VVX Software User Manual

Issue 5.0

(for VVX FM PBS V2.0 and SBS V2.60)

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DOCUMENT CHANGE RECORD			
DOCUMENT TITLE: **VVX Software User Manual**			
DOCUMENT REFERENCE NUMBER: VVX-DLR-MA-001			
Issue	Rev	Date	Change
1	0	07/03	Initial revision based on VIR-DLR-MA-006, Issue 2.3 - Secondary boot software for VVX is new release V1.x - Considering PROM V1.1 implemtation in VVX EM - TM packet supplementary header added for HS link transfer - MTC_Annealing ST6 changed to ST60 (ASPERA conflict) - M_Test, H_Test sequence slightly modified
1	1	08/03	- Re-change of MTC_Annealing from ST60 to ST6 - Reference to VIR-RO-RW-0038 added, chapter 1.8.1
2	0	02/04	- Update for FM version - Update parameter range and scale for M_*_DELAY and M_*_EXPO in functional and calibration parameter set - Update default values of M_*_DELAY and M_*_EXPO in functional and calibration parameter set - Updated default parameter related to the –M Scan Unit - Updated default –H pixel map coefficients - New –H dead pixel mask (Appendix 16) - Changing the progress event 47910 format (adding dead pixel mask parameters)
2	1	02/04	- Add the “VVX-GAF-WV-006” and “VVX-DLR-NC-001” reference in ch. 1.8.1 - Change of M_CCD_WINX1, X2 parameter to initialize of M-PEM in ch. 10.11
3	0	07/04	- Release of new SBS release V2.40, see release note VVX-DLR-LI-002 - Correction and adding of information related to VVX-GAF-NC-015 (ch. 1.8.2) - New transfer function of H_HKMS_DET_TEMP for –H annealing (ch. 11.10) - Update of chapter 10.7 and 10.8 about ECA and cover handling - Update of chapter 10.13; remove of M-Cover automatic after starting a science sequence - Change of H_Close_Cover_Step to 120 (old: 60) and M_Close_Cover_Step=120 (old: 81) in functional TC parameter - Change of H_HKMS_I_SHUTTER_HEATER_MIN = -70 (ADU bit) (old: +20) H_HKMS_I_SHUTTER_HEATER_MAX = +2000 (ADU bit) (old: +1000) - Func. param. H_INT_SPECT_T_NUM is set to 0.5sec (old value: 1.5sec) - Func. param. H_INT_RAD_NUM is set to 0.5sec (old value: 2.5sec) - Default value of M_IR_WIN_Y1 is changed from 11 to 7 - Default value of M_IR_WIN_Y2 is changed from 266 to 262 - Default value of M_IR_EXPO6 is changed from 250 to 25 - Default value of M_CCD_EXPO6 is changed from 250 to 25
4	0	9/04	- S/W V2.50 released - Change of default parameter of MTC_Change_Funct_Param_* - Changes concerning –H detector exchange and new calibration of –H - change of transfer function for annealing H_DET_TEMP temp. calculation - new dead pixel map - new pixel map coefficients parameter - default parameter H_XWIN, H_YWIN changed
5	0	9/07	**S/W V2.60 released.** Due to this release the following changes are applicable: - Disable of periodic science HK generation when science mode is started (to avoid TM burst, VVX-DLR-NC-003) - change of H-PEM shutter synchronization but there is no change in the user manual - Change of the default value of M_INIT_COVER_STEP from 16 to 21 - RD(15) updated, now Issue 6.1 is valid for V2.60

			Other general changes/corrections in the user manual independent of the V2.60 release - M_CCD_DELAY=20msec, M_CCD_EXPO=20msec, corrected in MTM_PEM_VIS_HK_Report - Note about exceptions for commanding VTC_Failure_Override CAT ALL (7), in chapter 9.6 - Note added in chapter 7.15.1: If the 1355 link is not established and a science mode shall be started, TC_Enable_Science_HS_Link() is not accepted sending a TM packet TM_TC_Acceptance_Report_Failure with failure code 7 and parameter 3 is set to 9. - Note added in chapter 7.15.1: If science mode is not started MTM_Dump_* or HTM_Dump_* isn't sent as TM - few other additions/corrections

c – DISTRIBUTION LIST

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1 Introduction

This document, the Software User Manual (SUM) describes the use of the VIRTIS PROM (Primary Boot S/W) and EEPROM (Secondary Boot or Application) software.

The manual provides all information needed by the user to understand the purpose of the software and it's role in the controlling of the VIRTIS instrument system. All information necessary for the user to make an efficient use of the functions and the interface behaviour are provided. This document includes an overview, the description of the functions and preconditions as well as interface definitions to start and to operate the software.

The VIRTIS software was developed by the software developer team at DLR department of Optical Information Systems (OS) at in the German Aerospace Center in Berlin. The software development process (e.g. User Requirement definition) was intensively supported by the whole VIRTIS team in Italy and France as main user of the VIRTIS instrument.

1.1 Intended readership

This Software User Manual (SUM) is indented for a reader with medium knowledge of the VIRTIS software, of the Main Electronics hardware on which the software runs, and of the VIRTIS instrument.

The reader should be familiar with operation and telecommanding of VIRTIS and with the telemetry concept as written in RD(1) and RD(7).

Readers are persons responsible for VIRTIS test and operations, the Principle investigator (PI) and other team members involved in the VIRTIS project or the Venus Express (VEX) mission.

1.2 Applicability statement

This document applies to versions

- PROM (Primary Boot) software **V2.0-1** (Rosetta/VIRTIS FM release) (identical to VEX/VIRTIS FM release) and
- EEPROM (Secondary Boot) software **V2.60** (FM release) (based on Rosetta/VIRTIS V3.61 and specific performance improvements and partially interface changes only for VVX FM)

EEPROM software V2.x works properly only on VIRTIS ME FM. It does not work completely on VIRTIS EM because the M-PEM EM has a different performance (slower read-out). Nevertheless the DPU and ME hardware is compatible for all hardware models from the software point of view so that V2.x can operate with VIRTIS-H FM and EM.

Note: the VVX SBS versions works on VVX EM hardware too. Some operational constrains have to be considered due to the specific VIRTIS hardware configuration (e.g. Cover is only simulated)

The document is a deliverable within the VIRTIS Main Electronics and VIRTIS software project. It is applicable to the design and implementation of the Main Electronics (ME) and installed software at the time of the release of the document.

1.3 Purpose

The main purpose of the VIRTIS software is to make it possible for the user (i.e. PI, GA, DESPA, the VIRTIS team and Astrium/ESA representatives) to control the VIRTIS instrument and to process the data acquired from the 3 VIRTIS data channels during all VIRTIS development and test phases on-ground in GA/Italy and DLR/Berlin, integration and test phases at Astrium/Toulouse, and VEX mission phases in flight (software FM version). It is used also for ME hardware sub-system tests at DLR and/or KT/Munich.

1.4 How to use this document

The SUM is organized according to the table of contents described in RD(8).

In Chapter 1 (this one) some general information about the document are given.

Chapters 2 and 3 give an overview about the software and the ME hardware is described to get environmental information needed to understand the software handling, interface in- and outputs.

Chapter 4 describes shortly the hardware facility needs or options to operate the software in several hardware configurations.

Chapter 5 contains information about software installation and maintenance.

Chapter 6 and following chapters describe the software functions with respect to information or definitions in the Appendixes of this document.

Appendixes contains the TC and TM packet definitions and structures, the list of events as well as other tables and figures.

1.5 Reference documents

RD(1)	ROSETTA Experiment Interface Document Part A (EID-A), RO-EST-RS-0002/EID-A, Issue 2.0, 01.06.1999 for VEX: Astrium TBD
RD(2)	ROSETTA Experiment Interface Document, Part B, RO-EST-RS-30015/EID-B, Issue 1.0, 1/99 for VEX: Astrium TBD
RD(3).a	VIRTIS Software User Requirement Document (URD), VVX-GAF-UR-001, Issue 1, 01/2004, VIR-DES-304, Issue 11, 03.07.2001
RD(3).b	VVX Specific Software Requirements, VVX-DLR-RS-001, Issue 4.0, 09/2004
RD(4)	VIRTIS Software Requirement Document (SRD), VIR-DLR-RS-003, Issue 3.1, 20.07.01
RD(5)	Up- and Download of VIRTIS software and memory, VIR-DLR-TN-028, Issue 3.0, 14.02.2000
RD(6)	VIRTIS SW INTERNAL ICD, VVX-GAF-IC-002, Issue 1, 12/2003
RD(7)	VIRTIS OBDH SW ICD, VVX-GAF-IC-003, Issue 5, 9/2004
RD(8)	ESA software engineering standard, ESA PSS-05-0 Issue 2, February 1991
RD(9)	VIRTIS ME Acceptance Data Package, VVX-KAY-DP-0xx
RD(10)	VIRTIS Software Acceptance Data Package, VVX-DLR-DP-001
RD(11)	Software User Manual for Creating TC lists based on a VIRTIS EEPROM software executable, VIR-DLR-MA-004, Issue 1, 26.07.2001
RD(12)	EEPROM Software Installation Procedure (based on Memory Upload by SIS TC list) VIR-DLR-MA-002, 6/2000
RD(13)	VIRTIS ME Software Internal ICD, VIR-DLR-IC-003, Issue 2.0, 12.10.2000
RD(14)	PROM software release note, VIR-DLR-LI-021, Issue 2.0, 01.02.2001
RD(15)	EEPROM software release note, VVX-DLR-LI-002, Issue 6.1, 22.03.2007

1.6 Conventions

Frame/Image

A Frame (more used for –M) or Image (more used for –H) is a full window acquisition from –M or –H. Full window means all elements (e.g. pixels) are requested and read from the –M detectors (via M-PEM) or from –H detector (via H-PEM). These are 438x256 elements for M-VIS channel, 438x270 for the M-IR channel and 438x270 for the H-IR channel.

M_Slice

A Slice is a 2-dimentional array of 16bit-elements with a spectral (X) and spatial (Y) dimension/resolution. For –M a Slice is an Image but already window adjusted. Window adjustment means “cutting” the Image from a M-VIS window of 438x256 elements or a M-IR window of 438x270 elements to a Slice of 432x256. A slice of 432x256 (spectral x spatial) can be decomposed to sub-slices of 144x64 (spectral x spatial). Sub-slices are needed for data compression.

H_Spectrum

A H_Spectrum is a composition of the 8 orders imaged on the H-IR detector, optically with a spectral resolution. It has a dimension of 3456 x 1 elements and is built by software based on 8 orders of 432 elements and a width of 5 pixel/order. The order width of 5 pixels are reduced to 1 pixel by averaging, so that a H_Spectrum of 8x432x1 (3456x1) is build.

H_Image_Slice
–H produces normally a H_Spectrum or H_Spectra. In some modes an H_Image_Slice (432x256 pixel) is transferred as TM data. In order to be able to compress a H_Image_Slice (e.g. in H_Calibration mode), the H_Image_Slice is read from the H-PEM as H_Image of 438x270 pixel, is window adjusted to a H_Image_Slice of 432x256 pixel and is processed/compressed in the same way as a M_Slice.

H_Spectra_Slice
A H_Spectra_Slice is 2-dimentional data array, software composed by 64 x successive H_Spectrum of science data and has a total dimension of 3456 x 64 elements. This H_Spectra_Slice is composed in order to be able to have a spatial correlation of data inside the H_Spectra_Slice and therefore to be able to compress the data with a sub-slice (a 144x64 piece of a H_Spectra_Slice) as a compression unit. Before compression it is decomposed to 24 sub-slices to be sent as TM data.
Note that only science H_Spectrum (H_Spectra) are composed to a H_Spectra_Slice. A dark/background H_Spectrum is sent as spectrum to TM but without compression.

Sub-slice
A Sub-slice is a piece of a Slice and has a dimension of 144x64 elements. A Sub-slice is decomposed from a Slice or a 2-dimensial data array. This can be a M-VIS slice, a M-IR slice, a H_Image_Slice or a H_Spectra_Slice, all with a dimension of a multiple of a sub-slice (144x64) elements. The slice or 2-dimensial data array is decomposed to 12 sub-slices.
A sub-slice is always a compression unit.

Mode
A mode is a special operational case for the VIRTIS as instrument, working with a special configuration set by –M and/or –H parameter. This special configuration results to a unique VIRTIS TM data rate and power consumption (as main characteristics defined by ESA requirements), and to a special VIRTIS internal function, TM format, etc.. The Mode is influenced by operational parameters (e.g. M_Data_Production_Mode) or sub-system commanding (e.g. MTC_Cooler). It is built by software considering the commanded parameter and the instrument states (e.g. Cooler mode). The VIRTIS mode is composed by the 3 sub-system modes, M_Mode, H_Mode and ME_Mode and is shown in the TM_Default_HK report packet.

Data production parameter
Data production parameter are used for changing/initializing a –M or/and –H science mode which have influence on TM data rate and format (e.g. M_CALIBRATION mode).

Operational parameter
Operational parameter are mainly used for changing/initializing –M or/and –H science operation parameter which have influence on TM data rate and format (e.g. M_ERT).

Functional parameter
Functional parameter are mainly used for initialization the –M and –H sub-systems and have normally no impact on TM data rate and power consumption (e.g. M_IR_EXPO time).

Calibration parameter
Calibration parameter are mainly used for initialization the –M and –H sub-systems during on-board calibration and have normally no impact on TM data rate and power consumption (e.g. M_IR_LAMP_STAB time)

Alternate parameter
The Alternate parameter set is a small functional parameter set used only for M-IR alternate mode operation and have no impact on TM data rate and power consumption. The alternate default parameter set can be used only by changing the M_Data_Production_Mode parameter.

1.7 Abbreviations

ADC	Analog Digital Converter
ADP	Acceptance Data Package
AID	Acquisition Identifier
APID	Application Process Identifier
BBC	Board and Boot Controller
BKG	Background
BIT	Build-In Test
BPL	Backplane
CA	Composite Acquisition
CAC	Composite Acquisition Cycle
CAT	Category
CCD	Charged Coupled Device
CCE	Cooler Controller Electronics
COMI	Communication Memory (on DPU for 1355 I/F)
CRC	Cyclic Redundancy Code
DD	Data Dictionary
DHSU	Data Handling and Support Unit
DLR	German Centre of Aerospace
DM	Data Memory
Dmo	Development Model (sometimes also only DM)
DMS	Data Management System
DN	Digital Number
DP	Data Production
DPU	Digital Processing Unit
DSP	Digital Signal Processor
DSS	Donier Satellitensysteme GmbH (since 5/2000 Astrium GmbH)
ECA	Emergency Cover Actuator
e.g.	for example
EGSE	Electrical Ground Support Equipment
EID	Event Identification
EOP	End Of Packet (IEEE 1355 standard)
EQM	Electrical Qualification Model
ERT	External Repetition Time
FIFO	First In First Out
FM	Flight Model
FS	Flight Spare Model
GA	Galileo Avionica
HFC	High Frequency Clock
HK	HouseKeeing (sometimes also written as ‘H/K’)
HRD	High Rate Data
HS	High Speed
ICD	Interface Control Document
ID	Identification
IEEE	Institute of Electrical and Electronics Engineers
i.e.	that means
IFE	InterFace Electronics
IR	InfraRed
IRT	Internal Repetition Time
LCD	Liquid Crystal Display
LESIA	Laboratoire d’Etudes Spatiales et d’Instrumentation en Astrophysique
LSB	Least Significant Bit
LSW	Least Significant Word
ME	Main Electronics
MLC	Memory Load Command (one 16 bit TC word)
MSB	Most Significant Bit
MSW	Most Significant Word
NCR	Non Conformance Report
OBDH	On Board Data Handling

OG	Officine Galileo (Italian company, Florence), since 01.01.2002 Galileo Avionica
OM	Optics Module
OS	Optical Information System, department of DLR
OTS	Onboard Timer Synchronization
PAD	Process Application ???
PAT	Process Activation Table
PC	Personal Computer
PCAT	Packet Category
PEM	Proximity Electronics Module
PEU	Proximity Electronics Unit (located in PEM)
PI	Principle Investigator
PID	Process Identification
PM	Program Memory
PROM	Programmable Read Only Memory
PS	Power Supply
PUS	Packet Utilization Standard
P/SR	PROM Software Requirements
QM	Qualification Model
RAM	Random Access Memory
RD	Related Documents
RFW	Request for Waiver
ROM	Read Only Memory
RS	Requirement Specification
RTOS	Real Time Operating System
RTU	Remote Terminal Unit
SA	Structure Analysis
SS	Slice
SSL	Sub-Slice
SCET	SpaceCraft Elapsed Time
SDT	Serial Digital Telemetry (sometimes called Slow Data Telemetry)
SEU	Single Event Upset
SID	Structure Identifier
SIS	Spacecraft Interface Simulator
SMCS	Scalable Multichannel Communication Subsystem
SRD	Software Requirement Document
SS	Sub-Slice
SSMM	Solid State Mass Memory
SU	Scan Unit
SUM	Software User Manual
S/C	SpaceCraft
TBC	To Be Confirmed
TBD	To Be Determine
TBW	To Be Written
TC	Telecommand
TM	Telemetry
TSY	Timer Synchronization Signal
UR	User Requirement
URD	User Requirement Document
VEX	Venus Express
VIRTIS	Visible and Infrared Thermal Imaging Spectrometer
VIS	VISible
VVX	VIRTIS for Venus Express
X-CCE	either M-CCE or H-CCE
X-Cooler	either M-Cooler or H-Cooler
X-ECA	either M-ECA or H-ECA
X-PEM	either M-PEM or H-PEM

1.8 Problem reporting instructions

1.8.1 PROM software V2.0 implemented in ME FM

This section is valid for PROM software V2.0 and has to be considered for VVX FM.

All software NCRs as shown in RD(9) and issued during the software development and test have been closed.

Some Request for Waivers are applicable. These are:

- VIR-DLR-WV-002 (RO-VIR-RW-0031), Large TM response time after Connection Test Request
- VIR-DLR-WV-003 (RO-VIR-RW-0032), Length of CRC Appl. Field in TM_Memory_Check_Report
- VIR-DLR-WV-004 (RO-VIR-RW-0036), TC_Memory_Check not applicable for MemID=144 and 145
- VIR-DLR-WV-005 (RO-VIR-RW-0037), No TC Accept. Report after TC_Reset_TM_Output_Buffer
- VIR-RO-RW-0038 (DLR RfW has not been issued), PROM S/W does not accept service 9,2 if started unsynchronised
- VVX-GAF-WV-006 HS packet size and performance

These RfWs are mainly related to PROM software. A re-coding is not possible because PROM software V2.0 is burned in PROM and is soldered on the FM DPU.

After switching-on VIRTIS, a Primary Boot software doesn't issue a Primary Boot event (as required from Rosetta). In order to see that VIRTIS works, the VTM_ME_Default_HK_Report should be monitored by S/C/user.

1.8.2 FM ME hardware problems which has influence on Secondary Boot software

1) VVX-DLR-NC-001 EEPROM power switching problem
This problem is applicable only for PROM software but does not affect the user operation.

2) In case of –H science TM data are transferred by RTU link, the –H operational parameter H_Dark_Rate (commanded by HTC_Change_Operat_Param_*) should be greater than 2 otherwise the event 47928 "H_Data_Slice_Lost" (data acquisition lost from H-PEM). The TM data are correct but some acquisitions from H-PEM (e.g. H_Spectrum) are lost.

3) The following NCRs must be considered concerning ME Default HK "ME_PS_TEMP" and "ME_DPU_TEMP" interpretation which is applicable for the ME with the FM and QM Power Supply:

- RO-VIR-NCR-0059 (ME hardware), +4°C Power Supply temperature (ME_PS_TEMP) offset
- RO-VIR-NCR-0072 (ME hardware), +3°C DPU temperature (ME_DPU_TEMP) offset
- VVX-GAF-NC-015 ME_PS_TEMP HK changes in reference to the IFE status
- VIR-KAY-NC-072 Offset of PS temperature measurements

Due to these NCRs 3…4K must be substracted from the Default HK "ME_PS_TEMP" and "ME_DPU_TEMP" in case that the ME redundant channel is ON but the H-CCE (inside the ME) is switched-OFF. If the H-CCE is ON the temperature HKs ME_PS_TEMP and ME_DPU_TEMP are correctlz displayed.

2 Overview of the Software

From the Software design point of view, the software is divided in two parts (i.e. two separate executables), the PROM software and the EEPROM software. The PROM software (also called

Primary Boot software) is active after VIRTIS ME power-on. The EEPROM software (also called Secondary Boot or Application software) is started by a special TC, given in Safe mode (i.e. VTC_Enter_Idle_Mode).

Generally the PROM and EEPROM software have the following tasks (FM level):

- Managing the start-up procedure after power-on
- Verification and check of telecommands (TC) and packing of telemetry
- Memory management (up- and download of software)
- Initiating and overall control of the instrument modes
- Health checking, diagnostics and error handling including watch-dog control
- Management/storage/maintenance of default system parameter configuration and system status
- Initialising and command of the –M and –H sub-system
- Control of Visible and IR detector units, calibration sources, shutters, annealing heaters
- Movement and status control of covers by controlling the stepper motor and Emergency Cover Actuators (ECA)
- Commanding and mode control of active cooling sub-systems
- Request, acquisition and verification of science data and housekeeping
- Calculation and management of pixel map –or -H selective pixel read-out
- Performing and managing of operational science and control sequences

2.1 PROM / Primary Boot Software functions

The PROM software provides low level functionality and is the 'BIOS' of VIRTIS with the following functions:

- Initialization of the ME DPU and ME Power Supply (PS) after power-on
- Power-up, reset management and SCET synchronization
- Entering the Safe mode (default for VIRTIS operation) or Development mode (only for EEPROM S/W development purposes)
- Collection and providing Default HK TM
- Low level TC receipt (via MLC interface), verification, acceptance and execution
- TM packing, buffering and transfer to S/C via SDT interface
- ME DPU Memory Management including upload, dump and check of memory (i.e. RAM, EEPROM and PORTs) performed by separate TCs via MLC interface
- Boot and start of Secondary Boot software in RAM by IEEE-1355 interface (Boot loader provided by ASTRIUM)
- Maintenance of up to 8 different secondary boot executables in EEPROM
- Health check and error/event handling incl. failure override function
- Test display control for displaying Safe mode status and HK information

Note: In Safe mode (i.e. with PROM software) it is never possible for the user to have access to the –M and –H sub-system. Only the memory upload/dump to/from memory ports allows (i.e. very low level) to have access on all H/W interfaces, also to –M and –H. But this option is recommended to perform only by ME and/or software developers.

2.2 EEPROM / Secondary Boot Software functions

The EEPROM software provides partially the same functionality as the PROM software and additionally all VIRTIS-M and -H control functions. These are:

- Initialization of the ME M- and/or H-Interface Electronics as well as the –M and –H sub-system after power-on
- Low level and high level TC verification, acceptance and execution
- TM packing, buffering and transfer to S/C
- SCET re-synchronization
- Collection and providing of VIRTIS Default, General and PEM science HK
- Interfacing the M-PEM, H-PEM, coolers and ECAs
- Control and monitoring of –M and –H control, calibration and science sequences
- Entering the ME IDLE mode, instrument control modes and Science modes

- Science data acquisition, TM packing and transfer to the S/C via IEEE-1355 HS link or via SDT interface
- -M and –H science data handling, processing and compression
- Health check and error/event handling incl. failure override function of several error categories
- Test display control for displaying instrument status and HK information

2.3 Software design

The PROM software is hard-coded in the Main Electronics/DPU and the EEPROM software is stored in EEPROM and is changeable by memory upload (memory management service).
The PROM software is written in Assembler, the V2.0-1 has a size of 5139 48bit instructions and consists of 66 modules.

After Primary Boot the PROM software runs using only the Program Memory (PM) for safety reasons. Primary Boot is performed by the DPU Board and Boot Controller (BBC) after +28V power-on. The PM has a very good Single Event Upset (SEU) performance (almost SEU free) while the Data Memory (DM) is SEU sensitive. Therewith a safe behaviour of all PROM software functions can be assumed.

The EEPROM software is stored in EEPROM as PM and DM segments with segment checksum for verification during upload and start (i.e. Secondary Boot from EEPROM in RAM). It runs in PM and DM RAM.

The EEPROM software is mainly written in C with low level functions in Assembler for speed and code optimization. The Real Time Operating System (RTOS) VIRTUOSO is used and 51 processes can be active simultaneously (FM software). The Secondary Boot software consists of about 200 functions, excluding VIRTUOSO functions/library. VIRTUOSO V4.1 R2.05 is used.

The size of the secondary boot software is about 83Kwords with 68K Instructions and 15K Program data/parameter. The compressed (mem21k) code stored in EEPROM is 354Kbyte (about 60Kwords). This means two executables are able to be stored in EEPROM from the size point of view. Generally about 170K Instructions can be stored in EEPROM as maximum and up to 8 different executables.

For uploading a new SBS in EEPROM about 1600 memory upload TCs are needed to be sent to VIRTIS.

3 Overview of the Main Electronics Hardware

3.1 Use of the Main Electronics

The handling of the ME hardware is shown in the VIRTIS ME hardware ADP, see RD(9).

3.2 Hardware Architecture

3.2.1 General

The ME consists of the following modules:

- The DPU (main or redundant) as processing core with DSP, RAM, PROM, EEPROM, S/C interface electronics and interfaces to the ME internal modules
- The Power Supply (PS) consisting 4 independent DC/DC converters for supplying
  * the internal ME modules, main DPU including M-IFE and H-IFE
  * the internal ME modules, redundant DPU including M-IFE and H-IFE
  * the external M-PEM and related –M electronics in the OM (e.g. cover unit)
  * the external H-PEM and related –H electronics in the OM (e.g. cover unit)
- The M-CCE (Cooler Control Electronics) for controlling the M-cooler located in the OM
- The H-CCE for controlling the H-cooler located in the OM

In case of switching-on the main +28V S/C power interface, the main DPU and the main PS +5V DHSU converter is ON, in case of switching-on the redundant +28V S/C power interface, the red. modules are ON.

3.2.2 Digital Processing Unit

Core of the DPU is the Digital Signal Processor (DSP) TSC21020E. It is a hi-rel version of the ADSP21020 and is functional compatible with this Analog Device DSP.

The DPU communicates with the VIRTIS-M, VIRTIS-H sub-systems by serial command/data interfaces. It provides the IEEE-1355 high speed science data interface (HS link) to the S/C Solid State Mass Memory (SSMM), the low speed data (SDT) interface for the transfer of housekeeping and the MLC interface to the Remote Terminal Unit (RTU) for VIRTIS telecommanding by the S/C or to the EGSE/SIS for on-ground tests. Internally, the DPU controls all other ME units, using separate low speed serial or parallel interfaces.

The DPU memory is divided into three sections, the program code memory, the program data memory and the image data memory. The program memory consists of a PROM, EEPROMs and SRAMs. The PROM contains PROM software (i.e. primary boot loader) as safe mode kernel. The EEPROM bank stores permanently the main part of the application S/W and parameters which can be up-loaded from ground. An image data memory is used to store the raw science data and the intermediate products for data handling and compression.

The main functionality of DPU is concentrated around the Digital Signal Processor (DSP) TSC21020E which provides computational resources and control capabilities. The DSP operates at 20 MHz yielding 40 MFLOPs (typical) to 60 MFLOPs (peak) processing power. A further key function is the high-speed serial link communication, which is realised by an ASIC implementation (SMCS332) of the IEEE-1355 standard. The SMCS332 has 3 IEEE-1355 full-duplex links (2 links are used for VIRTIS) that execute data transfers with low CPU intervention. Each of the links supports high level protocol handling running full-duplex at up to 200Mbit/s. For VIRTIS only two links with a maximum speed of 10 Mbit/s are used, one for the transfer of scientific data to the SSMM, the other for interacting with a controlling Host PC for development and verification purposes.

The DPU local memory concept is based on a fast static RAM (SRAM). It provides 128 kwords (48 bit) program memory, for 512 kwords (40 bit) data memory and 8 kwords (16 bit) dual-ported communication memory. The communication memory provides bi-directional buffering between the local processor and the SMCS332. It decouples the different speed characteristics of the DSP and the communication link.

The DPU contains a BBC implemented in an ACTEL FPGA. It manages the start-up phase of the board by copying the byte-wide PROM content (initialisation and secondary boot routines) into the Program Memory workspace. Additionally the BBC provides functions such as a timer, an interrupt control circuit, watchdog and a specific power save mode logic.

The DPU Extension Board is an extension unit for the DPU which contains only VIRTIS specific functionalities. These are the On-Board Data Handling (OBDH) interfaces, a data memory extension, an EEPROM bank, internal interfaces to other Main Electronics units and additional control logics located in an ACTEL-FPGA. Reading the status of the DPU Extension Board, as well as writing the configuration of the local resources, is managed by simple memory accesses of the TSC21020E.

A 2Mx16bit image memory extension is used for intermediate buffering the spectral data before compression. A 1024K*8bit EEPROM memory (1024K*8bit = size for EQM/QM/FM, DM size = 768k*8bit) provides non-volatile storage of program code and mode parameters. The EEPROMs are only switched-on/off during the secondary boot load of EEPROM content into the Program Memory in order to minimize radiation influences during VIRTIS mission operation. The necessary separation of the EEPROM lines from the DPU buses is realised by means of additional bus drivers in order to avoid power loading conflicts.

Serial 16bit unidirectional interfaces to the spacecraft (MLC and SDT) are used for telecommand (TC) and telemetry (TM) transmission from and to the S/C. TM and TC data are buffered by two separate 8K x 9bit FIFOs. Power Supply, M-IFE, H-IFE and the external test display are controlled by additional separate 16bit serial unidirectional interfaces. Several timers are implemented for providing the VIRTIS on-board time, for synchronising the internal data acquisition and health checking functionalities, clocked by the external high accuracy High Frequency Clock (HFC) provided by the spacecraft. Interface and timer events activate a control logic signalling interrupt to the processor TSC21020E.

The software communicates with the hardware sub-system or units by several software interfaces, externally to the S/C, VIRTIS internally to the PEMs and ME internally to several ME units.

The following software interfaces connect VIRTIS with the S/C :

- MLC interface,
- SDT interface.
- High Rate Data (HRD) interface (also called HS link interface) and

Additionally, the software controls the M-PEM and H-PEM by separate hardware and software interfaces provides by the M-IFE and H-IFE.

4 Test Display as Support Facilities for the User

For easy monitoring of few VIRTIS software and hardware status information if VIRTIS is not integrated on the Rosetta Spacecraft, a test display can be used by a software/ME user and developer.

It is recommended to use the test display as much as possible before VIRTIS is integrated on the S/C. So, the user gets always a quick overview about status and behaviour of the ME additional to the EGSE.

If the Main DPU (i.e. Main +28V is ON) is active the test display (1P10) has to be connected directly on the ME test connector 1J10. In case that the redundant DPU (Red. +28V is ON) is used, an adapter A_1J10_Red has to be connected between the test display and the 1J10 connector. A_1J10_Red is needed for cross wiring the test display interface from the redundant DPU to the test display connector.

Connecting or not connecting the test display on 1J10 has no influence on the software behaviour. The test display itself is supplied by +5V located on 1J10, derived from the ME DPU voltage. It takes about 80mA from +5V.

40x4 alphanumeric letters are shown on the LCD test display. A test switch "TEST-INPUT" is integrated in the display which allows a simple input control by the user, managed by PROM or EEPROM software. A reset bottom "DPU-RESET" allows the user to reset the DPU, which causes a Primary Boot and start of PROM software. "RES-1", "RES-2" and "RES-3" are not used or not connected.

The following information are shown on the **display view 1** (issued by PROM or EEPROM software) as shown in Appendix 5:

- Current active ME mode by e.g. "Mode: Safe" (Develop, ME_IDLE, ME_SCIENCE, or ME_TEST)
- Last occurred error ID by e.g. "Error ID: 0" (it is reset to "0" after each push the test switch)
- Current SCET status by e.g. "SCET: 123sec"
- Number of received TC packets by e.g. "TC count: 10" (it is reset to "0" after power-on)
- Last receipt TC type and sub-type by e.g. "Last TC: T9/1"
- Number of transferred SDT TM packets by e.g. "TM count: 15" (it is reset to "0" after power-on)

In case that an error (event) is detected by software, the error ID (event number 47501...48000) is displayed by **Error ID:** ... and the SCET is catched when the error is occurred (i.e. the SCET display stops to run) until the test switch is pushed. Then the SCET runs again and the Error ID: 0 (no error) is displayed. This allows the user to recognize the time of error/event occurrence. If a "new" error occurs while catching, this error is not displayed, only the last one.

The following information are shown on the **display view 2** (issued by PROM or EEPROM software) as shown in Appendix 5:

- DHSU (DPU and M/H-IFE) voltage by e.g. "DHSU voltage: 5.0V"
- DHSU (DPU and M/H-IFE) +5V current by e.g. "DHSU current: 1.0A"
- EEPROM +5V power status by e.g. "EEPROM power: ON"
- Power Supply temperature by e.g. "PS temp: +37°C" (temperature of the PS HK module)
- DPU temperature by e.g. "DPU temp: +28°C" (temperature of the DPU PM chips)
- Number of transferred HRD TM packets by e.g. "HRD count: 0" (only in EEPROM software, it is reset to "0" after each TC_Enable_Science)

The following information are shown on the **display view 3** (issued only by EEPROM software) as shown in Appendix 5:

- M-PEM, M-IFE, M-CCE/Cooler status by e.g. "V-M power: OFF"

- H-PEM, H-IFE, H-CCE/Cooler status by e.g. "M-IFE power: ON"

Changing the views can be achieved by pushing the test switch on the test display.

Note: the "TEST-INPUT" switch is polled by software only once a second, so that changing the display views are only possible once per second (not faster).

In addition to the LCD display, the following information are shown by LEDs, controlled by M-IFE or H-IFE hardware (not by software).

- 2 x 4 different LEDs show a low level M-PEM and H-PEM communication status (4 LEDs for -M and 4 LEDs for -H)

1. LED "CMD" -> command transfer to PEM
2. LED "CMD CCE" -> command transfer to CCE
3. LED "IR-DATA" or "VIS/IR-DATA" -> -H IR–and/or -M VIS/IR data transfer
4. LED "Diagnose DATA" -> IFE is in diagnosis mode (i.e. active in ME test mode)

Note, that the display provides only simple auxiliary information for the ME/VIRTIS user and can not replace any function of the EGSE or SIS.

For software development purposes (only possible at DLR) host level debugging information provided by VIRTUOSO can be displayed on a Host PC in the development mode (transferred by the 1355 link test interface on 1J10). During development mode the executable S/W code is uploaded and executed directly in the DPU RAM without any reprogramming the EEPROM. For connection 1J10 with the host PC, an RS422/PECL adapter is needed which can connect both, the 4links PC board (located in Host PC) and the test display.

5 Installation and Maintenance of the Software

The PROM software is hard-coded in the DPU PROM and cannot be changed without opening the ME box. That's why an easy change isn't possible and will be done only once per ME model. The EEPROM software is stored in EEPROM on the main and redundant DPU, i.e. the same (identical) S/W version on each DPU.

In case that an update is needed, the EEPROM software can be changed by upload TCs in Safe mode (memory management service TC, see TC_Load_Memory (T6, ST2), page 103, Memory ID: 140).

The DLR has developed on-ground tools which generates SIS compatible TC lists based on an EEPROM software executable. The TC list can be very large (e.g. the size of TC list for EEPROM software is over 1600 TC packets with a TC packet size of 124 words). Details about uploading/installing of a new executable or about creating of a TC list from an executable is described in RD(12) and RD(11).

Uploading takes therefore few minutes up to hours depending on the TC rate. The TC packet rate shall not be faster than 110ms / TC packet.

After upload, the new executable can be started in Safe mode by VTC_Enter_Idle_Mode (T192, ST2) (see page 110) (including EEPROM address). In order to know, how the EEPROM status is:

1. The EEPROM status list can be used (located in the Software ADP, see RD(10))

2. VTC_Get_EEPROM_Status (T192, ST64) (see page 112) can be used in order to get the EEPROM status by TM (see TM_EEPROM_Stat_Report (T5, ST1, EID47502, APID51,7), page 147), i.e. the version of all executables located in EEPROM.

3. For verification, an Normal Progress Event TM report TM_Secondary_Boot_Completed (EID=47501, see page 148) is sent to the S/C after the Secondary Boot is completed (few milliseconds). This report includes information about the S/W version to be booted from EEPROM.

Note: max. 8 executables (depending on size) can be maintained in EEPROM, nominally 2 executables of FM level software

The valid EEPROM software version is located on and has to be started from EEPROM address <u>0x20078000</u> or <u>0x20000000</u> (see TM_EEPROM_Stat_Report) as current baseline EEPROM configuration.

Further details are shown in chapter 7.10, Memory Management Service, page 33.

6 Getting Started after VIRTIS/ME power-on

6.1 Preconditions before VIRTIS power-on

Be sure that the ME hardware/software is configured as follows (see also “ME transport, handling, installation procedure located in RD(9) for details):

- 1J01 and 1J02 (main) or/and 1J03 and 1J04 (red.) are connected to the SIS/EGSE or S/C (mandatory)
- the High Frequency Clock (HFC) is running (before power-on !) provided by SIS/EGSE or S/C on 1J02 or 1J04 (mandatory)
- the test display is connected on 1J10 (optional, but recommended for users with less or medium knowledge with the VIRTIS software or operations) with A_1J10_Red if the red. channel is used (see chapter 4, page 20 for details). Note: for DLR internal software development purposes, the RS422/PECL adapter has to be connected on 1J10.
- 1J05, 1J06, 1J07, 1J08, 1J09 are connected (optional depends on the goal of the software/hardware use)
- the proper EEPROM software is installed/stored in the main or red. EEPROM (mandatory if a –M or –H operation shall be done)

If the ME is properly configured, the +28V can be switch-on.

Note 1: with +28V power-on only a part of the ME (PS DPU converter, HK unit and DPU) are ON. **No** other unit or sub-system is powered. Powering of –M or –H can be done only by user action (i.e. TC transfer) if the ME_IDLE mode (i.e. EEPROM software) is active.

Note 2: if the ME M-PEM Power Supply converter shall be switched-on without connecting the M-PEM with the ME, an failure event occurs, because the Power Supply signals that the M-PEM is not switched-on. Therefore, the M-PEM voltage grounds/return lines must be connected together otherwise the grounds are floating which is detected by the PS hardware status acquisition circuit.

6.2 Operations after VIRTIS power-on

4 seconds (as maximum) after VIRTIS ME +28V power-on (i.e. PS DPU converter and DPU are ON), the PROM software is booted and started in PM RAM, it waits for TC receipt, and is ready for TC execution.

That means, after power-on VIRTIS stays in Safe mode.

Within the first 60 seconds after PROM software start, only the TC_Accept_Time_Update (T9, ST1) (see page 106) is accepted for execution. **No** TM is sent to the S/C until the SCET has been sent by the S/C (or EGSE/SIS) and the VIRTIS/ME internal timer is updated and runs. If a TC_Accept_Time_Update (T9, ST1) isn’t received within this first 60 seconds, the ME timer starts automatically with an unsynchronized time equal to 0x8000 0000 0000 (= 2147483648 seconds).

In any case, if the ME (SCET) timer runs synchronized or unsynchronized:
- the Default HK (SID=1) TM packet is sent automatically once every 10sec, i.e. the Default HK generation is enabled after power-on
- the software is able to execute all TCs which are allowed for execution in Safe mode.

Note, a special primary boot TM message (packet) is not sent by TM. The first TM after power-on is the default HK TM packet (i.e. VTM_ME_Default_HK_Report).

If the user wants to go directly to a VIRTIS-M or/and –H operation, the VTC_Enter_Idle_Mode (T192, ST2), which starts the secondary boot from EEPROM, can be sent and the ME waits in ME_IDLE mode for further commanding (e.g. MTC_Cooler (ON)).

After VTC_Enter_Idle_Mode (T192, ST2) and immediately after successful entering the ME_IDLE mode, a TM_Secondary_Boot_Completed is sent confirming a start of a Secondary Boot executable.

Note, the parameter ME_DPU_Reset_Cause (located in TM_Secondary_Boot_Completed) must be set to “1” (ME/DPU +28V (+5V) Power OFF/ON.

Normally when science data shall be acquired from VIRTIS by the HS link, the HS link has to be established by TC_Start_HS_Link or by TC_Reset_And_Start_HS_Link (see chapter 6.3, 7.17.3 and 7.17.4).

Note, the HS link can not be established in Safe mode (i.e. by PROM software). It has to be established in ME Idle mode (performed by Secondary Boot software).

6.3 Starting the High Speed link before Acquisition of Science Data

Before Science Data are acquired from VIRTIS or a science, test or calibration mode shall be started, the HS link has to be started (i.e. established) before starting the TM packet / HRD transfer via HS link. For this purpose the following steps have to be performed (see also Figure "High Rate Link Start-up Procedure" below):

1. Be sure that the ME_IDLE mode is already active (started with VTC_Enter_Idle_mode), that means the EEPROM software runs.

   Note: establishing the HS link is **not possible in Safe mode** (i.e. the HS link isn't supported by PROM software)

2. Be sure that the S/C (SIS or EGSE) is ready for receiving tokens from the ME over the HS link. That means the HS link hardware is reset and ready for receipt.
3. Sent TC_Reset_And_Start_HS_Link or TC_Start_HS_Link to VIRTIS in order to request sending of NULL tokens from the ME to the S/C (SIS or EGSE).
4. The S/C receives the token and sent back token from the S/C to the ME
5. If the procedure is successfully performed, the link is established which means tokens (i.e. control characters) are exchanged between the S/C and the VIRTIS ME.
6. Now the science data transfer can be enabled by TC_Enable_Science (M or/and H)

Note: the ME HS link transmitter is initialized and work always with 10Mbit/s. Transferring data from the ME to the S/C with 5Mbit/s (as option foreseen in RD(1)) is not possible.

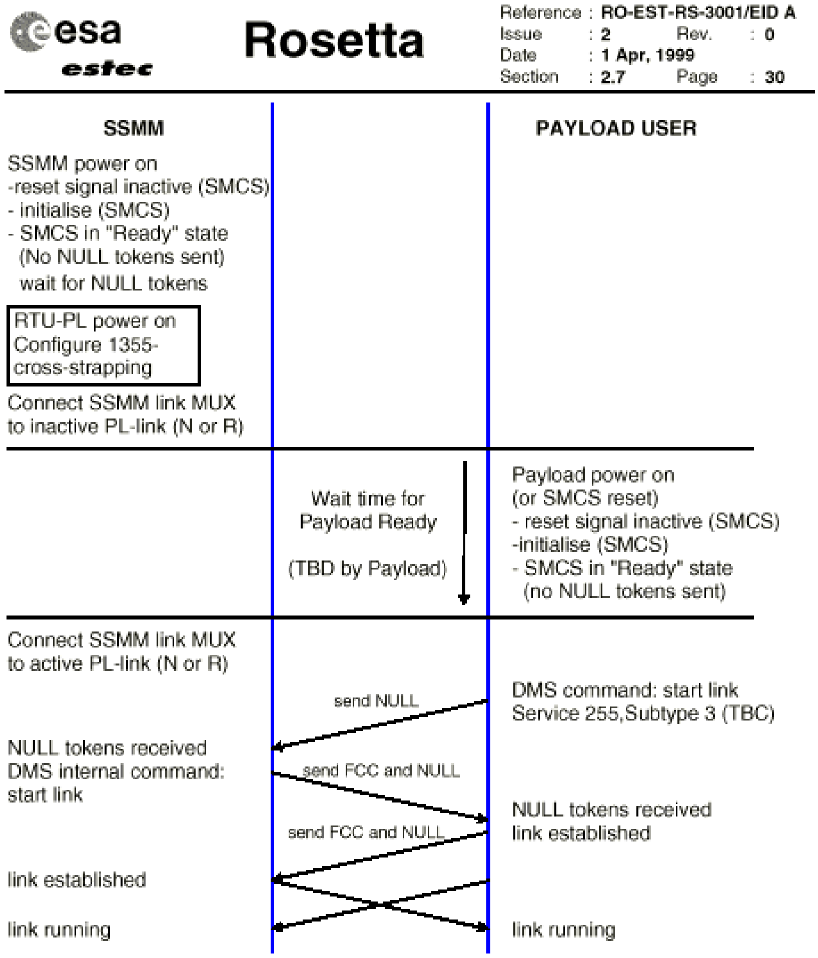


Figure 2.7.3-6: High Rate Link Start-up Procedure

6.4 Default science operation

In case that VIRTIS was successfully switched-on, the SCET timer is synchronized and the HS link is established, VIRTIS can be started in a default (nominal) science mode without commanding it with operational, functional or other parameter. A minimum commanding to go in the VIRTIS default mode “M_SCIENCE_NOMINAL_1” and in “H_SCIENCE_NOMINAL_DATA_RATE” is shown in Appendix 13b: Examples: VIRTIS science default operation (page 194).

In case that VIRTIS shall work in an other mode different from the default mode, the operational parameter must be changed as shown in the chapters 8, 10 and 11.

7 TC and TM Servicing

7.1 Generals

VIRTIS is operated mainly by Telecommands [TCs] transferred by MLC interface. Some few functions has to be commanded directly from the S/C by separate hardware interfaces. These are the Decontamination heaters and the M-CCD heaters supplied by separated +28V interfaces, fully controlled by the S/C.
Telemetry [TM] data, generated by VIRTIS, are transferred by the SDT and HRD interface to the S/C. By default science data are transferred by a separate High Speed 1355 link interface (i.e. High Rate Data, HRD interface), due to the large amount of data produced by VIRTIS. Other TM with low data rate are transferred by SDT interface.
Additionally, some Thermistor hardware interfaces provide temperature information directly acquired by S/C if VIRTIS is powered-off.

TCs as well as TM data are exchanged between VIRTIS and the S/C based on a standardized software interface containing a character → exchange → packet → service → user layer structure. The standardised packet data field structure (following the ESA Packet Utilisation Standard, PSS-07-101, Issue 1) allows functional decomposition of on-board data interfaces, which reflect the operational requirements of the S/C.

For the user of the VIRTIS software the main "visible" part of the software interfaces is the TC and TM packet structure and handling, which implies the packet, service and user layer.
Each TC or TM packet has a standardized packet format with specific information to verify and handle the incoming (TCs) and outgoing (TMs) data.
The VIRTIS functionality (as all other VENUS EXPRESS payloads) related to operational concept on-board and on-ground is expressed in terms of packet services in order to operate all payloads in a consistent way. Servicing mean that VIRTIS is capable to recognise TCs and produce TM packets consistent for a specific service type as described below.
A unique service number is designated to each service. The service is broken down into Service Requests (TC packets or TCs) and Service Reports (TM packets). Requests and reports are identified by a sub-type number, which is unique within the service.

VIRTIS supports or doesn't support the services as shown in the table below:

Service Type	Service Name	Supported
1	Telecommand Verification	Yes
3	Housekeeping Reporting	Yes
5	Event Reporting	Yes
6	Memory Management	Yes
9	Time Synchronization	Yes
17	Test Service	Yes
18	Context Transfer	No
19	Information Distribution	No
20	Science Data Transfer	Yes
192-254	Payload Private Telecommands (for VIRTIS 192, 193, 194)	Yes
255	Common Payload Telecommands	Yes

More details about TC/TM servicing and structure are shown in RD(7) and RD(1).

7.2 TC Receipt, Acceptance and Execution

From the software point of view, the TC receipt, SDT TM generation and the HRD (science data) transfer are separate and independent processes.
All incoming TC packets are buffered in a hardware FIFO. That means TC data cannot be lost for a certain time period (depends on the TC data rate) without resetting the hardware. VIRTIS can physically buffer up to 4096 16bit MLC words without any loss. In any case, the TC acceptance/execution time (or TC data rate) has to be considered by the user for long TC sequences. Internally, the MLC interface is polled once per 100ms while other processes are running parallel.

It is recommended to command VIRTIS with a TC rate not faster than one TC per 110ms average for TCs with TM acceptance reporting only. The TC acceptance takes max. 4 seconds and the TC execution takes several seconds up to about 30sec maximum (e.g. opening the cover takes seconds/minutes) before issuing acceptance TM report or execution TM report. Execution TM reporting is done only for some TCs which execution takes longer than about 10sec.

TM execution reporting is done for:

- **XTC_Cover** (execution time is about 60sec maximum, depending on functional parameters X_OPEN_COVER_STEP, X_CLOSE_COVER_STEP and X_INIT_COVER_STEP cover control)
- **XTC_ECA** (execution time is several minutes, depending on functional parameter X_ECA_ACT for ECA control)
- **XTC_PEM** (execution time is several seconds in case of XTC_PEM(on), depending on duration of the X-Cover initialization procedure)
- TC_Disable_Science_HS_Link and TC_Disable_Science_RTU_Link (execution time is msec up to seconds depends on finalizing the science data acquisition and transfer)

Note: “X” stands as a place holder for M, H or V

After receipt of a TC packet, the TC is verified (see TC verification service), is accepted (or not accepted in case of failure) and is executed depending on type and sub-type of the TC. Execution means, the requested functionality of the TC is performed together with related TM reports and corresponding TM reports are sent to S/C.
Note, that each TC has one consistent function. That means, from the commanding point of view it is never needed to send two or more TCs to achieve one function, except two cases (i.e. after XTC_ECA or after VTC_Failure_Override) where a VTC_Confirm is needed for safety reasons. Of course, normally it is needed to command a sequence of TCs to operate VIRTIS in a logical consistent way (e.g. to enter VIRTIS in a specific science mode).

7.3 TM Generation and Transfer

VIRTIS TM packets are generated via SDT (operational and science TM) or HS link interface (only science TM):

- after request by TC (e.g. TC verification Service Report, or TC Test Report)
- if an asynchronous event occurs (e.g. on-board action event report)
- periodically e.g. for HK acquisition/generation
- continuously if a science data generation/transfer is enabled in degraded mode (if the HS link cannot be used)

Transferring the **SDT TM packets** to the S/C is performed:

- if the ME internal TM collection buffer is full (6144 words block size is achieved) **or**
- if the ME internal TM packet collection interval of 16 seconds is over **or**
- if a TC acceptance TM report is generated and max. after 4 seconds of TC receipt/acceptance
- if a TM_Connection_Test_Report is generated max. 16 sec. after TC_Connection_Test_Request
- and if the S/C polls and acquires the TM data

All generated TM packets are buffered in a software FIFO buffer with a size of 6144 16bit words and in a hardware FIFO buffer with a size of 4096 16bit words. This allows avoiding TM data loss between the S/C polling interval (gap). The S/C polls the SDT interface once every 1 second (min) to 16 second (max). Polling the SDT interface means, the S/C gets a 16bit word from the SDT interface after a period of time (i.e. Polling Sequence Table, PST). If the content of the word is equal “0x0000”, there are no TM data available in the TM hardware FIFO buffer and the S/C collects no additional TM data. If the content of the word is greater than “0x0000”, it represents the number of words to be acquired as TM block. A TM block can contain one or more than one TM packets and its max. size is 6144 words. A TM packet size can be 8 ... 2056words, which corresponds to a TM packet length of 9...4105 octets.

Note: if a SDT interface polling is not active, the internal buffer overflows after a while. The software detects an error (FIFO overflow) but it is not possible to send an event TM report to the S/C. In this case the software resets the DPU which means VIRTIS goes in Safe mode.

Transferring the **HS link TM packets** to the S/C is performed after TC_Enable_Science_HS_Link. The TM packet size is 14words ... 512words (incl. TM header and Science header fields). 512words is the nominal TM packet size. Smaller TM packets are sent only in case that the "rest" of a sub-slice (data packet for -M or –H) or of a spectrum (data packet only for –H) is transfered. The 1355/TM interface performance is shown in Appendix 15.

Note especially for VEX and sending TM data by HS link

Each TM packet has a supplementary header of 32bit containing 0x1C000000. But the maximum physical size of a TM packet sent by HS link remains as 512 words. That means one science TM packet (for –M or –H) contains 498words (i.e. real science data without header) and not 500words as sending science TM packets by SDT interface.

7.4 PAD Field Handling in TC and TM Packet Header

The PAD field of some TCs is copied in the PAD field of the corresponding 'solicited' TM packet (ref. AD(1), Sec.2.8.3.12). This has to be considered for the following services where a TC requests causes a explicit or implicit TM report.

- **Memory Management service (i.e. Dump, Check Memory),**

1. The PAD field content is copied from TC_Dump_Memory (T6, ST5), see page 105 into the TM_Memory_Dump_Report (T6, ST6), see page 130.
2. The PAD field content is copied from TC_Check_Memory (T6, ST9), see page 105 into the TM_Memory_Check_Report (T6, ST10), see page 129.

- **Telecommand Verification service**

The PAD field of each TC which has to be accepted by an Acceptance Report is copied into the TM_TC_Acceptance_Report_Success (T1, ST1), see page 126 and TM_TC_Acceptance_Report_Failure (T1, ST2), see page 126.

- **Test service (i.e. Connection Test)**

The PAD field content is copied from TM_Connection_Test_Report (T17, ST1), see page 129 into the TM_Connection_Test_Report (T17, ST1), see page 129.

7.5 Sequence Counter Handling in TC and TM Packet Header

The TC sequence counter (word 2 of each TC packet) is **not** verified or interpreted by the software.

The TM sequence counter (word 2 of each TM packet) is increased by 1 after VIRTIS power-on (starting from 0 for the first TM packet). For each APID a separate sequence counter is maintained by the software. Each sequence counter has a size of 14bit and wraps around starting with 00000000000000b (0) to 11111111111111b (16383) before starting with 0 again. All sequence counters are reset to 0 only after power-on.

Different sequence counters are maintained for TM reports with an APID as follows:

APID (PID, PCAT)	TM report
PID51, PCAT1	Acceptance Reports
PID51, PCAT4	HK reports
PID51, PCAT7	Event Reports and Connection Test Report
PID51, PCAT9	Memory Management reports
PID52, PCAT12	M-Science data and ME M-IFE test pattern
PID53, PCAT12	H-Science data and ME H-IFE test pattern

7.6 Time Stamping of each TM Packet

Each TM packet sent to the S/C is time stamped using the internal ME SCET timer (see chapter 7.11"Time Synchronization Service", page 35). The 48bit time is written in the TM packet word 4...6. The resolution is 15,3µs (LSB).
ME internally, the time is read from the 48bit timer if the event occurs (i.e. it is not read if the TM packet is put in the TM buffer or sent to the S/C) in order to achieve a high correlation between the event for TM production and the absolute SCET. That means:

- The time for stamping the Science data/HK TM packets is read when the first word of the science data has been acquired from the PEM. That means all TM packets containing a –M or –H slice and the M-PEM and H-PEM HK have the same (identical) SCET.
- The time for stamping the event TM packets are read immediately (few µsec) after event occurrence.
- The time for stamping the HK TM packets are read immediately after acquiring the HK.
- The accuracy for Science and HK TM time stamping is better than about 20ms.

Notes:

Accuracy
The 20msec value comes from the polling cycle of the hardware FIFO when the data (sent by the PEM) are stored. That means the SBS recognizes the first incoming data word from the PEM-Interface at latest after 20ms and therefore the time stamping accuracy is +0...20ms.

(Non-)Correlation between Packets sequence Counter and SCET
For science data and PEM HK data the time stamping (read and internal storage of SCET) is done when the first word of data is received from PEM but the Sequence counter is counted-up (and set together with corresponding SCET) shortly before the TM packets are written in the TM buffer.
This is done in order to have the best absolute time correlation of the -M and -H science data.

7.7 Telecommand Verification Service

Each TC receipt is verified about:

- APID of TC packet header. It must be always PID=51, PCAT=12
- Correctness of packet length / completeness of TC packet
- Correctness of acknowledgement field in TC packet header
- Type and sub-type of allowed VIRTIS TCs
- Correctness of CRC
- Range of Application data parameter. It is checked the minimum and maximum of the application data field parameter.
- Consistency check of –M or –H parameter after TC_Enable_Science_*

Additionally, the TCs are checked against the current VIRTIS mode (see Appendix 6: MTC acceptance against M-Mode, page 153 and Appendix 9: HTC acceptance against H-Mode, page 156).

In any case, for each TC, an Acceptance TM Report (TM_TC_Acceptance_Report_Success (T1, ST1) see page 126, TM_TC_Acceptance_Report_Failure (T1, ST2) incl. error code, see page 126) is generated if the **Acceptance bit "A"** is set to "1" in the TC data field header as shown below. If it is set to "0", no TM acceptance is sent to the S/C after TC acceptance.
If a failure is detected, an "Acceptance TM report – failure" with error code 1...7 is sent to the S/C (see event list in Appendix 10, Table A10-2: List of Events, events with Category VI or VII, page 159...191).

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	Packet ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L = Packet Length in octets
4	DATA FIE.	U	U	U	C	E	0	0	A	T	T	T	T	T	T	T	T	'U'-PUS, 'C'-CRC, 'E'-Execution 'A'-Acceptance, T=Type
5	HEADER	S	S	S	S	S	S	S	S	P	P	P	P	P	P	P	P	S=Sub-type, P=Pad
6	APPLI-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Word 1
...	CATION	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Word ...
n-1	DATA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Word ...
n		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

UUU - PUS = 000; C - CRC = 1/Yes; E - Execution Acknowledge = only for few TCs

A - Acceptance Acknowledge = 0/No or 1/Yes

TC__Packet_Structure_General.doc, 10.06.1999

TC_Packet_Structure_General

7.8 HK Reporting Service

VIRTIS is able to generate 6 different types of HK TM packets (identified by SID1 ... SID6, word 9 in the TM packet). These are:

1. **Default HK (SID1).** This HK TM packet "VTM_ME_Default_HK_Report" contains general information about VIRTIS mode or ME status. It is always periodically generated (every 10 seconds) after VIRTIS power-on if SID1 is enabled. The HK TM packet structure "VTM_ME_Default_HK_Report" is shown on page 132.
   Note: the analog values within the Default HK are averaged by factor 32 (i.e. 32 x acquisition, summing and dividing of summed HK by 32) in order to reduce PS ADC and analog chain noises/peaks.
2. **ME/M General HK (SID2).** This HK TM packet "MTM_ME_General_HK_Report" contains general information of the –M sub-system acquired in the ME. It is periodically generated (every 10 seconds) if a –M mode different from "M_OFF" is active (e.g. if the M-Cooler is ON) and if HK reporting with SID2 are enabled. The HK TM packet structure "MTM_ME_General_HK_Report" is shown on page 133.
3. **ME/H General HK (SID3).** This HK TM packet "HTM_ME_General_HK_Report" contains general information of the –H sub-system acquired in the ME. It is periodically generated (every 10 seconds) if a –H mode different from "H_OFF" is active (e.g. if the H-Cooler is ON) and if HK reporting with SID3 is enabled. The HK TM packet structure "HTM_ME_General_HK_Report" is shown on page 141.
4. **M-VIS-HK (SID4).** This HK TM packet "MTM_PEM_VIS_HK_Report" contains HK of the -M sub-system acquired from the M-PEM VISible channel (e.g. –M voltages). It is periodically generated (every 10 seconds) if the M-PEM is powered-on or with the period (about 3,5...300sec) of M-VIS Science data acquisition in Science/Calibration mode and if HK reporting with SID4 is enabled. That means the HK are sent as TM packet either with the period of 10sec in PEM IDLE mode or with the science data production period (M_ERT) when a science or calibration mode is started.
   The HK TM packet structure "MTM_PEM_VIS_HK_Report" is shown on page 134.
5. **M-IR-HK (SID5).** This HK TM packet "MTM_PEM_IR_HK_Report" contains HK of the -M sub-system acquired from the M-PEM InfraRed channel (e.g. grating temperature). It is periodically generated (every 10 seconds) if the M-PEM is powered-on or with the period (about 3,5...300sec) of M-IR Science data acquisition in Science/Calibration mode and if HK reporting with SID5 is enabled. That means the HK are sent as TM packet either with the period of 10sec in PEM IDLE mode or with the science data production period (M_ERT) when a science or calibration mode is started. The HK TM packet structure "MTM_PEM_IR_HK_Report" is shown on page 135.
6. **H-HK (SID6).** This HK TM packet "HTM_PEM_HK_Report" contains HK of the -H sub-system acquired from the H-PEM (e.g. detector temperature). It is periodically generated (every 10 seconds) if the H-PEM is powered-on or with the period (about 0,7s...minutes) of -H Science data acquisition in Science/Calibration mode and if HK reporting with SID6 is enabled. That means the HK are sent as TM packet either with the period of 10sec in PEM IDLE mode or with the science data production period (H_IRT) when a science or calibration mode is started. The HK TM packet structure "HTM_PEM_HK_Report" is shown on page 142.

