.1.4 TC Verification

PUS-9646//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-9648//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] The (PID,EID) couple already is in the detection list, and the corresponding Action status is Enabled	FID_ACTION_ACTIVE
[3] Capacity overflow (on the detection list or on action TC pool)	FID_DETECTION_OVERFLOW
[4] Not enough space in TC pool	FID_TC_POOL_OVERFLOW
[5] The Event Identifier is not allowed (if equal to EID_ACTION_TRIG)	FID_FORBIDDEN_EID

4.16.2 TC(19,2): Delete Events from the Detection List

4.16.2.1 Description

Upon reception of TC(19,2) the specified event shall be deleted.

Note: The specified event action entry must be disabled by means of TC(19,5) Disable Actions before being deleted.

4.16.2.2 Structure

PUS-9655//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 19

Service Subtype : Must be set to 2

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Filler	PRID	EID
Default 0 bin	Enumerated	Enumerated
1 bit	7 bit	2 bytes

Table 4.16-4: Structure of the Application data TC(19,2)

4.16.2.3 Parameter Definition & Range

PUS-9676//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
PRID	Process ID	See Volume B.
EID	Event Identifier	Must be set according to a valid *EID* present in the event detection list.

Table 4.16-5: Parameters of the Application Data for TC(19,2)

4.16.2.4 TC Verification

PUS-9692//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-9694//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] The (PID,EID) couple is not in the detection list	FID_UNKNOWN_ACTION
[3] The (PID,EID) couple is in the detection list, but the associated Action status is Enabled.	FID_ACTION_ACTIVE

4.16.3 TC(19,3): Clear the Events Detection List

4.16.3.1 Description

Upon reception of TC(19,3) the all entries in the event detection list shall be deleted.

Note: The event action service must be globally disabled by means of TC(19,5) Disable Actions (N = 0) before clearing of the whole event detection list.

4.16.3.2 Structure

PUS-9702//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 19

Service Subtype : Must be set to 3

TC(19,3) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.16.3.3 TC Verification

PUS-9709//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-9711//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length.	FID_LENGTH_DISCREP
[2]	The Event Action Service is enabled on service level	FID_ACT_SERVICE_ENABLED

4.16.3.4 Remarks

Note: The TC should be refused if the service is not disabled

4.16.4 TC(19,4): Enable Actions

4.16.4.1 Description

Upon reception of TC(19,4) the action associated to the specified event shall be enabled.

4.16.4.2 Structure

PUS-9717//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 19

Service Subtype : Must be set to 4

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	Filler	PRID	EID
Unsigned Integer	Default 0 bin	Enumerated	Enumerated

N	Filler	PRID	EID
1 byte	1 bit	7 bit	2 bytes
	< ------ repeat *N* times ------ >		

Table 4.16-6: Structure of the Application data TC(19,4)

4.16.4.3 Parameter Definition & Range

PUS-9744//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	Number of parameter sets to follow	**N = 0 :** The Event/Action status shall be changed on Service level. All individual entries remain unchanged. ***N* > 0:** Each parameter set in the request shall be processed in turn and the status shall be set accordingly.
PRID	Process ID	See Volume B.
EID	Event Identifier	See Volume B.

Table 4.16-7: Parameters of the Application Data for TC(19,4)

4.16.4.4 TC Verification

PUS-9764//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-9766//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is : either not consistent with the real length of the packet data field OR out of the range specified above	FID_NACT_LEN_DISCREP
[3]	At least one of the (PID,EID) couples is not in the detection list	FID_UNKNOWN_ACTION

4.16.5 TC(19,5): Disable Actions

4.16.5.1 Description

Upon reception of TC(19,5) the action associated to the specified event shall be disabled.

Use of this command with counter value set to zero shall be defined as critical in the SRDB.

4.16.5.2 Structure

PUS-9774//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 19

Service Subtype : Must be set to 5

The structure of the *Application Data* field within the TC *Packet Data* field is identical to the one defined for TC(19,4). See Table 4.16-6 (Structure of the Application Data TC(19,4)).

4.16.5.3 TC Verification

PUS-9781//

TM(1,2): TC Acceptance Report - Failure shall be generated

• if one of the static checks according to Section 4.1 failed

PUS-9783//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is : either not consistent with the real length of the packet data field OR out of the range specified above	FID_NACT_LEN_DISCREP
[3]	One of the (PID,EID) couples is not in the detection list	FID_UNKNOWN_ACTION

4.16.6 TC(19,6): Report the Event Detection List

4.16.6.1 Description

Upon reception of TC(19,6) the report TM(19,7) shall be generated.

4.16.6.2 Structure

PUS-9791//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 19

Service Subtype : Must be set to 6

TC(19,6) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.16.6.3 TC Verification

PUS-9798//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-9800//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length.	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.16.7 TM(19,7): Event Detection List Report

4.16.7.1 Description

TM(19,7) is the response to TC(19,6).

4.16.7.2 Structure

PUS-9807//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 19

Service Subtype : Must be set to 7

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N	filler	PRID	E ID	Action Status	TC Header
Unsigned integer	Default 0 bin	enumerated	Enumerated	Enumerated	Unsigned integer
1 byte	1 bit	7 bit	2 bytes	1 byte	10 byte
	< ------ repeat *N* times ------ >				

Table 4.16-8: Structure of the Source data TM(19,7)

4.16.7.3 Parameter Definition & Range

PUS-9840//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
N	Repetition count	0 … MAX
PRID	Application Process ID	Copy of the relevant entry in the event detection list
EID	Event Identifier	Copy of the relevant entry in the event detection list

Parameters of Source Data Field	Description	Range or value
Action Status	Event Action Status for given PRID/EID	0 =DISABLED 1 =ENABLED
TC Header	Telecommand packet header plus Data Field Header	Copy of the relevant entry in the event detection list

Table 4.16-9: Parameters of the Source data for TM(19,7)

4.16.7.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfil the request. The bandwidth adjustment mechanism is applicable for this TM.

4.16.8 TC(19,130): Report Single Event Detection Entry

4.16.8.1 Description

Upon reception of TC(19,130) the report TM(19,131) shall be generated.

4.16.8.2 Structure

PUS-9873/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 19

Service Subtype : Must be set to 130

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Filler	PRID	EID
Default 0 bin	Enumerated	Enumerated
1 bit	7 bit	2 bytes

Table 4.16-10: Structure of the Application data TC(19,130)

4.16.8.3 Parameter Definition & Range

PUS-9894/I

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value

Parameters of Application Data Field	Description	Range or value
PRID	Process ID	See Volume B.
EID	Event Identifier	See Volume B.

Table 4.16-11: Parameters of the Application Data for TC(19,130)

4.16.8.4 TC Verification

PUS-9910//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-9914//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The (PID,EID) couple is not in the detection list	FID_UNKNOWN_ACTION

4.16.9 TM(19,131): Single Event Detection Entry Report

4.16.9.1 Description

TM(19,131) is the response to TC(19,130).

4.16.9.2 Structure

PUS-9921//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 19

Service Subtype : Must be set to 131

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

filler	PRID	E ID	Action Status	TC
Default 0 bin	enumerated	Enumerated	Enumerated	Unsigned integer
1 bit	7 bit	2 bytes	1 byte	variable

Table 4.16-12: Structure of the Source data TM(19,131)

4.16.9.3 Parameter Definition & Range

PUS-9948//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
PRID	Application Process ID	Copy of the relevant entry in the event detection list
EID	Event Identifier	Copy of the relevant entry in the event detection list
Action Status	Event Action Status for given PRID/EID	0 = DISABLED 1 = ENABLED
TC	Complete telecommand packet	Copy of the relevant entry in the event detection list

Table 4.16-13: Parameters of the Source data for TM(19,131)

4.17 Service 140: Parameter Management

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(140,1)	TC	Set N Parameters	Basic
(140,2)	TC	Get N Parameters	Basic
(140,3)	TM	Parameter Report	Basic
(140,4)	TC	Define Onboard Parameter	Specific

Table 4.17-1: Service 140 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with "*Basic*" will be supported by all on-board packet terminals:

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Objective

This service allows the ground to manage on board parameters by changing or reading onboard parameters values.

Description

An onboard parameter allow the ground to access to Application SW data that can be either software variable or equipment acquisition data.

The onboard parameter function manages an onboard parameters list per application process ID. Onboard parameters list definition is extracted from the SRDB.

Each onboard parameter contains the following information:

- the onboard parameter identifier
- the onboard parameter address
- the onboard parameter length
- the onboard parameter type
- a "spare" flag that indicates if the onboard parameter can be used to program a new diagnostic parameter

Ground commanding

The onboard parameters definition is defined in the SRDB and is supposed to be frozen for a flight software release. Nevertheless, a subset of parameters are tagged with a flag 'spare' in order to provide to ground the facility to modify these parameters definition. This can be useful for ground investigations in order to be able to easily handle through diagnostic TM, SW variables that were not initially defined in the SRDB because no necessary for nominal ground operations. This service is supported by TC(140,4).

In order not to resort to load and dump services which are heavy and risky to use, the service 140 provides access to onboard parameters through their parameter id rather than their address. It may be very useful to upload new value in a parameter when a private TC doesn't exist to do that. Nevertheless the usage of this service is not nominal: the recommended design is to define all the private telecommand necessary to update the parameters that are foreseen to be updated during the mission and all parameters produced onboard that have to be used by ground have to be defined in HK or diagnostic TM or in private TM. The reason why the service 140 to change onboard parameter value is not recommended is that no onboard check is possible, so ground can change any onboard parameter value including parameters that are periodically updated by the software. Changing that kind of parameters from ground can be dangerous because can lead to inconsistent onboard state. So, this service has been made available to manage those cases that could not have been foreseen.

4.17.1 TC(140,1): Set N Parameters

4.17.1.1 Description

Upon reception of TC(140,1) the values of N predefined parameters shall be set to a given value.

4.17.1.2 Structure

PUS-10016//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 140

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

NPAR	Parameter ID	Parameter Value

NPAR	Parameter ID	Parameter Value
Unsigned integer	Enumerated	Any
1 bytes	4 bytes	deduced
	< ------ repeat *NPAR* times ------ >	

Table 4.17-2: Structure of the Application data TC(140,1)

4.17.1.3 Parameter Definition & Range

PUS-10040//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
NPAR	Amount of parameters to be set	1...NPAR_MAX[1)]
Parameter ID	Number uniquely identifying a parameter out of a list	Any valid value of the list of predefined parameters
Parameter Value	new parameter value	Defined by PTC/PFC of the parameter

Table 4.17-3: Parameters of the Application Data for TC(140,1)

Note 1)

NPAR_MAX = 38 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7 and in case all parameter values are 1byte long)

4.17.1.4 TC Verification

PUS-10060//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-10062//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	NPAR is out of the range specified above	FID_INVALID_NPAR
[3]	NPAR is inconsistent with the real length of the packet data field	FID_PAR_LENGTH_DISCREP
[4]	The Parameter ID is not defined	FID_UNKNOWN_PAR_ID
[5]	At least one of the Parameter values with a Parameter ID's Type = float is not legal (NaN, infinite or denormalised)	FID_INVALID_PAR_VAL
[6]	The parameter Type is not valid	FID_ILLEGAL_PAR_SET

4.17.2 TC(140,2): Get N Parameters

4.17.2.1 Description

Upon reception of TC(140,2) the value of *N* predefined parameters shall be reported by TM(140,3)

4.17.2.2 Structure

PUS-10072//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 140

Service Subtype : Must be set to 2

The structure of the *Application Data* field within the TC *Packet Data* field is defined here below.

NPAR	Parameter ID
Unsigned integer	Enumerated
1 bytes	4 bytes
	< --- repeat *NPAR* times --- >

Table 4.17-4: Structure of the Application data TC(140,2)

4.17.2.3 Parameter Definition & Range

PUS-10093//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
NPAR	Amount of parameters to be reported	1..... NPAR_MAX[1)]
Parameter ID	Number uniquely identifying a parameter out of a list	Any valid value out of the list of predefined parameters (see relevant annex)

Table 4.17-5: Parameters of the Application Data for TC(140,2)

Note 1)

NPAR_MAX = 48 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.17.2.4 TC Verification

PUS-10109//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-10111//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	NPAR is out of the range specified above	FID_INVALID_NPAR
[3]	NPAR is inconsistent with the real length of the packet data field	FID_PAR_LENGTH_DISCREP
[4]	At least one of the Parameter IDs is not defined	FID_UNKNOWN_PAR_ID
[5]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.17.3 TM(140,3): Parameter Report

4.17.3.1 Description

TM(140,3) is the response to TC(140,2).

4.17.3.2 Structure

PUS-10119//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 140

Service Subtype : Must be set to 3

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

NPAR	Parameter ID	Parameter Value
Unsigned integer	Enumerated	Deduced
1 byte	4 bytes	variable
	< --- repeat *NPAR* times --- >	

Table 4.17-6: Structure of the Source data TM(140,3)

4.17.3.3 Parameter Definition & Range

PUS-10143//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
NPAR	Amount of parameters in report	As many as requested in TC (140,2)
Parameter ID	Number uniquely identifying a parameter out of a list	Any valid value out of the list of predefined parameters
Parameter Value	actual parameter value	Defined by PTC/PFC of the parameter

Table 4.17-7: Parameters of the Source Data for TM(140,3)

4.17.3.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.17.4 TC(140,4) Define Onboard Parameter

4.17.4.1 Description

TC(140,4) defines or re-defines new onboard Parameter**s** in the Data Pool. This definition associates a predefined "auxiliary=spare" logical identifier (unique "Parameter ID") to a physical PM RAM memory location which corresponds to a data of the CSW."

Thus, once the definition has been performed, the onboard Parameter can be used through its logical "Parameter ID" in the frame of other services (Housekeeping, Monitoring, TM Extraction …). .

4.17.4.2 Structure

PUS-11666//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 140

Service Subtype : Must be set to 4

The structure of the Application Data field within the TC Packet Data field is defined here below.

NPAR	Parameter ID	RAM Address	Param Length	Param Type
Unsigned integer	Unsigned integer	Unsigned Integer	Unsigned Integer	Unsigned Integer
1 byte	4 bytes	4 bytes	1 byte	4 bytes
	< ------ repeat NPAR times ------ >			

Table 4.17-8: Structure of the Application data TC(140,4)

4.17.4.3 Parameter Definition & Range

PUS-11693//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
NPAR	number of cumulated parameters in the definition	1 … NPAR_MAX[1)]
Parameter ID	Number uniquely identifying a parameter out of a list of generic parameters	Any valid generic ID out of the list of predefined parameters

Parameters of Application Data Field	Description	Range or value
RAM Address	Memory address building the pointer to the data value to be assigned to the HK	Any valid physical memory address
Param Length	Length of memory in small addressable units (SAU) are to be assigned to Parameter ID See Note 3)	1..255 The parameter length specified in this element must agree with the value of parameter type element
Param Type	Type of associated data: See Note 2)	•ENUM8 = 0x00020008 •ENUM16 = 0x00020010 •ENUM32 = 0x00020020 •UINT8 = 0x00030004 •UINT16 = 0x0003000C •UINT32 = 0x0003000E •INT8 = 0x00040004 • INT16 = 0x0004000C •INT32 = 0x0004000E •FLOAT_SINGLE_PREC = 0x00050001 •FLOAT_DOUBLE_PREC = 0x00050002 •FLOAT_DBL_TO_SGL = 0x00050003 • BYTE_ARRAY =0x00000000 see Note 3)

Table 4.17-9: Parameters of the Application Data for TC(140,4)

Note 1)

NPAR_MAX = 14 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

Note 2)

The FLOAT_DBL_TO_SGL means a double precision float which will be read and reported as a single precision float

Note 3)

Not all parameter types are supported by all applications. Some parameter types are constraint for use in service 3 and the parameter service itself. Param type and applicable SAU of Param Length are given in Volume B.

4.17.4.4 TC Verification

PUS-11717//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-11719//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	NPAR is out of the range specified above	FID_INVALID_NPAR
[3]	NPAR is inconsistent with the real length of the packet data field	FID_PAR_LENGTH_DISCREP
[4]	At least one of the RAM addresses is out of allowed range	FID_INVALID_MEM_ADDR
[5]	At least one of the Parameter Ids either is not defined OR has its “Auxiliary=Spare flag” in the Datapool set to False	FID_UNKNOWN_PAR_ID

4.18 Service 142: Functional Monitoring

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(142,1)	TC	Enable Functional Monitoring	Specific
(142,2)	TC	Disable Functional Monitoring	Specific
(142,5)	TC	Add Functional Monitoring entry to Monitoring List	Specific
(142,6)	TC	Delete Functional Monitoring entry from Monitoring List	Specific
(142,8)	TC	Report Current Functional Monitoring List	Specific
(142,9)	TM	Current Functional Monitoring List Report	Specific
(142,10)	TC	Report Current FMON Status List	Specific
(142,11)	TM	Current FMON Status List Report	Specific
(142,12)	TC	Protect Functional Monitoring	Specific
(142,13)	TC	Unprotect Functional Monitoring	Specific

Table 4.18-1: Service 142 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with "*Basic*" will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *"Specific"* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Description

The on-board Functional Monitoring service provides the capability to monitor on-board functions (for example, SW applications or HW units) by managing associations of individual parameters monitoring, those parameters representing altogether the current health status of the function. The On-Board Functional Monitoring service requires that Parameter Monitoring (service type 12) is implemented, as it is using the internal state of the individual parameter monitoring of the same application process.

Functional Monitoring reports any transition of the function's state to the service user. An event report shall be generated by Functional Monitoring, as the result of a given monitoring violation of any of the underlying parameters. To achieve this, the service maintains a Functional Monitoring item list in which each item corresponds to a set of parameter monitoring identifiers (Monitoring ID) and additional information linked to the functional level.

The functional monitoring events will have the following details:

FMON ID	Time-Out	Type	Triggering parameter monitoring ID	Current checking status of parameter monitoring ID	Trigger Time
Unsigned Integer	Unsigned Integer	Enumerated	Enumerated	Enumerated	Satellite Time (see Section 4.8)
4 byte	2 bytes	1 bytes	4 byte	1 byte	6 bytes

Table 4.18-2: Structure of the Application data for Functional Monitoring Events Report

Because the service essentially composes the on-board FDIR, any FDIR item entry is basically protected against modification, which protection must be removed before any update and restored after update.

The user can modify or report the contents of the Functional Monitoring list using service requests to:

- add FMON entries to or delete FMON entries from the Functional Monitoring list;
- enable or disable the FMON entries in the Functional Monitoring list;
- report the information for all FMON entries of the Functional Monitoring list;
- report the individual states of the FMON entries.
- protect or unprotect the FMON definition w.r.t any modification or deletion

The user can also enable or disable Functional Monitoring at service level.

The on-board Functional Monitoring service shall maintain for each FMON its state w.r.t FDIR. The transitions of this FMON state depend of the user defined enable state, of board condition and also on transition statuses of the underlying Monitoring ID (i.e. any out-of-limit Monitoring ID transition is assumed to be a failure detection and result in a FMON transition to a "Failed" state in case of OR-type functional monitoring).

- If the FMON becomes “disabled” then the new FMON state shall become “Unchecked” immediately, whatever its current state is;

- If the FMON becomes “Enabled” and if the current FMON state is “Unchecked” then the new FMON state becomes “Running” immediately;

- If the FMON is required to enter “Failed” state and if the current FMON state is “Running” then the FMON state becomes “Failed” immediately;

- When invoked (e.g. via a connected Monitoring ID) and prior to any other action, a “Running” FMON shall be immediately set to “Invalid” depending on whether the FMON validity condition is FALSE;

- When invoked (e.g. via a connected Monitoring ID) and prior to any other action, an “Invalid” FMON shall be immediately set to “Running” depending on whether the FMON validity condition is TRUE;

Any Monitoring ID transition when FMON is in other state than running is ignored by FMON. Hence there is no report generation in that case. Furthermore, evolution of FMON current state shall not impact states of Monitoring ID to which it is connected

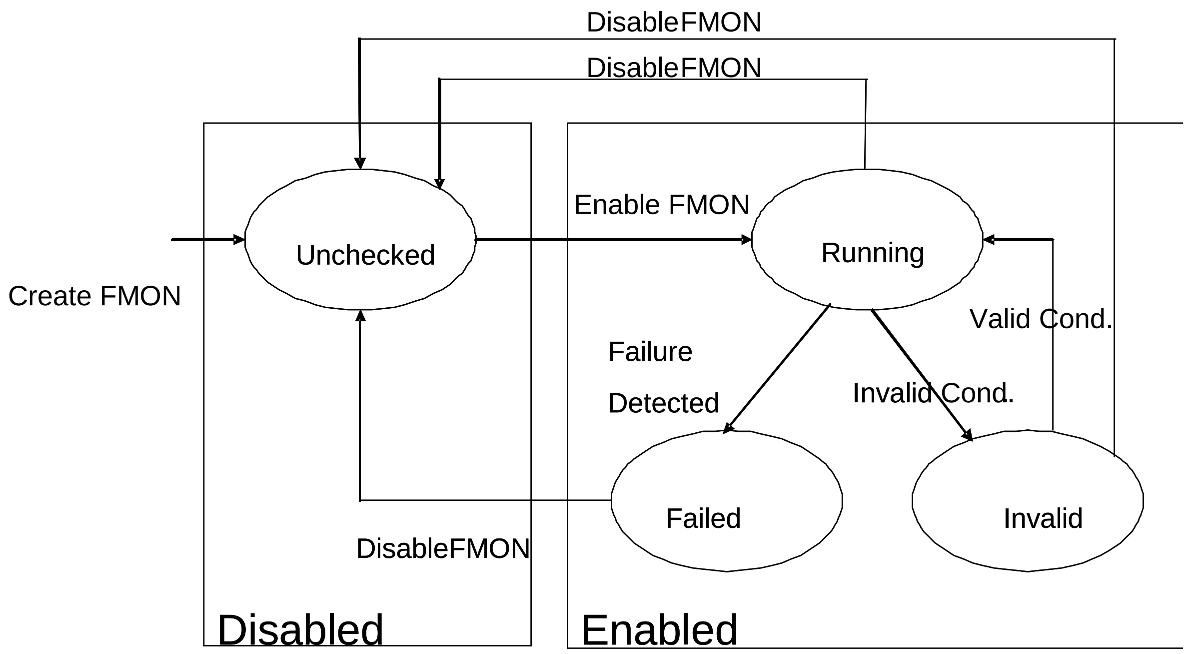
By default, when the FMON is added to the Functional Monitoring list by TC(142,5), its initial setup shall be:

- FMON status == "disabled-unchecked";

- FMON protection == "unprotected";

Furthermore, the FMON state includes information about the source of transition to “Failed”. This source is one of the connected Monitoring ID. The time at which this transition occurred shall be appended to information record. This information shall be downlinked to ground system within reporting of the Functional Monitoring.

The following state diagram illustrates transitions of the FMON state.



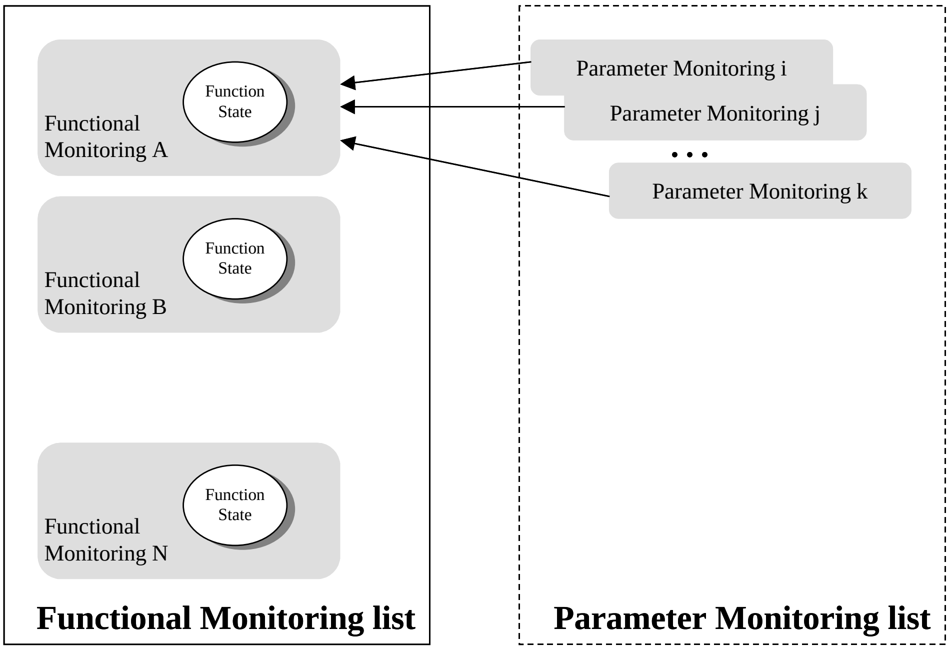


Figure 4.18-1: Functional Monitoring definitions and status

The FMON lets inputs (Monitoring ID's attached to FDIR) perform checks as long as:

- the Functional Monitoring is enabled at service-level, and
- the FMON state is “Running”, which implicitly means:
  - the FMON definition is enabled, and
  - the FMON validity condition is valid.

The Validity condition is a boolean expression as follows:

Valid_Cond = (Value(ParamId)

Result (TRUE/FALSE) of Valid_Cond determines whether the function is monitored or not.

If a FMON transition to “Failed” state occurs, for which the FMON identifies an associated event report, a telemetry packet of type 5 shall be immediately generated according to service type 5 rules, having the structure defined in the table above.

4.18.1 TC(142,1) Enable Functional Monitoring

4.18.1.1 Description

When the service provider receives this request:

If N = 0, it shall set the Functional Monitoring service level status to “Enabled”.

If N > 0, each FMON in the request shall be processed in turn and its FMON definition status shall be set to “Enabled”.

If a Functional Monitoring Identifier contained within request is not defined in the Functional Monitoring list, then the request shall not be executed and a failure report of service type1 shall be issued.

For enabling of an FMON entry which are in "Failed" state, th FMON entry needs to be disabled by TC(142,2) and then enabled by TC(142,1).

4.18.1.2 Structure

PUS-12671//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 142

Service Subtype : Must be set to 1

The structure of the Application Data field within the TC Packet Data field is defined here below.

N	FMON ID
Unsigned Integer	Enumerated
2 bytes	4 bytes
	<--- repeat N times ----->

Table 4.18-3: Structure of the Application data TC(142,1)

4.18.1.3 Parameter Definition & Range

PUS-12690//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameter of the Application Data Field	Description	Range or Value

Parameter of the Application Data Field	Description	Range or Value
N	Number of parameter ID'sfollowing	0....N_MAX[1)] ***N* = 0:** The monitoring on service level shall be set to "ENABLED" Each individual entry shall stay in its current state. ***N* > 0:** Each FMON in the request shall be processed in turn and its status shall be set to "ENABLED "
FMON ID	Identification of a FMON control table entry	1....255

Table 4.18-4: Parameters of the Application data TC(142,1)

Note 1)

N_MAX = 48 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.18.1.4 TC Verification

PUS-12706//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-12708//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[3] At least one of the FMON IDs is not defined	FID_FMON_UNKNOWN_ID
[4] PMON (service 12) is disabled at service level	FID_FMON_PMON_DISABLED
[5] PMON enable state conditions are not fulfilled for at least one FMON (i.e one PMON entry disabled for an AND-ing or all entries disabled for an OR-ing)	FID_FMON_PMON_ENA_STATE

4.18.1.5 Remarks

Note: For TC(142,1) with N = 0 the functional monitoring service shall be enabled at service level. In this case, the functional monitoring service shall start to monitor functions with individual monitoring being set to “enable”. It shall not change the individual monitoring status of a functional monitor.

4.18.2 TC(142,2) Disable Functional Monitoring

4.18.2.1 Description

When the service provider receives this request:

If N = 0, it shall set the Functional Monitoring service level status to “Disabled”.

If N > 0, each FMON in the request shall be processed in turn and its FMON definition status shall be set to “Disabled”.

If a Functional Monitoring Identifier contained within the request is not defined in the Functional Monitoring list, then the request shall not be executed and a failure report of service type1 shall be issued.

Note: Disabling FMON definition which are in “Failed” state, is useless, as FMON initial setup will be applied when exiting the “Failed” state (i.e. FMON will be disabled anyway).

4.18.2.2 Structure

PUS-12724//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 142

Service Subtype : Must be set to 2

The structure of the Application Data field within the TC Packet Data field is defined here below.

N	FMON ID
Unsigned Integer	Enumerated
2 bytes	4 bytes
	<--- repeat N times ----->

Table 4.18-5: Structure of the Application data TC(142,2)

4.18.2.3 Parameter Definition & Range

PUS-12746//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameter of Application Data Field	Description	Range or Value

Parameter of Application Data Field	Description	Range or Value
N	Number of parameter ID's following	0....N_MAX 1) ***N* = 0:** The monitoring on service level shall be set to "DISABLED" Each individual entry will stay in its current state. ***N* > 0:** Each FMON in the request shall be processed in turn and its status monitoring shall be set to "DISABLED
FMON ID	Identification of a FMON control table entry	1....255

Table 4.18-6: Parameters of the Application data TC(142,2)

Note 1)

N_MAX = 48 (TC nested in TC(11,4) ot TC(151,4))

4.18.2.4 TC Verification

PUS-12766//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-12768//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[3]	At least one of the FMON IDs is not defined	FID_FMON_UNKNOWN_ID

4.18.2.5 Remarks

Note: For TC(142,2) with N = 0 the functional monitoring service shall be disabled at service level. In this case, the functional monitoring service shall initiate a time-out at TC execution, and then autonomously re-enable itself at time-out expiration.

4.18.3 TC(142,5) Add Functional Monitoring to the Monitoring List

4.18.3.1 Description

The total number of Functional Monitoring which can take place in the Functional Monitoring list shall be limited to a maximum of <FMONLIST_MAX_FMON>.

When the service provider receives this request, it shall add the Functional Monitoring information to the

Functional Monitoring list, shall set the Functional Monitoring status to “Disabled” and shall connect the identified parameters monitoring to the Functional Monitoring.

FMON can only be overwritten if it is unprotected and disabled

If an error is detected during the processing of the information for the Functional Monitoring described within request, this FMON shall not be added to the Functional Monitoring list and the parameters monitoring shall not be connected to this FMON. A failure report of service type 1 shall be issued.

A standard error occurs, if:

- the Functional Monitoring list is full,
- the FMON ID is already in the list and is either protectd or enabled,
- the parameter’s monitoring (Monitoring ID) to connect is not accessible or does not exist
- the parameter Id of validity condition is not accessible (undefined or unknown from application).

Note: The application process has access to a given set of parameters. If this parameter does not lie within this set, it is deemed “not accessible”.

4.18.3.2 Structure

PUS-12790//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 142

Service Subtype : Must be set to 5

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

FMON ID	Validity Parameter	EID	Timeout	Type	NMON	Monitoring ID	Check State Type
Enumerated	Enumerated	Enumerated	Unsigned Integer	Enumerated	Unsigned Integer	Enumerated	Enumerated
4 bytes	4 bytes	2 bytes	2 bytes	1 byte	1 byte	4 bytes	1 byte
						<---- repeat NMON times ---->	

Table 4.18-7: Structure of the Application data TC(142,5)

4.18.3.3 Parameter Definition & Range

PUS-12824//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameter of Application Data Field	Description	Range or Value

Parameter of Application Data Field	Description	Range or Value
FMON ID	Identification of a FMON control table entry	1....255
Validity Parameter	A parameter whose value determines whether the Functional Monitoring item is valid (i.e. can be executed) or not.	By convention, if the validity parameter# is 0, the corresponding Functional Monitoring is always valid.
EID	The identifier of the event report to be generated in the event of a Functional Monitoring violation, which occurs when at least one or all (dependng on Type) of the attached parameters monitoring returns a monitoring violation as stated in service type 12	By convention, the value 0 for RID shall mean "no event report is generated".
Timeout	Number of cycles to wait before the Functional Monitoring is re-enabled if not done as part of event action sequence connected to the released event	ZERO = DISABLED, no automatic enable. 1...... 65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 2 Hz and 1 sec HK data provision is wanted then the value needs to be set to 2)
Type	The logic to be applied for combination of the single parameter monitoring states	0 - OR 1 - AND In case Type = OR it is sufficient that one of the defined parameter monitoring entries reaches th defined state. In case Type = AND all defined parameter monitoring entries have to reach the defined state
NMON	The number of parameters monitoring attached to the Functional Monitoring FMON ID, which follow.	1....NMON_MAX[1)]
Monitoring ID	ID of Monitoring Control Table Entry (see Service 12)	1.....255

Parameter of Application Data Field	Description	Range or Value
Check State Type	The value identifies the check state which causes triggering of the FMON ID	0 - WIL 1 - N/A 2 - INV 3 - N/A 4 - BLL 5 - AHL 6 - OOL

Table 4.18-8: Parameters of the Application data TC(142,5)

Note 1)

NMON_MAX = 36 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

The possible Check State Type value are described in the table below

State	Description
0 - WIL	In Limit / Expected Value
1 - N/A	Not Applicable
2 - INV	Invalid
3 - N/A	Not Applicable
4 - BLL	Below Low Limit / Unexpected Value
5 - AHL	Above High Limit
6 - OOL	Out of Limit (either case BLL or AHL)

Table 4.18-9: Check State Type Description

4.18.3.4 TC Verification

PUS-12856//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-12858//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] The Validity Parameter ID is not a defined parameter ID	FID_FMON_UNKNOWN_VAL_PAR
[3] EID <> 0 AND (PID,EID) is not a defined combination	FID_FMON_UNKNOWN_EID
[4] Type is out of the range specified above	FID_FMON_INVALID_TYPE
[5] NMON is out of the range specified above (=0)	FID_FMON_INVALID_NMON
[6] NMON is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[7] At least one of the Monitoring ID is not defined	FID_FMON_UNKNOWN_PMON
[8] At least one of the Expected Check State is out of the range specified above	FID_FMON_INVALID_STATE
[9] FMON ID is out of the range specified above	FID_FMON_INVALID_ID
[10] FMON ID is already defined and is "protected"	FID_FMON_PROTECTED_ID
[11] The maximum number of defined FMON IDs has already been reached for that PID (MAX_NB_FMON_PER_PID)	FID_FMON_MAX_NB
[12] FMON ID is enabled	FID_FMON_ENABLED_ID

4.18.4 TC(142,6) Delete a Functional Monitoring from the Monitoring List

4.18.4.1 Description

When the service provider receives this request, it shall process each FMON in turn, by:

Disconnecting parameter monitorings attached to specified functional monitoring,

Removing its corresponding Functional Monitoring information, if any, from the Functional Monitoring list (the entry becomes free).

If a FMON ID contained within request is not defined in the Functional Monitoring list, is currently enabled or protected then the request shall not be executed and a failure report of service type 1 shall be issued.

If a FMON ID invoked within request is currently enabled, then the request shall not be executed and a failure report of service type1 shall be issued.

4.18.4.2 Structure

PUS-12868//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 142

Service Subtype : Must be set to 6

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

N	FMON_ID
Unsigned Integer	Enumerated
1 byte	4 bytes
	<---- repeat N times----->

Table 4.18-10: Structure of the Application data TC(142,6)

4.18.4.3 Parameter Definition & Range

PUS-12901//

The parameters of the Application Data *field shall be inserted according to the following table:*

Parameter of Application Data Field	Description	Range or Value
N	The number of FMON entries which shall be deleted	1....N_MAX[1)]
FMON_ID	Identification of a FMON control table entry	1....255

Table 4.18-11: Parameters of the Application data TC(142,6)

Note 1)

N_MAX = 48 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.18.4.4 TC Verification

PUS-12917//

TM(1,2): TC Acceptance Report - Failure shall be generated

• if one of the static checks according to Section 4.1 failed

PUS-12919//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is out of the range specified above (=0)	FID_INVALID_NPAR
[3]	N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[4]	At least one of the FMON IDs is not defined	FID_FMON_UNKNOWN_ID
[5]	At least one of the FMON IDs is "protected"	FID_FMON_PROTECTED_ID
[6]	At least one of the FMON IDs is enabled	FID_FMON_ENABLED_ID

4.18.5 TC(142,8) Report Current Functional Monitoring List

4.18.5.1 Description

When the service provider receives this request, it shall issue a report with the current static contents of the Functional Monitoring list as defined in (142,9).

4.18.5.2 Structure

PUS-12925//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 142

Service Subtype : Must be set to 8

TC(142,8) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.18.5.3 TC Verification

PUS-12943//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-12945//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.18.6 TM(142,9) Current Functional Monitoring List Report

4.18.6.1 Description

Current static contents of the Functional Monitoring list

4.18.6.2 Structure

PUS-12951//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 142

Service Subtype : Must be set to 9

The structure of the *Source Data* field within the TC Packet Data field is defined here below.

Functional Monitoring Status	N	FMON Information
Enumerated	Unsigned Integer	Structure
1 byte	1 byte	
		<---- repeat N times----->

Table 4.18-12: Structure of the Source data TM(142,9)

The Structure of the FMON Information is the following:

	FMON Information								
FMON_ID	FMON Protection	FMON Status	Validity Parameter	EID	Timeout	Type	NMON	Monitoring ID	Check State Type

	FMON Information								
Enumerated	Enumerated	Enumerated	Enumerated	Enumerated	Unsigned Integer	Enumerated	Unsigned Integer	Enumerated	Enumerated
4 bytes	1 byte	1 byte	4 bytes	2 bytes	2 bytes	1 byte	1 byte	4 bytes	1 byte
								< --------- repeat NMON times ------ >	

Table 4.18-13: Structure of the FMON Information TM(142,9)

4.18.6.3 Parameter Definition & Range

PUS-13022//

The parameters of the Source Data *field shall be inserted according to the following table:*

Parameter of Application Data Field	Description	Range or Value
Functional Monitoring Status	This indicates whether the overall Functional Monitoring is “enabled” or “disabled”	1 = enabled 0 = disabled
N	The current number of Functional Monitoring entries of the functional monitoring list	
FMON ID	Identification of a FMON control table entry	1....255
FMON Protection	This indicates the current status of each Functional Monitoring item, i.e. whether one functional monitoring entry is "Protected" or "Unprotected".	1 = Protected 0 = Unprotected
FMON Status	This indicates whether the monitoring of the corresponding parameter is “enabled” or “disabled”.	Disabled-Unchecked = 0000b Enabled-Running = 0010b Enabled-Failed = 0110b Enabled-Invalid = 1010b
Validity Parameter	A parameter whose value determines whether the Functional Monitoring item is valid (i.e. can be executed) or not.	By convention, if the validity parameter# is 0, the corresponding Functional Monitoring item is always valid.