In order to distinguish between HK acquired periodically every 10sec and HK acquired together with science data the SCET is located in the TM packets. This is valid for M-VIS, M-IR and H-HK (SID=4,5,6). The H-HK contains a bit in HTM_PEM_HK_Report "H_HK_Periodic" which sign whether the HK packet is periodically acquired every 10sec or acquired together with science data. Nevertheless in a science mode the HK period is equal to the science data production period from the PEMs, in an IDLE mode the HK period is 10sec.

Acquiring/transferring HK can be enabled or disabled by TC_Enable_HK_Report_Generation (T3, ST5) (see page 102) and TC_Disable_HK_Report_Generation (T3, ST6) (see page 102).
By default all HK are enabled. That means if a acquisition is physically possible (e.g. if the M-PEM is ON) the HK are acquired periodically (i.e. normally immediately after power-on).

Note, due to the HK acquisition period, the TM SDT buffer time of 16sec., and the S/C (or SIS/EGSE) acquisition interval, acquisition of the HK by the S/C (SIS/EGSE) takes up to about 42 seconds or longer. For M-PEM or H-PEM HK if a science mode is active the acquisition time depends on the science data acquisition interval (e.g. M_ERT).

7.9 Event Reporting Service

The software is able to generate events asynchronously at each time, sent as TM packet to the S/C. All events have service type #5. There are different types of events identified by different sub-types as TM report. These are:

- Normal progress events (sub-type 1)
- Anomaly/warning events (sub-type 2)
- Ground action events (sub-type 3)
- On-board action events (sub-type 4)

Normal progress events are used to signal a significant and pre-defined operational step of VIRTIS (e.g. Secondary Boot completed) but Anomaly/warning, ground action and on-board action events signal an unexpected status of VIRTIS which are normally errors to be handled on-board by VIRTIS S/W, on-board by S/C or on-ground. Each VIRTIS event has an event number between 47501 ... 48000. Error/anomaly events can have up to 4 parameter words (16bit).
Examples of event TM packets structures are shown at page 150.
Details about existing VIRTIS events, error categories and event enumeration are shown in “Appendix 12: List of events/errors” (see page 159).

7.10 Memory Management Service

The DPU memory can be loaded, dumped or checked by the memory management service. The service is mainly used for uploading a new software executable, for patching the software or for verification of the memory content (service type #6).
Memory management can only be done in Safe mode (executed only by PROM software) by means of several TCs. In all other modes, these TCs are not accepted (i.e. TM Acceptance failure reports are generated if the Acknowledge flag is set in TC header). The TC packet structures are shown in Appendix “TC_Load_Memory (T6, ST2)”, page 103, “TC_Check_Memory (T6, ST9)”, page 105 and “TC_Dump_Memory (T6, ST5)”, page 105.

The DPU has different memory types to be loaded, dumped or checked as shown in table below.

For checking the memory content by TC_Check_Memory the 16bit CRC is used. If a memory with a width not equal 16bit is checked, the 8, 32, 40 or 48bit data are formatted to 16bit before CRC calculation.

Examples for loading memory and CRC calculation are shown in Appendix.

Memory ID/ address range	Memory width	Remark
MemID=140 EEPROM / 0x20000000... 0x200FFFFF	8 bit	The DM and PM segments from *.stk file are packed as 8bit items in the TC packet without any gaps in order to limit the upload period for large uploads especially on-ground of e.g. a whole new executable program. The EEPROM size is 1024k x 8bit. Note, an upload of data in to the EEPROM should be done only with data generated by the S/W developer team in order to avoid overwriting the Secondary Boot code. For **MemID=140/**EEPROM load/check/dump memory test purposes the last 4 EEPROM addresses 0x200FFFFC... 0x200FFFFF can be used which is nominally a free EEPROM area.
MemID=141 PM RAM 0x000000... 0x01FFFF	48 bit	The 48bit word items are used to write in to the PM RAM on DPU base board or to verify the content (check, dump). The PM RAM size is 128k x 48bit. A dump of memory can be done on complete memory area 0x000000...0x01FFFF. But note, for **MemID=141/**PM load/check memory test purposes, only the PM address range 0x006300...0x01FFFF is allowed to be use which is a free PM area. The PROM software runs in PM RAM. Therefore the PM content at addresses 0x000000...0x0062FF should never be changed by load memory because the PROM code V2.0 is located on this PM area and uploading would destroy the PROM S/W. In this case an undefined and therefore critical behaviour of PROM S/W execution is expected.
MemID=142 DM RAM 0x00000000... 0x0007FFFF	40 bit	The 40bit word items are used to write in to the DM RAM on DPU base board or to verify the content (check, dump). The DM RAM size is 512k x 40bit.. Load, check and dump of memory is allowed on complete memory area 0x00000000...0x0007FFFF. The PROM software runs only in PM RAM.
MemID=143 DM RAM 0x30000000... 0x301FFFFF	16 bit	The 16bit word items are used to write in to the DM RAM on DPU extension board or to verify the content (check, dump). The DM RAM size is 2048k x 16bit. Load, check and dump of memory is allowed on complete memory area 0x30000000...0x301FFFFF.
MemID=144 PM port 0xFFFFF0... 0xFFFFFF	48 bit	The 48bit word items are used to write in to a PM port mainly on the DPU base board or to read a PM port to dump the content. With a 48bit item width, a 16 and 32 bit PM port can be written (48bit PM ports are not available on the DPU), but it is the same format as for PM RAM which reduces the effort for TC upload packet generation on-ground. Note, upload/check and dump of Port memory should only be done by the S/W developer because the Ports are real hardware interfaces which loading is critical. Additionally the Port content is undefined from the user point of view because internally the PROM software uses the Ports, therefore dump of ports makes only sense to do by S/W developer too. If a port shall be loaded or dumped the ME internal S/W ICD has to be used where the port content is described (see RD(3)).
MemID=145 DM port 0x50000000... 0xC000000C	40 bit	The 40bit word items are used to write in to a DM port mainly on the DPU base board or to read a DM port to dump the content. With a 40bit item width, a 16 and 32 bit DM port can be written (40bit DM ports are not available on the DPU), but it is the same format as for PM RAM (always 48bit) which reduces the effort for TC upload packet generation on-ground. That means if e.g. a 16bit port has to be uploaded (written), a 48bit word (D47...D0) is transferred but only D23...D8 is the relevant valid 16bit word content. Note, ... see MemID=144

Table 7.10-1: Types for Memory Upload, Dump and Check

The format of TC application data are shown in TC packet structure (Appendix).

Additional information about memory management are written in RD(5).

7.11 Time Synchronisation Service

The timer synchronization service is used for setting or updating the ME internal 48bit timer with the S/C SCET by TC_Accept_Time_Update (T9, ST1), see page 106. Note, if the ME SCET timer doesn't run, VIRTIS is not able to accept any TCs and to send TM packets to the S/C.
After VIRTIS power-on, timer updating is the first action which is needed to be performed. If a valid TC_Accept_Time_Update is not received within 60sec after power-on, the timer starts with an unsynchronized time 0x8000000000.
After updating the timer with synchronized (by S/C) or unsynchronized (ME internally) time, VIRTIS is able to receive other TCs and is able to sent TM (at least Default HK after power-on).
If the timer already runs synchronized and the timer is updated by a new TC_Accept_Time_Update, following functions are performed by software:

- read the ME SCET timer
- compare the (old) timer value with the new one (received by TC_Accept_Time_Update)
- if the time difference is more than +/-20ms TM event packet 47602 "wrong SCET" is issued
- in any case, the time is updated by the new SCET received from the S/C if it is in range of 0x0...0x7FFF FFFF FFFF for Safe mode or any SCET (i.e. 0x0...0xFFFF FFFF FFFF FFFF) in all other VIRTIS modes

There are two general cases about TC_Accept_Time_Update acceptance:

1. TC_Accept_Time_Update commanding if the ME timer runs unsynchronized

If the timer already runs unsynchronized, an update of the timer by TC_Accept_Time_Update commanding is not allowed in Safe mode in order to avoid mixing TM packet with synchronized and unsynchronized time stamping. In this case, TC_Accept_Time_Update is not accepted. That means it is possible to update the SCET while running unsynchronized in all modes (e.g. ME_IDLE mode), except in Safe mode.

2. TC_Accept_Time_Update commanding containing an unsynchronized time (=>0x8000 0000 0000)

In Safe mode, the TC_Accept_Time_Update which contains a SCET equal to or greater than 0x8000 0000 0000 (i.e. unsynchronized time) is not accepted.
In ME_IDLE mode and all other modes (except Safe mode) a TC_Accept_Time_Update containing an unsynchronized time is accepted.

For additional information see chapter 6.2 "Operations after VIRTIS power-on", page 23.

7.12 Test Service

The test service is used for testing the MLC and SDT interface connection between VIRTIS and the S/C. The TC_Connection_Test_Request (T17, ST1) (see page 106) requests a TM_Connection_Test_Report (T17, ST1) (see page 129). No other action is performed by VIRTIS.
If the TC is properly accepted and the corresponding TM packet is sent by VIRTIS and acquired by the S/C, the MLC and SDT interfaces are successfully tested.

7.13 Context Transfer Service

N/A for VIRTIS

7.14 Information Distribution Service

N/A for VIRTIS

7.15 Science Data Transfer Service

7.15.1 TC_Enable_Science

There are two different TCs for starting science data acquisition and transfer to the S/C; TC_Enable_Science_HS_Link (T20, ST10) (see page 108) and TC_Enable_Science_RTU_Link (T20, ST1) (see page 107).

Each TC enables science data request from the M-PEM (by TC with parameter =52) or from the H-PEM (by TC with parameter =53) either transferred via HS 1355 link to the S/C SSMM or via SDT link to the S/C RTU.

Before using TC_Enable_Science_HS_Link(*) be sure that the HS link is established in order to be able to acquire science data TM packets from VIRTIS by the S/C (see chapter 6.3).

If needed set/change –M or –H parameters by MTC_Change_... or HTC_Change_.... If parameters are not needed to be changed, the current parameter configuration is used, valid after power-on
Note, default parameter are possible to be set by MTC_Default_Configuration or HTC_Default_Configuration

After commanding VIRTIS with TC_Enable_Science_*(-M) or ... (-H), following actions are performed:

1. Read the internal—M (or -H) ACTUAL parameter from the—M (or -H) ACTUAL parameter store
2. Parameter consistency check (e.g. data rate)
3. If parameter and status is consistent the parameter are sent as dump TM
4. Interpret the parameter and start a sequence (mode) initialized with the –M or –H parameter
5. Initialize/command e.g. the M- (or H-)PEM
6. Normally start of periodically science data/HK request from the M- (or H-)PEM and transfer of these data to the S/C

Notes:

- The 1355 link must be established before sending TC_Enable_Science_HS_Link() otherwise an TM_TC_Acceptance_Report_Failure (failure code 7 and parameter 3 set to 9) is sent.

- If TC_Enable_Science() is not accepted, the science mode is not started and the configuration parameter are not sent as progress events MTM_Dump_* or HTM_Dump_*

- The complete science processing for –M and –H is sub-slice oriented. The sub-slice processing of –M and –H is independent and depending on the RTOS scheduler priorities and timing. That means the sub-slices of –M and –H are prcessed in parallel and can be sent in a mixed order as TM.

7.15.2 TC_Disable_Science

There are two different TCs, TC_Disable_Science_HS_Link (T20, ST11) (see page 108) and TC_Disable_Science_RTU_Link (T20, ST2) (see page 107).
Each TC disables (i.e. stops) science data request and production from –M (TC parameter =52) or from –H (TC parameter =52) either transferred via HS 1355 link to the S/C SSMM or via SDT link to the S/C RTU.
Note, after TC_Disable_Science_HS_Link commanding the HS link is still established. That means the Null tokens are still running and the science data transfer is possible to start (enable) again by TC_Enable_Science_HS_Link.
After TC_Disable_Science an execution report is sent to the S/C after all science data has been completely (i.e. a consistent data set/Slice) sent to the S/C. Note, sending the execution report could take several seconds up to minutes depends on the selected data acquisition/repetition rate for –M or –H. Therefore the user or S/C should wait for execution reporting until a new data production mode is started by TC_Enable_Science_*(-M) or ... (-H).

After commanding VIRTIS by TC_Disable_Science_*(-M) or ... (-H), the following functions are performed in detail:

for –M:
- the M-IR detector is switched-off
- the M-Scan Unit is switched-off
- the science, calibration or test sequence for requesting data from M-PEM is stopped and therefore the TM data production is stopped after a delay,
- send last M_VIS_Slice and M_IR_Slice (requested from M-PEM) by TM
- issue a TM_Execution_Report_Success.

for –H:
- the science, calibration or test sequence for requesting data from H-PEM is stopped and therefore the TM data production is stopped after a delay,
- send last H_IMAGE_SLICE or last complete H_SPECTRA_SLICE (requested from H-PEM) by TM
- Issue a TM_Execution_Report_Success.

7.16 Payload Private Telecommand Service

Payload Private TCs are all TCs called by VTC_..., MTC_... and HTC_.... which functions are described in chapter 9 (see page 41), chapter 10 (see page 47) and chapter 11 (see page 70).

7.17 Common Payload Telecommand Service

7.17.1 TC_Reset_TM_Output_Buffer

This TC resets the SDT TM buffer and can be used e.g. for a recovery action if no or wrong TM data are acquired by the S/C. That means, if TM packets are collected in the ME TM buffer but these TM packets are not acquired by the S/C, the TM packets are deleted.

Note: TC_Reset_TM_Output_Buffer is accepted and executed in each VIRTIS mode but a TM_Acceptance_Report_Success is not issued to the S/C (see VIR-DLR-WV-005) because all TM packets located in the TM software and FIFO hardware buffer are deleted, also the TM_Acceptance_Report_Success report, located in the TM buffer before TC_Reset_TM_Output_Buffer execution.

7.17.2 TC_Reset_SMCS_Chip

This TC resets the SMCS332 chip on the DPU which is responsible for HS 1355 link management. It is applicable for resetting/establishing the HS link (e.g. for interface synchronization) before enabling science data acquisition via HS link. Normally, the TC is not needed to be used due to the pre-defined reset state of the chip after power-on.

Note: in case of using the Development mode (only DLR internal) where the 1355 host link (test interface on 1J10) is connected to the Host PC, the TC should not be used because it resets all links of the SMCS chip, the HS link connected to the S/C and the HS link connected to the Host PC.

7.17.3 TC_Start_HS_link

This TC starts the HS link token transfer from the VIRTIS ME to the S/C for establishing the HS link communication (see chapter 6.3, page 25 for additional information).

Note: for EQM there is a Non Conformance (VIR-DLR-NCR-B-036) about establishing the HS link communication. That means if the link interface is physically not properly connected and the TC is used, the software stays in an endless loop which can be left only by DPU reset (i.e. ME power-off → on).

7.17.4 TC_Reset_And_Start_HS_link

This TC combines the function of 1. TC_Reset_SMCS_Chip and 2. TC_Start_HS_link as shown in the chapters 7.17.3 and 7.17.2 above.

8 TC Functions and TC Execution according to VIRTIS Modes

8.1 Common VIRTIS TCs accepted in Safe Mode

If the Safe mode (0x2041) is active (i.e. -M and –H are OFF) and the ME (SCET) timer runs, the following TCs are accepted and perform related functions as shown in the list below. A general overview about all TC acceptable by PROM and EEPROM software is shown in “Appendix 1: VIRTIS TC list (see page 100)”.

TC allowed in Safe mode	Function	Remark
TC_Enable_HK_Report_Generation (SID=1)	Enable generation of Default HK	see chapter HK Reporting Service, page 32; only SID=1 is allowed
TC_Disable_HK_Report_Generation (SID=1)	Disable generation of Default HK	
TC_Load_Memory	Load patches/data in PM, DM, EEPROM or in Ports	see chapter Memory Management Service, page 33
TC_Dump_Memory	Dump memory patches/data from PM, DM, EEPROM or in Ports	
TC_Check_Memory	Calculate checksum of memory areas in PM, DM, EEPROM	
TC_Accept_Time_Update	Synchronize/set the ME internal timer by the S/C SCET	see chapter Time Synchronisation Service, page 35
TC_Connection_Test_Request	Perform a MLC/SDT (TC/TM) connection test TM transfer	see Test Service, page 35; no internal actions are performed
TC_Reset_TM_Output_Buffer	Reset (empty) the ME SDT and HW FIFO buffer	see chapter TC_Reset_TM_Output_Buffer, page 37
VTC_Enter_Safe_Mode	Reset of DPU after 30sec and perform Primary Boot as after power-on, enter Safe mode	see chapter Payload Private Telecommand Service, page 37
VTC_Enter_Idle_Mode	Start secondary boot from EEPROM or from RAM	see chapter Payload Private Telecommand Service, page 37
VTC_Failure_Override(CAT V)	Override of an internal software event/error recovery action	Even if failures are “overriden”, event messages are sent in any case; only event/error category 5 (CAT V) is applicable, see chapter Payload Private Telecommand Service, page 37
VTC_Failure_Deoverride(CAT V)	De-override of an internal software event/error recovery action	
VTC_Confirm	Confirmation of critical TCs (only for VTC_Failure_Override)	see chapter Payload Private Telecommand Service, page 37
VTC_Get_EEPROM_Status	Requests the EEPROM configuration status and sends an Event TM report to S/C	EID 47502; see chapter Payload Private Telecommand Service, page 37

8.2 Common VIRTIS TCs accepted in ME Idle Mode

If the ME Idle mode (Mode: 0x4041) is active, VIRTIS-M and –H are OFF, the following TCs are accepted and perform related functions as shown in the list below. A general overview about all TC acceptable by PROM and EEPROM software is shown in “Appendix 1: VIRTIS TC list (see page 100)”.

TC allowed in ME Idle mode	Function	Remark
TC_Enable_HK_Report_ Generation (SID=1,2,3,4,5,6 or ALL)	Enable generation of HK	see chapter HK Reporting Service, page 32; all HK can be to be enabled/disabled
TC_Disable_HK_Report_ Generation (SID=1,2,3,4,5,6 or ALL)	Disable generation of HK	
TC_Accept_Time_Update	Synchronize/set the ME internal timer by the S/C SCET	see chapter Time Synchronisation Service, page 35
TC_Connection_Test_Request	Perform a MLC/SDT (TC/TM) connection test TM transfer	see Test Service, page 35; no internal actions are performed
TC_Reset_TM_Output Buffer	Reset (empty) the ME SDT and HW FIFO buffer	see chapter TC_Reset_TM_Output_Buffer, page 37
VTC_Enter_Safe_Mode	Reset of DPU after 30sec, perform Primary Boot as after power-on	see chapter Payload Private Telecommand Service, page 37
VTC_Enter_Idle_Mode	<u>no</u> action is performed, only a warning event 47510 is issued	see chapter Payload Private Telecommand Service, page 37
VTC_Failure_Override	Override an internal software event/error recovery action	Even if failures are “overriden”, event messages are sent in any case; all event categories are applicable, see chapter Payload Private Telecommand Service, page 37
VTC_Failure_Deoverride	Restore of internal software event/error recovery action, which was overridden by the previous VTC_Failure_Override	
VTC_Confirm	Confirmation of critical TCs	see chapter Payload Private Telecommand Service, page 37
TC_Reset_SMCS_Chip	Reset the SMCS chip (1355 interfaces to S/C and test)	see chapter TC_Reset_SMCS_Chip, page 37
TC_Start_HS_link	Establishing/start of S/C 1355 HS link without reset	
TC_Reset_And_Start_HS_Link	Reset the SMCS chip and start the HS link	
VTC_PEM(ON)	Switch-on the M-PEM and H-PEM	see chapters “VIRTIS Common M/H Control TCs and Functions” (see page 41)
VTC_Cooler(ON, stand-by)	Switch-on the M-Cooler/CCE and H-Cooler/CCE	see chapters “VIRTIS Common M/H Control TCs and Functions” (see page 41)
MTC_*	VIRTIS-M related TCs, Specific –M sub-system control function	TCs are accepted or not accepted depends on the M_Mode, see chapter 9 (page 41), chapter 10 (page 47).
HTC_*	VIRTIS-H related TCs, Specific –M sub-system control function	TCs are accepted or not accepted depends on the H_Mode, see chapter 9 (page 41), chapter 11 (page 70).

8.3 Common VIRTIS TCs accepted in a VIRTIS Data Production Mode

If VIRTIS works in a data production mode (e.g. Science) the following TCs are accepted and perform specific functions as shown in the list below. A data production mode means a mode after successful accepted TC_Enable_Science(-M or/and –H). A general overview about all TC acceptable by PROM and EEPROM software is shown in "Appendix 1: VIRTIS TC list (see page 100)".

TC allowed in a DP mode	Function	Remark
TC_Enable_HK_Report_ Generation (SID=1,2,3,4,5,6 or ALL)	Enable generation of HK	see chapter HK Reporting Service, page 32; all HK can be to be enabled/disabled
TC_Disable_HK_Report_ Generation (SID=1,2,3,4,5,6 or ALL)	Disable generation of HK	
TC_Accept_Time_Update	Synchronize/set the ME internal timer by the S/C SCET	see chapter Time Synchronisation Service, page 35
TC_Connection_Test_Request	Perform a MLC/SDT (TC/TM) connection test TM transfer	see Test Service, page 35; no internal actions are performed
TC_Reset_TM_Output Buffer	Reset (empty) the ME SDT and HW FIFO buffer	see chapter TC_Reset_TM_Output_Buffer, page 37
VTC_Enter_Safe_Mode	Reset of DPU after 30sec, perform Primary Boot as after power-on	see chapter Payload Private Telecommand Service, page 37
VTC_Enter_Idle_Mode	Switch-off of all –M and –H related hardware (e.g. coolers, PEMs, etc.), a warning event 47510 is issued	see chapter Payload Private Telecommand Service, page 37
VTC_Failure_Override	Override of an internal software event/error recovery action	Even if failures are "overriden", event messages are sent in any case; all event categories are applicable, see chapter Payload Private Telecommand Service, page 37
VTC_Failure_Deoverride	Deoverride of an internal software event/error recovery action	
VTC_Confirm	Confirmation of critical TCs, (VTC_Failure_Override)	see chapter Payload Private Telecommand Service, page 37
MTC_*	VIRTIS-M related TCs, Specific –M sub-system control function	TCs are accepted or not accepted depends on the M_Mode, see chapter 9 (page 41), chapter 10 (page 47)
HTC_*	VIRTIS-H related TCs, Specific –M sub-system control function	TCs are accepted or not accepted depends on the H_Mode, see chapter 9 (page 41), chapter 11 (page 70)

9 VIRTIS Common M/H Control TCs and Functions

There are some TCs which have **V**IRTIS common functionality. The names of these TCs are started with 3 letters "VTC" and therefore called "VTC...". The **V**TC... related functions are described below.

9.1 Entering the Safe Mode by VTC_Enter_Safe_Mode

This TC should be used carefully. It enters the SAFE mode and is accepted in all instrument modes. Entering the SAFE mode means, after commanding the instruments goes in a Safe state (immediately if VIRTIS is already in Safe mode or after 30sec if VIRTIS is not in Safe mode), all sub-systems are powered-off and the instrument has the same state as after +28V power-on.

9.2 Entering the ME Idle Mode by VTC_Enter_Idle_Mode

This VTC_Enter_Idle_Mode has two functions:

1. Starting the Secondary Boot S/W or (same meaning) entering the ME_IDLE mode from SAFE mode. In this case an event TM_Secondary_Boot_Completed (T5, ST1, EID47501, APID51,7) (see page 148) is issued.
2. Force entering the ME_IDLE mode if a ME test mode, a –M or/and –H mode is active. In this case **no** S/W Secondary Boot from EEPROM is done and an event 47510 EVENT_ENTER_IDLE_MODE_COMMANDED is issued which signals a not nominal (but possible) commanding.

Normally this TC is used for entering the ME_IDLE mode if the SAFE mode is active and is executed by the PROM software. The TC starts the Secondary Boot S/W from EEPROM (or from RAM) from a defined memory address given as parameter of VTC_Enter_Idle_Mode.
That means if the VTC_Enter_Idle_Mode is successfully accepted and executed, the Secondary Boot software runs.

For exceptional cases (normally not needed for the user), there is one additional function if the Secondary Boot software runs and any other mode is active (e.g. ME_TEST, COOL_DOWN or Science). If there is a undefined/not consistent situation of instrument behaviour the user can use the TC as a recovery action to force entering the ME_IDLE mode from any other mode (except the Safe mode). If the TC is executed, all sub-systems are switched-off, the ME_IDLE mode is active and the software/ hardware has the same state as after Entering the ME_IDLE mode from the SAFE mode.

E.g. –M is in Science Mode, -H is in COOL_DOWN and there is a problem. The user can command VTC_Enter_Idle_Mode, the –M Science mode and data production is stopped, the M-PEM is switched-off, the –H cooler is switched-off (i.e. only the DPU and the DPU power converter are ON) and the user can start a new –M or/and –H mode.

Note: if the VTC_Enter_Idle_Mode is used for the 2nd purpose, the parameter "EEPROM/RAM start address" is not applicable, the software ignores this parameter.

9.3 Entering the ME Test Mode by VTC_Enter_Test_Mode

VTC_Enter_Test_Mode is used for entering the ME_Test_Mode. It is used for testing the main parts of the ME (DPU, M/H-IFE, PS).

ME test mode means:
- entering the test mode by VTC_Enter_Test_Mode(ME) can only be done in ME_IDLE mode
- only the DHSU power converter and the H-IFE and M-IFE are switched-ON
- the –M and –H power converters are OFF
- after VTC_Enter_Test_Mode(ME) and after TC_Enable_Science, the M-IFE and/or H-IFE produces periodically pseudo random test pattern
- the pseudo random test pattern are compared (completely word by word) on-line by software,
- if there is an error in the pattern, an event is issued to the S/C, so IFE/DPU hardware problems can be detected
- the pattern are processed (as defined by the –M/-H data processing parameter), packed in TM packets (as for science data coming from the PEMs) and are sent to the S/C via HS link or SDT interface
- the data volume to be generated by the M-IFE or/and H-IFE and the repetition rate for each channel are selected by the parameter in VTC_Enter_Test_Mode
- VTC_Enter_Idle_Mode must be commanded to leave the ME_Test mode

<u>Example:</u> Entering a ME test mode with max. data volume and high repetition rate

1. Be sure that the ME_IDLE mode is active
2. Be sure that the SIS/EGSE (S/C) is ready to establish the HS link
3. Issue the following TCs
   3.1 TC_Reset_And_Start_HS_Link (if the HS link is not established)
   3.2 MTC_Change_Operat_Param_RAM(ALL_PIX_FULL_WIN, NO_COMPRESSION)
   3.3 HTC_Change_Operat_Param_RAM(NO_COMPRESSION)
   3.4 VTC_Enter_Test_Mode(ME,M=5sec, M_VIS=112153, M_IR=118280, H=5sec, H_IR=118296)
   3.5 TC_Enable_Science_HS_Link (M=52) ; start of M-IFE pattern generation
   3.6 TC_Enable_Science_HS_Link (H=53) ; start of H-IFE pattern generation
4. Each 5 seconds 684 (3 x 228) Science TM packets and 3 PEM-HK TM packets are produced.
   That means the data are produced with a average rate of about 1,1 Mbit/s
   684 TM packets are calculated as follows:

4.1 Window adjustment:	M-VIS 438x256 to 432x256; M-IR 438x270 to 432x256 -H 438x270 to 432x256
4.2 Decomposition to subslices:	M-VIS – 12 sub-slices; M-IR – 12 sub-slices -H – 12 sub-slices
4.3 Decomposition to TM packets:	1 sub-slice to 19 TM packets (144x64/500=18.43)
4.4. Total TM packets:	36 subslices x 19 TM packets = 684 TM packets

5. Stop the data generation by
   5.1 TC_Disable_Science_HS_Link(M) and
   5.2 TC_Disable_Science_HS_Link(H)
6. Finalize the ME_Test mode by
   VTC_Enter_Idle_Mode ()

<u>Verification:</u>
1. the HS link transfer is active and the VIRTIS mode = 0x6FFF (as shown in Default HK if enabled).
2. The image type within the TM science header is set to 0xFF (255).
3. After TC_Disable_Science_HS_Link(M), TC_Disable_Science_HS_Link(H) and VTC_Enter_Idle_Mode(), the VIRTIS mode is entered to the ME_Idle mode (as shown in Default HK).
4. ME internally the simulated 16bit pseudo random data pattern are generated by ME IFE FPGA hardware. This pattern (e.g. 112128 VIS words every 5sec) are compared completely against the expected data by software. If TM event doesn't occur, the data pattern are correct produced by ME IFE FPGA and correct transferred from ME IFE to DPU. This means the ME data channel hardware works correctly.
5. The data content in TM are only 8bit (LSB) of the 16bit pseudo random pattern (i.e. very noisy data). The MSB (8bit) is set to 0x00. The pattern content is shown in RD(13).

Note1: In ME test mode data rate and volume to be simulated from the IFEs is defined only by the VTC_Enter_Test_Mode (not by –M or –H specific parameter, e.g. the M_ERT)

Note2: The TM contains simulated pseudo random pattern (i.e. very noisy data). The ME IFE generates and compare/process the pseudo random pattern as 16bit data. But only 8bit (LSB) are sent to TM due to the option that compression shall be possible in ME_Test mode which is only possible by compressing of 8bit (not 16bit) pseudo random pattern. Compressing of 16bit pseudo random pattern instead of 8bit would cause a compression factor <1. Compressing of 8bit pseudo random pattern causes a compression factor >1 which is not allowed.

9.4 Common M/H-PEM Control by VTC_PEMS

VTC_PEMS (T192, ST4) (see page 118) is used for powering/resetting of both PEMs (M-PEM and H-PEM) together. E.g. if the TC is commanded, both PEMs can be switched-on and by default PEM HK are acquired and transferred to the S/C. The function is the same as for separate M- or H-PEM control. Generally this TC is allowed to be executed if both single TCs MTC_PEM() and HTC_PEM() are allowed to by executed as shown in "Appendix 6: MTC acceptance against M-Mode" (see page 153) and "Appendix 9: HTC acceptance against H-Mode" (see page 156).
For details see chapter M-PEM Power Switching and Reset Control by MTC_PEM or VTC_PEM (see page 55) or H-PEM Power Switching and Reset Control (see page 77).

Example 1 - VTC_PEMS acceptance:
-M is in mode M_OFF, -H is in mode H_OFF. VTC_PEMS(ON) is accepted.
After VTC_PEMS(ON), –M is in mode M_ON and –H is in mode H_ON.

Example 2 - VTC_PEMS acceptance:
-M is in mode M_ON, -H is in mode H_OFF. VTC_PEMS(ON) is accepted.
After VTC_PEMS(ON), –M is in mode M_ON and –H is in mode H_ON.

Example 3 - VTC_PEMS acceptance:
-M is in mode M_IDLE, -H is in mode H_COOLDOWN. VTC_PEMS(ON) is accepted. After VTC_PEMS(OFF), –M is in mode M_COOLDOWN and –H is in mode H_ COOLDOWN.

Example 4 - VTC_PEMS acceptance:
-M is in mode M_PEM_ON, -H is in mode H_PEM_ON. VTC_PEMS(Reset) is accepted.
After VTC_PEMS(Reset), both PEMs are reset and –M is still in mode M_PEM_ON and –H is still in mode H_ PEM_ON.

Example 5 - VTC_PEMS not acceptance:
-M is in mode M_PEM_IDLE, -H is in mode H_PEM_ON. VTC_PEMS(Reset) is not accepted.
After VTC_PEMS(Reset), PEM reset is not performed and –M is still in mode M_PEM_IDLE and –H is still in mode H_ PEM_ON.

Example 6 - VTC_PEMS not acceptance:
-M is in mode M_SCIENCE_*, -H is in mode H_PEM_ON. VTC_PEMS(OFF) is not accepted.
After VTC_PEMS(OFF), –M is still in mode M_SCIENCE_* and –H is still in mode H_ PEM_ON.

Note, after correcting a software bug, VTC_PEMS and the examples above work correctly with software V3.61.

9.5 Common M/H-Cooler Control by VTC_Coolers

VTC_Coolers (T192, ST5) (see page 113) is used for mode controlling both coolers (-M cooler and –H cooler) together. E.g. if the TC is commanded, both coolers are switched-on in the same mode with the same parameters. The function is the same as for separate –M or –H cooler control.
For details see chapter M-Cooler Control (page 56) or H-Cooler Control (page 77).

Example 1 - VTC_Coolers acceptance:
-M is in mode M_OFF, -H is in mode H_OFF. VTC_Coolers(ON) is accepted.
After VTC_Coolers(ON), –M is in mode M_COOLDOWN and –H is in mode H_COOLDOWN.

Example 2 - VTC_Coolers not acceptance:
-M is in mode M_IDLE, -H is in mode H_OFF. VTC_Coolers(ON) is not accepted.
After VTC_Coolers(ON), –M is in mode M_IDLE and –H is in mode H_OFF.

Note, after correcting a software bug, VTC_COOLERS and the examples above work correctly with software V3.61.

9.6 Failure Override/Deoverride by VTC_Failure_Override/.._Deoverride

VTC_Failure_Override (T192, ST10) (see page 111) or (VTC_Failure_Deoverride (T192, ST11), see page 111) is used for setting (or resetting) an override flag in the software which causes an override of the on-board software action. The software can generate error events as shown in Appendix (see page 159). This events/errors are classified in event categories. For each category an on-board software action is defined which has to be performed. In some cases, a software action can cause an undesired situation or behaviour (e.g. Entering the Safe mode by resetting the DPU in case of CATV errors). To avoid these software actions in case of failures, the VTC_Failure_Override can be used. The event category has to be put in the TC as parameter, so that only one category is overridden.

In any case, the software action "send an event TM report" can't be overridden. That means, the user get always a TM event report if a failure or an event is detected.

VTC_Failure_Override is classified as critical. Therefore VTC_Failure_Override has to be confirmed by VTC_Confirm, otherwise VTC_Failure_Override alone has no functionality.

Note:
1. VTC_Failure_Override CAT ALL (7) is only possible to command in SBS (all modes except Safe mode). That mean it is not possible to command (TC is not accepted) in PBS.
2. VTC_Failure_Override CAT 5 is possible to command in PBS (Safe mode).

Example: Override Failure Category "CAT V" in Safe mode

Assumption:
- a failure occurs (e.g. 47601, MLC FIFO overflow) which causes a DPU reset (i.e. enter of Safe mode) after 30 seconds. E.g. the cause for failure occurrence is a high TC rate over a long period, so that the ME MLC FIFO buffer is overflown
- for further investigation of this failure, a failure override shall be commanded and the operation with high MLC TC rate is done again

Issue the following TCs:

- VTC_Failure_Override (Parameter = 5) ; override category V
- VTC_Confirm (Parameter: Type 192, Subtype: 10)

After this commanding the error will not cause a DPU reset if the MLC FIFO overflows.

9.7 Confirmation of Critical TCs by VTC_Confirm

Critical TCs are:

VTC_Failure_Override - because the user disables all software error handling
XTC_ECA - because moving the ECA is possible only once without refurbishment of the ECA hardware

For confirmation of critical TCs (e.g. VTC_Failure_Override) VTC_Confirm (T192, ST12) (see page 111) has to be commanded immediately after commanding the critical TC (e.g. VTC_Failure_Override). That means, e.g. using VTC_Failure_Override can only be done by commanding:

1. VTC_Failure_Override and
2. VTC_Confirm (parameter Type 192, Sub-type 10)

without any other TC commanded between VTC_Failure_Override and VTC_Confirm.

See chapters 9.6, 10.7 and 11.7 for further information.

Note, between the TC to be confirmed and VTC_Confirm itself, no other TC shall be sent. Otherwise a no acceptance TM report is sent.

9.8 Request of EEPROM status by VTC_Get_EEPROM_Status

After VTC_Get_EEPROM_Status (T192, ST64) (see page 112), the software investigates the EEPROM configuration and collects the EEPROM status as reported in TM_EEPROM_Stat_Report (T5, ST1, EID47502, APID51,7) (see page 147). Requesting the status is needed in order to get an overview about the stored executable(s) in the EEPROM. The following status parameters are shown for each executable in the TM report:

- S/W version string of all executables stored in EEPROM
- EEPROM start address of each executable
- EEPROM end address of each executable

Note: up to 8 Secondary Boot executables can be stored in EEPROM (depending on size of the executables) and reported in TM_EEPROM_Stat_report.

9.9 -M/-H Dependencies of Mode Execution

Logically the –M and –H sub-systems work totally independent from each other. But physically (of course) the software controls both sub-systems at the same time, so that generally there are some dependencies concerning
- S/C interface (e.g. 1355 interface, SDT interface data rate, TC acceptance/execution)
- DPU duty cycle

Note: from the user point of view (i.e. in terms of VIRTIS performance) there are generally no constrains about –M and –H operation at the same time. That means every –M mode can be performed together with each –H mode and every –H mode can be performed together with each –M mode. Mainly the S/C interface data rate is the most important constrain. This is the case if science data are transferred by RTU link (i.e. SDT interface) in degraded modes. The main constrains are:

1. The RTU data rate must be
   - less than about 30Kbit/s in –M degraded mode if –M works alone or
   - less than about 10Kbit/s in –H degraded mode if –H works alone.
   This data rates are checked by the VIRTIS software. If the commanded data rate is too high, the TC_Enable_Science_RTU_Link(-M or -H) is not accepted.

2. Additionally if both are active (i.e. –H and -M degraded mode at the same time), the repetition rate for –M must be M_ERT=60sec or =300sec in order to guarantee that a H_SPECTRA_SLICE, a

M_VIS_SLICE and a M_IR_SLICE are able to be transferred to the S/C assumed a 1sec SDT interface polling rate by the S/C.

A data rate calculation is shown in chapter 10.4.2 (see page 53).

9.10 -M/-H Parameter Handling

Generally there a 3 parameter sets (DEFAULT, CURRENT, ACTUAL) to be used by software internally where only 2 parameter sets (CURRENT and ACTUAL) are changeable by the user.

After power-on, VIRTIS works always with the ACTUAL parameter set (located in RAM) containing the CURRENT parameter set stored in EEPROM.

The **ACTUAL parameter** set is stored only in RAM as working/current parameter set read after starting a –M or –H operational or science mode. These parameters are changeable by HTC_Change..._RAM. After power-on, the first initialization is a copy of the CURRENT parameter set from EEPROM.

The **CURRENT parameter** set is stored in EEPROM as pre-initialized (with DEFAULT parameter) memory content in EEPROM software executable but changeable by MTC_Change..._EEPROM. It is used for maintaining the last updated -M instrument parameter configuration if VIRTIS is powered-off. Note, the CURRENT parameter set is overwritten if a new EEPROM software release is uploaded.

The **DEFAULT parameter** set is stored in EEPROM as initialized memory content in EEPROM software executable. It is used for a default operation selectable by the user with XTC_Default_Configuration. The user is only able to change the default parameter set by uploading a new EEPROM software.

For further information, see chapter 9.10 and 11.3 about –M and –H parameter usage.

10 VIRTIS-M Control and Science Data Production

10.1 Generals and Preconditions

The VIRTIS-M sub-system can be controlled only by secondary boot software in ME_Idle mode (started by VTC_Enter_Idle_Mode) by entering a –M specific mode by VTC_PEM, VTC_Cooler, an other MTC_.... or by entering a –M data production mode by TC_Enable_Science_*(M).

The M-PEM interface (1J08) has to be connected. Otherwise the software detects an open data interface and generates a warning event "PEM not connected" after each M-PEM power-on or M-PEM reset.

10.2 -M Mode Control

The -M sub-system is entered in a defined –M mode (e.g. M_OFF, M_CALIBRATION, M_SCIENCE_NOMINAL_1). For verification, which –M mode is entered, the currently active –M Mode is shown in the Default HK (see mode definition in VTM_ME_Default_HK_Report (T3, ST25, SID1), page 132).

M-mode building is performed by software based on the M-parameter (commanded by the MTC_Change_* or stored as Default parameter in EEPROM) and the internal sub-system status (e.g. Cooler status, PEM status, etc.) as shown in "Appendix 7: M-Mode build according ME internal -M status and TC commanding" (see page 154).
There are some restrictions for commanding –M depends on the –M mode. The table that presents which TC is allowed to be commanded in which M-Mode is shown in "Appendix 6: MTC acceptance against M-Mode" (see page 153).
If a TC is commanded but not allowed in the current active mode, a TM_TC_Acceptance_Report_Failure (T1, ST2) is issued by TM.

10.3 –M Parameter Usage

The following MTC_Change_XXX TCs are responsible to configure the VIRTIS-M sub-system before enabling M-Science Data acquisition by TC_Enable_Science(-M) or before starting a –M control sequence (e.g. Cooling down, Annealing, etc.).

- MTC_Change_Data_Product_RAM (or ..._EEPROM)
- MTC_Change_Func_Param_RAM (or ..._EEPROM)
- MTC_Change_Operat_Param_RAM (or ..._EEPROM)
- MTC_Change_Calibration_Param_RAM (or ..._EEPROM)
- MTC_Change_Altern_Param_RAM (or ..._EEPROM)

The TC e.g. MTC_Change_Data_Product_EEPROM writes the parameter in the –M ACTUAL parameter set in RAM and in EEPROM (i.e. as CURRENT parameter set). After Secondary Boot the CURRENT parameter set in the EEPROM is copied in the ACTUAL parameter set in RAM. So the user is able to prepare a kind of "working default configuration", the CURRENT parameter set. Details about general parameter usage are shown in chapter 9.10, page 46.

If the ACTUAL parameter set was changed by MTC_Change_XXX, the default configuration (see MTC_Change_XXX structures) can be set or reconfigure by MTC_Default_Configuration.

All parameters of TCs are checked against minimum and maximum values in order to protect the software, to avoid not allowed or not meaningful commanding of H-PEM and to limit the parameter ranges to support proper commanding by the user.
Allowed minimum and maximum parameter ranges and the parameter default configuration are shown in the TC structure definition in Appendix.

10.3.1 Data Production Parameter Usage (MTC_Change_Data_Product_*)

The M_DATA_PRODUCTION parameter is used for selecting a –M science, calibration or test sequence (i.e. –M data production mode) to be started after TC_Enable_Science_*(-M) and which type of science/test/calibration data are produced. The parameter can be commanded by MTC_Change_Data_Product_Param_RAM or *_EEPROM. The structure of this TC is shown in Appendix, page 114. A M_SCIENCE, M_CALIBRATION or M_TEST sequence is started after TC_Enable_Science(-M) before selecting the M_DATA_PRODUCTION mode as follows:

- M_DATA_PRODUCTION = M_DATA_SCIENCE, see chapter 10.13, page 63
- M_DATA_PRODUCTION = M_DATA_CALIBRATION, see chapter 10.12, page 60
- M_DATA_PRODUCTION = M_DATA_TEST, see chapter 10.11, page 59

10.3.2 Functional Parameter Usage (MTC_Change_Func_Param_*)

The functional parameter are used mainly for –M initialization/configuration purposes. They can be commanded by MTC_Change_Func_Param_RAM or *_EEPROM. The TC structure incl. parameter default settings is shown in Appendix, page 115. The TC parameter (located in appl. data field) are used as shown in table as follows:

Parameter	Purpose/Function
M_IR_WIN_X1 M_IR_WIN_X2 M_IR_WIN_Y1 M_IR_WIN_Y2	Co-ordinates for window adjustment of the IR detector data received from the M-PEM. X1 and X2 are the co-ordinates for the spectral direction 0...437. Y1 and Y2 are the co-ordinates for the spatial direction 0...269. Nominally the window has a size of 432x256 (i.e. a SLICE) to be able to decompose sub-slices with a size 144x64. For –M acquisition modes M_IR_ONLY_1x4 a size of 288x256 has to be commanded. The parameter are used only by the ME software for window adjustment. ME internally, the M-PEM is always commanded by fix VIS and IR windows, i.e. IR full window mode 438x270.
M_IR_VDETCOM M_IR_VDETADJ	These parameters are used for initializing the M-PEM at the beginning of the calibration or science sequence. Both parameter represent bias voltage to be set for IR detector.
M_IR_DELAY M_IR_EXPO	These parameters are used for initializing the M-PEM at the beginning of the science sequence. M_IR_DELAY represents an IR integration delay time and M_IR_EXPO the IR exposition (integration) time. M_IR_DELAY is needed for synchronizing the IR detector readout related to the CCD channel because the CCD and IR channel has different integration and read-out times.
M_CCD_WIN_X1 M_CCD_WIN_X2 M_CCD_WIN_Y1 M_CCD_WIN_Y2	Co-ordinates for window adjustment of the CCD detector data received from the M-PEM. X1 and X2 are the co-ordinates for the spectral direction 0...437. Y1 and Y2 are the co-ordinates for the spatial direction 0...255. Nominally the window has a size of 432x256 (i.e. a SLICE) to be able to decompose in sub-slices with a size of 144x64. For –M acquisition modes M_VIS_ONLY_1x4 a size of 288x256 has to be commanded. The parameter are used only by the ME software for window adjustment. ME internally, the M-PEM is always commanded by fix VIS window, i.e. a VIS full window size of 876x512. Note: the M-PEM CCD channel is commanded internally by a window of 876x512 elements, but the PEM send a data set of 438x256 pixel to the ME which means the M-PEM performs a element binning of 2x2 (i.e. 4 detector elements are binned to 1 pixel).
M_CCD_DELAY M_CCD_EXPO	These parameters are used for initializing the M-PEM at the beginning of the science sequence. M_CCD_DELAY represents a CCD integration delay time and M_CCD_EXPO the CCD exposition (integration) time. M_CCD_DELAY is needed for synchronizing the CCD detector readout related to the IR channel because the CCD and IR channel has different integration and read-out times.
M_SU_MODE	These parameter are needed for Scan Unit (SU) control within the Science sequence (mode).

M_SU_ANGLE_FIRST M_SU_ANGLE_LAST M_SU_ANGLE_STEP_SIZE M_SU_NUM_IRT_ANGLE	If M_SU_MODE=Off, the SU is not switched-on and no PEM commanding for SU control is done by the software independent from the –M mode. If M_SU_MODE=Point, the SU is switched-on and is commanded via M-PEM only once (if M_SU_NUM_IRT_ANGLE=1) i.e. the SU is placed on a fix point (boresight) given by parameter M_SU_ANGLE_FIRST. If M_SU_MODE=Scan the SU is switched-on and is commanded via M-PEM once per IRT i.e. the SU steps from the beginning of a start electrical angle (given by parameter M_SU_ANGLE_FIRST) to the end electrical angle (given by parameter M_SU_ANGLE_LAST) with a predefined step size (given by parameter M_SU_ANGLE_STEP_SIZE). M_SU_NUM_IRT_ANGLE defines the number of IRT (i.e. detector read-out cycles) and the SU is commanded one step. Scanning by Scan Unit is needed to expand the optical FOV to about –2°...+2° of the –M VIS and IR channel.
M_D_BCK_RATE	This parameter (i.e. Dark/Background rate) defines the period of dark acquisitions within the science sequence (mode). If e.g. M_D_BCK_RATE=10 every 11th acquisition is a dark, i.e. 10 science slices and 1 dark slice are acquired. IR and CCD data acquisition is a dark slice previously commanded by M_Shutter=Close.
M_SHUTT_CURR	This parameter (-M shutter current) is used for setting the current for shutter control. It is used for M-PEM commanding always before the shutter is commanded.
M_SHUTT_STAB	This parameter (-M shutter stabilization time) is used by software for setting a wait time after each M-PEM shutter commanding.
M_ANNEAL_LIMITS	This is a temperature used for IR detector annealing control. It represents a temp. limit detected by software for finalizing the annealing procedure, i.e. switching-off IR detector header via M-PEM. Note: annealing is needed for recovering IR detector degradations e.g. due to cosmic radiation.
M_ANNEAL_TIME_OUT	This parameter is used for IR detector annealing control. It represents the maximum time for annealing (i.e. max. switch-on time of annealing header) if annealing isn't stopped by TC or isn't stopped due to achieving the pre-defined IR detector temperature (M_ANNEAL_LIMITS).
M_ECA_ACT	This parameter defines the max. M-ECA actuation time (ECA +28V switching-on time). After this time, the +28V ECA is switched-off even if the ECA status hasn't shown that the ECA is already moved completely. If the ECA status shows that the ECA is moved to the end stoke, the +28V ECA voltage is switched-off before.
M_OPEN_COVER_STEP M_CLOSE_COVER_STEP M_INIT_COVER_STEP	These parameters are needed for M-Cover control, in case of - cover initialization after e.g. M-PEM power-on (M_INIT_COVER_STEP is used by software and for M-PEM control) - closing the cover (M_CLOSE_COVER_STEP is used by software and for M-PEM control) - opening the cover (M_OPEN_COVER_STEP is used by software and for M-PEM control) The parameters define how many steps (of the cover stepper motor) are needed to init, open and close the cover.
M_IR_DET_OFF	This parameter allows to switch-off/on the M-IR detector to be able to operate at room temperature (i.e. IR detector must be OFF) in nominal science or calibration modes. If M_IR_DET_OFF is not equal 0x??FF (default=0), the detector is switched-on. If M_IR_DET_OFF is equal 0x??FF, the detector is not switched-on (i.e. switched-off). That means by default the IR detector is switched-on.

Table 10.3.2-1: -M functional parameter description

10.3.3 Operational Parameter Usage (MTC_Change_Operat_Param_*)

The operational parameter are used for defining the type of –M data processing and the repetition rate to produce/transfer science data to the S/C. All parameter have influence on the –M TM data production rate and on the TM data format.
The parameter can be commanded by MTC_Change_Operat_Param_RAM or *_EEPROM. The TC structure incl. parameter default settings is shown in Appendix, page 116. The TC parameters (located in appl. data field) are used as shown in table as follows.

Parameter	Function
M_ERT	External Repetition Time which represents the period of sending a M-VIS and/or IR slice to the S/C. Normally it represents also the IRT (internal Repetition Time) for –M data acquisition if M_SS = 1. If M_SS > 1 (i.e. slice summing is commanded) M_IRT = M_ERT / M_SS. E.g. if M_ERT=60sec and M_SS=10 every M_IRT=6sec an acquisition from the M-PEM is performed internally, a slice summing of 10 acquired slices is done and every 60sec a (summed) slice is sent to the S/C.
M_SS	Number of slices to be summed (SS = Slice Summing). The default value is "1" which means "no Slice Summing"
M_ACQ_MODE	-M acquisition and data processing mode which influence the data volume and structure to be sent to the S/C within one M_ERT period. Depends on the mode, the data are reduced by pixel binning in spectral or/and spatial direction or only VIS or IR slices are sent to the S/C. Note, it is assumed that the VIS and IR window (defined with functional parameter M_IR_WIN_* and M_CCD_WIN_*) have nominal sizes of 432x256, except for the M_ACQ_MODE_REDUCED_SLIT_3x1, M_ACQ_MODE_VIS_ONLY_1x4 and M_ACQ_MODE_IR_ONLY_1x4. In this case the window size must be 432x64 otherwise the TC_Enable_Science_* is not accepted. ****** M_ACQ_MODE_NOMINAL_3x4_FULL_WIN** the VIS and IR slices pixels are binned in spatial direction by factor 4 and in spectral direction factor 3. The data volume for VIS and IR is 2 * 256/4*432/3 = 2 * 64x144 = 1 VIS Sub-slice + 1 IR Sub-slice. ****** M_ACQ_MODE_VIS_ONLY_1x4** Only VIS data are sent to the S/C. The VIS slices pixels are binned in spatial direction by factor 4 and not in spectral direction. The data volume is 256/4*288 = 64x288 = 2 VIS Sub-slices. ****** M_ACQ_MODE_IR_ONLY_1x4** Only IR data are sent to the S/C. The IR slices pixels are binned in spatial direction by factor 4 and not in spectral direction. The data volume is 256/4*288 = 64x288 = 2 IR Sub-slices. ****** M_ACQ_MODE_HIGH_SPECTRAL_1x4_FULL_WIN** the VIS and IR slices pixels are binned in spatial direction by factor 4 and not in spectral direction. The data volume for VIS and IR is 2 * 256/4*432 = 2 * 64x432 = 3 VIS Sub-slices + 3 IR Sub-slices. ****** M_ACQ_MODE_HIGH_SPATIAL_3x1_FULL_WIN** the VIS and IR slices pixels are binned in spectral direction by factor 3 and not in spatial direction. The data volume for VIS and IR is 2 * 256*432/3 = 2 * 256x144 = 4 VIS Sub-slices + 4 IR Sub-slices. ****** M_ACQ_MODE_ALL_PIX_FULL_WIN** No pixel binning of the VIS and IR slices is applicable. The data volume for VIS and IR is 2 * 256*432 = 12 VIS Sub-slices + 12 IR Sub-slices. ****** M_ACQ_MODE_REDUCED_SLIT_3x1** the VIS and IR slices are window adjusted to 432x64 and the pixels are binned in spectral direction by factor 3 (not in spatial direction).

	The data volume for VIS and IR is 2 * 432/3*64 = 2 * 144x64 = 1 VIS Sub-slice + 1 IR Sub-slice. ****** M_ACQ_MODE_ALTER_IR_ONLY_1x4** the same as for M_ACQ_MODE_IR_ONLY_1x4 but alternate parameter are used (commanded by MTC_Change_Altern_Param_RAM (T193, ST19)), not functional parameter.
M_COMP_MODE	Defines the on-line compression mode for compression of sub-slices (144x64) as compression units. The modes represent different data quality and compression factors. **M_NO_COMPRESSION:** no compression is done **M_LOSSLESS_COMPRESSION:** it represents a data compression without any loss a differential algorithm is performed with rice encoding. The compression factor is low (about 1.5) for very noisy M-PEM IR data up to high (about 14) for synthetic IR ramp data. The nominal average compression factor is about 2...4. **M_WAVELET_F1_COMPRESSION:** the wavelet compression is “low” lossy. The data compression factor is 8. **M_WAVELET_F2_COMPRESSION:** the wavelet compression is “medium” lossy. The data compression factor is 10,67. **M_WAVELET_F3_COMPRESSION:** the wavelet compression is “high” lossy. The data compression factor is 16.

Table 10.3.3-1: -M operational parameter description

Note: depends on the M_ACQ_MODE and the M_COMP_MODE different data volumes are sent to the S/C but always a sub-slice oriented TM output is applicable. This means either the number of sub-slices / PEM acquisition varies depends on the M_ACQ_MODE or the number of TM packets for one sub-slice varies depends on M_COMP_MODE

- number of sub-slices / PEM VIS+IR acquisition/slice = 2...24 (depends on M_ACQ_MODE)
- number of TM packets / sub-slice = 2...19 (depends on data dynamics/ correlation/ compression factor)

10.3.4 Calibration Parameter Usage (MTC_Change_Calibration_Param_*)

The calibration parameters are used for calibration purposes only by calibration sequence (i.e. if the M_DATA_PRODUCT_MODE= M_CALIBRATION) and defines special parameter for M-PEM initializing. The parameters don’t have any influence on the –M TM data production rate or TM data format.
The parameter can be commanded by MTC_Change_Calibration_Param_RAM or *_EEPROM or are predefined as default parameter already stored in EEPROM. The TC structure including parameter default settings is shown in Appendix, page 117. The TC parameter (located in application data field) are used as shown in table as follows.

Note: the calibration mode includes 7 phases (Phase 0...6) but the TC contains only parameter for 6 phases, phase 1...6.
Phase 0 is performed with fix parameter, except the M_MIRROR_ANGLE parameter used from the –M functional parameter set (see also chapter 10.12, page 60):

M_Cover=Close
M_Shutter=Open
M_MIRROR_ANGLE= (commanded, see –M functional parameter)
M_IR_EXPO=0.0s
M_CCD_EXPO=0.0s
M_IR_DELAY=0.0s
M_CCD_DELAY=0.0s
M_IR_LAMP=OFF
M_CCD_LAMP=OFF

Parameter	Function
M_IR_DELAY1... M_IR_DELAY6 M_IR_EXPO1... M_IR_EXPO6 M_CCD_DELAY1... M_CCD_DELAY6 M_CCD_EXPO1... M_CCD_EXPO6	These parameters are used only for initializing the M-PEM at the beginning of each calibration phase inside the calibration sequence. For phase 1...6 one parameter set M_IR_DELAY_*, M_IR_EXPO_*, M_CCD_DELAY_* and M_CCD_EXPO_* is defined. M_*_DELAY_* represents an integration delay time and M_*_EXPO_* the exposition (integration) time (see also Table: functional parameter description).
M_IR_LAMP_STAB M_CCD_LAMP_STAB	For –M calibration the IR and CCD calibration lamps are switched-on depending on the calibration phase. Each lamp has an electrical/optical stabilization time and a radiation intensity related to the lamp current. The M_*_LAMP_STAB and M_*_LAMP_CURR parameters define the time and the current separately for each lamp and are used inside the calibration sequence as software delay time (*_STAB) or for PEM initialization (*_CURR).

Table 10.3.4-1: -M calibration parameter description

10.3.5 Alternate Parameter Usage (MTC_Change_Altern_Param_*)

The –M alternate parameter are used only for a special IR operation in case that M_ACQ_MODE_ALTER_IR_ONLY is selected as operational parameter. The user is able to use an “alternate” IR parameter set only by changing the operational parameter. The function of the alternate parameters are equal to the same type of –M functional parameter.

10.4 –M Parameter check after TC_Enable_Science_*(-M)

In order to protect VIRTIS science operation against wrong parameter commanding, a parameter consistency check is done after TC_Enable_Science_*(-M).

The following checks are done:
- the internal calculated M_IRT is checked against M_ERT in order to avoid a too short internal repetition of data request from M-PEM
- the TM data rate is checked in order to guarantee a maximum data rate to be able to produce by the software from the performance point of view
- the –M window size is checked in order to have a consistent data set to be processed and compressed

10.4.1 M_IRT / M_ERT check

This check is needed in order to be sure that the calculated M_IRT, as a period for –M data request from M-PEM, is shorter than the commanded M_ERT but longer than the internal possible repetition for M-PEM data request.