Parameter of Application Data Field	Description	Range or Value
EID	The identifier of the event report to be generated in the event of a Functional Monitoring item violation, which occurs when at least one or all (depending on Type) of the attached parameters monitoring returns a monitoring violation as stated in service type 12.	By convention, the value 0 for RID shall mean "no event report is generated".
Timeout	Number of cycles to wait before the functional monitoring is re-enabled	1.....65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 2 Hz and 1 sec HK data provision is wanted then the value needs to be set to 2)
Type	The logic to be applied for combination of the single parameter monitoring states.	0 - OR 1 - AND In case Type = OR it is sufficient that one of the defined parameter monitoring entries reaches th defined state. In case Type = AND all defined parameter monitoring entries have to reach the defined state.
NMON	The number of parameters monitoring attached to the Functional Monitoring item FMON ID, which follow.	
Monitoring ID	Any of the monitoring# of the monitoring list of service type 12	
Check State Type	The value identifies the check state which causes triggering of the FMON ID	0 - WIL 1 - N/A 2 - INV 3 - N/A 4 - BLL 5 - AHL 6 - OOL

Table 4.18-14: Parameters of the Source data TM(142,9)

The possible Check State Type value are described in the table below

State	Description
0 - WIL	In Limit / Expected Value
1 - N/A	Not Applicable
2 - INV	Invalid
3 - N/A	Not Applicable
4 - BLL	Below Low Limit / Unexpected Value
5 - AHL	Above High Limit
6 - OOL	Out of Limit (either case BLL or AHL)

Table 4.18-15: Check State Type Description

4.18.6.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.18.7 TC(142,10) Report Current FMON Status List

4.18.7.1 Description

When the service provider receives this request, it shall issue a report (TM(142,11))containing the current FMON status.

4.18.7.2 Structure

PUS-13075/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 142

Service Subtype : Must be set to 10

TC(142,10) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.18.7.3 TC Verification

PUS-13096//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-13098//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.18.8 TM(142,11) Current FMON Status List Report

4.18.8.1 Description

TM(142,11) is the response to TC(142,10).

4.18.8.2 Structure

PUS-13105//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 142

Service Subtype : Must be set to 11

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

N	FMON_ID	FMON Protection	FMON Status
Unsigned Integer	Enumerated	Enumerated	Enumerated
2 bytes	4 bytes	1 byte	1 byte
	<---- repeat N times----->		

Table 4.18-16: Structure of the Source data TM(142,11)

4.18.8.3 Parameter Definition & Range

PUS-13134//

The parameters of the Source Data *field shall be inserted according to the following table.*

Parameter of Application Data Field	Description	Range or Value
N	The current number of Functional Monitoring item entries of the Functional Monitoring item list	

Parameter of Application Data Field	Description	Range or Value
FMON_ID	Identification of a FMON control table entry	1....255
FMON Protection	This indicates the current status of each Functional Monitoring item, i.e. whether one functional monitoring entry is "Protected" or "Unprotected".	1 = Protected 0 = Unprotected
FMON Status	This indicates the current status of each Functional Monitoring item	Disabled-Unchecked = 0000b Enabled-Running = 0010b Enabled-Failed = 0110b Enabled-Invalid = 1010b

Table 4.18-17: Parameters of the Source data TM(142,11)

4.18.8.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.18.9 TC(142,12) Protect Functional Monitoring of Parameters

4.18.9.1 Description

When the service provider receives this request, each FMON in the request shall be processed in turn and its FMON definition status shall be set to “protected”.

If a Functional Monitoring Identifier contained within the request is not defined in the Functional Monitoring item list, then the request shall not be executed and a failure report of service type1 shall be issued.

4.18.9.2 Structure

PUS-13165//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 142

Service Subtype : Must be set to 12

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

N	FMON_ID
Unsigned Integer	Enumerated
2 byte	4 bytes
	<---- repeat N times----->

Table 4.18-18: Structure of the Application data TC(142,12)

4.18.9.3 Parameter Definition & Range

PUS-13184//

The parameters of the Application Data *field shall be inserted according to the following table.*

Parameter of Application Data Field	Description	Range or Value
N	The number of FMON entries which shall be protected or unprotected.	N = 0 is illegal
FMON_ID	Identification of a FMON control table entry	1....255

Table 4.18-19: Parameters of the Application data TC(142,12)

4.18.9.4 TC Verification

PUS-13200//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-13202//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is out of the range specified above (=0)	FID_INVALID_NPAR
[3]	N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[4]	At least one of the FMON IDs is not defined	FID_FMON_UNKNOWN_ID

4.18.10 TC(142,13) Unprotect Functional Monitoring of Parameters

4.18.10.1 Description

When the service provider receives this request, each FMON in the request shall be processed in turn and its FMON definition status shall be set to “unprotected".

If a Functional Monitoring Identifier contained within the request is not defined in the Functional Monitoring item list, then the request shall not be executed and a failure report of service type1 shall be issued.

4.18.10.2 Structure

PUS-13210//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 142

Service Subtype : Must be set to 13

The structure of the Application Data field within the TC Packet Data field is identical with the one defined for TC(142,12). See Table 4.18-18 (Structure of the Application Data TC(142,12))

4.18.10.3 TC Verification

PUS-13228//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-13230//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	N is out of the range specified above (=0)	FID_INVALID_NPAR
[1]	N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[3]	At least one of the FMON IDs is not defined	FID_FMON_UNKNOWN_ID

4.19 Service 145 Spacecraft State Vector (SSV) Management

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(145,1)	TC	Start SSV Distribution	Specific
(145,2)	TC	Stop SSV Distribution	Specific
(145,3)	TC	Report SSV Distribution Settings	Specific
(145,4)	TM	SSV Distribution Settings Report	Specific
(145,128)	TC	Update Spacecraft State Vector (SSV)	Specific

Table 4.19-1: Service 145 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

- All services marked with *“Basic”* will be supported by all on-board packet terminals;
- i.e. by all PRID's.
- All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Description

This service provides S/C related AOCS and general spacercraft status data to other applications for internal processing of S/C position and attitude related data. It allows to manage the generation and distribution of this S/C information.

The S/C State Vector will consist of:

- S/C State Vector quality field
- Orbit State vector (Torb, position, velocity) w.r.t. WGS84
- Attitude state vector (Torb, quaternian) w.r.t. J2000
- Orbit position (Torb, Argument of Latitude)

The S/C state vector will be distributed with 2 Hz.

4.19.1 TC(145,1) Start SSV Distribution

4.19.1.1 Description

TC(145,1) is used to selectively start the periodic distribution of the Spacecraft State Vector to the receiving applications.

The frequency of the SSV distribution is mission specific, but fixed.

4.19.1.2 Structure

PUS-15628//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 145

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

N	Filler	PRID	AckFlags
Unsigned Integer		Enumerated	Enumerated

N	Filler	PRID	AckFlags
1 byte	1 bit	7 bit	1 byte
	< ---- repeat N times ----- >		

Table 4.19-2: Structure of the Application data TC(145,1)

4.19.1.3 Parameter Definition & Range

PUS-15653//

The parameters of the Application Data *field shall be inserted according to the following table.*

Parameter of Application Data Field	Description	Range or Value
N	The number of PRID's to follow	1....N_MAX[1)]
PRID	Process ID (part of the APID)	Must be set to a value according to the to the PRID Table in Volume B
AckFlags	TC Acceptance flags according to the definition of the TC secondary header in Section 1.6	$0000_b = 0_{dec}$ <=> ACH NONE $0001_b = 1_{dec}$ <=> ACH ACC Note: only used for maintenance $1000_b = 8_{dec}$ <=> ACH EXE Note: only used for maintenance $1001_b = 9_{dec}$ <=> ACH A&E Note: only used for maintenance

Table 4.19-3: Parameters of the Application data TC(145,1)

Note 1)

N_MAX is determined by the mission specific number of applications receiving TC(145,128). The applicable mission specific number is given in Volume B.

4.19.1.4 TC Verification

PUS-15673//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-15675//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if one of the supplied PRID's is invalid

4.19.2 TC(145,2) Stop SSV Distribution

4.19.2.1 Description

TC(145,2) is used to stop the distribution of the Spacecraft State Vector to the receiving applications.

4.19.2.2 Structure

PUS-15679//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 145

Service Subtype : Must be set to 2

The structure of the *Application Data* field within the TC Packet Data field is defined here below.

N	Filler	PRID
Unsigned Integer		Enumerated
1 byte	1 bit	7 bit
	< ---- repeat N times ----- >	

Table 4.19-4: Structure of the Application data TC(145,2)

4.19.2.3 Parameter Definition & Range

PUS-15702//

The parameters of the Application Data *field shall be inserted according to the following table.*

Parameter of Application Data Field	Description	Range or Value
N	The number of PRID's to follow	1....N_MAX[1)]
PRID	Process ID (part of the APID)	Must be set to a value according to the to the PRID Table in Volume B

Table 4.19-5: Parameters of the Application data TC(145,2)

Note 1)

N_MAX is determined by the mission specific number of applications receiving TC(145,128). The applicable mission specific number is given in Volume B

4.19.2.4 TC Verification

PUS-15722//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-15724//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if one of the supplied PRID's is invalid

4.19.3 TC(145,3) Report SSV Distribution Settings

4.19.3.1 Description

TC(145,3) is used to request the SSV distribution settings report TM(145,4).

4.19.3.2 Structure

PUS-15728//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 145

Service Subtype : Must be set to 3

TC(145,3) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.19.3.3 TC Verification

PUS-15731//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-15733//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

4.19.4 TM(145,4) SSV Distribution Settings Report

4.19.4.1 Description

TM(145,4) is the response to TC(145,3)

4.19.4.2 Structure

PUS-15737//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 145

Service Subtype : Must be set to 4

The structure of the *Source Data* field within the TC Packet Data field is defined here below.

N	Filler	PRID	AckFlags
Unsigned Integer		Enumerated	Enumerated
1 byte	1 bit	7 bit	1 byte
	< ---- repeat N times ----- >		

Table 4.19-6: Structure of the Source data TM(145,4)

4.19.4.3 Parameter Definition & Range

PUS-15760//

The parameters of the Source Data *field shall be inserted according to the following table.*

Parameter of Application Data Field	Description	Range or Value
N	The number of PRID's to follow	1....N_MAX[1)]
PRID	Process ID (part of the APID)	Must be set to a value according to the to the PRID Table in Volume B
AckFlags	TC Acceptance flags according to the definition of the TC secondary header in Section 1.6	$0000_b = 0_{dec}$ <=> ACH NONE $0001_b = 1_{dec}$ <=> ACH ACC $1000_b = 8_{dec}$ <=> ACH EXE $1001_b = 9_{dec}$ <=> ACH A&E

Table 4.19-7: Parameters of the Source data TM(145,4)

Note 1)

see corresponding note in Section 4.19.2.3

4.19.5 TC(145,128) Update Spacecraft State Vector (SSV)

4.19.5.1 Description

The service sub-type shall be supported by each application having the need to get information about the current spacecraft state like orbit position, quality of the supporting services and other mission specific realtime information. The service sub-type is generated on-board and sent to other on-board applications for example instruments and/or equipments to distribute the Spacecraft State Vector as needed.

4.19.5.2 Structure

PUS-15782//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 145

Service Subtype : Must be set to 128

The structure of the *Application Data* field within the TC Packet Data field is defined in Volume B.

4.19.5.3 Parameter Definition & Range

PUS-15805//

The parameters of the Application Data *field shall be inserted according to the following table.*

Parameter of Application Data Field	Description	Range or Value
SSV	Spacecraft State Vector	See Volume B

Table 4.19-8: Parameters of the Application data TC(145,128)

4.19.5.4 TC Verification

PUS-15895//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-15897//

TM(1,8): TC Execution Completion Report - Failure shall be generated

- if one of the consistency checks according to Section 4.1 failed

4.20 Service 148: On Board Macro Procedures

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(148,1)	TC	Load Procedure	n/a
(148,2)	TC	Delete Procedure	specific
(148,3)	TC	Start Procedure	specific
(148,4)	TC	Stop Procedure	specific
(148,5)	TC	Suspend Procedure	n/a
(148,6)	TC	Resume Procedure	n/a
(148,7)	TC	Communicate parameters to a procedure	n/a

Service, Subservice	TM/TC	Description	Applicability
(148,8)	TC	Report list of On-Board Operation Procedures	specific
(148,9)	TM	On-Board Operation Procedures List Report	specific
(148,10)	TC	Report list of Active On-Board Operation Procedures	specific
(148,11)	TM	Active On-Board Operation Procedures List Report	specific
(148,128)	TC	Add TC to OBCP	specific
(148,129)	TC	Delete TC from OBCP	specific
(148,130)	TC	Dump On-Board Procedure	specific
(148,131)	TM	On-Board Procedure Dump	Specific
(148,132)	TC	Set Procedure LOCK Status	Specific
(148,133)	TC	Start Procedure Conditionally	Specific
(148,140)	TC	OBCP Logical Decision Directive	specific
(148,141)	TC	OBCP Jump Directive	Specific
(148,142)	TC	OBCP Send Event Directive	Specific

Table 4.20-1: Service 148 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

- All services marked with *“Basic”* will be supported by all on-board packet terminals;
- i.e. by all PRID's.
- All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Objective

The ground system can define a set of operations procedures (OBCP) that it can load to an application process, which then manages the on-board storage of these procedures and their subsequent execution under ground system control. In principle, such an operations procedure can also be controlled (e.g. started) autonomously on-board, e.g. as the result of detection of a specific on-board event.

The on-board operations procedure service provides standard service requests and reports for controlling the execution of these procedures and monitoring their status.

Description:

A simplified approach of “On Board Procedures” shall be used. OBCP’s shall be implemented as TC macros instead of a fully fledged programming language. Thus, an OBCP is a sequence of TC’s executed one after the other with pre-defined time delays between two commands. A set of control commands is defined to enable control over the procedure flow but these commands are rejected if sent as stand-alone commands.

An OBCP shall be identified by a unique OBCP identifier, whereas one single step of such a sequence shall be identified by a sequence step number.

An OBCP can be created/modified by TC(148,128) and TC(148,129). For PUS compliance reason TC(148,2) is supported as well.

It shall be possible to run OBCP's in parallel, whereas the OBCP-Design is in charge for resolving possible conflicts caused by this concept. Requests to start an already running OBCP shall be discarded. Only running procedures can be stopped .

An OBCP can be stopped by TC(148,4). In this case the currently executed TC will be finished and after that the procedure state shall be set to "Inactive". At the next start the OBCP will run from the beninning (no "Suspend" or "Resume" functions will be supported by Service 148)

OBCPs will have a specific locking mechanism. TC(148,132) is used to set- reset the OBCP lock bit. If the procedure is **locked** the user will be able to modify or even delete the procedure, whereas a start command TC(148,3) will be rejected.

If the procedure is **unlocked** the following TC's to modify or delete the OBCP will be rejected: TC(148,2), TC(148,128) and TC(148,129).

4.20.1 TC(148,2) DELETE Procedure

4.20.1.1 Description

Upon reception of TC(148,2), the specified onboard procedure shall be deleted from the list of loaded onboard procedures and the area occupied by the procedure code shall be cleared.

The request shall be rejected if the procedure status is not "inactive" or the LOCK status is "unlocked".

4.20.1.2 Structure

PUS-14844//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 2

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Procedure ID
Enumerated
1 Byte

Table 4.20-2: Structure of the Application data TC(148,2)

4.20.1.3 Parameter Definition & Range

PUS-14856//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Procedure ID	Unique ID of procedure	1....255

Table 4.20-3: Parameters of the Application Data for TC(148,2)

4.20.1.4 TC Verification

PUS-14868//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-14870//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The OBCS ID is not defined	FID_UNKNOWN_OBCS_ID
[3]	OBCS status is “active”	FID_OBCS_ACTIVE
[4]	OBCS status is “unlocked”	FID_OBCS_UNLOCKED

4.20.2 TC(148,3) START Procedure

4.20.2.1 Description

Upon reception of TC(148,3), the specified onboard procedure shall be started.

The procedure status shall then be “active”. The request shall be rejected if the status of the procedure is not "inactive" or the LOCK status is "locked".

4.20.2.2 Structure

PUS-14878//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 3

The structure of the *Application Data* field within the TC *Packet Data* field is identical to the one defined for TC(148,2). See Table 4.20-2 (Structure of the Application Data TC(148,2)).

4.20.2.3 TC Verification

PUS-14882//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-14884//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The OBCS ID is not defined	FID_UNKNOWN_OBCS_ID
[3]	OBCS status is "active"	FID_OBCS_ACTIVE
[4]	Either the maximum number of OBCSs have been started OR there is no free element in the pool	FID_TOO_MANY_OBCS
[5]	OBCS status is "locked"	FID_OBCS_LOCKED
[6]	OBCS is not "critical" AND a "critical" OBCS is "active"	FID_OBCS_CRITICAL_ACTIVE

4.20.3 TC(148,4) STOP Procedure

4.20.3.1 Description

Upon reception of TC(148,4), the specified onboard procedure shall be stopped. The procedure status shall then be "inactive".

The request shall be rejected if the procedure already has the "inactive" status.

4.20.3.2 Structure

PUS-14892//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 4

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Procedure ID
Enumerated
1 Byte

Table 4.20-4: Structure of the Application data TC(148,4)

4.20.3.3 Parameter Definition & Range

PUS-14904//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Procedure ID	Unique ID of procedure	[0-255] 0 means all OBCPs

Table 4.20-5: Parameters of the Application Data for TC(148,4)

4.20.3.4 TC Verification

PUS-14916//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-14918//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The OBCS ID is not defined	FID_UNKNOWN_OBCS_ID
[3]	The OBCS status is “inactive”	FID_OBCS_INACTIVE

4.20.3.5 Remarks

PUS-17958//

In addition to the TC verification reporting, an event report is generted that reports all OBCP's which were stopped by this TC.

4.20.4 TC(148,5) SUSPEND Procedure

This service subtype is not applicable

4.20.5 TC(148,8) Report list of On-Board Operation Procedures

4.20.5.1 Description

Upon reception of TC(148,8), the report TM(148,9) shall be generated.

4.20.5.2 Structure

PUS-14953//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 8

TC(148,8) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.20.5.3 TC Verification

PUS-14957//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-14959//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.20.6 TM(148,9) On-Board Operation Procedures List Report

4.20.6.1 Description

TM(148,9) is the response to TC(148,8).

4.20.6.2 Structure

PUS-14966//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 148

Service Subtype : Must be set to 9

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

NPROC	Procedure Id	Status	Position
Enumerated	Enumerated	Enumerated	Unsigned Byte
1 byte	1 byte	1 byte	1 byte
	< ----- repeat *NPROC* times ------ >		

Table 4.20-6: Structure of the Source data TM(148,9)

4.20.6.3 Parameter Definition & Range

PUS-14990//

The parameters of the Source Data *Field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
NPROC	The number of procedures loaded on-board that follow	0 .. 255
Procedure ID	Unique ID of procedure that is being loaded	[1-255]

Parameters of Source Data Field	Description	Range or value
Status	Current OBCP status	**Bit [7]:** 0 = inactive 1 = active (running) **Bit [6]:** 0 = unlocked 1 = locked
Position	The first OBCP step ID	[1-255]

Table 4.20-7: Parameters of the Source data for TM(148,9)

4.20.6.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.20.7 TC(148,10) Report list of Active On-Board Operation Procedures

4.20.7.1 Description

Upon reception of TC(148,10), the report TM(148,11) shall be generated.

4.20.7.2 Structure

PUS-17265//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 10

TC(148,10) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.20.7.3 TC Verification

PUS-17269//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-17271//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.20.8 TM(148,11) Active On-Board Operation Procedures List Report

4.20.8.1 Description

TM(148,11) is the response to TC(148,10).

4.20.8.2 Structure

PUS-17278//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 148

Service Subtype : Must be set to 11

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

NPROC	Procedure Id	Status	Position
Enumerated	Enumerated	Enumerated	Unsigned Byte
1 byte	1 byte	1 byte	1 byte
	< ----- repeat *NPROC* times ------ >		

Table 4.20-8: Structure of the Source data TM(148,11)

4.20.8.3 Parameter Definition & Range

PUS-17302//

The parameters of the Source Data *Field shall be inserted according to the following table:*

Parameters of Source Data Field	Description	Range or value
NPROC	The number of procedures loaded on-board that follow	0 .. 255
Procedure ID	Unique ID of procedure that is being loaded	[1-255]
Status	Current OBCP status	**Bit [7]:** 1 = active (running) **Bit [6]:** 0= unlocked

Parameters of Source Data Field	Description	Range or value
Position	The last released OBCP step	0 = first step of procedure is not yet released, or procedure is not running (see *Status*) [1-254] last released procedure step, note that 255 can not occur, because after release of the last step the procedure is no longer running.

Table 4.20-9: Parameters of the Source data for TM(148,11)

4.20.8.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.20.9 TC(148,128) Add TC to OBCP

4.20.9.1 Description

Upon reception of TC(148,128), the application process shall add the provided TC to the OBCP selected by the *Procedure ID*. The parameter *Procedure Step* defines the position where the TC shall be inserted. An already existing TC at this position shall be replaced.

Note: Since all delay times are relative to the previous step, insertion of an OBCP step changes the timing of all subsequent procedure steps.

If the procedure with the specified ID does not exist, the application process shall create a new procedure and add the TC at the required step. The status of the new procedure shall be set to “inactive” and the LOCK status shall be set to "locked".

The request shall be rejected if the procedure status is not "inactive" or the LOCK status is "unlocked".

4.20.9.2 Structure

PUS-15023/*/*

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 128

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Procedure ID	Procedure Step	Delay	TC
Enumerated	Unsigned Byte	Unsigned Byte	Byte String

Procedure ID	Procedure Step	Delay	TC
1 Byte	1 Byte	2 Byte	See Note 1)

Table 4.20-10: Structure of the Application data TC(148,128)

Note 1)

Min: 12 bytes

Max: 190 bytes (if TC(148,128)is nested in time-tag command)

Max: 210 bytes (if TC(148,128)is not nested in time-tag command)

4.20.9.3 Parameter Definition & Range

PUS-15044//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Procedure ID	Unique ID of procedure that is being loaded	[1-255]
Procedure Step	Position where the TC should be inserted into the OBCP	Range: [1 .. 255]
Delay	Time Delay for start of execution of the current step related to the start of execution of the previous step expressed in multiples of the minimum OBCP time slice	0…N_MAX_DELAY [1)] Min.: 0 = No Delay
TC	Complete TC packet	Any valid TC

Table 4.20-11: Parameters of the Application Data for TC(148,128)

Note 1)

N_MAX_DELAY = 65535, LSB = 62,5 ms which yields a maximum value of 4095.375 sec

4.20.9.4 Remarks

The Procedure Step shall be mantained similar as a line number. This means that after insertion the procedure steps shall not b renumbered automatically by the software. Therefore it is recommended to let some space between subsequent procedure steps in order to allow later insertionmof TC's with minimum effort.

4.20.9.5 TC Verification

PUS-15069//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-15071//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The Step ID is out of the range specified above (=0)	FID_OBCS_STEP_INVA
[3]	OBCS status is “active”	FID_OBCS_ACTIVE
[4]	Not enough space in TC pool	FID_TC_POOL_OVERFLOW
[5]	No more free OBCS or step block	FID_OBCS_MEM_OVERFLOW
[6]	OBCS status is “unlocked”	FID_OBCS_UNLOCKED
[7]	TC length is not consistent with the header of the included TC	FID_TC_LENGTH_DISCREP
[8]	The OBCS ID is out of the range specified above (=0)	FID_OBCS_ID_INVALID

4.20.10 TC(148,129) Delete TC from OBCP

4.20.10.1 Description

Upon reception of TC(148,129), the application process shall delete the provided *Procedure Step* from the OBCP identified by *Procedure ID.*

Note: Since all delay times are relative to the previous step, deletion of an OBCP step changes the timing of all subsequent procedure steps.

The request shall be rejected if the procedure status is not "inactive" or the LOCK status is "unlocked".

4.20.10.2 Structure

PUS-15080//

The Packet Header shall have the following structure:

4PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 129

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Procedure ID	Procedure Step
Enumerated	Unsigned Byte
1 Byte	1 Byte

Table 4.20-12: Structure of the Application data TC(148,129)

4.20.10.3 Parameter Definition & Range

PUS-15095//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value

Parameters of Application Data Field	Description	Range or value
Procedure ID	Unique ID of procedure that is being loaded	[1-255]
Procedure Step	Position of the TC to be deleted from the OBCP	Range: [0 .. 255] **Procedure Step = 0:** all procedure steps shall be deleted, the OBCP status shall be set to "Empty" Note; This has the same effect as TC(148,2) !

Table 4.20-13: Parameters of the Application Data for TC(148,129)

4.20.10.4 TC Verification

PUS-15111//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-15113//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The OBCS ID is not defined	FID_UNKNOWN_OBCS_ID
[3]	The Step ID is not defined	FID_OBCS_STEP_INVA
[4]	OBCS status is "active"	FID_OBCS_ACTIVE
[5]	OBCS status is "unlocked"	FID_OBCS_UNLOCKED

4.20.11 TC(148,130) Dump On-Board Procedure

4.20.11.1 Description

Upon reception of TC(148,130), the specified onboard procedure shall be dumped. TM(148,131) will be generated as response .

4.20.11.2 Structure

PUS-15120//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 130

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Procedure ID

Procedure ID
Enumerated
1 Byte

Table 4.20-14: Structure of the Application data TC(148,130)

4.20.11.3 Parameter Definition & Range

PUS-15132//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Procedure ID	Unique ID of procedure that is being loaded	[1-255]

Table 4.20-15: Parameters of the Application Data for TC(148,130)

4.20.11.4 TC Verification

PUS-15144//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-15146//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The OBCS ID is not defined	FID_UNKNOWN_OBCS_ID
[3]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.20.12 TM(148,131) On-Board Procedure Dump

4.20.12.1 Description

TM(148,131) is the response to TC(148,130).

4.20.12.2 Structure

PUS-15153//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 148

Service Subtype : Must be set to 131

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

Procedure ID	NoProcSteps	Procedure Step	Delay	TC
Enumerated	Unsigned Byte	Unsigned Byte	Unsigned Byte	Byte String
1 Byte	1 Byte	1 Byte	2 Byte	See Note 1)
		< --- repeat *NoProcStep* times --->		

Table 4.20-16: Structure of the Source data TM(148,131)

Note 1)

Min: 12 bytes

Max: 210 bytes

4.20.12.3 Parameter Definition & Range

PUS-15180//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Procedure ID	Unique ID of procedure that is being dumped	[1-255]
NoProcSteps	Number of *Procedure Steps* in TM Pkt.	Range: [1 .. 255]
Procedure Step	Position	Range: [1 .. 255]
Delay	Time Delay for start of execution of the current step related to the start of execution of the previous step expressed in multiples of the minimum OBCP time slice	0…N_MAX_DELAY [1)] Min.: 0 = No Delay
TC	TC packet	Any valid TC

Table 4.20-17: Parameters of the Source data for TM(148,131)

Note 1)

N_MAX_DELAY = 65535, LSB = 62,5 ms which yields a maximum value of 4095.375 sec

4.20.12.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.20.13 TC(148,132) Set Procedure LOCK Status

4.20.13.1 Description

TC(148,132) is used to set- reset the OBCP lock bit. If the procedure is **locked** the user will be able to modify or even delete the procedure, whereas a start command TC(148,3) will be rejected.

If the procedure is **unlocked** the following TC's to modify or delete the OBCP will be rejected: TC(148,2), TC(148,128) and TC(148,129).

4.20.13.2 Structure

PUS-15215//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 132

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Procedure ID	LockStatus
Enumerated	Enumerated
1 Byte	1 Byte

Table 4.20-18: Structure of the Application data TC(148,132)

4.20.13.3 Parameter Definition & Range

PUS-15230//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Procedure ID	Unique ID of procedure	[1-255]
LockStatus	Defines whether the procedure is locked or unlocked for user updates	0 = unlocked 1 = locked

Table 4.20-19: Parameters of the Application Data for TC(148,132)

4.20.13.4 TC Verification

PUS-15246//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-15248//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	The OBCS ID is not defined	FID_UNKNOWN_OBCS_ID
[3]	OBCS status is “active” – it can't be locked	FID_OBCS_ACTIVE

4.20.14 TC(148,133) START Procedure Conditionally

4.20.14.1 Description

Upon reception of TC(148,133), the specified onboard procedure shall be started only in case that no other procedures from the identfied ID ranges are active

The procedure status shall then be “active”. The request shall also be rejected if the status of the procedure is not "inactive" or the LOCK status is "locked".

4.20.14.2 Structure

PUS-18198//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 133

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Procedure ID	Nb of ranges	Min Procedure ID	Max Procedure ID
Enumerated	Enumerated	Enumerated	Enumerated
		<--------------- repeat Nb of Ranges -------------------->	
1 Byte	1 Byte	1 Byte	1 Byte

Table 4.20-20: Structure of the Application data TC(148,133)

4.20.14.3 Parameter Definition & Range

PUS-18217//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Procedure ID	Unique ID of procedure	1....255

Parameters of Application Data Field	Description	Range or value
Nb of ranges	Number of ranges of procedure ID's to check in the TC	0..min(255, (MAX_DATA_LENGTH-2)/2)) 0 means all procedures
Min Procedure ID	minimum ID value of given range	
Max Procedure ID	maximum ID value of given range	

Table 4.20-21: Parameters of the Application Data for TC(148,133)

4.20.14.4 TC Verification

PUS-18202//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-18204//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] The OBCS ID is not defined	FID_UNKNOWN_OBCS_ID
[3] OBCS status is “active”	FID_OBCS_ACTIVE
[4] Either the maximum number of OBCSs have been started OR there is no free element in the pool	FID_TOO_MANY_OBCS
[5] OBCS status is “locked”	FID_OBCS_LOCKED
[6] OBCS is not "critical" AND a "critical" OBCS is "active"	FID_OBCS_CRITICAL_ACTIVE
[7] At least one of the interlocking OBCS is active	FID_OBCS_INTERLOCK

4.20.14.5 Remark

When this request is received, the specified OBCS is started and its status is set to “active”.

•If the OBCS is already “active”, the request is rejected and an error is reported.

•If the sequence status is "locked", the request is rejected and an error is reported.

•If one OBCS, whose ID is included in one of the ranges, is "active", the request is rejected and an error is reported.

4.20.15 TC(148,140) OBCP Logical Decision Directive

4.20.15.1 Description

This telecommand can only be executed in an OBCP to branch the execution of a running OBCP to a step, based on a test of an on-board TM parameter:

IF (condition(Parameter ID, Test Value)) **THEN** {

(execute TRUE step);

} **ELSE** {

(execute FALSE step);

};

4.20.15.2 Structure

PUS-15257//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 140

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Testype	ParameterID	TestValue	TestMask	TrueStep	FalseStep
Enumerated	Enumerated	Deduced	Unsigned	Enumerated	Enumerated
1 Byte	4 Bytes	8 Bytes	4 Bytes	1 Byte	1 Byte

Table 4.20-22: Structure of the Application data TC(148,140)

4.20.15.3 Parameter Definition & Range

PUS-15284//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Test Type	Type of the test to perform on the parameter w.r.t. the Test Value	1: LT (Less Than) “<” 2: GT (Greater Than) “>” 3: EQ (Equal) “=” 4: NE (Not Equal) “<>”
Parameter ID	Identifier of the Parameter to evaluate	

Parameters of Application Data Field	Description	Range or value
Test Value	Raw value used to test the parameter	
Test Mask	Bit mask to be applied on the test value before evaluation	0xFFFFFFFF: no mask
TRUE step	OBCP identifier of the step to execute if the condition is true	0: exit (end of the OBCP) 1.255 Next step to execute
FALSE step	OBCP identifier of the step to execute if the condition is false	0: exit (end of the OBCP) 1.255 Next step to execute

Table 4.20-23: Parameters of the Application Data for TC(148,140)

Note: It is only possible to jump to a forward step or step zero to exit the procedure (i.e. to a greater step number than the one containing this TC).

4.20.15.4 TC Verification

PUS-15317/I

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-15319/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Test Type is out of the range specified above	FID_OBCS_INVA_TEST_TYPE
[3] Parameter ID is not defined	FID_OBCS_UNKNOWN_PARAM
[4] Step to jump to (TRUE Step or FALSE Step) is not defined	FID_OBCS_STEP_INVA
[4] Step to jump to (TRUE Step or FALSE Step) is not defined	FID_OBCS_STEP_INVA
[5] Step to jump to (TRUE Step or FALSE Step) is inconsistent (smaller than the current OBCS step)	FID_OBCS_STEP_INCO
[6] TC destination PID is not equal to the PID which is processing the TC directive	FID_INVALID_DEST_ID
[7] At least one of the Test Values, expected as float, is Not a number (Nan)	FID_INVALID_DATA

4.20.16 TC(148,141) OBCP JUMP Directive

4.20.16.1 Description

This telecommand can only be executed in an OBCP to jump, during the execution of a running OBCP, to another step.

4.20.16.2 Structure

PUS-15326/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 141

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

NextStep
Enumerated
1 Byte

Table 4.20-24: Structure of the Application data TC(148,141)

4.20.16.3 Parameter Definition & Range

PUS-15338//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
NextStep	OBCP identifier of the next step to execute.	0: exit (end of the OBCP) 1.255 Next step to execute

Table 4.20-25: Parameters of the Application Data for TC(148,141)

Note: It is only possible to jump to a forward step (i.e. to a greater step number than the one containing this TC).

4.20.16.4 TC Verfication

PUS-15351//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-15353//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Step ID is not defined	FID_OBCS_STEP_INVA
[3]	Step to jump to is inconsistent (smaller than the current OBCS step)	FID_OBCS_STEP_INCO
[4]	TC destination PID is not equal to the PID which is processing the TC directive	FID_INVALID_DEST_ID

4.20.17 TC(148,142) OBCP SEND EVENT Directive

4.20.17.1 Description

This telecommand can only be executed in an OBCP to generate an event report reporting the current OBCP and step identifiers.

4.20.17.2 Structure

PUS-15360//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 148

Service Subtype : Must be set to 142

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

EID
Enumerated
2 Byte

Table 4.20-26: Structure of the Application data TC(148,142)

4.20.17.3 Parameter Definition & Range

PUS-15372//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
EID	Event Identifier	Must be set to a valid *EID* for the given *PRID.*

Table 4.20-27: Parameters of the Application Data for TC(148,142)

Note: The severity of the event is determined on-board according to the EID.

4.20.17.4 TC Verification

PUS-15385//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-15387//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] The (PID,EID) combination is not defined	FID_OBCS_UNKNOWN_EID
[3] TC destination PID is not equal to the PID which is processing the TC directive	FID_INVALID_DEST_ID

4.21 Service 149: Thermal Control Service

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(149,1)	TC	Set Global Discrete Thermal Control Status (Global enable/disable)	Specific
(149,2)	TC	Select Discrete Thermal Mode Table	Specific
(149,3)	TC	Set Discrete Thermal Mode Table Entry	Specific
(149,4)	TC	Get Discrete Thermal Mode Table	Specific
(149,5)	TM	Discrete Thermal Mode Table Report	Specific
(149,6)	TC	Set Discrete Thermal Control Loop Configuration Table Entry	Specific
(149,7)	TC	Get Discrete Thermal Control Configuration Table	Specific
(149,8)	TM	Discrete Thermal Control Configuration Table Report	Specific
(149,10)	TC	Set Discrete Thermal Control Loop Activation Status	Specific

Table 4.21-1: Service 149 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with "*Basic*" will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *”Specific”* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Service Concept:

The service executes the thermal control algorithms and provides in addition the command and telemetry interfaces of the thermal control system configuration settings.

This will be achieved by maintaining the on-board table's Thermal control Table (TCT) and Thermal Mode Table (TMT).

The discrete thermal control systems sub-services, typically applied in platform applications and/or non-operational/low-performance payload applications, are based on the following key HW element configurations.

The discrete thermal control system service has the capability to control all SW controlled heater lines. Every line will consist of 2 physical heater circuits and 3 Thermistors. An application dependent major type weighting/selection algorithm is used to select the thermal control sensor value. One of the heater circuits will be used as the nominal heater circuit whereas the second will be used as the redundant heater circuit.

The power to every heater circuit is provided via a dedicated and independent electronic transistor switch (TSW) within the power electronics. The power to the electronic switches is distributed via LCL's in the power electronics. There will be separate LCL's for the nominal and the redundant circuits. A group of up to 8 TSW's will get the power from the same LCL. The heater circuits powered by the same LCL will be referenced as TCS heater control group.

The power electronics will have 2 independent control boards to control the function of LCL's and TSW's. The 3 Thermistors of a loop are located such that they will represent the same behaviour of a thermal aspect in the system. Each of the 3 Thermistors of a loop will be conditioned via separate electronics boards.

The functional combination of TCS heater line and related heater line data processing is defined as TCS Loop.