<u>Example:</u> the –M default parameter are used, but M_SS=4

M_IRT depends on –M parameter and the min. allowed M_IRT is calculated as follows:

M_IRT = MAX [(M_CCD_DELAY + M_CCD_EXPO + M_CCD_READOUT_TIME_MAX + M_DATA_PROCESSING_MARGIN) OR (M_IR_DELAY + M_IR_EXPO + M_IR_READOUT_TIME_MAX + M_DATA_PROCESSING_ MARGIN)]

M_IRT = [(100ms + 0ms + 1450ms + 100ms) OR (0ms + 0ms + 1210ms + 100ms)] = 1650ms

That means if M_ERT=5sec and M_SS=4 → 5000msec are less than (1650ms * 4); this parameter configuration is <u>not</u> allowed to be accepted. Therefore TC_Enable_Science_*(-M) is <u>not accepted</u> which means that a TM_TC_Acceptance_Report_Failure is issued, with failure code=7 and parameter3=4. The user should change either M_ERT to 20sec or M_SS to 1, so that TC_Enable_Science_*(-M) is accepted.

10.4.2 –M TM data rate check and calculation

This check is needed in order to be sure that the calculated TM data rate doesn't exceed defined allowed values as maximum S/C interface performance.

The max. TM data rate is defined as follows:

- for –M data transfer via HS link: M_HS_DATA_RATE_MAX = 221184 Words/1,8sec (1,97Mbit/s)
- for –M data transfer via RTU link: M_RTU_DATA_RATE_MAX = 1800 Word (28,8kBit/s)

Concerning RTU data rate check, it is assumed that the S/C RTU can poll VIRTIS with a maximum defined data rate and VIRTIS-M and –H are able to work simultaneously.

The calculation and check of -M TM data rate is done as follows:

M_Calibration mode:

There is no TM data rate check implemented because calibration is a one shot sequence with a fix (not periodical transferred) data volume. In order to have a defined and not too high peak data rate on the S/C interface some delays are added between several internal data requests/acquisitions from M-PEM inside the calibration procedure. The TM data rate during calibration is shown in Appendix 8: M-Mode TM data format and TM data rates (page 155).

M_ME_Test mode:

There is a data rate checked against the maximum allowed values. In this mode it is calculated as follows:

M_Data_Rate (words/ms) = (M_VIS_Pattern_Size + M_IR_Pattern_Size) / M_Pattern_Rep_Rate

M_VIS_Pattern_Size, M_IR_Pattern_Size and M_Pattern_Rep_Rate are parameter commanded by VTC_Enter_Test_Mode

All other modes where Science data are sent by TM S/C interfaces:

There is a data rate checked against the maximum allowed TM data rate. In the science modes the data rate is calculated as follows:

M_Data_Rate (words/sec) = M_Data_Size / (M_ERT * M_Compression_Factor)

The M_Data_Size depends on the M_ACQ_MODE and is shown in table located in chapter 10.4.3 (page 54). The M_Compression_Factor depends on the compression mode commanded. M_ERT is commanded by MTC_Change_Operat_Param_* as parameter. For data rate calculation the following compression factors are used:

- M_NO_COMPRESSION: M_Compression_Factor = 1
- M_LOSSLESS_COMPRESSION: M_Compression_Factor = 2
- M_WAVELET_F1_COMPRESSION: M_Compression_Factor = 8
- M_WAVELET_F2_COMPRESSION: M_Compression_Factor = 10
- M_WAVELET_F2_COMPRESSION: M_Compression_Factor = 16

Example for data rate calculation / check in M_SCIENCE_NOMINAL_1 mode:

Parameter commanded:
M_DATA_PRODUCTION_MODE = M_DATA_SCIENCE
M_ACQ_MODE = M_ACQ_MODE_NOMINAL_3x4_FULL_WIN
M_ERT = 5s
M_COMP_MODE = M_LOSSLESS_COMPRESSION:

The following calculation is done:

IR window size = 432*256 words IR binning factor = 12 (X=3, Y=4)
VIS window size = 432*256 words VIS binning factor = 12 (X=3, Y=4)

M_Data_Size = (432/3) * (256/4) + (432/3) * (256/4) = 18432 Words

M_Data_Rate = 18432 Words / (5s * 2) = 1844 Words/s = **29,5kBit/s**

M_Data_Rate < M_HS_DATA_RATE_MAX, 29,5kBit/s **<** 1,97Mbit/s
M_Data_Rate < M_RTU_DATA_RATE_MAX, 29,5kBit/s **>** 28,8kBit/s

That means, the calculated M_Data_Rate of 29,5kBit/s is allowed to be produced by HS link. TC_Enable_Science_HS_Link(-M) is accepted to be commanded.
Otherwise commanding TC_Enable_Science_RTU_Link(-M) is not accepted to be commanded because the M_Data_Rate produced is higher than allowed to be transferred by RTU link. In this case the user should command an other compression mode with higher compression factor (e.g. M_WAVELET_F1_COMPRESSION) or a higher M_ERT (e.g. 20sec).

10.4.3 –M window size check

This check is needed in order to be sure that the window size of M-VIS and M-IR detector data is a multiple of a sub-slice size after –M window adjustment and after binning of –M detector data. A sub-slice is always a compression unit and must always have a size of 144x64 elements (words).

Depends on the M_ACQ_MODE as M_Operational_Parameter (see chapter 10.3.3, page 50) the allowed window size set by M_IR_WIN_*, M_CCD_WIN_* as M_Functional_Parameter (see chapter 10.3.2, page 48) the parameter are checked as shown in the table below.

M_ACQ_MODE_*	allowed TC window dimension concerning binning factor		allowed TC window size concerning window adjustment		Remark (sent to TM for each slice)	
	VIS	IR	VIS	IR	VIS	IR
...NOMINAL_3X4_FULL_WIN **(1)**	multiple of X=3, Y=4	multiple of X=3, Y=4	X*Y; 432*256	X*Y; 432*256	1 SSL 144x64	1 SSL 144x64
...VIS_ONLY_1X4 **(1)**	multiple of X=1, Y=4	N/A	X*Y; 288*256	N/A	2 SSLs 288x64	No TM
...IR_ONLY_1X4 **(1)**	N/A	multiple of X=1, Y=4	N/A (no TM)	X*Y; 288*256	No TM	2 SSLs 288x64
...HIGH_SPECTRAL_1X4_FULL_WIN **(1)**	multiple of X=1, Y=4	multiple of X=1, Y=4	X*Y; 432*256	X*Y; 432*256	3 SSLs 432x64	3 SSLs 432x64
...HIGH_SPATIAL_3X1_FULL_WIN **(1)**	multiple of X=3, Y=1	multiple of X=3, Y=1	X*Y; 432*256	X*Y; 432*256	4 SSLs 144x256	4 SSLs 144x256
...ALL_PIX_FULL_WIN **(1)**	multiple of X=1, Y=1	multiple of X=1, Y=1	X*Y; 432*256	X*Y; 432*256	12 SSLs 432x256	12 SSLs 432x256
...REDUCED_SLIT_3X1 **(1)**	multiple of X=3, Y=1	multiple of X=3, Y=1	X*Y; 432*64	X*Y; 432*64	1 SSL 144x64	1 SSL 144x64
...ALTER_IR_ONLY_1X4 **(2)**	N/A	multiple of X=1, Y=4	N/A	X*Y; 288*256	No TM	2 SSLs 288x64

(1) check of ACTUAL functional parameter commanded by MTC_Change_Func_Param_*
(2) check of ACTUAL alternate parameter commanded by MTC_Change_Altern_Param_*

M_Param_Consistency_Check.doc, Last Edit: 22.05.2001

Example 1: M_ACQ_MODE= M_ACQ_MODE_HIGH_SPECTRAL_1x4_FULL_WIN,

M_IR_WIN_X1= 2	M_CCD_WIN_X1= 3
M_IR_WIN_X2= 433	M_CCD_WIN_X2= 434
M_IR_WIN_Y1= 6	M_CCD_WIN_Y1= 0
M_IR_WIN_Y2= 261	M_CCD_WIN_Y2= 255

TC_Enable_Science_*(-M) is accepted and the science mode is started because the commanded window is allowed to be adjusted. The VIS (CCD) window is 432 (434-3+1) x 256 (261-6+1) and for each acquisition from M-PEM, 3 VIS sub-slices are sent the S/C. The IR window is 432 (434-3+1) x 256 (261-6+1) and for each acquisition from M-PEM, 3 IR sub-slices are sent the S/C.

Example 2: M_ACQ_MODE= M_ACQ_MODE_HIGH_SPECTRAL_1x4_FULL_WIN,

M_IR_WIN_X1= **5**	M_CCD_WIN_X1= 3
M_IR_WIN_X2= 433	M_CCD_WIN_X2= 434
M_IR_WIN_Y1= 6	M_CCD_WIN_Y1= 0
M_IR_WIN_Y2= 261	M_CCD_WIN_Y2= 255

TC_Enable_Science_*(-M) is not accepted and the science mode is not started because the commanded window isn't allowed to be adjusted. The VIS (CCD) window is 430 (434-5+1) x 256 (261-6+1) and it is not possible to get consistent sub-slices with a size of 144x64 elements.

Example 3: M_ACQ_MODE= M_ACQ_MODE_VIS_ONLY_1x4

M_IR_WIN_X1= N/A	M_CCD_WIN_X1= 2
M_IR_WIN_X2= N/A	M_CCD_WIN_X2= 289
M_IR_WIN_Y1= N/A	M_CCD_WIN_Y1= 0
M_IR_WIN_Y2= N/A	M_CCD_WIN_Y2= 255

TC_Enable_Science_*(-M) is accepted and the M_SCIENCE_NOMINAL_* mode is started. In case that M_ACQ_MODE= M_ACQ_MODE_VIS_ONLY_1x4 only the M-VIS data are sent to the S/C (i.e. no M-IR data) binned in Y-spatial direction by factor 4 due to software data processing. In spectral X-dimension 288 elements are selected by M_CCD_WIN_X1=2 and M_CCD_WIN_X2=289 without binning.
Note: if (M_CCD_WIN_X2 – M_CCD_WIN_X1 + 1) is not equal 288, the TC_Enable_Science_* is not accepted and a TM_TC_Acceptance_Report_Failure with failure code 7 is issued to S/C.

10.5 M-PEM Power Switching and Reset Control by MTC_PEM or VTC_PEM

By commanding of VTC_PEMS (T192, ST4) (see page 118) or MTC_PEM (T193, ST1) (see page 112), the M-PEM is :

- **Power-ON by MTC_PEM(ON) or VTC_PEM(ON)**
  1. the ME PS –M converter is switched-on and all –M voltages are switched-on at 1J08
  2. the quiescent state of the M-PEM/ME IR and VIS data input interface is checked. If it is not active (not low), an event is generated and sent by TM
  3. the M-Cover is initialized using the ACTUAL parameter, that means the M-Cover is closed if it is open or not closed
  4. by default PEM HK are acquired and transferred to the S/C

- **Power-OFF by MTC_PEM(OFF) or VTC_PEM(OFF)**

  1. the ME PS –M converter is switched-off and all –M voltages are switched-off at 1J08

- **Reset by MTC_PEM(Reset) or VTC_PEM(Reset)**
  1. the M-PEM is reset by the hardware reset pulse at 1J08 / Reset_M
  Note: Reset of the PEM is only possible if the PEM is already switched-on

10.6 M-Cooler Control by MTC_Cooler or VTC_Cooler

By commanding of VTC_Coolers (T192, ST5) (see page 113) or MTC_Cooler (T193, ST5) (see page 113), the H-CCE/Cooler is :

- +28V powered ON and commanded in open loop mode if TC param., word 6= 2
- +28V powered ON and commanded in closed loop mode if TC param., word 6= 3
- +28V powered ON but in Stand-by due to the cooler motor drivers = OFF if TC param, word6= 4
- +28V powered OFF (TC parameter, word 6 = 1)

“Open loop” mode means that the cooler is commanded by a motor speed (rotation per minute). This motor speed is located in XTC_Cooler as parameter.
“Closed loop” mode means that the cooler is commanded by a cold tip temperature to regulate by cooler electronics. This cold tip temperature is located in XTC_Cooler as parameter.

The M-Cooler analog and digital HK are sent periodically (every 10sec) to the S/C (if enabled) by the MTM_ME_General_HK_Report (T3, ST25, SID2) (see page 133).

If the Cooler is in Cool Down (i.e. normally after starting closed or open loop mode), the cold tip temperature of the ME/General HK is monitored once every 10sec if the ME/General-HK are enabled. If the Cooler achieves the Steady state (i.e. the cold tip temperature has been achieved as commanded in close loop mode, see cold tip temperature parameter of XTC_Cooler) or as a fix temperature of 65K in Open Loop mode (Note: 65K is needed considering the delta between cold tip and detector temperature). The cold tip temperature tolerance for steady state detection is +/-1.5K. Note, the ME General HK accuracy is about 4%.

The cold tip temperature is checked for 1,5 hours (5400sec) after switching-on the cooler in close loop mode every 10sec at each M-HK acquisition in order to detect the cooler steady state. Note, for this check the M-HK acquisition must be enabled. If the cold tip temperature is inside the expected tolerance after 1,5 hours, an event 47706 EVENT_M_COOL_DOWN_END_SUCCESS is issued otherwise event 47777 EVENT_M_COOL_DOWN_END_FAILURE is issued by TM.

In case that the cooler is in steady state but the cold tip temperature is detected outside the “expected temperature +/-1.5K” range, the event 47766 EVENT_M_COOL_STEADY_STATE_FAILURE is issued.

10.7 M-ECA Control by MTC_ECA and VTC_Confirm

By commanding of MTC_ECA (T193, ST4) (see page 113) and immediately after a VTC_Confirm (with param T193, ST4), the M-ECA is:

- Forced opened, i.e. the +28V power is switched-on at 1J09 / Em_Actuator_M_1 and Em_Actuator_M_2
- the ECA +28V is automatically switched-off
  - after timeout, defined by the TC parameter M_ECA_ACT commanded by MTC_Change_Func_Param_* or
  - if the M-ECA has been moved, which is signalled by the ECA status at 1J07 / ECA_M_Status if the ECA_M_Status switch goes from OPEN to CLOSE.

The ECA can be switched-on only if the M-PEM is OFF. During ECA moving no M-Mode change is done.

Depends on the parameter M_ECA_ACT (see MTC_Change_Func_Param_*) the procedure takes several minutes (nominally about 30minutes). Therefore a TM_TC_Execution_Report_Success (T1, ST7) is sent if the ECA has been moved successfully (nominally after about 30minutes) or a TM_TC_Execution_Report_Failure (T1, ST8) is sent if the ECA moving procedure failed.

The M-ECA status (acquired from 1J07) is shown in the MTM_ME_General_HK_Report (T3, ST25, SID2) (see page 133). The status is shown in the HK TM packet as same level provided by the ECA status hardware interface (switch OPEN=1, switch CLOSED=0).

10.8 M-Cover Control by MTC_Cover

The M-Cover can be commanded OPEN or CLOSE by MTC_Cover (Open or Close).

1. In case of commanding MTC_Cover (Open),
   - a Cover open procedure is executed by commanding the M-PEM and monitoring the M-PEM HK,
   - the Cover is expected to be closed (as default configuration after M-PEM power-on) and after finalizing the procedure the Cover is open,
   - depends on the Cover parameter M_CLOSE_COVER_STEP (see MTC_Change_Func_Param_*) the procedure takes several seconds (nominally about 21sec). Therefore a TM_TC_Execution_Report_Success (T1, ST7) is sent if the Cover has been opened successfully or a TM_TC_Execution_Report_Failure (T1, ST8) is sent if the Cover is not open after the procedure is completed.

2. In case of commanding MTC_Cover (Close),
   - a Cover close procedure is executed by commanding the M-PEM and monitoring the M-PEM HK,
   - the Cover is expected to be opened and after finalizing the procedure the Cover is closed,
   - depends on the Cover parameter M_OPEN_COVER_STEP (see MTC_Change_Func_Param_*) the procedure takes several seconds (nominally about 21sec). Therefore a TM_TC_Execution_Report_Success (T1, ST7) is sent if the Cover has been closed successfully or a TM_TC_Execution_Report_Failure (T1, ST8) is sent if the Cover is not close after the procedure is completed.

In any case if the software detects some undefined or not nominal behaviour of the Cover (shown in and detected by the PEM-HK by HES1 and HES2) an event is issued by TM.

Note: during cover execution no M-Mode change is performed.

10.9 M-PEM Low Level Commanding by MTC_PEM_Command_Word

Low level commanding the M-PEM is only possible in M_Test mode as shown in chapter 10.11 (see page 59).
For low level commanding the M-PEM, the MTC_PEM_Command_Word (T193, ST2) (TC structure see page 112) is used which is allowed to be executed only in M-TEST mode.
The M-PEM command word located as parameter in the TC, is transferred to the PEM without modification. Only 3 PEM commands are interpreted internally by software with the following background:

1. After M_START_EXPO, the M-PEM is requested to transfer VIS and IR science data and HK. The software waits internally for data receipt (110592+25 VIS words and 118260+20 IR words), the data are processed and packed into TM packets and these are sent to the S/C.

2. After M_START_HK, the M-PEM is requested to transfer VIS and IR HK. The software waits internally for HK receipt and the HK are transferred to the S/C via SDT interface as one HK TM packet.

3. After M_IR_DETECTOR(ON) (...OFF) and if the mode M_PEM_ON is active, the M_PEM_MODE is transferred from M_PEM_IR_ON (...FULL_WINDOW) to M_PEM_IR_IDLE (...ON). This is done for internal mode handling. Depends on the state of the –M ACTUAL parameter set, the –M mode can be changed to M_Calibration, M_Science_XXX or M_Test.

All other commands are transferred to the M-PEM without any interpretation.

Note: the user has the full responsibility about consistency of PEM commanding, about time between PEM commanding and about order of PEM commanding. In addition, the user can look in the M-VIS and/or M-IR HK for status monitoring. The HK are periodically requested by on-board software always if the M-PEM is switched-on and the HK are enabled.

Example:

After switching-on the M-PEM, establishing the HS link, entering the M-TEST mode and commanding the PEM commands as follows:

1. MTC_PEM_Command_Word (100110 0001100100) ; M_CCD_EXPO, 2sec
2. MTC_PEM_Command_Word (000010 0001000110) ; M_IR_EXPO, 1,4sec
3. MTC_PEM_Command_Word (010110 0000000001) ; M_CCD_LAMP, ON, 273mA
4. MTC_PEM_Command_Word (100010 0000011111) ; M_IR_LAMP, ON, 167mA

the exposition times are set, the lamps are switched-on, the science data (Full VIS and IR window) are acquired by the ME with a rate defined by ERT, the data are processed (depends on the –M actual parameter) and are sent to the S/C. The amount of TM science data depends on the –M actual parameter (e.g. depends on compression mode).

10.10 M-IR Detector Annealing commanded by MTC_Annealing

Annealing is needed to heat the M-IR detector to recover radiation/degradation effects. MTC_Annealing (T193, ST6) (see page 114) is used to start or stop annealing sequence/mode. If annealing is started, the following procedure is performed:

- the M-PEM is commanded by M_IR_DETECTOR_OFF, the IR detector is switched-off
- the M-PEM is commanded by M_IR_ANNEALING_ON, the annealing heater is switched-on
- the M-Mode is changed to M_ANNEALING as shown in VTM_ME_Default_HK_Report
- the M_IR_TEMP PEM-HK are monitored every 10seconds and the M_IR_TEMP is checked against the M_ANNEAL_LIMITS (given by the ACTUAL functional parameter). If the M_IR_TEMP is 5K over M_ANNEAL_LIMITS the PEM is commanded by M_IR_ANNEALING_OFF

- wait for receiving a MTC_Annealing(Stop) or time-out (given by M_ANNEAL_TIME_OUT in ACTUAL functional parameter). If MTC_Annealing(Stop) is received or M_ANNEAL_TIME_OUT is over, the PEM is commanded by M_IR_ANNEALING_OFF. The M-Mode M_ANNEALING is left.

10.11 Execution of a M_TEST Sequence/Mode

The M_TEST mode/sequence is mainly used for test purposes of the M-PEM in order to request periodically M-VIS and IR data and HK without pre-initializing the M-PEM by software. In this case the default hardware configuration of the M-PEM is used, the MTC_PEM_Command_Word is accepted by the software and the period for data request is defined by M_ERT of operational parameter.
A –M parameter consistency check in M_TEST mode is not done, so the user is fully responsible for –M-PEM control at all. Additional information about MTC_PEM_Command_Word execution is shown in a separate chapter (see page 58).

The M_TEST mode/sequence is started if:

1. the M-PEM is switched-on (cooler is not needed to be on),
2. the HS link is established (in case that TC_Enable_Science_HS_Link shall be used),
3. the M_DATA_PRODUCTION mode is set to M_DATA_TEST (=3) commanded by MTC_Change_Data_Product_RAM (T193, ST11) (see page 114).
4. a TC_Enable_Science_HS_Link(-M) or TC_Enable_Science_RTU_Link(-M) is commanded

The following functional steps are performed after TC_Enable_Science_*(-M):

1. Initialize M-PEM with window parameters as follows:
```
M_CCD_WIN_X1=72   (PEM command: 0x2848)
M_CCD_WIN_Y1=0    (PEM command: 0xA800)
M_CCD_WIN_X2=947  (PEM command: 0x6BB3)
M_CCD_WIN_Y2=511  (PEM command: 0xE9FF)
```
2. Wait M_ERT
3. Request periodically M-PEM data/HK by sendig M_START_EXPO once after M_ERT
(Note: **no** other initialization commands are sent to the M-PEM)
4. VIS Data and HK are acquired from the PEM with full VIS detector size=112128data + 25HK words
5. IR Data and HK are acquired from the PEM with full IR detector size=118260data + 20HK words
6. M-PEM VIS and IR HK are sent to the S/C if enabled
7. Science data are processed according to the –M operational parameter commanded by MTC_Change_*_Param_*. That means window adjustment, pixel binning, slice summing, compression, etc. is done.
8. Max. 2 x 228 Science TM packets + 2 HK TM packets for each PEM acquisition are sent to the S/C depends on the –M parameter relevant for data processing/compression.

Verification 1: the VIRTIS mode is changed to 0101 XXXXXX 000110b,
i.e. ME_Science=5 and M_Test=6 (see default HK),
The M-mode is unchanged.

Verification 2: Science data (slices) are sent to the S/C with a repetition rate of M_ERT

Note 1: M_ERT is read from the ACTUAL operational parameter set (Default M_ERT = 5 sec) and can be changed by MTC_Change_Operat_Param_RAM (T193, ST15) (see page 116).
Note 2: Parameter related to data processing are read from the ACTUAL parameter set.
Note 3: During sequence execution, M-PEM commands can be commanded by MTC_PEM_Command_Word (PEM command) (e.g. M_DETECTOR_ON)

Note 4: The M-Cooler has not mandatory to be switched-on in M_TEST mode.

10.12 Execution of a M_CALIBRATION Sequence/Mode

On-board calibration is used to get a set of calibration/science data with specific environmental on-board conditions and defined calibration parameter. These calibration data represent the VIRTIS performance and are used for on-ground data processing.

The calibration sequence consists of 7 calibration phases (phase 0...6). This sequence is executed if the –M data production mode is commanded to M_CALIBRATION by MTC_Change_Data_Product_RAM (or *_EEPROM) and after accepted enabling the data transfer by TC_Enable_Science_*(-M).

The M_CALIBRATION mode is defined as shown in “Appendix 7: M-Mode build according ME internal -M status and TC commanding” (see page 154), For example, the compression mode has to be set to M_NO_COMPRESSION by MTC_Change_Operat_Param_RAM or *_EEPROM in other to start the M_CALIBRATION mode in the Default HK, otherwise a mode M_USER_DEFINED is signalled by TM. In case that a compression mode M_LOSSLESS_COMPRESSION or any other compression mode is commanded, TC_Enable_Science_*(-M) is accepted and the user is able to get all calibration data as compressed data by TM.

The M_ACQ_MODE must be commanded as M_ACQ_MODE_ALL_PIX_FULL_WIN (operational parameter) otherwise TC_Enable_Science_*(-M) is not accepted.

The TM data rate and format to be produced in M_CALIBRATION mode is shown in “Appendix 8: M-Mode TM data format and TM data rates” (see page 155).

The calibration sequence is a “one shot sequence”. That means it is executed only once, not periodically. After starting the sequence by MTC_Enable_Science_*(-M), it has to be stopped by MTC_Disable_Science_*(-M). If the calibration sequence isn’t completely finalized yet, the current running calibration phase is finalized but the next phase will not be started.

The calibration sequence takes several minutes to be completely executed (see table below). In order to know what phase is executed, after each phase a progress event EVENT_M_CALIBR_SEQ_PHASE_FINALIZED, 47767 is issued with the phase number as parameter.

For Calibration Phase 0 there are constant parameter set in software but for Phase 1...6 the calibration parameter (changeable by MTC_Change_Calibration_Param_*) are used for commanding the M-PEM or used ME/software internally for calibration sequence control. For parameter description see also chapter 10.3.4, page 51.

The following 7 calibration phases are performed within the calibration sequence. At the beginning of each phase, the M-PEM is initialized and controlled accordingly considering functional and calibration parameter as shown below.

```
Close the –M Cover
Switch-on the –M Scan Unit if M_FUNC_PARAM.M_SU_MODE!=2 (OFF)
Switch-on the M-IR detector if M_FUNC_PARAM.M_IR_DET_OFF!=0xFF (OFF)
Command the M-PEM in M-IR full window mode
Wait 30sec as M-IR detector stabilization time
```

```
Phase 0 – READ OUT NOISE, acqusition of 5 Slices in condition :
          M_SHUTTER= open;
          M_MIRROR_ANGLE= M_FUNC_PARAM (default +4.9, boresight);
          M_IR_EXPO= 0.0s;
          M_CCD_EXPO= 0.0s;
          M_IR_DELAY= 0.1s;
          M_CCD_DELAY= 0.1s;
          M_IR_LAMP= off;
          M_CCD_LAMP= off;

Send EVENT_M_CALIBR_SEQ_PHASE_FINALIZED(Phase0) to TM

Phase 1 – BKG PRE, acqusition of 5 Slices in condition :
          M_SHUTTER= open;
          M_MIRROR_ANGLE= M_FUNC_PARAM (default +4.9, boresight);
          M_IR_EXPO= M_CALIBR_PARAM (default 0.5s);
```

```
          M_CCD_EXPO= M_CALIBR_PARAM (default 1.0s);
          M_IR_DELAY= M_CALIBR_PARAM (default 9.8s);
          M_CCD_DELAY= M_CALIBR_PARAM (default 0.1s);
          M_IR_LAMP= off;
          M_CCD_LAMP= off;

Send EVENT_M_CALIBR_SEQ_PHASE_FINALIZED(Phase1) to TM
```

Phase 2 – DARK PRE, acqusition of 5 Slices in condition :

```
          M_COVER= close;
          M_SHUTTER= close;
          M_MIRROR_ANGLE= M_FUNC_PARAM (default +4.9, boresight);
          M_IR_EXPO= M_CALIBR_PARAM (default 0.5s);
          M_CCD_EXPO= M_CALIBR_PARAM (default 1.0s);
          M_IR_DELAY= M_CALIBR_PARAM (default 9.8s);
          M_CCD_DELAY= M_CALIBR_PARAM (default 0.1s);
          M_IR_LAMP= off;
          M_CCD_LAMP= off;

Send EVENT_M_CALIBR_SEQ_PHASE_FINALIZED(Phase2) to TM
```

Phase 3 – IR calib, acqusition of 5 Slices in condition :

```
          M_SHUTTER=open;
          M_MIRROR_ANGLE= M_FUNC_PARAM (default +4.9 boresight);
          M_IR_EXPO= M_CALIBR_PARAM (default 0.5s);
          M_CCD_EXPO= M_CALIBR_PARAM (default 20.0s);
          M_IR_DELAY= M_CALIBR_PARAM (default 9.8s);
          M_CCD_DELAY= M_CALIBR_PARAM (default 0.1s);
          M_IR_LAMP= ON + M_FUNC_PARAM (default 100mA);
          M_CCD_LAMP= off;

Send EVENT_M_CALIBR_SEQ_PHASE_FINALIZED(Phase3) to TM
```

Phase 4 – VIS Calib, acqusition of 5 Slices in condition :

```
          M_SHUTTER= open;
          M_MIRROR_ANGLE= M_FUNC_PARAM (default +4.9, boresight);
          M_IR_EXPO= M_CALIBR_PARAM (default 0.02s);
          M_CCD_EXPO= M_CALIBR_PARAM (default 1.0s);
          M_IR_DELAY= M_CALIBR_PARAM (default 0.3s);
          M_CCD_DELAY= M_CALIBR_PARAM (default 0.1s);
          M_IR_LAMP= off;
          M_CCD_LAMP= ON + M_FUNC_PARAM (default 250mA);

Send EVENT_M_CALIBR_SEQ_PHASE_FINALIZED(Phase4) to TM
```

Phase 5 – DARK POST, acqusition of 5 Slices in condition :

```
          M_SHUTTER= close;
          M_MIRROR_ANGLE= M_FUNC_PARAM (default +4.9, boresight);
          M_IR_EXPO= M_CALIBR_PARAM (default 0.5s);
          M_CCD_EXPO= M_CALIBR_PARAM (default 1.0s);
          M_IR_DELAY= M_CALIBR_PARAM (default 9.8s);
          M_CCD_DELAY= M_CALIBR_PARAM (default 0.1s);
          M_IR_LAMP= off;
          M_CCD_LAMP= off;

Send EVENT_M_CALIBR_SEQ_PHASE_FINALIZED(Phase5) to TM
```

Phase 6 – BKG POST, acqusition of 5 Slices in condition :

```
          M_SHUTTER= open;
          M_MIRROR_ANGLE= M_FUNC_PARAM (default +4.9, boresight);
          M_IR_EXPO= M_CALIBR_PARAM (default 5.0s);
          M_CCD_EXPO= M_CALIBR_PARAM (default 5.0s);
          M_IR_DELAY= M_CALIBR_PARAM (default 9.8s;
          M_CCD_DELAY= M_CALIBR_PARAM (default 0.1s);
          M_IR_LAMP= off;
          M_CCD_LAMP= off;
```

```
Send EVENT_M_CALIBR_SEQ_PHASE_FINALIZED(Phase6) to TM
Switch-off the M-IR detector
Switch-off the –M Scan Unit if it was ON
```

After TC_Disable_Science_*(-), the calibration sequence is stopped and the M_Idle mode is activated.

The total duration of the calibration is about 750sec (~13min) with default parameter configuration in case of HS link data transfer. The calibration duration depends on the M_Calibration parameter (e.g. lamp stabilization time, delay time, etc.) and some constant wait times for repeating the –M data requests from M-PEM, mainly needed in case of slow TM data transfer by RTU link. The following table summarizes the duration of calibration with default parameter for each phase separately if calibration data are transferred by HS link or RTU link. The duration can be shorter or longer in case that the calibration parameters are changed.

M_Cal_Phase	Duration (data transfer via HS link)	Duration (data transfer via RTU link)
0	120sec	303sec
1	121sec	301sec
2	60sec	245sec
3	171sec	333sec
4	75sec	367sec
5	120sec	288sec
6	83sec	272sec
Total: 0...6	**750sec**	**2109sec**

Verification:
- After TC_Enable_Science_* the M_CALIBRATION mode is shown in the VTM_ME_Default_HK_Report if proper parameter are set, otherwise M_USER_DEFINE mode is shown
- M_Degraded mode is shown in VTM_ME_Default_HK_Report if calibration data are transferred by RTU link.
- 7 progress events are issued by TM
- Calibration data are transferred by HS or RTU link (the data rate is shown in Appendix 8: M-Mode TM data format and TM data rates, page 155)

10.13 Execution of a M_SCIENCE Sequence/Mode

The –M science sequence is the main sequence for –M science operation in several science modes. In general, the science sequence has the following function if M_DATA_PRODUCTION_MODE is set to M_DATA_SCIENCE (default) and after commanding TC_Enable_Science_HS_Link or *_RTU_Link:
- Initialization of the M-PEM, incl. switching-on/off the IR-Detector
- Periodically request of science data and HK from M-PEM VIR and IR channel
- Controlling/moving the –M Scan Unit
- -M Shutter control for periodically request of –M dark/background science data

The science data are processed and compressed as shown in chapter 10.14, page 66.
A –M science mode is characterized by a defined processing activities of IR and/or VIS science/dark data and pre-defined M-PEM controlling sequence as described as follows.

Note, there are some constrains related to simultaneous operation of –M and –H in case of science data transfer by RTU link. For details see chapter 9.9, page 45.

Initialization of the M-PEM

1. Before starting the periodical sequence the following initialization is done:
2. Switch-on the –M Scan Unit if M_SU_MODE!=2 (OFF) (functional parameter)
3. Initialize the M-PEM with the functional parameter set if M_ACQ_MODE is not equal to M_ACQ_MODE_IR_ONLY_1x4 or with the alternate parameter set if M_ACQ_MODE is equal to M_ACQ_MODE_ALTER_IR_ONLY_1x4
4a. Switch-off the M-CCD lamp
4b. Switch-off the M-IR lamp
5. Open the –M Shutter
6. Switch-on the M-IR detector if M_FUNC_PARAM.M_IR_DET_OFF is not equal to “0xFF” (OFF) otherwise the M-IR detector remains off
7. Command the M-PEM in M-IR full window mode
8. Wait 30sec as M-IR detector stabilization time
9. Open the –M Cover (Note: opening the cover takes several seconds)
10a. Close the Shutter
10b. Inititialize the Scan Unit, move the Scan Unit to the “start” position angle M_SU_ANGLE_FIRST if M_SU_MODE=0 (Point). M_SU_MODE and M_SU_ANGLE_FIRST are set as functional parameter
10c. Request science data/HK once to get a dark slice
10d. Open the Shutter

Periodically science, dark data/HK request and Scan Unit control

The –M science data and M-HK are requested periodically every Internal Repetition Rate (M_IRT). M_IRT is calculated by M_IRT = M_ERT / M_SS (M_ERT and M_SS are operational parameter). After each science data request the Scan Unit is moved M_SU_NUM_IRT_ANGLE steps if M_SU_MODE=1 (Scan). In case that the Scan Unit is stepped to the end of ist max/last angle M_SU_ANGLE_LAST, the Scan Unit is moved from the last position to the first position M_SU_ANGLE_FIRST. The Scan Unit step size is defined by M_SU_ANGLE_STEP_SIZE.

Note, M_SU_MODE, M_SU_NUM_IRT_ANGLE, M_SU_ANGLE_FIRST, M_SU_ANGLE_LAST and M_SU_ANGLE_STEP_SIZE are –M functional parameter.

Periodically every dark/background rate (set by functional parameter M_D_BCK_RATE), a dark science data acquisition is requested by closing the –M shutter before data request from M-PEM and opening the shutter after dark data request.

Note, in case that dark data (shutter is closed) are requested, the Scan Unit is not moved before, only in case of science data (shutter is open) request the Scan Unit is moved.

In order to be sure, how parameters influence the science sequence including Scan Unit control, the following example is given based on the –M default parameter configuration:

Note 1: if M_ACQ_MODE=M_VIS_ONLY_1x4 is commanded the M-IR detector isn't switched-on, i.e. the M-IR detector is always OFF independent from the –M functional parameter M_IR_DET_OFF.

Note 2: The angles for Scan Unit commanding is transferred (calculated) to SIN and COS values to be able to command the M-PEM based on parameter M_SU_ANGLE_FIRST, M_SU_ANGLE_LAST and M_SU_ANGLE_STEP_SIZE. The resolution for commanding the PEM is only 12bit, but the resolution of the functional parameter are 16bit. Therefore the M-Scan Unit HK M_MIRROR_SIN_HK and M_MIRROR_COS_HK (located in MTM_PEM_VIS_HK_Report) can be slightly different from the expected values based on M_SU_ANGLE_FIRST, M_SU_ANGLE_LAST and M_SU_ANGLE_STEP_SIZE, especially M_MIRROR_COS_HK in case of a small angle position of the Scan Unit around zero degree (i.e. –3°...+3°).

Verification:

After TC_Enable_Science_HS_Link or *_RTU_Link:

- the MTM_Dump_* parameter events 47701, 47702, 47703, 47704, 47705 are issued in order to see the actual parameter configuration
- a M_SCIENCE mode is shown in the VTM_ME_Default_HK_Report if proper parameter are set, otherwise M_USER_DEFINE mode is shown
- M_Degraded mode is shown in VTM_ME_Default_HK_Report if science data are transferred by RTU link.
- processed science data are transferred periodically by HS or RTU link (the data rate is shown in Appendix 8: M-Mode TM data format and TM data rates, page 155)

Example for –M science sequence execution:

M_ERT = 5sec (=1)
M_SS = no summing (=1)
M_D_BCK_RATE = 20
M_SU_MODE = Scan (=1)
M_SU_NUM_IRT_ANGLE = 1 (every IRT one step)
M_SU_ANGLE_FIRST = 0,15° ((32904-32768) * 1,0979° * 10^{-3}/bit)
M_SU_ANGLE_LAST = 33,045° (62847-32768)
M_SU_ANGLE_STEP_SIZE = 0,258° (235bit * 1,0979° * 10^{-3} /bit)

ID Nr **	Science data	Dark data	Scan Unit position, °	Remark
1		1	0,150	Dark acquired once at the beginning
2	1		0,408	from now 20 science data requests/acquisitions
3	2		0,666	
4	3		0,924	
5	4		1,182	
6	5		1,440	
...	6...18		...	
20	19		5,052	
21	20		5,310	
22		2	5,310	SU not moved
23	21		5,568	from now 20 science data requests/acquisitions
24	22		5,826	
...	23...39		...	
42	40		10,470	
43		3	10,470	SU not moved
44	41		10,728	from now 20 science data requests/acquisitions
45	42		10,986	
...	43...119		...	Darks acquisitions 4,5,6 are performed
126	120		31,110	
127		7	31,110	SU not moved
128	121		31,368	from now 20 science data requests/acquisitions
129	122		31,626	
130	123		31,884	
131	124		32,142	
132	125		32,400	
133	126		32,658	
134	127		32,916	
135	128		33,174	last SU step because the last angle (33,045°) is achieved ***
136	129		0,150	SU is moved back to first position ***
137	130		0,408	
...	...		...	

The acquisitions number 1,22,43,64,85,106,127,148, ... are dark data acquisitions. 128 science data acquisitions have to be performed until the Scan Unit is moved back to the first position.

** This number is shown as Acquisition ID in the MTM_Science_Report TM packets. That means the user is able to recognize e.g. the completeness of all acquisitions without a gap in the acquisition ID or which acquisition from the M-PEM is a dark or a science acquisition with which Scan Unit/Mirror position.

*** The algorithm is as follows:
If (M_SU_ANGLE_CURRENT_POSITION > M_SU_ANGLE_LAST + M_SU_ANGLE_STEP_SIZE/2)
Then command SU to go back to M_SU_ANGLE_FIRST
Else command SU next step M_SU_ANGLE_CURRENT_POSITION + M_SU_ANGLE_STEP_SIZE

10.14 –M Science Data Processing, Formatting and TM Transfer

The –M Science data processing/handling flow is performed by software as follows (see also Figure: -M Science Data Processing Flow, page 68) influenced by –M functional and operational parameters: A more detailed example of an IR data processing flow is shown at Figure: Example of M-IR Processing Flow, page 69.

1. M_IMAGE data acquisition from the M-PEM
2. M_IMAGE data normalization of each slice pixel
3. M_IMAGE window adjustment to get a M_SLICE
4. M_SLICE Pixel binning
5. M_SLICE summing if M_SS > 1
6. M_SLICE dark subtraction
7. Decomposition of a M_SLICE to sub-slices
8. Data compression of sub-slices if M_COMP_MODE > 0
9. Decomposition of each sub-slice to TM packets
10. Transfer of TM packets to the S/C by HS link or RTU link

The general data processing flow is always the same for each M_Science, M_Calibration or M_Test mode. Only some functional and operational parameters have influence on data content, format and volume sent to the S/C.

10.14.1 M_SLICE Data Acquisition from M-PEM

The data and HK are acquired from M-PEM after each request. The software check the number of words expected, transfer rate, data dynamics, etc. If one of these checks are wrong an event is sent to the S/C. For TM time stamping the SCET is read from the ME internal timer when the first data are acquired from the ME M-PEM interface electronics. This "Slice" or "acquisition" time, except in case of Slice Summing, is written in each TM packet containing science or HK data (see also chapter 7.6 "Time Stamping of each TM Packet").
At each successful slice acquisition and within one session started by TC_Enable_Science_* and stopped by TC_Disable_Science_*, an acquisition counter is counted-up to be put in the TM science packets as "Acquisition ID" (see MTM_Science_Report (HS_Link or RTU_Link) (APID52/12, T20, ST13 or 3)) .

10.14.2 Data normalization and dynamics

After M-PEM VIS and IR data request and acquisition, the raw data coming from M-PEM are nomalized in order to get a consistent data scale for each data channel –M VIS, -M IR and –H.
The data normalization is done in each mode in the same way independent from the input parameter commanded by TC.

Normalization means each 16bit pixel value is converted as follows:

<u>VIS data:</u>
- M_VIS_PIX(raw)= 16372...65535 DN
- M_VIS_PIX(normalized)=[M_VIS_PIX(raw)-16372]/2
- M_VIS_PIX(normalized)= 0... 24575DN

The purpose is to obtain a 15bit value (16bit signed integer) increasing from 0 (no signal) to 24575.

<u>IR data:</u>
- M_IR_PIX(raw)= 61000...7500 DN
- M_IR_PIX(normalized)= [61000-M_IR_PIX(raw)]/2
- M_IR_PIX(normalized)= 0... 26750DN

The purpose is to obtain a 15bit value (16bit signed integer) increasing from 0 (no signal) to 26750.

10.14.3 Window Adjustment

After normalization of data a window adjustment is done. That means the rectangle (X,Y) organized data are cut so that the data size is a multiple of 144x64 elements (pixel) as a sub-slice unit. This is needed in order to be able to compress all data on sub-slice level without any rest.

Window Adjustment is done using the functional parameters and data production parameters:

- M_CCD_WIN_X1, M_CCD_WIN_X2, M_CCD_WIN_Y1, M_CCD_WIN_Y2
- M_IR_WIN_X1, M_IR_WIN_X2, M_IR_WIN_Y1, M_IR_WIN_Y2
- M_ACQ_MODE

Further explanations using these parameters are shown in chapter 10.3 "–M Parameter Usage".

10.14.4 Pixel Binning

Pixel Binning is done in order to reduce the VIS and IR data volume either by reducing the spatial (binning in Y-direction) or spectral (binning in X-direction) resolution by building of marco pixel. The binning factor and type depends on the TC data production parameter M_ACQ_MODE what results to different –M science modes. Further explanations using the M_ACQ_MODE parameter are shown in chapter 10.3 "–M Parameter Usage".

10.14.5 Slice Summing

The purpose of Slice Summing is to increase the Single to Noise Radio of VIS and IR science data. It is done only in case that the parameter M_SS is greater than 1. M_SS (commanded by MTC_Change_Operat_Param_RAM (T193, ST15)) defines the number of slice to be summed. Additional information using the M_SS parameter are shown in chapter 10.3 "–M Parameter Usage".

Note, in case of Slice Summing , the acquisition SCET of the last Slice summed is sent by TM in TM packets.

10.14.6 Dark/Background subtraction

Each VIS and IR Slice (already normalized, window adjusted, binned and summed) is subtracted by a dark slice previously acquired and stored in DPU memory. The criteria whether a Slice is a Science or Dark/Background Slice is the M-Shutter status located in the M-HK acquired together with each science data Slice. Therefore in the science sequence (see chapter 10.13 "Execution of a M_SCIENCE Sequence/Mode") at the beginning a Dark/Background Slice is requested from the M-PEM.
Dark/Background subtraction is not done in M_Calibration mode.

10.14.7 Decomposition of a Slice to Sub-Slices

Before VIS and IR data compression (sub-slice oriented) a processed slice (Science or Dark/Background) is decomposed to 1 or several sub-slices to be able to compress. The number of sub-slices depends on window adjustment and binning.

10.14.8 Data Compression

Each VIS and IR sub-slice is compressed by 4 different compression modes or is not compressed depends on the operational parameter M_COMP_MODE. Additional information using the M_COMP_MODE parameter are shown in chapter 10.3 "–M Parameter Usage".
More details about compression itself (applicable for –M and –H data processing) are shown in chapter 12 "–M and –H data compression", page 99.

10.14.9 Decomposition of each sub-slice to TM packets

Each compressed or not compressed sub-slice is divided in data blocks of max. 500 words to be put in TM packets before transferring them to the S/C.

10.14.10 Transfer of TM packets by HS link or RTU link

Each TM packet is either transferred via HS link or RTU link to the S/C depending on the starting a science data production by TC_Enable_Science_HS_Link(-M) or TC_Enable_Science_RTU_Link(-M).

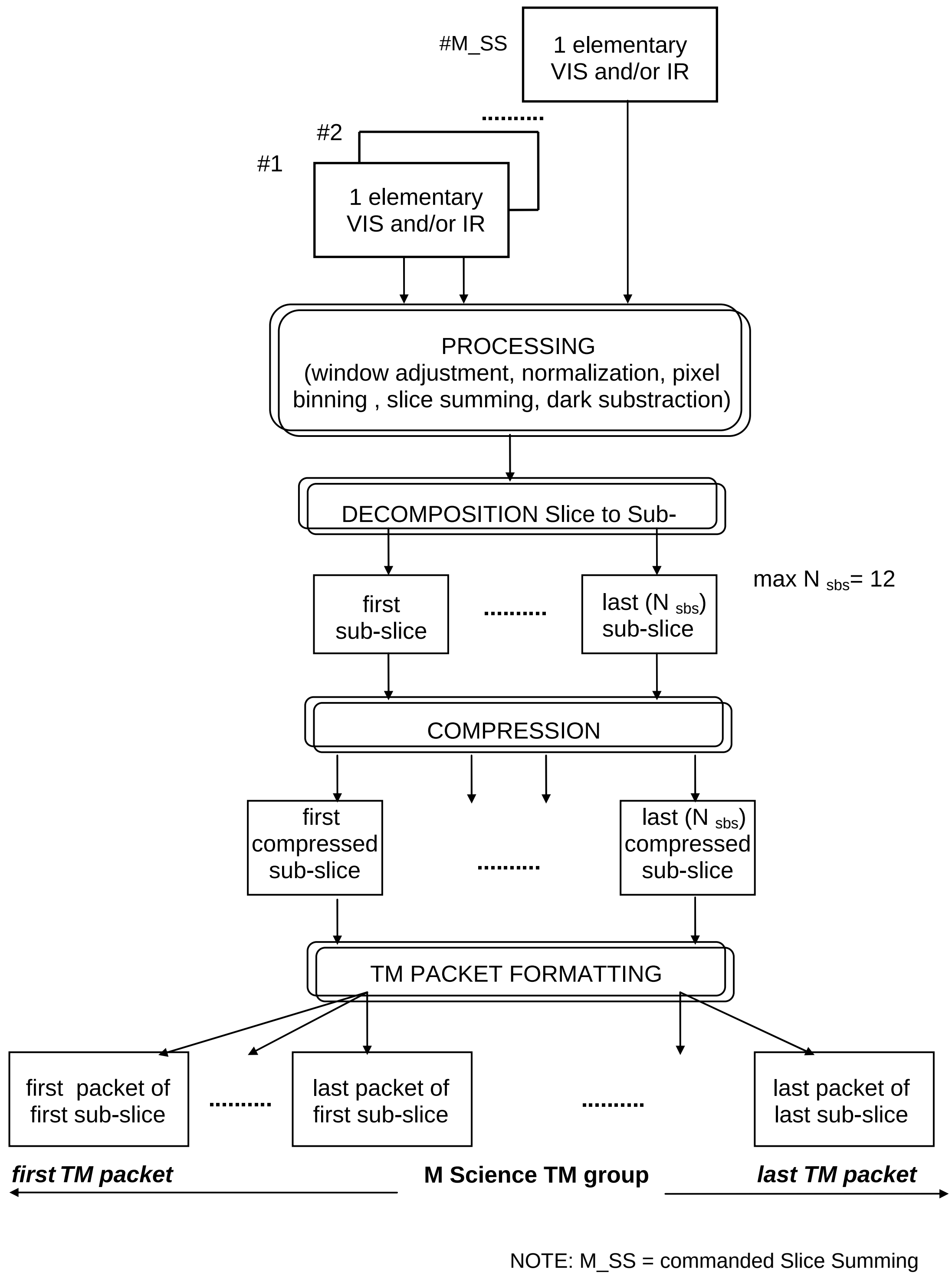


Figure: -M Science Data Processing Flow

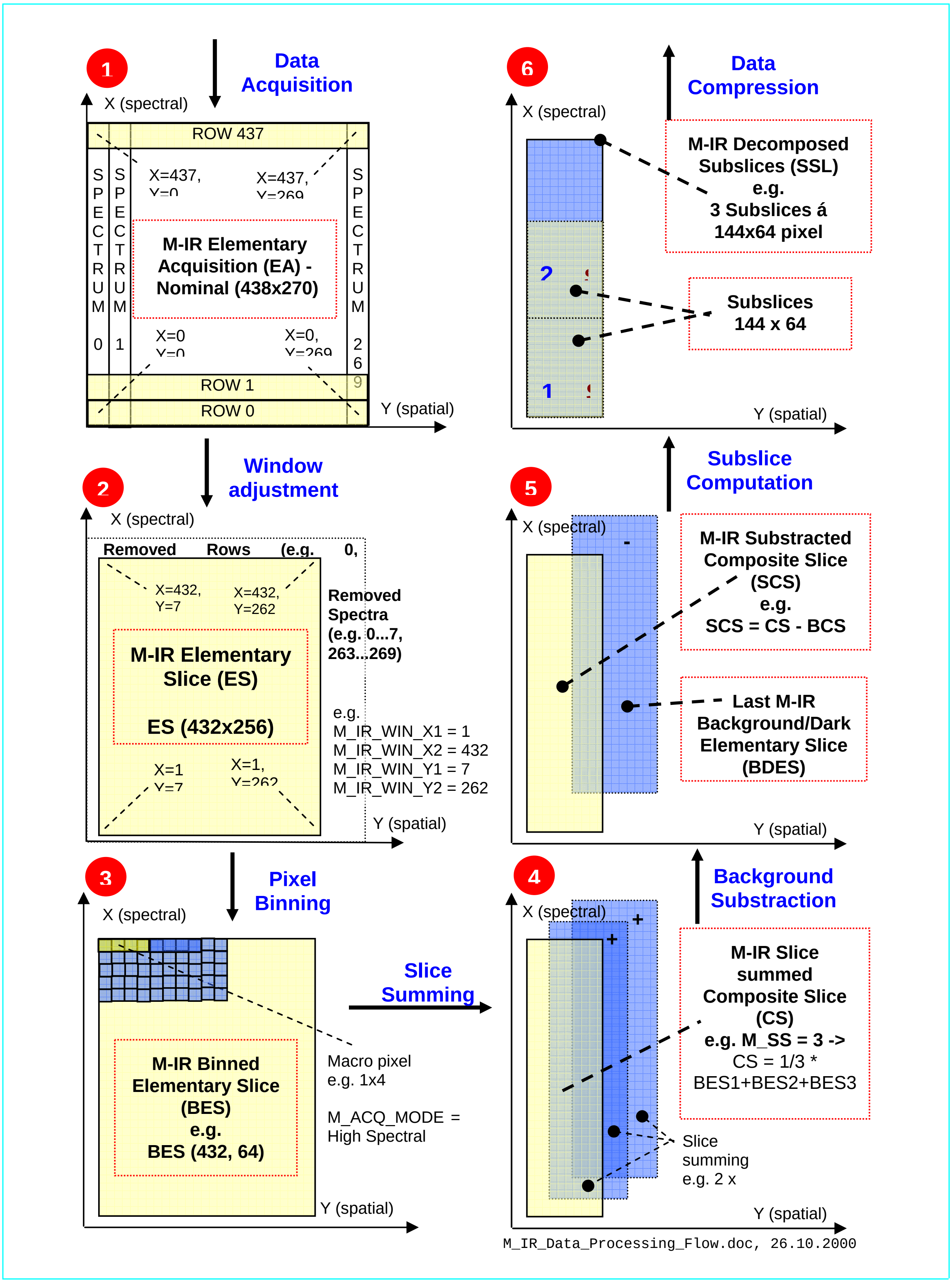


Figure: Example of M-IR Processing Flow

10.15 M-PEM HK generation

The M-HK acquired from M-PEM (by ME and software) are located in and transferred by MTM_PEM_VIS_HK_Report (see page 134) and MTM_PEM_IR_HK_Report (see page 135).

General information are shown in chapter 7.8 (page 32).

The ME/Software doesn't change anything of the M-PEM HK structure. That means the M-PEM HK are transferred to the S/C in the same format and content as acquired from the M-PEM. Therefore in general the HK structure in TM is compatible with the S/W ICD RD(6).

11 VIRTIS-H Control and Science Data Production

11.1 Generals and Preconditions

The VIRTIS-H sub-system can be controlled only by EEPROM software in ME_Idle mode (started by VTC_Enter_Idle_Mode) or by entering a H-Mode by VTC_PEM, VTC_Cooler or an other HTC_....
The H-PEM interface (1J05) has to be connected. Otherwise the software detects an open data interface and generates an error event "PEM not connected" after each H-PEM power-on.
For verification, that a –H mode is achieved, the currently active –H Mode is shown in the Default HK (see mode definition in VTM_ME_Default_HK_Report (T3, ST25, SID1), page 132).

11.2 H-Mode Control

The -H sub-system is entered in a defined –H mode (e.g. H_OFF, H_CALIBRATION, H_SCIENCE_NOMINAL_DATA_RATE). For verification, which –H mode is entered, the currently active H-Mode is shown in the Default HK (see mode definition in VTM_ME_Default_HK_Report (T3, ST25, SID1), page 132).

H-Mode building is performed by software based on the H-parameter (commanded by the HTC_Change_* or stored as Default parameter in EEPROM) and the internal sub-system status (e.g. Cooler status, PEM status, etc.) as shown Appendix 10: H-Mode build according ME internal –H status and TC commanding" (see page 157).
There are some restrictions for commanding –H depends on the H-Mode. The table that presents which TC is allowed to be commanded in which H-Mode is shown in "Appendix 9: HTC acceptance against H-Mode" (see page 156).
If a TC is commanded but not allowed in the current active mode, a TM_TC_Acceptance_Report_Failure (T1, ST2) is issued by TM.

11.3 –H Parameter Usage

The following HTC_Change_XXX TCs are responsible to configure the VIRTIS-H sub-system before enabling H-Science Data acquisition by TC_Enable_Science_*(-H):

- HTC_Change_Data_Product_RAM (or ..._EEPROM)
- HTC_Change_Func_Param_RAM (or ..._EEPROM)
- HTC_Change_Operat_Param_RAM (or ..._EEPROM)
- HTC_Change_Pixel_Map_Param_RAM (or ..._EEPROM)

The TC e.g. HTC_Change_Data_Product_EEPROM writes the parameter in the –H ACTUAL parameter set in RAM and in EEPROM (i.e. as CURRENT parameter set). After Secondary Boot the CURRENT parameter set in the EEPROM is copied in the ACTUAL parameter set in RAM. So the user is able to prepare a kind of "working default configuration", the CURRENT parameter set. Details about general parameter usage are shown in chapter 9.10, page 46.

If ACTUAL parameter were changed by HTC_Change_XXX, the default configuration (see HTC_Change_XXX structures) can be set or reconfigure by HTC_Default_Configuration.

All parameters of TCs are checked against minimum and maximum values in order to protect the software, to avoid not allowed or not meaningful commanding of H-PEM and to limit the parameter ranges to support proper commanding by the user.
Allowed minimum and maximum parameter ranges and the parameter default configuration are shown in the TC structure definition in Appendix.

11.3.1 Data Production Parameter Usage (HTC_Change_Data_Product_*)

The H_DATA_PRODUCTION parameter is used for selecting a -H science, calibration or test sequence/mode to be started after TC_Enable_Science_*(-H) and therefore it has influence on data type (science/test/calibration data) and volume and format to be produced. The parameter can be commanded by MTC_Change_Data_Product_Param_RAM or *_EEPROM. The structure of this TC is shown in Appendix, page 120. A H_SCIENCE_*, H_CALIBRATION or H_TEST sequence is started after TC_Enable_Science(-H) and commanding the H_DATA_PRODUCTION mode as follows:

- H_DATA_PRODUCTION = H_DATA_NOMINAL_OBSERVATION (default), see chapter 11.13, page 83
- ... = H_DATA_CALIBRATION, see chapter 11.16, page 86
- ... = H_DATA_NOMINAL_SIMULATION, see chapter 11.13, page 83
- ... = H_DATA_SPECTRAL_CALIBRATION_SIMULATION, see chapter 11.15, page 86
- ... = H_DATA_SCIENCE_BACKUP, see chapter 11.14, page 86
- ... = H_DATA_TEST, see chapter 11.12, page 82

11.3.2 Functional Parameter Usage (HTC_Change_Func_Param_*)

The functional parameter are used mainly for –H initialization/configuration purposes. They can be commanded by HTC_Change_Func_Param_RAM or *_EEPROM. The TC structure incl. parameter default settings is shown in Appendix, page 121. The TC parameter (located in appl. data field) are used as shown in table as follows.

Parameter	Purpose/Function
H_INT_SPECT_T_NUM	Integration time for H_CALIBRATION mode phase 2 = Telescope_Spectral_Calibration. It is used for H-PEM commanding inside the calibration sequence.
H_INT_SPECT_S_NUM	Integration time for H_CALIBRATION mode phase 1 = Slit_Spectral_Calibration. It is used for H-PEM commanding inside the calibration sequence.
H_INT_RAD_NUM	Integration time for H_CALIBRATION mode phase 3 = Image_Slice_Radiometric_Calibration and phase 4 = Spectrum_Radiometric_Calibration. It is used for H-PEM commanding inside the calibration sequence.
H_V_BIAS	This parameter is used for initializing the H-PEM inside the H-PEM reset sequence after H-PEM power-on by HTC_PEM(ON) or after H-PEM reset by HTC_PEM(reset) or after TC_Enable_Science(-H)
H_I_LAMP_SPEC_T	Current of calibration lamp commanded to H-PEM before Telescope_Spectral_Calibration in H_CALIBRATION mode.
H_I_LAMP_SPEC_S	Current of calibration lamp commanded to H-PEM before Slit_Spectral_Calibration in H_CALIBRATION mode.
H_I_LAMP_RADIO	Current of calibration lamp commanded to H-PEM before Spectrum_Radiometric_Calibration in H_CALIBRATION mode.
H_I_SHUTTER	This parameter is used for initializing the H-PEM inside the H-PEM reset sequence after H-PEM power-on by HTC_PEM(ON) or after H-PEM reset by HTC_PEM(reset) or after TC_Enable_Science(-H)
H_STAB_LAMP_TIME	Stabilization time after switching-on the calibration lamp in H_CALIBRATION mode
H_STAB_DET_TIME	Stabilization time after switching-on the IR detector in H_CALIBRATION or H_SCIENCE_* mode
H_SHUTTER_TIME	Stabilization time after switching-on the H-Shutter in H_CALIBRATION or H_SCIENCE_* mode
H_OPEN_COVER_STEP H_CLOSE_COVER_STEP H_INIT_COVER_STEP	These parameters are needed for H-Cover control, in case of - cover initialization after e.g. H-PEM power-on (H_INIT_COVER_STEP is used by software and for H-PEM control) - closing the cover (H_CLOSE_COVER_STEP is used by software and for H-PEM control) - opening the cover (H_OPEN_COVER_STEP is used by software

	and for H-PEM control) The parameters define how many steps (of the cover stepper motor) are needed to init, open and close the cover.
H_SPARE	not used
H_ECA_ACT	This parameter defines the max. H-ECA actuation time (ECA ME +28V switching-on time). After this time, the +28V ECA is switched-off even if the ECA status hasn't shown that the ECA is already moved completely. If the ECA status shows that the ECA is moved to the end stoke, the +28V ECA voltage is switched-off before.
H_ANNEAL_CHECK_PERIOD	This parameter defines the period for checking of IR detector temperature inside H-HK in order to detect when H-IR detector annealing shall be stopped.
H_ANNEAL_TEMP	This parameter defines the temperature (periodically checked inside H-HK) when H-IR detector annealing shall be stopped.
H_ANNEAL_TIME	This parameter defines the max. annealing time (i.e. IR detector heating time) until H-IR detector annealing is stopped.
H_XWIN	Defines the start pixel X-co-ordinates where the –H orders are illuminated on the detector. It is used for –H Pixel Map calculation in order to mask the pixel not used from 0...H_XWIN in order to get a window of 8 orders á 432 pixel (not 438 pixel concerning detector size).
H_XWIN H_YWIN	Defines start co-ordinates for window adjustment during H-data processing to be relevant if the full –H detector is read-out. During window adjustment, the window size is reduced from 438x270 pixel to H_XWIN+432 x H_YWIN+256 (432x256) pixel. These window adjustment is applicable in all mode where a full –H detector window is acquired from H-PEM and transferred to the S/C (e.g. H_SCIENCE_BACKUP, H_TEST).
H_TEST_INIT	Defines the start value of test pattern commanded to and generated by H-PEM in all –H simulation modes, H_NOMINAL_SIMULATION, H_SPECTRAL_CALIBRATION_SIMULATION where only test pattern are generated from H-PEM and sent to the S/C. It is a start value of a 12bit wrapped around counter inside the H-PEM.