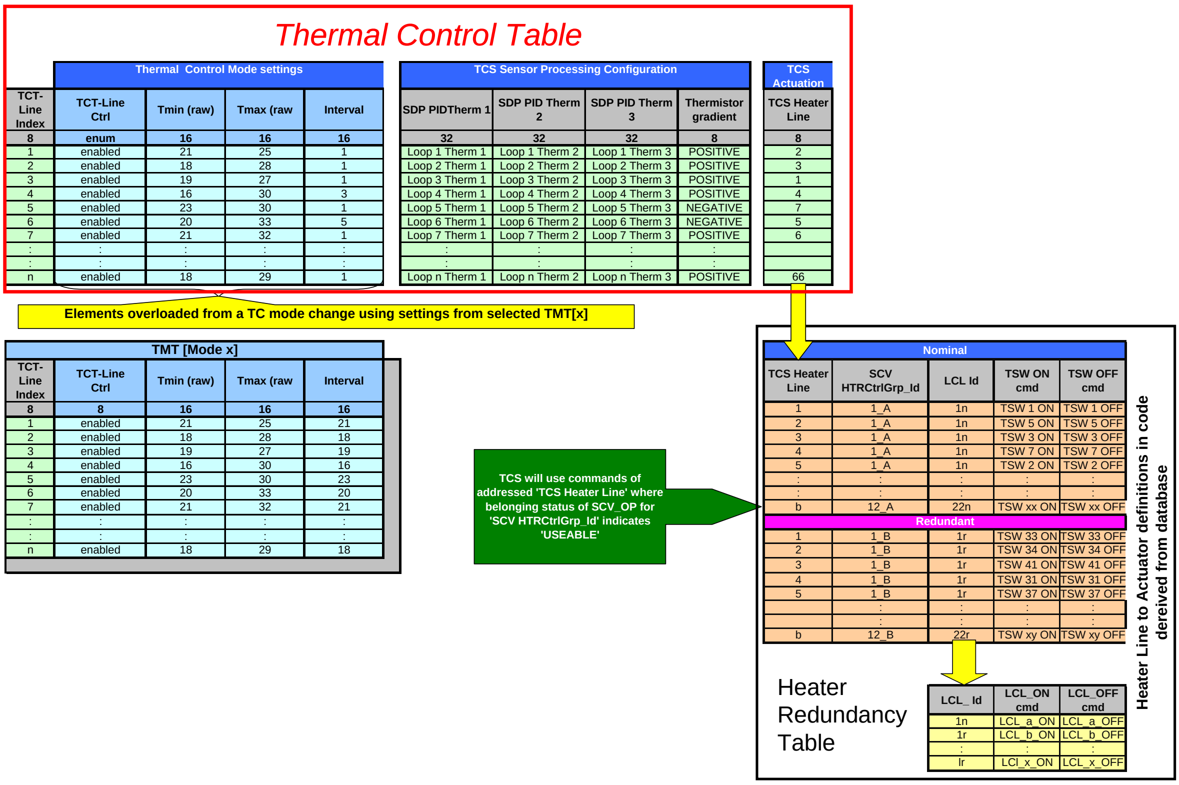


Figure 4.21-1: TCT and TMT tables

4.21.1 TC(149,1) Set Global Discrete Thermal Control Status

4.21.1.1 Description

Upon reception of TC (149,1) 'Set Global Thermal Control Status' the S/W shall enable or disable the cyclic operation of thermal control.

4.21.1.2 Structure

PUS-16540//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 149

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Operation
Enumerated
1 Byte

Table 4.21-2: Structure of the Application data TC(149,1)

4.21.1.3 Parameter Definition & Range

PUS-16521//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Operation	ID of operation	0 = DISABLE 1 = ENABLE

Table 4.21-3: Parameters of the Application Data for TC(149,1)

4.21.1.4 TC Verification

PUS-16533//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-16535//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if Operation is not a valid value

4.21.2 TC(149,2) Select Discrete Thermal Mode table

4.21.2.1 Description

Upon reception of TC (149,2) 'Select Thermal Mode Table' the thermal mode shall be changed to the selected one. Therefore the S/W shall transfer the parameters from the corresponding Thermal Mode Table (TMT) as stored on-board and overwrite the corresponding elements of the actual Thermal Control Table to be used in the ongoing thermal control.

4.21.2.2 Structure

PUS-16578//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 149

Service Subtype : Must be set to 2

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

TMT ID
Enumerated
1 Byte

Table 4.21-4: Structure of the Application data TC(149,2)

4.21.2.3 Parameter Definition & Range

PUS-16562//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
TMT ID	ID of the Thermal Mode Table	[1-MaxNoOfThermalModes]

Table 4.21-5: Parameters of the Application Data for TC(149,2)

4.21.2.4 TC Verification

PUS-16574//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-16576//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if TMT ID is not in the allowed range

4.21.3 TC(149,3) Set Discrete Thermal Mode Table Entry

4.21.3.1 Description

Upon reception of TC (149,3) 'Set Thermal Mode Table Entry' the S/W shall perform an update of the selected parameters within the selected thermal mode table.

4.21.3.2 Structure

PUS-16595//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 149

Service Subtype : Must be set to 3

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

TMT ID	TCT Line Index	TCT Line Control	T_min	T_max	Interval
Enumerated	Unsigned Integer	Enumerated	Unsigned Integer	Unsigned Integer	Unsigned Integer
1 Byte	1 byte	1 byte	2 bytes	2 bytes	2 bytes

Table 4.21-6: Structure of the Application data TC(149,3)

4.21.3.3 Parameter Definition & Range

PUS-16607//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
TMT ID	ID of the Thermal Mode Table	[1-MaxNoOfThermalModes]
TCT Line Index	Index of Thermal Control Loop	1 … MAX_NO_LOOP
TCT Line Control	Control State of the Line	0 = DISABLED 1 = ENABLED
T_min	Nominal switch on temperature of control loop	Limit value, right aligned if not the complete field length is required
T_max	Nominal switch off temperature of control loop	Limit value, right aligned if not the complete field length is required

Parameters of Application Data Field	Description	Range or value
Interval	Divider of control loop fundamental interval to be used for the loop expressed in number of cycles	1....65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10)

Table 4.21-7: Parameters of the Application Data for TC(149,3)

4.21.3.4 TC Verification

PUS-16619//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-16621//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if TMT ID is not in the allowed range

•if TCT-Line Index is not in the allowed range

•if operation is not a valid value

4.21.4 TC(149,4) Get Discrete Thermal Mode Table

4.21.4.1 Description

Upon reception of TC (149,4) ' Get Thermal Mode Table' the report TM(149,5) shall be generated for the selected thermal mode table.

4.21.4.2 Structure

PUS-16663//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 149

Service Subtype : Must be set to 4

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

TMT ID

TMT ID
Enumerated
1 Byte

Table 4.21-8: Structure of the Application data TC(149,4)

4.21.4.3 Parameter Definition & Range

PUS-16675//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
TMT ID	ID of the Thermal Mode Table	[1-MaxNoOfThermalModes]

Table 4.21-9: Parameters of the Application Data for TC(149,4)

4.21.4.4 TC Verification

PUS-16687//

TM(1,2): TC Acceptance Report - Failure shall be generated

- if one of the static checks according to Section 4.1 failed

PUS-16689//

TM(1,8): TC Execution Completion Report - Failure shall be generated

- if one of the consistency checks according to Section 4.1 failed
- if TMT ID is not in the allowed range

4.21.5 TM(149,5) Discrete Thermal Mode Table report

4.21.5.1 Description

TM (149,5) is the response to TC(149,4).

4.21.5.2 Structure

PUS-16694//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 149

Service Subtype : Must be set to 5

The structure of the *Source Data* field within the *TC Packet Data* field is defined here below.

TMT ID	N	TCT Line Index	TCT Line Control	T_min	T_max	Interval
Enumerated	Unsigned Integer	Unsigned Integer	Enumerated	Unsigned Integer	Unsigned Integer	Unsigned Integer
1 Byte	1 byte	1 byte	1 byte	2 bytes	2 bytes	2 bytes
		< -------------- repeated N times ----------- >				

Table 4.21-10: Structure of the Source data TM(149,5)

4.21.5.3 Parameter Definition & Range

PUS-16721//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
TMT ID	ID of the Thermal Mode Table	[1-MaxNoOfThermalModes]
N	Repetition of the following fields	1......MAX_NO_LOOP
TCT Line Index	Index of Thermal Control Loop	1 … MAX_NO_LOOP
TCT Line Control	Control State of the Line	0 = DISABLED 1 = ENABLED
T_min	Nominal switch on temperature of control loop	Limit value, right aligned if not the complete field length is required
T_max	Nominal switch off temperature of control loop	Limit value, right aligned if not the complete field length is required
Interval	Divider of control loop fundamental interval to be used for the loop expressed in number of cycles.	1....65535 *cycle* identifies the maximum scheduling rate of one application (e.g. if application scheduling is done with 10 Hz and 1 sec HK data provision is wanted then the value needs to be set to 10)

Table 4.21-11: Parameters of the Source Data for TM(149,5)

4.21.5.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.21.6 TC(149,6) Set Discrete Thermal Control Loop Configuration Table Entry

4.21.6.1 Description

Upon reception of TC (149,6) ' Set Thermal Control Loop Configuration Table Entry ' the S/W shall perform an update of the selected parameters within the thermal control Loop Configuration table.

4.21.6.2 Structure

PUS-16779//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 149

Service Subtype : Must be set to 6

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

TCT Line Index	TCT Line Control	T_min	T_max	Interval	SDP Id Therm 1	SDP Id Therm 2	SDP Id Therm 3	Thermist or Gradient	Heater Line
Unsigned Integer	Enumerated	Unsigned Integer	Unsigned Integer	Unsigned Integer	Unsigned Integer	Unsigned Integer	Unsigned Integer	Enumerated	Unsigned Integer
1 byte	1 byte	2 bytes	2 bytes	2 bytes	4 bytes	4 bytes	4 bytes	1 byte	1 byte

Table 4.21-12: Structure of the Application data TC(149,6)

4.21.6.3 Parameter Definition & Range

PUS-16806//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
TCT Line Index	Index of Thermal Control Loop	1 … MAX_NO_LOOP
TCT Line Control	Control State of the Line	0 = DISABLED 1 = ENABLED
T_min	Nominal switch on temperature of control loop	Limit value, right aligned if not the complete field length is required

Parameters of Application Data Field	Description	Range or value
T_max	Nominal switch off temperature of control loop	Limit value, right aligned if not the complete field length is required
Interval	Multiple of basic cycles in which this TCS control loop is to be processed.	1....65535
SDP Id Therm 1	Unique identification of the parameter reflecting the 1st Thermistor value to be used by the Thermal Ctrl SW	See Parameter ID in SRDB
SDP Id Therm 2	Unique identification of the parameter reflecting the 2nd Thermistor value to be used by the Thermal Ctrl SW	See Parameter ID in SRDB
SDP Id Therm 3	Unique identification of the parameter reflecting the 3rd Thermistor value to be used by the Thermal Ctrl SW	See Parameter ID in SRDB
Thermistor Gradient	gradient of Thermistor curve for all 3 Thermistors	0 = POSITIV 1 = NEGATIV
Heater Lines	Id of Heater referring to the onboard hardware cross reference of nominal and redundant heaters used for the control of line	1.....MAX_NO_OF_HEATER_LINES

Table 4.21-13: Parameters of the Application Data for TC(149,6)

4.21.6.4 TC Verification

PUS-16838//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-16840//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if TCT-Line Index is not in the allowed range

•if TCT-Line Ctrl is not a valid value

•if one of the SDP Id's is an invalid Parameter ID

•if Thermistor gradient is not a valid value

•if Heater Line ID is not a valid value

4.21.7 TC(149,7) Get Discrete Thermal Control Configuration Table

4.21.7.1 Description

Upon reception of TC (149,7) ' Get Thermal Control Configuration Table ' the report TM(149,8) shall be generated for the actual thermal control table.

4.21.7.2 Structure

PUS-16896//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 149

Service Subtype : Must be set to 7

TC (149,7) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.21.7.3 TC Verification

PUS-16920//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-16922//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

4.21.8 TM(149,8) Discrete Thermal Control Configuration Table Report

4.21.8.1 Description

TM (149,8) is the response to TC(149,7).

4.21.8.2 Structure

PUS-16929//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 149

Service Subtype : Must be set to 8

The structure of the *Source Data* field within the *TC Packet Data* field is defined here below.

N	TCT Line Index	TCT Line Control	T_min	T_max	Interval	SDP Id Therm 1	SDP Id Therm 2	SDP Id Therm 3	Thermistor Gradient	Heater Line
Unsigned Integer	Unsigned Integer	Enumerated	Unsigned Integer	Unsigned Integer	Unsigned Integer	Unsigned Integer	Unsigned Integer	Unsigned Integer	Enumerated	Unsigned Integer
1 byte	1 byte	1 byte	2 bytes	2 bytes	2 bytes	4 bytes	4 bytes	4 bytes	1 byte	1 byte
	< -- repeated N times -- >									

Table 4.21-14: Structure of the Source data TM(149,8)

4.21.8.3 Parameter Definition & Range

PUS-16974//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	Repetition of the following fields	1......MAX_NO_LOOP
TCT Line Index	Index of Thermal Control Loop	1 … MAX_NO_LOOP
TCT Line Control	Control State of the Line	0 = DISABLED 1 = ENABLED
T_min	Nominal switch on temperature of control loop	Limit value, right aligned if not the complete field length is required
T_max	Nominal switch off temperature of control loop	Limit value, right aligned if not the complete field length is required
Interval	Divider of control loop fundamental interval to be used for the loop.	1....(TBD)
SDP Id Therm 1	Unique identification of the parameter reflecting the 1st Thermistor value to be used by the Thermal Ctrl SW	See Parameter ID in SRDB
SDP Id Therm 2	Unique identification of the parameter reflecting the 2nd Thermistor value to be used by the Thermal Ctrl SW	See Parameter ID in SRDB

Parameters of Application Data Field	Description	Range or value
SDP Id Therm 3	Unique identification of the parameter reflecting the 3rd Thermistor value to be used by the Thermal Ctrl SW	See Parameter ID in SRDB
Thermistor Gradient	gradient of Thermistor curve for all 3 Thermistors	0 = POSITIV 1 = NEGATIV
Heater Group	Id of Heater referring to the onboard hardware cross reference of nominal and redundant heaters used for the control of line	1.....MAX_NO_OF_HEATER_LINES

Table 4.21-15: Parameters of the Source Data for TM(149,8)

4.21.8.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.21.9 TC(149,10) Set Discrete Thermal Control Loop Activation Status

4.21.9.1 Description

Upon reception of TC (149,10) ' Set Discrete Thermal Control Loop Activation Status' the S/W shall perform the setting of the TCT-Line Ctrl parameters of the actual TCT for the selected records to the status as given in the corresponding parameter.

4.21.9.2 Structure

PUS-17429//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 149

Service Subtype : Must be set to 10

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	TCT Line Index	TCT Line Ctrl
Unsigned Integer	Unsigned Integer	Enumerated
1 Byte	1 byte	1 byte

N	TCT Line Index	TCT Line Ctrl
	<---- repeated N times ------>	

Table 4.21-16: Structure of the Application data TC(149,10)

4.21.9.3 Parameter Definition & Range

PUS-17441//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N	Repetition of the following fields	[1-Max_No_Loop]
TCT-Line Index	ID of Thermal Mode Loop	[1-Max_No_Loop]
TCT Line Ctrl	Heater Line Selection	0 = DISABLED 1 = ENABLED

Table 4.21-17: Parameters of the Application Data for TC(149,10)

4.21.9.4 TC Verification

PUS-17471//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-17473//

TM(1,8): TC Execution Completion Report - Failure shall be generated

•if one of the consistency checks according to Section 4.1 failed

•if N is not in the allowed range

•if TCT-Line Index is not in the allowed range

•if TCT-Line Ctrl is not a valid value

•if N does not correspond to the number of supplied parameters

4.22 Service 151: Orbit Position Schedule (OPS)

Service Summary

Service, Subservice	TM/TC	Description	Applicability
(151,1)	TC	Enable Release of OPS Telecommands	Specific
(151,2)	TC	Disable Release of OPS Telecommands	Specific

Service, Subservice	TM/TC	Description	Applicability
(151,3)	TC	Reset OPS	Specific
(151,4)	TC	Insert Telecommands in OPS	Specific
(151,5)	TC	Delete Telecommands	Specific
(151,6)	TC	Delete Telecommands over position range	Specific
(151,7)	TC	Position-Shift selected OPS Telecommands	Specific
(151,8)	TC	Position-Shift selected OPS Telecommands over Position Range	Specific
(151,9)	TC	Report Subset of OPS in Detailed Form	Specific
(151,10)	TM	Detailed OPS Report	Specific
(151,11)	TC	Report Subset of OPS in Detailed Form over Position Range	Specific
(151,12)	TC	Report Subset of OPS in Summary Form	Specific
(151,13)	TM	Summary OPS Report	Specific
(151,14)	TC	Report Subset of OPS in Summary Form over Position Range	Specific
(151,15)	TC	Position-Shift all OPS Telecommands	Specific
(151,16)	TC	Report OPS in Detailed Form	Specific
(151,17)	TC	Report OPS in Summary Form	Specific
(151,18)	TC	Report Status of OPS	Specific
(151,19)	TM	OPS Status Report	Specific

Table 4.22-1: Service 151 sub-services

The column “Applicability” in the table above shall be interpreted as follows:

•All services marked with "*Basic*" will be supported by all on-board packet terminals;

i.e. by all PRID's.

•All services marked with *"Specific"* will be supported by a selected number of packet terminals (PRID's). The detailed assignment for each PRID will be provided in VOLUME B.

Objective

The on-board operations scheduling service provides the capability to command on-board application processes using telecommands pre-loaded on-board the satellite and released at specific values of two orbit-related parameters. To achieve this, the service maintains an on-board command schedule and ensures the timely execution of telecommands contained therein.

The orbit position tag is composed of

a) an integer number of orbits subsequently counting the crossings of the ascending node w.r.t a user defined reference

b) the orbit angle, also denoted as argument of latitude, representing the angle of the spacecraft position w.r.t. the ascending node.

The orbit position format and resolution is given in Table 4.8-14.

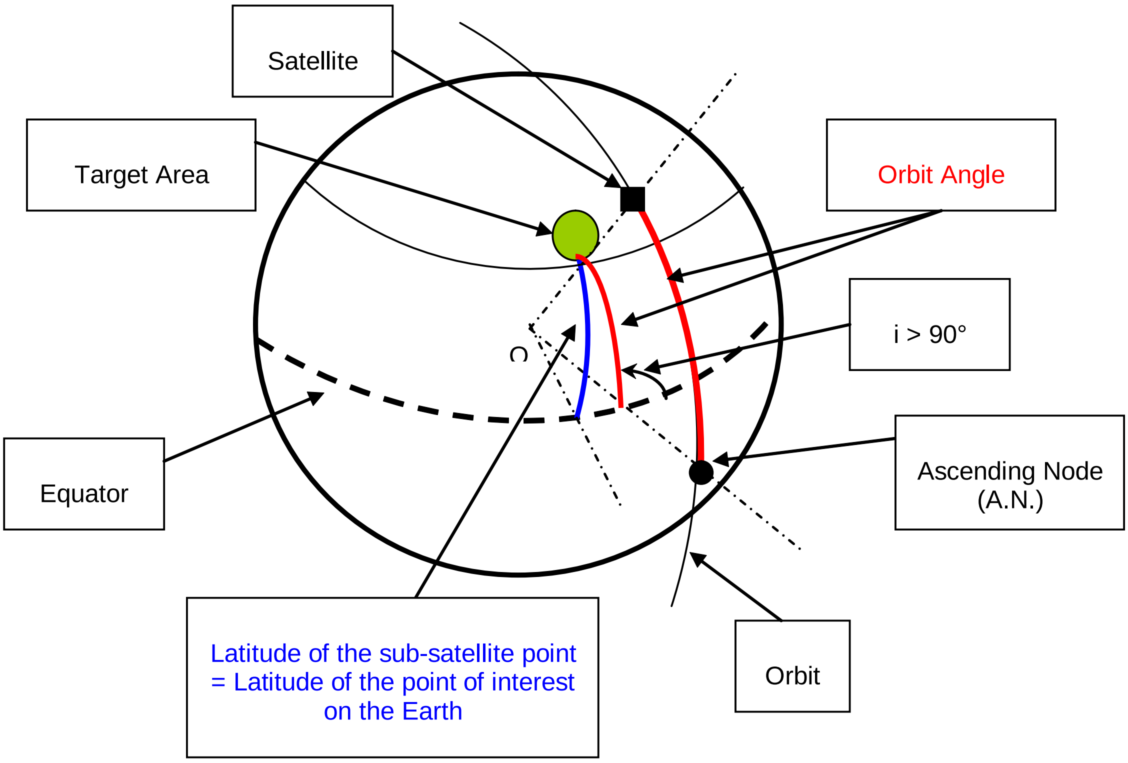
The advantage of this “orbit position-tag” approach (instead of the time-tag one) can be seen keeping in mind that the intersection points between the ground track and the areas of interest (ground station coverage area, radio-telescope ground area, etc) are well determined and have an exact value of Latitude.

In general the orbit angle (a.k.a. Argument of Latitude) will <u>not</u> be exactly equal to the sub-satellite point Latitude. A simple equation of Spherical Triangle Geometry relates the Latitude angle to the Orbit angle and the Inclination angle (i).

In details: sin (Latitude) = sin (Orbit angle) sin (180° - i)

That means for each value of the orbit angle there will be a corresponding value of the sub-satellite point Latitude.

The figure below is a graphical representation of the orbit angle / related latitude on ground:



Description

General

The on-board operations scheduling service shall maintain a command schedule which contains telecommand packets and their associated scheduling information.

The service user(s) can request the following activities:

- Enable the scheduling of all, or a subset of, the telecommands in the command schedule (e.g. those to be sent to specified application processes).
- Disable the scheduling of all, or a subset of, the telecommands in the command schedule.
- Add telecommands to the command schedule.
- Delete all, or a subset of, the telecommands in the command schedule (e.g. the telecommands becoming due for release within a specified time period).
- Report on all, or a subset of, the telecommands in the command schedule.
- Report the status of the command schedule.

The command schedule

The on-board operations scheduling service maintains a command schedule consisting of telecommand packets together with their scheduling attributes. The scheduling attributes of a telecommand indicate the following:

- The sub-schedule with which the telecommand is associated. A sub-schedule is a grouping mechanism for telecommands that enables them to be controlled together with others in the same group (see point b. below).

Telecommand release status

The on-board operations scheduling service shall maintain appropriate information to determine whether a telecommand should be released or not at specific values of two orbit-related parameters.

The release status of a telecommand shall be affected by the user requests to enable or disable the release of all or a subset of the telecommands in the command schedule. The telecommand release status shall be either “disabled” or “enabled”.

The release status of a telecommand shall be “enabled” if the release of telecommands is enabled from the command schedule, from the sub-schedule to which the telecommand belongs and from the destination application process of the telecommand.

The release status shall be “disabled” in all other cases.

Conceptually, this is as if each telecommand has three independent controlling attributes (at schedule level, at sub-schedule level and at destination application process level) whose values determine the release status of the telecommand in accordance with Table 4.22-2

The release status will be managed according to Table 4.22-2:

Schedule	Sub-schedule	APID	Release Status
D(isabled)	E(nabled)	E	D
D	D	E	D
D	E	D	D
D	D	D	D
E	E	E	E
E	D	E	D for TC's of any PRID in disabled sub-schedule
E	E	D	D for TC's of disabled PRIDs in all sub-schedules
E	D	D	D

Table 4.22-2: Release status decision table

Auxiliary information

The on-board operations scheduling service shall also have access to other information needed for the proper execution of its activities. This includes:

- The maximum number of entries or maximum size of the command schedule.
- The maximum number of sub-schedules which can be simultaneously managed.
- The list of sources from which the service can receive telecommand packets to be scheduled.
- The list of on-board application processes to which the service can release telecommand packets.

The service shall use this information for error detection and reporting.

The scheduling activity

The processing of a telecommand packet whose release time is due shall always be performed (even if the command schedule is disabled).

The corresponding service activity shall be:

- The telecommand shall not be released if the telecommand release status is “disabled”
- Otherwise, the telecommand shall be released.
- **<u>Note</u>:** if case a TC is due to be executed, but the release status is “disabled”, the TC shall be removed from the command schedule. In this case a TM(5,2) Error/Anomaly Report - Low Severity shall be generated.

4.22.1 TC(151,1): Enable Release of OPS Telecommands

4.22.1.1 Description

TC(151,1) is used to enable the release of Telecommands..

4.22.1.2 Structure

PUS-10290//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 1

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N1	Sub-schedule ID	N2	Filler	PRID
Unsigned	Enumerated	Unsigned	Bool	Enumerated
1 byte	1 byte	1 byte	1bit	7bits
			< ----- repeat *N2* times ---->	
	< ----- repeat *N1* times ---->			

Table 4.22-3: Structure of the Application data TC(151,1)

N1	Sub-schedule ID	N2	PRID	Description
0				Affect the OPS-schedule control bit
1	0	0		Apply to all Sub-schedules
N1 >= 1	[i], [j], [k]...	0		Apply to the N1 Sub-schedules i, j, k,...
1	0	N2 >= 1	[a], [b], [c]...	Apply to the N2 PRID's a, b, c, ...

N1	Sub-schedule ID	N2	PRID	Description
1	SSID <> 0	N2 >= 1	[a], [b], [c]...	Not allowed combination of SSID and PRID

Table 4.22-4: Possible Combinations of Sub-schedules and PRID's

Note: All PRIDs not possible since PRID=0 is used for TIME-packet.

4.22.1.3 Parameter Definition & Range

PUS-10324/*/*

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
N1	Number of sub-schedule which follow	*N1* = 0, the command will effect the schedule control bit. *N* 1> 0, *N* 2= 0 the command will effect the sub-schedule level controlling attribute of the telecommands with the specified sub-schedule ID N1=1, N2>0 and SubScheduled=0 the application process level controlling attribute of the telecommands with the specified destination application processes will be affected. Note that the PRID status and SubSchedule statuses are completely independent from each other. This means in particular that when a given PRID is disabled, no TC of this PRID will be released at all, whatever the subschedule.
Sub-schedule ID	The identification of the sub-schedule(s) to be enabled or disabled.	By convention, the value 0 for Sub-schedule ID shall mean “all sub-schedules”.

Parameters of Application Data Field	Description	Range or value
N2	Number of PRID which follow	See N1 row
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Table 4.22-5: Parameters of the Application Data for TC(151,1)

4.22.1.4 TC Verification

PUS-10397//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-10399//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	(N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTL_OPS_INVALID_SUBSET
[3]	At least one of the Sub-schedule IDs is out of the range specified	FID_MTLOPS_INVALID_SSID

4.22.2 TC(151,2): Disable Release of OPS Telecommands

4.22.2.1 Description

TC(151,2) is used to disable the release of Telecommands..

4.22.2.2 Structure

PUS-10409//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 2

The structure of the *Application Data field within the TC Packet Data* field is identical with the one defined for TC(151,1). See Table 4.22-3 (Structure of the Application Data TC(151,1)).

4.22.2.3 TC Verification

PUS-10416//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-10418//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	(N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTL_OPS_INVALID_SUBSET
[3]	At least one of the Sub-schedule IDs is out of the range specified	FID_MTLOPS_INVALID_SSID

4.22.3 TC(151,3): Reset OPS

4.22.3.1 Description

Upon reception of TC(151,3) the service provider shall reset the sub-schedule and PRID enabled state of the command schedule to its inital values and clear all entries from the schedule.

The actual initial state is not part of the PUS definition.

After TC execution the global OPS state is disabled.

The release of telecommand needs to be globally disabled by TC(151,2) before execution of the command.

4.22.3.2 Structure

PUS-10431//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 3

TC(151,3) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.22.3.3 TC Verification

PUS-10438//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-10440//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	OPS is enabled at service level	FID_MTLOPS_SERVICE_ENABLI

4.22.4 TC(151,4): Insert Telecommands in OPS

4.22.4.1 Description

Upon reception of TC(151,4) the TC specified by the field Telecommand Packet is inserted in the OPS. TC's in the command schedule are reordered with increasing position tag. TC's with identical position tags are sorted in the sequence they are received. The resolution of the Position Tags is given by the format of the spacecraft position. However, the execution accuracy of the TC's might be less than the Position Tag resolution itself.

Note: TC Packet Header and TC Packet Data Field may be stored separately in order to minimise CPU time for reordering the command schedule.

4.22.4.2 Structure

PUS-10448//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 4

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Sub-schedule ID	N	OrbitPosition	TC Packet
Unsigned Integer	UNsigned Integer	Orbit Position (see Section 4.8))	Byte String
1 bytes	1 byte	6 bytes	See Section 1.7
		<-------- repeated N times-------->	

Table 4.22-6: Structure of the Application data TC(151,4)

4.22.4.3 Parameter Definition & Range

PUS-10468//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Sub-schedule ID	The identification of the sub-schedule	see Note 2)
N	Number of TCs to add in the Sub-schedule	See Note 1)
OrbitPosition	Orbit Position consisting of *OrbitNumber* and *OrbitAngle*	see Section 4.8
TC packet	Complete TC packet	See Section 1.7

Table 4.22-7: Parameters of the Application Data for TC(151,4)

Note 1)

N shall be a constant equal to 1 in the Database definition

Note 2)

SSID = [1 .. 32]

4.22.4.4 TC Verification

PUS-10488//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-10490//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Sub Schedule is out of the range specified above (= 0)	FID_MTLOPS_INVALID_SSID
[3] N is out of the range specified above (= 0)	FID_INVALID_NPAR
[4] At least one of the Orbit Position Tags is < current Orbit Position + OPS_INSERT_POS_MARGIN	FID_MTLOPS_TAG_EXPIRED
[5] The command cannot be inserted in the command schedule (no more control block in OPS)	FID_MTLOPS_SCH_OVERFLOW
[6] TC length is not consistent with the headers of the included TCs	FID_TC_LENGTH_DISCREP
[7] TC to be inserted is either TC(OPS,4) or TC(11,4)	FID_MTLOPS_FORBIDDEN_TC
DELETED	
[9] Not enough space in TC pool	FID_TC_POOL_OVERFLOW

4.22.5 TC(151,5): Delete Telecommands from OPS

4.22.5.1 Description

Upon reception of TC(151,5) all TC's which satisfy the selection criteria defined by the *PRID*, Sequence Count and the Number of TC's shall be deleted.

4.22.5.2 Structure

PUS-10502//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 5

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	Filler	PRID	Filler	Sequence Count	Number of TC's
Unsigned integer		Enumerated		Unsigned integer	Unsigned integer
1 byte	1 bit	7 bits	2 bits	14 bits	1 byte
	< ----- repeat *N* times ---->				

Table 4.22-8: Structure of the Application data TC(151,5)

Note: Destination PRID and Sequence Number correspond to the Packet Header Definition in Section 1.5 .

4.22.5.3 Parameter Definition & Range

PUS-10536//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N	Number of TC areas to be deleted ("scattered delete")	1 to N_MAX[1].
PRID	Destination PRID of the TC to be deleted	Must be set to a value according to the PRID Table in Volume B Value is a copy of the corresponding field of the TC Packet Header of the TC's to be deleted from the command schedule
Sequence Count	The sequence number of the first TC to be deleted	An existing *Sequence Count*, value is a copy of the corresponding field of the TC Packet Header of the first TC to be deleted from the command schedule
Number of TC's	Number of successive TC's to be deleted	All TC's with given PRID between Sequence Count and Sequence Count + *Number of TC' s* - 1 shall be deleted.

Table 4.22-9: Parameters of the Application Data for TC(151,5)

Note 1)

N_MAX = 48 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.22.5.4 TC Verification

PUS-10560//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-10562//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
DELETED	
[2] N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[3] "Nb of SSCs" is out of the range specified above (=0)	FID_MTLOPS_INVALID_NB_SSC
[4] SSC overflow (Start SSC + Nb of SSCs - 1> 0x3FFF)	FID_MTLOPS_SSC_OVERFLOW
DELETED	

4.22.5.5 Remarks

Note: If the Number of Telecommands exceeds the total number of commands that satisfy the selection criteria, then all commands that satisfy the selection criteria shall be deleted

4.22.6 TC(151,6): Delete Telecommands over Position Range

4.22.6.1 Description

Upon reception of TC(151,6) the TC's specified shall be removed from the command schedule. TC's in the command schedule are reordered with increasing OPS Tag.

4.22.6.2 Structure

PUS-10573//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 6

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Range	OPSTag 1	OPSTag 2	N1	Sub-schedule ID	N2	Filler	PRID
Enumerated	Orbit Position (see Section 4.8)	Orbit Position (see Section 4.8)	Unsigned integer	Enumerated	Unsigned integer		Enumerated
1 byte	6 bytes	6 bytes	1 byte	1 byte	1 byte	1 bit	7 bits
						< ----- repeat *N2* times ---->	
				< ----- repeat *N1* times ---->			

Table 4.22-10: Structure of the Application data TC(151,6)

4.22.6.3 Parameter Definition & Range

PUS-10615//

The parameters of the Application Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Range	Parameter for interpretation of the period given by OPS Tags	Range = 0: complete OPS Range = 1: clear between orbit positions Range = 2: clear before orbit position 1 Range = 3: clear after orbit position 1
OPS Tag 1 & 2	Absolute orbit position tag for the TC	orbit position
N1	Number of Sub-schedules follow	*see* Table 4.22-12
Sub-schedule ID	The identification of the sub-schedule(s)	*see* Table 4.22-12, see Note 1)
N2	Number of PRID combinations to follow	see Table 4.22-12
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Table 4.22-11: Parameters of the Application Data for TC(151,6)

Note 1)

SSID = 0 all sub-schedules

SSID = [1 .. 32]

N1	Sub-schedule ID	N2	PRID	Description
0	-	-	-	the command will apply to TC's for any PRID in all sub-schedules.
>= 1	[i], [j],[k]...	0	-	the command will apply to TC's of all PRID's in the identified sub-schedules
1	0	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in all sub-schedules.
1	[i]	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedule.
>= 1	[i], [j],[k]...	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedules.

Table 4.22-12: Possible Combination of Sub-schedules and PRID's

The meaning and presence of the OPS Tag parameters is according following table.

Range	OPS Tag 1	OPS Tag 2
0 (ALL)	n/a	n/a
1 (between)	Earliest absolute OPS	Latest absolute OPS
2 (before)	Latest absolute OPS	n/a
3 (after)	Earliest absolute OPS	n/a

Table 4.22-13: Time Tag Parameters

4.22.6.4 TC Verification

PUS-10670//

TM(1,2): TC Acceptance Report - Failure shall be generated

• if one of the static checks according to Section 4.1 failed

PUS-10672//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Range Type is out of the range specified above	FID_IMTLOPS_NVALID_RANGE_TYPE
[3] Orbit position tag parameters are inconsistent (BETWEEN, Tag1>Tag2)	FID_MTLOPS_INVALID_TAG_RANGE
[4] (N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTLOPS_INVALID_SUBSET
DELETED	
[6] At least one of the Sub-schedule IDs is out of the range specified	FID_MTLOPS_INVALID_SSID

4.22.7 TC(151,7): Position-Shift selected OPS Telecommands

4.22.7.1 Description

The request to position-shift a selected subset of telecommands in the orbit position schedule.

4.22.7.2 Structure

PUS-10683//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 7

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Orbit Number Offset	Orbit Angle	N	Filler	PRID	Filler	Sequence Count	Number of TC's

Orbit Number Offset	Orbit Angle	N	Filler	PRID	Filler	Sequence Count	Number of TC's
Signed integer	Unsigne d integer	Unsigne d integer		Enumer ated		Unsigned integer	Unsigned integer
4 bytes	2 bytes	1 byte	1 bit	7 bits	2 bits	14 bits	1 byte
			< ----- repeat *N* times ---->				

Table 4.22-14: Structure of the Application data TC(151,7)

Note: Destination PRID and Sequence Number correspond to the Packet Header Definition in Section 1.5 .

4.22.7.3 Parameter Definition & Range

PUS-10723//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
OrbitNumberOffset	A positive or negative interval of Orbit Number	The format shall be identical to the Orbit Position format (See Section 4.8) A negative OPS offset is expressed as the "2's complement" of the corresponding positive offset..
OrbitAngle	The corresponding orbit angle to the orbit number.	Note: The *OrbitAngle* is an unsigned value, The shift direction is indicated by the sign of the corresponding orbit number.
N	Number of TC areas to be shifted ("scattered shifting")	1… N_MAX
PRID	Destination PRID of the TC to be shifted	Must be set to a value according to the PRID Table in Volume B Value is a copy of the corresponding field of the TC Packet Header of the TC's to be shifted in the command schedule
Sequence Count	The sequence number of the first TC to be shifted	An existing *Sequence Count*, value is a copy of the corresponding field of the TC Packet Header of the first TC to be shifted in the command schedule

Parameters of Application Data Field	Description	Range or value
Number of TC's	Number of successive TC's to be shifted	All TC's with given PRID between Sequence Count and Sequence Count + *Number of TC' s* - 1 shall be shifted.

Table 4.22-15: Parameters of the Application Data for TC(151,7)

Note 1)

N_MAX = 46 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.22.7.4 TC Verification

PUS-10755//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-10757//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
DELETED	
[2] N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[3] "Nb of SSCs" is out of the range specified above (=0)	FID_MTLOPS_INVALID_NB_SSC
[4] SSC overflow (Start SSC + Nb of SSCs - 1> 0x3FFF)	FID_MTLOPS_SSC_OVERFLOW
DELETED	
[6] At least one of the new computed Orbit Position Tags is < current Orbit Position + OPS_INSERT_POS_MARGIN	FID_MTLOPS_TAG_EXPIRED
[7] Orbit Position Offset is out of the range specified above (overflow) for at least one TC Orbit Position tag	FID_MTLOPS_TAG_OVERFLOW

4.22.8 TC(151,8): Position-Shift selected OPS Telecommands over Position Range

4.22.8.1 Description

The request shifts selected telecommands over a position range.

4.22.8.2 Structure

PUS-10766//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 8

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

RANGE	OPSTAG 1	OPS TAG 2	ORBIT NUMBER OFFSET	ORBIT ANGLE	N1	SUB-SCHEDULE ID	N2	FILLER	PRID
Enumerated	Orbit Position (see chapter 4.8)	Orbit Position (see chapter 4.8)	Signed integer	Unsigned integer	Unsigned integer	Enumerated	Unsigned integer		Enumerated
1 byte	6 bytes	6 bytes	4 bytes	2 bytes	1 byte	1 byte	1 byte	1 bit	7 bits
								<- repeat *N2* times ->	
						< ----- repeat *N1* times ---->			

Table 4.22-16: Structure of the Application data TC(151,8)

Note: Destination PRID and Sequence Number correspond to the Packet Header Definition in Section 1.5 .

4.22.8.3 Parameter Definition & Range

PUS-10775//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
Range	Parameter for interpretation of the period given by OPS Tags	Range = 0: complete command schedule Range = 1: shift between *OPSTag1* and *OPSTag2* Range = 2: shift before *OPSTag1* Range = 3: shift after *OPSTag1*
OPSTag 1 & 2	Absolute orbit position tag for the TC	orbit position
OrbitNumberOffset	A positive or negative interval of Orbit Number	The format shall be identical to the Orbit Position format (See Section 4.8) A negative OPS offset is expressed as the “2’s complement” of the corresponding positive offset..
OrbitAngle	The corresponding orbit angle to the orbit number.	Note: The *OrbitAngle* is an unsigned value, The shift direction is indcated by the sign of the corresponding orbit number. (see Section 4.8)
N1	Number of Sub-schedule ID's which follow	*see* Table 4.22-18
Sub-schedule ID	The identification of the sub-schedule	see Table 4.22-18 and note 1)
N2	Number of PRID’s which follow	see Table 4.22-18
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Table 4.22-17: Parameters of the Application Data for TC(151,8)

Note 1)

SSID = 0 all sub-schedules

SSID = [1 .. 32]

N1	Sub-schedule ID	N2	PRID	Description
0	-	-	-	the command will apply to TC's for any PRID in all sub-schedules.
>= 1	[i], [j],[k]...	0	-	the command will apply to TC's of all PRID's in the identified sub-schedules
1	0	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in all sub-schedules.
1	[i]	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedule.
>= 1	[i], [j],[k]...	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedules.

Table 4.22-18: Possible Combination of Sub-schedules and PRID's

4.22.8.4 TC Verification

PUS-10815//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-10817//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Range Type is out of the range specified above	FID_MTLOPS_INVALID_RANGE_TYPE
[3] Orbit position tag parameters are inconsistent (BETWEEN, OPT1>OPT2)	FID_MTLOPS_INVALID_TAG_RANGE
[4] (N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTL_OPS_INVALID_SUBSET
DELETED	
[6] At least one of the new computed Orbit Position Tags is < current orbit position + OPS_INSERT_POS_MARGIN	FID_MTLOPS_TAG_EXPIRED
[7] Orbit Position Offset is out of the range specified above (overflow) for at least one TC Orbit Position tag	FID_MTLOPS_TAG_OVERFLOW
[8] At least one of the Sub-schedule IDs is out of the range specified above	FID_MTLOPS_INVALID_SSID

4.22.9 TC(151,9): Report Subset of OPS in Detailed Form

4.22.9.1 Description

Upon reception of TC(151,9) the report TM(151,10) shall be generated.

4.22.9.2 Structure

PUS-10826//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 9

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	Filler	PRID	Filler	Sequence Count	Number of TC's
Unsigned integer		Enumerated		Unsigned integer	Unsigned integer
1 byte	1 bit	7 bits	2 bits	14 bits	1 byte
	< ----- repeat *N* times ---->				

Table 4.22-19: Structure of the Application data TC(151,9)

Note: Destination PRID and Sequence Number correspond to the Packet Header Definition in Section 1.5.

If there are less TC's in the command schedule than requested, the related TM(151,10) will just contain the matching TC's. No further notification is given.

4.22.9.3 Parameter Definition & Range

PUS-10861//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N	Number of TC areas to be reported ("scattered report")	1 … 56
PRID	Destination PRID of the TC to be reported	Must be set to a value according to the PRID Table in Volume B Value is a copy of the corresponding field of the TC Packet Header of the TC's to be reported from the command schedule

Parameters of Application Data Field	Description	Range or value
Sequence Count	The sequence number of the first TC to be reported	An existing *Sequence Count*, value is a copy of the corresponding field of the TC Packet Header of the first TC to be reported from the command schedule
Number of TC's	Number of successive TC's to be reported	All TC's with given *PRID* between Sequence Count and Sequence Count + *Number of TC' s* - 1 shall be reported.

Table 4.22-20: Parameters of the Application Data for TC(151,9)

Note 1)

N_MAX = 48 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.22.9.4 TC Verification

PUS-10885//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-10887//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
DELETED	
[2] N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[3] "Nb of SSCs" is out of the range specified above (=0)	FID_MTLOPS_INVALID_NB_SSC
[4] SSC overflow (Start SSC + Nb of SSCs - 1> 0x3FFF)	FID_MTLOPS_SSC_OVERFLOW
DELETED	
[6] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.22.10 TM(151,10): Detailed OPS Report

4.22.10.1 Description

TM(151,10) is the response to TC(151,9), TC(151,11) or TC(151,16).

4.22.10.2 Structure

PUS-10896//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 151

Service Subtype : Must be set to 10

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N	Sub-schedule ID	Sub-schedule status	PRID Status	OPSTag	TCData
Unsigned Integer	Enumerated	Unsigned Integer	Unsigned Integer	Orbit Position (see Section 4.8)	Unsigned Integer
1 byte	1 byte	1 byte	1 byte	6 bytes	Variable
	< ----- repeat *N* times ---->				

Table 4.22-21: Structure of the Source data TM(151,10)

4.22.10.3 Parameter Definition & Range

PUS-10926//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
N	Number of *OPSTag + TC Packets* to follow	0 - No TC in requested range 1 … N_MAX[1)]
Sub-schedule ID	The identification of the sub-schedule	
Sub-schedule Status	Sub-schedule enable status	1 = enabled 0 = disabled
PRID Status	PRID enable status	1 = enabled 0 = disabled
OPSTag	Absolute orbit position tag for the TC	Copy of the ops tag of the TC in the ops schedule
TCData	TC raw data	

Table 4.22-22: Parameters of the Source data for TM(151,10)

Note 1)

N_MAX = 88 (in case of minimum "TCData" length of 12 - see Note 2)

Note 2)

Min: 12 bytes

Max: 206 bytes

4.22.10.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.22.11 TC(151,11): Report Subset of OPS in Detailed Form over Position Range

4.22.11.1 Description

Upon reception of TC(151,11) the report TM(151,10) shall be generated.

4.22.11.2 Structure

PUS-10959//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 11

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Range	OPSTag 1	OPS Tag 2	N1	Sub-schedule ID	N2	Filler	PRID
Enumerated	Orbit Position (see Section 4.8)	Orbit Position (see Section 4.8)	Unsigned integer	Enumerated	Unsigned integer		Enumerated
1 byte	6 bytes	6 bytes	1 byte	1 byte	1 byte	1 bit	7 bits
					< ----- repeat *N2* times ---->		
				< ----- repeat *N1* times ---->			

Table 4.22-23: Structure of the Application data TC(151,11)

4.22.11.3 Parameter Definition & Range

PUS-11002//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value

Parameters of Application Data Field	Description	Range or value
Range	Parameter for interpretation of the period given by OPS Tags	Range = 0: complete command schedule Range = 1: report between OPSTag's Range = 2: report before OPSTag 1 Range = 3: report after OPSTag 1
OPSTag 1 & 2	Absolute orbit position tag for the TC	A valid orbit position
N1	Number of Sub-schedule ID's which follow	see Table 4.22-25
Sub-schedule ID	The identification of the sub-schedule	*see* Table 4.22-25 see note 1)
N2	Number of PRID's which follow	see Table 4.22-25
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Table 4.22-24: Parameters of the Application Data for TC(151,11)

Note 1)

SSID = 0 all sub-schedules

SSID = [1 .. 32]

N1	Sub-schedule ID	N2	PRID	Description
0	-	-	-	the command will apply to TC's for any PRID in all sub-schedules.
>= 1	[i], [j],[k]...	0	-	the command will apply to TC's of all PRID's in the identified sub-schedules
1	0	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in all sub-schedules.
1	[i]	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedule.
>= 1	[i], [j],[k]...	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedules.

Table 4.22-25: Possible Combination of Sub-schedules and PRID's

The meaning and presence of the OPS Tag parameters is according following table.

Range	OPSTag 1	OPS Tag 2
0 (ALL)	n/a	n/a
1 (between)	Earliest absolute OPS	Latest absolute OPS
2 (before)	Latest absolute OPS	n/a
3 (after)	Earliest absolute OPS	n/a

Table 4.22-26: OPS Tag Parameters

4.22.11.4 TC Verification

PUS-11057//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-11059//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Range parameter is out of the range specified above	FID_MTLOPS_INVALID_RANGE_TYPE
[3] Orbit position tag parameters are inconsistent (BETWEEN, OPT1>OPT2)	FID_MTLOPS_INVALID_TAG_RANGE
[4] (N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTLOPS_INVALID_SUBSET
DELETED	
[6] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED
[7] At least one of the Sub-schedule IDs is out of the range specified above	FID_MTLOPS_INVALID_SSID

4.22.12 TC(151,12): Report Subset of OPS in Summary Form

4.22.12.1 Description

Upon reception of TC(151,12) the report TM(151,13) shall be generated.

4.22.12.2 Structure

PUS-11071//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 12

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

N	Filler	PRID	Filler	Sequence Count	Number of TC's
Unsigned integer		Enumerated		Unsigned integer	Unsigned integer
1 byte	1 bit	7 bits	2 bits	14 bits	1 byte
	< ----- repeat *N* times ---->				

Table 4.22-27: Structure of the Application data TC(151,12)

Note: Destination PRID and Sequence Number correspond to the Packet Header Definition in Section 1.5

4.22.12.3 Parameter definition & Range

PUS-11105//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
N	Number of TC areas to be reported ("scattered report")	1 … N_MAX[1)]
PRID	Destination PRID of the TC to be reported	Must be set to a value according to the PRID Table in Volume B Value is a copy of the corresponding field of the TC Packet Header of the TC's to be reported from the command schedule
Sequence Count	The sequence number of the first TC to be reported	An existing *Sequence Count*, value is a copy of the corresponding field of the TC Packet Header of the first TC to be reported from the command schedule
Number of TC's	Number of successive TC's to be reported	Minimum value = 1, maximum value = all TC's in the command schedule with the specified *PRID* and a *Sequence Number* value greater than the specified one.

Table 4.22-28: Parameters of the Application Data for TC(151,12)

Note 1)

N_MAX = 48 (TC nested in TC(11,4) or TC(151,4) - see Figure 1.7-1 in Section 1.7)

4.22.12.4 TC Verification

PUS-11129//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-11131//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
DELETED	
[3] N is not consistent with the real length of the packet data field	FID_NPAR_LENGTH_DISCREP
[4] "Nb of SSCs" is out of the range specified above (=0)	FID_MTLOPS_INVALID_NB_SSC
[5] SSC overflow (Start SSC + Nb of SSCs - 1> 0x3FFF)	FID_MTLOPS_SSC_OVERFLOW
DELETED	
[6] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.22.13 TM(151,13): Summary OPS Report

4.22.13.1 Description

TM(151,13) is the response to TC(151,12) , TC(151,14) and TC(151,17).

4.22.13.2 Structure

PUS-11140//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 151

Service Subtype : Must be set to 13

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N	Sub-schedule ID	Sub-schedule Status	PRID Status	Ops-Tag	TC Packet Header	TC Data Field Header
Unsigned integer	Enumerated	Enumerated	Enumerated	Enumerated	Unsigned integer	
2 bytes	1 byte	1 byte	1 byte	6 bytes	6 bytes	4 bytes
	< -------- Repeat *N* times ------ >					

Table 4.22-29: Structure of the Source data TM(151,13)

4.22.13.3 Parameter Definition & Range

PUS-11176//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value
N	Number of TC's reported in this TM Source Packet	0....N_MAX[1)]
Sub-schedule ID	The identification of the sub-schedule	
Sub-schedule Status	Status of the Sub-schedule	1 = enabled 0 = disabled
PRID Status	Status of the PRID	1 = enabled 0 = disabled
Ops-Tag		Copy of the *Orbit Number* & *Orbit Angle* of the TC as in the command schedule
TC Packet Header	TC Packet Header	defined in Section 1.5
TC Data Field Header	TC data Field Header	defined in Section 1.5

Table 4.22-30: Parameters of the Source data for TM(151,13)

Note 1)

N_MAX = 106

4.22.13.4 Remarks

Note: In case the amount of data to be down linked exceeds the TM source packet, as many source packets as required shall be generated to fulfill the request. The bandwidth adjustment mechanism is applicable for this TM.

4.22.14 TC(151,14): Report Subset of OPS in Summary Form over Position Range

4.22.14.1 Description

Upon reception of TC(151,14) the report TM(151,13) shall be generated.

4.22.14.2 Structure

PUS-11209/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 14

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

Range	OPSTag 1	OPS Tag 2	N1	Sub-schedule ID	N2	Filler	PRID
Enumerated	Orbit Position (see Section 4.8)	Orbit Position (see Section 4.8)	Unsigned integer	Enumerated	Unsigned integer		Enumerated
1 byte	6 bytes	6 bytes	1 byte	1 byte	1 byte	1 bit	7 bits
						< rep.*N2* times>	
				< ----- repeat *N1* times ---->			

Table 4.22-31: Structure of the Application data TC(151,14)

4.22.14.3 Parameter Definition & Range

PUS-11252//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Application Data Field	Description	Range or value
Range	Parameter for interpretation of the period given by OPS Tags	Range = 0: complete command schedule Range = 1: report between OPSTag's Range = 2: report before OPSTag 1 Range = 3: report after OPSTag 1
OPSTag 1 & 2	Absolute orbit position tag for the TC	A valid orbit position
N1	Number of PRID's which follow	see Table 4.22-33
Sub-schedule ID	The identification of the sub-schedule	*see* Table 4.22-33 see Note 1)
N2	Number of PRID's which follow	see Table 4.22-33
PRID	Process ID	Must be set to a value according to the PRID Table in Volume B

Table 4.22-32: Parameters of the Application Data for TC(151,14)

Note 1)

SSID = 0 all sub-schedules

SSID = [1 .. 32]

N1	Sub-schedule ID	N2	PRID	Description
0	-	-	-	the command will apply to TC's for any PRID in all sub-schedules.
>= 1	[i], [j],[k]...	0	-	the command will apply to TC's of all PRID's in the identified sub-schedules
1	0	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in all sub-schedules.
1	[i]	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedule.
>= 1	[i], [j],[k]...	>= 1	[a], [b], [c]...	the command will apply to TC's of the selected PRID's in the identified sub-schedules.

Table 4.22-33: Possible Combination of Sub-schedules and PRID's

The meaning and presence of the OPS Tag parameters is according following table.

Range	OPSTag 1	OPS Tag 2
0 (ALL)	n/a	n/a
1 (between)	Earliest absolute OPS	Latest absolute OPS
2 (before)	Latest absolute OPS	n/a
3 (after)	Earliest absolute OPS	n/a

Table 4.22-34: OPS Tag Parameters

4.22.14.4 TC Verification

PUS-11307//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-11309//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Range parameter is out of the range specified above	FID_MTLOPS_INVALID_RANGE_TYPE
[3] Orbit position tag parameters are inconsistent (BETWEEN, OPT1>OPT2)	FID_MTLOPS_INVALID_TAG_RANGE
[4] (N1, Sub-schedule ID, N2) is not consistent with the array above	FID_MTLOPS_INVALID_SUBSET
DELETED	
[6] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED
[7] At least one of the Sub-schedule IDs is out of the range specified above	FID_MTLOPS_INVALID_SSID

4.22.15 TC(151,15): Position-Shift all OPS Telecommands

4.22.15.1 Description

The request to position-shift all telecommands in the command schedule.

4.22.15.2 Structure

PUS-11321//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 15

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

OrbitNumberOffset	OrbitAngle
Signed integer	Unsigned Integer
4 bytes	2 bytes

Table 4.22-35: Structure of the Application data TC(151,15)

4.22.15.3 Parameter Definition & Range

PUS-11336//

The parameters of the Application Data *Field shall be inserted according to the following table:*

Parameters of Application Data Field	Description	Range or value
OrbitAngleOffset	A positive or negative interval of Orbit Number	The format shall be identical to the Orbit Position format (See Section 4.8) A negative OPS offset is expressed as the “2’s complement” of the corresponding positive offset..
OrbitAngle	The corresponding orbit angle to the orbit number.	Note: The *OrbitAngle* is an unsigned value, The shift direction is indicated by the sign of the corresponding orbit number.

Table 4.22-36: Parameters of the Application Data for TC(151,15)

4.22.15.4 TC Verification

PUS-11348//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-11350//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] At least one of the new computed Orbit Position Tags is < current Orbit Position + OPS_INSERT_POS_MARGIN	FID_MTLOPS_TAG_EXPIRED
[3] Orbit Position Offset is out of the range specified above (overflow) for at least one TC Orbit Position tag	FID_MTLOPS_TAG_OVERFLOW

4.22.16 TC(151,16): Report OPS in Detailed Form

4.22.16.1 Description

Upon reception of TC(151,16) TM(151,10) shall be generated.

4.22.16.2 Structure

PUS-11357//

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 16

TC(151,16) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.22.16.3 TC Verification

PUS-11364//

TM(1,2): TC Acceptance Report - Failure shall be generated

•if one of the static checks according to Section 4.1 failed

PUS-11366//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.22.17 TC(151,17): Report OPS in Summary Form

4.22.17.1 Description

Upon reception of TC(151,17) TM(151,13) shall be generated.

4.22.17.2 Structure

PUS-11373/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 17

TC(151,17) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.22.17.3 TC Verification

PUS-11380/I

TM(1,2): TC Acceptance Report - Failure shall be generated

• if one of the static checks according to Section 4.1 failed

PUS-11382/I

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1] The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2] Errors during the elaboration of the requested large TM :	
· The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
· The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.22.18 TC(151,18): Report Status of OPS

4.22.18.1 Description

Upon reception of TC(151,18) TM(151,19) shall be generated.

4.22.18.2 Structure

PUS-11389/I

The Packet Header shall have the following structure:

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 151

Service Subtype : Must be set to 18

TC(151,18) does not have any application data, i.e. the *Application Data* field within the *TC Packet Data* field does not exist (length = 0).

4.22.18.3 TC Verification

PUS-11396/I

TM(1,2): TC Acceptance Report - Failure shall be generated

• if one of the static checks according to Section 4.1 failed

PUS-11398//

TM(1,8): TC Execution Completion Report - Failure shall be generated

[1]	The actual TC length is different from the expected TC length	FID_LENGTH_DISCREP
[2]	Errors during the elaboration of the requested large TM :	
·	The requested TM output structure is larger than the current set MTU	FID_MTU_TOO_SMALL
·	The new TM output request has aborted a not yet finished TM output	FID_REPORT_ABORTED

4.22.19 TM(151,19): OPS Status Report

4.22.19.1 Description

TM(151,19) is the response to TC(151,18).

4.22.19.2 Structure

PRID : Must be set to a value according to the PRID Table in Volume B

PCAT : Must be set to 3 (table)

Service Type : Must be set to 151

Service Subtype : Must be set to 19

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

N1	Sub-schedule ID	Status	N2	Filler	PRID	Status
Unsigned integer	Enumerated	Enumerated	Unsigned integer		Enumerated	Enumerated
1 bytes	1 byte	8 bit	1 bytes	1 bit	7 bits	8 bit
				< -- Repeat *N2* times -- >		
	< ------- Repeat *N1* times ------ >					

Table 4.22-37: Structure of the Source data TM(151,19)

4.22.19.3 Parameter Definition & Range

PUS-11443//

The parameters of the Source Data *Field shall be inserted according to the following table.*

Parameters of Source Data Field	Description	Range or value

Parameters of Source Data Field	Description	Range or value
N1	Repetition counter for subschedule related information.	1...... N1_MAX1) Note that the PRID status and SubSchedule statuses are completely independent from each other. This means in particular that when a given PRID is disabled, no TC of this PRID will be released at all, whatever the subschedule
Sub-schedule ID	The identification of the sub-schedule	see Note 2)
Status	The status of the corresponding *sub-schedule*	0… disabled 1… enabled
N2	Repetition counter for PRID related information.	1.... N2_MAX1) forSSID = 0; 0 for SSID > 0
PRID	PRID of the TC	Must be set to a value according to the PRID Table in Volume B. The value is a copy of the corresponding field of the TC Packet Header.
Status	The status of the corresponding *PRID*	0… disabled 1… enabled

Table 4.22-38: Parameters of the Source data for TM(151,19)

Note 1)

N1_MAX = 33 with SSID = 0 giving the global status of the service as well as the PRID status and 1 <=SSID=>32 usable subschedules.

N2_MAX = number of on-board processe ID's (in any cas <=127)

Note 2)

SSID = 0 all sub-schedules

SSID = [1 .. 32]

4.23 Service 152: TC File Management

This Service is not applicable

Requirement/Section Cross Reference

Title: **Sentinel-2 PUS VOLUME B: Common Data Tables**

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Change Record

Issue	Date	Sheet	Description of Change
1	**08/08/2008**	all	First formal issue with separate document number **GS2.STD.ASD.SY.00002**. The change bars mark the differences to the draft. Updates based on ESA and Astrium review comments as communicated per ASD e-mail "S2-PUS Meeting" by S.Bursch dated 31.7.2008.
2	**10/10/2008**	all	• This document is now integrated as VOLUME B in the overall PUS document G**S2.STD.ASD.SY.00001**. • The change bars mark the differences to issue 1 of **GS2.STD.ASD.SY.00002**. • Document **GS2.STD.ASD.SY.00002** will no longer be maintained.
		§B1+B2	Updated TC and TM Layout Added Virtual Channel assinment and MAP-ID Assignment.
		§B2.10	Updated Common Event ID definition.
		all	Updates based on ESA and Astrium review comments as per "S2-PUS Meeting" ***GS2.MN.ASD.SY.00091*** 09.09.2008 and "S2-PUS telecon" GS2.MN.ASD.SY.00094.
		§B2.4 and §B2.5	Updated Source ID and Destination ID description.
		§B2.6	Added Service 3 SID assignment..
		§B2.10	Added common EID assignment..
		§B3.3	Renumbered the following Services: (3,128) ➔ (3,136) (3,129) ➔ (3,130) (3,130) ➔ (3,131) (3,131) ➔ (3,137) (3,132) ➔ (3,128) (3,133) ➔ (3,129)
		§B3.5	Renumbered the following Services: (5,128) ➔ (5,129) (5,130) ➔ (5,128) (5,133) removed, since covered in (5,131) (5,134) removed, since covered in (5,132)
		§B3.7	Renumbered the following Services: (8,128) ➔ (8,140) (8,129) ➔ (8,141) (8,130) ➔ (8,142) (8,131) ➔ (8,143) (8,132) ➔ (8,144) (8,133) ➔ (8,145)
		§B3.8	Renumbered the following Services: (9,129) ➔ (9,128) (9,131) ➔ (9,133) (9,132) ➔ (9,134) (9,133) ➔ (9,135)
		§B3.13	Renumbered the following Services: (15,129) ➔ (15,130) (15,130) ➔ (15,140) (15,131) ➔ (15,141)

Issue	Date	Sheet	Description of Change
			(15,132) ➔ (15,142) (15,133) ➔ (15,143) (15,134) ➔ (15,144) (15,135) ➔ (15,145) (15,136) ➔ (15,146) (15,1327) ➔ (15,128)
		§B3.15	Renumbered the following Services: (18,1228) ➔ (18,140) (18,1229) ➔ (18,141) (18,1230) ➔ (18,142) (18,1231) ➔ (18,143)
		§B3.17	Renumbered the following Services: (128,1) ➔ (129,1) (128,2) ➔ (129,2) (128,3) ➔ (129,3)
		§0	Renumbered the following Services: (130,x) ➔ (131,x)
			Updates based on comunality agreements of GPS meeting “***S3-MN-TAF-GN-00328***”:
		§B2.1	Updated GPS PRID
		§B3.23	Added detail layout for GPS service 3, 5, 6.
3	**12.12.2008**	all	Updates based on S-1; S-2; S3 review comments in the frame of the GPSR comunallity. As concluded in S3-MN-TAF-GN-00440 dated 04.12.2008.
		§B2.3	• Update of PCATs table
		§B3.3 §B3.23.1	• Updated Service 3 applicability Removed GPS Service(3,26)
		§B3.6	• Updated Service 6 applicability
		§B3.23	• Updated GPS Service
		§B3.23.7	• Added GPS Periodic Memory Diagnosis Service
4	**27.02.2009**		Document Change Note GS2.DN.ASD.SY.00020 • Sentinel-2 PUS update after System PDR
		§B1.1	• Added section for S/C ID
		§B1.4	• Updated TC Layout (Editorial RID 6)
		§B1.4	• Updated TM Layout
		§B2.3	• Changed PCAT 2, 4 and 5; Added PCAT 6 for S/C ancillary data (Editorial RID 32)
		§B2.4	• Changed Source IDs (Editorial RID 33)
		§B3.6 §B3.23.3	• Removed inconsistencies (SEAO-211)

Issue	Date	Sheet	Description of Change
		§B3.24.2	• Added Service(201,7) "MMFU Playback Satellite Ancillary Data with Memory freed or Data stored"
		§B4	• Added Specification of cyclic redundancy code (CRC)
5	**31.07.2009**		Sentinel-2 Packet Utilization Standard update: • update after clarification from Operations Meetings • refinement of service allocation • refinement of project specific definitions All changes are marked by change bars.
		§B1.2.3	• Added CPDU Command Format
		§B1.3.2	• Added OBC HPTM Format
		§B1.4	• Added Virtual Channel allocation for S- and X-Band
		§B1	• Removed TC structure since defined in Volume A
		§B1	• Removed S-Band TM structure since defined in Volume A
		§B2.1	• Updated Process ID Table
		§B2.2	• Updated Sentinel-2 PUS Service Type Range Allocation List
		§B2.3	• Updated TM/TC Packet Categories (PCAT)
		§B2.4	• Updated Source ID of TC Data Field Header
		§B2.6	• Updated SID assignment table
		§B2.9	• Updated Common Event IDs
		§B2.10	• Updated Memory IDs
		§B2.12	• Mapping of Services refined • LCT added.
6	-		Not issued.
7	**12.01.2010**		**Sentinel-2 Packet Utilization Standard updated.** **All changes are marked by change bars.**
		§B1.1	Added Spacecraft IDs
		§B1.2.2	Changed Table 1.3: AU Control Commands only via MAP-ID 63
		§B2.11	Added Service 8 Function-ID Assignment
		§B2.12.9	Removed Service(11,130)+(11,131)
		§B2.13.1.2	Added details to Service 145
		§B2.13.2.1	Removed Service(151,130)+(151,131)
		§B2.13.5	Changes in the GPS section: • Added summary table for service overview • Removed TBC for Service (6,210) • Updated subservice naming inline with GPS-CHDIS • Editorial changes
		§B2.13.6	Changes in the MMFU section: • Added summary table for service overview • Updated subservice naming • Added subservices to service 203 • Editorial changes

8	**12.05.2010**		**Sentinel-2 Packet Utilization Standard updated after CSW V2 SRR.**
		§B1.2.2	Added MAP-IDs 5+6.
		§B1.3.2	HPTM Packet Header: Version-Number set to = 0.
		§B2.1	Changed PRID for HPC to 2 and removed PRID=3 Added PRIDs for PFCT, DMS and MSIC and removed PRID=44 Renamed LCT into OCP
		§B2.2	Added PUS Service range for Platform Control.
		§B2.3	Updated PCATs according to GPRS CHKDIS issue 7.
		§B2.4	Added SourceID = 0x0A until 0x71. ***CSW-V2-SRR RID-175 AI-01:*** Added comment to clarify formulation “Set by ground”.
		§B2.7	***CSW-V2-SRR RID-196 AI-02:*** Added new paragraph for Packet Store ID assigmnentto allow playback from redundant OBC-MMU.
		§B2.9	Updated FID table.
		§B2.10	Updated EID table.
		§B2.10	***CSW_V2_SRR RID-24 AI-01 and RID-190 AI-01:*** Assigned OBC Memory IDs. Added Note.
		§B3	Updated applicability matrix for CSW APIDs: DMS, PF and PL.
		§B3.3	Updated applicability matrix for MMFU service 3.
		§B3.3	***CSW_V2_SRR RID-165 AI-02:*** Added Service (3,139).
		§B3.12.1	Added chapter to describe the Service 14 Packet Forwarding Table Reconstruction.
		§B3.13.1	Added chapter to describe the Service 15 Packet Storage Table Reconstruction.
		§B3.18	Added Service 142.
		§B3.19.5	***CSW_V2_SRR RID-174 AI-01:*** Added comment to Service (145,128). Refinement of SSV tailoured for LCT/OCP.
		§B3.20	***CSW_V2_SRR RID-26 AI-04:*** Added Service 148 and related applicability.
		§B3.21	Added Service 149.
		§B3.23	Removed GPSR Application Service details and referenced to GPSR TM/TC ICD.
		§B3.24	Removed MMFU Application Service details and referenced to MMFU TM/TC ICD.
		§B3.25	Added referenced to Startracker TM/TC ICD.
		§B3.26	Renamed LCT into LCT/OCP
		§B3.15 §B3.20	Renamed Service 18 to 148
		all	***CSW_V2_SRR RID-177 AI-03:*** Related comments from ESOC-XLS file implemented.
		all	Removed TBC and TBD.
		all	Corrected typos.

9	**22.10.2010**		**Sentinel-2 Packet Utilization Standard Volume B updated after CSW V2 PDR.** **All changes are marked by change bars.**
		all	Update based on red-marked S2-PUS as generated during the **working meeting GS2.MN.ASD.SY.00524** date 7.10.2010.
		§B1.1	Added X-Band Spacecraft-IDs as per **ESA e-mail OS 26.5.2010**.
		§B1.2.3	Corrected Application Process Identifier value to 0x2C
		§B1.3.2	Extended HPTM with AU details.
		§B1.4.1 §B2.3	Added PCAT=11, 12, 13 for Satellite Ancillary Data. see also **GS2.CN.ASD.SY.00103**
		§B1.4.1	Added virtual chanels 20, 21, 22 and 63 as per **GS2.CR.ASD.MMFU.00228**
		§B1.4.2	Updated Version Number and Time Quality in pictures ▪ “GS2 X-Band Satellite Housekeeping Data” ▪ “GS2 Telemetry X-Band Image Data”
		§B2.2	Updated LCT/OCP allocated service range.
		§B2.11	Added / refined OBC memory-IDs.
		§B3.8	Removed MMFU Services (9,135) applicability for CSW since it handles the Central OBT.
		§B3.19.5	Updated S/C State Vector TC(145,128)
		§B3.24	Removed MMFU Services (203,3+5+6).
		§B3.24.2.7	Removed TC(201,7): MMFU Playback Satellite Ancilliary Data and combined in TC(201,6)
		§3.24.4	Removed: TC(203,5) Dump Packet Store Default Size Table
		§3.24.4	Removed: TM(203,6) Packet Store Default Size Table Dump
		§3.26	Updated LCT/OCP service list.
		§4.3	Updated parameter type definitions.
10	**22.03.2011**	**all**	**Sentinel-2 Packet Utilization Standard Volume B updated after System CDR and CSW V3 SRR.** **All changes are marked by change bars.**
		all	ESOC S2-PUS comments reviewed and considered as per **SEO-SW-52.**
		§B1.2.2	Added column for packet aggregation.
		§B1.2.3	Corrected max. number of CPDU command instructions.
		§B1.4	Added reference to "Advanced Orbiting Systems Space Data Links Protocols".
		§B2.1	Updated allocated tasks of CSW-PRIDs. Added Fall back PRID for STR.
		§B2.11.1	Updated OBC specific Memory IDs.
		§B3.13	Added Service TC(15.154) to summary list.
		§B3.20	Added Service TC(148.133) to summary list.
		§B3.24.2.6	Implemented action of System CDR RID **SEO-ORV-73**, **ORV_64**: ▪ Updated description of MMFU service (201,6) to reflect indepent commanding of Satellite Ancillary and HK packet stores wrt. memory freeing

11	**21.10.2011**	**all**	**Sentinel-2 Packet Utilization Standard Volume B updated after CSW V3 PDR. All changes are marked by change bars.**
		§B2.1	Re-assigned MSI-PRID from 0x10 to 0x09. Added MMFU-PRIDs 0x22 and 0x23. Added note to PRID 29.
		§B2.3	Added TM(8,128) to PCAT 3.
		§B2.4	Added Source IDs for CSW commanding to STR and GPSR.
		§B2.7.1	Added reference to SW System ICD. Removed spare Packet Store 5.
		§B2.9	Corrected FIDs.
		§B2.10	Added Severity List for EIDs.
		§B2.11.1	Added Memory IDs for logical partitions of theDMS and MSIC Application.
		§B3.6	Added applicability of TC(6,5) and TC(6,6) for MSIC Application.
		§B4.3	Updated text in Parameter Type definition table and removed derived type. Updated text in Parameter Encoding table.
12	**25.05.2012**	**all**	**Sentinel-2 Packet Utilization Standard Volume B updated for CSW V2 CDR All changes are marked by change bars.**
		§B1.1	Updated typo from S2B PFM to S2B FM
		§B2.11.1	Updated address typo of Memory-ID 0x033. • Added Memory-ID 0x066 and 0x166.
		§B2.11.2	Updated MMFU Memory-ID: • Added Memory-ID 0x070 to 0x072and 0x080 to 0x082. • Extended Memory-IDs for physical and logical addressing.
		§B2.4	Added source ID for MSIC-Application.
		§B2.9	Revised list of FIDs
		§B3.ff	Updated STR related packets as per STR CDR RID-63 and STR PUS ICD: • Added Service (3,128) (3,129) (3,130) (3,131) (3,136) (8,220) • Removed Services (3,9) (3,10) (3,11) (3,12) (8,140) (8,141) (8,142) (8,143) (8,144) (8,145) (140,1) (140,2) (140,3) (224,2) (224,3)
		§B3.7	Added TM(8,128) for MSIC.
		§B3.8	Removed TC(9,136) for LCT.

13	**15.11.2012**	**All**	**Sentinel-2 Packet Utilization Standard Volume B clean-up. All changes are marked by change bars.**
		§B2.1	• AIDA GS2-MN.ASD.SY.00819-9: Added CSW internal PRID processing frequency. • Editorial change, removed <CR>
		§B2.7	Updated Service 15 after clarification with CSW-Team: • Packet Store IDs assigned for OBC MM B to range 5 to 8.
		§B2.10	Updated Table B1-1: Event ID allocation list.
		§B2.11.1	Updated DMS specific Memory ID Definitions: • Renamed in Table B2-12 MID “COCOS” to “Communication RAM”. • Updated in Table B2-12 memory ranges for MID “Communication RAM” inline with GS2.ICD.RSE.OBC.00002 issue 11 page 31. • Updated wording of Notes. • Editorial update of Table B2-13 and B2-14.
		§B3.17	Added Note for Service (140,4): CSW applications use the SAU size of 1 Byte.
		§B4.3	Updated parameter type table: • 4,15 not supported • 4,16 not supported The access can be implemented via other PTC 4 types.

Table of Contents of VOLUME B

B1. SENTINEL-2 TM/TC STRUCTURE

B1.1 Spacecraft ID

The Spacecraft IDs for the Sentinel-2's are assigned as listed below:

Version ID [hex]	***S/C ID*** [hex]	***Model***	***Spacecraft Link***
0	237	STB	for S-Band Uplink
0	237	STB	for S-Band Downlink
1	52	STB	for X-Band Downlink
0	231	EFM	for S-Band Uplink
0	231	EFM	for S-Band Downlink
1	52	EFM	for X-Band Downlink
0	233	PFM S2A	for S-Band Uplink
0	233	PFM S2A	for S-Band Downlink
1	53	PFM S2A	for X-Band Downlink
0	235	FM S2B	for S-Band Uplink
0	235	FM S2B	for S-Band Downlink
1	54	FM S2B	for X-Band Downlink

Table B1-1: Spacecraft ID

B1.2 Sentinel-2 Telecommand Structure

B1.2.1 TC Virtual Channel Assignment

The virtual channels are assigned as listed below:

Virtual Channel	Description
VC-ID 1	Decoder A of OBC
VC-ID 2	Decoder B of OBC

Table B1-2: Virtual Channels for TC

B1.2.2 MAP-ID Assignment

The MAP-IDs are assigned as listed below:

MAP-ID [dec]	Description	Aggregation [YES/NO]
0	CPDU HPC Commands	No
1	Commands to be processed by CSW	Yes
5	Re-init TM/RM/HPTM/OBT by TC-Decoder A TC segment with **header only** sent to MAP 5 will perform a re-initialisation of the TTRM module functions to its power-on state. The command does not affect the TC Decoder operation. The Re-init TTRM TM/RM/HPTM/OBT Map command affects only the TTRM board which received the TC command. As defined in GS2.ICD.RSE.OBC.00003 “OBC Electrical ICD”.	No
6	Set TC Only MAP command by TC-Decoder A TC segment with **header only**, MapID is set in the header, sent to MAP 6 will place the corresponding CPDM Selector in TC Only mode. A TC segment sent to MAP 6 will abort any ongoing CPDU packet execution ordered by the RM or the PM. The Set TC Only Map command affects only the TTRM board which received the TC command. As defined in GS2.ICD.RSE.OBC.00003 “OBC Electrical ICD”.	Yes
63	Commands to be processed by the Authentification Module. As defined in GS2.TN.RSE.OBC.00101 ”Authentication Unit User Manual”.	No

Table B1-3: MAP-IDs

Note: Other MAP-IDs are not used.

B1.2.3 CPDU Command Format

CPDU Telecommand Packet													
Packet Header							Packet Data Field						
Packet Identification				Packet Sequence Control		Packet Length	N Command Instructions (s)						Packet Error Control
Version Number	Type	Data Field Header flag	Application Process Id	Sequence flags	Sequence Count		Command Instruction 1				..	Command Instruction N	
							Output No. LSB	Output No. MSB	Parity	Pulse Length			
3 bits 0…2	1 bit 3	1 bit 4	11 bits 5..15	2 bits 0..1	14 bits 2..15	16 bits 0..15	8 bits	4 bits	1 bit	3 bits		16 bits	16 bits 0..15
2 octets				2 octets		2 octets	2*N octets						2 octets

Table B1-4: CPDU Command Format

The CPDU packet consists of:

- the **Packet Identification field**, being:
  - Version Number field = 0,
  - Type field = 1,
  - Data Field Header flag =0,
  - Application Process Identifier field =0x2C.

- the **Packet Sequence Control** consisting of:
  - The Sequence flags, which for a CPDU packet shall be 11_{bin} (standalone packet).
  - The Sequence Count, which identifies the CPDU packet in a sequence of CPDU packets.

- the **Packet Length** field specifies the length of the CPDU packet, with its value being (total number of octets in the CPDU packet – 7).

- between 1 and 504 **CPDU command instructions**. Each CPDU command instruction consists of:

  - Output Number LSB, specifying one of 256 possible CPDU command outputs.
  - Output Number MSB, specifying an extension up to 4096 outputs (not used).
  - 1 reserved bit which shall be set to 0
  - Pulse Length (3 bits), which determines the length of the CPDU pulse. The pulse
  - Length is defined as D·2L, where D is the CPDM duration and L is the 3-bit pulse length.

- The **Packet Error Control** field, which is a CRC used for detecting errors, which may exist in the CPDU packet. After initialising the encoder to all ones, it is generated over the entire CPDU Packet (except the Packet Error Control field) using the polynomial g(x) = x16 + x12 + x5 + 1.