Table 11.3.2-1: -H functional parameter description

11.3.3 Operational Parameter Usage (HTC_Change_Operat_Param_*)

The operational parameters are used for defining the type of –H data processing and the repetition rate to produce/transfer science data to the S/C. All parameter have influence on the –H TM data production rate and on the TM data format.
The parameter can be commanded by HTC_Change_Operat_Param_RAM or *_EEPROM. The TC structure incl. parameter default settings is shown in Appendix, page 122. The TC parameters (located in application data field) are used as shown in table as follows.

Parameter	Function
H_INT_SCIENCE_NUM	Defines the Integration Time used in all science, simulation and test modes. The parameter has influence on the H_IRT, the internal repetition time for H-PEM data request. Therefore it has also influence on the TM data rate.
H_SPARE	not used
H_SUM	Defines whether several successive H_SPECTRUM or H_IMAGE_SLICEs are summed or not. If H_SUM=YES, the number of H_SPECTRUM or H_IMAGE_SLICEs to be summed is defined by H_N_SUM_FRAME. The parameter has influence on the H_IRT, the internal repetition time for H-PEM data request. Therefore it has also influence on the TM data rate.
H_N_FRAME	Defines the number of frames (cycles) to request data from H-PEM in case that H_SUM=NO. A frame is an –H internal cycle of detector integration, detector readout and an Idle time. If e.g. H_N_FRAME = 3, data are requested every 3 frames (cycles). For more details, t–e -H

	operation has to be study. The parameter has influence on the H_IRT, the internal repetition time for H-PEM data request. Therefore it has also influence on the TM data rate.
H_N_SUM_FRAME	Defines the number of H_SPECTRA or H_IMAGE_SLICEs requested from H-PEM to be summed in case that H_SUM=YES. Data are requested from H-PEM at every internal frame cycle but due to summing only every H_N_SUM_FRAME is sent to the S/C. If e.g. H_N_SUM_FRAME = 6, data are requested every –H frame (cycles), 6 successive H_Spectra or H_IMAGE_SLICEs are summed and after summing every 6^{th} summed H_SPECTRA or H_IMAGE_SLICEs is sent to the S/C. For more details, t–e -H operation has to be study. The parameter has influence on the H_IRT, the internal repetition time for H-PEM data request. Therefore it has also influence on the TM data rate.
H_DARK_RATE	Defines the number of –H dark acquisitions, which represents a period for closing/opening the H-Shutter. If e.g. H_DARK_RATE = 10, dark H_Spectra or H_Image_Slices data (-H shutter closed) are requested every 10^{th} science acquisitions (-H shutter opened). The parameter has slightly influence on TM data rate in case of nominal observation modes (H_SCIENCE_*) due to the fact that only science data H_SPECTRA_SLICEs are compressed but H_DARK_SPECTUM are not compressed.
H_COMP_MODE	Defines the on-line compression mode for compression of sub-slices (144x64) as compression units. The modes represent different data quality and compression factors. H_NO_COMPRESSION: no compression is done H_LOSSLESS_COMPRESSION: it represents a data compression without any loss a differential algorithm is performed with rice encoding. The compression factor is low (about 1.5) for very noisy H-PEM data up to high (about 5). The nominal average compression factor is about 2...4. H_WAVELET_F1_COMPRESSION: the wavelet compression is “low” lossy. The data compression factor is 8. H_WAVELET_F2_COMPRESSION: the wavelet compression is “medium” lossy. The data compression factor is 10,67. H_WAVELET_F3_COMPRESSION: the wavelet compression is “high” lossy. The data compression factor is 16.

Table 11.3.3-1: -H operational parameter description

11.3.4 Pixel Map Parameter Usage (HTC_Change_Pixel_Map_Param_*)

Pixel Map parameters are used for –H Pixel Map calculation by software. The parameters are 3 coefficients for each (8) order position (polynom) to be calculated. The structure of this TC is shown in Appendix, page 124. The TC parameter (located in application data field) are used as follows:.

H_PIX_MAP_C11, *_C12 and *_C13 are 3 coefficients for calculating Order 1 position (one triplet per Order). For each Order 2...8 positions a set of 3 coefficients are available in the TC.

The coefficients default configuration represents the position and shape of the 8 orders on IR detector after VIRTIS-H on-ground calibration. The parameters have only be changes in case that optics to detector placement is changed too (e.g. due to instrument vibration).

11.4 –H Parameter check after TC_Enable_Science_*(-H)

In order to protect VIRTIS science operation against wrong parameter commanding, a parameter consistency check is done after TC_Enable_Science_*(-H).
The following checks are done:
- the internal calculated H_IRT is checked against a fix time value in order to guarantee a minimum time for requesting data from H-PEM
- the TM data rate is checked in order to guarantee a maximum data rate to be able to produce by the software from the performance point of view

11.4.1 H_IRT check

H_IRT is the ME/Software internal time period for requesting of science data (H_IMAGE or H_Spectrum) from H-PEM.
The H_IRT check is needed in order to be sure that the calculated H_IRT, as a period for –H data request from H-PEM, is longer than the internal H-PEM and ME performance allows it assumed a nominal S/C interface performance.

The calculated H_IRT must be longer than

1. H_IRT_SPECTRUM_MIN= **700ms** in case that H_SPECTRA are acquired (e.g. H_DATA_NOMINAL_OBSERVATION mode) or
2. H_IRT_IMAGE_MIN= **5000ms** in case that H_IMAGE_SLICEs are acquired (e.g. H_DATA_SCIENCE_BACKUP mode).

Note, the calculation of H_IRT must be exact because the ME software H_IRT timer shall be synchronous to the H-PEM internal free running detector "integration, read-out, idle" cycle.

H_IRT is calculated as follows:

H_IRT = H_FRAME_PERIOD * H_NR_FRAME

H_FRAME_PERIOD = H_INT_SCIENCE + H_READOUT_TIME + H_HK_READ_OUT_TIME + H_IDLE_TIME

The following definitions are valid:

If H_Sum = NO then
- H_NR_FRAME = H_N_FRAME (operational parameter)

If H_Sum = YES then
- H_NR_FRAME = 1 (operational parameter)

If H_DATA_PRODUCT_MODE = H_DATA_NOMINAL_OBSERVATION then
- H_READOUT_TIME = 284,58ms

If H_DATA_PRODUCT_MODE = H_DATA_SCIENCE_BACKUP then
- H_READOUT_TIME = 1193,4ms

H_HK_READ_OUT_TIME = 2,304ms
H_IDLE_TIME = 79,872ms

Example 1 for H_IRT check:

H_DATA_PRODUCT_MODE = H_DATA_NOMINAL_OBSERVATION
H_INT_SCIENCE=400ms, H_SUM=NO, H_N_FRAME=2

H_IRT = (400ms + 284,58ms + 2,304ms + 79,872ms) * 2 = **1533,51ms**

H_IRT > H_IRT_SPECTRUM_MIN → 1533,51ms > 700ms

That means this parameter configuration is accepted because the calculated H_IRT is higher than the minimum allowed H_IRT_SPECTRUM_MIN. Therefore TC_Enable_Science_*(-H) is accepted.

Example 2 for H_IRT check:

H_DATA_PRODUCT_MODE = H_DATA_SCIENCE_BACKUP
H_INT_SCIENCE=1000ms, H_SUM=YES

H_IRT = (1000ms + 1193,4ms + 2,304ms + 79,872ms) * 1 = **2275,6ms**

H_IRT > H_IRT_IMAGE_MIN → 2275,6ms < 5000ms

That means this parameter configuration is not accepted because the calculated H_IRT is lower than the minimum allowed H_IRT_IMAGE_MIN. Therefore TC_Enable_Science_*(-H) is not accepted which means that a TM_TC_Acceptance_Report_Failure is issued, with failure code=7 and parameter3=11.
The user should command either H_INT_SCIENCE>3.8sec or command H_SUM=NO and H_N_FRAME>2, so that TC_Enable_Science_*(-M) is accepted.

11.4.2 –H TM data rate check and calculation

This check is needed in order to be sure that the calculated TM data rate doesn't exceed defined allowed values as maximum S/C interface performance.

The max. TM data rate is defined as follows:

- for –H data transfer via HS link: H_HS_DATA_RATE_MAX = 52000 Word (832kbit/s)
- for –H data transfer via RTU link: H_RTU_DATA_RATE_MAX = 640 Word (10,3kBit/s)

Concerning RTU data rate check, it is assumed that the S/C RTU can poll VIRTIS with a maximum defined data rate and VIRTIS-M and –H are able to work simultaneously.
The calculation and check of -M TM data rate is done as follows:

H_Calibration mode:

There is no TM data rate check implemented because calibration is a one shot sequence with a fix (not periodical transferred) data volume. In order to have a defined and low peak data rate on the S/C interface some delays are added between several internal data requests/acquisitions from M-PEM inside the calibration procedure. The TM data rate during calibration is shown in Appendix 11: H-Mode TM data format and TM data rates (page 158).

H_ME_Test mode:

There is a data rate is checked against the maximum allowed values. In this mode it is calculated as follows:

Data_Rate (words/ms) = H_Pattern_Size / H_Pattern_Rep_Rate
H_Pattern_Size and H_Pattern_Rep_Rate are parameter commanded by VTC_Enter_Test_Mode

H_DATA_NOMINAL_OBSERVATION data production mode:

There is a data rate checked against the maximum allowed values. In this mode it is calculated as follows:

- H_Data_Rate (words/sec) = H_Dark_Data_Rate + 432*8 / (H_IRT * H_Compression_Factor)
- H_Dark_Data_Rate (words/sec) = 432*8 Words / (H_IRT * (H_DARK_RATE + 1))

The M_Compression_Factor depends on the compression mode commanded. H_IRT is calculated as shown in chapter 11.4.1 (page 74) and depends on parameter commanded by HTC_Change_Operat_Param_*. H_DARK_RATE is commanded by HTC_Change_Operat_Param_* as parameter. For data rate calculation the following compression factors are used:

- H_NO_COMPRESSION: H_Compression_Factor = 1
- H_LOSSLESS_COMPRESSION: H_Compression_Factor = 2
- H_WAVELET_F1_COMPRESSION: H_Compression_Factor = 8
- H_WAVELET_F2_COMPRESSION: H_Compression_Factor = 10
- H_WAVELET_F2_COMPRESSION: H_Compression_Factor = 16

H_DATA_NOMINAL_SIMULATION data production mode:

In this mode, the data are produced in a similar way as in H_DATA_NOMINAL_OBSERVATION data production mode except Dark data are not produced because the H-PEM doesn't simulate the Shutter status (responsible for dark data) in simulation mode.

There is a data rate checked against the maximum allowed values. In this mode it is calculated as follows:

- H_Data_Rate (words/sec) = (H_IRT * H_Compression_Factor)

other information are valid as shown for H_DATA_NOMINAL_OBSERVATION.

H_DATA_SCIENCE_BACKUP, H_DATA_SPECTRAL_CALIBRATION_SIMULATION, H_DATA_TEST data production mode:

There is a data rate checked against the maximum allowed values. In this mode it is calculated as follows:

- H_Data_Rate (words/sec) = H_Dark_Data_Rate + 432*256 / (H_IRT * H_Compression_Factor)

- H_Dark_Data_Rate (words/sec) = 432*256 Words / (H_IRT * (H_DARK_RATE + 1))

Generally the calculation is done in the same way as shown e.g. for H_DATA_NOMINAL_OBSERVATION but with a higher data volume of 432*256 words instead of 432*8 words.

Example for data rate calculation / check in H_NOMINAL_OBSERVATION mode:

Parameter commanded:
H_DATA_PRODUCTION_MODE = H_DATA_NOMINAL_OBSERVATION
H_INT_SCIENCE = 1sec
H_SUM = 0 (no Summing)
H_N_FRAME = 1
H_DARK_RATE=10
H_COMP_MODE = H_LOSSLESS_COMPRESSION

The following calculation is done:
H_IRT = 1,368s
H_Dark_Rate = 8*432 Words / (1,368s * (10 + 1)) = 227 Word/s = 3,64kbit/s

H_Data_Rate = 227 Words/s + (8*432 Words)/(1,368s * 2) = 1490 Words/s = 23,9kbit/s

H_Data_Rate < H_HS_DATA_RATE_MAX, 23,9kbit/s **<** 832kbit/s
H_Data_Rate < H_RTU_DATA_RATE_MAX, 23,9kbit/s **>** 10,3kBit/s

That means, the calculated H_Data_Rate of 23,9kBit/s is allowed to be produced by HS link. TC_Enable_Science_HS_Link(-H) is accepted to be commanded.
Otherwise commanding TC_Enable_Science_RTU_Link(-H) is not accepted to be commanded because the H_Data_Rate produced is higher than allowed to be transferred by RTU link. In this case the user should command an other compression mode with higher compression factor (e.g. H_WAVELET_F1_COMPRESSION), a higher H_INT_SCIENCE (e.g. > 3sec) or a higher H_N_FRAME (e.g. > 3).

11.5 H-PEM Power Switching and Reset Control by HTC_PEM

By commanding of VTC_PEMS (T192, ST4) (see page 118) or HTC_PEM (T194, ST1) (see page 118), the H-PEM is :

- **Power-ON by HTC_PEM(ON) or VTC_PEM(ON)**

  1. the ME PS –H converter is switched-on and all –H voltages are switched-on at 1J05

  2. the quiescent state of the H-PEM/ME data input interface is checked. If it is not active (not low), an event is generated and sent by TM

  3. the H-Cover is initialized using the ACTUAL parameter, that means the H-Cover is closed if it is open or not closed

4. by default PEM HK are acquired and transferred to the S/C

- **Power-OFF by HTC_PEM(OFF) or VTC_PEM(OFF)**

  the ME PS –H converter is switched-off and all –M voltages are switched-off at 1J05

- **Reset by HTC_PEM(Reset) or VTC_PEM(Reset)**

  the M-PEM is reset by the hardware reset pulse at 1J05 / Reset_H

  Note: Reset of the PEM is only possible if the PEM is already switched-on

Note, immediately after H-PEM power-on or reset, H-HK are requested and sent to TM in order to be able to see the power-on status before initialization and operation the H-PEM.

11.6 H-Cooler Control by HTC_Cooler

By commanding of VTC_Coolers (T192, ST5) (see page 113) or HTC_Cooler (T194, ST5) (see page 119), the H-CCE/Cooler is :

- +28V powered ON and commanded in open loop mode if TC param., word 6= 2
- +28V powered ON and commanded in closed loop mode if TC param., word 6= 3
- +28V powered ON but in Stand-by due to the cooler motor drivers are OFF if TC param, word 6= 4
- +28V powered OFF if TC parameter, word 6= 1

“Open loop” mode means that the cooler is commanded by a motor speed (rotation per minute). This motor speed is located in XTC_Cooler as parameter.
“Closed loop” mode means that the cooler is commanded by a cold tip temperature to regulate by cooler electronics. This cold tip temperature is located in XTC_Cooler as parameter.

The H-Cooler analog and digital HK are sent periodically to the S/C (if enabled) by the HTM_ME_General_HK_Report (T3, ST25, SID3) (see page 141).

If the Cooler is in Cool Down (i.e. normally after starting closed or open loop mode), the cold tip temperature of the ME/General HK is monitored once every 10sec if the ME/General-HK are enabled. If the Cooler achieves the Steady state (i.e. the cold tip temperature has been achieved as commanded in close loop mode, see cold tip temperature parameter of XTC_Cooler) or as a fix temperature of 65K in Open Loop mode (Note: 65K is needed considering the delta between cold tip and detector temperature). The cold tip temperature tolerance for steady state detection is +/-1.5K. Note, the ME General HK accuracy is about 4%.

The cold tip temperature is checked for 1,5 hours (5400sec) after switching-on the cooler in close loop mode every 10sec at each H-HK acquisition in order to detect the cooler steady state. Note, for this check the H-HK acquisition must be enabled. If the cold tip temperature is inside the expected tolerance after 1,5 hours, an event 47906 EVENT_H_COOL_DOWN_END_SUCCESS is issued otherwise event 47954 EVENT_M_COOL_DOWN_END_FAILURE is issued by TM.

In case that the cooler is in steady state but the cold tip temperature is detected outside the “expected temperature +/-1.5K” range, the event 47965 EVENT_H_COOL_STEADY_STATE_FAILURE is issued.

11.7 H-ECA Control by HTC_ECA and VTC_Confirm

The H-ECA is controlled in the same way as M-ECA but using HTC_ECA and VTC_Confirm (param T194, ST4).
Therefore see chapter 10.7 "M-ECA Control by MTC_ECA and VTC_Confirm", page 57.

11.8 H-Cover control by HTC_Cover

The H-Cover is controlled in the same way as M-Cover.
Therefore see chapter 10.8 "M-Cover Control by MTC_Cover", page 57.

11.9 H-PEM Low Level Commanding by HTC_PEM_Command_Word

Low level commanding the H-PEM is only possible in H_Test mode as shown in chapter 11.12 (see page 82).
For low level commanding the H-PEM, the HTC_PEM_Command_Word (T194, ST2) (see page 159) is used. The H-PEM command word located as parameter in the TC, is transferred to the PEM without modification. Only 4 PEM commands are interpreted internally by software with the following purpose:

1. After HSTART_S, the H-PEM is requested to transfer science data and HK. The software waits internally for data receipt (118260 science data + 36 HK words), the science data are packet into TM packets and these are sent to the S/C via HS link. HK are converted in the TM packet format and are sent to the S/C via SDT.

2. After HSTART_HK, the H-PEM is requested to transfer HK. The software waits internally for HK (36 words) receipt and the HK are transferred to the S/C via SDT interface as one HK TM packet.

3. After HSET_DET(ON) (...OFF) and if the mode H_PEM_ON is active, the H_PEM_MODE is transferred from H_PEM_ON to H_PEM_IDLE (or if ...OFF from H_PEM_IDLE to H_PEM_ON). This is done for internal mode handling. Only for EQM: the –H mode can be changed depends on the state of the –H ACTUAL parameter. For FM: this TC is only allowed in test mode.

4. After HSET_PEM_Mode the internal S/W H_PEM_MODE is set to

- H_PEM_OBSERVATION_8ORDERS or
- H_PEM_OBSERVATION_FULL_MATRIX or
- H_PEM_SIMULATION_8ORDERS or
- H_PEM_SIMULATION_FULL_MATRIX

depends on the command HSET_PEM_Mode (0,1,2,3).

This allows the software to know, which type of data has to be acquired from the H-PEM after HSTART_S, so that the received data from H-PEM can be transferred to the S/C.

All other commands are transferred to the H-PEM without any interpretation.

Note: in this mode, the user has the full responsibility about the consistency of PEM commanding, about time between PEM commanding and about order of commands sent to the H-PEM. In addition, the user is able to look in the H-HK for status monitoring. The HK are periodically requested by on-board software always if the H-PEM is switched-on and the HK are enabled.

Example: after switching-on the H-PEM, and after establishing the HS link, the following PEM commands are commanded:

1. HTC_PEM_Command_Word (010100 0001001011) ; HSET_INT_NUM1 (LSW), Int. time=
2. HTC_PEM_Command_Word (010101 0000010011) ; HSET_INT_NUM2 (MSW), 10sec
4. HTC_PEM_Command_Word (010001 0000000001) ; HSET_Det, ON
3. HTC_PEM_Command_Word (011010 0000000001) ; HSET_PEM_Mode, Observation Full Matrix
5. HTC_PEM_Command_Word (011011 0000000001) ; HSET_Shutter, ON (closed)
6. HTC_PEM_Command_Word (011101 0000000001) ; HSET_Lamp_Spect_T, ON

7. HTC_PEM_Command_Word (100000 0000000000) ; HSTART_S
8. Wait 15sec
9. HTC_PEM_Command_Word (100000 0000000000) ; HSTART_S

After setting the integration time and switching-on the lamps, ..., the science data (Full Matrix) are sent two times (about 10sec. after HSTART_S) by HS link and the H-HK two time by SDT to the S/C (i.e. 2 x 237 Science TM packets). Science data processing is done concerning commanded operational parameter (e.g. –H compression mode, H_COMP_MODE).

11.10 H-Annealing Start/Stop by HTC_Annealing

Annealing is needed to heat the H-IR detector to recover radiation/degradation effects. HTC_Annealing (T194, ST6) (see page 119) is used to start or stop annealing sequence/mode. If annealing is started by HTC_Annealing(ON), the following procedure is performed:

a) command H-PEM by HSET_DET_OFF, the IR detector is switched-off
b) command H-PEM by HSET_DET_TEMP/ON, the annealing temperature detector is switched-on
c) command H-PEM by HSET_FPA_HTR_ON, the annealing heater is switched-on
d) the H-Mode is changed to H_ANNEALING as shown in VTM_ME_Default_HK_Report
e) Start a H_ANNEALING_TIMER with a period of H_ANNEAL_TIME commanded as functional parameter (default = 30min)
f) Periodical request of H-HK and check of H_DET_TEMP (detector temperature as H_HKMS_DET_TEMP in H-HK) every H_ANNEAL_CHECK_PERIOD commanded as functional parameter (default = 10sec)

f1) If the H_DET_TEMP (located in requested H-HK) is less than H_ANNEAL_TEMP commanded as functional parameter (default = 333K) then command H-PEM by HSET_FPA_HTR_ON (switch-on the annealing heater again)

f2) If the H_DET_TEMP (shown in requested H-HK) is equal or greater than H_ANNEAL_TEMP commanded as functional parameter (default = 333K) then stop annealing as follows:

f2.1) stop periodical request/check of HK,
f2.2) issue a progress event EVENT_H_ANNEAL_STOPPED_AFTER_EXCEED_TEMP, 47952
f2.3) command H-PEM by HSET_FPA_HTR_OFF, the annealing heater is switched-off

g) Check whether the H_ANNEALING_TIMER time is over, if YES stop annealing as shown by f2.1, f2.2, f2.3

The H_ANNEALING mode can be started only if VIRTIS-H is in H_PEM_ON mode by HTC_Annealing(ON) (see also Appendix 9: HTC acceptance against H-Mode, page 156).

The H_ANNEALING mode can be stopped (if it is not stopped automatically) if VIRTIS-H is in H_ANNEALING mode by HTC_Annealing(OFF) (see also Appendix 9: HTC acceptance against H-Mode, page 156).

H_DET_TEMP is calculated as follows:

$$H\_DET\_TEMP(K) = (0 * H\_HKMS\_DET\_TEMP^2) + (-0.03495 * H\_HKMS\_DET\_TEMP) + 546$$

Example about H_DET_TEMP calculation:

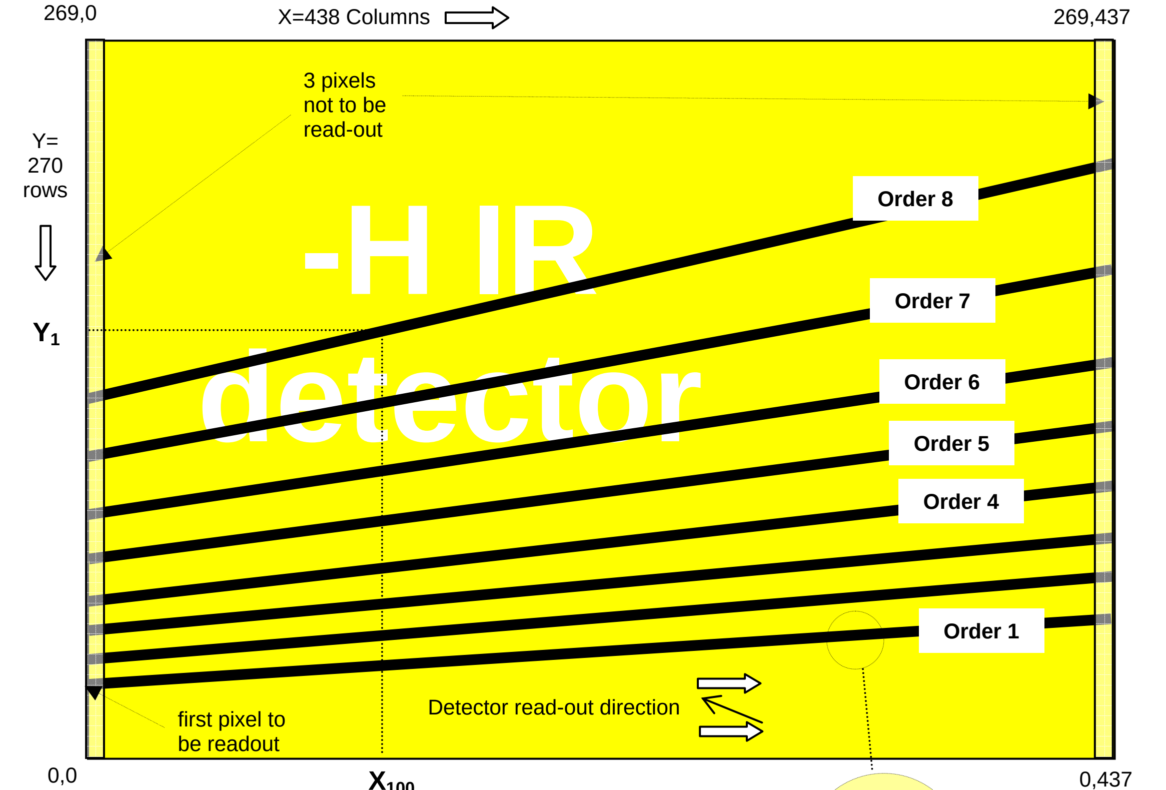
- H_ANNEAL_TEMP=333K (60°C) is the nominal value, commanded by the user.
- If the H-HK H_HKMS_DET_TEMP=13906DN, the annealing limit temperature achieves H_DET_TEMP = 60.0°C (333K).

Note: the transfer function is valid in the whole temperature range from 60K to 253K.

11.11 –H Pixel Map management

The –H Pixel Map is managed by software based on the Pixel Map coefficients as parameter commanded by HTC_Change_Pixel_Map_Param_*. Pixel Map management means, calculating the Pixel Map, commanding the H-PEM in order to upload it from the ME to the H-PEM, checking the correctness by downloading it from the H-PEM to the ME and compare it with the uploaded one stored in ME DPU memory.
The Pixel Map is a binary table. It is used by H-PEM for selecting (reading-out from the –H detector) only these pixels which are illuminated by the H-spectral orders and contains one bit for each IR detector pixel which defines YES or NO to be read-out or not.
The main purpose is to reduce the data volume acquired from the H-PEM and sent to TM in–a -H nominal observation mode by selecting only 5 pixels per order (i.e. 5pixel/order * 8 orders * 432 pixels/order = 17280pixels). That means the result of the Pixel Map algorithm for calculating which pixel are read-out from H-PEM detector is always 17280 pixel inside the Pixel Map uploaded to the H-PEM. In case that the calculation has a result more or less than 17280 pixel, due to inconsistent Pixel Map coefficients, an error event is issued by TM.

In the figure below the 8 orders illuminated on the IR detector are shown. The Pixel Map allows the H-PEM only reading-out these pixels which are "mapped" or selected.



Example for calculating the pixel/order position (Order1, Column100, Pixel0):
$Y_1(X_{100})$ = H_Pix_Map_C11+H_Pix_Map_C12*100+H_Pix_Map_C13*100^2

Note: (438-3-3)*8*5 bit has to be set to "1" in the Pixel Map,
i.e. 17280pixel are read-out from the H-PEM if all orders are acquired

Figure: -H Order Position for Pixel Map Generation   H_Order_Position.doc, 16.04.01

Calculation of Pixel Map

Calculation of Pixel Map means using the Pixel Map coefficients and calculate the polynom or shape of each order as follows:

Y(i) = H_PIX_MAP_Ci1 + (H_PIX_MAP_Ci2 * X) + (H_PIX_MAP_Ci3 * X^2)
where i = number of order 1...8 and X = number of pixel in X direction 1...438

In order to get an order size of 432 pixel/order (which is a multiple of 144) 6 bits has to be masked to "0" in the Pixel Map which means that these pixels (left and right margin) are not read-out. For this the –H functional parameter H_XWIN is used and the pixels 0...(H_XWIN-1) and (H_XWIN+432) are masked to "0" and are not read-out.

Pixel Map management by TCs

- HTC_Load_Pixel_Map (T194, ST26), see page 123;

Every time when this TC is commanded, the following function is performed:

1. Calculate and build the Pixel Map
2. Load it from the ME to the H-PEM by 14783 H-PEM upload request commands
3. Download it from the H-PEM to the ME by 14783 H-PEM download request commands
4. Compare the uploaded Pixel Map with the downloaded one about correctness of Pixel Map stored in H-PEM RAM and ME RAM.

This process takes about 28...40 seconds, depends on DPU duty cycle at all.

- HTC_Check_Pixel_Map (T194, ST27), see page 123;

For verification purposes the Pixel Map, previously uploaded from ME to H-PEM, is download and check but not uploaded.

- HTC_Change_Pixel_Map_Param_RAM (T194, ST21), see page 124)

see chapter 11.3.4, page 73

Pixel Map upload and check after starting a Science or Calibration mode

After commanding TC_Enable_Science_* and if the H_DATA_PRODUCTION_MODE = 0 (H_DATA_NOMINAL_OBSERVATION) or =2 (H_DATA_CALIBRATION) only for calibration phase 4 or =3 (H_DATA_NOMINAL_OBSERVATION) commanded by HTC_Change_Data_Product_*.

This means before starting a Nominal Observation Science or Simulation mode or the calibration mode/phase 4, the pixel map is uploaded and checked automatically in case that the pixel map has not been uploaded yet after H-PEM power-on. If the Pixel Map is already uploaded and checked successfully, an upload again is not performed until the H-PEM is switched-off and -on again.

11.12 Execution of the H_TEST Sequence/Mode

The H_TEST mode/sequence is mainly used for test purposes of the H-PEM in order to request periodically H-data (i.e. FULL_WINDOW, 432x256pixel) and H-HK with a small initialization of H-PEM but without additional action performed. In this case the HTC_PEM_Command_Word is accepted by the software and the period for data request is defined by H_FRAME_PERIOD calculated based on operational parameter H_INT_SCIENCE.
A –H parameter consistency check in H_TEST mode is <u>not</u> done, so the user is fully responsible for –H-PEM control at all. Additional information about HTC_PEM_Command_Word execution is shown in a separate chapter (see page 58).

The H_TEST mode/sequence is started if:

1. the H-PEM is switched-on (cooler is not needed to be on),
2. the HS link is established (in case that TC_Enable_Science_HS_Link shall be used),
3. the H_DATA_PRODUCTION mode is commanded to H_DATA_TEST (=9) commanded by HTC_Change_Data_Product_* (see page 120).
4. a TC_Enable_Science_HS_Link(-H) or TC_Enable_Science_RTU_Link (-H) is commanded

The following functional steps are performed after TC_Enable_Science_*(-H):

1. Initialization of H-PEM as follows:
   - Set the integration time H_INT_SCIENCE (operational parameter)
   - Set the H-PEM mode H_PEM_MODE_SIMULATION_FULL_MATRIX
   - Switch-on the IR detector (note, -H is not able to transfer any data in case that the detector is switched-off, either Science data nor Simulation data. Therefore the detector has to be switched-on.)
   - Set the H_V_BIAS and H_I_Shutter parameters (sent them to PEM)
2. Wait first for H_FRAME_PERIOD
3. Request periodically H-PEM data/HK by HSTART_S after each H_FRAME_PERIOD
4. Data and HK are acquired from the PEM with full detector size=118260words + 36HK words
5. H-HK are sent to the S/C if enabled
6. Science data are processed according to the –H operational commanded by HTC_Change_*_Param_*. That means window adjustment, compression, etc. is done.
7. 432x256 words + 2 HK packets are sent by TM packets for H_FRAME_PERIOD.

H_FRAME_PERIOD = H_INT_SCIENCE + 1276,3ms (data read-out + idle time)

<u>Verification 1:</u> the VIRTIS mode is changed to <u>0101</u> <u>000110</u> XXXXXXb,
i.e. ME_Science=5 and H_Test=6 (see default HK),
The H-mode is unchanged.

<u>Verification 2:</u> Simulation data (H_Image_Slices) are sent as TM with a rate of H_FRAME_PERIOD

<u>Notes:</u>

Parameter related to data processing are read from the ACTUAL parameter set.

During sequence execution, H-PEM commands can be commanded by HTC_PEM_Command_Word (PEM command) (e.g. HSET_INT_NUM1).

H_FRAME_PERIOD is always constant using H_INT_SCIENCE at start of the H_TEST sequence. Therefore it is possible to change the integration time by HTC_PEM_Command_Word without changing H_FRAME_PERIOD. In case that the user want to do this, it is recommended to set the operational parameter H_INT_SCIENCE to a high time (e.g. 30sec) to be able to change the integration time by PEM commanding, e.g. HSET_INT_* = 5sec, in any case lower than H_INT_SCIENCE.

The H-Cooler has not mandatory to be switched-on in H_TEST mode.

11.13 Execution the H_Nominal_Observation Sequence/Mode

The –H Nominal Observation Sequence is the main sequence for –H science operation valid for several science modes, H_SCIENCE_*_DATA_RATE, H_NOMINAL_SIMULATION, H_SCIENCE_BACKUP, H_USER_DEFINED and H_DEGRADED,
- If H_DATA_PRODUCTION_MODE = M_DATA_NOMINAL_OBSERVATION (default) or
- If H_DATA_PRODUCTION_MODE = M_DATA_NOMINAL_SIMULATION or
- If H_DATA_PRODUCTION_MODE = M_DATA_SCIENCE_BACKUP and
- after commanding TC_Enable_Science_HS_Link or *_RTU_Link.

The science sequence has the following functions:

- Initialization of the H-PEM, incl. switching-on the IR-Detector
- Periodically request of science data and HK from H-PEM
- Synchronous H-Shutter control for periodically request of –M dark/background data (only in case of M_DATA_NOMINAL_OBSERVATION and M_DATA_SCIENCE_BACKUP, not in case of M_DATA_NOMINAL_SIMULATION)
  Note, in H_Nominal_Simulation mode, dark data (H_Dark_Spectrum or H_Dark_Image_Slice) are not sent. The H-PEM is not able to simulate the H_Shutter status open/close in simulation mode.

The science and dark data are processed and compressed as shown in detail in chapter 11.17 (page 89).

A –H science mode is characterized by requesting a H_SPECTRUM or H_IMAGE_SLICE, by performing defined processing activities of science/dark data and by performing a defined H-PEM controlling sequence as described as follows.

Initialization of the H-PEM

Before starting a periodical data request from H-PEM the following initialization is done:
1a. Switch-OFF the IR detector
1b. Wait H_STAB_DET_TIME (functional parameter)
2a. If H_DATA_PRODUCTION_MODE = H_DATA_NOMINAL_OBSERVATION then calculate the Pixel Map, upload it to the H-PEM, download and check it. This is needed for H_SPECTRUM acquisitions.
2b. If H_DATA_PRODUCTION_MODE = H_DATA_SCIENCE_BACKUP then do nothing (no Pixel Map upload). This is needed for H_IMAGE_SLICE acquisitions.
3. Set the –H integration time using H_INT_SCIENCE (functional parameter)
4a. If H_DATA_PRODUCTION_MODE = M_DATA_NOMINAL_OBSERVATION then command the H-PEM mode by H_PEM_MODE_OBSERVATION_8ORDERS
4b. If H_DATA_PRODUCTION_MODE = M_DATA_SCIENCE_BACKUP then command the H-PEM mode by H_PEM_MODE_OBSERVATION_FULL_MATRIX
5a. Switch-ON the IR detector
5b. Wait H_STAB_DET_TIME (functional parameter)
6. Request and check some H-HK
7. Close the H-Shutter and request one dark data (i.e. one dark H_SPECTRUM or one dark H_IMAGE_SLICE)
8. Start the H_SCIENCE_SEQUENCE, for periodical request of science and dark/background data with a period of H_IRT
9. Wait for finalizing the sequence by TC_Disable_Science_*(-H)

The acquisition period H_IRT is calculated as shown in chapter 11.4.1 (page 74).

H_SCIENCE_SEQUENCE for periodically science, dark/background data and HK request

The H_SCIENCE_SEQUENCE requests periodically science, dark and HK data from H-PEM by commanding it with HSTART_S. The period is H_IRT which is a H_N_FRAME multiple of the H-PEM internal free running cycle (i.e. frame interval, H_FRAME_PERIOD). This H_FRAME_PERIOD is composed by the detector integration time (H_INT_SCIENCE) + the detector read-out time (H_READOUT_TIME) + an idle time (H_IDLE_TIME). This free running H_FRAME_PERIOD is a special –H operation/functionality and is an important topic for H-IR detector temperature stabilization. More details about –H "free running" operation/functionality are shown in RD(6).
Within the H_SCIENCE_SEQUENCE, the software has to synchronize the H_FRAME_PERIOD to the software H_IRT timer in order to request data and to command the H-Shutter at a certain point (H_IDLE_TIME) within the H_FRAME_PERIOD. That means the data are "synchronously" requested and the H-Shutter is "synchronously" commanded within the H_IDLE_TIME=79,872ms.

The following examples are defined in order to have a clear understanding of the (not easy) internal operation. But the user has to understand the functionality, otherwise the influences of the parameter H_N_FRAME, H_INT_SCIENCE, H_SUM, H_DARK_RATE and H_N_SUM_FRAME are difficult to understand:

Example 1: **H_DATA_PRODUCTION_MODE = H_DATA_NOMINAL_OBSERVATION**
H_INT_SCIENCE=400ms, H_SUM=NO, H_DARK_RATE=3 and H_N_FRAME=2
are commanded as operational parameter

H_FRAME_PERIOD=766,76ms, which means –H internally, the IR detector is integrated and read-out every 766,76ms,

H_IRT = 1533,51ms, which means the software send a HSTART_S request to H-PEM every 1533,51ms and command the H-Shutter every (H_DARK_RATE+1) * 1533,51ms.

H_FRAME_PERIOD and H_IRT are calculated as described in chapter 11.4.1 (page 74).

Time (ms)	Nr of H_FRAME (-H internal frame cycle)	Nr of H-PEM data request	H-Shutter close/open commanding	Data sent to TM
0000,00	0	1	X	H_SPECTRUM_DARK (1)
0766,76	1	-	-	-
1533,51	2	2	-	H_SPECTRUM (2)
2300,28	3	-	-	-
3067,04	4	3	-	H_SPECTRUM (2)
3833,80	5	-	-	-
4600,56	6	4	-	H_SPECTRUM (2)
5367,32	7	-	-	-
6134,08	8	5	X	H_SPECTRUM_DARK (1)
6900,84	9	-	-	-
7667,60	10	6	-	H_SPECTRUM (2)
8434,36	11	-	-	-
9201,12	12	7	-	H_SPECTRUM (2)
9967,88	13	-	-	-
10734,64	14	8	-	H_SPECTRUM (2)
11501,40	15	-	-	-
12268,16	16	9	X	H_SPECTRUM_DARK (1)
13034,92	17	-	-	-
13801,68	18	10	-	H_SPECTRUM (2)
14568,44	19	-	-	-
15335,20	20	11	-	H_SPECTRUM (2)
16101,96	...	-	...	...

(1) H_SPECTRUM_DARK data are sent to TM processed but uncompressed and on-line after acquisition from H-PEM (see chapter 11.17, page 89)
(2) H_SPECTRUM data are sent to TM delayed after composing to a H_SPECTRA_SLICE and after compression (see chapter 11.17, page 89)

Example 2: **H_DATA_PRODUCTION_MODE = H_DATA_NOMINAL_OBSERVATION**
H_INT_SCIENCE=400ms, H_SUM=YES, H_N_SUM_FRAME=2, H_DARK_RATE=3
are commanded as operational parameter

H_FRAME_PERIOD=766,76ms, which means –H internally, the IR detector is integrated and H-PEM internally read-out every 766,76ms,

H_IRT=766,76ms, which means the software send a HSTART_S request to H-PEM every 766,76ms and command the H-Shutter every (H_DARK_RATE+1) * 766,76ms. But note, no all requested science H_SPECTRUM are sent by TM because 2 H_SPECTRUM are summed together (H_SUM=YES, H_N_SUM_FRAME=2) and only one H_SPECTRUM_SUMMED is sent to the TM.

H_FRAME_PERIOD and H_IRT are calculated as described in chapter 11.4.1 (page 74).

Time (ms)	Nr of H_FRAME (-H internal frame cycle)	Nr of H-PEM data request	H-Shutter close/open commanding	Data sent to TM
0000,00	0	0	X	H_SPECTRUM_DARK_1 (1)
0766,76	1	1	-	H_SPECTRUM_SUMMED_1/1
1533,51	2	2	-	H_SPECTRUM_SUMMED_1/2 (2)
2300,28	3	3	-	H_SPECTRUM_SUMMED_2/1
3067,04	4	4	X	H_SPECTRUM_DARK_2 (1)
3833,80	5	5	-	H_SPECTRUM_SUMMED_2/2 (2)
4600,56	6	6	-	H_SPECTRUM_SUMMED_3/1
5367,32	7	7	-	H_SPECTRUM_SUMMED_3/2 (2)
6134,08	8	8	X	H_SPECTRUM_DARK_3 (1)
6900,84	9	9	-	H_SPECTRUM_SUMMED_4/1
7667,60	10	10	-	H_SPECTRUM_SUMMED_4/2 (2)
8434,36	11	11	-	H_SPECTRUM_SUMMED_5/1
9201,12	12	12	X	H_SPECTRUM_DARK_4 (1)
9967,88	13	13	-	H_SPECTRUM_SUMMED_5/2 (2)
10734,64	14	14	-	H_SPECTRUM_SUMMED_6/1
11501,40	15	15	-	H_SPECTRUM_SUMMED_6/2 (2)
12268,16	16	16	X	H_SPECTRUM_DARK_5 (1)
13034,92	17	17	-	H_SPECTRUM_SUMMED_7/1
13801,68	18	18	-	H_SPECTRUM_SUMMED_7/2 (2)
14568,44	19	19	-	H_SPECTRUM_SUMMED_8/1
15335,20	20	20	X	H_SPECTRUM_DARK_6 (1)
16101,96	...	...	...	...

H_SPECTRUM_DARK data are sent to TM processed but uncompressed and on-line after acquisition from H-PEM (see chapter 11.17, page 89)
H_SPECTRUM (summed) data are sent to TM delayed after composing H_SPECTRUM (summed) to a H_SPECTRA_SLICE and after compression (see chapter 11.17, page 89)

Verification:

After TC_Enable_Science_HS_Link or *_RTU_Link:
- the MTM_Dump_* parameter events 47901, 47902, 47903, 47904 are issued in order to see the ACTUAL parameter configuration
- a H_SCIENCE_* mode is shown in the VTM_ME_Default_HK_Report if proper parameter are set, otherwise H_USER_DEFINE mode is shown
- H_DEGRADED mode is shown in VTM_ME_Default_HK_Report if science data are transferred by RTU link.
- processed science data are transferred periodically by HS or RTU link (the data rate is shown in Appendix 11: H-Mode TM data format and TM data rates, page 158)

Compared with –M science mode operation, the H_Cover is not automatically opened before acquiring science data.

11.14 Execution the H_Science_Backup Sequence/Mode

The Science Backup Sequence/Mode is generally equal to the H_Nominal_Observation Sequence/Mode as shown in chapter 11.13 (page 83).

The only differences are:
- H_IMAGE_SLICES instead of H_SPECTRUM are requested from H-PEM
- the data processing is different for H_IMAGE_SLICES and for a H_SPECTRUM as shown in chapter 11.17 (page 89).

11.15 Execution of the HS_Spectral_Calibration_Simulation Sequence/Mode

In this mode full matrix simulated H_IMAGE_SLICE data (pattern) are requested and generated by the H-PEM.
The following sequence is executed after TC_Enable_Science_*(-H) and if H_DATA_PRODUCTION_MODE = H_DATA_SPECTRAL_CALIBRATION_SIMULATION:
1. Set the –H integration time using H_INT_SCIENCE (functional parameter)
2. command the H-PEM in H_PEM_MODE_SIMULATION_FULL_MATRIX mode
3. Switch-ON the IR detector
4. Init the H-PEM pattern counter by HSET_TEST_INIT(0x0000) commanding to H-PEM
5. Start the H_SPECTRAL_CALIBRATION_SIMULATION sequence, for periodical request of simulation data with a period of H_FRAME_PERIOD
6. Wait for finalizing the sequence by TC_Disable_Science_*(-H)

The acquisition period H_FRAME_PERIOD is calculated as shown in chapter 11.4.1 (page 74).

Note, the H-IR detector is always switched-on, even if the simulation mode is active. This is a constraint of the H-PEM. Therefore the H-IR detector is always commanded ON, otherwise science or simulation data can not be requested from H-PEM.

11.16 Execution of the H_Calibration Sequence/Mode

The H_Calibration Sequence/Mode is requests/produces calibration data H_IMAGE_SLICES and H_SPECTRA in 4 phases as shown in the table below:

-H Calibration Phase	Data requested from H-PEM and produced by TM
1 (Slit_Spectral_Calibration)	using functional param. integration time H_INT_SPECT_S 1 x H_IMAGE_SLICE, H_Cover closed, 1 x H_IMAGE_SLICE dark, H-Shutter closed 1 x H_IMAGE_SLICE, S-lamp switched-on
2 (Telescope_Spectral_Calibration)	using functional param. integration time H_INT_SPECT_T 1 x H_IMAGE_SLICE dark, H-Shutter closed 1 x H_IMAGE_SLICE, T-lamp switched-on
3 (Image_Slice_Radiometric_Calibration)	using functional param. integration time H_INT_RADIO 1 x H_IMAGE_SLICE dark, H-Shutter closed 1 x H_IMAGE_SLICE, R-lamp switched-on
4 (Spectrum_Radiometric_Calibration)	using functional param. integration time H_INT_RADIO Upload/check Pixel Map 1 x H_SPECTRUM dark, H-Shutter closed 1 x H_SPECTRUM, R-lamp switched-on
Total: 1...4	**7 x H_IMAGE_SLICE + 2 x H_SPECTRUM**

The different calibration phase take several seconds up to minutes as shown in the table below:

-H Calibration Phase	Duration (data transfer via HS link)	Duration (data transfer via RTU link)
1 Slit_Spectral_Calibration	148sec	148sec
2 Telescope_Spectral_Calibration	29sec	87sec
3 Image_Slice_Radiometric_Calibration	33sec	91sec
4 Spectrum_Radiometric_Calibration	64sec	122sec
Total: 1...4	**274 sec**	**448 sec**

In detail, the calibration phase sequences are performed as follows:

Phase 1: H_Slit_Spectral_Calibration sequence

The following sequence is performed:

1. Switch-off –H IR detector
2. Initialize H-PEM by H_INT_SPECT_S (functional parameter)
3. Initialize H-PEM in Observation full matrix mode
4. Switch-on –H IR detector and wait detector stabilization time H_STAB_DET_TIME (functional parameter)
5. 5. request a H_IMAGE_SLICE from H-PEMand send it to TM
6. Initialize and close the H-Shutter by H-PEM commanding with HSET_SHUTTER_ON using H_I_SHUTTER (functional parameter)- request a Dark H_IMAGE_SLICE from H-PEM and send it to TM
7. Switch-on the spectral lamp by H-PEM commanding with HSET_LAMP_SPECT_S_ON and wait H_STAB_LAMP_TIME (functional parameter)
8. Request a H_IMAGE_SLICE from H-PEM and send it to TM
9. Switch-off all calibration lamps by H-PEM commanding with HSET_CAL_OFF
10. Open the H-Shutter by H-PEM commanding with HSET_SHUTTER_OFF

Phase 2: Telescope_Spectral_Calibration sequence

The following sequence is performed:

1. Switch-off –H IR detector
2. Initialize H-PEM by H_INT_SPECT_T (functional parameter)
3. Initialize H-PEM in Observation full matrix mode
4. Switch-on –H IR detector and wait detector stabilization time H_STAB_DET_TIME (set by functional parameter)
5. Request a H_IMAGE_SLICE from H-PEM and send it to TM
6. Initialize and close the H-Shutter by H-PEM commanding with HSET_SHUTTER_ON using H_I_SHUTTER (functional parameter)
7. Request a Dark H_IMAGE_SLICE from H-PEM and send it to TM
8. Switch-on the spectral lamp by H-PEM commanding with HSET_LAMP_SPECT_T_ON and wait H_STAB_LAMP_TIME (functional parameter)
9. Request a H_IMAGE_SLICE from H-PEM and send it to TM
10. Switch-off all calibration lamps by H-PEM commanding with HSET_CAL_OFF

Phase 3: H_Image_Slice_Radiometric_Calibration sequence

The following sequence is performed:

1. Switch-off –H IR detector
2. Initialize H-PEM by H_INT_RADIO (functional parameter)
3. Initialize H-PEM in Observation full matrix mode
4. Switch-on –H IR detector and wait detector stabilization time H_STAB_DET_TIME (set by functional parameter)
5. Initialize and close the H-Shutter by H-PEM commanding with HSET_SHUTTER_ON using H_I_SHUTTER (functional parameter)
6. Request a dark H_IMAGE_SLICE from H-PEM and send it to TM
7. Initialize and switch-on the radiometric calibration lamp by H-PEM commanding with HSET_I_LAMP_RADIO (functional parameter), HSET_LAMP_RADIO_ON (switch-on) and wait H_STAB_LAMP_TIME (functional parameter)
8. Request a H_IMAGE_SLICE from H-PEM and send it to TM
9. Switch-off all calibration lamps by H-PEM commanding with HSET_CAL_OFF
10. Open the H-Shutter by H-PEM commanding with HSET_SHUTTER_OFF

Phase 4: H_Spectrum_Radiometric_Calibration sequence

The following sequence is performed:

1. Switch-off –H IR detector
2. Initialize H-PEM by H_INT_RADIO (functional parameter)
3. Upload and check the pixel map to H-PEM
4. Initialize H-PEM in Observation 8orders mode to acquire spectra
5. Switch-on –H IR detector and wait detector stabilization time H_STAB_DET_TIME (set by functional parameter)
6. Initialize and close the H-Shutter by H-PEM commanding with HSET_SHUTTER_ON using H_I_SHUTTER (functional parameter)
7. Request a dark H_SPECTRUM from H-PEM and send it to TM
8. Initialize and switch-on the radiometric calibration lamp by H-PEM commanding with HSET_I_LAMP_RADIO (functional parameter), HSET_LAMP_RADIO_ON (switch-on) and wait H_STAB_LAMP_TIME (functional parameter)
9. Request a H_SPECTRUM from H-PEM and send it to TM
10. Switch-off all calibration lamps by H-PEM commanding with HSET_CAL_OFF
11. Open the H-Shutter by H-PEM commanding with HSET_SHUTTER_OFF

11.17 –H Science data processing, formatting and TM transfer

In general, there are two data processing procedures performed to process a H_IMAGE_SLICE and to process H_SPECTRUM (H_SPECTRA) and H_SPECTRA_SLICE.

The H_IMAGE_SLICES are processed as follows:

1. H_IMAGE acquisition from the H-PEM
2. Data check of pixel value range
3. Window adjustment to get a H_IMAGE_SLICE
4. H_IMAGE_SLICE summing if H_SUM=YES
5. H_IMAGE_SLICE dark/background subtraction
6. Decomposition of a Slice to sub-slices
7. Data compression of sub-slices if H_COMP_MODE > 0
8. Decomposition of each sub-slice to TM packets
9. Transfer of TM packets to the S/C by HS link or RTU link

The general data processing flow is always the same for all –H modes if an H_IMAGE_SLICE is transferred by TM. Only some functional and operational parameters have influence on data content, format and volume sent to the S/C.

The H_SPECTRUM (H_SPECTRA) are processed as follows:

1. H_SPECTRUM (5x8x432 pixel) acquisition from the H-PEM
2. Data check of pixel value range
3. Rebuild of 5 pixel spectrum to get a H_IMAGE
4. H_SPECTRUM averaging based on the rebuilt H_IMAGE needed for averaging a H_Spectrum
5. H_SPECTRUM summing if H_SUM=YES
6. H_SPECTRUM dark/background subtraction
7. Composition of 64 H_SPECTRUM to a H_SPECTRA_SLICE
8. Decomposition of a H_SPECTRA_SLICE to sub-slices
9. Data compression of sub-slices if H_COMP_MODE > 0
10. Decomposition of each sub-slice to TM packets
11. Transfer of TM packets to the S/C by HS link or RTU link

A general data processing flow of a H_SPECTRUM (H_SPECTRA) is shown in Figure below.

A H_SPECTRA_SLICE is composed by 64 single science H_SPECTRA in the DPU buffer (i.e. double buffer for two H_SPECTRA_SLICEs á 64x432x8 words) in order to get a spatial correlation of data for good compression efficiency. H_DARK_SPECTRA are processed separately. After composing a science H_SPECTRA_SLICE, it is decomposed in 24 sub-slices (á 144x64) for compression. Each sub-slice is compressed (if compression is commanded), packed in TM packets and sent to the S/C.

Each H_DARK_SPECTRUM (8x432 words) is transferred to the S/C <u>without</u> composing and <u>without</u> compression as 7 TM packets.

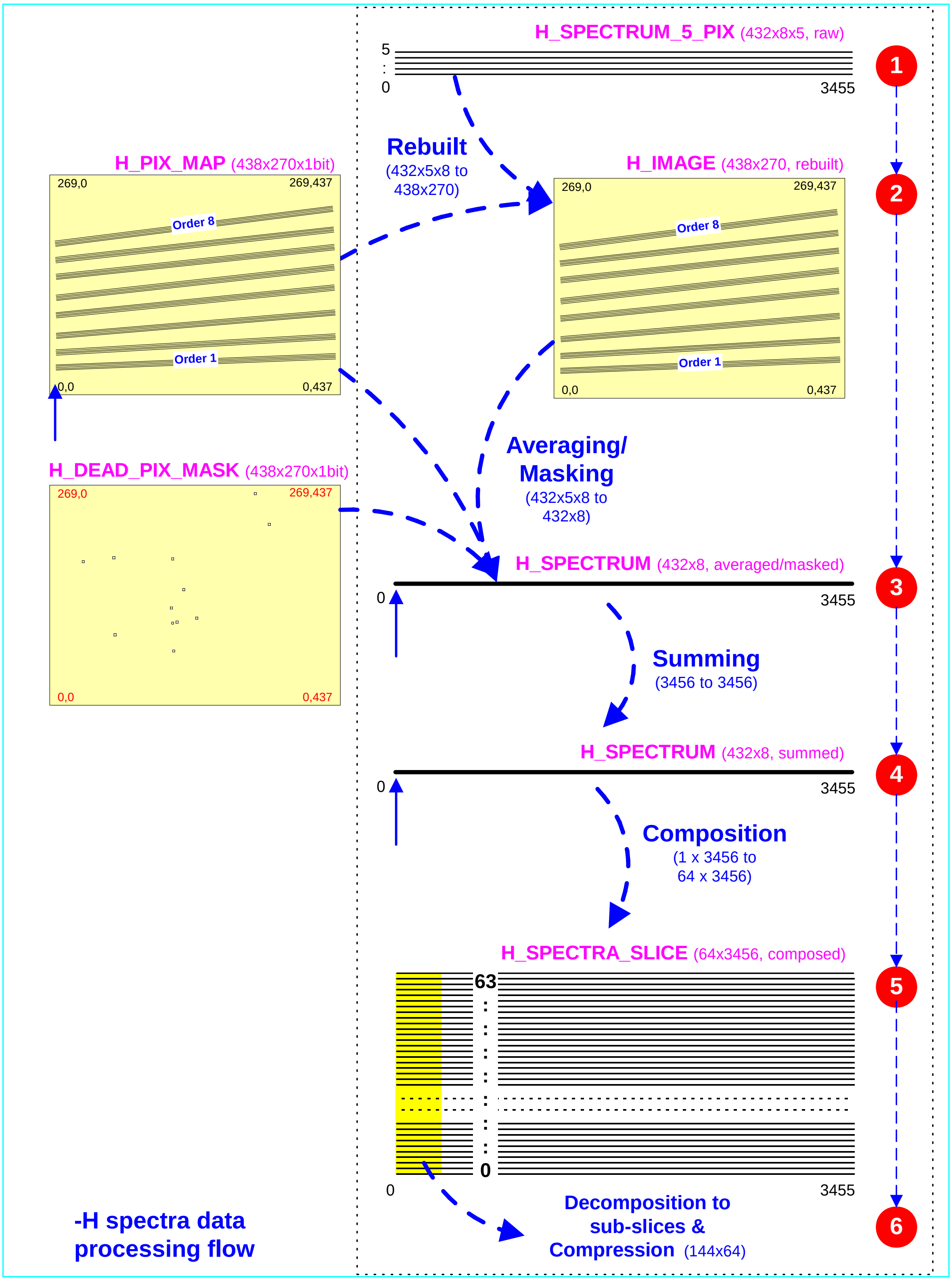


Figure: -H Spectra Data Processing Flow H_Spectra_Data_Processing_Flow.doc, 17.07.01

11.17.1 H_IMAGE_SLICE Data Processing

11.17.1.1 H_IMAGE Data Acquisition from H-PEM

In case that the H-PEM is commanded in Observation or simulation **Full Matrix** mode by science, calibration or simulation sequences, requested data are acquired as raw data from H-PEM. The data volume is 438x270 16bit words (science data) + 36 words (HK).
In case that the ME test mode is active, pseudo random test pattern are acquired which are generated by ME FPGA. The data volume depends from the FPGA initialization using the parameter located in VTC_Enter_Test_Mode.
After successful acquisition of a H_IMAGE an Acquisition counter is counted up to be but in TM packet header as Acquisition ID, in order to see in TM how many H_IMAGE_SLICES are successfully acquired from H-PEM.