B1.3 S-Band Telemetry

B1.3.1 S-Band TM Virtual Channel Assignment

The Virtual Channels for the S-Band are assigned as listed below:

Virtual Channel	Description	Contents
S-VC 0	Real Time HK Telemetry	Telemetry that is generated in Real-Time during an S-band pass
S-VC 1	High Priority Telemetry (HPTM)	Telemetry that is generated by the OBC HPTM generation function
S-VC 2	Playback HK Telemetry	TM packets that have been recorded on the OBC MM Packet Store
S-VC 3	*Spare channel*	*Spare channel from OBC PM*
S-VC 4-6	*Not used*	
S-VC 7	*Idle frames*	

Table B1-5: Virtual Channels for S-Band TM

B1.3.2 OBC HPTM (High Priority TM) Format

The OBC issues HPTM packet with the format as defined below. The format is Independent from the packet source (issued by TTRM A or TTRM B).

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN=001b</td><td>TY=0</td><td>DF=0</td><td colspan="11">APID = 0x25 (nom/red)</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">SSC</td></tr>
<tr><td>3</td><td colspan="16">PACKET LENGTH</td></tr>
<tr><td>4</td><td colspan="16">RSA Status [48:33] (nom) (TTRM A)</td></tr>
<tr><td>5</td><td colspan="16">RSA Status [32:17] (nom) (TTRM A)</td></tr>
<tr><td>6</td><td colspan="16">RSA Status [16:1] (nom) (TTRM A)</td></tr>
<tr><td>7</td><td colspan="16">RSA Status [48:33] (red) (TTRM B)</td></tr>
<tr><td>8</td><td colspan="16">RSA Status [32:17] (red) (TTRM B)</td></tr>
<tr><td>9</td><td colspan="16">RSA Status [16:1] (red) (TTRM B)</td></tr>
<tr><td></td><td colspan="16">TTRM A Status</td></tr>
<tr><td>10</td><td colspan="16">OBT 2^{31}-2^{16}</td></tr>
<tr><td>11</td><td colspan="16">OBT 2^{15}-2^{0}</td></tr>
<tr><td>12</td><td colspan="16">OBC status, PIO[31:16] TTRM A</td></tr>
<tr><td>13</td><td colspan="16">OBC status, PIO[15:0] TTRM A</td></tr>
<tr><td>14</td><td colspan="16">CPDM Selector Status [31:16] TTRM A</td></tr>
<tr><td>15</td><td colspan="16">CPDM Selector Status [15:0] TTRM A</td></tr>
<tr><td>16</td><td colspan="16">CPDM Selector Interface Status [31:16] TTRM A</td></tr>
<tr><td>17</td><td colspan="16">CPDM Selector Interface Status [15:0] TTRM A</td></tr>
<tr><td>18</td><td colspan="16">TC Decoder Frame Analysis Report [31:16] TTRM A</td></tr>
<tr><td>19</td><td colspan="16">TC Decoder Frame Analysis Report [15:0] TTRM A</td></tr>
<tr><td>20</td><td colspan="16">CPDU Status Report (ground commands) [31:16] TTRM A</td></tr>
<tr><td>21</td><td colspan="16">CPDU Status Report (ground commands) [15:0] TTRM A</td></tr>
<tr><td>22</td><td colspan="16">CPDU Status Report (PM or RM commands) [31:16] TTRM A</td></tr>
<tr><td>23</td><td colspan="16">CPDU Status Report (PM or RM commands) [15:0] TTRM A</td></tr>
<tr><td>24</td><td colspan="16">Current alarm status [31:16] TTRM A</td></tr>
<tr><td>25</td><td colspan="16">Current alarm status [15:0] TTRM A</td></tr>
<tr><td>26</td><td colspan="16">OBT of last reconfiguration [31:16] TTRM A</td></tr>
<tr><td>27</td><td colspan="16">OBT of last reconfiguration [15:0] TTRM A</td></tr>
<tr><td>28</td><td colspan="16">Alarm status at last reconfiguration [31:16] TTRM A</td></tr>
<tr><td>29</td><td colspan="16">Alarm status at last reconfiguration [15:0] TTRM A</td></tr>
<tr><td>30</td><td colspan="16">Attempt index of last reconfiguration [31:16] TTRM A</td></tr>
<tr><td>31</td><td colspan="16">Attempt index of last reconfiguration [15:0] TTRM A</td></tr>
<tr><td>32</td><td colspan="16">OBC status at last reconfiguration, PIO[31:16] TTRM A</td></tr>
<tr><td>33</td><td colspan="16">OBC status at last reconfiguration, PIO[15:0] TTRM A</td></tr>
<tr><td>34</td><td colspan="16">PM A summary boot report [31:16] TTRM A</td></tr>
<tr><td>35</td><td colspan="16">PM A summary boot report [15:0] TTRM A</td></tr>
<tr><td>36</td><td colspan="16">PM A RAM test result [31:16] TTRM A</td></tr>
<tr><td>37</td><td colspan="16">PM A RAM test result [15:0] TTRM A</td></tr>
<tr><td>38</td><td colspan="16">PM B summary boot report [31:16] TTRM A</td></tr>
<tr><td>39</td><td colspan="16">PM B summary boot report [15:0] TTRM A</td></tr>
</table>

40	PM B RAM test result [31:16] TTRM A	
41	PM B RAM test result [15:0] TTRM A	
	TTRM B Status	
42	OBT 2^{31}-2^{16} TTRM B	
43	OBT 2^{15}-2^{0} TTRM B	
44	OBC status, PIO[31:16] TTRM B	
45	OBC status, PIO[15:0] TTRM B	
46	CPDM Selector Status [31:16] TTRM B	
47	CPDM Selector Status [15:0] TTRM B	
48	CPDM Selector Interface Status [31:16] TTRM B	
49	CPDM Selector Interface Status [15:0] TTRM B	
50	TC Decoder Frame Analysis Report [31:16] TTRM B	
51	TC Decoder Frame Analysis Report [15:0] TTRM B	
52	CPDU Status Report (ground commands) [31:16] TTRM B	
53	CPDU Status Report (ground commands) [15:0] TTRM B	
54	CPDU Status Report (PM or RM commands) [31:16] TTRM B	
55	CPDU Status Report (PM or RM commands) [15:0] TTRM B	
56	Current alarm status [31:16] TTRM B	
57	Current alarm status [15:0] TTRM B	
58	OBT of last reconfiguration [31:16] TTRM B	
59	OBT of last reconfiguration [15:0] TTRM B	
60	Alarm status at last reconfiguration [31:16] TTRM B	
61	Alarm status at last reconfiguration [15:0] TTRM B	
62	Attempt index of last reconfiguration [31:16] TTRM	
63	Attempt index of last reconfiguration [15:0] TTRM B	
64	OBC status at last reconfiguration, PIO[31:16] TTRM B	
65	OBC status at last reconfiguration, PIO[15:0] TTRM B	
66	PM A summary boot report [31:16] TTRM B	
67	PM A summary boot report [15:0] TTRM B	
68	PM A RAM test result [31:16] TTRM B	
69	PM A RAM test result [15:0] TTRM B	
70	PM B summary boot report [31:16] TTRM	
71	PM B summary boot report [15:0] TTRM B	
72	PM B RAM test result [31:16] TTRM B	
73	PM B RAM test result [15:0] TTRM B	
	Authentification Unit A Status	
74	AU A Last TC Accepted Analysis Report Register [31:16]	AU_LTcAccAnR
75	AU A Last TC Accepted Analysis Report Register [15:0]	AU_LTcAccAnR
76	AU A Last TC Accepted LAC Register [31:16]	AU_LTcAccLac
77	AU A Last TC Accepted LAC Register [15:0]	AU_LTcAccLac
78	AU A Last TC Accepted Packet Header 1 Register [31:16]	AU_LTcAccPH1

79	AU A Last TC Accepted Packet Header 1 Register [15:0]	AU_LTcAccPH1
80	AU A Last TC Rejected Analysis Report Register [15:0]	AU_LTcRejAnR
81	AU A Last TC Rejected LAC Register [31:16]	AU_LTcRejLac
82	AU A Last TC Rejected LAC Register [15:0]	AU_LTcRejLac
83	AU A First TC Rejected Analysis Report Register [15:0]	AU_FTcRejAnR
84	AU A First TC Rejected LAC Register [31:16]	AU_FTcRejLac
85	AU A First TC Rejected LAC Register [15:0]	AU_FTcRejLac
86	AU A Master Key ID Register [31:16]	AU_MasK
87	AU A Master Key ID Register [15:0]	AU_MasK
88	AU A Session Key ID Register [31:16]	AU_SesK
89	AU A Session Key ID Register [15:0]	AU_SesK
90	AU A LAC Counter Normal Register [31:16]	AU_LacCNorm
91	AU A LAC Counter Normal Register [15:0]	AU_LacCNorm
92	AU A LAC Counter Control Register [31:16]	AU_LacCCont
93	AU A LAC Counter Control Register [15:0]	AU_LacCCont
94	AU A LAC Counter Recovery Register [31:16]	AU_LacCReco
95	AU A LAC Counter Recovery Register [15:0]	AU_LacCReco
96	AU A LAC Window Normal Register [31:16]	AU_LacWNorm
97	AU A LAC Window Normal Register [15:0]	AU_LacWNorm
98	AU A LAC Window Control Register [31:16]	AU_LacWCont
99	AU A LAC Window Control Register [15:0]	AU_LacWCont
100	AU A LAC Window Recovery Register [31:16]	AU_LacWReco
101	AU A LAC Window Recovery Register [15:0]	AU_LacWReco
	Authentification Unit B Status	
102	AU B Last TC Accepted Analysis Report Register [31:16]	AU_LTcAccAnR
103	AU B Last TC Accepted Analysis Report Register [15:0]	AU_LTcAccAnR
104	AU B Last TC Accepted LAC Register [31:16]	AU_LTcAccLac
105	AU B Last TC Accepted LAC Register [15:0]	AU_LTcAccLac
106	AU B Last TC Accepted Packet Header 1 Register [31:16]	AU_LTcAccPH1
107	AU B Last TC Accepted Packet Header 1 Register [15:0]	AU_LTcAccPH1
108	AU B Last TC Rejected Analysis Report Register [15:0]	AU_LTcRejAnR
109	AU B Last TC Rejected LAC Register [31:16]	AU_LTcRejLac
110	AU B Last TC Rejected LAC Register [15:0]	AU_LTcRejLac
111	AU B First TC Rejected Analysis Report Register [15:0]	AU_FTcRejAnR
112	AU B First TC Rejected LAC Register [31:16]	AU_FTcRejLac
113	AU B First TC Rejected LAC Register [15:0]	AU_FTcRejLac
114	AU B Master Key ID Register [31:16]	AU_MasK
115	AU B Master Key ID Register [15:0]	AU_MasK
116	AU B Session Key ID Register [31:16]	AU_SesK
117	AU B Session Key ID Register [15:0]	AU_SesK
118	AU B LAC Counter Normal Register [31:16]	AU_LacCNorm

119	AU B LAC Counter Normal Register [15:0]	AU_LacCNorm
120	AU B LAC Counter Control Register [31:16]	AU_LacCCont
121	AU B LAC Counter Control Register [15:0]	AU_LacCCont
122	AU B LAC Counter Recovery Register [31:16]	AU_LacCReco
123	AU B LAC Counter Recovery Register [15:0]	AU_LacCReco
124	AU B LAC Window Normal Register [31:16]	AU_LacWNorm
125	AU B LAC Window Normal Register [15:0]	AU_LacWNorm
126	AU B LAC Window Control Register [31:16]	AU_LacWCont
127	AU B LAC Window Control Register [15:0]	AU_LacWCont
128	AU B LAC Window Recovery Register [31:16]	AU_LacWReco
129	AU B LAC Window Recovery Register [15:0]	AU_LacWReco

Table B1-6: OBC HPTM format

B1.4 X-Band Telemetry

The X-Band is implemented in accordance with the "Advanced Orbiting Systems Space Data Links Protocols" [ND-117].

B1.4.1 X-Band TM Virtual Channel Assignment

The Virtual Channels for the X-Band are assigned as listed below:

Virtual Channel	Description		Contents
X-VC 0-1	*Not Used*		
X-VC 2	Satellite Ancillary Data		TM packets that have been recorded on the MMFU Satellite Ancillary Data Store. I.e. only the TM packets with PCAT = 6, 11, 12 and 13.
X-VC 3	Satellite Housekeeping		TM packets that have been recorded on the MMFU Satellite HK Packet Store. I.e. all TM packets (of all PCATs).
X-VC 4	Nominal Mission Data	half scene 1	
X-VC 5	Near Real Time Mission Data	half scene 1	
X-VC 6	Real Time Mission Data	half scene 1	
X-VC 20	Nominal Mission Data	half scene 2	
X-VC 21	Near Real Time Mission Data	half scene 2	
X-VC 22	Real Time Mission Data	half scene 2	
X-VC 63	*X-Band Idle frames*		

Table B1-7: Virtual Channels for X-Band TM

B1.4.2 X-Band Telemetry Layout

The X-Band Telemetry Layout is depicted on the following pages for:

- X-Band Satelite Housekeeping Data
- X-Band Image Data

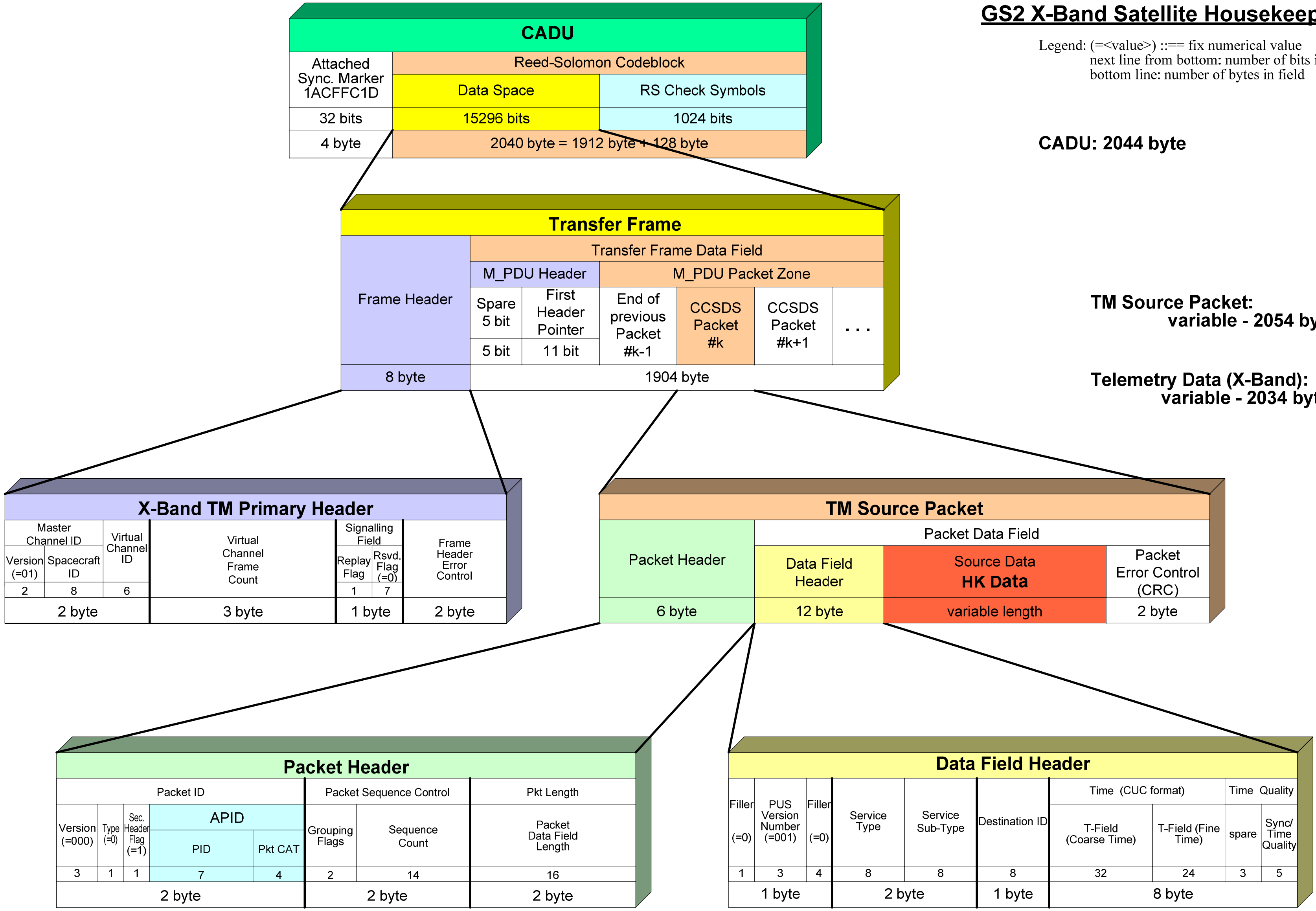
GS2 X-Band Satellite Housekeeping Data

Legend: (=<value>) ::== fix numerical value
next line from bottom: number of bits in field
bottom line: number of bytes in field

CADU: 2044 byte

TM Source Packet:
variable - 2054 byte max.

Telemetry Data (X-Band):
variable - 2034 byte max.



File: CCSDS_TMTC_GS2.vsd
Sheet: TM-X-Band HK
Date: 06.10.10

GS2 Telemetry X-Band Image Data

Legend: (=<value>) ::== fix numerical value
next line from bottom: number of bits in field
bottom line: number of bytes in field

CADU: 2044 byte

TM Source Packet: variable – 65 535 byte max.

CADU

Attached Sync. Marker 1ACFFC1D	Reed-Solomon Codeblock: Data Space	Reed-Solomon Codeblock: RS Check Symbols
32 bits	15296 bits	1024 bits
4 byte	2040 byte = 1912 byte + 128 byte	

Transfer Frame

Frame Header	Transfer Frame Data Field – M_PDU Header: Spare	M_PDU Header: First Header Pointer	M_PDU Packet Zone: End of previous Packet #k-1	CCSDS Packet #k	CCSDS Packet #k+1	. . .
	5 bit	11 bit				
8 byte	1904 byte					

X-Band TM Primary Header

Master Channel ID: Version (=01)	Master Channel ID: Spacecraft ID	Virtual Channel ID	Virtual Channel Frame Count	Signalling Field: Replay Flag	Signalling Field: Rsvd. Flag (=0)	Frame Header Error Control
2	8	6		1	7	
2 byte			3 byte	1 byte		2 byte

TM Source Packet

Packet Header	Packet Data Field: Data Field Header	Packet Data Field: Source Data Image Data	Spare n/a for uncompressed data	Packet Error Control (CRC)
6 byte	12 byte	variable length		2 byte

Packet Header

Packet ID: Version (=000)	Type (=0)	Sec. Header Flag (=1)	APID: Spare (=00)	APID: VCM Board (=0;1)	APID: Rsvd. (=0)	APID: WICOM Number (=00;01;10)	APID: Detector Number (=0,1)	APID: Band Number (=0000 to 1100)	Packet Sequence Control: Sequence Flags (always 11)	Sequence Count	Pkt Length: Packet Data Field Length
3	1	1	2	1	1	2	1	4	2	14	16
2 byte									2 byte		2 byte

Data Field Header

System Ancillary Data: Scene Start Time coarse & fine		Time correction value	MSI sync status (=0;1)	PPS LSB	System operation status	Compr. Status: Compression Status	Image Ancillary Data: Anc. Data Line #0	Anc. Data Line #1	...	Anc. Data Line #15
32	24	12	1	1	10	16	48	48	...	48
7 byte		3 byte				2 byte	96 byte			

File: CCSDS_TMTC_GS2.vsd
Sheet: TM-X-Band compressed
Date: 06.10.10

B1.4.3 Details of X-Band Telemetry Data Field Header

The X-Band Telemetry Data Field Header contains the following 10 bit parameter:

Parameter Value [hex]	**Parameter: Data Field Header System Ancillary Data System Operation Status**
0x001	Nominal Observation Mode (INS-NOBS)
0x002	Extended Observation Mode (INS-EOBS)
0x011	Dark Signal Calibration Mode (INS-DASC)
0x012	Absolute Radiometry Calibration Mode (INS-ABSR)
0x013	Vicarious Calibration Mode (INS-VIC)
0x021	Raw Measurement Mode (INS-RAW)
0x022	Test Mode (INS-TST)

Table B1-8: X-Band Image Data: System Operation Status

B2. SENTINEL-2 COMMON DATA TABLES

In this chapter all data tables which are common for all APIDs on Sentinel-2 are defined. The numbering convention is as follows: Common Identifiers are numbered from 0 to 127. APID specific numbering always starts at 128. Each APID start by itself at these number, i.e. there are no dedicated numbering sections for the APIDs.

B2.1 Process ID Table (PRID)

PRID(HEX)	UNIT	MN	APPLICATION	FUNCTIONS
00			TIME (only TM)	- Time Management
02	**OBC-HW**	HPC1	OBC High Priority **TC** Functions	- High Priority Commanding to CPDU (MAP-0)
02	**OBC-HW**	HPTM	OBC High Priority **TM** Functions	- for Prime/Red. HPTM Packet with PCAT=5
0F	**OBC-HW**		Authentication Function	
OBC CSW internal PRID's				
0A	**OBC CSW**	DMS	Data Management System Application	- Start and initialisation - Packet routing - Packet organization - System logging function - MTL/OPS function - OBC function - Patch/dump function - S/C Config. Management - Time Management function - OBC MM handling function - RIU related Functions - S-Band Functions - Housekeeping function - Event function - Event/action function - Monitoring function - Service 8, Service 17
0B	**OBC CSW**	AOCS	AOCS Application	- AOCS Command and Control - Housekeeping function - Event function - Event/action function - Monitoring function - Service 8, Service 17
0C	**OBC CSW**	PLCT	Payload Control Application	- Payload Command and Control - MMFU related Functions - OCP/LCT related Functions - X-Band Functions - Housekeeping function - Event function - Event/action function - Monitoring function - Service 8, Service 17
0D	**OBC CSW**	PFCT	Platform Control Application	- TCS Command and Control - PCDU Command and Control - Housekeeping function - Event function - Event/action function - Monitoring function - Service 8, Service 17
0E	**OBC CSW**	SYCT	System Control Application	- S/C modes - S/C Init - FDIR/S - SCV function - Housekeeping function - Event function - Event/action function - Monitoring function - Service 8, Service 17
09	**OBC CSW**	MSIC	MSI Control Application	- MSI Command and Control - Housekeeping function - Event function - Event/action function - Monitoring function - Service 8, Service 17

OBC CSW external PRID's				
20	**MMFU-A**		MMFU-A Application	- MMFU Command and Control
21	**MMFU-B**		MMFU-B Application	- MMFU Command and Control
22	**MMFU**		reserved	- MMFU internal Files
23	**MMFU**		reserved	- MMFU internal Files
25	**STR-1**		STR-1 Application	- STR Command and Control
26	**STR-2**		STR-2 Application	- STR Command and Control
27	**STR-3**		STR-3 Application	- STR Command and Control
29	**STR-F**		Fall back PRID for STR with invalid RT address	This PRID is NOT use by the CSW.
30	**GPS-A**		GPS-A Application	- GPS Command and Control
31	**GPS-B**		GPS-B Application	- GPS Command and Control
50	**LCT**		LCT/OCP Application	- LCT/OCP Command+Control
Others				
60-77	**EGSE**		reserved	
78-7C	**ESOC**		reserved	
7D-7E	**-**		reserved	
7F			IDLE PACKET	

Table B2-1: Process ID Table

Note: The "OBC CSW internal PRIDs" are processed at 2 Hz.

B2.2 Sentinel-2 PUS Service Type Range Allocation List

Service Type Range (dec.)	Application
0 - 127	General PUS Services
128 - 149	General Sentinel-2 application services
150 - 159	System Control (SYCT) application services
160 - 169	AOCS application services
170 - 179	Payload Control (PLCT) application services
180 - 189	Platform Control (PFCT) application sercives
190 - 199	reserved
200 - 209	MMFU application services
210 - 219	GPS application services
220 - 224	STR application services
225 - 234	reserved
235 - 239	MSI application services
240 - 247	LCT application services
248 - 254	spare
255	Authentication service

Table B2-2: PUS Service ID allocation list

B2.3 TM/TC Packet Categories (PCAT)

Packet categories are to be defined on Sentinel-2 System level.

Telecommand	
Packet Category	*Description*
12	CPDU HPC Commands via MAP-ID 0
12	TELECOMMAND

Table B2-3: Packet Category Tables for TC

Telemetry		
Packet Category (DEC)	***Description***	***TM Packets***
0	TIME	TM (9,2)
1	ACKNOWLEDGE	TM(1,1), TM(1,2), TM(1,7), TM(1,8), TM(2,129), TM(2,133), TM(17,2)
2	Diagnostic TM	TM(3,26) according to SID range as per table B2.6
3	TABLE	TM(3,10), TM(3,12), TM(3,129) TM(5,134), TM(5,130), TM(5,213) TM(6,10), TM(6,218) TM(8,128), TM(8,145) TM(11,10), TM(11,13), TM(11,19) TM(12,9), TM(12,11) TM(14,8), TM(14,12), TM(14,129), TM(14,131) TM(15,143), TM(15,146), TM(15,152) TM(19,7), TM(19,131) TM(140,3), TM(142,9), TM(142,11), TM(145,4) TM(148,9), TM(148,11) , TM(148,131) TM(149,5), TM(149,8) TM(151,10), TM(151,13), TM(151,19) TM(203,2), TM(203,8), TM(203,10), TM(203,12) TM(211,3), TM(224,3)
4	HK TM	TM(3,25) and for OBC-CSW according to SID range as per table B2.6
5	*High Priority TM*	High-Priority TM Packets from OBC HW (w/o SW)
6	*S/C Ancillary Data*	OBC-CSW TM(3,25) according to SID range as per table B2.6 and for GPSR packets TM(212,1) with SID=218, 223, 225, 226, 227.
7	EVENT	TM(5,1), TM(5,2), TM(5,3), TM(5,4)
8	Diagnostic TM to PS only	TM(3,26) according to SID range as per table B2.6
9	DUMP	TM (6,6), TM(6,216), TM(213,1)
10	*Reserved*	
11	*S/C Ancillary Data*	GPSR TM(212,1) packets with SID=216, 217.
12	Science 0	GPSR TM(212,1) packets with SID=215, 224, 235.
13	*S/C Ancillary Data*	GPSR TM(212,1) packets with SID=229, 230, 231, 232, 234.
14	reserved	
15	IDLE PACKET	

Table B2-4: Packet Category Tables for TM

B2.4 Source ID of TC Data Field Header

The Source ID in the Telecommand Data Field Header shall be inserted by the relevant application according to the table given here below. This value applies to the embedded commands inside the below listed services.

SOURCE ID (DEC)	SOURCE ID (HEX)	APPLICATION	PRID	SOURCE SEQUENCE COUNTER (SSC)
00	00	Ground	FOS	Set by ground
02	02	OBC CSW Service 8 (if related)	DMS	On-board generated
04	04	OBC CSW Service 11 (MTL)	DMS	Set by ground
05	05	OBC CSW Service 151 (OPS)	DMS	Set by ground
06	06	OBC CSW Service 18 / 148 (OBCP)	DMS	Set by ground
07	07	OBC CSW Service 19 (Event-Action)	DMS	Set by ground
08	08	OBC CSW Service 145 to LCT (S/C State Vector)	SYCT	On-board generated
10	0A	Authentification Unit commands		Set by ground
18	12	SYCT: OBC CSW Service 8 (if related)	SYCT	On-board generated
22	16	SYCT: OBC CSW Service 18 / 148 (OBCP)	SYCT	Set by ground
23	17	SYCT: OBC CSW Service 19 (Event-Action)	SYCT	Set by ground
34	22	AOCS: OBC CSW Service 8 (if related)	AOCS	On-board generated
38	26	AOCS: OBC CSW Service 18 / 148 (OBCP)	AOCS	Set by ground
39	27	AOCS: OBC CSW Service 19 (Event-Action)	AOCS	Set by ground
40	28	OBC CSW Service 224 to STR1,2,3 (Aberration)	AOCS	On-board generated
41	29	OBC CSW Service 211 to GPSR (Attitude)	AOCS	On-board generated
50	32	PFCT: OBC CSW Service 8 (if related)	PFCT	On-board generated
54	36	PFCT: OBC CSW Service 18 / 148 (OBCP)	PFCT	Set by ground
55	37	PFCT: OBC CSW Service 19 (Event-Action)	PFCT	Set by ground
66	42	PLCT: OBC CSW Service 8 (if related)	PLCT	On-board generated
70	46	PLCT: OBC CSW Service 18 / 148 (OBCP)	PLCT	Set by ground
71	47	PLCT: OBC CSW Service 19 (Event-Action)	PLCT	Set by ground
82	52	MSIC: OBC CSW Service 8 (if related)	MSIC	On-board generated
86	56	MSIC: OBC CSW Service 18 / 148 (OBCP)	MSIC	Set by ground
87	57	MSIC: OBC CSW Service 19 (Event-Action)	MSIC	Set by ground

Table B2-5: Source ID of TC Data Field Header

The following Source Sequence Counter (SSC) generation rules shall be applied for TCs depending on the identification “Set by user”::

a) In general just the next SSC, which is due for TC's to the PRID executing the service shall be applied. This also applies for TC(11,4) resp. TC(151,4). Exceptions to the basic rule the following specific rules shall be applied:

b) For TC(19,1) Event Action the SSC rule is:

```
SSC = 0xC000 | (Event ID)
```

c) For TC(148,128) OBCP ID & OBCP Step ID the SSC rule is:
`SSC = 0xC000 | (256* OBCP Number + OBCP Step ID)`
Note: "0xC000" represents the 2 segmentation bits of the TC packet sequence control field.

The user can be the ground i.e. FOS or the S/C supplier e.g. for default TC's stored on-board.

B2.5 Destination ID of TM Data Field Header

DESTINATION ID (DEC)	***APPLICATION***	***SOURCE SEQUENCE COUNTER (SSC)***
TC Source ID	TM(1,x) packets mirror the TC Source ID in the TM Destination ID field.	The TM SSC is incremented per APID
00	else TM uses Destination ID = Ground	The TM SSC is incremented per APID

Table B2-6: Destination ID of TM Data Field Header

B2.6 Service 3 SID Assignment

The Service(3,25) and (3,26) Structure IDs (SIDs) shall use the following assigned ranges:

Housekeeping SID's for TM(3,25)		
Structure ID Range (dec.)	**Assignment**	**Associated PCAT**
1 - 10	General Status & Summary Information HK SID's	**4**
11 - 30	Mode related HK SID's	**4**
31 - 60	Equipment related HK SID's	**4**
61 - 90	SpecificDataRequest HK SID's	**4**
91 - 100	spare	**4**
101 - 104	ESOC	**4**
105 - 127	Satellite Ancillary Data	**6**
Diagnostic SID's for TM(3,26)		
SID-Range (dec.)	**Assignment**	**Associated PCAT**
128 - 137	General Status & Summary Information Diagnostic SID's	**2**
138 - 157	Mode related Diagnostic SID's	**2**
158 - 187	Equipment Diagnostic HK SID's	**2**
188 - 217	Specific Diagnostic SID's	**2**
218 - 227	spare	**2**
228 - 231	ESOC	**2**
232 - 255	Diagnostic to Packet Store only	**8**

Table B2-7: Service(3,25) and (3,26) SID allocation list

B2.7 Service 15 Packet Store ID Assignment

B2.7.1 Packet Stores on OBC Mass Memory

OBC Mass Memory Packet Store ID [dec]		Name	Type	Contents
(TTRM A)	(TTRM B)			
PSID = 0	PSID = 0	Virtual Packet Store (⇔ Trash)	n/a	Not a real Packet Store. Used in the TC(15,x) commands to indicate that no routing is performed onto a packet store.
PSID = 1	PSID = 5	Spacecraft History Log	Circular without overwrite	Default Packet Store routing as per SW System ICD.
PSID = 2	PSID = 6	HK Log	Circular with overwrite	Default Packet Store routing as per SW System ICD.
PSID = 3	PSID = 7	Dumps and Report Log	Circular with overwrite	Default Packet Store routing as per SW System ICD.
PSID = 4	PSID = 8	Spare	Circular with overwrite	Spare

Table B2-8: OBC MM Packet Store ID list

The default size of the packet stores is specified in the System SW ICD.
To define a new packet store layout using TC(15,150) on the OBC Mass Memory the following rules apply:

- *Store ID*'s listed in the table above are allowed only (PSID=0 is not allowed since this will be a virtual store without physical representation on TTR boards)
- *Size* has to be specified in bytes and must be multiple of 128Kbyte
- PS start and end addresses are calculated by the CSW automatically
- Memory allocation starts at the first address of the storage area always following the order given by TC(15,150), therefore unallocated space will always be located at the end of the storage area.
- To append an additional store to the existing configuration requires to repeat the current configuration plus to add the additional PS configuration
- TC(15,150) will create circular buffers with overwrite per default, this can be changed later using TC(15,154), since the store content will be lost by this operation the packet store mode shall be set before packet routing has been enabled for this store.

B2.8 Common Structure of HK parameters

On Sentinel-2 the System Data Pool Parameter ID's (ParID) have the following structure:

System Data Pool Parameter ID (4 Bytes)			
Filler	***PRID***	***Local Parameter ID***	
		Access bit	***Local ID***
	enumerated	**R/W**	**Enumerated**
1bit	***7 bit***	***1bit***	***23 bit***

Table B2-9: System Data Pool Parameter ID Structure

The HK Parameter Local in the on-board SW is defined by the System Data Pool Parameter ID. Characteristics are:

- free selectable from the list of defined System Data Pool Parameters,
- no dedicated, especially no byte/bit map related algorithm shall be applied i.e. no re-mapping for a new software image shall be necessary.

The System Data Pool Parameter ID definition is divided into PRID and Local Parameter ID. The Local Parameter ID may be divided into sub-ranges, which can be considered as data pool groups

- HK Parameters of functional entity
- acquired from external interfaces or
- derived from internal H/W or S/W states
- Derived on-board TM parameters
- Status summary parameters
- Optimized HK parameters (e.g. type converted)
- Configuration parameters

A generic allocation of data pool groups to be considered is given in the Sentinel-2 Datapool ICD.

The access bit as part of the local ID is used to identify the access policy of the HK parameter. If the bit is set the parameter is considered as READ ONLY. Thus, it can not be modified or set by service 140.

Local Parameter IDs are maintained and control via the SRDB and are allocated to SW parameter names. The software receives the local parameter definition via configuration files at generation time.

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B2.9 Common Fault Identifiers (FID)

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
0	0	illegal APID		TM(1,2)	All				
1	1	incomplete or invalid length packet		TM(1,2)	All				
2	2	incorrect checksum		TM(1,2)	All				
3	3	illegal packet type		TM(1,2)	All				
4	4	illegal packet subtype		TM(1,2)	All				
5	5	illegal or inconsistent application data		TM(1,2)	All				
6	6	illegal segment sequence flag	FID_ILLEGAL_TCS_SF	TM(1,2)	All				
7	7	illegal MAP ID	FID_ILLEGAL_TCS_MAP_ID	TM(1,2)	All				
256	100	illegal CCSDS packet version number	FID_ILLEGAL_VERSION	TM(1,2)	All				
257	101	illegal packet type	FID_ILLEGAL_P_TYPE	TM(1,2)	All				
258	102	illegal data field header flag	FID_ILLEGAL_DFHF	TM(1,2)	All				
259	103	unknown Process Identifier	FID_UNKNOWN_PRID	TM(1,2)	All				
260	104	illegal packet category	FID_ILLEGAL_PCAT	TM(1,2)	All				
261	105	illegal sequence flag	FID_ILLEGAL_SF	TM(1,2)	All				
262	106	invalid number of parameters	FID_ILLEGAL_NPAR	TM(1,8)	(3,1) (3,2) (11,4) (11,7) (11,9) (11,12) (140,1) (140,2) (140,4) (142,6) (142,12) (142,13) (151,4) (151,5) (151,7) (151,9) (151,12)	received NPAR			
263	107	packet length out of allowed	FID_INVALID_PLENGTH	TM(1,2)	All	received			

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
		range				packet length			
264	108	packet length not in line with given type and subtype	FID_LENGTH_DISCREP	TM(1,8)	All	received packet length	expected packet length		
266	10A	illegal CCSDS secondary header flag	FID_ILLEGAL_SHF	TM(1,2)	All	data field header			
267	10B	illegal TC packet PUS version number	FID_ILLEGAL_TC_PUS	TM(1,2)	All	data field header			
268	10C	unknown service type	FID_UNKNOWN_S_TYPE	TM(1,2)	All	data field header			
269	10D	unknown service subtype	FID_UNKNOWN_S_SUBTYPE	TM(1,2)	All	data field header			
271	10F	calculated checksum not equal to received checksum	FID_CS_DISCREP	TM(1,2)	All	received checksum	calculated checksum		
272	110	overflow of TC input buffer	FID_TC_INBUF_OVERFLOW	TM(1,2)	All				
273	111	service requests a TM output with a logical structure larger than actually set MTU	FID_MTU_TOO_SMALL	TM(1,8)	All the TCs requesting a large TM report (*)	size of MTU	size of requested logical structure		
274	112	Ongoing TM request has been aborted by a new TM output request	FID_REPORT_ABORTED	TM(1,8)	All the TCs requesting a large TM report (*)				
275	113	Dump has aborted due to a HW error	FID_DUMP_ERROR	TM(1,8)	Not generated by any CDHS component but can be generated by an external				

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
					component (tmBandwith user) which build function returns an built error				
277	115	not enough space in TC pool	FID_TC_POOL_OVERFLOW	TM(1,8)	(11,4) (19,1) (148,128) (151,4)	type, subtype of TC (for S19)			
280	118	Error during HW access	FID_HW_ERROR	TM(1,8)	all	Error status returned by the HW			
511	1FF	A data expected as float is Not a number (Nan)	FID_INVALID_DATA	TM(1,8)	All the TCs with any float parameter	Index of the invalid data			
768	300	structure identifier out of allowed range	FID_INVALID_SID	TM(1,8)	(3,1) (3,2) (3,3) (3,4) (3,5) (3,6) (3,7) (3,8) (3,9) (3,11) (3,130) (3,131) (3,136) (3,138) (3,139)	received SID			
769	301	invalid collection interval	FID_INVALID_COLL_INT	TM(1,8)	(3,1) (3,2) (3,130) (3,131)	received collection interval			
770	302	invalid number of HK parameters	FID_INVALID_NPAR_HK	TM(1,8)	(3,1); (3,2); (128,4)	received NPAR			

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
771	303	amount of parameter identifiers not in line with NPAR parameter	FID_NPAR_LEN_DISCREP	TM(1,8)	(3,1) (3,138) (11,5) (11,7) (11,9) (11,12) (142,1) (142,2) (142,5) (142,6) (142,12) (142,13) (151,5) (151,7) (151,9) (151,12)	received NPAR	expected TC data length		
772	304	invalid parameter ID	FID_INVALID_PAR_ID	TM(1,8)	(3,1) (3,2) (3,138)	received parameter ID			
773	305	N1 and N2 not consistent with the data length of the received TC	FID_N1_N2_LENGTH_DISCREP	TM(1,8)	(3,2)	received N1	received N2	expected TC data length	data length of the received TC
775	307	maximum total number of defined SIDs is already reached	FID_MAX_TOTAL_SID_NB	TM(1,8)	(3,1) (3,2)				
776	308	NREP is incompatible with Collection Interval parameter	FID_NREP_INCO_INTERVAL	TM(1,8)	(3,2) (3,131)	received Collection Interval	NREP		
777	309	attempt to modify enabled (active) SID	FID_SID_ENABLED	TM(1,8)	(3,1) (3,2) (3,3) (3,4) (3,130) (3,131) (3,138)	received SID			
778	30A	structure identifier is not defined	FID_UNKNOWN_SID	TM(1,8)	(3,3) (3,4) (3,5) (3,7) (3,9) (3,11) (3,130) (3,131) (3,136) (3,138) (3,139)	received SID			
779	30B	invalid EID	FID_SID_INVALID_EID	TM(1,8)	(3,139)	received EID			

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
780	30C	invalid (PID,EID) combination	FID_SID_UNKNOWN_EID	TM(1,8)	(3,139)	received PID	received EID		
781	30D	HK/Diagnostic structure exceeds TM size	FID_TM_SIZE_EXCEEDED	TM(1,8)	(3,1) (3,2) (3,138)	filler (uint16) + type(uint8) + subtype (uint8)	SID		
782	30E	Maximum number of Hk SID already defined	FID_MAX_HK_NB_EXCEEDED	TM(1,8)	(3,1)	Number of HK SID already defined			
783	30F	maximum number of Diag SID already defined	FID_MAX_DIAG_NB_EXCEEDED	TM(1,8)	(3,2)	Number of Diag SID already defined			
784	310	total number of parameters for an existing SID too high	FID_TOTAL_NPAR_EXCEEDED	TM(1,8)	(3,138)	number of parameters computed	maximum number of parameters		
785	311	Invalid NFA	FID_INVALID_NFA	TM(1,8)	(3,2)	received NFA			
1280	500	invalid number of EID's	FID_INVALID_NEID	TM(1,8)	(5,5); (5,6)	received NEID			
1281	501	amount of event identifiers not in line with N parameter	FID_NEID_LEN_DISCREP	TM(1,8)	(5,5); (5,6)	received NEID	received number of event identifiers		
1282	502	selected EID does not exist	FID_UNKNOWN_EID	TM(1,8)	(5,5); (5,6)	index (1 to NEID) of unknown EID	received value of affected parameter		

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
1536	600	memory identifier out of allowed range	FID_INVALID_MEM_ID	TM(1,8)	(6,2); (6,5); (6,9);	received memory ID			
1537	601	start address out of allowed range	FID_INVALID_ADDRESS	TM(1,8)	(6,2); (6,5); (6,9);	received memory address			
1538	602	length out of allowed range	FID_INVALID_LENGTH	TM(1,8)	(6,2); (6,5); (6,9);)	received memory length			
1539	603	amount of data not in line with length parameter	FID_DATA_LEN_DISCREP	TM(1,8)	(6,2)	received memory length	received amount of data		
1540	604	memory access failed	FID_FAILED_MEM_ACCESS	TM(1,8)	(6,2); (6,5); (6,9);	cause (e.g. write protection, timeout, verify failure see SUM)			
1542	606	NPAR out of allowed range or not in line with the number of supplied parameters	FID_MEM_BLOCK_DISCREP	TM(1,8)		received NPAR			
2048	800	nvalid function Id in TC(8,*)	FID_UNKNOWN_FUNC_ID	TM(1,8)	(8,1); (8,140); (8,141); (8,142); (8,143); (8,144)	Invalid Function Id			
2049	801	Number of Function IDs out of allowed range	FID_INVALID_N_FUNC_ID	TM(1,8)	(8,140) (8,141) (8,142) (8,143) (8,144)	Parameter Number of FCtID read from the			

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
						packet			
2050	802	The contents of the parameter field is inconsistent withthe packet length	FID_FUNC_ID_LEN_DISCREP	TM(1,8)	(8,140) (8,141) (8,142) (8,143) (8,144)	Parameter "Number of functions" value	Computed number of functions in the packet		
2055	807	function execution failed	FID_FUNCTION_FAIL	TM(1,8)	(8,1)	function ID	status		
2056	808	attempt to execute disabled function	FID_FUNCTION_DIS	TM(1,8)	(8,1)	function ID			
2304	900	time synchronisation failed	FID_TIME_SYNC_FAIL	TM(1,8)	(9,133)				
2305	901	time setting in OBC CSW failed	FID_TIME_SET_FAIL	TM(1,8)	(9,128)				
2819	B03	Invalid number of source sequence counts (=0)	FID_MTLOPS_INVALID_NB_SSC	TM(1,8)	(11,5) (11,7) (11,9) (11,12) (151,5) (151,7) (151,9) (151,12)				
2820	B04	SSC overflow	FID_MTLOPS_SSC_OVERFLOW	TM(1,8)	(11,5) (11,7) (11,9) (11,12) (151,5) (151,7) (151,9) (151,12)	Start SSC	Number of SSCs		
2821	B05	Tags are inconsistent (BETWEEN and Tag1>Tag2)	FID_MTLOPS_INVALID_TAG_RA NGE	TM(1,8)	(11,6) (11,8) (11,11) (11,14) (151,6) (151,8) (151,11) (151,14)	coarse OBT (MTL) or Orbit Number (OPS) of Tag 1	filler (uint16) + fine OBT (MTL) or Orbit Angle (OPS) of Tag1	coarse OBT (MTL) or Orbit Number (OPS) of Tag2	filler (uint16)+ fine OBT (MTL) or Orbit Angle (OPS) of Tag2
2822	B06	TC length is not consistent with the headers of the included TCs	FID_TC_LENGTH_DISCREP	TM(1,8)	(11,4) (148,128) (151,4)	nb of TCs in the TC	index of the TC whose insertion fails		

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
2823	B07	Tag is too early	FID_MTLOPS_TAG_EXPIRED	TM(1,8)	(11,4) (11,7) (11,8) (11,15) (151,4) (151,7) (151,8) (151,15)	coarse OBT (MTL) or Orbit Number (OPS) of failed tagged TC	filler (uint16) + fine OBT (MTL) or Orbit Angle (OPS) of failed tagged TC		
2824	B08	No more control block in MTL/OPS	FID_MTLOPS_SCH_OVERFLOW	TM(1,8)	(11,4) (151,4)	current number of stored tagged TCs in MTL/OPS	total number of blocks in MTL/OPS	number of blocks needed for the TC treatment	
2825	B09	Tagged TC's Tag + Offset is overflow	FID_MTLOPS_TAG_OVERFLOW	TM(1,8)	(11,7) (11,8) (11,15) (151,7) (151,8) (151,15)				
2826	B0A	TC source ID is not valid	FID_MTLOPS_INVALID_SRC_ID	TM(1,8)	(11,4) (151,4)	TC source ID	received number of selection criteria sets		
2827	B0B	No TC found in the specified range	FID_MTLOPS_NO_TC_FOUND	TM(1,8)	(11,7) (11,8) (11,9) (11,12) (11,14) (151,5) (151,6) (151,7) (151,8) (151,9) (151,12) (151,14)	to be deleted ? not iline with CSHS 1.5 i1.2p77			
2828	B0C	Range type is not valid	FID_MTLOPS_INVALID_RANGE_TYPE	TM(1,8)	(11,6) (11,8) (11,11) (11,14) (151,6) (151,8)	range type			

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
					(151,11) (151,14)				
2829	B0D	TC to be inserted is either TC(11,4) or TC(OPS,4)	FID_MTLOPS_FORBIDDEN_TC	TM(1,8)	(11,4) (151,4)	filler (uint16) + type(uint8) + subtype (uint8)			
2830	B0E	N1, Sub-schedule ID and N2 are not consistent	FID_MTLOPS_INVALID_SUBSET	TM(1,8)	(11,1) (11,2) (11,6) (11,8) (11,11) (11,14) (151,1) (151,2) (151,6) (151,8) (151,11) (151,14)	number of sub-schedule IDs (N1)	number of PIDs (N2)		
2831	B0F	Invalid Sub-schedule ID (=0)	FID_MTLOPS_INVALID_SSID	TM(1,8)	(11,4) (151,4)				
2832	B10	MTL/OPS is globally enabled	FID_MTLOPS_SERVICE_ENABLED	TM(1,8)	(11,3) (151,3)				
3073	C01	amount of monitoring identifiers not in line with N parameter	FID_MON_ID_LEN_DISCREP	TM(1,8)	(12,1) (12,2) (12,5) (12,6) (12,7)	received N	received number of monitoring identifiers		
3074	C02	monitoring identifier is not defined	FID_UNKNOWN_MON_ID	TM(1,8)	(12,1) (12,2) (12,6) (12,7)	index (1 to N) of unknown monitoring ID	received value of affected parameter		
3075	C03	Attempt to assign a 64-bit float type on an expected Value check	FID_MON_FLOAT64_INVALID	TM(1,8)	(12,5)	Param ID			
3079	C07	monitoring identifier out of	FID_INVALID_MON_ID	TM(1,8)	(12,5)	index (1 to	received value		

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
		allowed range				N) of affected parameter set in the TC	of affected parameter		
3080	C08	monitoring parameter identifier is not defined	FID_UNKNOWN_MON_PAR_ID	TM(1,8)	(12,5)	index (1 to N) of affected parameter set in the TC	received value of affected parameter		
3081	C09	validity parameter is not defined	FID_UNKNOWN_VAL_PAR	TM(1,8)	(12,5)	index (1 to N) of affected parameter set in the TC	received value of affected parameter		
3084	C0C	repetition interval out of allowed range	FID_INVALID_REP_INTERVAL	TM(1,8)	(12,5)	index (1 to N) of affected parameter set in the TC	received value of affected parameter		
3085	C0D	Check interval out of allowed range	FID_INVALID_MON_INTERVAL	TM(1,8)	(12,5)	index (1 to N) of affected parameter set in the TC	received value of affected parameter		
3087	C0F	check type out of allowed range	FID_INVALID_CHK_TYPE	TM(1,8)	(12,5)	index (1 to N) of affected parameter	received value of affected parameter (upper 16bit		

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
						set in the TC	used for NOL, lower 16 bit used for NOE)		
3088	C10	selected event identifier is not defined	FID_UNKNOWN_MON_EID	TM(1,8)	(12,5) (12,7)	index (1 to N) of affected parameter set in the TC	received value of affected parameter		
3090	C12	too many monitoring ID's defined	FID_MON_LIST_OVERFLOW	TM(1,8)	(12,5)	index (1 to N) of affected parameter set in the TC	number of defined monitoring ID's		
3091	C13	attempt to delete active monitoring identifier	FID_MON_ACTIVE	TM(1,8)	(12,6);	index (1 to N) of affected parameter set in the TC	monitoring ID		
3092	C14	Monitoring Status is not a valid value	FID_MON_STAT_INVALID	TM(1,8)	(12,5) (12,7)	index (1 to N) of affected parameter set in the TC	received value		
3093	C15	Attempt to modify/delete a Monitoring identifier which is associated to a currently enabled and protected Functional Monitoring	FID_MON_GLOB_ACTIVE	TM(1,8)	(12,1) (12,2) (12,5) (12,7)	index (1 to N) of affected parameter set in the TC	monitoring ID		

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
3094	C16	Monitoring ID is used	FID_MON_USED_ID	TM(1,8)	(12,4) (12,6)	index (1 to N) of affected parameter set in the TC	monitoring ID		
3095	C17	Service is locked	FID_MON_LOCKED_SERVICE	TM(1,8)	(12,2)				
3096	C18	Monitoring is enabled at service level	FID_MON_SERVICE_ENABLED	TM(1,8)	(12,4)				
3585	E01	Unknown process identifier for forwarding control	FID_UNKNOWN_FORW_PID	TM(1,8)	(14,1) (14,2) (14,5) (14,6) (14,9) (14,10) (14,13) (14,14)	received PID			
3592	E08	amount of forward control criteria not in line with N1/N2/N3 parameters	FID_FORW_DISCREP	TM(1,8)	(14,1) (14,2) (14,5) (14,6) (14,9) (14,10) (14,13) (14,14)				
3593	E09	too many forward control rules commanded	FID_FORW_OVERFLOW	TM(1,8)	(14,1) (14,2) (14,5) (14,6) (14,9) (14,10) (14,13) (14,14)	current number of rules			
3594	E0A	Invalid Type value in the TC (type = 0)	FID_FORW_INVALID_TYPE	TM(1,8)	(14,1) (14,2)	Pid on which the error occured	Value of the invalid Type		
3595	E0B	Invalid Subtype value in the TC (type = 0)	FID_FORW_INVALID_SUBTYPE	TM(1,8)	(14,1) (14,2)	Pid on which the error occured	Type on which the error occurred	Value of the invalid Subtype	
3596	E0C	invalid value in the TC (eid/sid = 0)	FID_FORW_INVALID_RID	TM(1,8)	(14,5) (14,6) (14,9) (14,10) (14,13)	Pid on which the error	Value of the invalid		

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
					(14,14)	occured	EID/SID		
3841	F01	amount of store identifiers not in line with N parameter	FID_STORE_DISCREP	TM(1,8)	(15,1) (15,2)	received N	received number of store identifiers		
3842	F02	selected store does not exist	FID_UNKNOWN_STORE_ID	TM(1,8)	(15,1) (15,2) (15,3) (15,4) (15,140) (15,141)	received store identifier			
3844	F04	Invalid PRID identifier	FID_UNKNOWN_STORE_PID		(15,3) (15,4) (15,140) (15,141)	Received PID			
3851	F0B	amount of storage control criteria not in line with N1/N2/N3 parameters or N1 out of range or invalid number of definitions	FID_STORE_DEF_DISCREP	TM(1,8)	(15,3) (15,4) (15,140) (15,141)				
3852	F0C	too many storage control rules commanded	FID_STORE_OVERFLOW	TM(1,8)	(15,3); (15,140)	current number of rules			
3853	F0D	Invalid Type value in the TC (type = 0)	FID_STORE_INVALID_TYPE	TM(1,8)	(15,3) (15,4)	PID on which the error occurred	Value of the invalid Type		
3854	F0E	Invalid Subtype value in the TC (subtype = 0)	FID_STORE_INVALID_SUBTYPE	TM(1,8)	(15,3) (15,4)	PID on which the error occurred	Type on which the error occurred	Value of the invalid Subtype	
3855	F0F	Invalid SID value in the TC (SID	FID_STORE_INVALID_SID	TM(1,8)	(15,140) (15,141)	PID on	Value of the		

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
		= 0)				which the error occurred	invalid SID		
4608	1200	OBCS ID not found	FID_UNKNOWN_PROC_ID	TM(1,8)	(148,2) (148,3) (148,4) (148,129) (148,130) (148,132) (148,133)	OBCS ID			
4609	1201	Invalid OBCS ID (=0)	FID_OBCS_ID_INVALID	TM(1,8)	(148,128)				
4610	1202	OBCS should not be active	FID_PROC_ACTIVE	TM(1,8)	(148,2) (148,3) (148,128) (148,129) (148,132) (148,133)	OBCS ID			
4611	1203	OBCS should not be inactive	FID_OBCS_INACTIVE	TM(1,8)	(148,4)	OBCS ID			
4612	1204	no more free OBCS or step block	FID_PROC_MEM_OVERFLOW	TM(1,8)	(148,128)	OBCS ID	step ID		
4613	1205	The maximum number of OBCSs have been started or there is no free element in this pool	FID_TOO_MANY_OBCS	TM(1,8)	(148,3) (148,133)	OBCS ID	nbTotalActive Proc		
4614	1206	invalid step ID	FID_PROC_STEP_INVA	TM(1,8)	(148,128) (148,129) (148,140) (148,141)	OBCS ID	step ID		
4615	1207	inconsistent step ID	FID_OBCS_STEP_INCO	TM(1,8)	(148,140) (148,141)	OBCS ID	step ID		
4616	1208	invalid Test type	FID_OBCS_INVA_TEST_TYPE	TM(1,8)	(148,140)	OBCS ID	test type		

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
4617	1209	unknown Parameter ID	FID_OBCS_UNKNOWN_PARAM	TM(1,8)	(148,140)	OBCS ID	parameter ID		
4618	120A	undefined (PID,EID) combination	FID_OBCS_UNKNOWN_EID	TM(1,8)	(148,142)	OBCS ID	EID		
4619	120B	OBCS should not be unlocked	FID_OBCS_UNLOCKED	TM(1,8)	(148,2) (148,128) (148,129)	OBCS ID			
4620	120C	OBCS should not be locked	FID_OBCS_LOCKED	TM(1,8)	(148,3) (148,133)	OBCS ID			
4621	120D	A critical OBCS is running	FID_OBCS_CRITICAL_ACTIVE	TM(1,8)	(148,3) (148,133)	OBCS ID	ID of the active critical OBCS		
4622	120E	An interlocking OBCS is running	FID_OBCS_INTERLOCK	TM(1,8)	(148,133)	OBCS ID	ID of the active interlocking OBCS		
4623	120F	TC destination PID is not equal to the PID which is processing the TC directive	FID_INVALID_DEST_ID	TM(1,8)	(148,140) (148,141) (148,142)	OBCS ID	step ID	TC source ID	
4865	1301	Event Action is enabled at service level	FID_ACT_SERVICE_ENABLED	TM(1,8)	(19,3)	received PID			
4868	1304	detection list or action TC pool overflow	FID_DETECTION_OVERFLOW	TM(1,8)	(19,1)	received PID	received EID		
4869	1305	a PID/EID combination not present in the detection list is selected for delete, enable or disable	FID_UNKNOWN_ACTION	TM(1,8)	(19,2) (19,4) (19,5) (19,130)	received PID	received EID		
4870	1306	attempt to modify or delete an active detection list entry	FID_ACTION_ACTIVE	TM(1,8)	(19,1); (19,2)	received PID	received EID		

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
4872	1308	amount of PID/EID sets not in line with N parameter	FID_NACT_LEN_DISCREP	TM(1,8)	(19,4);(19,5)	received N	received number of PID/EID sets		
4873	1309	Provided EID is forbidden Note: This FID is n/a for application not supporting functional monitoring service 142	FID_FORBIDDEN_EID	TM(1,8)	(19,1)	received PID	received EID		
32769	8001	length of parameter data not in line with NPAR parameter	FID_PAR_LENGTH_DISCREP	TM(1,8)	(140,1) (140,2) (140,4)	received NPAR	expected TC data length		
32770	8002	parameter identifier not defined	FID_UNKNOWN_PAR_ID	TM(1,8)	(140,1) (140,2) (140,4)	affected parameter ID			
32771	8003	invalid parameter type	FID_ILLEGAL_PAR_SET	TM(1,8)	(140,1)	affected parameter ID			
32772	8004	float parameter value out of allowed range	FID_INVALID_PAR_VAL	TM(1,8)	(140,1)	affected parameter ID	affected parameter value		
32773	8005	memory address to be assigned to a parameter is out of allowed range	FID_INVALID_MEM_ADDR	TM(1,8)	(140,4)	received memory address			
33537	8301	unknown Fm ID	FID_INVALID_FM_ID	TM(1,8)	(142,1) (142,2) (142,5) (142,6) (142,12) (142,13)	received fmID			
33538	8302	unknown Sm ID	FID_INVALID_SM_ID	TM(1,8)	(142,5)	received smID			
33539	8303	invalid filter received in TC	FID_INVALID_FILTER	TM(1,8)	(142,5)	received			

FID (dec)	FID (hex)	Description of detected Error	Short Name	TM Report Type	PUS Service Originator	Parameter 1 (32 bit)	Parameter 2 (32 bit)	Parameter 3 (32 bit)	Parameter 4 (32 bit)
		modify filter				filter			
36353	8E01	FMON ID does not exist	FID_FMON_UNKNOWN_ID	TM(1,8)	(142,1) (142,2) (142,6) (142,12) (142,13)	FMON ID			
36354	8E02	PMON is disabled at service level	FID_FMON_PMON_DISABLED	TM(1,8)	(142,1)				
36355	8E03	validity parameter is not defined	FID_FMON_UNKNOWN_VAL_PAR	TM(1,8)	(142,5)	validity parameter ID			
36356	8E04	(PID,EID) is not a defined combination	FID_FMON_UNKNOWN_EID	TM(1,8)	(142,5)	PID	EID		
36357	8E05	FMON combination type is invalid	FID_FMON_INVALID_TYPE	TM(1,8)	(142,5)	FMON type			
36358	8E06	The number of PMONs is invalid	FID_FMON_INVALID_NMON	TM(1,8)	(142,5)	Number of PMONs			
36359	8E07	PMON ID is not defined	FID_FMON_UNKNOWN_PMON	TM(1,8)	(142,5)	PMON ID			
36360	8E08	Expected Check Sate is invalid	FID_FMON_INVALID_STATE	TM(1,8)	(142,5)	Expected Check Sate			
36361	8E09	invalid FMON ID	FID_FMON_INVALID_ID	TM(1,8)	(142,5)	invalid FMON ID			
36362	8E0A	FMON ID is protected	FID_FMON_PROTECTED_ID	TM(1,8)	(142,5) (142,6)	FMON ID			
36363	8E0B	maximum number of defined FMON IDs has already been reached for that PID	FID_FMON_MAX_NB	TM(1,8)	(142,5)	PID			

Table B2-10: Common Fault Identifiers (FID)

Note: Fault identifiers are finally defined by the SW supplier of the individual applications. The given list shall be applied to the maximum extend possible, however it is not considered exhaustive. The final applicable FID's are given in the TM/TC ICD resp. User Manuals of the individual software or equipment/instrument applications.

B2.10 Common Event Identifiers (EID)

The Event ID (EID) allocated of Service(5,x) reports from the different Applications shall be as follows:

Gravity	TM	Description
Normal	TM(5,1)	Normal progress report
Low	TM(5,2)	Low error anomaly report
Medium	TM(5,3)	Medium error anomaly report
High	TM(5,4)	High error anomaly report

EID 5,1	Event	EID 5,2	Event	EID 5,3	Event	EID 5,4	Event	Group
0x0000		0x4000		0x8000		0xC000		reserved
0x0001		0x4001		0x8001		0xC001		Boot S/W Events (fix allocation)
0x0002		0x4002		0x8002		0xC002		
…..		…..		…..		…..		
0x001E		0x401E		0x801E		0xC01E		
0x001F		0x401F		0x801F		0xC01F		
0x0020		0x4020		0x8020		0xC020		General Application S/W Events
0x0021		0x4021		0x8021		0xC021		
…..		…..		…..		…..		
0x041E		0x441E		0x841E		0xC41E		
0x041F		0x441F		0x841F		0xC41F		
0x0420		0x4420		0x8420		0xC420		Specific Application SW Events
0x0421		0x4421		0x8421		0xC421		
…..		…..		…..		…..		
0x141E		0x541E		0x941E		0xD41E		
0x141F		0x541F		0x941F		0xD41F		
0x1420		0x5420		0x9420		0xD420		Events from unexpected S/W and H/W Errors
0x1421		0x5421		0x9421		0xD421		
…..		…..		…..		…..		
0x149E		0x549E		0x949E		0xD49E		
0x149F		0x549F		0x949F		0xD49F		

0x14A0	Normal Monitoring Events	0x54A0	Low Severity Monitoring Events	0x94A0	Medium Severity Monitoring Events	0xD4A0	High Severity Monitoring Events	S12 Parameter Monitoring Events
0x14A1		0x54A1		0x94A1		0xD4A1		
…..		…..		…..		…..		
0x26FF		0x66FF		0xA6FF		0xE6FF		
0x2700	CHDS	0x6700		0xA700		0xE700		
…..		…..		…..		…..		
0x27FF		0x67FF		0xA7FF		0xE7FF		
0x2800	Normal Monitoring Events	0x6800		0xA800		0xE800		S142 Parameter Monitoring Events
…..								
0x349E		0x749E		0xB49E		0xF49E		
0x349F		0x749F		0xB49F		0xF49F		
0x34A0		0x74A0		0xB4A0		0xF4A0		OBCP Events
0x34A1		0x74A1		0xB4A1		0xF4A1		
…..		…..		…..		…..		
0x3EFE		0x7EFE		0xBEFE		0xFEFE		
0x3EFF		0x7EFF		0xBEFF		0xFEFF		
0x3F00		0x7F00		0xBF00		0xFF00		ESOC
0x3F01		0x7F01		0xBF01		0xFF01		
…..		…..		…..		…..		
0x3FFD		0x7FFD		0xBFFD		0xFFFD		
0x3FFE		0x7FFE		0xBFFE		0xFFFE		
0x3FFF		0x7FFF		0xBFFF		0xFFFF		reserved

Table B2-11: Event ID allocation list

Severity	TM	Description
Normal	TM(5,1)	Normal progress report
Low	TM(5,2)	Low error anomaly report
Medium	TM(5,3)	Medium error anomaly report
High	TM(5,4)	High error anomaly report

Check status	
0	Expected value / within limits
1	Unchecked
2	Invalid
4	Unexpected / below low limit
5	Above high limit

B2.11 Common Memory Identifiers (MemID)

The different Memory types of an equipment shall be addressed via Memory IDs (MemID). The MemID is represented at the begin of the packet datafield by 2 Bytes. The following MemIDs shall be used:

Memory ID „Unit A" (HEX)	Memory ID „Unit B" (HEX)	Memory Description	SAU [bit] (dec)	MUL (dec)
1	Unit A + 100_{HEX}	PROM	8	1
2	Unit A + 100_{HEX}	PROM	16	2
3	Unit A + 100_{HEX}	PROM	32	4
11	Unit A + 100_{HEX}	EEPROM	8	1
12	Unit A + 100_{HEX}	EEPROM	16	2
13	Unit A + 100_{HEX}	EEPROM	32	4
21	Unit A + 100_{HEX}	Processor RAM	8	1
22	Unit A + 100_{HEX}	Processor RAM	16	2
23	Unit A + 100_{HEX}	Processor RAM	32	4
31	Unit A + 100_{HEX}	SGM RAM	8	1
32	Unit A + 100_{HEX}	SGM RAM	16	2
33	Unit A + 100_{HEX}	SGM RAM	32	4
41	Unit A + 100_{HEX}	SGM EEPROM	8	1
42	Unit A + 100_{HEX}	SGM EEPROM	16	2
43	Unit A + 100_{HEX}	SGM EEPROM	32	4
for individual use		for individual use		

Definition:

- o The SAU is the "Smallest Addressable Unit" of a memory area, it can be 8 bit, 16 bit or 32 bit.
- o The MUL defines the "Address MULtiplier", it is the address increment needed to jump from one addressed SAU to the next following.

Nominally unit A and B use the same MemIDs, i.e. the unit A or B is selected by APID and always the same MemIDs are used for the active unit.

In case of cross memory access between redundant cross-coupled units, the MemIDs are related to the PHYSICAL Unit. In this case the memory on the Unit A shall use the MemIDs range from 1 to 255_{dec} (LSByte) and the memory on the Unit B shall use MemIDs from (257) until (511) (i.e. MSByte=1 plus MemID of Unit A).

Note: it is not required to implement all above Mem-IDs, but only the MUL/SAU combination applicable to the related HW. (e.g. Mem-ID 33 for 32 bit interfaces to the memory.)

B2.11.1 DMS specific Memory ID Definition

The following MemID Allocation and the related Service 6 usage shall be implemented by the CSW for the DMS application. They are related to physical OBC Memories on PM A and PM B as well as to logical memory partitions inside the physical memories:

PM A MemID (HEX)	PM B MemID (HEX)	Memory Description as detailed in [RD-8] table 6-1	Size	Physical address range Byte based as per [RD-8] table 6-1 (from address to address)	SAU [bit] (dec)	MUL (dec)	Logical address range SAU based as used by Service 6 (from address to address)	Service (6,2) Patch	Service (6,5)+(6,6) Dump	Service (6,9) CheckSum
		DMS-PRID								
0x003	**0x103**	**PROM** (BSW image)	64 KiB	0x0000_0000 0x0000_FFFF	**32**	**4**	0x0000_0000 0x0000_3FFF	**No**	Yes	Yes
0x013	**0x113**	**PM EEPROM Bank 0+1** (CSW image)	4 MiB	0x0080_0000 0x00BF_FFFF	**32**	**4**	0x0000_0000 0x000F_FFFF	Yes	Yes	Yes
0x023	**0x123**	**Processor RAM**	8 MiB	0x0200_0000 0x027F_FFFF	**32**	**4**	0x0000_0000 0x001F_FFFF	Yes	Yes	Yes
0x050	**0x150**	**ERC32SC System Register**[1]	512 KiB	0x01F8_0000 0x01FF_FFFF	**32**	**4**	0x0000_0000 0x0001_FFFF	**No**	Yes	Yes
0x051	**0x151**	**COCOS internal register**[2] (ERC32 I/O area 0)	128 KiB	0x1000_0000 0x1001_FFFF	**32**	**4**	0x0000_0000 0x0000_7FFF	Yes	Yes	Yes
0x052	**0x152**	**Outport/Power Register**[3] (ERC32 I/O area 1)	512 Byte	0x1100_0000 0x1100_01FF	**32**	**4**	0x0000_0000 0x0000_007F	Yes	Yes	Yes
0x053	**0x153**	**Communication RAM** (COCOS Map Page 1)	2 MiB	0x2400_0000 0x241F_FFFF	**32**	**4**	0x0000_0000 0x0007_FFFF	Yes	Yes	Yes

Table B2-12: Memory IDs of OBC Processor Module by DMS-PRID

General Note: Service 6 is only intended for maintenance. Writing to memory, which is in use by the CSW, may lead to unexpected software behaviour. Access of registers shall exclusively be allowed after consultaion of industry experts; it is not part of normal memory management.

Note A: The **Active OBC Processor Module** (e.g. **PM A** or **PM B**) may access **directly** the **TTR A and TTR B** memory areas.

Note B: The **Active OBC Processor Module** (e.g. **PM A** or **PM B**) may access **via interprocessor link** the following memories of the other OBC Processor Module (e.g. **PM B** or **PM A**) in service mode: PROM, PM EEPROM, PM RAM.

[1] **Attention:** Accessing addresses not listed in the OBC HW/SW ICD [RD-8] "ERC32 System Registers" address map will lead to unexpected SW behaviour.

[2] Accessing clear-on-read registers (e.g. COCOS PIR) may cause side effects. For details of the COCOS registers see OBC HW/SW ICD [RD-8].

[3] The Output Register is only 4 Byte. But as the addressable memory area is 512 Byte all logical addresses are mapped on this single register.

PM TTR A MemID (HEX)	PM TTR B MemID (HEX)	Memory Description as detailed in [RD-8] table 6-35	Size	Physical address range Byte based as per [RD-8] table 6-1 (from address to address)	SAU [bit] (dec)	MUL (dec)	Logical address range SAU based as used by Service 6 (from address to address)	Service (6,2) Patch	Service (6,5)+(6,6) Dump	Service (6,9) CheckSum
		DMS-PRID								
0x033	**0x133**	**SGM RAM bank 1**	256 KiB	0x0300_8000 0x0304_7FFF	**32**	**4**	0x0000_0000 0x0000_FFFF	Yes	Yes	Yes
0x034	**0x134**	**SGM RAM bank 2**	256 KiB	0x0304_8000 0x0308_7FFF	**32**	**4**	0x0000_0000 0x0000_FFFF	Yes	Yes	Yes
0x043	**0x143**	**SGM EEPROM bank 1**	128 KiB	0x0102_0000 0x0103_FFFF	**32**	**4**	0x0000_0000 0x0000_7FFF	Yes	Yes	Yes
0x044	**0x144**	**SGM EEPROM bank 2**	128 KiB	0x0200_0000 0x0201_FFFF	**32**	**4**	0x0000_0000 0x0000_7FFF	Yes	Yes	Yes
0x070	**0x170**	**OBC Mass Memory**[4]	2 GiB	0x0000 0000 0x7FFF FFFF	**32**	**4**	0x0000 0000 0x7FFF FFFF	Yes	Yes	Yes
0x060	**0x160**	**RM EEPROM bank 0**	128 KiB	0x0100_0000 0x0101_FFFF	**32**	**4**	0x0000_0000 0x0000_7FFF	Yes	Yes	Yes
0x061	**0x161**	**EEPROM bank 3**	128 KiB	**N.A.**	**32**	**4**	**N.A.**	No	No	No
0x062	**0x162**	**CROME SRAM**	32 KiB	0x0300_0000 0x0300_7FFF	**32**	**4**	0x0000_0000 0x0000_1FFF	Yes	Yes	Yes
0x063	**0x163**	**TME buffer**	180 KiB	0x0308_8000 0x030B_4FFF	**32**	**4**	0x0000_0000 0x0000_B3FF	No	Yes	Yes
0x064	**0x164**	**HAMSTER internal Registers**	32 KiB	0x0400_0000 0x0400_7FFF	**32**	**4**	0x0000_0000 0x0000_1FFF	Yes	Yes	Yes
0x065	**0x165**	**CROME Registers**	128 KiB	0x0700_0000 0x0701_FFFF	**32**	**4**	0x0000_0000 0x0000_7FFF	Yes	Yes	Yes
0x066	**0x166**	**TTR PROM Cartridge**	32 KiB	0x0000_0000 0x0000_7FFF	**32**	**4**	0x0000_0000 0x0000_1FFF	No	Yes	Yes

Table B2-13: Memory IDs of OBC TTR-Board by DMS-PRID

[4] Although the OBC Mass Memory is accessible in terms of service 6 TCs, this should only be used in case of OBC-MM-Maintenance. It is recommended to use Service 15 for all nominal operations.

The following logical MemID Allocation shall be implemented by the CSW for the DMS+MSIC application. They are related to logical memory partitions inside the running Processor RAM:

PM A MemID (HEX)	PM B MemID (HEX)	Memory Description	Size	Physical address range Byte based as per [RD-8] table 6-1 (from address to address)	SAU [bit] (dec)	MUL (dec)	Logical address range SAU based as used by Service 6 (from address to address)	Service (6,2) Patch	Service (6,5)+(6,6) Dump	Service (6,9) CheckSum
		DMS-PRID								
0x080	**0x080**	**MSI-Table: NUC-Table**	2.115.384 Bytes	Memory address assigned at compilation time.	**16**	**2**	0x0000_0000 0x0010_239B	**Yes**	**Yes**	**Yes**
0x081	**0x081**	**MSI-Table: WICOM-Table**	4.608 Bytes	Memory address assigned at compilation time.	**16**	**2**	0x0000_0000 0x0000_08FF	**Yes**	**Yes**	**Yes**
		MSIC-PRID (for Maintenance only)								
0x082	**0x082**	**VCU MEM: EEPROM**	1.572.864 Bytes	VCU EEPROM address 0x0008_0000 0x001F_FFFF	**16**	**2**	0x0000_0000 0x000B_FFFF	No[5]	**Yes**	No
0x083	**0x083**	**VCU MEM: SRAM**	131.072 Bytes	VCU SRAM address 0x0000_0000 0x0001_FFFF	**16**	**2**	0x0000_0000 0x0000_FFFF	No[6]	**Yes**	No

Table B2-14: Memory IDs of DMS+MSIC logical partitions

Note: The logical DMS memory partitions do not distinguish between PM A and PM B. They address always the running PM.

[5] Implemented by Low-Level Service 2 commanding. PUS-Packet-TC not feasable, since the required size of 256 Bytes (4 full messages to VCU EEPROM) is bigger than a max.size PUS-Packet-TC.

[6] Implemented by Low-Level Service 2 commanding.

B2.11.2 MMFU specific Memory ID Definition

MMFU A MemID (HEX)	MMFU B MemID (HEX)	Memory Description	Size	SAU [bit] (dec)	MUL (dec)	Service (6,2) Patch	Service (6,5)+(6,6) Dump	Service (6,9) CheckSum
0x003	**0x003**	PROM (BSW image)	64 KiB	**8**	**1**	**No**	Yes	Yes
0x013	**0x013**	EEPROM (ASW image)	1 MiB	**8**	**1**	Yes	Yes	Yes
0x023	**0x023**	Processor RAM	4 MiB	**8**	**1**	Yes	Yes	Yes
0x070	**0x070**	FMM0 (no parity)	1 GiB	**512*8**	**512**	Yes	Yes	Yes
0x071	**0x071**	FMM1 (no parity)	1 GiB	**512*8**	**512**	Yes	Yes	Yes
0x072	**0x072**	FMM2 (no parity)	1 GiB	**512*8**	**512**	Yes	Yes	Yes
0x080	**0x080**	FMM0 (with parity)	1 GiB	**(512+64) *8**	**512**	No	Yes	Yes
0x081	**0x081**	FMM1 (with parity)	1 GiB	**(512+64) *8**	**512**	No	Yes	Yes
0x082	**0x082**	FMM2 (with parity)	1 GiB	**(512+64) *8**	**512**	No	Yes	Yes

Table B2-15: Memory IDs of MMFU

Note 1:
For PROM, EEPROM and Processor RAM a single MemID is defined, i.e. the MMFU A or B is selected by APID and always the same MemIDs are used for the active Processor.

Note 2:
FMM0, FMM1, FMM2 can be accessed from both MMFU Cores (A or B).

B3. PUS GENERIC SERVICE/SUBSERVICE ALLOCATION

The on-board applications are abbreviated as follows in the sub-sequent tables of this chapter.

S … **SYCT** (System Control) APID
D … **DMS** (Data Management System) APID
A … **AOCS** APID
PF … **PFCT** (Platform Control) APID
PL … **PLCT** (Payload Control) APID
M … **MSIC** (MSI Control) APID

GPS … GPR-Receiver APID
MMFU … Mass Memory and Foramting Unit APID
STR … Startracker APID
LCT … Laser Comunication Terminal APID

The following tables define the applicability of the PUS-Services for each APID.