11.17.1.2 Data check of pixel value range

After data acquisition a data range check of the first and last data/pixel words is done in order to verify the data dynamics. The data words (pixel values) must be in range 0...32767 DN otherwise a warning event is issued.
In case that ME pseudo random pattern are acquired, a check of each pattern value is done against a pattern table generated by software algorithm. If one pattern value is wrong an event is issued which would mean that the ME hardware data channel (ME IFE or DPU) has a hardware problem.

11.17.1.3 Window adjustment to get a H_IMAGE_SLICE

In order to be able to compress data with sub-slices as compression units (144x64 words), a window adjustment (cutting the H_IMAGE_SLICE) is done from a window 438x270 to 432x256 words which is a multiple of 144x64. For window adjustment the functional parameter H_YWIN and H_XWIN are used to define the coordinates of the first pixel inside the window.

11.17.1.4 H_IMAGE_SLICE summing if H_SUM=YES

In case that the operational parameter H_SUM is set to YES, a H_IMAGE_SLICE summing is done. The number of successive H_IMAGE_SLICEs summed are defined by the operational parameter H_N_SUM_FRAME.
Summing means summing of the same pixels (16bit word) of all H_IMAGE_SLICEs to be summed and dividing of summed values (max. 32bit) by the number H_N_SUM_FRAME of pixels to be summed.
The result is a H_IMAGE_SLICE with 16bit (averaged) pixel values.

11.17.1.5 H_IMAGE_SLICE dark/background subtraction

Each H_IMAGE_SLICE acquired from H-PEM when the –H shutter is closed is a dark H_IMAGE_SLICE. When the shutter is open a (science) H_IMAGE_SLICE is acquired. The shutter status is read from the H-HK acquired together with each H_IMAGE_SLICE. The last acquired dark H_IMAGE_SLICE is stored in a software buffer and used for subtraction from a (science) H_IMAGE_SLICE. Each pixel value of the last dark H_IMAGE_SLICE is subtracted from the same pixel in a currently processed H_IMAGE_SLICE.
In case of negative values, this pixels are set to “0”.
Each dark and each science H_IMAGE_SLICE is further processed and finally sent to TM.

11.17.1.6 Decomposition of a Slice to sub-slices

Before compression a H_IMAGE_SLICE (dark or science) is decomposed in 12 sub-slices.

11.17.1.7 Data compression of sub-slices if H_COMP_MODE > 0

In case the compression is selected/commanded by operational parameter H_COMP_MODE > 0, each sub-slice is compressed by related compression mode H_COMP_MODE. Details are shown in chapter 12, page 99.

11.17.1.8 Decomposition of each sub-slice to TM packets

Each compressed or not compressed sub-slice is decomposed in up to 19 TM packets before sending them to the S/C.

11.17.1.9 Transfer of TM packets to the S/C by HS link or RTU link

Each TM packet is sent either by HS link (normal modes) or by RTU link in degraded modes. Before sending the TMs, the packets header and application data header is updated using internal information and settings as packet sequence counter, image type, etc.

Note about timestamping of a –H spectra:
The SCET put in TM is read when the first word of data are received (in ME) from the PEM-H. This is valid also for dark spectra.

Note about timestamping of a –H slice (or sub-slice):
The SCET of a –H slice (shown in TM packet) is the time of the last spectrum received from H-PEM. The acquisition time of the spetra before are not sent to the TM.

11.17.2 H_SPECTRUM Data Processing

The data processing flow of a H_SPECTRUM is shown by figure "-H Spectra Data Processing Flow" above (page).

11.17.2.1 H_SPECTRUM acquisition from the H-PEM

In case that the H-PEM is commanded in Observation or simulation **8Orders** mode by science, calibration or simulation sequences, requested data are acquired as raw data from H-PEM. The data volume is 8x432x5 16bit words (science data) + 36 words (HK).
In case that the ME test mode is active, pseudo random test pattern are acquired which are generated by ME FPGA. The data volume depends from the FPGA initialization using the parameter located in VTC_Enter_Test_Mode.
After successful acquisition of a H_SPECTRUM an Acquisition counter is counted up to be but in TM packet header as Acquisition ID, in order to see in TM how many spectra are successfully acquired from H-PEM.

11.17.2.2 Data check of pixel value range

After data acquisition a data range check of the first and last data/pixel words is done in order to verify the data dynamics. The data words (pixel values) must be in range 0...32767 DN otherwise a warning event is issued.
In case that ME pseudo random pattern are acquired, a check of each pattern value is done against a pattern table generated by software algorithm. If one pattern value is wrong an event is issued which would mean that the ME hardware data channel (ME IFE or DPU) has a hardware problem.

11.17.2.3 Rebuild of 5 pixel spectrum to get a H_IMAGE

In order to be able to average a H_SPECTRUM with 5pixel order width (432x8x5) acquired from H-PEM to a H_SPECTRUM sent as TM (432x8), the acquired spectrum is rebuilt to a H_IMAGE_SLICE by software internally in memory as "H-IR detector snap shot". Note, the orders/spectrum are illuminated as polynom (not linear) on the detector as shown by figure "-H Spectra Data Processing Flow".
For rebuilding the H_PIXEL_MAP is used (located in RAM) previously uploaded from ME to H-PEM (see chapter 11.11, page 80 for detail information about H_PIXEL_MAP management).

11.17.2.4 H_SPECTRUM averaging and masking based on the rebuilt H_IMAGE

After rebuilt of a H_SPECTRUM with 5pixel order width the spectrum is searched using the pixel map. The 5 pixels of a spectrum wavelength (column on detector) is averaged to 1 pixel considering a pixel mask. Note pixel map and pixel mask have different purposes and is not the same.
Pixel masking means only the "good" pixels are averaged to get a 'macro' pixel. "Bad" pixels are not averaged. For each pixel a bit is foreseen in the pixel mask which sign (or mask) a pixel as "good" or "bad". The pixel mask is stored in EEPROM and can only be changed by the user by VIRTIS memory upload service. Pixel mask handling is shown in detail in chapter 11.17.3, page 95.

11.17.2.5 H_SPECTRUM summing if H_SUM=YES

In case that the operational parameter H_SUM is set to YES, a summing of several averaged and masked H_SPECTRUM is done. The number of successive H_SPECTRA summed are defined by the operational parameter H_N_SUM_FRAME.
Summing means summing of the same pixels (16bit word) of all H_SPECTRA to be summed and dividing of summed values (max. 32bit) by the number H_N_SUM_FRAME of pixels to be summed.
The result is a H_SPECTRUM with 16bit (averaged) pixel values.

11.17.2.6 H_SPECTRUM dark/background subtraction

Each H_SPECTRUM acquired from H-PEM when the –H shutter is closed is a dark H_SPECTRUM. When the shutter is open a (science) H_SPECTRUM is acquired. The shutter status is read from the H-HK acquired together with each H_SPECTRUM. The last acquired dark H_SPECTRUM is stored in

a software buffer and used for subtraction from a (science) H_SPECTRUM. Each pixel value of the last dark H_SPECTRUM is subtracted from the same pixel in a currently processed H_SPECTRUM.
In case of negative values, this pixels are set to "0".
Each science H_SPECTRUM is further processed to compose a H_SPECTRUM_SLICE, to compress as sub-slices and finally sent to TM.
Each dark H_SPECTRUM is directly sent to TM without any compression.

11.17.2.7 Composition of 64 H_SPECTRUM to a H_SPECTRA_SLICE

As shown in figure "-H Spectra Data Processing Flow" above, 64 science H_SPECTRUM (1 x 3456 pixel) are collected in a buffer to get a H_SPECTRA_SLICE. This is needed in order to be able to compress the H_SPECTRUM. If a H_SPECTRA_SLICE is completely collected, a decomposition to sub-slices is done.

11.17.2.8 Decomposition of a H_SPECTRA_SLICE to sub-slices

Before compression a H_SPECTRA_SLICE (only science data without dark spectra) is decomposed in 24 sub-slices.

11.17.2.9 Data compression of sub-slices if H_COMP_MODE > 0

In case the compression is selected/commanded by operational parameter H_COMP_MODE > 0, each sub-slice is compressed by related compression mode H_COMP_MODE. Note, a H_SPECTRUM is not compressed. Details are shown in chapter 12, page 99.

11.17.2.10 Decomposition of each sub-slice to TM packets

Each compressed or not compressed H_SPECTRA_SLICE sub-slice is decomposed in up to 19 TM packets before sending them to the S/C. Additionally, each dark H_SPECTRUM (not compressed) is sent as 7 TM packets.
Note, in case of H_SPECTRA_SLICE TM transfer, the Acquisition ID (as entry in the application data header) of all TM packets is set with acquisition number (counter) of the last acquired H_SPECTRUM (number 64) to be composed to the H_SPECTRUM_SLICE. Therefore the Acquisition ID within the TM packets is a multiple of at least 64, considering the separated sent dark H_SPECTRUM, more than 64 depends on the operational parameter H_DARK_RATE. The Acquisition ID of a dark H_SPECTRUM is a multiple of H_DARK_RATE+1.

11.17.2.11 Transfer of TM packets to the S/C by HS link or RTU link

Each TM packet is sent either by HS link (normal modes) or by RTU link in degraded modes. Before sending the TMs, the packets header and application data header is updated using internal information and settings as packet sequence counter, image type, etc.

11.17.3 -H Dead Pixel Mask handling for spectrum processing

During the processing of –H IR spectral data a H_Spectrum (438x8x1 pixels) is build by averaging/masking of the rebuilt image which has a format of 438x8x5 pixels.
For this purpose the 'good' pixels (max=5) are averaged to build one 'macro' pixel of the H_Spectrum.

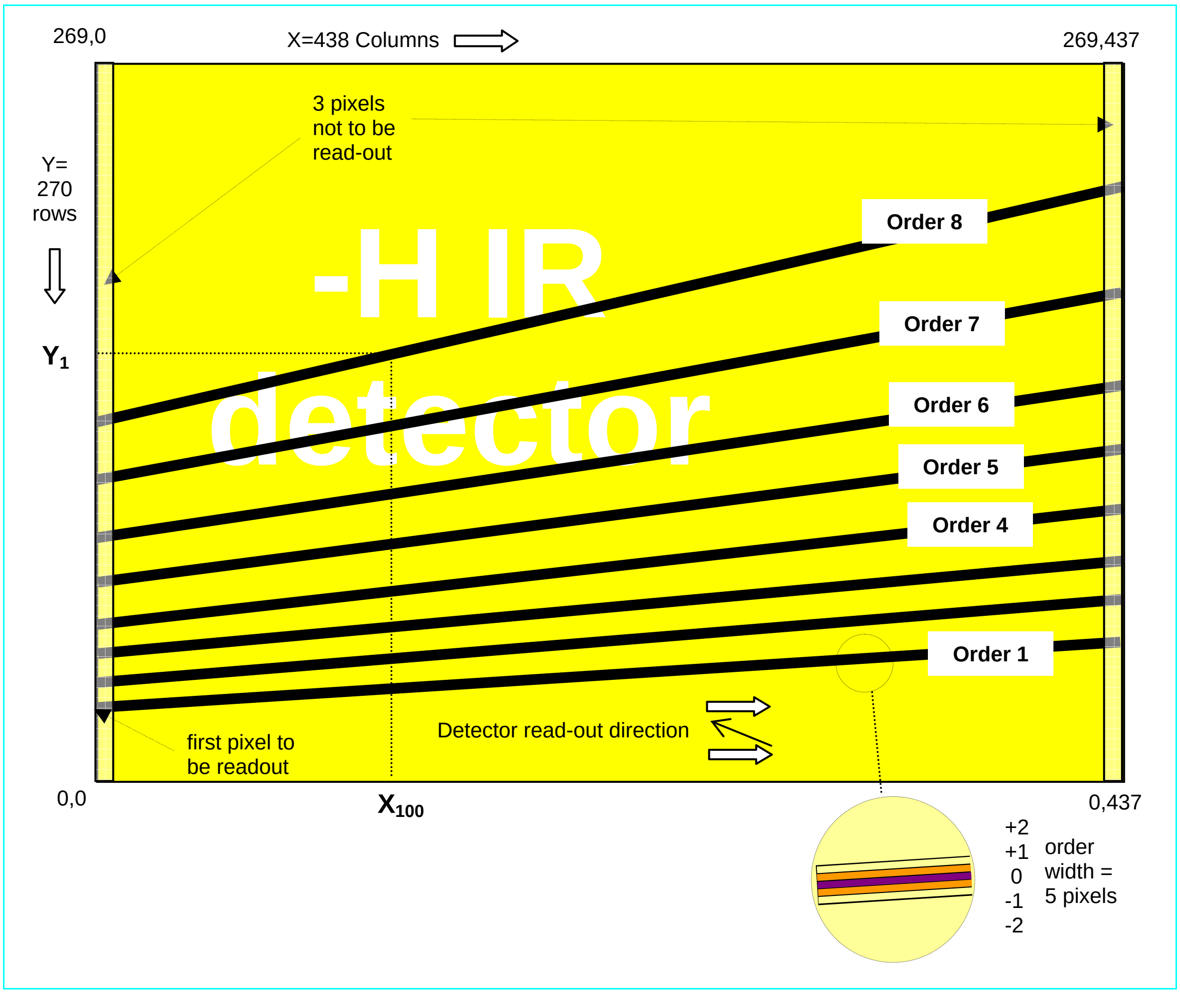


Figure: -H order position on the –H IR detector

The Figure above shows the order position on the –H IR detector. Each spectrum acquisition consists of 8 orders with 438 columns. Each column of an order consists of 5 pixels (see zoomed area on the bottom right-hand corner in Figure). These 5 pixels are averaged to the 'macro' pixel. But only the 'good' pixels are averaged, pixels which are marked as 'bad' are not included in the calculation. These 'bad' pixels are stored in a so-called 'Dead Pixel Mask' for the whole –H IR detector. The default dead pixel map (available in executable) is shown in Appendix 16. Following example shows the averaging/masking principle:

Example: Pixel 55 of Order 1 has following values and 'Dead Pixel Mask' entries:

Pixel value	*Dead Pixel Mask value*
Pix(0) = 120	Dead_Pix(0)= GOOD
Pix(1) = 55	Dead_Pix(0)= GOOD
Pix(2) = 166	Dead_Pix(0)= BAD
Pix(3) = 22	Dead_Pix(0)= BAD
Pix(4) = 44	Dead_Pix(0)= GOOD

The calculated 'macro' pixel has the value: (120+55+44) / 3 = 73

Note: If all pixels of a column are set to 'bad' in the 'Dead Pixel Mask' the 'macro' pixel value is set to zero !!!

The 'Dead Pixel Mask' is stored in the executable (read only) of the EEPROM-S/W and has by default all pixel set to GOOD. After start of the executable (secondary boot) the 'Dead Pixel Mask' is copied from PM to the Image RAM (438x270 items, one for each pixel of the detector). This copy in Image RAM is used for the –H data processing (i.e. averaging/masking).

The meaning of 'Dead Pixel Mask' values is as follows:

1 = bad pixel
0 = good pixel

The user can change the 'Dead Pixel Mask' only by modifying the EEPROM-S/W in the stored executable in EEPROM. This change has only affect to VIRTIS operation after re-start of the executable (by VTC_Enter_Idle_Mode).

Note: It is not foreseen that the user can change the 'Dead Pixel Mask' temporary during execution of EEPROM-S/W !!!

A change of the 'Dead Pixel Mask' can be performed by changing of the executable in EEPROM by means of memory upload TC's (low level memory management by TC_Load_Memory).
Basically the EEPROM-S/W can be modified by following possibilities:

1. Uploading a new executable (new version) with new 'Dead Pixel Mask'
2. Overwriting the current executable by the new executable
3. Modifying the current executable by overwriting only the 'Dead Pixel Mask'
4. Modifying the current executable by adding a patch containing the new 'Dead Pixel Mask'

Note: For detailed information see RD(5), "Patch and Update Concept for the EEPROM-S/W"

It is recommended to use option 3 to change the 'Dead Pixel Mask' by the following procedure:

1. Changing of the EEPROM-S/W source containing the 'Dead Pixel Mask' (ASCII data file "pixmask.dat")
2. Compiling and linking of the new executable
3. Extracting the delta between old and new executable and creating th memory upload TC list (DLR Tool)
4. Upload of the TC list in order to change the 'Dead Pixel Mask' in the current executable in EEPROM

Note: Creating of the upload TC list for changing the 'Dead Pixel Mask' shall be done only by DLR software developer team !!!!

Figure "Definition of Dead Pixel Mask for –H IR Detector" shows the relation between the 'Dead Pixel Mask' definition in the source file "pixmask.dat" and the result on the –H IR detector. The source file "pixmask.dat" contains 3696 32bit words (ASCII). Each item mask therefore 32 pixel of the detector. The whole mask consists of 438x270=118260 items where each can have the value 1 (BAD) or 0 (GOOD). Only 20bit of the last item of "pixmask.dat" are used (see Figure 2, 118260 pixel need 3695 32bit items + 20bit).

By this procedure it is easly possible to change the 'Dead Pixel Mask' (by editing the ASCII file "pixmask.dat", Step 1). After that only a patch for changing the EEPROM-S/W executable must be produced and uploaded (see step 2 ... 4) which must be performed very carefully and therefore recommended only done by DLR team.

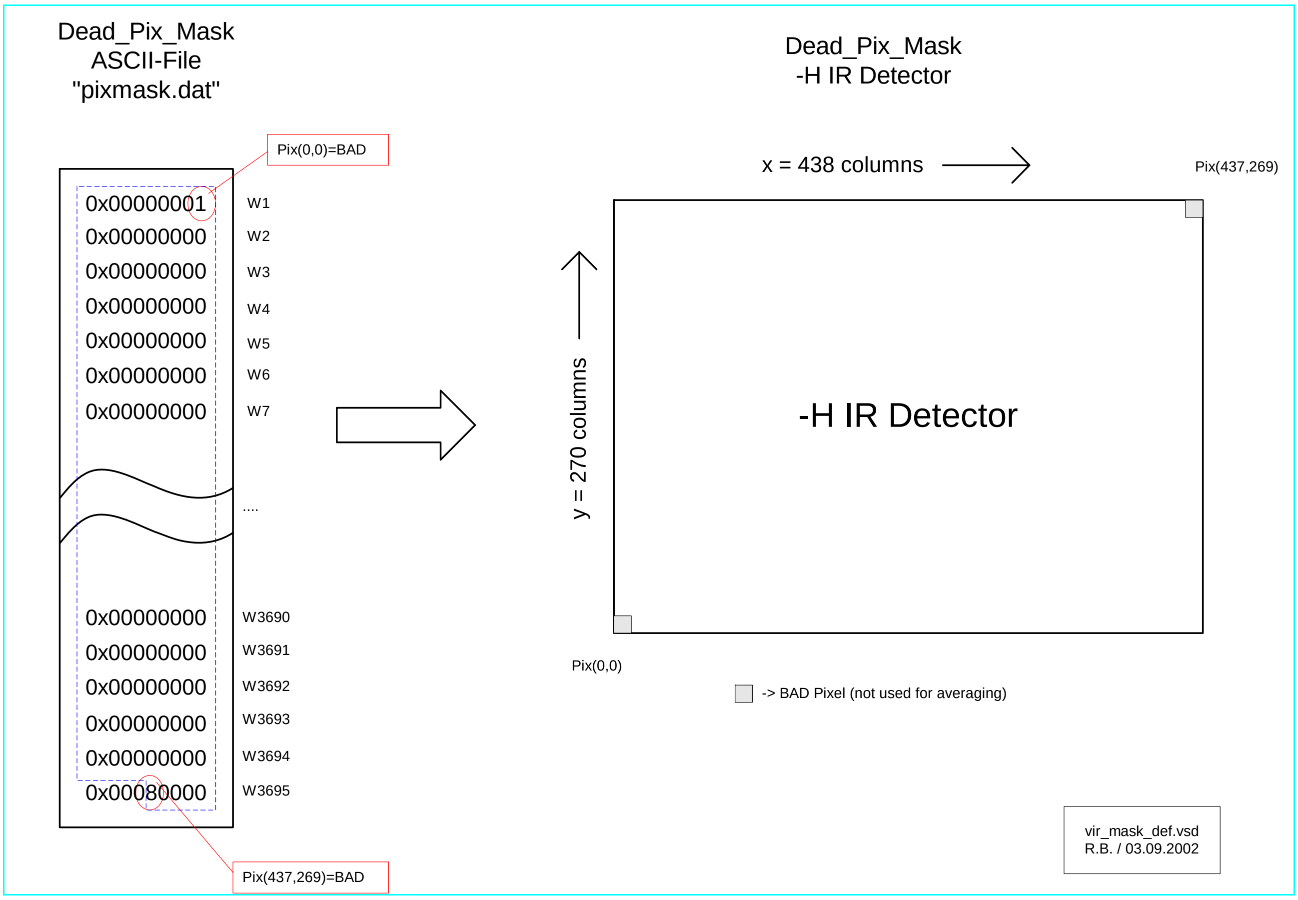


Figure: Definition of Dead Pixel Mask for –H IR Detector

See also TM_H_PIX_MAP_CHECK_SUCCESS (T5, ST1, EID47910, APID51,7) description shown in Appendix, page 149

11.18 H-PEM HK generation

The H-HK acquired from H-PEM (by ME and software) are located in and transferred by HTM_PEM_HK_Report (see page 142).

General information are shown in chapter 7.8 (page 32).

The H-PEM HK are transferred to the S/C generally with the same content (with few exception) but not in the format as acquired from M-PEM. The format is changed (re-ordered) by S/W in order to get a logical consistent HK set.

The exceptions about H-HK TM content different from the H-HK acquired from H-PEM are:

- H_HK_FPGA_HES1 and H_HK_FPGA_HES2 (represents the H-Cover position status) located in H_HKMS_STATUS (word 19 in HTM_PEM_HK_Report), which are manipulated by S/W and doesn't represent the H-PEM hardware status. The S/W memorizes the H_HK_FPGA_HES1 and H_HK_FPGA_HES2 status in case that H_HKRQ_COVER_STATUS is equal to "1" (Enable) which means the HES sensors are switched-on. In case that the HES sensors are switched-off, the S/W transfers the "memorized" H_HK_FPGA_HES1 and H_HK_FPGA_HES2 status (last valid HES status) within HTM_PEM_HK_Report to the S/C. Memorizing of H_HK_FPGA_HES1 and H_HK_FPGA_HES2 status is needed to see the real HES and therefore Cover status even the HES sensors are switched-off (internally commanded by S/W to H-PEM). Note, that the HES sensors are only switched-on for ME internally H-Cover management purposes by S/W. By default the HES sensors must be switched-off in order to avoid thermal dissipation in the optical/detector sub-system. This S/W feature is implemented only in V3.6 (or higher) and not in versions before (e.g. V3.54).
- H_HK_H_LAST_SENT_REQUEST (word 46 in HTM_PEM_HK_Report), which is added by S/W
- H_HK_Periodic (word 47 in HTM_PEM_HK_Report), which is added by S/W (see chapter 7.8, page 32).

Note:
The item H_HKRQ_COVER in TM packet HTM_PEM_HK_Report reflects the last cover request sent to the H-PEM by the command HSET_Cover. It does <u>not reflect</u> the <u>command request of the last cover movement procedure</u>!
Due to the last command of each cover movement procedure is HSET_Cover(disable HES) which contains the command code 0x4801 (direction=open, cover steps=0, wave=half wave, HES=disable) the request of last cover movement (e.g. close cover) is overwritten in the FPGA of the H-PEM.
Thus the item H_HKRQ_COVER in the HTM_PEM_HK_Report packet contains after the last cover movement the request status of the command HSET_Cover(disable HES).

12 –M and –H data compression

Data compression is done for reducing the TM data volume either by lossless or lossy compression. A compression unit is always a 144x64 element sub-slice. The compression is applicable for –M IR, -M VIS and –H using the same algorithms depending on the the operational parameters M_COMP_MODE and H_COMP_MODE. The following compression modes and with related factors are applicable:

M_LOSSLESS_COMPRESSION: it represents a data compression without any loss a differential algorithm is performed with rice encoding. The compression factor is low (about 1.5) for very noisy M-PEM IR data up to high (about 14) for synthetic IR ramp data. The nominal average compression factor is about 2...4.

M_WAVELET_F1_COMPRESSION: the wavelet compression is “low” lossy. The data compression factor is 8.

M_WAVELET_F2_COMPRESSION: the wavelet compression is “medium” lossy. The data compression factor is 10,67.

M_WAVELET_F3_COMPRESSION: the wavelet compression is “high” lossy. The data compression factor is 16.

<u>Generals about compression</u>

On-board data compression for VIRTIS is important for maximizing the scientific return of VIRTIS. Both reversible and lossy compression algorithms are implemented. The reversible algorithm is derived from that developed for the OMEGA and VIMS imaging spectrometers. It takes advantage of spatial / spectral correlations for pre-processing, then a Rice coding is applied on the residuals. It will be mainly used for validation purposes early in the mission and it provides typical compression ratios of 2 to 4 depending on the entropy content of the data.
The lossy algorithm is based on wavelet transforms. There is a specific compression mode for coma observations by VIRTIS-H, which implements very long observation times (up to 1 hour). In this case, a one dimension wavelet transform is applied, followed by coefficients entropy coding. This provides a minimum compression ratio of 8 within the acceptable distortion limits.
Additionally to the lossless compression, the optional compression strategy is based on wavelet transforms of spectral / spatial rectangles of data, which are obtained either directly from the VIRTIS-M detectors or by accumulating time series of VIRTIS-H spectra. These rectangles are divided in sub-units of typically 64 pixels x 144 spectrals, hence 4 steps of transform in each direction. Each sub-unit provides a self-consistent telemetry stream, so that an SEU can only result in the loss of a small fraction of the data. The result of the transform is coded using a version of the Said-Perlman tree coding algorithm which has been optimized for speed on a TSC21020E.

There is a different compression software implemented in V3.54 and V3.6x. In V3.54 the data are compressed as 2D sub-slice as acquired from the PEM. In V3.6x the compression algorithm considers an odd/even effect of –M and –H IR detector. Odd/even effect means that the pixel uniformity of odd rows is different from the even rows. This effect reduces the correlation of data and therefore the compression efficiency. Considering this effect in V3.6x means, that the compression efficiency/factor is higher than in software V3.54.

13 Software health check, SEU detection and error handling

13.1 Health check by Watchdog

In order to protect VIRTIS against software malfunctions, a health check is implemented using the DPU hardware watchdog. This watchdog is re-triggered periodically from 2 software processes, the TC receipt process and the Slow Speed TM management process. These processes are the most important processes to be able to communicate with the S/C (user). For the nominal case, when these TC/TM processes work correctly, the user gets housekeeping or events from VIRTIS as status information. But if one of these processes is blocked longer than 30sec (due to software problems, e.g. a Single Event Upset occurred) the watchdog isn't re-triggered, the DPU is reset after 30sec and VIRTIS goes automatically in Safe mode. In order to see that the DPU has been reset (due to watch-dog), ME_DPU_RESET_CAUSE_PARAM (included as a word in TM packet TM_Secondary_Boot_Completed) is issued after restarting the ME_IDLE mode by VTC_Enter_Idle_Mode. ME_DPU_RESET_CAUSE_PARAM contains the last reset cause before restart ME_IDLE mode.

13.2 Single Event Upset (SEU) detection

In order to get information about SEU frequency in DPU-RAM, some pieces of free (not used) DPU RAM is checked periodically. Note, especially the DPU image RAM and data memory RAM isn't SEU free. In general, big problems about SEUs are not expected. The SEU check is only done in order to confirm this assumption.

The SEU check is done every 10sec with the following memory areas and pattern:

Memory / MemID	Address range /Size	Pattern	Remark
Image RAM/ 143, 16bit	0x301FC8EC...0x301FCCEB 1Kword	0x9653	2 memory chips are checked 512Kx8 (Austin) AS5C4008F-25/883C Samsung die KM684002A
Data Memory/ 142, 40bit	0x0003EB00...0x0003EEFF 1Kword	0x53CA9653	only 32bit are checked 4 memory chips are checked 512Kx8 (Austin) AS5C4008F-25/883C Samsung die KM684002A
Program Memory/ 141, 48bit	0x000100...0x0004FF 1Kword	0xCA9653CA	only 32bit are checked 4 memory chips are checked 128Kx8 (Honeywell) HX6228

If a SEU (bit failure) is detected an event 47612 with some parameter is issued. For detailed information see "Appendix 12: List of events/errors" on page 159.

13.3 Error handling

Most of the events produced by software and sent to TM are warning or progress (CAT I) events without any error handling inside the ME.
In case that the watch-dog is triggered (e.g. due to SEU), a CATV/* event is generated or a (unexpected) power-off is performed, there is no possibility to see an event message immediately after occurring the anomaly. In order to get an information what was the last reason for VIRTIS break down or anomaly, the user has the possibility to see in TM the last ME_DPU_Reset_Cause as parameter after reboot in the TM_Secondary_Boot_Completed progress event 47501.
Further information about event generation/handling are shown in Appendix 12: List of events/errors (page 159).

Appendix 1: VIRTIS TC list

TC request	Type	Sub-Type	PROM SW	EEPROM SW	Low/High Level

TC request	Type	Sub-Type	PROM SW	EEPROM SW	Low/High Level
TC_Enable_HK_Report_Generation(SID=1)	3	5	X	X	Low
TC_Enable_HK_Report_Generation(SID=2,3,4,5,6,7)	3	5		X	High
TC_Disable_HK_Report_Generation(SID=1)	3	6	X	X	Low
TC_Disable_HK_Report_Generation(SID=2,3,4,5,6,7)	3	6		X	High
TC_Load_Memory	6	2	X		Low
TC_Dump_Memory	6	5	X		Low
TC_Check_Memory	6	9	X		Low
TC_Accept_Time_Update	9	1	X	X	Low
TC_Connection_Test_Request	17	1	X	X	Low
TC_Enable_Science_RTU_Link	20	1		X	High
TC_Disable_Science_RTU_Link	20	2		X	High
TC_Enable_Science_HS_Link	20	10		X	High
TC_Disable_Science_HS_Link	20	11		X	High
TC_Reset_TM_Output Buffer	255	1	X	X	Low
TC_Reset_SMCS_Chip	255	2		X	Low
TC_Start_HS_Link	255	3		X	Low
TC_Reset_And_Start_HS_Link	255	4		X	Low
VTC_Enter_Safe_Mode	192	1	X	X	Low
VTC_Enter_Idle_Mode	192	2	X	X	P=Low/ E=High
VTC_Enter_Test_Mode	192	3		X	High
VTC_PEMS	192	4		X	High
VTC_Coolers	192	5		X	High
VTC_Failure_Override	192	10	X	X	Low
VTC_Failure_Deoverride	192	11	X	X	Low
VTC_Confirm (VTC_Failure_Override; 192/10)	192	12	X	X	Low
VTC_Confirm (MTC_ECA, 193/4, HTC_ECA, 194/4)	192	12		X	High
VTC_Get_EEPROM_Status	192	13	X		Low
MTC_PEM	193	1		X	High
MTC_PEM_Command_Word	193	2		X	High
MTC_Cover	193	3		X	High
MTC_ECA	193	4		X	High
MTC_Cooler	193	5		X	High
MTC_Annealing	193	6		X	High
MTC_Default_Configuration	193	10		X	High
MTC_Change_Data_Product_Param_RAM	193	11		X	High
MTC_Change_Data_Product_Param_RAM_EEPROM	193	12		X	High
MTC_Change_Func_Param_RAM	193	13		X	High
MTC_Change_Func_Param_RAM_EEPROM	193	14		X	High
MTC_Change_Operat_Param_RAM	193	15		X	High
MTC_Change_Operat_Param_RAM_EEPROM	193	16		X	High
MTC_Change_Calibration_Param_RAM	193	17		X	High
MTC_Change_Calibration_Param_RAM_EEPROM	193	18		X	High
MTC_Change_Altern_Param_RAM	193	19		X	High
MTC_Change_Altern_Param_RAM_EEPROM	193	20		X	High
HTC_PEM	194	1		X	High
HTC_PEM_Command_Word	194	2		X	High
HTC_Cover	194	3		X	High
HTC_ECA	194	4		X	High
HTC_Cooler	194	5		X	High
HTC_Annealing	194	6		X	High
HTC_Default_Configuration	194	10		X	High
HTC_Change_Data_Product_Param_RAM	194	11		X	High
HTC_Change_Data_Product_Param_RAM_EEPROM	194	12		X	High
HTC_Change_Func_Param_RAM	194	13		X	High
HTC_Change_Func_Param_RAM_EEPROM	194	14		X	High
HTC_Change_Operat_Param_RAM	194	15		X	High
HTC_Change_Operat_Param_RAM_EEPROM	194	16		X	High
HTC_Change_Pixel_Map_Param_RAM	194	21		X	High
HTC_Change_ Pixel_Map_Param _RAM_EEPROM	194	22		X	High
HTC_Load_Pixel_Map	194	26		X	High
HTC_Check_Pixel_Map	194	27		X	High

Low Level TC = acceptance/execution in processes [2]+[6]; High Level TC = accept./exec. in processes [1]+[3]+[4]

Table: List of TCs — List_of_TCs.doc, DLR/G.P./07.03.2001

Appendix 2: Structures of VIRTIS TC packets

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL

3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7 octets
4	DATA FIE.	X	X	X	1	0	0	0	A	0	0	0	0	0	0	1	1	PUS (don't care),"A" – (**), **Type(3)**
5	HEADER	0	0	0	0	0	1	0	1	X	X	X	X	X	X	X	X	**Sub-Type (5)** + PAD (don't care)
6	APP.Data	X	X	X	X	X	X	X	X	N	0	0	0	0	N	N	N	don't care, SID (♦) (*)
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

(♦) SID=1: ME Default HK; 2: ME/M General HK; 3: ME/H General HK; 4: M-VIS HK; 5: M-IR HK; 6: H-HK; 7: ALL

(*) SID + 128: multiple (32 x) sample of analog HK **isn't** done (it is used only for DLR internal tests – **only in Safe mode**)

SID=7 (All) is possible only if VIRTIS is not in Safe mode, in Safe mode only SID=1 is accepted

(**) Acceptance Report A="1"-YES, A="0"-NO

`TC__Enable_HK_Report_Generation.doc, 26.10.2001`

TC_Enable_HK_Report_Generation (T3, ST5)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7 octets
4	DATA FIE.	X	X	X	1	0	0	0	A	0	0	0	0	0	0	1	1	PUS (don't care), "A" – (*), **Type(3)**
5	HEADER	0	0	0	0	0	1	1	0	X	X	X	X	X	X	X	X	**Sub-Type (6)** + PAD (don't care)
6	APP.Data	X	X	X	X	X	X	X	X	N	N	N	N	N	N	N	N	don't care, SID (♦)
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

(♦) SID=1: ME Default HK; 2: ME/M General HK; 3: ME/H General HK; 4: M-VIS HK; 5: M-IR HK; 6: H-HK

(*) Acceptance Report A="1"-YES, A="0"-NO

`TC__Disable_HK_Report_Generation.doc, 06.06.2000`

TC_Disable_HK_Report_Generation (T3, ST6)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	L	L	L	L	L	L	L	L	PACKET LENGTH = 15...241 octets
4	DATA FIE.	X	X	X	1	0	0	0	A	0	0	0	0	0	1	1	0	PUS (don't care), Accept.<u>Y</u>/N *, **Type (6)**
5	HEADER	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (2)** + PAD (don't care)
6		M	M	M	M	M	M	M	M	0	0	0	0	0	0	0	1	Memory ID / 1 block to be loaded
7	APPLI-	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Start Address (most sign. word)
8	CATION	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Start Address (least sign. word)
9	DATA	0	0	0	0	0	0	0	0	B	B	B	B	B	B	B	B	Upload data block length ≤ 228 items **
n-1		D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	Data to be uploaded; 1...228 items (1 ... 114 (16bit) words) 1 item = 8bit or 16bit or 40bit or 48bit
n	n=11...124	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

VIRTIS Memory IDs:		
	140 – EEPROM / 8bit items	144 – PM Port / 48bit items
	141 – PM / 48bit items	145 – DM Port / 40bit items
	142 – DM / 40bit items	146... 149 – not used
	143 – DM / 16bit items	

`TC__Load_Memory.doc`
`Last modification: 12.04.2000`

* Acceptance Report: A=”–” - **YES** or A=”0” – NO
** In case that Memory ID=140, the loaded block length is a multiple of 2 (two) 8bit items (e.g. 12, 100)

TC_Load_Memory (T6, ST2)

TC_Load_Memory - Application data format for MemID=140 (EEPROM)

Note: this format is for writing into the EEPROM unit, which is byte organized. The figure shows an example with a max. number of data items (max. 228 bytes). This content is located in the Application data field of the TC packet.

TC appl. data to be uploaded, formatted in 16bit words

word	2^{15}	2^{0}
1	Byte 1	Byte 0
2	Byte 3	Byte 2
...		
113	Byte 225	Byte 224
114	Byte 227 (max)	Byte 226

This field can contain 4...228bytes

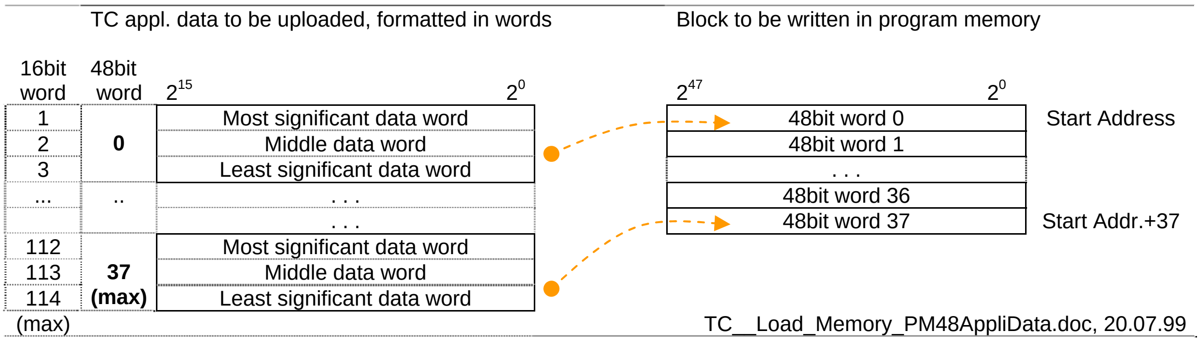
Block (bytes) to be written in EEPROM

2^{7} … 2^{0}	
Byte 1	Start Address
Byte 0	
Byte 3	
Byte 2	
. . .	
Byte 224	
Byte 227	
Byte 226	Start Addr.+227

TC__Load_Memory_EEPROMAppliData.doc, 20.07.99

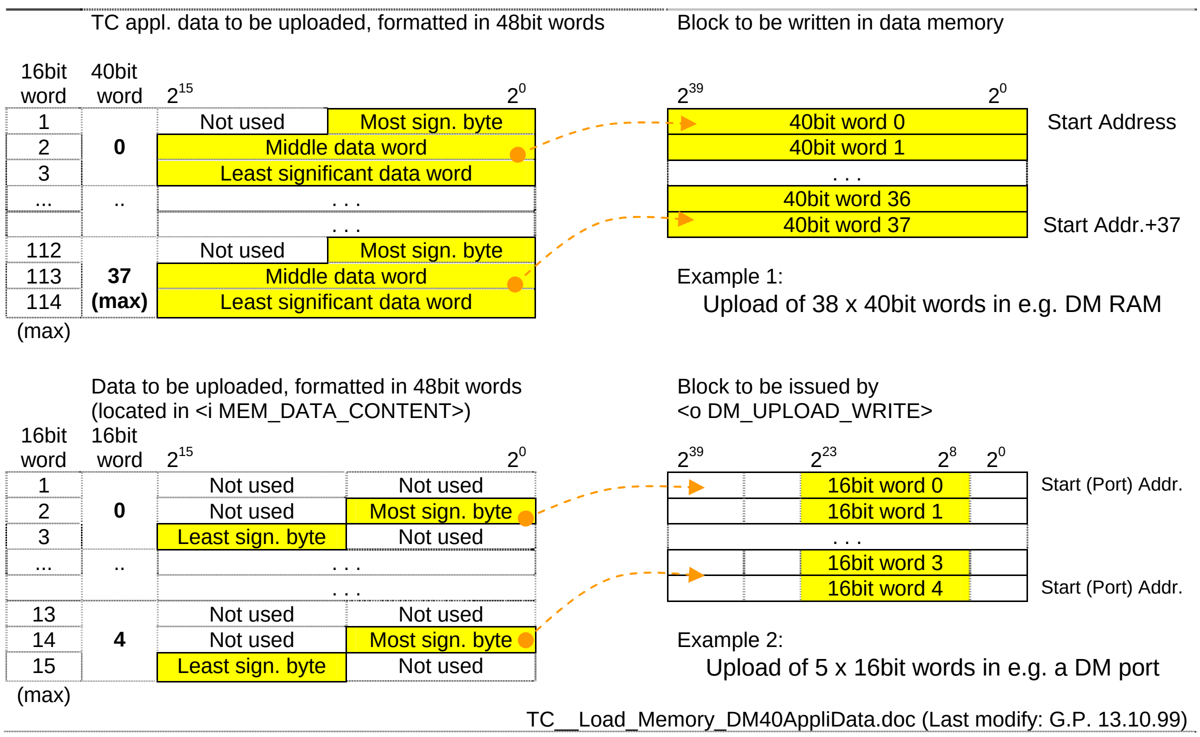
TC_Load_Memory - Application data format for MemID=141 (PM RAM/48bit) or MemID=144 (PM Port/48bit)

Note: this format is for writing the PM RAM or PM Port which is 48bit word organized. The figure shows an example with a maximum set of data (38 x 48bit words).



TC_Load_Memory - Application data format for MemID=142 (DM RAM/40bit) or MemID=145 (DM Port/40bit)

Note: this TC appl. data format is for writing the DM RAM on DPU base board (which is 40bit word organized) and the DM ports on the whole DPU (which is 16 or 32bit word organized). 40bit words for writing 16 or 32bit DM ports are used in order to reduces the Memory ID types, which reduces the effort on-ground for packet generation. The figure below shows an example (1) with a maximum set of data (38 x 40bit words). The example (2) shows a maximum set of data (38 x 16bit words) to be upload with one TC. E.g. 5 x 48bit words (D47...D0) have to be transferred in order to can upload (write) 5 x 16bit words on a DM port. Only D23...D8 is the relevant valid 16bit word content.



TC_Load_Memo–y - Application data format for MemID=143 (DM RAM/16bit)

The 16bit memory content is written in the TM packet in the same format and order as located in the 16bit DPU-RAM.

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	PACKET LENGTH = 13 octets
4	DATA FIE.	X	X	X	1	0	0	0	A	0	0	0	0	0	1	1	0	PUS (don't care), Accept. Y/**N** *, **Type (6)**
5	HEADER	0	0	0	0	0	1	0	1	X	X	X	X	X	X	X	X	**Sub-Type (5)** + PAD (♣)
6		M	M	M	M	M	M	M	M	0	0	0	0	0	0	0	1	Memory ID / 1 block to be dumped
7	APPLI-	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Start Address (most sign. word)
8	CATION	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Start Address (least sign. word)
9	DATA	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	Dump block length ≤ 4088 items **
10		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

VIRTIS Memory IDs:		
	140 – EEPROM / 8bit items	144 – PM Port / 48bit items
	141 – PM / 48bit items	145 – DM Port / 40bit items
	142 – DM / 40bit items	146... 149 – not used
	143 – DM / 16bit items	

TC__Dump_Memory.doc
13.04.2000

(♣) PAD to be copied into the corresponding Memory Dump Report TM packet (**T6, ST6**)
* Acceptance Report: A="1" - YES or A="0" – **NO**
** In case that Memory ID=140, the dumped block length is a multiple of 2 (two) 8bit items (e.g. 2, 1000, 4088)

Note: max. 4088 bytes can be initiate to be dumped with one Dump TC packet. 4088 bytes are the max. size in one TM packet. If 48bit or 40bit items shall be dumped, 681 items can be located as max. block length, in case of 16bit items, max. 2044 items.

TC_Dump_Memory (T6, ST5)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	PACKET LENGTH = 13 octets
4	DATA FIE.	X	X	X	1	0	0	0	A	0	0	0	0	0	1	1	0	PUS (don't care), Accept.Y/**N** *, **Type(6)**
5	HEADER	0	0	0	0	1	0	0	1	P	P	P	P	P	P	P	P	**Sub-Type(9)** + PAD (♣)
6		M	M	M	M	M	M	M	M	0	0	0	0	0	0	0	1	Memory ID / 1 block to be checked
7	APPLI-	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Start Address (most sign. word)
8	CATION	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Start Address (least sign. word)
9	DATA	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	Check data block length ≤ 65535 items **
10		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

VIRTIS Memory Ids:		
	140 – EEPROM / 8bit items	144... 149 – not used
	141 – PM / 48bit items	
	142 – DM / 40bit items	
	143 – DM / 16bit items	

TC__Check_Memory.doc
13.04.2000

(♣) PAD to be copied into the corresponding Memory Check Report TM packet (**T6, ST10**)
* Acceptance Report: A="1" - YES or A="**0**" – **NO**
** In case that Memory ID=140, the checked block length is a multiple of 2 (two) 8bit items (e.g. 2, 1000, 4088)

TC_Check_Memory (T6, ST9)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)

2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	PACKET LENGTH = 11
4	DATA FIE.	X	X	X	1	0	0	0	A	0	0	0	0	1	0	0	1	PUS (don't care), Accept.Y/N*, **Type (9)**
5	HEADER	0	0	0	0	0	0	0	1	X	X	X	X	X	X	X	X	**Sub-Type (1)** + PAD (don't care)
6	APPLI-	0	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	MSB is "0", Time: S = $Sec_{30} \dots Sec_{16}$
7	CATION	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	Time: S = $Sec_{15} \dots Sec_0$
8	DATA	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	Time: F = $Frac_{15} \dots Frac_0$
9		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* Acceptance Report: A="1" - YES or A="0" - NO

TC__Accept_Time_Update.doc, 31.01.2000

TC_Accept_Time_Update (T9, ST1)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	0	0	0	1	0	0	0	1	PUS (don't care), Accept. Y/**N** *, **Type(17)**
5	HEADER	0	0	0	0	0	0	0	1	P	P	P	P	P	P	P	P	**Sub-Type (1)** + PAD (♣)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

(♣) PAD to be copied into the corresponding Connection Test Report TM packet (**T17, ST2**)

* Acceptance Report: A="1" - YES or A="0" - **NO**

TC__Connection_Test_Request.doc, 31.01.2000

TC_Connection_Test_Request (T17, ST1)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	0	0	0	1	0	1	0	0	PUS (don't care),–A - Accept., **Type (20)**
5	HEADER	0	0	0	0	0	0	0	1	X	X	X	X	X	X	X	X	**Sub-Type (1)** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	P	P	P	P	P	P	P	P = PID *
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* PID (52, 53) enable of data generation 52=V-M, 53=V-H

TC__Enable_Science_RTU_Link.doc, 06.06.2000

TC_Enable_Science_RTU_Link (T20, ST1)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	0	0	0	1	0	1	0	0	PUS (don't care), E,A *, **Type (20)**
5	HEADER	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (2)** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	P	P	P	P	P	P	P	P = PID **
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* A – Acceptance TM report requested 0=No, 1=Yes
E – Execution TM report requested 0=No, 1=Yes

** PID (52, 53) enable of data generation 52=V-M, 53=V-H

TC__Disable_Science_RTU_Link.doc, 19.03.2001

TC_Disable_Science_RTU_Link (T20, ST2)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	0	0	0	1	0	1	0	0	PUS (don't care),–A - Accept., **Type (20)**
5	HEADER	0	0	0	0	1	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (10)** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	P	P	P	P	P	P	P	P = PID *
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* PID (52, 53) enable of science data generation 52=V-M, 53=V-H

TC__Enable_Science_HS_Link.doc, 06.06.2000

TC_Enable_Science_HS_Link (T20, ST10)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	E	0	0	A	0	0	0	1	0	1	0	0	PUS (don't care), E,A *, **Type (20)**
5	HEADER	0	0	0	0	1	0	1	1	X	X	X	X	X	X	X	X	**Sub-Type (11)** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	P	P	P	P	P	P	P	P = PID **
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* A – Acceptance TM report requested 0=No, 1=Yes
E – Execution TM report requested 0=No, 1=Yes

** PID (52, 53) enable of data generation 52=V-M, 53=V-H

TC__Disable_Science_HS_Link.doc, 19.03.2001

TC_Disable_Science_HS_Link (T20, ST11)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	1	1	1	1	1	1	PUS (don't care),–A - Accept., **Type (255)**
5	HEADER	0	0	0	0	0	0	0	1	X	X	X	X	X	X	X	X	**Sub-Type (1)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

TC__Reset_TM_Output_Buffer.doc, 05.09.2000

TC_Reset_TM_Output_Buffer (T255, ST1)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	1	1	1	1	1	1	PUS (don't care), A - Accept., **Type (255)**
5	HEADER	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (2)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

TC__Reset_SMCS_Chip.doc, 06.06.2000

TC_Reset_SMCS_Chip (T255, ST2)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	1	1	1	1	1	1	PUS (don't care),–A - Accept., **Type (255)**
5	HEADER	0	0	0	0	0	0	1	1	X	X	X	X	X	X	X	X	**Sub-Type (3)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

TC__Start_HS_Link.doc, 06.06.2000

TC_Start_HS_Link (T255, ST3)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	1	1	1	1	1	1	PUS (don't care), A - Accept., **Type (255)**
5	HEADER	0	0	0	0	0	1	0	0	X	X	X	X	X	X	X	X	**Sub-Type (4)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

TC__Reset_Start_HS_link.doc, 06.06.2000

TC_Reset_And_Start_HS_Link (T255, ST4)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	0	PUS (don't care), A - Accept., **Type (192)**
5	HEADER	0	0	0	0	0	0	0	1	X	X	X	X	X	X	X	X	**Sub-Type (1)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

VTC__Enter_Safe_Mode.doc, 06.06.2000

VTC_Enter_Safe_Mode (T192, ST1)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	PACKET LENGTH = 9
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	0	PUS (don't care),–A - Accept., **Type (192)**
5	HEADER	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (2)** + PAD (don't care)
6	APPLI.	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	EEPROM / RAM start addr. (2^{31}...2^{16}) *
7	DATA	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	EEPROM / RAM start addr. (2^{15}...2^{0}) *
8		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* address must be 0x20000000 ... 0x200FFFFF for EEPROM or 030000000 ... 0x301FFFFF for Image RAM

VTC__EnterIdleMode.doc, 05.09.2000

VTC_Enter_Idle_Mode (T192, ST2)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	PACKET LENGTH = 27
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	0	PUS (don't care), A - Accept., **Type (192)**
5	HEADER	0	0	0	0	0	0	1	1	X	X	X	X	X	X	X	X	**Sub-Type (3)** + PAD (don't care)
6	UNIT_ID	0	0	0	0	0	0	0	0	0	0	0	0	0	0	U	U	UNIT_ID=1 (ME test) *
7	M_IFE_TRP	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	M-IFE Test Pattern rep. rate (ms)
8	256...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	S	M-IFE-VIS Pattern size MSB (words)
9	127500	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M-IFE-VIS Pattern size LSB (words)
10	256...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	S	M-IFE-IR Pattern size MSB (words)
11	127500	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M-IFE-IR Pattern size LSB (words)
12		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M-IFE Test Parameter – Spare
13	100...65535	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	H-IFE Test Pattern rep. rate (ms)
14	256...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	S	H-IFE Test Pattern size MSB (words)
15	127500	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	H-IFE Test Pattern size LSB (words)
16		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	H-IFE Test Parameter – Spare
17		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* UNIT_ID=2 is not available anymore in V3.6 software
** After Enable_Science, -M or/and –H IFE pattern are generated depends on the PID parameter in Enable_Science

VTC_Enter_Test_Mode.doc, 16.05.2002

VTC_Enter_Test_Mode (T192, ST3)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	0	PUS (don't care), A - Accept., **Type (192)**
5	HEADER	0	0	0	0	1	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (10)** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	0	0	0	0	L	L	L	Override Category Level (1...7) *
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* the override level can be category 1 ... 7 (II, III, IV-M, IV-H, V, VI) or =7 (All) VTC__Failure_Override.doc, 06.06.2000

VTC_Failure_Override (T192, ST10)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	0	PUS (don't care), A - Accept., **Type (192)**
5	HEADER	0	0	0	0	1	0	1	1	X	X	X	X	X	X	X	X	**Sub-Type (11)** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	0	0	0	0	L	L	L	De-Override Category Level (1...7) *
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* the override level can be category 1 ... 7 (II, III, IV-M, IV-H, V, VI) or =7 (All) VTC__Failure_Deoverride.doc, 06.06.2000

VTC_Failure_Deoverride (T192, ST11)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	0	PUS (don't care), A - Accept., **Type (192)**
5	HEADER	0	0	0	0	1	1	0	0	X	X	X	X	X	X	X	X	**Sub-Type (12)** + PAD (don't care)
6	APPLI.	T	T	T	T	T	T	T	T	S	S	S	S	S	S	S	S	T = Type; S = Sub-type *
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* Confirms the execution of a critical TC (previous given) with Type and Sub-type

VTC__Confirm.doc, 06.06.2000

VTC_Confirm (T192, ST12)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	0	PUS (don't care), A - Accept., **Type (192)**
5	HEADER	0	0	0	0	1	1	0	1	P	P	P	P	P	P	P	P	**Sub-Type (13)** + PAD (♣)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

(♣) PAD to be copied into the corresponding EEPROM Status Report TM packet (**T5, ST1**)

VTC__Get_EEPROM_Status.doc, 18.12.2000

VTC_Get_EEPROM_Status (T192, ST64)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	E	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care), A-Acc/E-Exe, **T193***
5	HEADER	0	0	0	0	0	0	0	1	X	X	X	X	X	X	X	X	**Sub-Type (1)*** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	1=OFF, 2=ON, 3=Reset
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* Type/subtype = 192/4 for VTC_PEMS

MTC__PEM.doc, 26.10.2001

MTC_PEM (T193, ST1) , VTC_PEMS (T192, ST4)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care),–A - Accept., **Type (193)**
5	HEADER	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (2)** + PAD (don't care)
6	APPLI.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	PEM command word, see RD(6)
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

MTC__PEM_Command_Word.doc, 06.06.2000

MTC_PEM_Command_Word (T193, ST2)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	E	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care), E,A *, **Type (193)**
5	HEADER	0	0	0	0	0	0	1	1	X	X	X	X	X	X	X	X	**Sub-Type (3)** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	CC = 1 → M_COVER_OPEN CC = 2 → M_COVER_CLOSE
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* A – Acceptance TM report requested 0=No, 1=Yes
E – Execution TM report requested 0=No, 1=Yes

MTC__Cover.doc, 06.09.2000

MTC_Cover (T193, ST3)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	E	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care), E,A *, **Type (193)**
5	HEADER	0	0	0	0	0	1	0	0	X	X	X	X	X	X	X	X	**Sub-Type (4)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* A – Acceptance TM report requested 0=No, 1=Yes
E – Execution TM report requested 0=No, 1=Yes

MTC__ECA.doc, 06.09.2000

MTC_ECA (T193, ST4)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	PACKET LENGTH = 9
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care),–A - Accept., **Type (193)***
5	HEADER	0	0	0	0	0	1	0	1	X	X	X	X	X	X	X	X	**Sub-Type (5)*** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	Cooler mode
7		0	0	0	0	P	P	P	P	P	P	P	P	P	P	P	P	P = Cold Tip Temp. or Motor Speed
8		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

CCC = 1 → M_COOLER_OFF (CCE +28V=OFF)
CCC = 2 → M_COOLER_OPEN_LOOP (CCE +28V=ON / Cooler Motor Driver=ON)
CCC = 3 → M_COOLER_CLOSED_LOOP (CCE +28V=ON / Cooler Motor Driver=ON)
CCC = 4 → M_COOLER_STANDBY (CCE +28V=ON / Cooler Motor Driver=OFF)
if CCC = 1,4 : PPPPPPPPPPPP = N/A
If CCC = 2 : PPPPPPPPPPPP = Cooler Motor Speed (1...3800 rpm; 1bit/rpm)
If CCC = 3 : PPPPPPPPPPPP = Cold Tip Temperature (60...100K = 0...4095bit; 102,375 Bit/K)

* Type/subtype = 192/5 for VTC_Coolers

MTC__Cooler.doc, 28.02.2001

MTC_Cooler (T193, ST5), VTC_Coolers (T192, ST5)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care),–A - Accept., **Type (193)**
5	HEADER	0	0	0	0	0	1	1	0	X	X	X	X	X	X	X	X	**Sub-Type (6)** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	CC=1→Start, CC=2→Stop
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

MTC__Annealing.doc, 10.07.2003

MTC_Annealing (T193, ST6)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care),–A - Accept., **Type (193)**
5	HEADER	0	0	0	0	1	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (10)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

MTC__Default_Configuration.doc, 06.06.2000

MTC_Default_Configuration (T193, ST10)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care),–A - Accept., **Type (193)**
5	HEADER	0	0	0	0	1	0	1	1	X	X	X	X	X	X	X	X	**Sub-Type (1–) - RAM** + PAD (don't care)
6	**0**...2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	M	M_DATA_PRODUCTION_MODE (0...2)
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

MM → **0 = M_DATA_SCIENCE** (default) 2 = M_DATA_TEST
1 = M_DATA_CALIBRATION

MTC__Change_Data_Product_XXX.doc, 19.03.2001

MTC_Change_Data_Product_RAM (T193, ST11) ..._EEPROM (T193, ST12)

#																		
1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	PACKET LENGTH = 63
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care), A - Accept., **Type (193)**
5	HEADER	0	0	0	0	1	1	0	1	X	X	X	X	X	X	X	X	**Sub-Type (13) RAM** + PAD (don't care)
6	0 ... **1** ... 437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_X1 (coordinate, pixel nr)
7	0 ... **432** ... 437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_X2 (coordinate, pixel nr)
8	0 ... **7** ... 269	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_Y1 (coordinate, pixel nr)
9	0 ... **262** ... 269	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_Y2 (coordinate, pixel nr)
10	0...**2440**...4095	0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	M_IR_VDETCOM (2,012V + 0,49mV/bit)
11	0... **2213**...4095	0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	M_IR_VDETADJ (1,22mV/bit)
12	0...**5**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY (0,02s/bit) (0…20,46s)
13	0...**1**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO (0,02s/bit) (0…20,46s)
14	0...**5**...437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_CCD_WIN_X1 (coordinate, pixel nr)
15	0...**436**...437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_CCD_WIN_X2 (coordinate, pixel nr)
16	**0**... 255	0	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	M_CCD_WIN_Y1 (coordinate, pixel nr)
17	0...**255**	0	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	M_CCD_WIN_Y2 (coordinate, pixel nr)
18	**5** ...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY (0,02s/bit) (0,1…20,46s)
19	0...**1** ...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO (0,02s/bit) (0…20,46s)
20	0 ... **2** *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	M	M_SU_MODE (0=Point, 1=Scan, 2=Off) *
21	0...**37228**..65535	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	M_SU_ANGLE_FIRST (1.0979*10-3°/bit) (1)(2)
22	0...**65193**..65535	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	M_SU_ANGLE_LAST (1.0979*10-3°/bit) (1)
23	1...**235**...65535	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	M_SU_ANGLE_STEP_SIZE (1.0979*10-3°/bit) (1)(3)
24	**1**...65535	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	M_SU_NUM_IRT_ANGLE (number of IRT)
25	1...**20**...65535	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	M_D_BCK_RATE (dark acqu. rate, number)
26	0...**8**...15	0	0	0	0	0	0	0	0	0	0	0	0	I	I	I	I	M_SHUTT_CURR (1mA/bit + 41mA) (4)
27	1...**50**...255	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	M_SHUTT_STAB (1ms/bit)
28	0...**63**	0	0	0	0	0	0	0	0	0	0	T	T	T	T	T	T	M_ANNEAL_LIMITS (0,8°K/bit) (5)
29	1...**360**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_ANNEAL_TIME_OUT (1min/bit)
30	1...**30**...255	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	M_ECA_ACT (1 min/bit)
31	1...**81**...127	0	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	M_OPEN_COVER_STEP (1step/bit)
32	**0**...255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M_IR_DET_OFF (6)
33	1...**120**...127	0	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	M_CLOSE_COVER_STEP (1step/bit)
34	1...**21**...127	0	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	M_INIT_COVER_STEP (1step/bit)
35	↓	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

e.g. **1023** = Default value

(1) Electrical angle: 0 ... 65535 = -36°....+36° ; (corresponds to optical angle FOV=–2°...+2°) ref. RD(7)
(2) if M_SU_MODE=Point, 37228 (+4,9°) is default, if M_SU_MODE=Scan, 5268 (-30,213°) is default
(3) 235 as default (nominal) step size = 0.258° (corresponds to optical angle IFOV=250µrad)
(4) M_SHUTT_CURR (shutter current): 0=41mA, 1=42mA...15=56mA; ref. RD(7), Default=47mA
(5) M_ANNEAL_LIMITS: 000000b=+38°C, 111111b(63)=-13°C
(6) 0xFF means the M-IR detector is not switch-on (in –M data acquisition modes) otherwise it is switched-on