B3.1 Service 1: Telecommand Verification Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(1,1)	TM	Telecommand Acceptance Report – Success	X	X	X	X	X	X	X	X	X	X
(1,2)	TM	Telecommand Acceptance Report – Failure	X	X	X	X	X	X	X	X	X	X
(1,3)	TM	Telecommand Execution Started Report – Success										
(1,4)	TM	Telecommand Execution Started Report – Failure										
(1,5)	TM	Telecommand Execution Progress Report – Success										
(1,6)	TM	Telecommand Execution Progress Report – Failure										
(1,7)	TM	Telecommand Execution Completion Report – Success	X	X	X	X	X	X	X	X	X	X
(1,8)	TM	Telecommand Execution Completion Report – Failure	X	X	X	X	X	X	X	X	X	X

Table B3-1: Service 1 sub-services

B3.2 Service 2: Device Command Distribution Service

Service, Subservice	TM/ TC	Description	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(2,1)	TC	Distribute ON/OFF Commands										
(2,2)	TC	Distribute Register Load Commands		X								
(2,3)	TC	Distribute CPDU Commands		X								
(2,128)	TC	Distribute MIL-1553 Low-Level Command		X								
(2,129)	TM	MIL-1553 Low-Level Command Response		X								
(2,130)	TC	Distribute SpW-1355 Low-Level Command										
(2,131)	TM	SpW-1355 Low-Level Command Response										
(2,132)	TC	Direct I/O		X								
(2,133)	TM	Direct I/O Response		X								

Table B3-2: Service 2 sub-services

B3.3 Service 3: Housekeeping and Diagnostic Data Reporting Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(3,1)	TC	Define new HK Parameter Report	X	X	X	X	X	X				
(3,2)	TC	Define new Diagnostic Parameter Report	X	X	X	X	X	X				X
(3,3)	TC	Clear HK Parameter Report Definitions	X	X	X	X	X	X				
(3,4)	TC	Clear Diagnostic Parameter Report Definitions	X	X	X	X	X	X				X
(3,5)	TC	Enable HK Parameter Report Generation	X	X	X	X	X	X		X	X	X
(3,6)	TC	Disable HK Parameter Report Generation	X	X	X	X	X	X		X	X	X
(3,7)	TC	Enable Diagnostic Parameter Report Generation	X	X	X	X	X	X			X	X
(3,8)	TC	Disable Diagnostic Parameter Report Generation	X	X	X	X	X	X			X	X
(3,9)	TC	Report HK Parameter Report Definitions	X	X	X	X	X	X		X		X
(3,10)	TM	HK Parameter Report Definitions Report	X	X	X	X	X	X		X		X
(3,11)	TC	Report Diagnostic Parameter Report Definitions	X	X	X	X	X	X				X
(3,12)	TM	Diagnostic Parameter Report Definitions Report	X	X	X	X	X	X				X
(3,25)	TM	Housekeeping Parameter Report	X	X	X	X	X	X	X*	X	X	X
(3,26)	TM	Diagnostic Parameter Report	X	X	X	X	X	X			X	X
(3,128)	TC	Report HK/Diag Parameter Report Definitions in Summary Form	X	X	X	X	X	X		X	X	
(3,129)	TM	HK/Diag Parameter Definitions Report in Summary Form	X	X	X	X	X	X		X	X	
(3,130)	TC	Define HK Parameter Report Collection Interval	X	X	X	X	X	X		X	X	X
(3,131)	TC	Define Diagnostic Parameter Report Collection Interval	X	X	X	X	X	X			X	X
(3,136)	TC	Request HK Parameter Report	X	X	X	X	X	X		X	X	
(3,138)	TC	Add HK Parameters to existing HK Parameter Report	X	X	X	X	X	X				
(3,139)	TC	Request Snapshot HK Parameter Anomaly Report	X	X	X	X	X	X				

Table B3-3: Service 3 sub-services

*Note: GPS uses a specific layout for service 3 (see chapter B3.23.1)

B3.4 Service 4: Parameter Statistics Reporting Service

Not applicable for Sentinel-2.

B3.5 Service 5: Event Reporting Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(5,1)	TM	Normal/Progress Report	X	X	X	X	X	X	X	X	X	X
(5,2)	TM	Error/Anomaly Report -- Low Severity	X	X	X	X	X	X	X	X	X	X
(5,3)	TM	Error/Anomaly Report – Medium Severity	X	X	X	X	X	X	X	X	X	X
(5,4)	TM	Error/Anomaly Report – High Severity	X	X	X	X	X	X	X	X	X	X
(5,5)	TC	Enable Event Packet Generation	X	X	X	X	X	X		X	X	X
(5,6)	TC	Disable Event Packet Generation	X	X	X	X	X	X		X	X	X
(5,128)	TC	Clear System Log		X								
(5,129)	TC	Downlink the System Log		X								
(5,130)	TM	System Log Event occurrence table Report		X								
(5,131)	TC	Report Enabled Event Packets										
(5,132)	TC	Enabled Event Packets Report										
(5,133)	TC	Report Disabled EID's	X	X	X	X	X	X		X	X	X
(5,134)	TM	Disabled EID's Report	X	X	X	X	X	X		X	X	X

Table B3-4: Service 5 sub-services

Note: GPS uses private subservices for service 5 (see chapter B3.23.2)

B3.6 Service 6: Memory Management Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(6,2)	TC	Load Memory using Absolute Addresses		X					*	X	X	X
(6,5)	TC	Dump Memory using Absolute Addresses		X				X	*	X	X	X
(6,6)	TM	Memory Dump using Absolute Addresses Report		X				X	*	X	X	X
(6,9)	TC	Check Memory using Absolute Addresses		X					*	X	X	X
(6,10)	TM	Memory Check Report using Absolute Addresses		X					*	X	X	X

Table B3-5: Service 6 sub-services

* Note: GPS uses private subservices for service 6 (see chapter B3.23.3)

B3.7 Service 8: Function Management Service

Service, Subservice	TM/ TC	Description	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(8,1)	TC	Perform Function	X	X	X	X	X	X		X	X	X
(8,128)	TM	Downlink MSI-Tables						X				
(8,140)	TC	Enable Function Execution	X	X	X	X	X	X		X		X
(8,141)	TC	Disable Function Execution	X	X	X	X	X	X		X		X
(8,142)	TC	Enable Function Arming	X	X	X	X	X	X		X		X
(8,143)	TC	Disable Function Arming	X	X	X	X	X	X		X		X
(8,144)	TC	Report Function Status	X	X	X	X	X	X		X		X
(8,145)	TM	Function Status Report	X	X	X	X	X	X		X		X
(8,220)	TC	Manage long duration cmds									X	

Table B3-6: Service 8 sub-services

B3.8 Service 9: Time Management Service

Service, Subservice	TM/ TC	Description	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(9,1)	TC	Change Time Report Generation Rate		X								
(9,2)	TM	Time/OP Report		X								
(9,128)	TC	Set Central OBT		X								
(9,130)	TC	Set Orbit Number		X								
(9,133)	TC	Enable Synchronization of GPS to OBC time		X								
(9,134)	TC	Disable Synchronization of GPS to OBC time		X								
(9,135)	TC	Trigger Time Synchronisation Verification								X	X	X
(9,136)	TC	Select Time Synchronization Reference								X	X	

Table B3-7: Service 9 sub-services

B3.9 Service 11: On Board Operations Scheduling

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(11,1)	TC	Enable Release of Telecommands		X								
(11,2)	TC	Disable Release of Telecommands		X								
(11,3)	TC	Reset Command Schedule		X								
(11,4)	TC	Insert Telecommands in Command Schedule		X								
(11,5)	TC	Delete Telecommands		X								
(11,6)	TC	Delete Telecommands over Time Period		X								
(11,7)	TC	Time-Shift selected Telecommands		X								
(11,8)	TC	Time-Shift selected Telecommands over Time Period		X								
(11,9)	TC	Report Subset of Command Schedule in Detailed Form		X								
(11,10)	TM	Detailed Schedule Report		X								
(11,11)	TC	Report Subset of Command Schedule in Detailed Form over Time Period		X								
(11,12)	TC	Report Subset of Command Schedule in Summary Form		X								
(11,13)	TM	Summary Schedule Report		X								
(11,14)	TC	Report Subset of Command Schedule in Summary Form over Time Period		X								
(11,15)	TC	Time-Shift all Time Tagged Telecommands		X								
(11,16)	TC	Report Command Schedule in Detailed Form		X								
(11,17)	TC	Report Command Schedule in Summary Form		X								
(11,18)	TC	Report Status of Command Schedule		X								
(11,19)	TM	Command Schedule Status Report		X								

Table B3-8: Service 11 sub-services

B3.10 Service 12: On Board Parameter Monitoring

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(12,1)	TC	Enable Monitoring of Parameters	X	X	X	X	X	X				X
(12,2)	TC	Disable Monitoring of Parameters	X	X	X	X	X	X				X
(12,3)	TC	Change Maximum Reporting Delay										
(12,4)	TC	Clear Monitoring List	X	X	X	X	X	X				X
(12,5)	TC	Add/Modify Parameters to/in Monitoring List	X	X	X	X	X	X				X
(12,6)	TC	Delete Parameters from Monitoring List	X	X	X	X	X	X				X
(12,7)	TC	Modify Parameter Checking Information	X	X	X	X	X	X				
(12,8)	TC	Report Current Monitoring List	X	X	X	X	X	X				X
(12,9)	TM	Current Monitoring List Report	X	X	X	X	X	X				X
(12,10)	TC	Report Current Parameters Out-of-limit List	X	X	X	X	X	X				X
(12,11)	TM	Current Parameters Out-of-limit List Report	X	X	X	X	X	X				X
(12,12)	TM	Check Transition Report										

Table B3-9: Service 12 sub-services

B3.11 Service 13: Large Data Transfer

Not applicable for Sentinel-2.

B3.12 Service 14: Packet Forwarding Control Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(14,1)	TC	Enable Forwarding of Telemetry Source Packets		X								
(14,2)	TC	Disable Forwarding of Telemetry Source Packets		X								
(14,5)	TC	Enable Forwarding of Housekeeping Packets		X								
(14,6)	TC	Disable Forwarding of Housekeeping Packets		X								
(14,7)	TC	Report Enabled Housekeeping Packets		X								
(14,8)	TM	Enabled Housekeeping Packets Report		X								
(14,9)	TC	Enable Forwarding of Diagnostic Packets		X								
(14,10)	TC	Disable Forwarding of Diagnostic Packets		X								
(14,11)	TC	Report Enabled Diagnostic Packets		X								
(14,12)	TM	Enabled Diagnostic Packets Report		X								
(14,13)	TC	Enable Forwarding of Event Report Packets		X								
(14,14)	TC	Disable Forwarding of Event Report Packets		X								
(14,128)	TC	Report Telemetry Source Packet Forwarding Status		X								
(14,129)	TM	Telemetry Source Packet Forewarding Status Report		X								
(14,130)	TC	Report Event Report Packet Forwarding Status		X								
(14,131)	TM	Event Report Packet Forwarding Status Report		X								

Table B3-10: Service 14 sub-services

B3.12.1 Service 14: Packet Forwarding Table Reconstruction

Applying the following algorithm allow to reconstruct the fully populated packet routing tables for RT (i.e. service 14) according to ECSS E-70-41 from the Astrium CDHS service 14 TM reports:

Prerequisites to start the packet routing table reconstruction algorithm:
The following TM packets are available:

- TM (14,129): Telemetry Source Packet Forwarding Status
- TM (14,8): Enabled Housekeeping Packets Report
- TM (14,9): Enabled Diagnostic Packets Report
- TM (14,131): Event Report Packet Forwarding Status Report

1. Construct the basic packet forwarding table
    a. Extract from the PID table of the SRDB the colums PID_PID; PID_CAT, PID_TYPE, PID_STYPE, PID_P1VAL, PID_P2VAL, PID_SPID, PID_DESCR
    b. Sort the content of these columns according PID_PID, PID_TYPE, PID_STYPE, PID_P1VAL, PID_P2VAL
    c. Add one column for the RT channel with empty cells
2. Start to process TM (14,129): Telemetry Source Packet Forwarding Status
3. Read one entry of TM (14,129): Telemetry Source Packet Forwarding Status giving the basic RT routing for the first PID
4. For all packets matching the condition PID_PID=PRID mark the cells
5. Read the next entry of TM (14,129): Telemetry Source Packet Forwarding Status giving the dedicated routing for the first type/sub-type combination not following the general rule established for the PID
6. For all packets matching the condition PID_PID=PRID .AND PID_TYPE=TYPE and PID_STYPE=SUBTYPE AND FSTAT=DISABLED remove the existing marks.
7. repeat 5 and 6 until all routing definitions of one PID are processed
8. repeat 3 to 7 until all PRID's are processed
9. Start to process TM (14,8): Enabled Housekeeping Packets Report
10. Read one entry of TM (14,8): Enabled Housekeeping Packets Report giving the dedicated routing rule of a particular SID of one PID
11. Search the row which matches the conditions PID_PID=PRID .AND. PID_TYPE=3 . AND. PID_P1VAL=SID . AND. FSTAT=DISABLED and remove the existing marks
12. repeat 10 to 11 until all PRID's are processed
13. Start to process TM (14,9): Enabled Diagnostic Packets Report
14. Read one entry of TM (14,9): Enabled Diagnostic Packets Report giving the dedicated routing rule of a particular SID of one PID
15. Search the row which matches the conditions PID_PID=PRID .AND. PID_TYPE=3 . AND. PID_P1VAL=SID . AND. FSTAT=DISABLED and remove the existing marks
16. repeat 14 to 15 until all PRID's are processed
17. Start to process TM (14,131): Event Report Packet Forwarding Status Report
18. Read one entry of TM (14,131): Event Report Packet Forwarding Status Report giving the dedicated routing rule of a particular Event ID (EID) of one PID
19. Search the row which matches the conditions PID_PID=PRID .AND. PID_TYPE=5 . AND. PID_P1VAL=EID . AND. FSTAT=DISABLED and remove the existing marks
20. repeat 18 to 19 until all PRID's are processed
21. Extract the sub-tables matching the report definitions of ECSS-E-70-41.

B3.13 Service 15: On Board Storage and Retrieval

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(15,1)	TC	Enable Storage in Packet Stores		X								
(15,2)	TC	Disable Storage in Packet Stores		X								
(15,3)	TC	Add Packet Types & Sub-Types to Storage Selection Definition		X								
(15,4)	TC	Remove Packet Types & Sub-Types from Storage Selection Definition		X								
(15,9)	TC	Downlink Packet Store Contents for Time Period		X								
(15,10)	TC	Delete Content of Packet Store (up to Specified Packets)		X								
(15,11)	TC	Delete Content of Packet Store up to specified storage time		X								
(15,128)	TC	Stop Playback of HK Packet Store Contents		X								
(15,129)	TC	Start Playback of HK Packet Store Contents		X								
(15,140)	TC	Add SID's to Storage Selection Definition		X								
(15,141)	TC	Remove SID's from Storage Selection Definition		X								
(15,142)	TC	Report SID Storage Selection Definition		X								
(15,143)	TM	SID Storage Selection Definition Report		X								
(15,145)	TC	Report Storage Routing Definition Table		X								
(15,146)	TM	Storage Routing Definition Report		X								
(15,150)	TC	Format Packet Store Memory		X								
(15,151)	TC	Get Format of Packet Store Memory		X								
(15,152)	TM	Packet Store Format Report		X								
(15,153)	TC	Set Packet Store Playback Pointer		X								
(15,154)	TC	Change Packet Store Attributes		X								

Table B3-11: Service 15 sub-services

B3.13.1 Service 15: Packet Storage Table Reconstruction

Applying the following algorithm allows to reconstruct the fully populated packet routing tables for packet storage (i.e. service 15) according to ECSS E-70-41 from the Astrium CDHS service 15 TM reports:

Prerequisites to start the packet routing table reconstruction algorithm:
The following TM packets are available:

- TM (15,146): Storage Routing Definition Report
- TM (15,143): SID Storage Selection Definition Report
- TM (15,203) Storage Cluster Definition Report if storage clusters are supported

1. Construct the packet routing table
    a. Extract from the PID table of the SRDB the columns PID_PID; PID_CAT, PID_TYPE, PID_STYPE, PID_P1VAL, PID_P2VAL, PID_SPID, PID_DESCR
    b. Sort the content of these columns according PID_PID, PID_TYPE, PID_STYPE, PID_P1VAL, PID_P2VAL
    c. Add one column per on-board store with empty cells
2. Prepare the cluster definition support table for cluster ID decoding from TM (15,203) Storage Cluster Definition Report in case storage cluster are reported by the application
3. Start processing of TM (15,146): Storage Routing Definition Report giving the basic routing store for the first PRID
4. Read one entry of TM (15,146): Storage Routing Definition Report
5. For all packets matching the condition PID_PID=PRID mark the cells of the given store ID. In case the reported store ID is a cluster ID do the same for all store ID's of the cluster
6. Read the next entry of TM (15,146): Storage Routing Definition Report giving the routing store for the first type/sub-type combination not following the general rule established for the PID
7. For all packets matching the condition PID_PID=PRID, PID_TYPE=TYPE and PID_STYPE=SUBTYPE remove the existing marks and mark the cells of the given reported store ID resp. cluster ID.
8. repeat 5 and 6 until all routing definitions of one PID are processed
9. repeat 4 to 8 until all PRID's are processed
10. Start to process TM (15,143): SID Storage Selection Definition Report
11. Read one entry of TM (15,143): SID Storage Selection Definition Report giving the dedicated routing rule of a particular SID of one PID
12. Search the row which matches the conditions PID_PID=PRID .AND. PID_TYPE=3 . AND. PID_P1VAL=SID
13. Remove the existing marks and mark the reported store ID resp. cluster ID
14. repeat 11 to 12 until all PRID's are processed
15. Extract the sub-tables matching the report definitions of ECSS-E-70-41.

B3.14 Service 17: Test Service

Service, Subservice	TM/ TC	Description	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(17,1)	TC	Perform Connection Test	X	X	X	X	X	X	X	X	X	X
(17,2)	TM	Link Connection Report	X	X	X	X	X	X	X	X	X	X

Table B3-12: Service 17 sub-services

B3.15 Service 18: On-Board Operations Procedures

See Service 148.

B3.16 Service 19: Event/Action Service

Service, Subservice	TM/ TC	Description	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(19,1)	TC	Add Events to the Detection List	X	X	X	X	X	X				X
(19,2)	TC	Delete Events from the Detection List	X	X	X	X	X	X				X
(19,3)	TC	Clear the Event Detection List	X	X	X	X	X	X				X
(19,4)	TC	Enable Actions	X	X	X	X	X	X				X
(19,5)	TC	Disable Actions	X	X	X	X	X	X				X
(19,6)	TC	Report the Event Detection List	X	X	X	X	X	X				X
(19,7)	TM	Event Detection List Report	X	X	X	X	X	X				X
(19,130)	TC	Report Single Event Detection Entry	X	X	X	X	X	X				X
(19,131)	TM	Single Event Detection Entry Report	X	X	X	X	X	X				X

Table B3-13: Service 19 sub-services

B3.17 Service 140: Parameter Management Service

Service, Subservice	TM/ TC	Description	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(140,1)	TC	Set N Parameters	X	X	X	X	X	X		X		X
(140,2)	TC	Get N Parameters	X	X	X	X	X	X		X		X
(140,3)	TM	Parameter Report	X	X	X	X	X	X		X		X
(140,4)	TC	Define Onboard Parameter	X	X	X	X	X	X				

Table B3-14: Service 140 sub-services

Note: The Service (140,4) uses for the CSW applications the SAU size of 1 Byte.

B3.18 Service 142: Functional Monitoring Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(142,1)	TC	Enable Functional Monitoring	X	X	X	X	X	X				
(142,2)	TC	Disable Functional Monitoring	X	X	X	X	X	X				
(142,5)	TC	Add Functional Monitoring to the Monitoring List	X	X	X	X	X	X				
(142,6)	TC	Delete Functional Monitoring to the Monitoring List	X	X	X	X	X	X				
(142,8)	TC	Report the Current Functional Monitoring List	X	X	X	X	X	X				
(142,9)	TM	Current Functional Monitoring List Report	X	X	X	X	X	X				
(142,10)	TC	Report the Current FMON Status List	X	X	X	X	X	X				
(142,11)	TM	Current FMON Status List Report	X	X	X	X	X	X				
(142,12)	TC	Protect Functional Monitoring of Parameters	X	X	X	X	X	X				
(142,13)	TC	Unprotect Functional Monitoring of Parameters	X	X	X	X	X	X				

Table B3-15: Service 142 sub-services

B3.19 Service 145: Spacecraft State Vector Distribution

Service, Subservice	TM/ TC	Description	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(145,1)	TC	Start SSV distribution	X									
(145,2)	TC	Stop SSV distribution	X									
(145,3)	TC	Report SSV distribution settings	X									
(145,4)	TM	SSV distribution setting report	X									
(145,128)	TC	Update Spacecraft State Vector (SSV)										X

Table B3-16: Service 145 sub-services

B3.19.1 TC (145,1): Start SSV distribution

TC (145,1) is used to START the distribution of the Spacecraft State Vector (SSV) to Intruments / Units.

B3.19.2 TC (145,2): Stop SSV distribution

TC (145,2) is used to STOP the distribution of the Spacecraft State Vector (SSV) to Intruments / Units.

B3.19.3 TC (145,3): Report SSV distribution settings

TC (145,3) is used to REPORT the distribution of the Spacecraft State Vector (SSV) settings.

B3.19.4 TM (145,4): SSV distribution setting report

TM (145,4) is response to TC(145,3). I.e. the settings of the Spacecraft State Vector (SSV) distribution service.

B3.19.5 TC (145,128): Update Spacecraft State Vector (SSV)

TC (145,128) is used to distribute the Sentinel-2 Spacecraft State Vector (SSV).
It defines the on- board interface between the CSW and the LCT/OCP.

Structure:

PRID	:	Must be set to a value according §B2.1 "Process ID Table (PRID)"
PCAT	:	Must be set to 12 (telecommand)
Service Type	:	Must be set to 145
Service Subtype	:	Must be set to 128

The parameters of the Application Data field are to be inserted according to the following table.

PARAMETERS OF APPLICATION DATA FIELD	LENGTH	TYPE	DESCRIPTION	RANGE OR VALUE
posTimeSec	32 bit	unsigned integer	Indicates the time in seconds at which the satellite has reached the appended position and velocity data	0 to 2^{32} - 1 sec, LSB = 1 sec
posTimeSubsec	24 bit	unsigned integer	Indicates the time in subseconds at which the satellite has reached the appended position and velocity data	0 to 16777215 (1/16777216) sec, LSB = 59.6 nsec
posQualId	8 bit	Enumerated	Indicates the validity status of the satellite CoM position and velocity data	Bit 7: (LSB) Position / velocity vector status; 1 = valid 0 = invalid Condition for valid: as per AOCS Algorithm.
pos_X	32 bit	Signed integer	Indicates the value of the satellite CoM position in X-direction referred to geocentric J2000	Unit: cm LSB = 1 cm Functional range: -7.5 E+8 to +7.5 E+8 cm
pos_Y	32 bit	Signed integer	Indicates the value of the satellite CoM position in Y-direction referred to geocentric J2000	Unit: cm LSB = 1 cm Functional range: -7.5 E+8 to +7.5 E+8 cm
pos_Z	32 bit	Signed integer	Indicates the value of the satellite CoM position in Z-direction referred to geocentric J2000	Unit: cm LSB = 1 cm Functional range: -7.5 E+8 to +7.5 E+8 cm
vel_X	32 bit	Signed integer	Indicates the value of the satellite CoM velocity in X-direction referred to geocentric J2000	Unit: mm/s LSB = 1 mm/sec Functional range: -8. E+6 to +8. E+6 mm/sec
vel_Y	32 bit	Signed integer	Indicates the value of the satellite CoM velocity in Y-direction referred to geocentric J2000	Unit: mm/s LSB = 1 mm/sec Functional range: -8. E+6 to +8. E+6 mm/sec
vel_Z	32 bit	Signed integer	Indicates the value of the satellite CoM velocity in Z-direction referred to geocentric J2000	Unit: mm/s LSB = 1 mm/sec Functional range: -8. E+6 to +8. E+6 mm/sec
orbitNum	32 bit	unsigned integer	Indicates the orbit number, counts up when passing ascending node, initial value settable by TC	Unit: - LSB = 1 orbit Functional range: 0 .. 2^{32} -1
OrbitAng	16 bit	unsigned integer	Indicates the value of the orbit angle starting from zero at the ascending node	Angle = 0 corresponds to each ascending equator crossing. The angle in [radians] x 10000. Unit: rad LSB: = 1. E-4 Functional Range: 0 to +2π

PARAMETERS OF APPLICATION DATA FIELD	LENGTH	TYPE	DESCRIPTION	RANGE OR VALUE
SPARE	16 bit	Signed integer	SPARE	-
SPARE	32 bit	Signed integer	SPARE	-
attTimeSec	32 bit	unsigned integer	Indicates the time in seconds at which the satellite has reached the appended attitude and rate data	0 to 2^{32} - 1 sec, LSB = 1 sec
attTimeSubsec	24 bit	unsigned integer	Indicates the time in subseconds at which the satellite has reached the appended attitude and rate data	0 to 16777215 (1/16777216) sec, LSB = 59.6 nsec
attQualId	8 bit	Enumerated	Indicates the validity status of the satellite attitude data	Bit 7: (LSB) Attitude data status; 1 = valid 0 = invalid Condition for valid: as per AOCS Algorithm.
att_qv1	32 bit	Signed integer	Quaternion defining inertial attitude of satellite reference frame wrt J2000	Unit: - LSB = 1. E-9 Functional range: -1 to 1
att_qv2	32 bit	Signed integer	Quaternion defining inertial attitude of satellite reference frame wrt J2000	Unit: - LSB = 1. E-9 Functional range: -1 to 1
att_qv3	32 bit	Signed integer	Quaternion defining inertial attitude of satellite reference frame wrt J2000	Unit: - LSB = 1. E-9 Functional range: -1 to 1
att_qs	32 bit	Signed integer	Quaternion defining inertial attitude of satellite reference frame wrt J2000	Unit: - LSB = 1. E-9 Functional range: -1 to 1
rate_x	32 bit	Signed integer	Inertial rate component along satellite reference frame x-axis	Unit: rad/s LSB: = 0.05 µrad/s Functional Range: -1. E+5 to +1. E+5 µrad/s
rate_y	32 bit	Signed integer	Inertial rate component along satellite reference frame y-axis	Unit: rad/s LSB: = 0.05 µrad/s Functional Range: -1. E+5 to +1. E+5 µrad/s
rate_z	32 bit	Signed integer	Inertial rate component along satellite reference frame z-axis	Unit: rad/s LSB: = 0.05 µrad/s Functional Range: -1. E+5 to +1. E+5 µrad/s

PARAMETERS OF APPLICATION DATA FIELD	LENGTH	TYPE	DESCRIPTION	RANGE OR VALUE
rateQualId	8 bit	Enumerated	Indicates the validity status of the satellite rate data	Bit 7: (LSB) rate data status; 1 = valid 0 = invalid Condition for valid: valid rate measurement from IMU available

Table 3.19-17: Spacecraft State Vector (SSV) of TC(145,128)

Definition of attitude quaternion

The quaternion elements qv1, qv2, qv3, qs listed in the table above are defined by the transformation matrix from inertial J2000 to the body fixed satellite reference frame. Note the identity (qv1=q_1, qv2=q_2, qv3=q_3, qs=q_4)

If this transformation matrix is denoted by C_{BA}, then a vector r is transformed from its representation wrt J2000 (r_A) to its representation wrt bodyfixed satellite reference frame (r_B) by:

$$r_B = C_{BA}\, r_A.$$

The transformation matrix C_{BA} expressed in terms of quaternions listed in table above is given by:

$$\mathbf{C}_{BA} = \begin{pmatrix} 1-2\cdot(q_2{}^2+q_3{}^2) & 2\cdot(q_1\cdot q_2+q_3\cdot q_4) & 2\cdot(q_1\cdot q_3-q_2\cdot q_4) \\ 2\cdot(q_1\cdot q_2-q_3\cdot q_4) & 1-2\cdot(q_1{}^2+q_3{}^2) & 2\cdot(q_2\cdot q_3+q_1\cdot q_4) \\ 2\cdot(q_1\cdot q_3+q_2\cdot q_4) & 2\cdot(q_2\cdot q_3-q_1\cdot q_4) & 1-2\cdot(q_1{}^2+q_2{}^2) \end{pmatrix}$$

TC verification:

TM(1,2): TC Acceptance Report - Failure

if one of the static checks failed

TM(1,8): TC Execution Completion Report - Failure

if one of the consistency checks failed

B3.20 Service 148 (like Service 18): On Board Control Procedures

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(148,2)	TC	Delete Procedure	X	X	X	X	X	X				
(148,3)	TC	Start Procedure	X	X	X	X	X	X				
(148,4)	TC	Stop Procedure	X	X	X	X	X	X				
(148,8)	TC	Report list of On-Board Control Procedures	X	X	X	X	X	X				
(148,9)	TM	On-Board Control Procedures List Report	X	X	X	X	X	X				
(148,10)	TC	Report list of Active Onboard Control Procedures	X	X	X	X	X	X				
(148,11)	TM	Active On-Board Control Procedures List Report	X	X	X	X	X	X				
(148,128)	TC	Add TC to OBCP	X	X	X	X	X	X				
(148,129)	TC	Delete TC from OBCP	X	X	X	X	X	X				
(148,130)	TC	Dump On-Board Control Procedure	X	X	X	X	X	X				
(148,131)	TM	On-Board Control Procedure Dump	X	X	X	X	X	X				
(148,132)	TC	Set Procedure Lock Status	X	X	X	X	X	X				
(148,133)	TC	Start Procedure Conditionally	X	X	X	X	X	X				
(148,140)	TC	OBCP Logical Decision Directive	X	X	X	X	X	X				
(148,141)	TC	OBCP JUMP Directive	X	X	X	X	X	X				
(148,142)	TC	OBCP Send Event Directive	X	X	X	X	X	X				

Table B3-18: Service 148 sub-services

B3.21 Service 149: Thermal Control Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(149,1)	TC	Set Global Discrete Thermal Control Status				X						
(149,2)	TC	Select Discrete Thermal Mode Table				X						
(149,3)	TC	Set Discrete Thermal Mode Table Entry				X						
(149,4)	TC	Get Discrete Thermal Mode Table				X						
(149,5)	TM	Discrete Thermal Mode Table Report				X						
(149,6)	TC	Set Discrete Thermal Control Configuration Table Entry				X						
(149,7)	TC	Get Discrete Thermal Control Configuration Entry				X						
(149,8)	TM	*Discrete Thermal Control Configuration Table Report*				X						
(149,10)	TC	Set Discrete Thermal Control Loop Activation Status				X						

Table B3-19: Service 149 sub-services

B3.22 Service 151: Orbit Position Scheduling Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(151,1)	TC	Enable Release of OPS Telecommands		X								
(151,2)	TC	Disable Release of OPS Telecommands		X								
(151,3)	TC	Reset OPS		X								
(151,4)	TC	Insert Telecommands in OPS		X								
(151,5)	TC	Delete Telecommands from OPS		X								
(151,6)	TC	Delete Telecommands over Position Range		X								
(151,7)	TC	Shift Telecommands		X								
(151,8)	TC	Shift Telecommands over Position Range		X								
(151,9)	TC	Report Subset of OPS in Detailed Form		X								
(151,10)	TM	Detailed OPS Report		X								
(151,11)	TC	Report OPS in Detailed Form over Position Range		X								
(151,12)	TC	Report Subset of OPS in Summary Form		X								
(151,13)	TM	Summary OPS Report		X								
(151,14)	TC	Report Subset of OPS in Summary Form over Position Range		X								
(151,15)	TC	Positio-Shift all OPS Telecommands		X								
(151,16)	TC	Report OPS in Detailed Form		X								
(151,17)	TC	Report OPS in Summary Form		X								
(151,18)	TC	Report Status of OPS		X								
(151,19)	TM	OPS Status Report		X								

Table B3-20: Service 151 sub-services

B3.23 GPS Application Services

The private GPS application services and subservices shall use the range from 210 till 219.

The first part of this section describes the additional details of the general Services, which are needed for the commonality between Sentinel-1, Sentinel-2 and Sentinel-3.

SERVICE/ SUBSERVICE	DESCRIPTION
3	GPS Housekeeping Reporting Service
5	GPS Event Reporting Service
6	GPS Memory Management Service

Table B3-21: general GPS Services for S1, S2 and S3 comunality

The second part of this section describes the GPS application specific services.

SERVICE	DESCRIPTION
210	GPS Mode Service
211	GPS Parameter Service
212	GPS Science Data Service
213	GPS Periodic Memory Diagnosis Service

Table B3-22: private GPS Services

B3.23.1 Service 3: GPS Housekeeping and Diagnostic Data Reporting Service

The Structure ID (SID) is defined differently for the three projects:

- Sentinel-1 uses 2 Bytes
- Sentinel-2 uses 1 Bytes
- Sentinel-3 uses 4 Bytes

Therefore 3 Filler Bytes are introduced for the following services:

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(3,25)	TM	Housekeeping Parameter Report							X			

Table B3-23: GPS Service 3 sub-services

B3.23.1.1 GPS TM (3,25): Housekeeping Parameter Report

The Housekeeping Parameter Report shall be generated by GPS in the format as described below. The difference to the generic TM(3,25) are marked yellow.

Structure:

PRID	:	Must be set to a value according §B2.1 "Process ID Table (PRID)" (Volume B)
PCAT	:	Must be set to 4 (HK)
Service Type	:	Must be set to 3
Service Subtype	:	Must be set to 25

The structure of the Source Data field within the TM Packet Data field is defined here below.

SID	FILLER	PARAMETER 1	………	PARAMETER N
Enumerated	ZERO	Any		Any
1 byte	3 byte	variable		variable

Figure B3-1: Source data TM(3,25)

The parameters of the Source Data field are to be inserted according to the following table.

PARAMETERS OF SOURCE DATA FIELD	DESCRIPTION	RANGE OR VALUE
SID	The structure ID of the HK Report	Any existing SID value
Filler	Filler Bytes to fit with comunality between S1, S2 and S3.	ZERO
Parameter 1 to *Parameter N*	Parameter meaning according to the definition of this HK Report	A valid value for this parameter

Table 3-24: Source Data for TM(3,25)

B3.23.2 Service 5: GPS Event Reporting Service

The Event ID (EID) is defined differently for the three projects:

- Sentinel-1 uses 2 Bytes
- Sentinel-2 uses 2 Bytes
- Sentinel-3 uses 4 Bytes

Therefore 2 Filler Bytes are introduced for the following services:

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(5,1)	TM	Normal/Progress Report							X			
(5,2)	TM	Error/Anomaly Report -- Low Severity							X			
(5,3)	TM	Error/Anomaly Report – Medium Severity							X			
(5,4)	TM	Error/Anomaly Report – High Severity							X			
(5,210)	TC	Enable Event Packet Generation							X			
(5,211)	TC	Disable Event Packet Generation							X			
(5,212)	TC	Report Disabled Event Packets							X			
(5,213)	TM	Disabled Event Packets Report							X			

Table 3-25: GPS Service 5 sub-services

Further details are defined in the GPSR “Command and Housekeeping Data Interface Specification” ([RD-4] CHKDIS)

B3.23.2.1 TM (5,1) Normal/Progress Report

TM (5,1) shall be generated to report the normal progress of an on board action that does not relate to a fault condition. The Event Report shall be generated by GPS in the format as described below. The difference to the generic TM(5,x) are marked yellow.

Structure:

PRID	:	Must be set to a value according table 3-1 (Volume B)
PCAT	:	Must be set to 7 (event)
Service Type	:	Must be set to 5
Service Subtype	:	Must be set to 1

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

EID	FILLER	PARAMETER
Enumerated	Enumerated	Any
2 bytes	2 bytes	variable

Figure B3-2: Source data TM(5,1)

The parameters of the Source Data field are to be inserted according to the following table.

PARAMETERS OF SOURCE DATA FIELD	DESCRIPTION	RANGE OR VALUE
EID	Event Identifier	See Annex
Filler	Filler Bytes to fit with comunality between S1, S2 and S3.	ZERO
Parameter	this field provides complementary information about the event.	variable

Table B3-26: Source Data for TM(5,1)

B3.23.2.2 TM (5,2) Error/Anomaly Report -- Low Severity

This report shall be generated to report the errors or anomalies of low severity.

Structure:

PRID	:	Must be set to a value according table 3-1 (Volume B)
PCAT	:	Must be set to 7 (event)
Service Type	:	Must be set to 5
Service Subtype	:	Must be set to 2

The structure of the *Source Data* field within the TM *Packet Data Field* is identical with the one defined for TM (5,1) (see above).

B3.23.2.3 TM (5,3) Error/Anomaly Report -- Medium Severity

This report shall be generated to report the errors or anomalies of medium severity.

Structure:

PRID	:	Must be set to a value according §B2.1 “Process ID Table (PRID)” (Volume B)
PCAT	:	Must be set to 7 (event)
Service Type	:	Must be set to 5
Service Subtype	:	Must be set to 3

The structure of the *Source Data* field within the TM *Packet Data Field* is identical with the one defined for TM (5,1) (see above).

B3.23.2.4 TM (5,4) Error/Anomaly Report -- High Severity

This report shall be generated to report the errors or anomalies of high severity.

Structure:

PRID	:	Must be set to a value according §B2.1 “Process ID Table (PRID)” (Volume B)
PCAT	:	Must be set to 7 (event)
Service Type	:	Must be set to 5
Service Subtype	:	Must be set to 4

The structure of the *Source Data* field within the TM *Packet Data Field* is identical with the one defined for TM (5,1) (see above).

B3.23.2.5 TC (5,210) GPS Enable Event Packet Generation

As detailed in the GPSR Command and Housekeeping Data Interface Specification ([RD-4] CHKDIS).

B3.23.2.6 TC (5,211) GPS Disable Event Packet Generation

As detailed in the GPSR Command and Housekeeping Data Interface Specification ([RD-4] CHKDIS).

B3.23.2.7 TC (5,212) GPS Report Disabled Event Packets

As detailed in the GPSR Command and Housekeeping Data Interface Specification ([RD-4] CHKDIS).

B3.23.2.8 TM (5,213) GPS Disabled Event Packets Report

As detailed in the GPSR Command and Housekeeping Data Interface Specification ([RD-4] CHKDIS).

B3.23.3 Service 6: GPS Memory Management Service

The Memory ID (MemID) is defined differently for the three projects:

- Sentinel-1 uses 2 Bytes
- Sentinel-2 uses 2 Bytes
- Sentinel-3 uses 1 Bytes

Therefore 2 Filler Bytes are introduced.

The GPS shall use no scattered Memory Patch/Dump.
No checksum shall be included in Services (6,212) and (6,216)

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(6,210)	TC	Copy Memory							X			
(6,212)	TC	Load Memory using Absolute Addresses							X			
(6,215)	TC	Dump Memory using Absolute Addresses							X			
(6,216)	TM	Memory Dump using Absolute Addresses Report							X			
(6,219)	TC	Check Memory using Absolute Addresses							X			
(6,218)	TM	Memory Check Report using Absolute Addresses							X			

Table 3-27: GPS Service 6 sub-services

Further details are defined in the GPSR “Command and Housekeeping Data Interface Specification” ([RD-4] CHKDIS).

B3.23.3.1 TC (6,210): GPS Copy Memory

TC(6,210) copies the specified number of words from a *Source Memory ID* to a *Destination Memory ID.*

Structure:

PRID:	:Must be set to a value according table 3-1 (Volume B)
PCAT	:Must be set to 12 (telecommand)
Service Type	:Must be set to 6
Service Subtype	:Must be set to 210

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

SOURCE MEMORY ID	DESTINATIO MEMORY ID	SOURCE START ADDRESS	DESTINATION START ADDRESS	LENGTH
Enumerated	Enumerated	Unsigned integer	Unsigned integer	Unsigned integer
2 bytes	2 bytes	4 bytes	4 bytes	4 bytes

Figure B3-3: Application data TC(6,210)

The parameters of the *Application Data* field are to be inserted according to the following table.

PARAMETERS OF APPLICATION DATA FIELD	DESCRIPTION	RANGE OR VALUE
Source Memory ID	Identification Number of the on board memory block from which the data shall be copied	Must be set according to a valid memory See Annex.
Destination Memory ID	Identification Number of the on board memory block to which the data shall be copied	Must be set according to a valid memory ID (see Annex)
Source Start Address	Source Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero)	A valid address of the memory addressed by *Memory ID.*
Destination Start Address	Destination Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero)	A valid address of the memory addressed by *Memory ID.*
Length	Length (in **S**mallest **A**ddressable **U**nits, with count starting from one) of data block to be copied	Source Start Address + Length - 1 must be within the physical limits of the memory. Destination Start Address + Length - 1 must be within the physical limits of the memory. Source and destination Memory area shall have no overlap.

Table B3-28: Application Data for TC(6,210)

TC verification:
TM(1,2): TC Acceptance Report - Failure
if one of the static checks according to section 4.1 of Volume A failed
TM(1,7): TC Execution Completion Report – Success

a TM(1,7) report shall be generated when all data have been copied from source to destination.
TM(1,8): TC Execution Completion Report - Failure
if one of the consistency checks according to section 4.1 of Volume A failed
if the *Source Memory ID* is invalid
if the *Destination Memory ID* is invalid
if the addressed memory is not accessible (i.e. if *Start Address* + *Length exceeds* the physical memory)
if physical access is not possible (i.e. EEPROM access failed, time out, write protection etc.)

B3.23.3.2 TC (6,212): GPS Load Memory using Absolute Addresses

TC(6,212) shall load any data or code to the GPS memory onboard identified by the relevant parameters of the TC.

Structure:

PRID : Must be set to a value according §B2.1 “Process ID Table (PRID)” (Volume B)
PCAT : Must be set to 12 (telecommand)

Service Type : Must be set to 6

Service Subtype : Must be set to 212

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

MEMORY ID	START ADDRESS	LENGTH	DATA
Enumerated	Unsigned integer	Unsigned integer	Variable
2 bytes	4 bytes	4 bytes	

Figure B3-4: Application data TC(6,212)

The parameters of the *Application Data* field are to be inserted according to the following table.

PARAMETERS OF APPLICATION DATA FIELD	DESCRIPTION	RANGE OR VALUE
Memory ID	Identification Number of the on board memory block	Must be set according to a valid memory ID See Annex.
Start Address	Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero) within the memory block for loading the data	A valid address of the memory addressed by *Memory ID.*
Length	Length of data block (in **S**mallest **A**ddressable **U**nits, with count starting from one)	Limited by size of TC Application Data field. Start Address + Length - 1 must be within the physical limits of the memory.
Data	The data to be loaded	Data must be arranged in increasing order of SAU.

Table B3-29: Application Data for TC(6,212)

Note: In case the amount of data to be uploaded exceeds the capacity of a TC Source Packet, as many source packets as required shall be generated, each with consistent parameters.

B3.23.3.3 TC (6,215): GPS Dump Memory using Absolute Addresses

TC(6,215) requests a GPS dump of any data or code from the memory onboard identified by the relevant parameters of the TC.

Structure:

PRID	:	Must be set to a value according §B2.1 "Process ID Table (PRID)" (Volume B)
PCAT	:	Must be set to 12 (telecommand)
Service Type	:	Must be set to 6
Service Subtype	:	Must be set to 215

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

MEMORY ID	START ADDRESS	LENGTH
Enumerated	Unsigned integer	Unsigned integer
2 bytes	4 bytes	4 bytes

Figure B3-5: Application data TC(6,215)

The parameters of the *Application Data* field are to be inserted according to the following table.

PARAMETERS OF APPLICATION DATA FIELD	DESCRIPTION	RANGE OR VALUE
Memory ID	Identification Number of the on board memory block	Must be set according to a valid memory ID See Annex.
Start Address	Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero) within the memory block for loading the data	A valid address of the memory addressed by *Memory ID.*
Length	Number of **SAU**'s to be dumped	1 …. MAXSAU (MAXSAU is application depending, datails are provided in the APID specific annexes of this document.) Start Address + Length - 1 must be within the physical limits of the memory.

Table B3-30: Application Data for TC(6,215)

TC verification:
TM(1,2): TC Acceptance Report - Failure
if one of the static checks according to section 4.1 of Volume A failed
TM(1,7): TC Execution Completion Report – Success
a TM(1,7) report shall be generated when the last packet of the requested dump has been released
TM(1,8): TC Execution Completion Report - Failure

if one of the consistency checks according to section 4.1 of Volume A failed
if the *Memory ID* is invalid
if the addressed memory is not accessible (i.e. if *Start Address* + *Length exceeds* the physical memory)
if physical access is not possible (i.e. EEPROM access failed, time out, write protection etc.)

B3.23.3.4 TM (6,216): GPS Memory Dump using Absolute Addresses Report

TM(6,216) is the GPS response to TC(6,215).
In case the amount of data to be down linked exceeds the max. size of a TM(6,216), as many TM(6,216) packets as requested by TC(6,215) shall be generated. Each of these TM packets will be self-contained, i.e. Start Address and Length of dump are consistent with the dumped data presented in the related TM dump packet. The bandwidth for the amount of TM(6,216) packets may be reduced (bandwidth adjustment mechanism).

Structure:

PRID	:	Must be set to a value according table 3-1 (Volume B)
PCAT	:	Must be set to 9 (dump)
Service Type	:	Must be set to 6
Service Subtype	:	Must be set to 216

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

MEMORY ID	START ADDRESS	LENGTH	DATA
Enumerated	Unsigned integer	Unsigned integer	Variable
2 bytes	4 bytes	4 bytes	

Figure B3-6: Source data TM(6,216)

The parameters of the *Source Data* field are to be inserted according to the following table.

PARAMETERS OF SOURCE DATA FIELD	DESCRIPTION	RANGE OR VALUE
Memory ID	Identification Number of the on board memory block	SeeVolume B.
Start Address	Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero)	Address of the memory addressed by *Memory ID.*
Length	Length of data block (in **S**mallest **A**ddressable **U**nits, with count starting from one)	The maximum value is limited by size of TM Source Packet and may be further restricted by the individual APID
Data	dump data	Data are arranged in increasing order of SAU.

Table B3-31: Source Data for TM(6,216)

Note: The 'Data' field shall contain data referring to memory addresses which are contiguous i.e. increasing without gaps (e.g. page boundaries shall be taken into account such that several dump packets are generated if the dump request goes across them).

The meaning of Length field shall be the same as for the load command TC(6,2).

B3.23.3.5 TM (6,218): GPS Memory Check using Absolute Addresses Report

TM(6,218) is the GPS response to TC(6,219).

Structure:

PRID	:	Must be set to a value according table 3-1 (Volume B)
PCAT	:	Must be set to 3 (Table)
Service Type	:	Must be set to 6
Service Subtype	:	Must be set to 218

The structure of the *Source Data* field within the *TM Packet Data* field is defined here below.

MEMORY ID	START ADDRESS	LENGTH	CHECKSUM
Enumerated	Unsigned integer	Unsigned integer	Fixed Bit-string
2 bytes	4 bytes	4 bytes	2 bytes

Figure B3-7: Source data TM(6,218)

The parameters of the *Source Data* field are to be inserted according to the following table.

PARAMETERS OF SOURCE DATA FIELD	DESCRIPTION	RANGE OR VALUE
Memory ID	Identification Number of the on board memory block	See Volume B.
Start Address	Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero)	Address of the memory addressed by *Memory ID.*
Length	Length of data block (in **S**mallest **A**ddressable **U**nits, with count starting from one)	Limited by size of addressed Memory
Checksum	CRC 16 bit checksum (according to [ND-154])	

Table B3-32: Source Data for TM(6,218)

B3.23.3.6 TC (6,219): GPS Check Memory using Absolute Addresses

TC(6,219) allows for requesting a checksum report.

Structure:

PRID	:	Must be set to a value according table 3-1 (Volume B)
PCAT	:	Must be set to 12 (telecommand)
Service Type	:	Must be set to 6
Service Subtype	:	Must be set to 219

The structure of the *Application Data* field within the *TC Packet Data* field is defined here below.

MEMORY ID	START ADDRESS	LENGTH
Enumerated	Unsigned integer	Unsigned integer
2 bytes	4 bytes	4 bytes

Figure B3-8: Application data TC(6,219)

The parameters of the *Application Data* field are to be inserted according to the following table.

PARAMETERS OF APPLICATION DATA FIELD	DESCRIPTION	RANGE OR VALUE
Memory ID	Identification Number of the on board memory block	Must be set according to a valid memory ID See Annex.
Start Address	Start Address (in **S**mallest **A**ddressable **U**nits, with count starting from zero)	A valid address of the memory addressed by *Memory ID.*
Length	Length of data block (in **S**mallest **A**ddressable **U**nits, with count starting from one)	Start Address + Length - 1 must be within the physical limits of the memory.

Table B3-33: Application Data for TC(6,219)

TC verification:
TM(1,2): TC Acceptance Report - Failure
if one of the static checks according to section 4.1 of Volume A failed
TM(1,8): TC Execution Completion Report - Failure
if one of the consistency checks according to section 4.1 of Volume A failed
if the *Memory ID* is invalid
if the addressed memory is not accessible (i.e. if *Start Address* + *Length exceeds* the physical memory)
if physical access is not possible (i.e. EEPROM access failed, time out, write protection etc.)

B3.23.4 Service 210: GPS Mode Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(210,1)	TC	Change GPS Mode							X			

Table 3-34: GPS Service 210 sub-services

Details are defined in the GPSR “Command and Housekeeping Data Interface Specification” ([RD-4] CHKDIS).

B3.23.5 Service 211: GPS Parameter Service

The GPS Parameter Service sets all modifiable parameter of the GPS including the HK repetition frequency parameters.

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(211,1)	TC	Pre-Load GPS Function Parameter							X			
(211,2)	TC	Report GPS Function Parameter							X			
(211,3)	TM	GPS Function Parameter Report							X			

Table 3-35: GPS Service 211 sub-services

Details are defined in the GPSR "Command and Housekeeping Data Interface Specification" ([RD-4] CHKDIS).

B3.23.6 Service 212: GPS Science Data Service

The GPS Science Data Service is used to report the science data telemetry.

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION							GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(212,1)	TM	GPS Science Data using about 17 different SID							X			

Table 3-36: GPS Service 212 sub-services

Details are defined in the GPSR "Command and Housekeeping Data Interface Specification" ([RD-4] CHKDIS).

B3.23.7 Service 213: GPS Periodic Memory Diagnosis Service

The GPS provids a Periodic Memory Diagnosis Service, which periodically reports data from different (scattered) RAM Memory locations. The layout of the related sub-services is defined in the GPSR "Command and Housekeeping Data Interface Specification" [RD-4].

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(213,1)	TC	GPS periodic Memory Diagnosis							X			
(213,2)	TM	GPS periodic Memory Diagnosis Report							X			
(213,3)	TC	GPS Abort Memory Service Command							X			

Table 3-37: GPS Service 213 sub-services

B3.24 MMFU Application Services

The private MMFU application services range from 200 till 209.

SERVICE	DESCRIPTION
200	MMFU Record Service
201	MMFU Playback Service
202	MMFU Mode Transistion Service
203	MMFU Management Service

Table 3-38: private MMFU Services

B3.24.1 Service 200: MMFU Record Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(200,1)	TC	MMFU Record Nominal								X		
(200,2)	TC	MMFU Record NRT								X		
(200,9)	TC	MMFU Stop Record								X		

Table 3-39: Service 200 sub-services

B3.24.1.1 TC (200,1): MMFU Record Nominal

Upon reception and execution of the TC “Record Nominal” the MMFU will:

- Enable mission data acquisition
- Store the acquired mission data and mark them as “Nominal”

Further details are described in the MMFU TM/TC ICD [RD-5].

B3.24.1.2 TC (200,2): MMFU Record NRT

Upon reception and execution of the TC “Record NRT” the MMFU will:

- Enable mission data acquisition
- Store the acquired mission data and mark them as “NRT”

Further details are described in the MMFU TM/TC ICD [RD-5].

B3.24.1.3 TC (200,9): MMFU Stop Record

Upon reception and execution of the TC “Stop Record” the MMFU will Stop the MMFU Record.
Details are described in the MMFU TM/TC ICD [RD-5].

B3.24.2 Service 201: MMFU Playback Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(201,1)	TC	MMFU Playback Regular with Memory freed or Data stored								X		
(201,2)	TC	MMFU Playback NRT with Memory freed or Data stored								X		
(201,3)	TC	MMFU Playback Nominal with Memory freed or Data stored								X		
(201,4)	TC	MMFU Playback RT with Memory freed or Data stored								X		
(201,5)	TC	MMFU Playback from <Time> with Memory freed or Data stored								X		
(201,6)	TC	MMFU Playback all Satellite Ancillary Data and/or all Satellite HK Data with Memory freed or Data stored								X		
(201,9)	TC	MMFU Stop Playback								X		

Table 3-40: Service 201 sub-services

B3.24.2.1 TC (201,1): MMFU Playback Regular

Upon reception and execution of the TC “Playback Regular” the MMFU will:

- Playback NRT data (oldest stored data with first priority) until the “Stop Playback” is received and executed
- In case that there are no NRT data available or left for playback, the MMFU will autonomously playback Nominal data (oldest stored data with first priority) until the “Stop Playback” is received and executed

Depending on a dedicated parameter the MMFU does:

- Free the playback data in the mass memory
- Maintain the payback data stored in the mass memory

Further details are described in the MMFU TM/TC ICD [RD-5].

B3.24.2.2 TC (201,2): MMFU Playback NRT

Upon reception and execution of the TC “Playback NRT” the MMFU will:

- Playback **only** NRT data (oldest stored data with first priority) until the “Stop Playback” is received and executed
- In case that there are no NRT data available or left for playback, the MMFU will **NOT** continue with the playback of Nominal data

Depending on a dedicated parameter the MMFU does:

- Free the playback data in the mass memory
- Maintain the payback data stored in the mass memory

Further details are described in the MMFU TM/TC ICD [RD-5].

B3.24.2.3 TC (201,3): MMFU Playback Nominal

Upon reception and execution of the TC "Playback Nominal" the MMFU will:

- o Playback **only** Nominal data (oldest stored data with first priority) until the "Stop Playback" is received and executed
- o In case that there are no Nominal data available or left for playback, the MMFU will **NOT** continue with the playback of NRT data

Depending on a dedicated parameter the MMFU does:

- o Free the playback data in the mass memory
- o Maintain the payback data stored in the mass memory

Further details are described in the MMFU TM/TC ICD [RD-5].

B3.24.2.4 TC (201,4): MMFU Playback RT

Before real time playback, the MMFU recording is enabled by a separate TC to

- o MMFU Record Nominal, or
- o MMFU Record NRT

Then, the actual real time playback is enabled by the TC "Playback RT". Upon reception and execution of this command the MMFU will:

- o Playback the acquired data in real time until the "Stop Playback" is received and executed; the acquired (Nominal or NRT) data are played back as RT data

Depending on a dedicated parameter the MMFU does:

- o Free the playback data in the mass memory
- o Maintain the payback data stored in the mass memory; either as Nominal or NRT data depending on the related MMFU Record (Nominal or NRT) command

Further details are described in the MMFU TM/TC ICD [RD-5].

B3.24.2.5 TC (201,5): MMFU Playback from <Time>

Upon reception and execution of the TC "Playback from <Time>" the MMFU will:

- o Playback data (oldest stored data with first priority) acquired by the MMFU at or after <MMFU on-board time> until the "Stop Playback" is received and executed
- o The Playback priority is given by the FIFO principle (data stored at < TIME > with first priority), without differentiation between Nominal and NRT data

Depending on a dedicated parameter the MMFU does:

- o Free the playback data in the mass memory
- o Maintain the payback data stored in the mass memory

Further details are described in the MMFU TM/TC ICD [RD-5].

B3.24.2.6 TC (201,6): MMFU Playback all Satellite Ancillary and/or all HK

Upon reception and execution of the TC “Playback all Satellite Ancillary and/or all HK” the MMFU will:

- Playback the acquired Satellite Ancillary and/or HK data (oldest stored data with first priority) until the data stores are emptied

Depending on a dedicated parameter the MMFU does:

- Free the playback data in the mass memory indepent for Satellite ANC and HK
- Maintain the payback data stored in the mass memory indepent for Satellite ANC and HK

Further details are described in the MMFU TM/TC ICD [RD-5].

B3.24.2.7 TC (201,9): MMFU Stop Playback

Upon reception and execution of the TC “Stop Playback” the MMFU will Stop the MMFU Playback.

Details are described in the MMFU TM/TC ICD [RD-5].

B3.24.3 Service 202: MMFU Mode Transition Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(202,1)	TC	Goto Init Mode								X		
(202,2)	TC	Goto Config Mode								X		
(202,3)	TC	Goto Operational Mode								X		
(202,4)	TC	Goto Test Mode								X		

Table 3-41: Service 202 sub-services

Details are described in the MMFU TM/TC ICD [RD-5].

B3.24.4 Service 203: MMFU Management Service

The MMFU Mamagement Service controls the MMFU internal tables.

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(203,1)	TC	Report Packet Store Status								X		
(203,2)	TM	Packet Store Status Report								X		
(203,7)	TC	Dump Scene Lookup Table								X		
(203,8)	TM	Scene Lookup Table Dump								X		
(203,9)	TC	Dump Allocation Unit Link Table								X		
(203,10)	TM	Allocation Unit Link Table Dump								X		
(203,11)	TC	Dump Bit Error Statistics Table								X		
(203,12)	TM	Bit Error Statistics Table Dump								X		

Table 3-42: Service 203 sub-services

Details are described in the MMFU TM/TC ICD [RD-5].

B3.25 STR Application Services

The private STR application services range from 220 till 224.

B3.25.1 Service 220: STR Mode Service

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(220,1)	TC	Change STR Mode									X	

Table 3-43: Service 220 sub-services

Further details are defined in the STR TM/TC ICD [RD-6].

B3.25.2 Service 221-223: STR Service

The STR private Services are defined in the STR TM/TC ICD [RD-6].

B3.25.3 Service 224: STR Parameter Service

The STR Parameter Service sets all modifiable parameter of the STR.

SERVICE, SUBSERVICE	TM/ TC	DESCRIPTION	CSW						GPS	MMFU	STR	LCT
			S	D	A	PF	PL	M				
(224,1)	TC	Load STR Parameter									X	
(224,2)	TC	Report STR Parameter										
(224,3)	TM	STR Parameter Report										

Table 3-44: Service 224 sub-services

Further details are defined in the STR TM/TC ICD [RD-6].

B3.26 LCT/OCP Application Services

The private LCT/OCP application services range from 240 till 244.

SERVICE	DESCRIPTION
241	LCT Mode Transistion Service
242	LCT Configuration Service
244	LCT Table Management Service
245	LCT Commanded Functional Test Mode Service
246	LCT Commanded Functional Test Mode Service
247	LCT Launch Lock Release Mode Service

Table 3-45: private OCP/LCT Services

The LCT/OCP private Services are defined in the LCT/OCP TM/TC ICD [RD-7].

B4. GENERIC PUS ANNEXES

In this chapter all annexes which are applicable from the generic ECSS E70-41 A PUS are given

B4.1 Parameter Types

Each field in a telecommand or telemetry packet described in this document is designed to hold a parameter value. Each parameter field has a type, defining the set of values that can be assigned to the parameter. The parameter types are defined below.

This appendix defines the physical encoding rules for each type, i.e. the permitted lengths of the parameter fields and the internal format used to encode values. This appendix does not define the conversion of data parameters into physical or engineering units or user messages.

When defining telecommand and telemetry packets only parameter types defined in this section shall be allowed.

B4.2 Encoding Formats of Parameter Types

The parameter type defines the range of possible parameter values. A given parameter type can vary in format and length. Each combination of parameter type and encoding format has an associated parameter code, which defines the type and its physical encoding.
The parameter code shall be used whenever a definition of a parameter field is required. The parameter codes shall be applicable to both telecommand and telemetry data.
The parameter code PC, is defined as follows:

PARAMETER TYPE CODE (PTC)	*PARAMETER FORMAT CODE (PFC)*
enumerated	enumerated

The parameter code is written as (PTC, PFC) in the tables below.

B4.3 Parameter Type Definitions

The table below lists the Parameter Type and Format Codes supported by Sentinel-2 (in compliance with GSOC's SCOS-2000 system). It also specifies the parameter type (internal format) and the parameter width assumed by the importer for each PTC. Reference is made to the nomenclature adopted in the Packet Utilization Standard [ND-33].

PTC [DEC]	PFC [DEC]	STANDARD TYPE	LENGTH	REMARK / COMMENT DEFAULTS
Boolean Parameter:				
1	0		1 bit	Boolean parameter; 0 = false; 1= true
Enumeration Parameter:				
2	1 .. 32		PFC bits = (1 .. 32 bits)	Enumerated parameter. In the PUS only some PFCs are allowed for this parameter type. In Sentinel-2 (compliant with SCOS-2000, the only restriction is the maximum parameter length (32 bits)).
Unsigned Integer Parameter:				
3	0 .. 12	Unsigned Integer	PFC+4 bits	Unsigned integer parameter
3	13		24 bits	
3	14		32 bits	
3	15		48 bits	Signed and unsigned integers larger that four octets are not supported by S2K and should not be included in the delivered SRDB. An alternative method should be defined for structures requiring such parameter type and format codes.
3	16		64 bits	Signed and unsigned integers larger that four octets are not supported by S2K and should not be included in the delivered SRDB. An alternative method should be defined for structures requiring such parameter type and format codes.
Signed Integer Parameter:				
4	0 .. 12	Signed Integer	PFC+4 bits	Signed integer parameter
4	13		24 bits	
4	14		32 bits	
4	15		48 bits	Not supported.
4	16		64 bits	Not supported.
Real Parameter:				
5	1	Simple precision real (IEEE standard)	32 bits	Simple precision real parameter (IEEE) for detailed format: refer to section 23 of [ND-33]
5	2	Double precision real (IEEE standard)	64 bits	Double precision real parameter (IEEE) for detailed format: refer to section 23 of [ND-33]

Bit-String Parameter:				
6	0	Bit string	Variable	not used on Sentinel-2
6	>0, <33	string of '0' and '1' characters	PFC bits	PUS bit-string parameters are handled by SCOS-2000 as unsigned integer parameters with the length given by their PFC (up to 32 bits). They are only handled on the telemetry side (i.e. not on the commanding side). for detailed format: refer to section 23 of [ND-33]
Byte-String Parameter:				
7	0	Byte string	Variable	Variable-length octet-string. This is only supported for command/sequence parameters (i.e. not for telemetry parameters). for detailed format: refer to section 23 of [ND-33]
7	1..255	Byte string	PFC bytes	Fixed-length octet-strings. These types are supported on both the telemetry and commanding side. for detailed format: refer to section 23 of [ND-33]
Character-String Parameter:				
8	0	ASCII string	Variable	Variable-length character-string. This is only supported for command parameters (i.e. not for telemetry parameters). for detailed format: refer to section 23 of [ND-33]
8	1..255	ASCII string	PFC bytes	Fixed-length character-strings. These types are supported on both the telemetry and commanding side. for detailed format: refer to section 23 of [ND-33]
Time Parameter: (for P Field = 0010 1100 4 bytes coarse time and 0 bytes fine time)				
9	15	Byte String	4 bytes	Supported on commanding side, (no fine time)
Time Parameter: (for P Field = 0010 1110 4 bytes coarse time and 2 bytes fine time)				
9	17	Byte String	6 bytes	Supported by Command Schedule (TC time tag)
Time Parameter: (for P Field = 0010 1111 4 bytes coarse time and 3 bytes fine time)				
9	18	Byte String	7 bytes	for detailed format: refer to section 23 of [ND-33]
Relative Time Parameter: (4 bytes coarse time and 2 bytes fine time)				
10	17	Byte String	6 bytes	for detailed format: refer to SCOS-MIB ICD
Relative Time Parameter: (4 bytes coarse time and 3 bytes fine time)				
10	18	Byte String	7 bytes	for detailed format: refer to SCOS-MIB ICD

Table 4.3-1: Parameter Type Definitions

The table below lists the applicable encoding and raw formats for each parameter type.

TYPE	ENCODED FORMAT	COMMENT
Unsigned integer	Unsigned integer	
Signed integer	2's complement (first bit used for the sign)	Only decimal is allowed.
Single precision real (IEEE)	IEEE Std 754-1985	This is referred to as PTC=5, PFC=1 in [ND-33]
Double precision real (IEEE)	IEEE Std 754-1985	This is referred to as PTC=5, PFC=2 in [ND-33]
Byte-string	Unsigned integer	In the case of Variable Byte String parameters, the actual parameter length is determined by reading the value of 'n' (number of characters) (see Section 23.5.8 of [ND-33]). Parameters of this type cannot be associated to a calibration curve.
Character-string	ASCII string	In the case of Variable Character String parameters, the actual parameter length is determined by reading the value of 'n' (number of characters) (see Section 23.5.8 of [ND-33]). Parameters of this type cannot be associated to a calibration curve.
Absolute time	Byte String	Parameters of this type cannot be associated to a calibration curve.

Table B4.3-2: Parameter Encoding and Raw Format

B4.4 Specification of cyclic redundancy code (CRC)

B4.4.1 General specification

The packet error control field provides the capability for detecting errors which have been introduced into the telemetry source packet (or telecommand packet) by the lower layers during the transmission process or during other processing or storage activities. The standard error detection encoding/decoding procedure, which is described in detail in the following subclauses, produces a 16-bit Packet Check Sequence (PCS) which is placed in the packet error control field. The characteristics of the PCS are those of a cyclic redundancy code, and can be expressed as follows:
The generator polynomial is:

$$\mathbf{g(x) = x^{16} + x^{12} + x^{5} + 1}$$

Both encoder and decoder are initialized to the “all-ones” state for each packet.
PCS generation is performed over the data space “D” as shown in Figure B4.4-1 where “D” covers the entire packet including the packet header but excluding the final packet error control field.
The error detection properties of the CRC can be expressed as follows:
The proportion of all errors in the data that are not detected is approximately 1,53 × 10-5.
An error in the data affecting an odd number of bits shall always be detected.
An error in the data affecting exactly two bits, no more than 65 535 bits apart, shall always be detected.
If an error in the data affects an even number of bits (greater than or equal to 4), the probability that the error shall not be detected is approximately 3 × 10-5 for a data length of 4 096 octets. The probability increases slightly for larger data lengths and decreases slightly for smaller data lengths.
A single error burst spanning 16 bits or less of the data shall always be detected. Not all intermediate bits in the error burst span need be affected.
This code is intended only for error detection purposes and no attempt should be made to utilize it for correction.

<-- Packet --->	
“D” DATA SPACE	PCS
7 to 65 540 OCTETS	2 OCTETS

Figure B4.4-1 Standard packet check sequence generation

B4.4.2 Encoding procedure

The encoding procedure accepts an (n-16)-bit message and generates a systematic binary (n, n-16) block code by appending a 16-bit Packet Check Sequence (PCS) as the final 16 bits of the block. This PCS is inserted into the packet error control field. The equation for PCS is:

PCS = [x16 × M(x) + x(n-16) × L(x)] MODULO G(x)

where:

M(x) is the (n-16)-bit message to be encoded expressed as a polynomial with binary coefficients, n being the number of bits in the encoded message (i.e. the number of bits in the complete packet).

L(x) is the presetting polynomial given by:

$$L(x) = \sum_{i=0}^{15} x^i \quad \text{(all "1" polynomial of order 15)}$$

G(x) is the CCITT recommendation V.41 (Reference [10]) generating polynomial given by:

$g(x) = x^{16} + x^{12} + x^5 + 1$

\+ is the modulo 2 addition operator (Exclusive OR).

NOTE The encoding procedure differs from that of a conventional cyclic block encoding operation in that the x(n-16) × L(x) term has the effect of presetting the shift register to an all ones state (rather than a conventional all zeros state) prior to encoding.

B4.4.3 Decoding procedure

The error detection syndrome, S(x) is given by:

S(x) = [x16 × C*(x) + xn × L(x)] MODULO G(x)

where:

C*(x) is the received block in polynomial form.

S(x) is the syndrome polynomial which is zero if no error has been detected.

B4.4.4 Realization of a CRC encoder - decoder

B4.4.4.1 General

This subclause describes two arrangements, based on a shift register, for encoding and decoding a telemetry source packet (or telecommand packet) according to the packet check sequence procedures defined above.

B4.4.4.2 Encoder

Figure B4.4-2 shows an arrangement for encoding with the aid of a shift register. To encode, the storage stages are set to “one”, gates A and B are enabled, gate C is inhibited, and (n-16) message bits are clocked into the input. They appear simultaneously at the output. After the bits have been entered, the output of gate A is clamped to “zero”, gate B is inhibited, gate C is enabled, and the register is clocked a further 16 counts. During these counts, the applicable check bits appear in succession at the output.

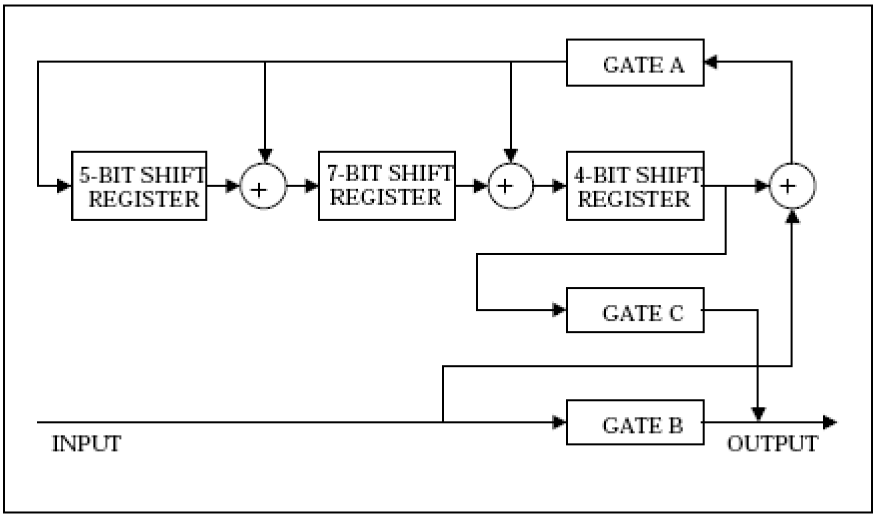

Figure B4.4-2 Encoder

B4.4.4.3 Decoder

Figure B4.4-3 shows an arrangement for decoding with the aid of a shift register. To decode, the storage stages are set to “one” and gate B is enabled. The received n bits (i.e. the (n-16) message bits plus the 16 bits of PCS) are then clocked into the input and after (n-16) counts gate B is inhibited. The 16 check bits are then clocked into the input and the contents of the storage stages are then examined. For an error-free packet, the contents shall be “zero”. Nonzero contents indicates an erroneous packet.

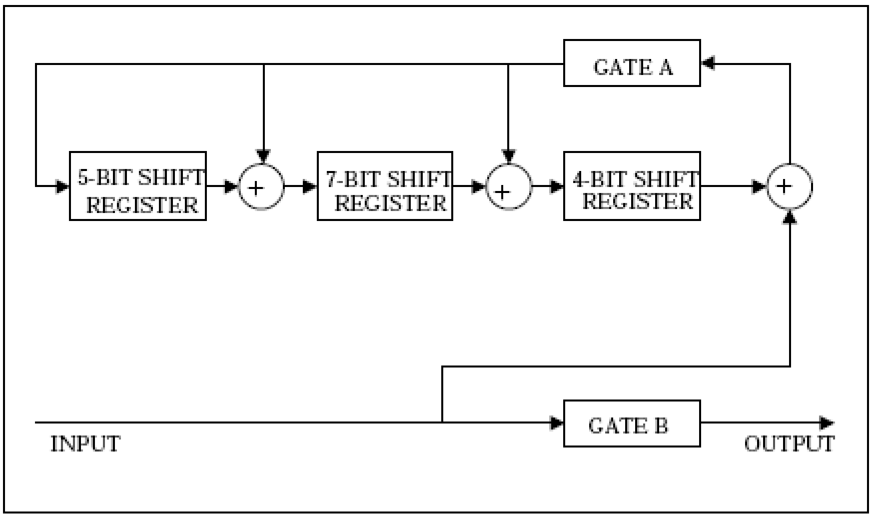

Figure B4.4-3 Decoder

B4.4.4.4 Verification of compliance

The binary sequences defined in this subclause are provided to the designers of packet systems as samples for early testing, so that they may verify the correctness of their CRC error-detection implementation. All data are given in hexadecimal notation. For a given field (data or CRC) the leftmost hexadecimal character contains the most significant bit.

Data	CRC
00 00	1D 0F
00 00 00	CC 9C
AB CD EF 01	04 A2
14 56 F8 9A 00 01	7F D5

Table B4-3: CRC Verification Table

B4.4.5 Software implementation

B4.4.5.1 Introduction

In addition to their interesting performance, CRC codes are particularly efficient when it comes to hardware implementation. Software implementation, on the other hand, is more complex. The following C-language code describes the software routines to implement the CRC encoder. To implement the CRC decoder, the same routines can be used: data and the syndrome are encoded and the resulting syndrome should be equal to zero if no error is present.

B4.4.5.2 Functions applicable to generate the CRC placed at the end of a packet.

a. **Crc FUNCTION**

The Crc function calculates the CRC for one byte in serial fashion and returns the value of the calculated CRC checksum.

b. **Crc_opt FUNCTION**

This function can be used instead of the Crc function given above. The Crc_opt function generates the CRC for one byte and returns the value of the new syndrome. This function is approximately 10 times faster than the non-optimized Crc function.

c. **InitLtbl FUNCTION**

The InitLtbl function initiates the look-up table used by Crc_opt.

```
unsigned int Crc(Data, Syndrome)
        unsigned char Data; /* Byte to be encoded */
        unsigned Syndrome; /* Original CRC syndrome */

        {
                int i;
                for (i=0; i<8; i++) {
                        if ((Data & 0x80) ^ ((Syndrome & 0x8000) >> 8)) {
                                Syndrome = ((Syndrome << 1) ^ 0x1021) & 0xFFFF;
                        } else {
                                Syndrome = (Syndrome << 1) & 0xFFFF;
                }
                Data = Data << 1;
                }
                return (Syndrome);
        }

unsigned int Crc_opt (D, Chk, table)
        unsigned char D; /* Byte to be encoded */
        unsigned int Chk; /* Syndrome */
        unsigned int table [ ]; /* Look-up table */
        {
        return (((Chk << 8) & 0xFF00)^table [(((Chk >> 8)^D) & 0x00FF)]);
        }

void InitLtbl (table)
        unsigned int table [ ];
        {
                unsigned int i, tmp;
                for (i=0; i<256; i++) {
                tmp=0;
                        if ((i & 1) != 0) tmp=tmp ^ 0x1021;
                        if ((i & 2) != 0) tmp=tmp ^ 0x2042;
                        if ((i & 4) != 0) tmp=tmp ^ 0x4084;
                        if ((i & 8) != 0) tmp=tmp ^ 0x8108;
                        if ((i & 16) != 0) tmp=tmp ^ 0x1231;
                        if ((i & 32) != 0) tmp=tmp ^ 0x2462;
                        if ((i & 64) != 0) tmp=tmp ^ 0x48C4;
                        if ((i & 128) != 0) tmp=tmp ^ 0x9188;
                        table [i] = tmp;
                }
        }
```

```
/* Simple program to test both CRC generating functions */
void main ( )
        {
                unsigned int Chk; /* CRC syndrome */
                unsigned int LTbl[256]; /* Look-up table */
                unsigned char indata[32]; /* Data to be encoded */
                int j;
                indata[0] = 0x31; indata[1] = 0x23; indata[2] = 0x48; indata[3] = 0x07;
                indata[4] = 0x00; indata[5] = 0xEC; indata[6] = 0xD0; indata[7] = 0x37;
                Chk = 0xFFFF; /* Reset syndrome to all ones */
                for (j=0; j<8; j++) {
                        Chk = Crc(indata[j], Chk); /* Unoptimized CRC */
                }
                printf(" CRC = %x (should be 0)\n",Chk);
                InitLtbl(LTbl); /* Initiate look-up table */
                Chk = 0xFFFF; /* Reset syndrome to all ones */
                for(j=0;j<8;j++) {
                        Chk = Crc_opt(indata[j],Chk,LTbl); /* Optimized CRC */
                }
                printf(" CRC = %x (should be 0)\n", Chk);
        }
```

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