MTC__Change_Func_Param_XXX.doc, 27.09.2004

MTC_Change_Func_Param_RAM (T193, ST13) ..._EEPROM (T193, ST14)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	PACKET LENGTH = 13
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care), A - Accept., **Type (193)**
5	HEADER	0	0	0	0	1	1	1	1	X	X	X	X	X	X	X	X	**Sub-Type (15) RAM** + PAD (don't care)
6	**0**, 1, 2, 3, 4, 5	0	0	0	0	0	0	0	0	0	0	0	0	0	t	t	t	M_ERT (0=5s, 1=20s, 2=60s, 3=300s, 4=2,5s, 5=10sec)
7	**1**...65535	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M_SS (Slice Summing, number of slices)
8	**0**... 7	0	0	0	0	0	0	0	0	0	0	0	0	0	R	R	R	M_ACQ_MODE (0 ... 7) *
9	0 ... **1** ... 4	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	M_COMP_MODE (0 ... 4) **
10	↓	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

e.g. **1** = Default value

* M_ACQ_MODE:

0 = M_ACQ_MODE_NOMINAL_3X4_FULL_WIN
1 = M_ACQ_MODE_VIS_ONLY_1X4
2 = M_ACQ_MODE_IR_ONLY_1X4
3 = M_ACQ_MODE_HIGH_SPECTRAL_1X4_FULL_WIN
4 = M_ACQ_MODE_HIGH_SPATIAL_3X1_FULL_WIN
5 = M_ACQ_MODE_ALL_PIX_FULL_WIN
6 = M_ACQ_MODE_REDUCED_SLIT_3X1
7 = M_ACQ_MODE_ALTER_IR_ONLY_1X4

** M_COMP_MODE:

0 = M_NO_COMPRESSION
1 = M_LOSSLESS_COMPRESSION
2 = M_WAVELET_F1_COMPRESSION
3 = M_WAVELET_F2_COMPRESSION
4 = M_WAVELET_F3_COMPRESSION

MTC__Change_Operat_Param_XXX.doc, 03.12.2003

MTC_Change_Operat_Param_RAM (T193, ST15) ... _EEPROM (T193, ST16)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	PACKET LENGTH = 17
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care), A - Accept., **Type (193)**
5	HEADER	0	0	0	1	0	0	1	1	X	X	X	X	X	X	X	X	**Sub-Type (19) RAM** + PAD (don't care)
6	0 ... **1** ... 437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_X1 (coordinate, pixel nr)
7	0 ... **432** ... 437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_X2 (coordinate, pixel nr)
8	0 ... **7** ... 269	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_Y1 (coordinate, pixel nr)
9	0 ... **262** ... 269	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_Y2 (coordinate, pixel nr)
10	0 ... **5**... 1023s	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY (0,02s/bit) (0…20,46s)
11	0 ... **5**... 1023s	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO (0,02s/bit) (0…20,46s)
12	↓	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

e.g. **1** = Default value

MTC__Change_Altern_Param_XXX.doc, 03.12.2003

MTC_Change_Altern_Param_RAM (T193, ST19) ..._EEPROM (T193, ST20)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	PACKET LENGTH = 61
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	0	1	PUS (don't care), A - Accept., **Type (193)**
5	HEADER	0	0	0	1	0	0	0	1	X	X	X	X	X	X	X	X	**Sub-Type (17) RAM** + PAD (don't care)
6	0...**490**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY1 (0,02s/bit)
7	0...**490**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY2 (0,02s/bit)
8	0... **490**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY3 (0,02s/bit)
9	0...**15**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY4 (0,02s/bit)
10	0... **490**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY5 (0,02s/bit)
11	0... **490**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY6 (0,02s/bit)
12	0...**25**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO1 (0,02s/bit)
13	0...**25**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO2 (0,02s/bit)
14	0...**25**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO3 (0,02s/bit)
15	0...**1**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO4 (0,02s/bit)
16	0...**25**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO5 (0,02s/bit)
17	0...**250**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO6 (0,02s/bit)
18	1...**600**...65535	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	M_IR_LAMP_STAB (0,1s/bit)
19	0...**6**...15 *	0	0	0	0	0	0	0	0	0	0	0	0	I	I	I	I	M_IR_LAMP_CURR (1mA/bit + 94mA) *
20	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY1 (0,02s/bit)
21	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD _DELAY2 (0,02s/bit)
22	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY3 (0,02s/bit)
23	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY4 (0,02s/bit)
24	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY5 (0,02s/bit)
25	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY6 (0,02s/bit)
26	0...**50**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO1 (0,02s/bit)
27	0...**50**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO2 (0,02s/bit)
28	0...**1000**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO3 (0,02s/bit)
29	0...**50**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO4 (0,02s/bit)
30	0...**50**.. 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO5 (0,02s/bit)
31	0...**250**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO6 (0,02s/bit)
32	1...**600**...65535	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	M_CCD_LAMP_STAB (0,1s/bit)
33	0...**2**...3 **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	I	I	M_CCD_LAMP_CURR (XXXmA)**
34		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

e.g. **10** = Default value

* IR lamp current : 0=94mA, 1=95mA ... 15=109mA; default=100mA, ref. RD(7)
** CCD lamp current : 0=240, 1=244, 2=250 or 3=254mA; default=250mA, ref. RD(7)

MTC__Change_Calibration_Param_XXX.doc, 25.01.2004

MTC_Change_Calibration_Param_RAM (T193, ST17) ... _EEPROM (T193, ST18)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	E	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A-Acc/E-Exec, **T194***
5	HEADER	0	0	0	0	0	0	0	1	X	X	X	X	X	X	X	X	**Sub-Type (1)*** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	1=OFF, 2=ON, 3=Reset
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* Type/subtype = 192/4 for VTC_PEMS

HTC__PEM.doc, 26.10.2001

HTC_PEM (T194, ST1), VTC_PEMS (T192, ST4)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A - Accept., **Type (194)**
5	HEADER	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (2)** + PAD (don't care)
6	APPLI.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	PEM command word, see RD(6)
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

HTC__PEM_Command_Word.doc, 06.06.2000

HTC_PEM_Command_Word (T194, ST2)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	E	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), E,A *, **Type (194)**
5	HEADER	0	0	0	0	0	0	1	1	X	X	X	X	X	X	X	X	**Sub-Type (3)** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	CC = 1 → H_COVER_OPEN CC = 2 → H_COVER_CLOSE
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* A – Acceptance TM report required 0=No, 1=Yes
E – Execution TM report requested 0=No, 1=Yes

HTC__Cover.doc, 06.09.2000

HTC_Cover (T194, ST3)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	E	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), E,A *, **Type (194)**
5	HEADER	0	0	0	0	0	1	0	0	X	X	X	X	X	X	X	X	**Sub-Type (4)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* A – Acceptance TM report requested 0=No, 1=Yes
E – Execution TM report requested 0=No, 1=Yes

HTC__ECA.doc, 06.09.2000

HTC_ECA (T194, ST4)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	PACKET LENGTH = 9
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A - Accept., **Type (194)***
5	HEADER	0	0	0	0	0	1	0	1	X	X	X	X	X	X	X	X	**Sub-Type (5)*** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	Cooler mode
7		0	0	0	0	P	P	P	P	P	P	P	P	P	P	P	P	P = Cold Tip Temp. or Motor Speed
8		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

CCC = 1 → H_COOLER_OFF (CCE +28V=OFF)
CCC = 2 → H_COOLER_OPEN_LOOP (CCE +28V=ON / Cooler Motor Driver=ON)
CCC = 3 → H_COOLER_CLOSED_LOOP (CCE +28V=ON / Cooler Motor Driver=ON)
CCC = 4 → H_COOLER_STANDBY (CCE +28V=ON / Cooler Motor Driver=OFF)
if CCC = 1,4 : PPPPPPPPPPPP = N/A
If CCC = 2 : PPPPPPPPPPPP = Cooler Motor Speed (1...3800 rpm; 1bit/rpm)
If CCC = 3 : PPPPPPPPPPPP = Cold Tip Temperature (60...100K = 0...4095bit; 102,375 Bit/K)

* Type/subtype = 192/5 for VTC_Coolers

HTC__Cooler.doc, 28.02.2001

HTC_Cooler (T194, ST5), VTC_Coolers (T192, ST5)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A - Accept., **Type (194)**
5	HEADER	0	0	0	0	0	1	1	0	X	X	X	X	X	X	X	X	**Sub-Type (6)** + PAD (don't care)
6	APPLI.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	CC=1→Start, CC=2→Stop
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

HTC__Annealing.doc, 06.06.2000

HTC_Annealing (T194, ST6)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A - Accept., **Type (194)**
5	HEADER	0	0	0	0	1	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (10)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

HTC__Default_Configuration.doc, 06.06.2000

HTC_Default_Configuration (T194, ST10)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	PACKET LENGTH = 7
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A - Accept., **Type (194)**
5	HEADER	0	0	0	0	1	0	1	1	X	X	X	X	X	X	X	X	**Sub-Type (11) - RAM** + PAD (don't care)
6	0,2,3,7,8,9	0	0	0	0	0	0	0	0	0	0	0	0	M	M	M	M	H_DATA_PRODUCTION_MODE
7		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

MMMM →

0 = H_DATA_NOMINAL_OBSERVATION (Default)
1 = N/A, Deleted
2 = H_DATA_CALIBRATION
3 = H_DATA_NOMINAL_SIMULATION
4 = N/A, Deleted
5 = N/A, Deleted
6 = N/A, Deleted
7 = H_DATA_SPECTRAL_CALIBRATION_SIMULATION
8 = H_DATA_SCIENCE_BACKUP
9 = H_DATA_TEST

Note: The following data are sent as TM image types to the S/C if a H_DATA_PRODUCTION_MODE is commanded
if H_DATA_PRODUCTION_MODE =0, 3 – TM data are H_SPECTRA_SLICEs and H_SPECTRUMs
if H_DATA_PRODUCTION_MODE =2 – TM data are 7 x H_IMAGE_SLICE + 2 x H_SPECTRUM
if H_DATA_PRODUCTION_MODE =7,8,9 – TM data are H_IMAGE_SLICEs

HTC__Change_Data_Product_XXX.doc, 06.05.2002

HTC_Change_Data_Product_RAM (T194, ST11) ..._EEPROM (T194, ST12)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)	
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL	
3		0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	PACKET LENGTH = 55	
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A - Accept., **Type (194)**	
5	HEADER	0	0	0	0	1	1	0	1	X	X	X	X	X	X	X	X	**Sub-Type (13) RAM** + PAD (don't care)	
6	512µs ... **0,5** ... 134,218 sec **	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	H_INT_SPECT_T_NUM1 (LSW)	resol.= 512µs **
7		0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_INT_SPECT_T_NUM2 (MSW)	
8	512µs ... **6,14ms** ...	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	H_INT_SPECT_S_NUM1 (LSW)	resol.= 512µs **
9	134,218 sec **	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_INT_SPECT_S_NUM2 (MSW)	
10	512µs ... **0,5** ... 134,218 sec **	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	H_INT_RAD_NUM1 (LSW)	resol.= 512µs **
11		0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_INT_RAD_NUM2 (MSW)	
12	0...**2,7**...3,722V	0	0	0	0	0	0	0	0	V	V	V	V	V	V	V	V	H_V_BIAS (14,594mV/bit); 2,7V=185bit	
13	0...**12,3**...25mA	0	0	0	0	0	0	0	0	I	I	I	I	I	I	I	I	H_I_LAMP_SPEC_T (0,90588mA/bit)	
14	0...**12,3**...25mA	0	0	0	0	0	0	0	0	I	I	I	I	I	I	I	I	H_I_LAMP_SPEC_S (0,90588mA/bit)	
15	0...**12,3**...25mA	0	0	0	0	0	0	0	0	I	I	I	I	I	I	I	I	H_I_LAMP_RADIO (0,90588mA/bit)	
16	0...**55**..128,2mA	0	0	0	0	0	0	0	0	I	I	I	I	I	I	I	I	H_I_SHUTTER (0.5027mA/bit)	
17	10..**630**..2000ms	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_STAB_LAMP_TIME (10ms/bit)	
18	1...**10**...127s	0	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	H_STAB_DET_TIME (1sec/bit)	
19	2...**20**...30ms	0	0	0	0	0	0	0	0	0	0	0	0	t	t	t	t	H_SHUTTER_TIME (2msec/bit)	
20	1...**60**...255	0	0	0	0	0	0	0	0	S	S	S	S	S	S	S	S	H_OPEN_COVER_STEP (1step/bit)	
21	**0**...65535	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	H_SPARE	
22	1...**120**...255	0	0	0	0	0	0	0	0	S	S	S	S	S	S	S	S	H_CLOSE_COVER_STEP (1step/bit)	
23	1...**16**...255	0	0	0	0	0	0	0	0	S	S	S	S	S	S	S	S	H_INIT_COVER_STEP (1step/bit)	
24	1...**30**...255	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_ECA_ACT (1min/bit)	
25	1...**10**...255s	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_ANNEAL_CHECK_PERIOD (1sec/bit)	
26	293..**333**..353K	0	0	0	0	0	0	0	T	T	T	T	T	T	T	T	T	H_ANNEAL_TEMP (1K/bit)	
27	1...**30**...255min	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_ANNEAL_TIME (1min/bit)	
28	0...**2**...6pixel	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	H_XWIN (pixel, X coordinate)	
29	0...**10**...14pixel	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	C	H_YWIN (pixel, Y coordinate)	
30	**0**...1023	0	0	0	0	0	0	D	D	D	D	D	D	D	D	D	D	H_TEST_INIT (1. H-PEM pattern value)	
31		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)	

e.g. **30** = Default value

** Example: 1,0sec = **1953** bit → MSW = 00000000-**00000001**, LSW = 000000-**1110100001**

HTC__Change_Func_Param_XXX.doc, 27.09.2004

HTC_Change_Func_Param_RAM (T194, ST13) ..._EEPROM (T194, ST14)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	PACKET LENGTH = 21
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A - Accept., **Type (194)**
5	HEADER	0	0	0	0	1	1	1	1	X	X	X	X	X	X	X	X	**Sub-Type (15) RAM** + PAD (don't care)
6	512µs ... **1,0** ... 268 sec *	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	H_INT_SCIENCE_NUM1 (LSW) — resol.= 512µs *
7		0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_INT_SCIENCE_NUM2 (MSW)
8	**0**...65535	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	H_SPARE
9	**0**...1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	S	H_SUM (No=0, Yes=1)
10	**1**...2047	0	0	0	0	0	F	F	F	F	F	F	F	F	F	F	F	H_N_FRAME (Nr of frames if H_SUM=No)
11	1...**10**...255	0	0	0	0	0	0	0	0	F	F	F	F	F	F	F	F	H_N_SUM_FRAME (# of frames summed)
12	1...**10**...255	0	0	0	0	0	0	0	0	F	F	F	F	F	F	F	F	H_DARK_RATE (dark each X frames)
13	0 ... **1** ... 4	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	H_COMP_MODE (0 ... 4) **
14		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

e.g. **1** = Default value

* Example: 1,0sec = **1953** bit → MSW = 00000000-**00000001**, LSW = 000000-**1110100001**

** H_COMP_MODE:

0 = H_NO_COMPRESSION
1 = H_LOSSLESS_COMPRESSION
2 = H_WAVELET_F1_COMPRESSION
3 = H_WAVELET_F2_COMPRESSION
4 = H_WAVELET_F3_COMPRESSION

HTC__Change_Operat_Param_XXX.doc, 06.05.2002

HTC_Change_Operat_Param_RAM (T194, ST15) ... _EEPROM (T194, ST16)

* Max value changed from H_N_FRAME=2048s in V3.54 to H_N_FRAME=2047s in V3.6

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A - Accept., **Type (194)**
5	HEADER	0	0	0	1	1	0	1	0	X	X	X	X	X	X	X	X	**Sub-Type (26)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

HTC__Load_Pixel_Map.doc, 06.06.2000

HTC_Load_Pixel_Map (T194, ST26)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	PACKET LENGTH = 5
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A - Accept., **Type (194)**
5	HEADER	0	0	0	1	1	0	1	1	X	X	X	X	X	X	X	X	**Sub-Type (27)** + PAD (don't care)
6		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

HTC__Check_Pixel_Map.doc, 06.06.2000

HTC_Check_Pixel_Map (T194, ST27)

1	PACKET	0	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	PACKET ID (APID 51, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	PACKET LENGTH = 101
4	DATA FIE.	X	X	X	1	0	0	0	A	1	1	0	0	0	0	1	0	PUS (don't care), A-Accept., **Type (194)**
5	HEADER	0	0	0	1	0	1	0	1	X	X	X	X	X	X	X	X	**Sub-Type (21) RAM** + PAD (don't care)
6	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C11* (**0X423DFF7C**)
7	**47.4995**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
8	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C12* (**0X3DFF7271**)
9	**0.124730**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
10	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C13* (**0X38CF6C3C**)
11	**9.89069e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
12	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C21* (**0X42C6C5A1**)
13	**99.3860**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
14	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C22* (**0X3DC99FD6**)
15	**0.0984494**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
16	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C23* (**0X389498AF**)
17	**7.08563e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
18	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C31* (**0X43062B02**)
19	**134.168**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
20	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C32* (**0X3DA7414A**)
21	**0.0816675**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
22	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C33* (**0X384E4AEA**)
23	**4.91840e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
24	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C41* (**0X431F2F9D**)
25	**159.186**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
26	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C42* (**0X3D886FDB**)
27	**0.0666196**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
28	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C43* (**0X382BB899**)
29	**4.09415e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
30	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C51* (**0X4331570A**)
31	**177.340**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
32	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C52* (**0X3D6A0323**)
33	**0.0571319**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
34	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C53* (**0X37E2BBB0**)
35	**2.70287e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
36	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C61* (**0X433E77CE**)
37	**190.468**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
38	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C62* (**0X3D66C530**)
39	**0.0563404**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
40	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C63* (**0X36B0BDD9**)
41	**5.26731e-006**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
42	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C71* (**0X43493333**)
43	**201.200**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
44	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C72* (**0X3D3EA42F**)
45	**0.0465433**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
46	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C73* (**0X37334F52**)
47	**1.06877e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
48	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C81* (**0X43515062**)
49	**209.314**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
50	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C82* (**0X3D44DEA6**)
51	**0.0480639**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
52	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C83* (**0XB7125D35**)
53	**-8.72398e-006**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
54	**Default**	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	PACKET ERROR CONTROL (CRC)

* Real format (32bit) **S**ign=1bit, **E**xponent=8bit, 23bit=**F**raction (ANSI/IEEE Std 754-1985, see AD(5))

e.g.: **203.46156** → S=0, E=134 (127+7), F=(203.46156-2^7)/2^7=0.58954)

→ 0 10000110 10010110111011000101000 → **0X434B7628**

HTC__Change_Pixel_Map_Param_XXX.doc, 27.08.2004

HTC_Change_Pixel_Map_Param_RAM (T194, ST21) ... _EEPROM (T194, ST22)

Appendix 3: VIRTIS TM packet list

TM reports incl. normal progress events	APID / PCAT	Type/ Subtype	EID SID	PROM SW	EEPROM SW
TM_TC_Acceptance_Report_Success	51 / 1	1 / 1	-	X	X
TM_TC_Acceptance_Report_Failure	51 / 1	1 / 2	-	X	X
TM_TC_Execution_Report_Success	51 / 1	1 / 7	-		X
TM_TC_Execution_Report_Failure	51 / 1	1 / 8	-		X
TM_Connection_Test_Report	51 / 7	17 / 2	-	X	X
TM_Memory_Dump_Report	51 / 9	6 / 6	-	X	
TM_Memory_Check_Report	51 / 7	6 / 10	-	X	
VTM_ME_Default_HK_Report	51 / 4	3 / 25	1	X	X
MTM_ME_General_HK_Report	51 / 4	3 / 25	2		X
MTM_PEM_VIS_HK_Report	51 / 4	3 / 25	4		X
MTM_PEM_IR_HK_Report	51 / 4	3 / 25	5		X
MTM_Science_Report_HS_Link	52 / 12	20 / 13	-		X
MTM_Science_Data_RTU_Link	52 / 12	20 / 3	-		X
HTM_ME_General_HK_Report	51 / 4	3 / 25	3		X
HTM_PEM_HK_Report	51 / 4	3 / 25	6		X
HTM_Science_Data_HS_Link	53 / 12	20 / 13	-		X
HTM_Science_Data_RTU_Link	53 / 12	20 / 3	-		X
TM_Anomaly_Warning_Event_Report ...	51 / 7	5 / 2	(1)		X
TM_Ground_Action_Event_Report ...	51 / 7	5 / 3	(1)		X
TM_OnBoard_Action_Event_Report ...	51 / 7	5 / 4	(1)	X	X
Normal progress events					
TM_Secondary_Boot_Completed	51 / 7	5 / 1	47501		X
TM_EEPROM_Stat_Report	51 / 7	5 / 1	47502	X	
MTM_Dump_Data_Production_Parameter	51 / 7	5 / 1	47701		X
MTM_Dump_Functional_Parameter	51 / 7	5 / 1	47702		X
MTM_Dump_Operational_Parameter	51 / 7	5 / 1	47703		X
MTM_Dump_Alternate_Parameter	51 / 7	5 / 1	47704		X
MTM_Dump_Calibration_Parameter	51 / 7	5 / 1	47705		X
MTM_Cool_Down_End_Success	51 / 7	5 / 1	47706		X
MTM_Calibr_Phase_Finalized	51 / 7	5 / 1	47767		X
HTM_Dump_Data_Production_Parameter	51 / 7	5 / 1	47901		X
HTM_Dump_Functional_Parameter	51 / 7	5 / 1	47902		X
HTM_Dump_Operational_Parameter	51 / 7	5 / 1	47903		X
HTM_Dump_Pixel_Map_Parameter	51 / 7	5 / 1	47904		X
HTM_H_Annealing_Flag	51 / 7	5 / 1	47905		X
HTM_COOL_DOWN_END_SUCCESS	51 / 7	5 / 1	(1)		X
HTM_ANNEAL_STOPPED_DET_TEMP_REACHED	51 / 7	5 / 1	(1)		X
HTM _ANNEAL_STOPPED_AFTER_TIME_OUT	51 / 7	5 / 1	(1)		X
HTM _PIX_MAP_CHECK_SUCCESS	51 / 7	5 / 1	(1)		X
HTM_Calibr_Phase_Finalized	51 / 7	5 / 1	47988		X
(1) see events in ME, -M and –H event/error lists					

Table A3-1: List of TM Packets Reports

List_of_TMs.doc, 17.05.2001

Appendix 4: Structures of VIRTIS TM packets

1		0	0	0	0	1	0	1	1	0	0	1	1	0	0	0	1	PACKET ID (APID 51, 1)
2	PACKET	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3	HEADER	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	PACKET LENGTH = 13
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_{0}
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_{0}$

Word	Field																	Description
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**Type (1)**
8		0	0	0	0	0	0	0	1	P	P	P	P	P	P	P	P	**Sub-Type (1)** + PAD (♦)
9	SOURCE																	TC PACKET ID (♦)
10	DATA																	TC PACKET SEQ. CONTROL (♦)

(♦) PAD, PID and Seq. control are copied from the PAD, PID and Seq. control fields of the corresponding TC

TM__TC_Acceptance_Report_Success.doc, 02.11.1999

TM_TC_Acceptance_Report_Success (T1, ST1)

Word	Field																	Description
1		0	0	0	0	1	0	1	1	0	0	1	1	0	0	0	1	PACKET ID (APID 51,1)
2	PACKET	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3	HEADER	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	PACKET LENGTH = 21 (or 17 **)
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**Type (1)**
8		0	0	0	0	0	0	1	0	P	P	P	P	P	P	P	P	**Sub-type (2)** + PAD (♦)
9																		TC PACKET ID (♦)
10																		TC PACKET SEQ. CONTROL (♦)
11	SOURCE	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	C	Failure Event Code: 1...7
12	DATA	T	T	T	T	T	T	T	T	S	S	S	S	S	S	S	S	Param.1=Type, Param. 2=Sub-type (♦)
13		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter 3 (**)
14		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter 4 (**)

(♦) PAD, PID, Seq. control, Type and Sub-type are copied from fields of the corresponding TC

(**) In case of **failure code 3**, parameter 3 +4 are not available; i.e. in this case the TM packet is **only 12 words long** (not 14 words) or packet length is 17 (not 21)

TM__TC_Acceptance_Report_Failure.doc, 09.06.2001

TM_TC_Acceptance_Report_Failure (T1, ST2)

Description of failure codes and parameter see next page.

Failure Code	Parameter 1 8 bit	Parameter 2 8 bit	Parameter 3 16 bit	Parameter 4 16 bit
1 (incomplete TC packet)	Packet type from received TC	Packet Subtype from received TC	Number of octets in the packet header * (1)	Number of octets actually received * (2)
2 (Incorrect checksum)	Packet type from received TC	Packet Subtype from received TC	Received Checksum (from TC packet)	Expected Checksum (calculated)
3 (Incorrect APID)	Packet type from received TC	Packet Subtype from received TC	not available in TM packet, i.e. in this case TM packet is shorter	
4 (Invalid TC code, Type/Subtype/ TC length)	Packet type from received TC	Packet Subtype from received TC	0000hex	0000hex
5 (TC cannot be accepted at this time)	Packet type from received TC	Packet Subtype from received TC	0000hex	0000hex
6 (TC data field inconsistent)	Packet type from received TC	Packet Subtype from received TC	Word position (offset zero) of first field error	Erroneous Word Value Read
7 (other Virtis specific failure)	Packet type from received TC	Packet Subtype from received TC		0000hex

* Note that number (1) and number (2) cannot be directly compared. (1) is a logical number of packet header and (2) is a physical number of octets which is really received

when failure code is 7, parameter 3 has the following meaning:

0 = No additional information
1 = Unexpected value of acknowledgement field
2 = Invalid –M data rate (1)
3 = Invalid mode transition
4 = –M External Repetition Time (M_ERT) too short (2)
5 = Invalid –M window size (6)
6 = Confirmed a non critical TC
7 = Confirmed a not received TC
8 = Cover TC after ECA actuation
9 = ME HS Link is not established
10 = M_ACQ_MODE not expected (5)
11 = –H Internal Repetition Time (H-IRT) too short (3)
12 = -H TM data rate too high (4)

Note: not all parameter3 values are applicable for low and high level TCs

TM__TC_Acceptance_ErrorParameter2.doc, Last Edit: 24.01.2002

(1) occurs if –M TM rate is more than 1,6MBit/s (105Kwords) in case of data transfer via HS link
occurs if –M TM rate is more than 30KBit/s (1800words) in case of data transfer via RTU link

(2) occurs if M_ERT < (M_IRT * M_SS) in case of M_Data_Production_Mode = M_SCIENCE (see chapter 10.4, page 52)

(3) occurs if H_IRT < 700ms if H_Data_Production_Mode= 0 or 3 (H_Spectrum acquisition)
occurs if H_IRT < 5000ms if H_Data_Production_Mode= 8 or 9 (H_Image acquisition)

(4) occurs if –H TM rate is more than 830KBit/s (52Kwords) in case of data transfer via HS link
occurs if –H TM rate is more than 10KBit/s (640words) in case of data transfer via RTU link

(5) occurs if M_ACQ_MODE is not equal to M_ACQ_MODE_ALL_PIX_FULL_WIN (=5) (as –M operational parameter) and if –M data production mode is equal to M_DATA_CALIBRATION (=1)

(6) occurs if M_ACQ_MODE is equal to M_ACQ_MODE_IR_ONLY (as –M operational parameter)
and if –M window size M_IR_WIN_X2 - M_IR_WIN_X1 is not equal to 288 **or**
if M_ACQ_MODE is equal to M_ACQ_MODE_VIS_ONLY (as –M operational parameter)
and if –M window size M_CCD_WIN_X2 - M_CCD_WIN_X1 is not equal to 288

1		0	0	0	0	1	0	1	1	0	0	1	1	0	0	0	1	PACKET ID (APID 51, 1)
2	PACKET	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3	HEADER	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	PACKET LENGTH = 13
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_{0}
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**Type (1)**
8		0	0	0	0	0	1	1	1	P	P	P	P	P	P	P	P	**Sub-Type (7)** + PAD (♦)
9	SOURCE																	TC PACKET ID (♦)
10	DATA																	TC PACKET SEQ. CONTROL (♦)

(♦) PAD, PID and Seq. control are copied from the PAD, PID and Seq. control fields of the corresponding TC

TM__TC_Execution_Report_Success.doc, 16.11.2000

TM_TC_Execution_Report_Success (T1, ST7)

1		0	0	0	0	1	0	1	1	0	0	1	1	0	0	0	1	PACKET ID (APID 51,1)
2	PACKET	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3	HEADER	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	PACKET LENGTH = 17
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_{0}
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**Type (1)**
8		0	0	0	0	1	0	0	0	P	P	P	P	P	P	P	P	**Sub-type (8)** + PAD (♦)
9																		TC PACKET ID (♦)
10																		TC PACKET SEQ. CONTROL (♦)
11	SOURCE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Failure Event Code: 1 (*)
12	DATA	T	T	T	T	T	T	T	T	S	S	S	S	S	S	S	S	Param.1=Type, Param. 2=Sub-type (♦)

(♦) PAD, PID, Seq. control, Type and Sub-type are copied from fields of the corresponding TC

(*) 1 = The correct commanded status was not achieved

TM__TC_Execution_Report_Failure.doc, 16.10.2000

TM_TC_Execution_Report_Failure (T1, ST8)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51,7)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	PACKET LENGTH = 9 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} \ldots Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} \ldots Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} \ldots Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	**Type (17)**
8		0	0	0	0	0	0	1	0	P	P	P	P	P	P	P	P	**Sub-Type (2)** + PAD (♦)

(♦) Pad is copied from the Pad field of the corresponding Connection Test TC (**T17, ST1**)

TM__Connection_Test_Report.doc, 02.11.1999

TM_Connection_Test_Report (T17, ST1)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	PACKET LENGTH = 21 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} \ldots Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} \ldots Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} \ldots Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	**Type (6)**
8		0	0	0	0	1	0	1	0	P	P	P	P	P	P	P	P	**Sub-Type (10)** + PAD (♦)
9		M	M	M	M	M	M	M	M	0	0	0	0	0	0	0	1	Memory ID / 1 block checked
10	APPLI-	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Start Address (most sign. word)
11	CATION	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Start Address (least sign. word)
12	DATA	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	Checked block length ≤ 65535 items
13		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SPARE
14		C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	Checksum

VIRTIS Memory IDs:		
	140 – EEPROM / 8bit items	144 – PM Port / 48bit items
	141 – PM / 48bit items	145 – DM Port / 40bit items
	142 – DM / 40bit items	146... 149 – not used
	143 – DM / 16bit items	

(♦) Pad is copied from the Pad field of the corresponding Check Memory TC (T6, ST9)

TM__Memory_Check_Report.doc, 01.11.1999

TM_Memory_Check_Report (T6, ST10)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	1	0	0	1	PACKET ID (APID 51, 9)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	PACKET LENGTH = 19...4105 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_0
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_0$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	**Type (6)**
8		0	0	0	0	0	1	1	0	P	P	P	P	P	P	P	P	**Sub-Type (6)** + PAD (♦)
9		M	M	M	M	M	M	M	M	0	0	0	0	0	0	0	1	Memory ID / 1 block dumped
10	APPLI-	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Start Address (most sign. word)
11	CATION	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Start Address (least sign. word)
12	DATA	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	Dumped block length ≤ 4088 items
n	n = 13...2056	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	Data to be dumped; 1...4088 items (1 ... 2044 (16bit) words) (4088 bytes if MEM_ID=EEPROM/8bit) 1 item = 8bit, 16bit, 32bit, 40bit or 48bit

VIRTIS Memory IDs:		
	140 – EEPROM / 8bit items	144 – PM Port / 48bit items
	141 – PM / 48bit items	145 – DM Port / 40bit items
	142 – DM / 40bit items	146... 149 – not used
	143 – DM / 16bit items	

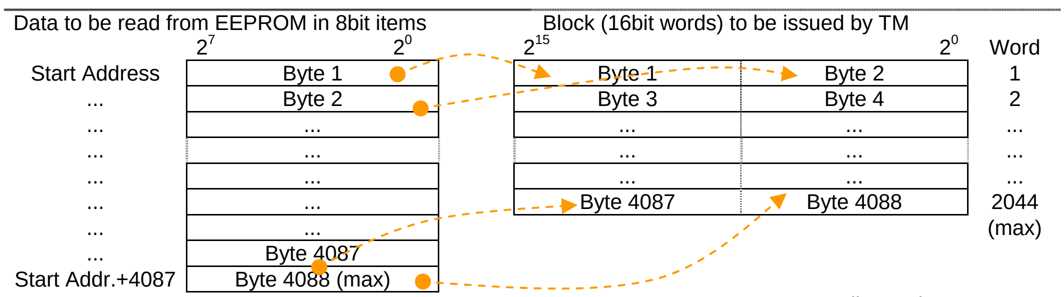
(♦) Pad is copied from the Pad field of the corresponding Dump Memory TC (T6, ST5)

TM__Memory_Dump_Report.doc, 01.11.1999

TM_Memory_Dump_Report (T6, ST6)

TC_Memory_Dump - Application data format for MemID=140 (EEPROM)

Note: this format is valid for packing the dumped data in a TM packet, which is 16bit word organized. The figure below shows an example with a max. number of data items (4088 bytes).



TC__Dump_Memory_Rep_EEPROMAppliData.doc, 05.09.99

The formatted data block with max. 2044 16bit words are issued as TM report together the Memory ID = 140, Start address, the dumped block length in bytes and the current valid SCET timer value.

TM_Memory_Dump - Application data format for MemID=141 (PM RAM/48bit) or MemID=144 (PM Port/48bit)

The requested and received PM RAM data located in are formatted as shown in the following figure.

Note: this format is valid for packing the dumped data in a TM packet, which is 16bit word organized. The figure shows an example with a max. number of data items (max. 681 48bit words or max. 2044 16bit words) to be received as TM application data.

memory data to be dumped (48bit words)

	48bit word	2^{47}		2^{0}
Start Addr.	1	MSW 1	middle 1	LSW 1
	2	MSW 2	middle 2	LSW 2
	3			
	...			
	680			
Start Ad.+680	681 (max)	MSW 681	middle 681	LSW 681

Block (16bit words) to be located in TM packet

2^{15} … 2^{0}	16bit word
MSW 1	1
middle 1	2
LSW 1	3
	...
	...
	...
MSW 681	2042
middle 681	2043
LSW 681	2044 (max)

MSW – Most Significant Word LSW – Low Significant Word

TC__Dump_Memory_Report_PM48AppliData.doc, 22.10.99

TM_Memory_Dump - Application data format for MemID=142 (DM RAM/40bit) or MemID=145 (DM Port/40bit)

The dumped DM RAM data are formatted as shown in the following figure.

Note: this format is prepared for packing the dumped data in a TM packet, which is 16bit word organized. The figure shows an example with a max. number of data items (max. 681 40bit words or 2044 16bit words) to be received as TM application data.

memory data to be dumped (40bit words)

	40bit word	2^{39}		2^{0}
Start Addr.	1	MSB 1	middle 1	LSW 1
	2	MSB 2	middle 2	LSW 2
	3			
	...			
	680			
Start Ad.+680	681 (max)	MSB	middle 681	LSW 681

Block (16bit words) to be located in TM packet

2^{15}	2^{0}	16bit word
not used	MSB 1	1
middle 1		2
LSW 1		3
		...
		...
		...
not used	MSB	2042
middle 681		2043
LSW 681		2044 (max)

MSB – Most Significant Byte, LSW – Low Significant Word

TC__Dump_Memory_Report_DM40AppliData.doc, 22.10.99

TM_Memory_Dump - Application data format for MemID=143 (DM RAM/16bit)

The 16bit memory content is written in the TM packet in the same format and order as located in the 16bit RAM.

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	0	0	PACKET ID (APID 51, 4)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	PACKET LENGTH = 27 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	Const. field + TYPE (**3**)
8		0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	SUB-TYPE (**25**) + PAD
9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	ME Default HK SID (**1**)
10		E	E	E	E	H	H	H	H	H	H	M	M	M	M	M	M	V-mode „E" ME; "H" - V-H; „M" V–M
11		I	0	0	0	0	0	0	0	0	0	B	B	B	B	B	B	„I" DPU_ID; „B" ME_PWR_STAT *
12	SOURCE	0	0	0	0	T	T	T	T	T	T	T	T	T	T	T	T	ME_PS_TEMP (0,244 K/bit)
13	DATA	0	0	0	0	T	T	T	T	T	T	T	T	T	T	T	T	ME_DPU_TEMP (0,244 K/bit)
14		0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	ME_DHSU_VOLT (2,442 mV/bit)
15		0	0	0	0	C	C	C	C	C	C	C	C	C	C	C	C	ME_DHSU_CURR (2,442 mA/bit)
16		0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	ME_IFE_VOLT (2,442 mV/bit) **
17		0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	ME_EEPROM_VOLT (2,442 mV/bit)***

V-mode: 2^{15} ... 2^{12} – ME mode, 2^{11} ... 2^{6} –H mode, 2^{5} ... 2^{0} –M mode (see mode table(s) in Appendix)
DPU_ID="1" - Redundant +28V Power/DPU is ON; **DPU_ID="0"** - Main Power/DPU is ON
* **ME_PW_STAT / 2^5** - ME DPU/EEPROM +5V power status, "0" = OFF, "1" = ON
* **ME_PW_STAT / 2^4** - ME PS/ADC power status, "0" = OFF, "1" = ON
* **ME_PW_STAT / 2^3** - ME H-IFE +5V power status, "0" = OFF, "1" = ON
* **ME_PW_STAT / 2^2** - ME M-IFE +5V power status, "0" = OFF, "1" = ON
* **ME_PW_STAT / 2^1** - ME PS H-power converter status, "0" = OFF, "1" = ON
* **ME_PW_STAT / 2^0** - ME PS M-power converter status, "0" = OFF, "1" = ON
** **ME_IFE_VOLT** – if the **main** DPU/PS is active, this value shows the **M-IFE** voltage
if the **red.** DPU/PS is active, this value shows the **H-IFE** voltage
*** **ME_EEPROM_VOLT** – only +5V if EEPROM is switched-on

VTM__ME_Default_HK_Report.doc, 04.12.2003

VTM_ME_Default_HK_Report (T3, ST25, SID1)

VTM_ME_Default_HK_Report, Word 10, 16bit (e.g. 0x2041 = Safe mode active after VIRTIS power-on)

ME Operative Mode		**V-H Operative Mode**		**V-M Operative Mode**	
E E E E		H H H H H H		M M M M M M	
1	ME_OFF	**1**	H_OFF	**1**	M_OFF
2	ME_SAFE	**2**	H_COOL_DOWN	**2**	M_COOL_DOWN
3	ME_DEVELOPMENT	**3**	H_IDLE	**3**	M_IDLE
4	ME_IDLE	**4**	H_ANNEALING	**4**	M_ANNEALING
5	ME_SCIENCE	**5**	H_PEM_ON	**5**	M_PEM_ON
6	ME_TEST	**6**	H_TEST	**6**	M_TEST
		7	H_CALIBRATION	**7**	M_CALIBRATION
		8	H_NOMINAL_SIMULATION	**8**	M_SCIENCE_HIGH_SPECTRAL_1
		9	H_SCIENCE_MAXIMUM_ DATA_RATE	**9**	M_SCIENCE_HIGH_SPECTRAL_2
		10	H_SCIENCE_NOMINAL_ DATA_RATE	**10**	M_SCIENCE_HIGH_SPECTRAL_3
		11	H_SCIENCE_MINIMUM_ DATA_RATE	**11**	M_SCIENCE_HIGH_SPATIAL_1
		12	H_DELETED	**12**	M_SCIENCE_HIGH_SPATIAL_2
		13	H_SCIENCE_BACKUP	**13**	M_SCIENCE_HIGH_SPATIAL_3
		14	H_USER_DEFINED	**14**	M_SCIENCE_NOMINAL_1
		15	H_DELETED	**15**	M_SCIENCE_NOMINAL_2
		16	H_DELETED	**16**	M_SCIENCE_NOMINAL_3
		17	H_DELETED	**17**	M_SCIENCE_NOMINAL_ COMPRESSED
		18	H_SPECTRAL_CALIBRATION_ SIMULATION	**18**	M_SCIENCE_REDUCED_SLIT
		19	H_DEGRADED	**19**	M_USER_DEFINED
				20	M_DEGRADED
		63	H_ME_TEST	**63**	M_ME_TEST

Table A3-2: List of VIRTIS modes

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	0	0	PACKET ID (APID 51, 4)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	PACKET LENGTH = 25 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	**Type (3)**
8		0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (25)** + PAD
9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	ME General HK SID **(2)**
10		0	0	0	0	0	0	0	P	0	0	0	0	0	0	0	O	M_ECA_STAT, P–PWR, O-OPEN/CLOSE
11		0	0	0	0	0	0	0	P	0	0	0	D	0	0	0	M	M_COOL_STAT, P–PWR, D-DRV, M-MODE
12		0	0	0	0	T	T	T	T	T	T	T	T	T	T	T	T	M_COOL_TIP_TEMP ($9,768*10^{-3}$ K/bit + 60K)
13	SOURCE	0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	M_COOL_MOT_VOLT (4,884 mV/bit)
14	DATA	0	0	0	0	C	C	C	C	C	C	C	C	C	C	C	C	M_COOL_MOT _CURR (0,4884 mA/bit)
15		0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	M_CCE_SEC_VOLT(4,884 mV/bit)
16		T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	M_SCIENCE_TM_PACKET_COUNTER

M_ECA_STAT / PWR = "1" - ECA +28V is ON; "0" - ECA +28V is OFF
M_ECA_STAT / OPEN/CLOSE = "1" (High at ECA_M_Status I/F) - Open; "0" (Low at ...) - Closed
M_COOL_STAT / PWR = "1" - CCE +28V is ON; "0" - CCE +28V is OFF
M_COOL_STAT / DRV = "1" - Cooler Motor Driver = ON; "0" - Cooler Motor Driver = OFF
M_COOL_STAT / MODE = "1" - Open Loop Cooler Mode; "0" - Closed Loop Cooler Mode
M_SCIENCE_TM_PACKET_COUNTER starts at 0x0000 after each TC_Enable_Science_*(-M)

MTM__ME_General_HK_Report.doc, 13.01.2002

MTM_ME_General_HK_Report (T3, ST25, SID2)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	0	0	PACKET ID (APID 51, 4)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	PACKET LENGTH = 61 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} \dots Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} \dots Sec_0$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} \dots Frac_0$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	**Type (3)**
8		0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (25)** + PAD
9	always 4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	M_VIS_HK_SID **(4)**
10	32768...56745	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_CCD_VDR_HK ([N-32768]*49,2/2^{16}V)
11	32768...49024	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_CCD_VDD_HK ([N-32768]*79,746/2^{16}V)
12	32768...49970	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_+5V_VOLT ([N-32768]*20/2^{16}V)
13	32768...53360	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_+12V_VOLT ([N-32768]*40,1/2^{16}V)
14	12176...32768	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_-12V_VOLT ([N-32768]*40,1/2^{16}V)
15	32768...50026	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_+20V_VOLT ([N-32768]*79,746/2^{16}V)
16	32768...52491	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_+21V_VOLT ([N-32768]*79,746/2^{16}V)
17	35798...53125	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_CCD_LAMP_VOLT ([N-32768]*49,9/2^{16}V)
18	32768...39322	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_CCD_TEMP_OFFSET ([N-32768]*10/2^{16}V)
19	35798...55460	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	M_CCD_TEMP (see RD(6))
20	32768...36372	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	M_CCD_TEMP_RES ([N-32768]*0,1/2^{16}A)
21	35798...55460	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	RADIATOR_TEMP (see RD(6))
22	35798...55460	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	LEDGE_TEMP (see RD(6))
23	35798...55460	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	OM_BASE_TEMP (see RD(6))
24	35798...55460	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_COOLER_TEMP (see RD(6))
25	35798...55460	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	M_COOLER_TEMP (see RD(6))
26	0...1023	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	M_CCD_WIN_X1 (X coordinate first pixel)
27	0...511	0	0	0	0	0	0	0	Y	Y	Y	Y	Y	Y	Y	Y	Y	M_CCD_WIN_Y1 (Y coordinate first pixel)
28	0...1023	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	M_CCD_WIN_X2 (X coordinate last pixel)
29	0...511	0	0	0	0	0	0	0	Y	Y	Y	Y	Y	Y	Y	Y	Y	M_CCD_WIN_Y2 (Y coordinate last pixel)
30	0...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY (20ms/bit)
31	0...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO (20ms/bit)
32	+/- ...	0	0	0	S	S	S	S	S	S	S	S	S	S	S	S	S	M_MIRROR_SIN_HK
33	see below	0	0	0	0	C	C	C	C	C	C	C	C	C	C	C	C	M_MIRROR_COS_HK
34	see below	0	0	0	0	0	0	0	L	0	0	0	L	E	E	A	S	M_VIS_FLAG_ST *****

* $2^{15} \dots 2^9$ – 0000000 (BIT0...6)
2^8 – M_CAL_LAMP_LAST_CMD (L) (BIT7)
$2^7 \dots 2^5$ – 000 (BIT8...10)

* 2^4 – M_VIS_ADC_LATCHUP_ST (L) (BIT11)
2^3 – M_WORD_ERROR_FLAG (E) (BIT12)
2^2 – M_TIME_ERROR_FLAG (E) (BIT13)
2^1 – M_HK_ACQUISITION_FLAG (A) (BIT14)
2^0 – M_CCD_SCAN_FLAG (S) (BIT15)

MTM__PEM_VIS_HK_Report.doc, 19.06.2000

MTM_PEM_VIS_HK_Report (T3, ST25, SID4)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	0	0	PACKET ID (APID 51, 4)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	PACKET LENGTH = 51 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_{0}
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	**Type (3)**
8		0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (25)** + PAD
9	always 5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	M_IR_HK_SID **(5)**
10	32768...45875	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_IR_VDETCO_HK ([N-32768]*20/2^{16}V)
11	32768...49152	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_IR_VDETADJ_VOLT ([N-32768]*20/2^{16}V)
12	35798...49152	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	M_IR_VPOS ([N-32768]*20/2^{16}V)
13	35798...49152	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_IR_VDP ([N-32768]*20/2^{16}V)
14	32768...39322	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_IR_TEMP_OFFSET ([N-32768]*10/2^{16}V)
15	38350...50555	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	M_IR_TEMP (see RD(6))
16	32768...39977	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	M_IR_TEMP_RES ([N-32768]*0,05/2^{16}A)
17	35798...55460	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	M_SHUTTER_TEMP (see RD(6))
18	35798...55460	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	M_GRATING_TEMP (see RD(6))
19	35798...55460	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	M_SPECT_TEMP (see RD(6))
20	35798...55460	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	M_TELE_TEMP (see RD(6))
21	35798...55460	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_SU_MOTOR_TEMP (see RD(6))
22	35798...53125	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	M_IR_LAMP_VOLT ([N-32768]*49,9/2^{16}V)
23	16384...49152	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	M_SU_MOTOR_CURR ([N-32768]*0,1/2^{16}A)
24	0...269	0	0	0	0	0	0	0	Y	Y	Y	Y	Y	Y	Y	Y	Y	M_IR_WIN_Y1 (Y coordinate first pixel)
25	0...269	0	0	0	0	0	0	0	Y	Y	Y	Y	Y	Y	Y	Y	Y	M_IR_WIN_Y2 (Y coordinate last pixel)
26	0...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY (100ms/bit)
27	0...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO (100ms/bit)
28	see below	0	0	0	C	I	I	I	I	0	0	0	L	V	V	V	V	M_IR_LAMP_SHUTTER **
29	see below	0	C	C	D	0	0	A	0	0	L	S	E	E	E	A	S	M_IR_FLAG_ST *

*** M_IR_FLAG_ST**

2^{15} – always 0 (BIT0)
2^{14} – M_COVER_OPEN_POS [C] (BIT1)
2^{13} – M_COVER_CLOSE_POS [C] (BIT2)
2^{12} – M_LAST_COVER_CMD_DIR [D] (BIT3)
2^{11} ... 2^{10} – 00 (BIT4,5)
2^{9} – M_ANNEAL_HTR_LAST_CMD (A) (BIT6)
2^{8} ... 2^{7} – 00 (BIT7,8)
2^{6} – M_IR_ADC_LATCHUP (L) (BIT9)
2^{5} – M_IR_DET_ST (S) (BIT10)
2^{4} – M_SCAN_WORD_ERROR_FLAG (E) (BIT11)
2^{3} – M_IR_WORD_ERROR_FLAG (E) (BIT12)
2^{2} – M_TIME_ERROR_FLAG (E) (BIT13)
2^{1} – M_HK_ACQUISITION_FLAG (A) (BIT14)
2^{0} – M_IRFPA_SCAN_FLAG (S) (BIT15)

**** M_IR_LAMP_SHUTTER**

2^{15}... 2^{13} – 000 (BIT0...2)
2^{12} – M_SHUTTER_STAT [C] (BIT3)
2^{11} ... 2^{8} – M_SHUTTER_CURR [I] (BIT4...7)
2^{7}... 2^{5} – 000 (BIT8...10)
2^{4} – M_IR_CAL_LAMP_STAT [L] (BIT11)
2^{3}... 2^{0} – M_IR_CAL_LAMP_CURR [V] (BIT12...15)

MTM__PEM_IR_HK_Report.doc
27.06.2001

MTM_PEM_IR_HK_Report (T3, ST25, SID5)

1	PACKET	0	0	0	0	1	0	1	1	0	1	0	0	1	1	0	0	PACKET ID (APID **52**, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	L	L	L	L	L	L	L	L	L	L	PACKET LENGTH = 19...1017 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_{0}
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_{0}$
7	HEADER	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	TYPE (**20**)
8		0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	SUB-TYPE (**13**)* + PAD
9		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A = Acquisition ID (see below)
10		N	N	N	N	N	N	N	N	S	S	S	S	S	S	S	S	N=Nr of SS/slice; S=ser.Nr of SS (see below)
11		D	D	D	M	M	M	M	M	P	P	P	P	P	P	P	P	DDD, MMMMM, PPPPPPPP (see below)
12	SOURCE	Q	T	H	K	K	K	Z	Z	C	C	C	C	C	C	C	C	Q,T,H,K, Z, C (see below)
13	DATA	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	Science Data word 1
		W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	Science Data word 2
...		W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	Science Data word ...
...		W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	Science Data word ...
n-1		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
n	n=13...512	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	Science Data word X

* SUB-TYPE	Sub-type=13: HS link report, or =3: RTU report
AAA... AAA →	Serial number of Slices (i.e. M-PEM acquisitions) 1...65535
NNNNNNNN →	Total number of Subslices/Slice = 1...12
SSSSSSSS →	Serial number of Subslices within a Slice = 1...12
DDD →	Total number of Subslices in spatial direction = 1 or 4
MMMMM →	Total number of TM packets/Subslices = 1...19 (depends on compression factor)
PPPPPPPP →	Serial number of TM packets within a Subslice = 1...19
Q →	Last word in TM packet is a dummy word = 1, ... is a real science word = 0
T →	Spectrum Type; VIS = 1, IR = 0
H →	Shutter State; Closed = 1, Open = 0
KKK →	Compression mode; NO_COMPRESSION=0, LOSSLESS_COMPRESSION=1, H_WAVELET_F1_COMPRESSION=2, WAVELET_F2_COMPRESSION=3, H_WAVELET_F3_COMPRESSION=4
ZZ →	Spare = 00b
CCCCCCCC →	Image Type; Science=0, Cal.phase0=1, ... Cal.phase6=7, ME/M-IFE test pattern=255

MTM__Science_Report.doc, 26.10.2001

MTM_Science_Report (HS_Link or RTU_Link) (APID52/12, T20, ST13 or 3)

Note for sending science TM packets by HS link:

Each TM packet has a supplementary header of 32bit containing 0x1C000000. That means one science TM packet (for –M or –H) contains 498words (i.e. real science data without header) and not 500words as sending science TM packets by SDT interface.

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	PACKET LENGTH = 13 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec$_{31}$ ... Sec$_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec$_{15}$ ... Sec$_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME Frac$_{15}$ ... Frac$_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9		**1**	**0**	**1**	**1**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	Event ID nr: **47701**
10	0...2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	M	M_DATA_PRODUCTION_MODE (0...3)

MM → **0 = M_DATA_SCIENCE**
1 = M_DATA_CALIBRATION
2 = M_DATA_TEST

MTM__Dump_Data_Production_Parameter.doc, 27.06.2001

MTM_Dump_Data_Production_Parameter (T5, ST1, EID 47701)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	PACKET LENGTH = 19 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec$_{31}$ ... Sec$_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec$_{15}$ ... Sec$_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME Frac$_{15}$ ... Frac$_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9		**1**	**0**	**1**	**1**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**1**	**1**	**1**	Event ID nr: **47703**
10	0,1,2,3,4,5	0	0	0	0	0	0	0	0	0	0	0	0	0	t	t	t	M_ERT (0=5s, 1=20s, 2=60s, 3=300s, 4=2,5s, 5=10sec)
11	1...65535	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M_SS (Slice Summing, nr of slices)
12	0 ...7	0	0	0	0	0	0	0	0	0	0	0	0	0	R	R	R	M_ACQ_MODE (0 ... 7) *
13	0...1... 4	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	M_COMP_MODE (0 ... 4) **

e.g. 1 = Default value

* M_ACQ_MODE

0 = M_ACQ_MODE_NOMINAL_3X4_FULL_WIN
1 = M_ACQ_MODE_VIS_ONLY_1X4
2 = M_ACQ_MODE_IR_ONLY_1X4
3 = M_ACQ_MODE_HIGH_SPECTRAL_1X4_FULL_WIN
4 = M_ACQ_MODE_HIGH_SPATIAL_3X1_FULL_WIN
5 = M_ACQ_MODE_ALL_PIX_FULL_WIN
6 = M_ACQ_MODE_REDUCED_SLIT_3X1
7 = M_ACQ_MODE_ALTER_IR_ONLY_1X4

** M_COMP_MODE:

0 = M_NO_COMPRESSION
1 = M_LOSSLESS_COMPRESSION
2 = M_WAVELET_F1_COMPRESSION
3 = M_WAVELET_F2_COMPRESSION
4 = M_WAVELET_F3_COMPRESSION

MTM__Dump_Operational_Parameter.doc, 04.12.2003

MTM_Dump_Operational_Parameter (T5, ST1, EID 47703)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	PACKET LENGTH = 23 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_0$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_0$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9		**1**	**0**	**1**	**1**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	Event ID nr: **47704**
10	0 ... **1** ... 437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_X1 (coordinate, pixel nr)
11	0 ... **432** ... 437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_X2 (coordinate, pixel nr)
12	0 ... **7** ... 269	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_Y1 (coordinate, pixel nr)
13	0 ... **262** ... 269	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_Y2 (coordinate, pixel nr)
14	0 ... **5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY (0,02s/bit) (0…20,46s)
15	0 ... **5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO (0,02s/bit) (0…20,46s)

e.g. **1** = Default value

MTM_Dump_Alternate_Parameter.doc, 03.12.2003

MTM_Dump_Alternate_Parameter (T5, ST1, EID 47704)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	PACKET LENGTH = 67 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_0$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_0$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9		**1**	**0**	**1**	**1**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**0**	**1**	Event ID nr: **47705**
10	0...**490**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY1 (0,02s/bit)
11	0...**490**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY2 (0,02s/bit)
12	0... **490**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY3 (0,02s/bit)
13	0...**15**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY4 (0,02s/bit)
14	0... **490**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY5 (0,02s/bit)
15	0... **490**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY6 (0,02s/bit)
16	0...**25**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO1 (0,02s/bit)
17	0...**25**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO2 (0,02s/bit)
18	0...**25**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO3 (0,02s/bit)
19	0...**1**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO4 (0,02s/bit)
20	0...**25**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO5 (0,02s/bit)
21	0...**25**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO6 (0,02s/bit)
22	1...**600**...65535	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	M_IR_LAMP_STAB (0,1s/bit)
23	0...**6**...15 *	0	0	0	0	0	0	0	0	0	0	0	0	I	I	I	I	M_IR_LAMP_CURR (1mA/bit + 94mA) *
24	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY1 (0,02s/bit)
25	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD _DELAY2 (0,02s/bit)
26	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY3 (0,02s/bit)
27	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY4 (0,02s/bit)
28	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY5 (0,02s/bit)
29	**5**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY6 (0,02s/bit)
30	0...**50**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO1 (0,02s/bit)
31	0...**50**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO2 (0,02s/bit)
32	0...**1000**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO3 (0,02s/bit)
33	0...**50**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO4 (0,02s/bit)
34	0...**50**.. 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO5 (0,02s/bit)
35	0...**25**... 1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO6 (0,02s/bit)
36	1...**600**...65535	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	M_CCD_LAMP_STAB (0,1s/bit)
37	0...**2**...3 **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	I	I	M_CCD_LAMP_CURR (XXXmA)**

* IR lamp current : 0=94mA, 1=95mA ... 15=109mA; default=100mA, ref. RD(7)
** CCD lamp current : 0=240, 1=244, 2=250 or 3=254mA; default=250mA, ref. RD(7)

MTM__Dump_Calibration_Parameter.doc, 03.07.2004

MTM_Dump_Calibration_Parameter (T5, ST1, EID 47705)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	PACKET LENGTH = 69 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9		**1**	**0**	**1**	**1**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**1**	**1**	**0**	Event ID nr: **47702**
10	0 ... **1** ... 437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_X1 (coordinate, pixel nr)
11	0 ... **432** ... 437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_X2 (coordinate, pixel nr)
12	0 ... **7** ... 269	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_Y1 (coordinate, pixel nr)
13	0 ... **262** ... 269	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_IR_WIN_Y2 (coordinate, pixel nr)
14	0...**2440**...4095	0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	M_IR_VDETCOM (2,012V + 0,49mV/bit)
15	0... **2213**...4095	0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	M_IR_VDETADJ (1,22mV/bit)
16	0...**5**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_DELAY (0,02s/bit) (0…20,46s)
17	0...**1**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_IR_EXPO (0,02s/bit) (0…20,46s)
18	0...**5**...437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_CCD_WIN_X1 (coordinate, pixel nr)
19	0...**436**...437	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	C	M_CCD_WIN_X2 (coordinate, pixel nr)
20	**0**... 255	0	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	M_CCD_WIN_Y1 (coordinate, pixel nr)
21	0...**255**	0	0	0	0	0	0	0	0	C	C	C	C	C	C	C	C	M_CCD_WIN_Y2 (coordinate, pixel nr)
22	**5** ...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_DELAY (0,02s/bit) (0,1…20,46s)
23	0...**1** ...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_CCD_EXPO (0,02s/bit) (0…20,46s)
24	0 ... **2**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	M	M_SU_MODE (0=Point, 1=Scan, 2=Off)
25	0...**37228**..65535	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	M_SU_ANGLE_FIRST (1.0979*10-3°/bit) (1)(2)
26	0...**65193**..65535	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	M_SU_ANGLE_LAST (1.0979*10-3°/bit) (1)
27	1...**235**...65535	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	M_SU_ANGLE_STEP_SIZE (1.0979*10-3°/bit) (1)(3)
28	**1**...65535	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	M_SU_NUM_IRT_ANGLE (number of IRT)
29	1...**20**...65535	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	M_D_BCK_RATE (dark acqu. rate, number)
30	0...**8**...15	0	0	0	0	0	0	0	0	0	0	0	0	I	I	I	I	M_SHUTT_CURR (1mA/bit + 41mA) (4)
31	1...**50**...255	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	M_SHUTT_STAB (1ms/bit)
32	0...**63**	0	0	0	0	0	0	0	0	0	0	T	T	T	T	T	T	M_ANNEAL_LIMITS (0,8°K/bit) (5)
33	1...**360**...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	M_ANNEAL_TIME_OUT (1min/bit)
34	1...**30**...255	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	M_ECA_ACT (1 min/bit)
35	1...**81**...127	0	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	M_OPEN_COVER_STEP (1step/bit)
36	**0**...255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M_IR_DET_OFF (6)
37	1...**120**...127	0	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	M_CLOSE_COVER_STEP (1step/bit)
38	1...**21**...127	0	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	M_INIT_COVER_STEP (1step/bit)

e.g. **1023** = Default value

(1) Electrical angle: 0 ... 65535 = -36°....+36° ; (corresponds to optical angle FOV=–2°...+2°) ref. RD(7)
(2) if M_SU_MODE=Point, 37228 (+4,9°) is default, if M_SU_MODE=Scan, 5268 (-30,213°) is default
(3) 235 as default (nominal) step size = 0.258° (corresponds to optical angle IFOV=250µrad)
(4) M_SHUTT_CURR (shutter current): 0=41mA, 1=42mA...15=56mA; ref. RD(7), Default=47mA
(5) M_ANNEAL_LIMITS: 000000b=+38°C, 111111b(63)=-13°C
(6) 0xFF means the M-IR detector is not switch-on (in –M data acquisition modes) otherwise it is switched-on

MTM__Dump_Functional_Parameter.doc, 27.09.2004

MTM_Dump_Functional_Parameter (T5, ST1, EID 47702)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	0	0	PACKET ID (APID 51, 4)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	PACKET LENGTH = 25 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	**Type (3)**
8		0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (25)** + PAD
9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	ME General HK SID **(3)**
10		0	0	0	0	0	0	0	P	0	0	0	0	0	0	0	O	H_ECA_STAT, P–PWR, O-OPEN/CLOSE
11		0	0	0	0	0	0	0	P	0	0	0	D	0	0	0	M	H_COOL_STAT, P–PWR, D-DRV, M-MODE
12		0	0	0	0	T	T	T	T	T	T	T	T	T	T	T	T	H_COOL_TIP_TEMP (9,768*10^{-3} K/bit + 60K)
13	SOURCE	0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	H_COOL_MOT_VOLT (4,884 mV/bit)
14	DATA	0	0	0	0	C	C	C	C	C	C	C	C	C	C	C	C	H_COOL_MOT _CURR (0,4884 mA/bit)
15		0	0	0	0	V	V	V	V	V	V	V	V	V	V	V	V	H_CCE_SEC_VOLT (4,884 mV/bit)
16		T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_SCIENCE_TM_PACKET_COUNTER

H_ECA_STAT / PWR = "1" - ECA +28V is ON; "0" - ECA +28V is OFF
H_ECA_STAT / OPEN/CLOSE = "1" (High at ECA_H_Status I/F) - Open; "0" (Low at ...) - Closed
H_COOL_STAT / PWR = "1" - CCE +28V is ON; "0" - CCE +28V is OFF
H_COOL_STAT / DRV = "1" - Cooler Motor Driver = ON; "0" - Cooler Motor Driver = OFF
H_COOL_STAT / MODE = "1" - Open Loop Cooler Mode; "0" - Closed Loop Cooler Mode
H_SCIENCE_TM_PACKET_COUNTER starts at 0x0000 after each TC_Enable_Science_*(-H)

HTM__ME_General_HK_Report.doc, 13.01.2002

HTM_ME_General_HK_Report (T3, ST25, SID3)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	0	0	PACKET ID (APID 51, 4)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	1	PACKET LENGTH = 87 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_{0}
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	**Type (3)**
8		0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (25)** + PAD
9	always 6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	H_HK_SID **=6**
10	0...255	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_HKRQ_INT_NUM2 (MSW) (512µs/bit) **(4)**
11	0...1023	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	H_HKRQ_INT_NUM1 (LSW)
12	0...255	0	0	0	0	0	0	0	0	V	V	V	V	V	V	V	V	H_HKRQ_BIAS (see RD(7))
13	0...255	0	0	0	0	0	0	0	0	I	I	I	I	I	I	I	I	H_HKRQ_I_LAMP (see RD(7))
14	0...255	0	0	0	0	0	0	0	0	I	I	I	I	I	I	I	I	H_HKRQ_I_SHUTTER (see RD(7))
15	0...3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	M	H_HKRQ_PEM_MODE (0,1,2,3) **(3)**
16	0...1023	0	0	0	0	0	0	P	P	P	P	P	P	P	P	P	P	H_HKRQ_TEST_INIT (0...1023)
17	see below	0	0	0	0	0	0	0	A	S	T	L	L	L	F	S	D	H_HKRQ_DEVICE_ON **(1)**
18	see below	0	0	0	0	0	0	V	V	V	V	V	V	V	S	T	D	H_HKRQ_COVER **(2)**
19	see below	0	0	0	0	0	0	0	0	0	0	A	F	F	S	S	A	H_HKMS_STATUS **(5)**
20	0...12000	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	H_HKMS_V_LINE_REF (see RD(7))
21	0...18000	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	H_HKMS_VDET_DIG (see RD(7))
22	0...17000	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	H_HKMS_VDET_ANA (see RD(7))
23	0...12000	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	H_HKMS_V_DETCOM (see RD(7))
24	0...11000	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	H_HKMS_V_DETADJ (see RD(7))
25	14900..16500	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	H_HKMS_V+5 (see RD(7))
26	13700..16900	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	H_HKMS_V+12 (see RD(7))
27	15200..18700	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	H_HKMS_V+21 (see RD(7))
28	-17000..-13900	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	H_HKMS_V-12 (see RD(7))
29	10000..12200	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_HKMS_TEMP_VREF (see RD(7))
30	TBD	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_HKMS_DET_TEMP (see RD(7))
31	-50...+50	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	H_HKMS_GND (see RD(7))
32	0...2000	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	H_HKMS_I_VDET_ANA (see RD(7))
33	0...200	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	H_HKMS_I_VDET_DIG (see RD(7))
34	250...450	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	H_HKMS_I_+5 (see RD(7))
35	500...800	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	H_HKMS_I_+12 (see RD(7))
36	70...800	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	H_HKMS_I_LAMP (see RD(7))
37	-70...+2000	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	H_HKMS_I_SHUT_HEAT (see also RD(7))
38	0...65535	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_HKMS_TEMP_PRISM (see RD(7))
39	0...65535	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_HKMS_TEMP_CAL_S (see RD(7))
40	0...65535	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_HKMS_TEMP_CAL_T (see RD(7))
41	0...65535	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_HKMS_TEMP_SHUT (see RD(7))
42	0...65535	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_HKMS_TEMP_GRATING (see RD(7))
43	0...65535	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_HKMS_TEMP_OBJECT (see RD(7))
44	0...65535	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_HKMS_TEMP_FPA (see RD(7))
45	0...65535	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	H_HKMS_TEMP_PEM (see RD(7))
46	0x0...0xFFFF	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	H_HKD_H_LAST_SENT_REQUEST
47	0/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	S	H_HK_PERIODIC (9)

(1) 2^8–H_HKMS_Req_During_Acq (=1)
2^7–H_HKRQ_STATUS_SHUTTER_ON (=1)
2^6–H_HKRQ_TEMP_DET_ON (=1)
2^5–H_HKRQ_LAMP_RADIO_ON (=1)
2^4–H_HKRQ_ LAMP_SPECT_S_ON (=1)
2^3–H_HKRQ_ LAMP_SPECT_T_ON (=1)
2^2–H_HKRQ_ FPAHTR_ON (=1)
2^1–H_HKRQ_ SHUTTER_ON (=1)
2^0–H_HKRQ_ DET_ON (=1)

(9) S=1 means periodic HK
S=0 means science HK

(2) 2^3 ... 2^9– H_HKRQ_COVER_STEP
2^2 – H_HKRQ_COVER_STATUS (1=Enable)
2^1 – H_HKRQ_COVER_WAVE (1=One Wave)
2^0 – H_HKRQ_COVER_DIR (1/0=OPEN/LOSE)

(3) 0 = H_PEM_OBERVATION_8ORDERS
1 = H_PEM_OBERVATION_FULL_MATRIX
2 = H_PEM_SIMULATION_8ORDERS
3 = H_PEM_SIMULATION_FULL_MATRIX

(4) H_INT = H_HKRQ_INT_NUM2 * 1024 + H_HKRQ_INT_NUM1

(5) 2^5 – H_HKMS_ANNEALING_LIMIT_FLAG **(6)**
2^4 – H_HK_FPGA_HES_2_H (cover open=0)
2^3 – H_HK_FPGA_HES_1_H (cover closed=0)
2^2 – H_HKMS_SHUTTER_OPEN **(7)**
2^1 – H_HKMS_SHUTTER_CLOSED **(8)**
2^0 – H_HKMS_ADC_LATCHUP

(6) ANNEAL_LIMIT active = 0
(7) OPEN=0 (not OPEN=1)
(8) CLOSE=0 (not CLOSED=1)

HTM__H_HK_Report.doc, 03.07.2002

HTM_PEM_HK_Report (T3, ST25, SID6)

1	PACKET	0	0	0	0	1	0	1	1	0	1	0	1	1	1	0	0	PACKET ID (APID **53**, 12)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	L	L	L	L	L	L	L	L	L	L	PACKET LENGTH = 19...1017 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_{0}
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_{0}$
7	HEADER	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	TYPE (**20**)
8		0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	SUB-TYPE (**13**) * + PAD
9		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A = Acquisition ID (see below)
10		N	N	N	N	N	N	N	N	S	S	S	S	S	S	S	S	N=Nr of SS/slice; S=ser.Nr of SS (see below)
11		D	D	D	M	M	M	M	M	P	P	P	P	P	P	P	P	DDD, MMMMM, PPPPPPPP (see below)
12	SOURCE	Q	T	H	K	K	K	Z	Z	C	C	C	C	C	C	C	C	Q,T,H,K, Z, C (see below)
13	DATA	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	Science Data word 1
		W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	Science Data word 2
...		W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	Science Data word ...
...		W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	Science Data word ...
n-1		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
n	n=13...512	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	Science Data word X

* SUB-TYPE	Sub-type=13: HS link report, or =3: RTU report
AAA... AAA →	Serial number of Slices or number of spectrels / H-PEM acquisitions = 1...65535
NNNNNNNN →	Total number of Subslices/Slice = 0 (if H_SPECTRUM); = 12 or 24 (if Sub-slice)
SSSSSSSS →	Serial number of Subslices within a Slice = 0 (if H_SPECTRUM); = 1...24 (if Sub-slice)
DDD →	Total number of Subslices in spatial direction = 1 (if H_SPECTRUM); = 1 or 4 (if Sub-slice)
MMMMM →	Total number of TM packets/Subslice = 1...19 (depends on compression factor) Total number of TM packets/Spectrum = 7
PPPPPPPP →	Serial number of TM packets within a Subslice or Spectrum = 1...19
Q →	Last word in TM packet is a dummy word = 1, ... is a real science word = 0
T →	Spectrum Type; for –H always = 0
H →	Shutter State; Closed = 1, Open = 0
KKK →	Compression mode; 0 = NO_COMPRESSION, 1 = LOSSLESS_COMPRESSION, 2 = H_WAVELET_F1_COMPRESSION, 3 = WAVELET_F2_COMPRESSION, 4 = H_WAVELET_F3_COMPRESSION (if H_SPECTRUM then always NO_COMPRESSION)
ZZ →	0 = no average/no summing; 1 = average/no summing; 2 = no average/summing; 3 = average/summing
CCCCCCCC →	Image Type; 0 = H_IMAGE_SLICE (12 sub-slices which composes a 432x256 slice) 1 = H_SPECTRA_SLICE (24 sub-slices which composes a 432 x 8 x 64 spectra slice) 2 = H_SPECTRUM (3456 words) 255 = ME/H-IFE test pattern (12 sub-slices)

HTM__Science_Report.doc, 22.07.2001

HTM_Science_Report (HS_Link or RTU_Link) (APID53/12, T20, ST13 or 3)

Note for sending science TM packets by HS link:

Each TM packet has a supplementary header of 32bit containing 0x1C000000 (MSB=0x1C). That means one science TM packet (for –M or –H) contains 498words (i.e. real science data without header) and not 500words as sending science TM packets by SDT interface.

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	PACKET LENGTH = 27 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9		**1**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	Event ID nr: **47903**
10	512µs ... **1,0** ... 268 sec *	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	H_INT_SCIENCE_NUM1 (LSW) resol.= 512µs *
11		0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_INT_SCIENCE_NUM2 (MSW)
12	**0**...65535	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	H_SPARE
13	**0**...1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	S	H_SUM (No=0, Yes=1)
14	**1**...2047	0	0	0	0	0	F	F	F	F	F	F	F	F	F	F	F	H_N_FRAME (Nr of frames if H_SUM=No)
15	1...**10**...255	0	0	0	0	0	0	0	0	F	F	F	F	F	F	F	F	H_N_SUM_FRAME (# of frames summed)
16	1...**10**...255	0	0	0	0	0	0	0	0	F	F	F	F	F	F	F	F	H_DARK_RATE (dark each X frames)
17	0 ... **1** ... 4	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	H_COMP_MODE (0 ... 4) **

* Example: 1,0sec = **1953** bit → MSW = 00000000-**00000001**, LSW = 000000-**1110100001**
** H_COMP_MODE:
0 = H_NO_COMPRESSION
1 = H_LOSSLESS_COMPRESSION
2 = H_WAVELET_F1_COMPRESSION
3 = H_WAVELET_F2_COMPRESSION
4 = H_WAVELET_F3_COMPRESSION

HTM__Dump_Operational_Parameter.doc, 03.07.2001

HTM_Dump_Operational_Parameter (T5, ST1, EID 47903)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	PACKET LENGTH = 13 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9		**1**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**1**	Event ID nr: **47901**
10		0	0	0	0	0	0	0	0	0	0	0	0	M	M	M	M	H_DATA_PRODUCTION_MODE (0...9)

MMMM →
0 = H_DATA_NOMINAL_OBSERVATION (Default)
1 = N/A, Deleted
2 = H_DATA_CALIBRATION
3 = H_DATA_NOMINAL_SIMULATION
4 = N/A, Deleted
5 = N/A, Deleted
6 = N/A, Deleted
7 = H_DATA_SPECTRAL_CALIBRATION_SIMULATION
8 = H_DATA_SCIENCE_BACKUP
9 = H_DATA_TEST

Note: The following data are sent as TM image types to the S/C if a H_DATA_PRODUCTION_MODE is commanded
if H_DATA_PRODUCTION_MODE =0, 3 – TM data are H_SPECTRA_SLICEs and H_SPECTRUMs
if H_DATA_PRODUCTION_MODE =2 – TM data are 7 x H_IMAGE_SLICE + 2 x H_SPECTRUM
if H_DATA_PRODUCTION_MODE =7,8,9 – TM data are H_IMAGE_SLICEs

HTM__Dump_Data_Product_Parameter.doc, 18.07.2001

HTM_Dump_Data_Product_Parameter (T5, ST1, EID 47901)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)	
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL	
3		0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	PACKET LENGTH = 61 octets	
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} \ldots Sec_{16}$	
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} \ldots Sec_{0}$	
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} \ldots Frac_{0}$	
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**	
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD	
9		**1**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	Event ID nr: **47902**	
10	512µs ... **0,5** ... 134,218 sec **	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	H_INT_SPECT_T_NUM1 (LSW)	resol.= 512µs **
11		0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_INT_SPECT_T_NUM2 (MSW)	
12	512µs ... **6,14ms** ... 134,218 sec **	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	H_INT_SPECT_S_NUM1 (LSW)	resol.= 512µs **
13		0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_INT_SPECT_S_NUM2 (MSW)	
14	512µs ... **0,5** ... 134,218 sec **	0	0	0	0	0	0	t	t	t	t	t	t	t	t	t	t	H_INT_RAD_NUM1 (LSW)	resol.= 512µs **
15		0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_INT_RAD_NUM2 (MSW)	
16	0...**2,7**...3,722V	0	0	0	0	0	0	0	0	V	V	V	V	V	V	V	V	H_V_BIAS (14,594mV/bit); 2,7V=185bit	
17	0...**12,3**...25mA	0	0	0	0	0	0	0	0	I	I	I	I	I	I	I	I	H_I_LAMP_SPEC_T (0,90588mA/bit)	
18	0...**12,3**...25mA	0	0	0	0	0	0	0	0	I	I	I	I	I	I	I	I	H_I_LAMP_SPEC_S (0,90588mA/bit)	
19	0...**12,3**...25mA	0	0	0	0	0	0	0	0	I	I	I	I	I	I	I	I	H_I_LAMP_RADIO (0,90588mA/bit)	
20	0...**55**..128,2mA	0	0	0	0	0	0	0	0	I	I	I	I	I	I	I	I	H_I_SHUTTER (0.5027mA/bit)	
21	10..**630**..2000ms	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_STAB_LAMP_TIME (10ms/bit)	
22	1...**10**...127s	0	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	H_STAB_DET_TIME (1sec/bit)	
23	2...**20**...30ms	0	0	0	0	0	0	0	0	0	0	0	0	t	t	t	t	H_SHUTTER_TIME (2msec/bit)	
24	1...**60**...255	0	0	0	0	0	0	0	0	S	S	S	S	S	S	S	S	H_OPEN_COVER_STEP (1step/bit)	
25	**0**...65535	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	H_SPARE	
26	1...**120**...255	0	0	0	0	0	0	0	0	S	S	S	S	S	S	S	S	H_CLOSE_COVER_STEP (1step/bit)	
27	1...**16**...255	0	0	0	0	0	0	0	0	S	S	S	S	S	S	S	S	H_INIT_COVER_STEP (1step/bit)	
28	1...**30**...255min	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_ECA_ACT (1 min/bit)	
29	1...**10**...255s	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_ANNEAL_CHECK_PERIOD (1sec/bit)	
30	293..**333**..353K	0	0	0	0	0	0	0	T	T	T	T	T	T	T	T	T	H_ANNEAL_TEMP (1K/bit)	
31	1...**30**...255min	0	0	0	0	0	0	0	0	t	t	t	t	t	t	t	t	H_ANNEAL_TIME (1min/bit)	
32	0...**2**...6pixel	0	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	H_XWIN (pixel, X coordinate)	
33	0...**10**...14pixel	0	0	0	0	0	0	0	0	0	0	0	0	C	C	C	C	H_YWIN (pixel, Y coordinate)	
34	**0**...1023	0	0	0	0	0	0	D	D	D	D	D	D	D	D	D	D	H_TEST_INIT (1. H-PEM pattern value)	

e.g. **7** = Default value

** Example: 1,0sec = **1953** bit → MSW = 00000000-**00000001**, LSW = 000000-**1110100001**

HTM__Dump_Functional_Parameter.doc, 27.09.2004

HTM_Dump_Functional_Parameter (T5, ST1, EID 47902)

1	PACKET	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	HEADER	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	1	PACKET LENGTH = 107 octets
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_{0}
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9		**1**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	Event ID nr: **47904**
10	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C11* (**0X423DFF7C**)
11	**47.4995**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
12	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C12* (**0X3DFF7271**)
13	**0.124730**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
14	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C13* (**0X38CF6C3C**)
15	**9.89069e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
16	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C21* (**0X42C6C5A1**)
17	**99.3860**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
18	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C22* (**0X3DC99FD6**)
19	**0.0984494**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
20	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C23* (**0X389498AF**)
21	**7.08563e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
22	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C31* (**0X43062B02**)
23	**134.168**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
24	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C32* (**0X3DA7414A**)
25	**0.0816675**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
26	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C33* (**0X384E4AEA**)
27	**4.91840e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
28	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C41* (**0X431F2F9D**)
29	**159.186**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
30	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C42* (**0X3D886FDB**)
31	**0.0666196**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
32	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C43* (**0X382BB899**)
33	**4.09415e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
34	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C51* (**0X4331570A**)
35	**177.340**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
36	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C52* (**0X3D6A0323**)
37	**0.0571319**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
38	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C53* (**0X37E2BBB0**)
39	**2.70287e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
40	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C61* (**0X433E77CE**)
41	**190.468**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
42	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C62* (**0X3D66C530**)
43	**0.0563404**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
44	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C63* (**0X36B0BDD9**)
45	**5.26731e-006**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
46	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C71* (**0X43493333**)
47	**201.200**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
48	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C72* (**0X3D3EA42F**)
49	**0.0465433**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
50	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C73* (**0X37334F52**)
51	**1.06877e-005**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
52	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C81* (**0X43515062**)
53	**209.314**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
54	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C82* (**0X3D44DEA6**)
55	**0.0480639**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
56	$10^{-45}...10^{+38}$	S	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	H_PIX_MAP_C83* (**0XB7125D35**)
57	**-8.72398e-006**	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	

* Real format (32bit) **S**ign=1bit, **E**xponent=8bit, 23bit=**F**raction (ANSI/IEEE Std 754-1985, see AD(5))

e.g.: **203.46156** → S=0, E=134 (127+7), F=(203.46156-2^7)/2^7=0.58954)

→ 0 10000110 10010110111011000101000 → **0X434B7628**

HTM__Dump_Pixel_Map_Parameter.doc, 27.09.2004

HTM_Dump_Pixel_Map_Parameter (T5, ST1, EID 47904)

1		0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51,7)
2	PACKET	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3	HEADER	0	0	0	0	0	0	0	1	0	0	1	1	1	0	1	1	PACKET LENGTH = 315
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_{0}
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9		1	0	1	1	1	0	0	1	1	0	0	0	1	1	1	0	Event ID nr: **47502**
10	SOURCE	0	1	0	1	0	0	1	1	0	0	1	0	1	1	1	1	S/W version string 1."S" + 2. "/" (1.EXE)
11	DATA	0	1	0	1	0	1	1	1	0	0	1	0	0	0	0	0	S/W version string 3."W" + 4." "
12		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	S/W version string 5."V" + 6. ...
13		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	...
14		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	...
15		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
16		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
17		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
18		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
19		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
20		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
21		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
22		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
23		V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
24		V	V	V	V	V	V	V	V	0	0	0	0	0	0	0	0	S/W version string 29.,30. "\0"
...		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	EEPROM Start Address MSW (1. EXE)
		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	EEPROM Start Address LSW
		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	EEPROM End Address MSW
		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	EEPROM End Address LSW (1. EXE)
		0	1	0	1	0	0	1	1	0	0	1	0	1	1	1	1	S/W version string 1."S" + 2. "/" (2.EXE)
...		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
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161		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	EEPROM End Address LSW (8. EXE)

TM__EEPROM_Stat_Report.doc, 13.04.2000

TM_EEPROM_Stat_Report (T5, ST1, EID47502, APID51,7)

1		0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (51, 7)
2	PACKET	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3	HEADER	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	PACKET LENGTH = 65
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec31 ... Sec16
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec15 ... Sec0
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME Frac15 ... Frac0
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9		1	0	1	1	1	0	0	1	1	0	0	0	1	1	0	1	Event ID nr: **47501**
10	APPL.	0	1	0	1	0	0	1	1	0	0	1	0	1	1	1	1	EEPROM S/W Version string “S”, “/”
11	SOURCE	0	1	0	1	0	1	1	1	0	0	1	0	0	0	0	0	EEPROM S/W Version string “W”, “ ”
12	DATA	0	1	0	1	0	1	1	0	x	x	x	x	x	x	x	x	EEPROM S/W Version string “V”, “...”
13		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
14		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
15		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
16		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
17		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
18		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
19		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
20		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
21		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
22		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
23		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
24		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	EEPROM S/W Version string “...”, “...”
25		0	0	1	0	S	S	S	S	S	S	S	S	S	S	S	S	EEPROM_START_ADDRESS MSW
26		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	EEPROM_START_ADDRESS LSW
27		0	0	1	0	E	E	E	E	E	E	E	E	E	E	E	E	EEPROM_END_ADDRESS MSW
28		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	EEPROM_END_ADDRESS LSW
29		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	Enable HK status (SID1) Yes/No
30		0	0	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TM_SEQ_COUNTER_PID51_PCAT1
31		0	0	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TM_SEQ_COUNTER_PID51_PCAT4
32		0	0	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TM_SEQ_COUNTER_PID51_PCAT7
33		0	0	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TM_SEQ_COUNTER_PID51_PCAT9
34		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	F	FAIL_OVER_CAT5 status (Yes/No)
35		0	0	0	0	0	0	0	0	0	0	0	0	0	R	R	R	ME_DPU_RESET_CAUSE (1...5) *
36		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	ME_DPU_RESET_CAUSE_PARAM **

* ME_DPU_RESET_CAUSE due to (occured in a VIRTIS mode except Safe mode, i.e. not supported by PROM software)	** ME_DPU_RESET_CAUSE_PARAM
0 = N/A	N/A
1 = ME/DPU +28V (+5V) Power OFF/ON	N/A; 0x0000
2 = VIRTUOSO dead lock or Test Display reset	N/A; 0x0000
3 = VTC_Enter_Safe_Mode given within a mode	Active VIRTIS Mode when VTC_Enter_Safe_Mode was commanded
4 = Event generated in a mode	Event ID which caused the reset (i.e. Event CAT V/*)
5 = Watch-dog activated in a mode	1=TC/MLC acquisition process is blocked; 2=TM/SDT transfer process is blocked; 3=Both, MLC and SDT are blocked
6...65535 = N/A	N/A

TM__Secondary_Boot_Completed, 22.04.2000

TM_Secondary_Boot_Completed (T5, ST1, EID47501, APID51,7)

1	PACKET HEADER	0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2		1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3		0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	1	PACKET LENGTH = 1017
4	DATA FIELD HEADER	C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_{0}
6		F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_{0}$
7		0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**Sub-type (1)** + PAD
9	APPL. DATA	1	0	1	1	1	0	1	1	0	0	1	0	0	1	1	0	Event ID nr: 47910
10		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	DEAD_PIX_NUM (1)
11		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	DEAD_PIX_X_POS1 (2)
12		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	DEAD_PIX_Y_POS1 (2)
13		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	DEAD_PIX_SPEC_POS1 (2)
14		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	DEAD_PIX_X_POS2
15		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	DEAD_PIX_Y_POS2
16		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	DEAD_PIX_SPEC_POS2
17		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	...
509		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	DEAD_PIX_X_POSn
510		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	DEAD_PIX_Y_POSn
511		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	DEAD_PIX_SPEC_POSn
512		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SPARE

TM_H_PIX_MAP_CHECK_SUCCESS (T5, ST1, EID47910, APID51,7)

(1) DEAD_PIX_NUM is the total number of dead pixels detected within the spectrum
(2) For each detected dead pixel within a spectrum the following parameters are located in the event TM packet:
- Position within the –H image sent to the S/C in H_Science_Backup mode (432 x 256 pixels),
  DEAD_PIX_X_POS (0…431, 16bit – nominal),
  DEAD_PIX_Y_POS (0…255, 16bit – nominal)
- Position within the averaged –H spectrum (1 x 3456 spectals)
  DEAD_PIX_SPEC_POS (0…3455, 16bit)

Note: for calculating of DEAD_PIX_X_POS, DEAD_PIX_Y_POS and DEAD_PIX_SPEC_POS the functional parameter H_XWIN and H_YWIN are used
DEAD_PIX_X_POS and DEAD_PIX_Y_POS can have negative values or a maximum value of 438 depends on the parameter H_XWIN and H_YWIN

Note: the dead pixel map shown in Appendix 16 corresponds to the event packet content:
DEAD_PIX_NUM=5

DEAD_PIX_X_POS1=167;	DEAD_PIX_Y_POS1=107;	DEAD_PIX_SPEC_POS1=599
DEAD_PIX_X_POS2=215;	DEAD_PIX_Y_POS2=146;	DEAD_PIX_SPEC_POS2=1079
DEAD_PIX_X_POS3=137;	DEAD_PIX_Y_POS3=210;	DEAD_PIX_SPEC_POS3=3261
DEAD_PIX_X_POS4=293;	DEAD_PIX_Y_POS4=211;	DEAD_PIX_SPEC_POS4=3317
DEAD_PIX_X_POS5=408;	DEAD_PIX_Y_POS5=182;	DEAD_PIX_SPEC_POS5=1704

1		0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	PACKET	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3	HEADER	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	PACKET LENGTH = 19
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{31} ... Sec_{16}
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME Sec_{15} ... Sec_0
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15}$ ... $Frac_0$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**Sub-type (4)** + PAD
9		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	Event ID nr: 47501 ... 48000
10	APPL.	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter 1
11	SOURCE	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter 2
12	DATA	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter 3
13		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter 4

TM__OnBoard_Action_Event_Report, 06.11.1999

TM_OnBoard_Action_Event_Report (T5, ST4, APID51,7)

Examples for event parameter

9		1	0	1	1	1	0	0	1	1	1	1	1	0	X	X	X	Event ID nr: **47601 or 47607**
10	APPL.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Empty (no) parameter
11	SOURCE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Empty (no) parameter
12	DATA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Empty (no) parameter
13		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Empty (no) parameter

47601 / EVENT_ME_MLC_FIFO_FULL -- On-Board Action Event Application Data
47607 / EVENT_SW_612_EEPROM_END_SEG_FAILED -- On-Board Action Event Application Data

9		1	0	1	1	1	0	0	1	1	1	1	1	0	0	1	0	Event ID nr: **47602**
10	APPL.	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	MSW: old SCET before update
11	SOURCE	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	
12	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	LSW: old SCET before update
13		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

47602 / EVENT_ME_SCET_WRONG -- On-Board Action Event Application Data

9		1	0	1	1	1	0	0	1	1	1	1	1	0	0	1	1	Event ID nr: **47603**
10	APPL.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	PS command issued
11	SOURCE	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	PS status received
12	DATA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Empty (no) parameter
13		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Empty (no) parameter

47603 / EVENT_ME_PS_DAT_ID_WRONG -- On-Board Action Event Application Data

The TM event reports are shown above are examples. The complete list of events are shown in Appendix, "Table A10-2: List of Events", page 159...191

1		0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	PACKET	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3	HEADER	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	PACKET LENGTH = 19
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**Sub-type (2)** + PAD
9		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	Event ID nr: 47501 ... 48000
10	APPL.	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter (0...64bit, depends on event)
11	SOURCE	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	
12	DATA	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	
13		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	

TM__Anomaly_Warning_Event_Report, 06.11.1999

TM_Anomaly_Warning_Event_Report (T5, ST2, APID51,7)

1		0	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	PACKET ID (APID 51, 7)
2	PACKET	1	1	K	K	K	K	K	K	K	K	K	K	K	K	K	K	PACKET SEQUENCE CONTROL
3	HEADER	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	PACKET LENGTH = 19
4		C	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{31} ... Sec_{16}$
5	DATA	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	TIME $Sec_{15} ... Sec_{0}$
6	FIELD	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	TIME $Frac_{15} ... Frac_{0}$
7	HEADER	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	**Type (5)**
8		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	**Sub-type (3)** + PAD
9		E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	Event ID nr: 47501 ... 48000
10	APPL.	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter 1
11	SOURCE	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter 2
12	DATA	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter 3
13		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Parameter 4

TM__Ground_Action_Event_Report, 06.11.1999

TM_Ground_Action_Event_Report (T5, ST3, APID51,7)

Appendix 5: Display views issued by PROM and EEPROM software

```
1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
**  VIRTIS PROM S/W V2.0-1/DLR,07/2001 **
Mode:Safe           TC count:000000000
Error ID:0          Last TC :T000/S000
SCET:0000000005sec  TM count:000000000
```

1. Start display after VIRTIS power-on (display only in Safe mode)

```
1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
***  VIRTIS PROM S/W V4.01/DSS,2/1999 ***
Mode:Development    TC count:--
Error ID:--         Last TC :--
SCET:2147483659sec  TM count:--
```

2. Start display after VIRTIS power-on (display only in Development mode)

```
1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
**  VIRTIS EEPROM S/W V2.1/DLR,02/2004 **
Mode:ME_IDLE        TC count:000000002
Error ID:0          Last TC :T021/S000
SCET:0000000032sec  TM count:000000006
```

3. Start display after entering the ME Idle mode (display in each mode – except in Safe mode)

```
1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
*********  VIRTIS ME H/W Status **********
DHSU voltage:5.0V   PS temp:+037°C
DHSU current:1.0A   DPU temp:+028°C
EEPROM power:OFF    HRD count:0
```

4. Display of ME H/W status in each mode and after pushing the test switch on test display

```
1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
******** VIRTIS M/H power status *******
V-M power:     OFF  V-H power:     OFF
M-IFE power:   OFF  H-IFE power:   OFF
M-COOL power:  OFF  H-COOL power:  OFF
```

5. Display of M/H status in each mode (except Safe mode) after pushing of test switch on test display

Figure: Test Display **Views** `Test_Display_View.doc, G.P. 15.01.2004`

Appendix 6: MTC acceptance against M-Mode

Nr (1)	High level MTC acceptance in M-MODE	Number of High level –M related TCs (see TC list →) 01.	02.	03.	04.	05.	06.	07.	08.	09.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
1	M_OFF	X	-	X	-	-	X	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X
2	M_COOL_DOWN	X	-	X	X	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X
3	M_IDLE	X	X	-	X	X	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	X	X
4	M_ANNEALING	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	M_PEM_ON	X	X	-	-	X	-	X	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	X	X
6	M_TEST	-	-	-	X	X	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7	M_CALIBRATION	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
8	M_SCIENCE_ HIGH_SPECTRAL_1	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
9	M_SCIENCE_ HIGH_SPECTRAL_2	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
10	M_SCIENCE_ HIGH_SPECTRAL_3	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
11	M_SCIENCE_ HIGH_SPATIAL_1	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
12	M_SCIENCE_ HIGH_SPATIAL_2	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
13	M_SCIENCE_ HIGH_SPATIAL_3	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
14	M_SCIENCE_NOMINAL_1	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
15	M_SCIENCE_NOMINAL_2	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
16	M_SCIENCE_NOMINAL_3	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
17	M_SCIENCE_ NOMINAL_COMPRESSED	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
18	M_SCIENCE_ REDUCED_SLIT	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
19	M_USER_DEFINED	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
20	M_DEGRADED	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
63	M_ME_TEST	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-

01. MTC_PEM(ON, OFF)
02. MTC_PEM(Reset)
03. MTC_Cooler (ON, Stand-by)
04. MTC_Cooler (OFF)
05. MTC_Cover
06. MTC_ECA
07. MTC_Annealing(Start)
08. MTC_Annealing(Stop)
09. MTC_PEM_Command_Word
10. TC_Enable_Science_HS_Link (M)
11. TC_Enable_Science_RTU_Link (M)
12. TC_Disable_Science_HS_Link (M)
13. TC_Disable_Science_RTU_Link (M)
14. MTC_Default_Configuration
15. MTC_Change_Data_Product_ Param_RAM
16. MTC_Change_Func_Param_RAM
17. MTC_Change_Operat_Param_RAM
18. MTC_Change_Calibration_Param_ RAM
19. MTC_Change_Altern_Param_RAM
20. MTC_Change_Data_Product_ Param_RAM_EEPROM
21. MTC_Change_Func_Param_ RAM_EEPROM
22. MTC_Change_Operat_Param_ RAM_EEPROM
23. MTC_Change_Calibration_ Param_RAM_EEPROM
24. MTC_Change_Altern_Param_ RAM_EEPROM

Note:
VTC_...'s which have influence on both –M and –H modes are accepted separately

(1) Mode Nr located in Default HK TM "X" means, the TC is accepted, "-" means TC is not accepted

Table A6-1: TC acceptance of –M related TCs against M-Mode

M_Mode_TC_Accept.doc, 16.05.2002

Appendix 7: M-Mode build according ME internal -M status and TC commanding

M-MODE		M_IFE_ MODE	M_COOLER_MODE (commanded by TC)	M_PEM_VIS_MODE M_PEM_IR_MODE	M_DATA_PRODUCT_ PARAM (MODE) (commanded by TC)	M_ACQ_MODE (commanded by TC)	M_COMP_MODE, M_ERT (commanded by TC)
1	M_OFF	M_IFE_OFF|| M_IFE_ON	M_COOLER_OFF	M_PEM_VIS_OFF && M_PEM_IR_OFF	M_DATA_NO	-	-
2	M_COOL_DOWN	M_IFE_ON	M_COOLER_STAND_BY || M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_OFF **&&** M_PEM_IR_OFF	M_DATA_NO	-	-
3	M_IDLE	M_IFE_ON	M_COOLER_STAND_BY || M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON **||** M_PEM_IR_IDLE	M_DATA_NO	-	-
4	M_ANNEALING	M_IFE_ON	M_COOLER_OFF	M_PEM_IR_ANNEALING	M_DATA_NO	-	-
5	M_PEM_ON	M_IFE_ON	M_COOLER_OFF	M_PEM_VIS_ON **&&** M_PEM_IR_ON	M_DATA_NO	-	-
6	M_TEST	M_IFE_ON	M_COOLER_ANY_MODE	M_PEM_VIS_ON || M_PEM_IR_ON	M_DATA_TEST	-	-
7	M_CALIBRATION	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_CALIBRATION	M_ACQ_MODE_ ALL_PIX_FULL_WIN	M_NO_COMPRESSION
8	M_SCIENCE_ HIGH_SPECTRAL_1	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE	M_ACQ_MODE_HIGH_ SPECTRAL_1X4_FULL_WIN	M_LOSSLESS_COMPRESSION && M_ERT = 0 (5sec)
9	M_SCIENCE_ HIGH_SPECTRAL_2	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE	M_ACQ_MODE_HIGH_ SPECTRAL_1X4_FULL_WIN	M_LOSSLESS_COMPRESSION && M_ERT = 1 (20sec)
10	M_SCIENCE_ HIGH_SPECTRAL_3	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE	M_ACQ_MODE_HIGH_ SPECTRAL_1X4_FULL_WIN	M_LOSSLESS_COMPRESSION && M_ERT = 2 (60sec)
11	M_SCIENCE_ HIGH_SPATIAL_1	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE	M_ACQ_MODE_HIGH_ SPATIAL_3X1_FULL_WIN	M_LOSSLESS_COMPRESSION && M_ERT = 0 (5sec)
12	M_SCIENCE_ HIGH_SPATIAL_2	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE	M_ACQ_MODE_HIGH_ SPATIAL_3X1_FULL_WIN	M_LOSSLESS_COMPRESSION && M_ERT = 1 (20sec)
13	M_SCIENCE_ HIGH_SPATIAL_3	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE	M_ACQ_MODE_HIGH_ SPATIAL_3X1_FULL_WIN	M_LOSSLESS_COMPRESSION && M_ERT = 2 (60sec)
14	M_SCIENCE_ NOMINAL_1	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE	M_ACQ_MODE_NOMINAL_3X4_FULL_WIN || M_ACQ_MODE_VIS_ONLY_1X4 || M_ACQ_MODE_IR_ONLY_1X4 || M_ACQ_MODE_ALTER_IR_ONLY_1X4	M_LOSSLESS_COMPRESSION && M_ERT = 0 (5sec)
15	M_SCIENCE_ NOMINAL_2	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE		M_LOSSLESS_COMPRESSION && M_ERT = 1 (20sec)
16	M_SCIENCE_ NOMINAL_3	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE		M_LOSSLESS_COMPRESSION && M_ERT = 2 (60sec)
17	M_SCIENCE_ NOMINAL_COMPRESSED	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE	M_ACQ_MODE_ NOMINAL_3X4_FULL_WIN	M_WAVELET_F1_COMPRESSION || M_WAVELET_F2_COMPRESSION || M_WAVELET_F3_COMPRESSION
18	M_SCIENCE_ REDUCED_SLIT	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE	M_ACQ_MODE_ REDUCED_SLIT_3X1	M_LOSSLESS_COMPRESSION
19	M_USER_DEFINED	M_IFE_ON	Any other combinations except these which are applicable for mode 1...18 and 63				
20	M_DEGRADED	M_IFE_ON	M_COOLER_OPEN_LOOP || M_COOLER_CLOSED_LOOP	M_PEM_VIS_ON || M_PEM_IR_FULL_WINDOW	M_DATA_SCIENCE	-	-M data transfer via RTU link is active by TC_ENABLE_SCIENCE_RTU(M)
63	M_ME_TEST	M_IFE_ DIAGNOSE	M_COOLER_ANY_MODE	M_PEM_ANY_MODE	M_DATA_IFE_TEST_ PATTERN	-	-

Table A7-1: M-Mode build according M-IFE, M-Cooler, M-PEM and M-Parameter

M_Mode_Build.doc, 16.05.2002

Appendix 8: M-Mode TM data format and TM data rates

	M-MODE	M-Science TM Data Format (1)	Max. M-Science TM Data Rate (2)	M-HK TM format	Max. M-HK TM Data Rate (3)	Remark
1	M_OFF	N/A	N/A	N/A	N/A	No science data transfer to S/C
2	M_COOL_DOWN	N/A	N/A	MTM_ME_General_HK = 16words/10s	53bit/s	
3	M_IDLE	N/A	N/A	(MTM_PEM_IR_HK + MTM_PEM_VIS_HK) / 10s + MTM_ME_General_HK / 10s = (29+34)words/10s + 16words/10s	151bit/s	
4	M_ANNEALING	N/A	N/A			
5	M_PEM_ON	N/A	N/A			
6	M_TEST	depends on –M operational parameter (max. 1 VIS + 1 IR Slice every M_ERT=5s, 20s, 60s or 300s not compressed, i.e. 12 VIS + 12 IR SSLs, 456 TM packets)	0,03 ... 730KBit/s	(MTM_PEM_IR_HK + MTM_PEM_VIS_HK) / M_ERT + (MTM_PEM_IR_HK + MTM_PEM_VIS_HK) / 10s + MTM_ME_General_HK / 10s = (29+34)words/5s...300s + (29+34)words/10s + 16words/10s	130...328Bit/s	Science data are transferred by HS link to S/C, TC_Enable_Science_HS_Link (-M) is commanded
7	M_CALIBRATION	5 x (7 VIS + 7 IR) Slices only once (i.e. 5 x (84 VIS + 84 IR) SSLs or 15960 TM packets, not compressed)	< 169Kbit/s (131Mbit once within min. 775s)	7 * 5 * (29+34)words/775s + (29+34)words/10s + 16words/10s	172Bit/s	
8	M_SCIENCE_HIGH_SPECTRAL_1	1 VIS + 1 IR Slice every M_ERT=5s (i.e. 3 VIS + 3 IR SSLs or < 60 TM packets depends on lossless compression factor > 2)	< 89Kbit/s	(29+34)words/5s + (29+34)words/10s + 16words/10s	328Bit/s	
9	M_SCIENCE_HIGH_SPECTRAL_2	every M_ERT=20s ...	< 23Kbit/s	(29+34)words/20s + (29+34)words/10s + 16words/10s	177Bit/s	
10	M_SCIENCE_HIGH_SPECTRAL_3	every M_ERT=60s ...	< 8Kbit/s	(29+34)words/60s + (29+34)words/10s + 16words/10s	144Bit/s	
11	M_SCIENCE_HIGH_SPATIAL_1	1 VIS + 1 IR Slice every M_ERT=5s (i.e. 4 VIS + 4 IR SSLs or < 80 TM packets depends on lossless compression factor > 2)	< 118Kbit/s	(29+34)words/5s + (29+34)words/10s + 16words/10s	328Bit/s	
12	M_SCIENCE_HIGH_SPATIAL_2	every M_ERT=20s ...	< 30Kbit/s	(29+34)words/20s + (29+34)words/10s + 16words/10s	177Bit/s	
13	M_SCIENCE_HIGH_SPATIAL_3	every M_ERT=60s ...	< 10Kbit/s	(29+34)words/60s + (29+34)words/10s + 16words/10s	144Bit/s	
14	M_SCIENCE_NOMINAL_1	1 VIS + 1 IR Slice every M_ERT=5s (i.e. 1 VIS + 1 IR SSL or < 20 TM packets depends on lossless compression factor > 2)	< 30Kbit/s	(29+34)words/5s + (29+34)words/10s + 16words/10s	328Bit/s	
15	M_SCIENCE_NOMINAL_2	every M_ERT=20s ...	< 8Kbit/s	(29+34)words/20s + (29+34)words/10s + 16words/10s	177Bit/s	
16	M_SCIENCE_NOMINAL_3	every M_ERT=60s ...	< 3Kbit/s	(29+34)words/60s + (29+34)words/10s + 16words/10s	144Bit/s	
17	M_SCIENCE_NOMINAL_ COMPRESSED	1 VIS + 1 IR Slice every M_ERT=5s, 20s, 60s or 300s (i.e. 1 VIS + 1 IR SSL or 4...6 TM packets depends on lossy compr. factor = 8...16)	3,6 Kbit/s (5s, F1 compr.) ... 0,03Kbit/s (300s, F3 compr.)	(29+34)words/5s...300s + (29+34)words/10s + 16words/10s	130...328Bit/s	
18	M_SCIENCE_REDUCED_SLIT	1 VIS + 1 IR Slice every M_ERT=5s (i.e. 1 VIS + 1 IR SSL or < 20 TM packets depends on lossless compression factor > 2)	30Kbit/s (5s) ... 8Kbit/s (20s) ... 3Kbit/s (60s) 0,5Kbit/s (300s)	(29+34)words/5s...300s + (29+34)words/10s + 16words/10s	130...328Bit/s	
19	M_USER_DEFINED	depends on –M operational parameter (see M_TEST)	0,03 ... 730KBit/s	(29+34)words/5s...300s + (29+34)words/10s + 16words/10s	130...328Bit/s	
20	M_DEGRADED	1 VIS + 1 IR Slice every M_ERT=5s, 20s, 60s, 300s (i.e. 1...12 VIS + 1...12 IR SSLs or < 4...240 TM packets depends on ERT, compr. factor 2...16)	< 30Kbit/s (calculated by S/W, if > 35Kbit/s TC_Enable_Science_ RTU_link is not accepted)	(29+34)words/5s...300s + (29+34)words/10s + 16words/10s	130...328Bit/s	Science data are transferred by RTU link to S/C, TC_Enable_Science_RTU_Link
63	M_ME_TEST	depends on VTC_Enter_Test_Mode parameter	0,03 ... 730KBit/s	(29+34)words/5s...300s	3...202Bit/s	Science data are transferred by HS link to S/C

Table A8-1: M-Mode TM data format and TM data rates

(1) Science data TM packet size = 512 words are enabled
(1) TM SCET is the SCET of the first word acquired from M-PEM

(2) Data rate for summing factor M_SS=1
If M_SS > 1, TM data rate = TM data rate / M_SS

(3) if HK

05.01.2002

Appendix 9: HTC acceptance against H-Mode

Nr (1)	High level HTC acceptance in H-MODE	01.	02.	03.	04.	05.	06.	07.	08.	09.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
1	**H_OFF**	X	-	X	-	-	X	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	-	-
2	**H_COOL_DOWN**	X	-	X	X	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	-	-
3	**H_IDLE**	X	X	-	X	X	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	X	X	X
4	**H_ANNEALING**	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	**H_PEM_ON**	X	X	-	-	X	-	X	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	X	X	X
6	**H_TEST**	-	-	-	X	X	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7	H_CALIBRATION	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
8	H_NOMINAL_ SIMULATION	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
9	H_SCIENCE_ MAXIMUM_DATA_RATE	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
10	H_SCIENCE_ NOMINAL_DATA_RATE	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
11	H_SCIENCE_ MINIMUM_DATA_RATE	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
12	N/A, Deleted	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	H_SCIENCE_BACKUP	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
14	H_USER_DEFINED	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
15	N/A, Deleted	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	N/A, Deleted	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	N/A, Deleted	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	H_SPECTRAL_ CALIBRATION_SIMULATION	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
19	H_DEGRADED	-	-	-	X	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
63	H_ME_TEST	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-

Column heading: Number of High level –H related TCs (see TC list →)

01. HTC_PEM(ON, OFF)
02. HTC_PEM(Reset)
03. HTC_Cooler (ON, Stand-by)
04. HTC_Cooler (OFF)
05. HTC_Cover
06. HTC_ECA
07. HTC_Annealing(Start)
08. HTC_Annealing(Stop)
09. HTC_PEM_Command_Word
10. TC_Enable_Science_HS_Link (H)
11. TC_Enable_Science_RTU_Link (H)
12. TC_Disable_Science_HS_Link (H)
13. TC_Disable_Science_RTU_Link (H)
14. HTC_Default_Configuration
15. HTC_Change_Data_Product_ Param_RAM
16. HTC_Change_Func_Param_RAM
17. HTC_Change_Operat_Param_RAM
18. HTC_Change_Pixel_Map_Param_ RAM
20. HTC_Change_Data_Product_ Param_RAM_EEPROM
21. HTC_Change_Func_Param_ RAM_EEPROM
22. HTC_Change_Operat_Param_ RAM_EEPROM
23. HTC_Change_Pixel_Map_ Param_RAM_EEPROM
24. HTC_Load_Pixel_Map
25. HTC_Check_Pixel_Map

Note:
VTC_...'s which have influence on both –M and –H modes are accepted separately

(1) Mode Nr located in Default HK TM "X" means, the TC is accepted, "-" means TC is not accepted

Table A9-1: TC acceptance of –H related TCs against H-Mode

H_Mode_TC_Accept.doc, 26.07.2001

Appendix 10: H-Mode build according ME internal –H status and TC commanding

	H_MODE (2)	H_IFE_MODE	H_COOLER_MODE (commanded by TC)	H_PEM_MODE	H_DATA_PRODUCT_MODE (commanded by TC)	H_SCIENCE_ DATA_RATE (1)	Science data to RTU_Link
1	H_OFF	H_IFE_OFF|| H_IFE_ON	H_COOLER_OFF	H_PEM_OFF	H_DATA_NO	-	-
2	H_COOL_DOWN	H_IFE_ON	H_COOLER_STAND_BY || H_COOLER_OPEN_LOOP || H_COOLER_CLOSED_LOOP	H_PEM_OFF	H_DATA_NO	-	-
3	H_IDLE	H_IFE_ON	H_COOLER_STAND_BY || H_COOLER_OPEN_LOOP || H_COOLER_CLOSED_LOOP	H_PEM_ON **||** H_PEM_IDLE	H_DATA_NO	-	-
4	H_ANNEALING	H_IFE_ON	H_COOLER_OFF	H_PEM_IR_ANNEALING	H_DATA_NO	-	-
5	H_PEM_ON	H_IFE_ON	H_COOLER_OFF	H_PEM_ON	H_DATA_NO	-	-
6	H_TEST	H_IFE_ON	H_COOLER_ANY_MODE	Not equal H_PEM_OFF	H_DATA_TEST	-	-
7	H_CALIBRATION	H_IFE_ON	H_COOLER_OPEN_LOOP || H_COOLER_CLOSED_LOOP	Not equal H_PEM_OFF	H_DATA_CALIBRATION	H_NO_COMPRESSION	NO
8	H_NOMINAL_SIMULATION	H_IFE_ON	H_COOLER_ANY_MODE	Not equal H_PEM_OFF	H_DATA_NOMINAL_SIMULATION	-	NO
9	H_SCIENCE_ MAXIMUM_DATA_RATE	H_IFE_ON	H_COOLER_OPEN_LOOP || H_COOLER_CLOSED_LOOP	Not equal H_PEM_OFF	H_DATA_NOMINAL_OBSERVATION	28 ... 87KBit/s	NO
10	H_SCIENCE_ NOMINAL_DATA_RATE	H_IFE_ON	H_COOLER_OPEN_LOOP || H_COOLER_CLOSED_LOOP	Not equal H_PEM_OFF	H_DATA_ NOMINAL_OBSERVATION	3.5 ... 27KBit/s	NO
11	H_SCIENCE_ MINIMUM_DATA_RATE	H_IFE_ON	H_COOLER_OPEN_LOOP || H_COOLER_CLOSED_LOOP	Not equal H_PEM_OFF	H_DATA_ NOMINAL_OBSERVATION	< 3.4KBit/s	NO
13	H_SCIENCE_BACKUP	H_IFE_ON	H_COOLER_OPEN_LOOP || H_COOLER_CLOSED_LOOP	Not equal H_PEM_OFF	H_DATA_SCIENCE_BACKUP	-	NO
14	H_USER_DEFINED	H_IFE_ON	Any other combinations except these which are applicable for mode 1...13, 18, 19 and 63				
18	H_SPECTRAL_ CALIBRATION_SIMULATION	H_IFE_ON	H_COOLER_ANY_MODE	H_PEM_SIMULATION_FULL_MATRIX	H_DATA_SPECTRAL_ CALIBRATION_SIMULATION	-	NO
19	H_DEGRADED	H_IFE_ON	H_COOLER_OPEN_LOOP || H_COOLER_CLOSED_LOOP	H_PEM_OBSERVATION_8ORDERS	H_DATA_ NOMINAL_OBSERVATION	-	YES
63	H_ME_TEST	H_IFE_ DIAGNOSE	H_COOLER_ANY_MODE	H_PEM_ANY_MODE	H_DATA_IFE_TEST_PATTERN	-	-

(1) is calculated by software: **H_SCIENCE_DATA_RATE** = (H_NR_PIXEL_PER_ORDER * H_NR_ORDER * 16bit) / (H_**IRT *** H_COMP_FACTOR * H_NR_SUM_FRAME * 1024bit/s)

H_NR_PIXEL_PER_ORDER = 432pixel
H_NR_ORDER = 8pixel
if H_Sum = No
(H_NR_SUM_FRAME = 1
H_NR_FRAME = H_OPERAT_PARAM.H_N_FRAME)

H_IRT = (H_OPERAT_PARAM.H_INT_SCIENCE + H_8ORDERS_READOUT_TIME + H_HK_READ_OUT_TIME + H_IDLE_TIME) * H_NR_FRAME

if H_Sum = Yes
(H_NR_SUM_FRAME = H_OPERAT_PARAM.H_N_SUM_FRAME
H_NR_FRAME = 1)

H_8ORDERS_READOUT_TIME = 284,58ms
H_HK_READ_OUT_TIME = 2,304ms
H_IDLE_TIME = 79,872ms

Note: the H_Dark_Rate is not considerred for H_SCIENCE_DATA_RATE calculation by S/W. The H_Dark_Rate is assumed as negligible.

Table A10-1: H-Mode build according H-IFE, H-Cooler, H-PEM and H-Parameter

H_Mode_Build.doc, 16.05.2002

Appendix 11: H-Mode TM data format and TM data rates

	H-MODE	H-Science TM Data Format (1)	Max. H-Science TM Data Rate (2)	H-HK TM format (2)	Max. H-HK TM Data Rate (2)	Remark
1	H_OFF	N/A	N/A	N/A	N/A	No science data transfer to S/C
2	H_COOL_DOWN	N/A	N/A	H_General_HK/10sec = 16words/10s	53bit/s	
3	H_IDLE	N/A	N/A	H_PEM_HK/10sec + H_General_HK/10sec = 47words/10s + 16words/10s	101bit/s	
4	H_ANNEALING	N/A	N/A			
5	H_PEM_ON	N/A	N/A			
6	H_TEST	depends on –H operational parameter, the max. data rate is generated if a Image Slice is produced every 5s, not compressed, (i.e. 1 H_Image_Slice = 12 SSLs = 228 TM packets)	< 354KBit/s (if data rate is greater 354Kbit/s, TC_Enable_Science is not accepted to be commanded)	HTM_PEM_HK/IRT + HTM_PEM_HK/10sec + HTM_ME_General_HK/10sec = 47words/5s (min.IRT) + 47words/10s +16words/10s	< 252Bit/s	5000ms is the shortest allowed H_IRT in data production mode H_TEST
7	H_CALIBRATION (via HS link)	A data set is generated only <u>once</u> (within ca. 274 sec) with 7 H_Image_Slice's + 2 H_Spectra (i.e. 7 x 12 SSLs + 2 Spectra = 7 x 12 x 19 + 2 x 7 TM packets = 1610 TM packets, <u>not</u> compressed)	< 45,6 kbit/sec (12497Kbit / 274 sec)	7 x HTM_PEM_HK + 2 x HTM_PEM_HK + HTM_PEM_HK/10sec + HTM_ME_General_HK/10sec = 9 x 47words/274sec + 47words/10s +16words/10s within 274 sec	< 125 bit/sec	
	H_CALIBRATION (via RTU link)	A data set is generated only <u>once</u> (within ca. 448 sec) with 7 H_Image_Slice's + 2 H_Spectra (i.e. 7 x 12 SSLs + 2 Spectra = 7 x 12 x 19 + 2 x 7 TM packets = 1610 TM packets, <u>not</u> compressed)	< 29,9 kbit/sec (12497Kbit / 448 sec)	7 x HTM_PEM_HK + 2 x HTM_PEM_HK + HTM_PEM_HK/10sec + HTM_ME_General_HK/10sec = 9 x 47words/448sec + 47words/10s +16words/10s within 448 sec	< 116 bit/sec	
8	H_NOMINAL_SIMULATION	depends on –H operational parameter, the max. data rate is generated every 64 x 700ms a H_Spectra_Slice not compressed, (i.e. 1 H_Spectra_Slice = 24 SSLs = 456 TM packets)	< 83,4 kbit/s (3735552 bit/44,8sec)	47words / 0,7s + 47words/10s +16words/10s	< 1175 bit/sec	700ms is the shortest allowed H_IRT in data production mode H_NOMINAL_OSERVATION
9	H_SCIENCE_MAXIMUM_DATA_RATE	depends on –H operational parameter, the max. data rate is generated every 64 x 700ms a H_Spectra_Slice compressed or not compressed, (i.e. 1 H_Spectra_Slice = 24 SSLs = 456 TM packets) H_Spectrum_Dark are considered as negligible (see H_DATA_RATE calculation in chapter 11.4.2, page 75)	28 ... 87KBit/s	47words / 0,7s + 47words/10s +16words/10s	< 1175 bit/sec	
10	H_SCIENCE_NOMINAL_DATA_RATE		3.5 ... 27KBit/s	(< 1175 bit/sec) / 87/27Kbit/sec	< 365 bit/sec	
11	H_SCIENCE_MINIMUM_DATA_RATE		< 3.4KBit/s	47words/10s +16words/10s	< 101bit/sec	
13	H_SCIENCE_BACKUP	depends on –H operational parameter, the max. data rate is generated if a Image Slice is produced every 5s, not compressed, (i.e. 1 H_Image_Slice = 12 SSLs = 228 TM packets)	< 354KBit/s (if data rate is greater 354Kbit/s, TC_Enable_Science is not accepted to be commanded)	HTM_PEM_HK/IRT + HTM_PEM_HK/10sec + HTM_ME_General_HK/10sec = 47words/5s (min.IRT) + 47words/10s +16words/10s	< 252Bit/s	5000ms is the shortest allowed H_IRT in data production mode H_SCIENCE_BACKUP
14	H_USER_DEFINED	see H_NOMINAL_SIMULATION	< 83,4 kbit/s	47words / 0,7s + 47words/10s +16words/10s	< 1175 bit/sec	
18	H_SPECTRAL_CALIBRATION_SIMULATION	only one H_IMAGE_SLICE (simulated data)	-	-	-	
19	H_DEGRADED	see H_SCIENCE_*_DATA_RATE	< 83,4 kbit/s			Data are transferred by RTU link to S/C,TC_Enable_Science_RTU_Link
63	H_ME_TEST	depends on VTC_Enter_Test_Mode param.	0,03 ... 730KBit/s	(29+34)words/5s...300s	3...202Bit/s	Science data transferred by HS link

Table A11-1: H-Mode TM data format and TM data rates

(1) Science data TM packet size = 512 words
(2) Including TM packet header

M_Mode_Build.doc, 20.05.2002

Appendix 12: List of events/errors

All hardware and software anomalous events are listed in Table 10-2. The events are identified by an name, an event ID (+parameter) and an event category. The event categories (category O ... VIII) determine the needed action (S/W / On-Board / On-Ground action). Table 10-1 lists all categories and there meaning (ref. RD(4), G/SR3-0-75). The categories O, VII, VIII, IX and X are only internally used. The event ID identifies the event. In addition up to four parameter are provided to show the malfunction details (see Table 10-2). The event ID and the parameter will be sent by the TM Event Report. The column 'Issued by' in Table 10-2 shows which software produces the error (E = only EEPROM-S/W, P = only PROM-S/W, B = Both, EEPROM or PROM S/W).

Event Category	Description	ME Software Action	TM Event Report Type (subtype)
O	internal category, no error handling needed	None (only S/W internal operational action)	n/a
I/1	does not prevent to continue with operations, TM Event packet	None (only S/W operational action)	Anomaly Warning (2)
I/2	does not prevent to continue with operations, TM Event packet is sent only once if the event first time occurs	None (only S/W operational action)	Anomaly Warning (2)
II	"Retry" type, recovery can be performed, , TM Event packet	Retry to send command to the H/W which was not properly executed	Anomaly Warning (2)
III	"Reset" type, recovery can be performed, , TM Event packet	Reset H/W unit which shows the malfunction	Anomaly Warning (2)
IV/H	prevents to continue with PEM-H operations, TM Event packet	Switch off (or not switch on) VIRTIS-H	Anomaly Warning (2)
IV/M	prevents to continue with PEM-M operations, TM Event packet	Switch off (or not switch on) VIRTIS-M	Anomaly Warning (2)
V/1	OBDH action required (switch to redundant/degraded mode, On-Board action	Send Event TM packet, Perform Board-Reset (causes entering of Safe Mode)	On-Board Action (4)
V/2	OBDH action required (switch to redundant, On-Board action, TM Event packet)	Send Event TM packet, Perform ME/DPU Board-Reset (causes entering of Safe Mode) after 30 sec delay	On-Board Action (4)
V/3	OBDH action required (switch to redundant/upload code, On-Board action, TM Event packet	Send Event TM packet, Perform ME/DPU Board-Reset (causes entering of Safe Mode) after 30 sec delay	On-Board Action (4)
V/2*	OBDH action required (switch to redundant, On-Board action)	Perform ME/DPU Board-Reset (causes entering of Safe Mode) immediately without any delay	n/a
VI	Ground action required)	Send Event TM packet, Perform ME/DPU Board-Reset (causes entering of Safe Mode)	Ground-Action (3)
VII	internal category, TC receive error handling	Send TC Acceptance Report Failure TM packet	n/a
VIII	internal category, TC verify error handling	Send TC Acceptance Report Failure TM packet	n/a
IX	internal category, Normal Progress Event Reports	Normal Progress Event Reports is sent	Normal Progress (1)
X	internal category, TC Execution Report Failure	Send TC Execution Report Failure TM packet	n/a

Table A12-1: On-Board Software Event Categories

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		General events (47501 ... 47550)			
47501	IX	EVENT_SECONDARY_BOOT_COMPLETE Parameter see TM packet structure, page 148	E	Secondary Boot S/W is successfully started	N/A
47502	IX	EVENT_EEPROM_STAT Parameter see TM packet structure, page 147	P	Status report of EEPROM content	N/A
47503	I/1	EVENT_WRONG_EVENT_CAT Par1: Event ID (event code + wrong event category) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Wrong event category detected, must be in range CAT_O ... CAT_X in Event handler	No action by user possible (S/W re-design /re-coding needed)
47504	I/1	EVENT_SW_53_COMPR_BUFFER_OVERFLOW Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Internal memory usage exceeded (buffer overflow) during compression	No action by user possible (S/W re-design /re-coding needed)
47505	I/1	EVENT_SW_53_COMPR_SIZE_WRONG Par1: XS size value of compression unit (SSL) Par2: YS size value of compression unit (SSL) Par3: empty (0x0000) Par4: empty (0x0000)	E	compression parameter unit size wrong (XS, YS not a multiple of 8)	No action by user possible (S/W re-design /re-coding needed)
47506	I/1	EVENT_SW_53_COMPR_IBR_WRONG Par1: Value compression parameter IBR Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Compression parameter 'ibr' out of range (not in range of 0 ...63)	No action by user possible (S/W re-design /re-coding needed)
47507	I/1	EVENT_SW_53_COMPR_UNKNOWN_ERROR Par1: Returned error code by compression function Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Compression function returns unknown error code, must be in range -1 ... -3	No action by user possible (S/W re-design /re-coding needed)
47508	I/1	EVENT_SW_CALL_NOT_ACTIVE_TASK Par1: Task ID (MSW) Par2: Task ID (LSW) Par3: Task name (MSW) Par4: Task name (LSW)	E	Attempt to call a not active VIRTUOSO task	No action by user possible (S/W re-design /re-coding needed)
47509	I/1	EVENT_ENTER_SAFE_MODE_COMMANDED	E	The TC_Enter_Safe_Mode was	Not nominal commanding should be avoided. Use of

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
				commanded possibly in Science mode which reset the DPU and therefore stops the data acquisition, switches-off the coolers, the PEMs and goes in ME_SAFE mode	TC_Disable_Science_*, XTC_PEM(Off) or XTC_Cooler(Off) is recommended
47510	I/1	EVENT_ENTER_IDLE_MODE_COMMANDED	E	The TC_Enter_Idle_Mode was commanded possibly in Science mode which stops the data acquisition, switches-off the coolers and the PEMs and goes in ME_IDLE mode	Not nominal commanding should be avoided. Use of TC_Disable_Science_*, XTC_PEM(Off) or XTC_Cooler(Off) is recommended
47511	I/1	EVENT_SW_53_COMP_FACTOR_LESS_THAN_1	E	The Compression factor is less than 1, than means the data amount after compression is higher than before compression	This can happen mainly in ME test mode for compression pseudo random test pattern (very strong noise). Change the mode or no compression.
47522	I/1	EVENT_SW_212_NO_TC_PACKET_BLOCK_FREE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Out of high level TC memory pool	Send VTC_Enter_Idle_Mode or VTC_Enter_Safe_Mode for restart or reboot the Secondary Boot S/W (EEPROM-S/W)
47523	I/1	EVENT_SW_212_FIFO_OVERFLOW Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	S/W FIFO overflow	Try last action once more, if failed switch to redundant DPU
47524 ... 47525		FREE			
47526	I/1	EVENT_SW_26_LINK_NOT_ESTABLISHED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	HRD Link is not established	Establish the HRD link by using TC_Reset_And_Start_HS_Link
47527	I/1	EVENT_SW_237_HRD_TM_TRANSFER_TIME_OUT Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	HRD TM packet transfer time out. A TM packet took more than 500ms transfer time via HS link.	There is a bad peak HS link data acquisition performance. Disable Science data transfer, change the VIRTIS mode with lower data rate on the HS link.
47528	I/1	EVENT_SW_26_WRONG_HRD_PACKET_SIZE Par1: Wrong HRD packet size value Par2: empty (0x0000)	E	HRD packet size is wrong	Restart the Science data transfer possibly due to an SEU effect in DPU Data or Programm memory

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par3: empty (0x0000) Par4: empty (0x0000)			
47529		FREE			
47530	VII	EVENT_SW_23_TM_APID_WRONG Par1: Wrong APID value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	TM packet ID is wrong, not a valid APID for Safe Mode (APID 51, PCAT 1,4, 7 or 9)	Restart the Science data transfer possibly due to an SEU effect in DPU Data or Programm memory
47531	V/2	EVENT_SW_233_HK_SID_WRONG Par1: Wrong SID value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	SID of HK TM data block is wrong	No action by user possible (S/W re-design /re-coding needed)
47532	V/2	EVENT_SW_614_RAM_RD_ADDRESS_WRONG Par1: Wrong address MSW Par2: Wrong address LSW Par3: empty (0x0000) Par4: empty (0x0000)	B	RAM Read/Write address is wrong	No action by user possible (S/W re-design /re-coding needed)
47533	V/2	EVENT_SW_614_RAM_RD_BLOCK_SIZE_WRONG Par1: Wrong block size value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	RAM Read/Write block size is wrong	No action by user possible (S/W re-design /re-coding needed)
47534	V/2	EVENT_SW_614_RAM_RD_WR_MODE_WRONG Par1: Wrong RAM read/write mode Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	RAM Read/Write mode is wrong	No action by user possible (S/W re-design /re-coding needed)
47535	V/3	EVENT_SW_612_EEPROM_NO_BOOT_DATA_FOUND Par1: EEPROM address MSW Par2: EEPROM address LSW Par3: empty (0x0000) Par4: empty (0x0000)	P	No secondary boot data found at given address	Check EEPROM address in Enter Idle Mode TC, Send VTC_Get_EEPROM_Status in order to get the right start address of the executable
47536	V/2	EVENT_SW_6_WATCH_MODE_WRONG Par1: Wrong watchdog mode parameter value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	Watchdog mode is wrong, only INIT, TRIGGER or RESET allowed	No action by user possible (S/W re-design /re-coding needed)
47537	V/2	EVENT_SW_6_TIMER_WRONG Par1: Wrong timer name / number	P	Timer number is not valid, must be TIMER_1, TIMER_2 or TIMER_3	No action by user possible (S/W re-design /re-coding needed)

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)			
47538	V/2	EVENT_SW_6_TIMER_MODE_WRONG Par1: Wrong timer mode value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Timer mode is not valid, must be RD or WR	No action by user possible (S/W re-design /re-coding needed)
47539	V/2	EVENT_SW_25_SCET_TIMER_MODE_WRONG Par1: Wrong SCET timer mode value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	Parameter mode (RD/WR) for SCET Timer driver is wrong	No action by user possible (S/W re-design /re-coding needed)
47540	O	EVENT_SW_24_SDT_BUFFER_COMPLETE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	SDT buffer is completed now, ready for transfer	**nothing to do !!**
47541	V/2	EVENT_SW_24_SDT_BLOCK_STATUS_WRONG Par1: Current SDT buffer block size Par2: Current SDT buffer size Par3: empty (0x0000) Par4: empty (0x0000)	B	SDT-Block size is more than maximum block size (6144)	Try last action once more after reboot of the S/W, if failed switch to redundant DPU
47542	III	EVENT_SW_24_SDT_BUFFER_FULL Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	SDT TM packet buffer is full	check that SDT polling is enabled by S/C (SIS or EGSE), Reset DPU (VTC_Enter_Safe_Mode) or TM buffer (TC_Reset_TM_Output_Buffer)
47543	V/2	EVENT_SW_24_NO_SDT_BLOCK_IN_BUFFER Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	Buffer don't contain a complete SDT block for transfer	No action by user possible (S/W re-design /re-coding needed)
47544	V/2	EVENT_SW_613_EEPROM_SWITCH_VAL_WRONG Par1: Wrong EEPROM switch value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Parameter for switching EEPROM is not ON/OFF	No action by user possible (S/W re-design /re-coding needed)
47545	V/2	EVENT_SW_613_EEPROM_RD_WR_MODE_WRONG Par1: Wrong EEPROM read/write mode value	P	Read/Write mode for EEPROM is wrong	No action by user possible (S/W re-design /re-coding needed)

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)			
47546	V/2	EVENT_SW_613_EEPROM_NOT_ENOUGH_SPACE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Not enough space in EEPROM for reading/writing data block	Check EEPROM address and size in Load Memory TC, shall be in range of 0x20000000 ... 0x200fffff
47547	V/2	EVENT_SW_613_EEPROM_ADDRESS_WRONG Par1: Wrong EEPROM address MSW Par2: Wrong EEPROM address LSW Par3: empty (0x0000) Par4: empty (0x0000)	P	Address for writing into EEPROM is wrong	Check EEPROM address in TC_Load_ Memory, shall be in range of 0x20000000 ... 0x200fffff
47548	V/2	EVENT_SW_613_EEPROM_BLOCK_SIZE_IS_ZERO Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Data block size for read/write EEPROM is zero	No action by user possible (S/W re-design /re-coding needed)
47549	O	EVENT_SW_3_4_VIR_DATA_CHANNEL_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Selected VIRTIS data channel is wrong	No action by user possible (S/W re-design /re-coding needed)
47550	V/2	EVENT_SW_0_CRC_BLOCK_SIZE_IS_ZERO Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	Block size for CRC calculation is zero	No action by user possible (S/W re-design /re-coding needed)
		ME Unit Hardware related Events/Errors (47601 ... 47700)			
47601	V/2	EVENT_ME_MLC_FIFO_FULL Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	MLC FIFO overflow, no more TC's can be received and executed	- reduce the TC data rate - reboot of ME
47602	V/2 in Safe mode I/1 in other modes	EVENT_ME_SCET_WRONG Par1: Read SCET timer value MSW Par2: Read SCET timer value MID Par3: Read SCET timer value LSW Par4: empty (0x0000)	B	SCET Timer value has a deviation to the received time (Service 9) more as allowed (+/- 20ms)	Take care for updating the proper consistent SCET by TC

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
47603	V/2	EVENT_ME_PS_DAT_ID_WRONG Par1: Sent PS command Par2: Received PS data word Par3: empty (0x0000) Par4: empty (0x0000)	B	Dat-ID received from power supply is not equal to Cmd-ID	Try last action once more after reboot, if failed switch to redundant DPU
47604	V/2	EVENT_ME_DPU_DM1_WRITE_WRONG Par1: address LSW Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Write error occurred in DPU base data memory	Try last action once more, if failed switch to redundant DPU
47605	V/2*	EVENT_ME_EEPROM_WRITE_WRONG Par1: EEPROM address MSW Par2: EEPROM address LSW Par3: empty (0x0000) Par4: empty (0x0000)	P	Write error EEPROM	Try last action once more after reboot, if failed switch to redundant DPU
47606	V/2*	EVENT_SW_612_EEPROM_START_SEG_WRONG Par1: EEPROM address MSW Par2: EEPROM address LSW Par3: Segment ID MSW Par4: Segment ID LSW	P	No segment header found at EEPROM start address	Send VTC_Get_EEPROM_Status in order to get the current EEPROM status, if failed perform upload of executable into EEPROM once more
47607	V/2*	EVENT_SW_612_BOOT_END_SEG_FAILED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	End segment in EEPROM is missing or wrong	Send VTC_Get_EEPROM_Status in order to get the current EEPROM status, if failed perform upload of executable into EEPROM once more
47608	V/2*	EVENT_SW_612_BOOT_SEG_CRC_WRONG Par1: Boot address MSW Par2: Boot address LSW Par3: CRC read from boot memory (EEPROM/RAM) Par4: CRC calculated	P	Segment checksum error in EEPROM	Perform upload of executable into EEPROM once more in order to overwrite the wrong version
47609	V/2	EVENT_ME_DPU_DM2_WRITE_WRONG Par1: Image RAM address LSW Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Write error occurred in image data memory	Try last action once more after reboot, if failed switch to redundant DPU
47610	V/2	EVENT_ME_PS_NO_RESPONSE Par1: Sent PS command Par2: empty (0x0000) Par3: empty (0x0000)	B	No response from Power Supply after sending a command	Try last action once more after reboot, if failed switch to redundant DPU

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par4: empty (0x0000)			
47611	V/2	EVENT_ME_PS_ADC_DATA_WRONG Par1: Sent PS command Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	ADC data obtained from Power Supply are wrong	Check ADC power status (HK, Test Display) after reboot, if OK, switch to the redundant DPU
47612	I/1	EVENT_ME_SEU_DETECTED Par1: MSW of memory address Par2: LSW of memory address Par3: Memory ID (141, 142, 143, see TC_Upload_Memory) Par4: Failure mode 0=bit is flipped from 1 to 0 1=bit is flipped from 0 to 1	E	a Single Event Upset is detected in ME DPU Image memory RAM, Data Memory RAM or Program Memory RAM The check is done only in “free” (not used) memory areas. The checked memory size is 3kwords, that means less than 1% of the total DPU memory area.	The user should decide (depends on the event frequency) whether a VIRTIS operation is temporary useful or not because the science data could be corrupted or the software could crash due to memory flipping failure.
47613 47628		FREE			
47629	I/1	EVENT_ME_PS_UNKNOWN_ERROR_CODE Par1: Received error code from PS Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	Error code received from Power Supply is unknown	Send VTC_Enter_Safe_Mode for reboot the Secondary Boot S/W (EEPROM-S/W), try the last action once more, if failed switch to the redundant DPU
47630	I/1	EVENT_SC_TC_CONFIRMATION_FAILED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Confirmation of last received TC failed	Send the confirmation TC as very next TC after sending of the TC to be confirmed
47631	I/1	EVENT_SCET_RUNS_UNSYNCHRONIZED Par1: Current SCET time MSW Par2: Current SCET time MID Par3: Current SCET time LSW Par4: empty (0x0000)	P	SCET timer runs unsynchronized, no time update execution is performed (only in Safe mode) but TC is accepted	In order to set SCET timer with synchronized time, send VTC_Enter_Safe_Mode and activate Time Update Service
47632 47647		FREE			
47648	I/1	EVENT_ME_HK_DPU_VOLTAGE_OUT_OF_RANGE Par1: Received DPU voltage value (dig) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Expected DHSU voltage out of range (4.5...5.5V)	Switch to the redundant DPU
47649	I/1	EVENT_ME_HK_PS_TEMP_OUT_OF_RANGE	E	Expected Power Supply temperature out	Switch of VIRTIS-H/M cooler/PEM (VTC_Enter_Idle_Mode),

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1: Received PS temperature value (dig) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)		of range (-30°C...+80°C)	if temperature still out of range, switch to redundant DPU
47650	I/1	EVENT_ME_HK_DPU_TEMP_OUT_OF_RANGE Par1: Received DPU temperature value (dig) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Expected DPU temperature out of range (-30°C...+80°C)	Switch of the ME-Box and switch on again, if error occurs once more, switch to redundant DPU
47651		FREE			
47652	I/1	EVENT_IFE_INVALID_PORT_ADDRESS Par1: Wrong port address MSW Par2: Wrong port address LSW Par3: empty (0x0000) Par4: empty (0x0000)	E	M-IFE port address for commanding PEM's is wrong	No action by user possible (S/W re-design /re-coding needed)
47653	V/2	EVENT_ME_HRD_PARITY_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	HRD channel parity wrong	Re-establish the HRD link by using TC_Reset_And_Start_HS_Link
47654	V/2	EVENT_ME_HRD_DISCONNECT Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	HRD channel disconnection	Re-establish the HRD link by using TC_Reset_And_Start_HS_Link
47655	V/2	EVENT_SC_HS_LINK_COMMANDED_TWICE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	TC_Reset_And_Start_HS_Link was commanded twice which is danger, therefore CATV/2	ME Internally there is a problem of science data consistency if the HS link is tried to be established twice in ME_IDLE mode. The user should never do this otherwise the science data are corrupted. Start the HS link only once which should work normally, otherwise use the other DPU (main or redundant).
47656 47657		FREE			
47658	V/2	EVENT_ME_PS_CMD_VIR_MONITOR_FAIL Par1: Sent PS command Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	PS detected VIRTIS monitor failure	Try commanding once more after reboot, if failed, switch to the redundant DPU
47659	V/2*	EVENT_ME_PS_CMD_VIR_UNDERVOLTAGE	B	PS detected VIRTIS under-voltage error	Try commanding once more after reboot, if failed, switch to

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1: Sent PS command Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)			the redundant DPU
47660	V/2*	EVENT_ME_PS_CMD_VIR_OVERVOLTAGE Par1: Sent PS command Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	PS detected VIRTIS over-voltage error	Try commanding once more after reboot, if failed, switch to the redundant DPU
47661	V/2	EVENT_ME_PS_CMD_EXECUTE_ERROR Par1: Sent PS command Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	PS detected an execution error	Try commanding once more after reboot, if failed, switch to the redundant DPU
47662	V/2	EVENT_ME_PS_CMD_UNKNOWN Par1: Sent PS command Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	PS received an unknown command	Try commanding once more after reboot, if failed, switch to the redundant DPU
47663	V/2	EVENT_ME_PS_CMD_SHADOW_WRONG Par1: Sent PS command Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	PS detected a shadow command error	Try commanding once more after reboot, if failed, switch to the redundant DPU
47664	V/2	EVENT_ME_PS_POW_STAT_WRONG Par1: Sent PS command, see RD(13) Par2: Received PS data word, see RD(13) Par3: empty (0x0000) Par4: empty (0x0000)	B	PS Status after commanding is wrong	Try commanding once more after reboot, if failed, switch to the redundant DPU
47665	V/2	EVENT_ME_PS_ADC_NOT_ON Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	ADC is not on before reading analogous HK	Try HK acquisition once more, if failed, switch to the redundant DPU
47666	O	EVENT_ME_EEPROM_NO_EXE_END_FOUND Par1: EEPROM address MSW Par2: EEPROM address LSW Par3: empty (0x0000) Par4: empty (0x0000)	P	No end segment for executable found in EEPROM	Check EEPROM status by VTC_Get_EEPROM_Status
47667	V/2	EVENT_ME_DPU_BBC_WRITE_WRONG	P	BBC register initialization failed	Try initialization once more after reboot, else switch to

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1: BBC status LSW Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)			redundant DPU
47668	V/2	EVENT_ME_DPU_REG_WRITE_WRONG Par1: Register address LSW Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	DPU register initialization failed	Try initialization once more after reboot, else switch to redundant DPU
47669	V/2	EVENT_ME_WATCHDOG_DISABLED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	Watchdog is disabled, safety function not active !!	Try initialization once more after reboot,else switch to redundant DPU
47670	V/2	EVENT_ME_TIMER_3_NOT_READABLE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	TIMER_3 is write only, mode=RD is not valid for this timer	No action by user possible (S/W re-design /re-coding needed)
47671	V/2* PROM O EEPROM	EVENT_ME_SCET_TIMER_NOT_RUNNING Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	SCET Timer is not running after setting or before reading	Try SCET time update once more after reboot, if failed switch to redundant DPU
47672	O	EVENT_ME_EEPROM_NO_EXE_VERSION_FOUND Par1: EEPROM address MSW Par2: EEPROM address LSW Par3: empty (0x0000) Par4: empty (0x0000)	P	No version number of executable found in EEPROM	The executable in EEPROM was possibly not built correct. As the S/W developer to provide proper executable to be uploaded.
47673	O	EVENT_ME_EEPROM_NO_EXE_FOUND Par1: EEPROM address MSW Par2: EEPROM address LSW Par3: empty (0x0000) Par4: empty (0x0000)	P	No valid executable found in EEPROM	The executable in EEPROM was possibly not built correct. As the S/W developer to provide proper executable to be uploaded.
47674	V/3	EVENT_ME_EEPROM_WRITE_ERROR Par1: EEPROM address MSW Par2: EEPROM address LSW Par3: empty (0x0000) Par4: empty (0x0000)	P	Data written into EEPROM are wrong	Try memory upload once more after reboot, if failed switch to the redundant DPU
47675	V/3	EVENT_ME_EEPROM_NOT_WRITEABLE	P	Writing of data into EEPROM failed	Try last action once more after reboot, if failed switch to

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1: EEPROM address MSW Par2: EEPROM address LSW Par3: empty (0x0000) Par4: empty (0x0000)			redundant DPU
47676 47679		FREE			
47680	I/1	EVENT_NO_VTC_CONFIRM_AFTER_CRITICAL_TC Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	No VTC_Confirm received after a critical TC	Send the critical TC once more with a following VTC_Confirm for this TC
47681	V/3	EVENT_ME_EEPROM_CURRENT_PARAMETER_UPDATE_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Update of current parameter in EEPROM failed	Try last action once more after reboot, if failed switch to redundant DPU
47682	V/2	EVENT_SC_TC_UPLOAD_MEM_ID_WRONG Par1: Wrong memory ID value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Memory ID for upload must be in range of 140 ... 145	Check ‘Memory ID’ in TC_Load_Memory
47683	V/2	EVENT_SC_TC_UPLOAD_FORMAT_WRONG Par1: Wrong number of blocks Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Number of memory blocks to be uploaded must be “1”	Check ‘blocks to be loaded’ in TC_Load_Memory, must be 1
47684	V/2	EVENT_SC_TC_UPLOAD_SIZE_WRONG Par1: Wrong upload size value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Upload memory size is out of range	Check ‘data block length’ in TC_Load_Memory against ‘Memory ID’
47685	V/2	EVENT_SC_TC_UPLOAD_ADDRESS_WRONG Par1: Wrong upload address MSW Par2: Wrong upload address LSW Par3: empty (0x0000) Par4: empty (0x0000)	P	Upload memory address is out of range	Check address in TC_Load_Memory
47686	V/2	EVENT_SC_TC_DUMP_FORMAT_WRONG Par1: Wrong number of blocks	P	Number of memory blocks to be dumped must be one	Check ‘blocks to be loaded’ in TC_Dump_Memory, must be 1

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)			
47687	V/2	EVENT_SC_TC_CHECK_FORMAT_WRONG Par1: Wrong number of blocks Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Number of memory blocks to be checked must be one	Check ‘blocks to be loaded’ in TC_Check_Memory, must be 1
47688	O	EVENT_ME_MLC_FIFO_EMPTY Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	MLC FIFO is empty	N/A
47689	III	EVENT_SC_TC_WRONG_SAFE_MODE_TC Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	TC not allowed in Safe Mode	Check why the TC is not allowed, change the mode by VTC_Enter_Safe_Mode and try it again
47690	O	EVENT_ME_SDT_FIFO_HALF_FULL Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	SDT FIFO is more than half full, transfer to S/C not possible	N/A
47691	V/2*	EVENT_ME_SDT_FIFO_FULL Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	SDT FIFO overflow	No action by user possible (S/W re-design /re-coding needed), SDT-buffer is reset after reboot
47692	V/2	EVENT_ME_PS_EEPROM_NOT_OFF Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Switching off the EEPROM power not successful	Try last action once more after reboot, if failed switch to redundant DPU
47693	V/2	EVENT_ME_PS_EEPROM_NOT_ON Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Switching on the EEPROM power not successful	Try last action once more after reboot, if failed switch to redundant DPU
47694	V/2	EVENT_ME_PS_STAT_WRONG Par1: empty (0x0000)	B	PS_DATA_RDY of DPU extension status is not low	Try last action once more after reboot, if failed switch to redundant DPU

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)			
47695	V/2	EVENT_ME_DPU_NO_BBC_STATUS_AVAILABLE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	Reading of BBC status failed	Try last action once more after reboot, if failed switch to redundant DPU
47696	V/2	EVENT_ME_DPU_REG_ISR_WRONG Par1: wrong ISR reset value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Reset value of register ISR is wrong	Try last action once more after reboot, if failed switch to redundant DPU
47697	V/2	EVENT_ME_DPU_REG_TRS_WRONG Par1: Wrong TRS reset value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	Reset value of register TRS is wrong	Try last action once more after reboot, if failed switch to redundant DPU
47698	V/2	EVENT_ME_DPU_INIT_ERROR Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	P	DPU initialization error	Try last action once more after reboot, if failed switch to redundant DPU
47699	V/2*	EVENT_ME_DPU_PM_WRITE_WRONG Par1:address LSW Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	Write error occurred in DPU program memory	Try last action once more after reboot, if failed switch to redundant DPU
47700	V/2	EVENT_ME_DISP_DRV_STAT_WRONG_LOW Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	B	Frame-Signal of Test-IF becomes not low	Try last action once more after reboot, if failed switch to redundant DPU
		VIRTIS-M control software events (47701 ... 47740)			
47701	IX	EVENT_M_DUMP_DATA_PRODUCTION_PARAMETER Parameter see TM packet structure, page 137	E	Dump of actual Data Production Parameter	N/A
47702	IX	EVENT_M_DUMP_FUNCTIONAL_PARAMETER Parameter see TM packet structure, page 140	E	Dump of actual Functional Parameter	N/A

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
47703	IX	EVENT_M_DUMP_OPERATIONAL_PARAMETER Parameter see TM packet structure, page 137	E	Dump of actual Operational Parameter	N/A
47704	IX	EVENT_M_DUMP_ALTERNATE_PARAMETER Parameter see TM packet structure, page 138	E	Dump of actual Alternate Parameter	N/A
47705	IX	EVENT_M_DUMP_CALIBRATION_PARAMETER Parameter see TM packet structure, page 139	E	Dump of actual Calibration Parameter	N/A
47706	IX	EVENT_M_COOL_DOWN_END_SUCCESS Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Cool down successful finished	N/A
47707	I/1	EVENT_M_SU_ANGLE_STEP_SIZE_NOT_INT_OF_ANGLE_RANGE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	M SU movement angle range is not a multiple of step size	Change M functional parameter M_SU_ANGLE_STEP_SIZE or M_SU_ANGLE_FIRST/ M_SU_ANGLE_LAST
47708	I/1	EVENT_M_SU_FIRST_ANGLE_GREATER_LAST_ANGLE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	M SU first angle is greater than last angle	Change M functional parameter M_SU_ANGLE_FIRST or M_SU_ANGLE_LAST
47709 ... 47734		FREE			
47735	I/1	EVENT_SW_342_MODE_USER_DEFINED_STARTED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M user defined mode started	N/A
47736		FREE			
47737	I/1	EVENT_SW_31_M_PEM_CMD_FIFO_OVERFLOW Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-M PEM command S/W FIFO overflow	Try last action once more, if failed switch to redundant DPU
47738	I/1	EVENT_M_VIS_DATA_SLICE_LOST Par1: empty (0x0000) Par2: empty (0x0000)	E	VIRTIS-M VIS data slice is lost during VIS slice (frame) acquisition by ME from M-PEM	1. use an other M-Mode where the M_ERT is longer or 2. increase the S/C (EGSE) data acquisition performance or 3. decrease M_SS in case of slice summing (i.e. M_SS>1)

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par3: empty (0x0000) Par4: empty (0x0000)			
47739	I/1	EVENT_M_IR_DATA_SLICE_LOST Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-M IR data slice is lost during IR slice (frame) acquisition by ME from M-PEM	1. use an other M-Mode where the M_ERT is longer or 2. increase the S/C (EGSE) data acquisition performance or 3. decrease M_SS in case of slice summing (i.e. M_SS>1)
47740	I/1	EVENT_SW_34_M_MODE_UNVALID Par1: Wrong –M mode value Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-M Mode is unvalid	Switch off VIRTIS-M and start session once more,
		VIRTIS-M terminator hardware events (47741 ... 47800)			
47741	I/1	EVENT_M_COOLER_STEADY_NOT_REACHED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M steady state not reached, temperature too high	Command a higher temperature and start cool down once more by MTC_Cooler
47742	I/1	EVENT_M_COOLER_CMD_OFF_DURING_OPERATION Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Attempt to switch-off the -M cooler during operation	No action by user needed
47743	I/1	EVENT_M_COOLER_CMD_OPEN_LOOP Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Attempt to command the -M cooler during open loop mode	No action by user needed
47744	I/1	EVENT_M_COOLER_CMD_DURING_STEADY_STATE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Attempt to command the -M cooler during steady state	No action by user needed
47745	I/1	EVENT_M_COOLER_CMD_DURING_COOL_DOWN Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Attempt to command the -M cooler during cool down	No action by user needed
47746	I/1	EVENT_M_ECA_ALREADY_MOVED	E	-M ECA is already moved, only one time	No action by user needed

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)		possible	
47747	I/1	EVENT_M_ECA_NOT_MOVED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M ECA not moved	Try once more to move the ECA
47748	II	EVENT_M_IR_DETECTOR_NOT_OFF Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M IR detector is not off	Try once more to switch off the detector
47749	I/1	EVENT_M_ANNEAL_NOT_POSSIBLE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M annealing is not possible because detector could not be switched off	Try once more to start annealing and switching off the detector
47750	I/1	EVENT_M_ANNEAL_STOPPED_AFTER_EXCEED_TEMP Par1: commanded M_ANNEAL_LIMITS Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M annealing is stopped after exceeding temperature	No action by user needed
47751	I/1	EVENT_M_ANNEAL_STOPPED_AFTER_TIME_OUT Par1: commanded –M_ANNEAL_TIME_OUT Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M annealing is stopped after time out	Start annealing once more with lower M_ANNEAL_LIMITS (changed by MTC_Change_Func_Param_RAM)
47752	I/1	EVENT_M_COVER_CTRL_IN_M_MODE_X Par1: Current active –M mode Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Attempt to control -M cover in mode x	Check the current –M mode and try action once more
47753	I/1	EVENT_M_COVER_ALREADY_CLOSED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M cover is already closed	No action by user needed
47754	I/1	EVENT_M_COVER_ALREADY_OPEN	E	-M cover is already open	No action by user needed

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)			
47755	I/1	EVENT_M_COVER_OPEN Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M cover is open	No action by user needed
47756	I/1	EVENT_M_COVER_NOT_OPEN Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M cover is not open	Try last action once more (restart sequence)
47757	I/1	EVENT_M_COVER_CLOSED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M cover is closed	No action by user needed
47758	I/1	EVENT_M_COVER_NOT_CLOSED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M cover is not closed	Try last action once more (restart sequence)
47759	I/1	EVENT_M_SCIENCE_DATA_GENERATION_STOPPED Par1: EVENT_ID of Cat III error Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M science data generation is stopped	Check the occurred event and if possible try to restart the sequence once more
47760	I/1	EVENT_M_MODE_USER_DEFINED_STARTED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M user defined mode started, no predefined mode reached	No action by user needed
47761	I/1	EVENT_M_IR_DATA_OUTSIDE_OF_RANGE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M IR raw data outside of nominal range (61000...7500 DN)	No action possible
47762	I/1	EVENT_M_VIS_DATA_OUTSIDE_OF_RANGE	E	-M VIS raw data outside of nominal range	No action possible

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1: VIS data range Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)		(16384...65535 DN)	
47763	III	EVENT_M_IR_LESS_DATA_THAN_EXPECTED Par1:Expected Nr of M-VIS words(MSW) Par2:Expected Nr of M-VIS words(LSW) Par3:Received Nr of M-VIS words(MSW) Par4:Received Nr of M-VIS words(LSW)	E	-M IR less data received than expected	Stop and restart sequence
47764	III	EVENT_M_IR_DATA_ACQ_TIME_OUT Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M IR data acquisition time out	Stop and restart sequence
47765	III	EVENT_M_VIS_DATA_ACQ_TIME_OUT Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M VIS data acquisition time out	Stop and restart sequence
47766	I/1	EVENT_M_COOL_STEADY_STATE_FAILURE Par1: cooler mode Par2: Cold tip temperature to be achieved Par3: empty (0x0000) Par4: empty (0x0000)	E	Commanded -M cooler temperature is not equal to the current cold tip temperature in steady state	Stop sequence, start cooling by MTC_Cooler once more, After reaching the steady state start sequence once nore
47767	IX	EVENT_M_CALIBR_SEQ_PHASE_FINALIZED Par1: calibration phase number (1..6) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M calibration sequence phase (1..6) is finalized	No action by user needed
47768	I/1	EVENT_M_SU_HK_WRONG Par1: M_MIRROR_SIN_HK Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M scan unit HK wrong (M_MIRROR_SIN_HK)	Stop and restart sequence
47769	I/1	EVENT_M_SHUTTER_NOT_OPEN Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M shutter not open	Stop and restart sequence
47770	I/1	EVENT_M_MODE_WRONG	E	Wrong -M mode number	No action by user possible

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1: mode number Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)			(S/W re-design /re-coding needed)
47771	I/2	EVENT_M_IR_ADC_LATCH_UP Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	IR channel ADC latch-up	Stop and restart sequence Due to CAT I/2, switch-off and on the M-PEM and M-Cooler again in order to probably see the event again.
47772	III	EVENT_M_IR_CMD_TIME_ERROR Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	IR channel command received out of idle time	Stop and restart sequence
47773	III	EVENT_M_IR_CMD_WORD_ERROR Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	IR channel bad command id or command value out of range	Stop and restart sequence
47774	I/2	EVENT_M_VIS_ADC_LATCH_UP Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIS channel ADC latch-up	Stop and restart sequence Due to CAT I/2, switch-off and on the M-PEM and M-Cooler again in order to probably see the event again.
47775	III	EVENT_M_VIS_CMD_TIME_ERROR Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIS channel command received out of idle time	Stop and restart sequence
47776	III	EVENT_M_VIS_CMD_WORD_ERROR Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIS channel bad command id or command value out of range	Stop and restart sequence
47777	I/2	EVENT_M_COOL_DOWN_END_FAILURE Par1: commanded temperature Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Cool down not successful, expected temperature not reached	Start cool down once more by MTC_Cooler with a higher commanded temperature Due to CAT I/2, switch-off and on the M-PEM and M-Cooler again in order to probably see the event again.
47778	I/1	EVENT_M_PEM_CCD_NOT_FULL_WIN_SIZE	E	-M VIS window size not nominal (876x512	Change the window size by MTC_PEM_Command_Word in

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1:Commanded M_CCD_WIN_SIZE (MSW) Par2:Commanded M_CCD_WIN_SIZE (LSW) Par3: empty (0x0000) Par4: empty (0x0000)		CCD elements)	M_MODE_TEST
47779	I/2	EVENT_M_VIS_IFE_FIFO_CLK_NUMBER_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-M VIS channel clock number wrong	Stop and restart sequence Due to CAT I/2, switch-off and on the M-PEM and M-Cooler again in order to probably see the event again. A SEU on interface level could be detected.
47780	I/2	EVENT_M_IR_IFE_FIFO_CLK_NUMBER_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-M IR channel clock number wrong	Stop and restart sequence Due to CAT I/2, switch-off and on the M-PEM and M-Cooler again in order to probably see the event again. A SEU on interface level could be detected.
47781	I/1	EVENT_M_VIS_IFE_FIFO_EMPTY_FIFO_READ Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-M VIS empty FIFO read	Stop and restart sequence
47782	I/1	EVENT_M_IR_IFE_FIFO_EMPTY_FIFO_READ Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-M IR empty FIFO read	Stop and restart sequence
47783	I/1	EVENT_M_VIS_IFE_FIFO_RD_ORDER_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-M VIS read order wrong (MSB and LSB)	Stop and restart sequence
47784	I/1	EVENT_M_IR_IFE_FIFO_RD_ORDER_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-M IR read order wrong (MSB and LSB)	Stop and restart sequence
47785	III	EVENT_M_VIS_LESS_DATA_THAN_EXPECTED Par1:Expected Nr of M-VIS words(MSW) Par2:Expected Nr of M-VIS words(LSW) Par3:Received Nr of M-VIS words(MSW) Par4:Received Nr of M-VIS words(LSW)	E	-M VIS less data received than expected	Stop and restart sequence
47786	I/1	EVENT_M_IR_DATA_SIZE_TOO_LARGE	E	VIRTIS-M IR more data received than	Send VTC_Enter_Idle_Mode (FIFO reset) and start data

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1:Expected Nr of M-IR words(MSW) Par2:Expected Nr of M-IR words(LSW) Par3:Received Nr of M-IR words(MSW) Par4:Received Nr of M-IR words(LSW)		expected	acquisition once more
47787	IV_M	EVENT_M_PEM_IR_CONNECTION_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-M IR channel PEM connection wrong	Switch off and once more on the PEM, if failed switch off VIRTIS-M
47788	III	EVENT_M_VIS_IFE_FIFO_NOT_EMPTY Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-M IFE VIS FIFO not empty, more data than expected	Send VTC_Enter_Idle_Mode (FIFO reset) and start data acquisition once more
47789	III	EVENT_M_IR_IFE_FIFO_NOT_EMPTY Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-M IFE IR FIFO not empty, more data than expected	Send VTC_Enter_Idle_Mode (FIFO reset) and start data acquisition once more
47790	I/1	EVENT_M_VIS_DATA_SIZE_TOO_LARGE Par1:Expected Nr of M-VIS words(MSW) Par2:Expected Nr of M-VIS words(LSW) Par3:Received Nr of M-VIS words(MSW) Par4:Received Nr of M-VIS words(LSW)	E	VIRTIS-M VIS more data received than expected	Send VTC_Enter_Idle_Mode (FIFO reset) and start data acquisition once more
47791	I/1	EVENT_M_PEM_IR_NOT_FULL_WIN_SIZE Par1:Commanded M_IR_WIN_SIZE (MSW) Par2:Commanded M_IR_WIN_SIZE (LSW) Par3: empty (0x0000) Par4: empty (0x0000)	E	-M IR window size is not nominal (432x256 pixel)	Change the window size by MTC_Change_Func_Param_RAM or MTC_PEM_Command_Word in M_MODE_TEST
47792	IV/M	EVENT_M_IFE_ACCESS_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-M IFE register access failed	Switch off IFE and on once more, if failed switch off VIRTIS-M
47793	IV_M	EVENT_M_PEM_VIS_CONNECTION_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-M VIS channel PEM connection wrong	Switch off and once more on the PEM, if failed switch off VIRTIS-M
47794	IV/M	EVENT_M_IFE_COMMAND_WRONG	E	Command transfer to VIRTIS-M failed	Try last action once more, if failed switch off VIRTIS-M

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par1: address register Par2: wrong command Par3: empty (0x0000) Par4: empty (0x0000)			
47795	I/1	EVENT_M_VIS_IFE_TEST_PATTERN_WRONG Par1: position wrong pattern LSW Par2: wrong pattern word Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-M VIS IFE test pattern wrong	Try test pattern check once more, if failed switch off VIRTIS-M VIS channel
47796	I/1	EVENT_M_IR_IFE_TEST_PATTERN_WRONG Par1: position wrong pattern LSW Par2: wrong pattern word Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-M IR IFE test pattern wrong	Try test pattern check once more, if failed switch off VIRTIS-M IR channel
47797	III	EVENT_M_VIS_IFE_FIFO_FULL Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-M VIS overflow	Send VTC_Enter_Idle_Mode (FIFO reset) and start data acquisition once more
47798	III	EVENT_M_IR_IFE_FIFO_FULL Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-M IR overflow	Send VTC_Enter_Idle_Mode (FIFO reset) and start data acquisition once more
47799	I/1	EVENT_M_VIS_IFE_FIFO_EMPTY Par1: expected number of words Par2: received number of words Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-M VIS channel empty	Switch PEM off and on, start data acquisition once more
47800	I/1	EVENT_M_IR_IFE_FIFO_EMPTY Par1: expected number of words Par2: received number of words Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-M IR channel empty	Switch PEM off and on, start data acquisition once more
47801	I/1	EVENT_M_SHUTTER_NOT_CLOSED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Attempt to close -M Shutter has failed	The event is issued due to a shutter status/HK hardware problem. Check that only the Shutter HK are wrong or the shutter doesn't work correctly. If the shutter doesn't work correctly the user is not able to do something.

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
47802	I/1	EVENT_M_PEM_HK_ACQUISITION_TIME_OUT Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	M-PEM HK acquisition time-out occurred	The –H housekeeping are not received from H-PEM. The user may try to reset of power-off/on the H-PEM. If the event is still received there is a hardware problem.
47803	I/1	EVENT_M_COVER_INIT_HES1_FAILED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	HES1 (closed position) failed while M-Cover initialization	Check the M_Cover housekeeping where only the HES or the cover motor has a problem. If the cover motor is not working anymore use the M_ECA
47804	I/1	EVENT_M_COVER_NOT_OPEN_NOT_CLOSED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	M-Cover is not open and not closed before initialization	check the M_Cover housekeeping, switch-off/on the M-PEM in order to re-initialize the M_Cover
47805	I/1	EVENT_M_COVER_CLOSING_FAILED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Closing of M-Cover failed	check the M_Cover housekeeping
47806	I/1	EVENT_M_IR_DET_IS_NOT_SWITCHED_ON	E	the M-IR detector is not switched on in any Science or Calibration modes	the user gets only simulated (by M-PEM) science data from the IR channel, not real science data If the user wants to have real science data the –M functional parameter M_IR_DET_OFF must be set not equal to 0x??FF.
		VIRTIS-H control software events (47901 ... 47930)			
47901	IX	EVENT_H_DUMP_DATA_PRODUCTION_PARAMETER Parameter see TM packet structure, page 144	E	Dump of actual Data Production Parameter	the user know that now H_Science data are produced
47902	IX	EVENT_H_DUMP_FUNCTIONAL_PARAMETER Parameter see TM packet structure, page 145	E	Dump of actual Functional Parameter	
47903	IX	EVENT_H_DUMP_OPERATIONAL_PARAMETER Parameter see TM packet structure, page 144	E	Dump of actual Operational Parameter	
47904	IX	EVENT_H_DUMP_PIXEL_MAP_PARAMETER Parameter see TM packet structure, page 146	E	Dump of actual Pixel Map Parameter	
47905	IX	EVENT_H_ANNEALING_FLAG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Annealing limit flag in PEM-HK is set	The annealing limit flag is set unexpected. There could be a hardware problem. May be switching off/on the H-PEM could help to recover the problem.

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
47906	IX	EVENT_H_COOL_DOWN_END_SUCCESS Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Cool down successful finished	N/A
47907	I/1	EVENT_H_PIX_MAP_NOT_UPLOADED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	H-Pixel Map is not uploaded yet	The upload oh –H pixel map was not successful. May be switching off/on the H-PEM and tray uploading again could help to recover the problem.
47908	I/1	EVENT_H_PIX_MAP_NR_OF_BITS_WRONG Par1: Number of pixels set to ‘1’ in pixel map Par2: Expected number of pixel set to ‘1’ (always = 17280) Par3: empty (0x0000) Par4: empty (0x0000)	E	Number of bits in H-Pixel Map is wrong	Check the H-Pixel Map coefficients especially related to order overlapping
47909	I/1	EVENT_H_PIX_MAP_WRONG Par1: Position of wrong pixel map byte (1... 14783) Par2: Value of wrong pixel map byte Par3: Value of expected pixel map byte Par4: empty (0x0000)	E	Downloaded H-Pixel Map is not equal to the uploaded one	Change of Pixel Map coefficients is needed commanding by TC.
47910	IX	EVENT_H_PIX_MAP_CHECK_SUCCESS Parameters (dead pixels detected in spectrum) as shown in TM packet description (TM size=512 words)	E	Check of H-Pixel Map was successful	N/A
47911 ... 47927		FREE			
47928	I/1	EVENT_H_DATA_SLICE_LOST Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-H data slice is lost due to a slow S/C data rate or high amount of data volume	change mode or lower data repetition rate
47929	I/1	EVENT_M_SUMMING_NOT_PERFORMED_WITH_FULL_W IN	E	Slice summing is not perfomed with full IR and VIS window size The processing time would be to high related to the DPU duty cycle	Change the M_ACQ_MODE or set M_SS=1, Use never M_SS>1 together with M_ACQ_MODE_FULL_WIN
47930	I/1	EVENT_SW_44_H_MODE_UNVALID Par1: -H mode number Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-H Mode is unvalid	Switch off VIRTIS-H and start session once more,

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		VIRTIS-H terminator hardware events (47931 ... 47980)			
47931	I/1	EVENT_H_ADC_LATCH_UP Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	ADC latch up error detected in H-PEM HK	May be switching off/on the H-PEM could help to recover the problem.
47932	I/1	EVENT_H_HKMS_SHUTTER_STAT_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	H-Shutter open and closed status bit values in H-PEM HK are not reverse to each other	May be switching off/on the H-PEM could help to recover the problem.
47933	I/1	EVENT_H_COVER_INIT_HES1_FAILED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	HES1 (closed position) failed while H-Cover initialization	May be switching off/on the H-PEM could help to recover the problem.
47934	I/1	EVENT_H_COVER_NOT_OPEN_NOT_CLOSED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	H-Cover is not open and not closed before initialization	May be switching off/on the H-PEM could help to recover the problem.
47935	I/1	EVENT_H_COVER_CLOSING_FAILED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Closing of H-Cover failed	May be switching off/on the H-PEM could help to recover the problem.
47936	I/1	EVENT_H_ANNEAL_NOT_STARTED_HK_WRONG Par1: H_HKMS_I_SHUTTER_HEATER Par2: H_HKRQ_DEVICE_ON Par3: H_HKMS_STATUS Par4: empty (0x0000)	E	Annealing is not started because HK are wrong	May be switching off/on the H-PEM could help to recover the problem.
47937	I/1	EVENT_H_ANNEAL_PEM_LIMIT_DETECT Par1: H_DET_TEMP (detector temperature) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Annealing limit exceeded	May be switching off/on the H-PEM could help to recover the problem.
47938	I/1	EVENT_H_PEM_HK_WRONG_DURING_ANNEAL Par1: HKMS_I_SHUTTER_HEATER Par2: H_HKRQ_DEVICE_ON	E	HK are wrong during annealing process	May be switching off/on the H-PEM could help to recover the problem.

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par3: H_HKMS_STATUS Par4: empty (0x0000)			
47939	I/1	EVENT_H_PEM_HK_OUT_OF_RANGE_AFTER_RESET Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	HK are out of range after PEM reset	May be switching off/on the H-PEM could help to recover the problem.
47940	I/1	EVENT_H_COVER_CTRL_IN_MODE_X Par1: Current active –H mode Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Attempt to control -H cover in mode x	Check the current –H mode and try action once more
47941	I/1	EVENT_H_MODE_USER_DEFINED_STARTED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H user defined mode started, no predefined mode reached	No action by user needed
47942	I/1	EVENT_H_WIN_SIZE_NOT_NOMINAL Par1: H_WIN_SIZE (MSW) Par2: H_WIN_SIZE (LSW) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H window size not nominal (432x256)	No action by user needed
47943	I/1	EVENT_H_COOLER_STEADY_NOT_REACHED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H steady state not reached, temperature too high	Command a higher temperature and start cool down once more by HTC_Cooler
47944	I/1	EVENT_H_COOLER_CMD_OFF_DURING_OPERATION Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Attempt to switch-off the -H cooler during operation	No action by user needed
47945	I/1	EVENT_H_COOLER_CMD_OPEN_LOOP Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Attempt to command the -H cooler during open loop mode	No action by user needed
47946	I/1	EVENT_H_COOLER_CMD_DURING_STEADY_STATE Par1: empty (0x0000) Par2: empty (0x0000)	E	Attempt to command the -H cooler during steady state	No action by user needed

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par3: empty (0x0000) Par4: empty (0x0000)			
47947	I/1	EVENT_H_COOLER_CMD_DURING_COOL_DOWN Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Attempt to command the -H cooler during cool down	No action by user needed
47948	I/1	EVENT_H_ECA_ALREADY_MOVED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H ECA is already moved, only one time possible	No action by user needed
47949	I/1	EVENT_H_ECA_NOT_MOVED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H ECA not moved	Try once more to move the ECA
47950	II	EVENT_H_DETECTOR_NOT_OFF Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H detector is not off	Try once more to switch off the detector
47951	I/1	EVENT_H_ANNEAL_NOT_POSSIBLE Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H annealing is not possible because detector could not be switched off	Try once more to start annealing and switching off the detector
47952	I/1	EVENT_H_ANNEAL_STOPPED_AFTER_EXCEED_TEMP Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H annealing is stopped after exceeding temperature	No action by user needed
47953	I/1	EVENT_H_ANNEAL_STOPPED_AFTER_TIME_OUT Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H annealing is stopped after time out	Start annealing once more with lower M_ANNEAL_LIMITS (changed by MTC_Change_Func_Param_RAM)
47954	I/2	EVENT_ID_H_COOL_DOWN_END_FAILURE Par1: Commanded temperature Par2: empty (0x0000)	E	Cool down not successful, expected temperature not reached	command the cooler again Due to CAT I/2, switch-off and on the H-PEM and H-Cooler again in order to probably see the event again.

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par3: empty (0x0000) Par4: empty (0x0000)			
47955	I/1	EVENT_H_COVER_ALREADY_CLOSED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H cover is already closed	No action by user needed
47956	I/1	EVENT_H_COVER_ALREADY_OPEN Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H cover is already open	No action by user needed
47957	I/1	EVENT_H_COVER_OPEN Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H cover is open	No action by user needed
47958	I/1	EVENT_H_COVER_NOT_OPEN Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H cover is not open	Try last action once more (restart sequence)
47959	I/1	EVENT_H_COVER_CLOSED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H cover is closed	No action by user needed
47960	I/1	EVENT_H_COVER_NOT_CLOSED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H cover is not closed	Try last action once more (restart sequence)
47961	I/1	EVENT_H_SCIENCE_DATA_GENERATION_STOPPED Par1: EVENT_ID of Cat III error Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H science data generation is stopped	Check the occurred event and if possible try to restart the sequence once more
47962	I/1	EVENT_H_DATA_OUTSIDE_OF_RANGE Par1: empty (0x0000) Par2: empty (0x0000)	E	-H raw data outside of nominal range (0...32767 DN)	No action possible

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par3: empty (0x0000) Par4: empty (0x0000)			
47963	III	EVENT_H_LESS_DATA_THAN_EXPECTED Par1:Expected Nr of H words(MSW) Par2:Expected Nr of H words(LSW) Par3:Received Nr of H words(MSW) Par4:Received Nr of H words(LSW)	E	-H less data received than expected	Stop and restart sequence
47964	III	EVENT_H_DATA_ACQ_TIME_OUT Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H data acquisition time out	Stop and restart sequence
47965	I/1	EVENT_H_COOL_STEADY_STATE_FAILURE Par1: cooler mode Par2: Cold tip temperature to be achieved Par3: empty (0x0000) Par4: empty (0x0000)	E	Commanded -H cooler temperature is not equal to the current cold tip temperature in steady state	Stop sequence, start cooling by MTC_Cooler once more, After reaching the steady state start sequence once more
47966	I/1	EVENT_H_CALIBR_SEQ_FINALIZED Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H calibration sequence phase (1..6) is finalized	No action by user needed
47967	I/1	EVENT_H_MODE_NOT_EXPECTED Par1: H-Mode number Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H mode number is not expected	TBD
47968	I/2	EVENT_H_IFE_FIFO_CLK_NUMBER_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-H channel clock number wrong	Stop and restart sequence Due to CAT I/2, switch-off and on the H-PEM and H-Cooler again in order to probably see the event again.
47969	I/1	EVENT_H_IFE_FIFO_EMPTY_FIFO_READ Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-H empty FIFO read	Stop and restart sequence
47970	I/1	EVENT_H_IFE_FIFO_RD_ORDER_WRONG Par1: empty (0x0000) Par2: empty (0x0000)	E	FIFO VIRTIS-H read order wrong (MSB and LSB)	Stop and restart sequence

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par3: empty (0x0000) Par4: empty (0x0000)			
47971	I/1	EVENT_H_ECA_28V_SWITCH_CMD_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-H ECA +28V Switch driver command execution failed	Stop and restart sequence
47972	I/1	EVENT_H_IFE_COMMAND_WRONG Par1: IFE command word to be issued Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	Command transfer to VIRTIS-H failed	Try last action once more, if failed switch off VIRTIS-H
47973	III	EVENT_H_IFE_FIFO_NOT_EMPTY Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-H IFE FIFO not empty, more data than expected	Send VTC_Enter_Idle_Mode (FIFO reset) and start data acquisition once more
47974	I/1	EVENT_H_DATA_SIZE_TOO_LARGE Par1:Expected Nr of H words(MSW) Par2:Expected Nr of H words(LSW) Par3:Received Nr of H words(MSW) Par4:Received Nr of H words(LSW)	E	VIRTIS-H more data received than expected	Send VTC_Enter_Idle_Mode (FIFO reset) and start data acquisition once more
47975	I/1	EVENT_H_CCE_28V_SWITCH_CMD_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-H CCE +28V Switch driver command execution failed	Stop and restart sequence
47976	I/1	EVENT_H_IFE_ACCESS_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-H IFE register access failed	Switch off IFE and on once more, if failed switch off VIRTIS-H
47977	IV_H	EVENT_H_PEM_CONNECTION_WRONG Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VIRTIS-H channel PEM connection wrong	Switch off and once more on the PEM, if failed switch off VIRTIS-H
47978	I/1	EVENT_H_IFE_TEST_PATTERN_WRONG Par1: position wrong pattern LSW Par2: wrong pattern word	E	VIRTIS-H IFE test pattern wrong	Try test pattern check once more, if failed switch off VIRTIS-H channel

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par3: empty (0x0000) Par4: empty (0x0000)			
47979	III	EVENT_H_IFE_FIFO_FULL Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-H overflow	Send VTC_Enter_Idle_Mode (FIFO reset) and start data acquisition once more
47980	III	EVENT_H_IFE_FIFO_EMPTY Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	FIFO VIRTIS-H channel empty	Switch PEM off and on, start data acquisition once more
47981	I/1	EVENT_H_PEM_SHUTTER_OPEN_HK_WRONG Par1: H-HK word 3 (HKRQ_DEVICE_ON) Par2: H-HK word 5 (HKMS_STATUS) Par3: H-HK word25 (HKMS_I_SHUTTER_HEATER Par4: empty (0x0000)	E	-H shutter open HK are wrong	the H-PEM hardware has to be check
47982	I/1	EVENT_H_PEM_SHUTTER_CLOSE_HK_WRONG Par1: H-HK word 3 (HKRQ_DEVICE_ON) Par2: H-HK word 5 (HKMS_STATUS) Par3: H-HK word25 (HKMS_I_SHUTTER_HEATER Par4: empty (0x0000)	E	-H shutter close HK are wrong	the H-PEM hardware has to be check
47983	I/1	EVENT_H_SHUTTER_CTRL_TIME_EXCEEDED Par1: H Shutter control time (ms) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H shutter control time exceeded	the H-PEM hardware has to be check
47984	I/1	EVENT_H_CMD_WORD_ERROR Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	VITIS-H channel bad command id or command value out of range	the H-PEM hardware has to be check
47985	I/1	EVENT_H_SHUTTER_NOT_OPEN Par1: empty (0x0000) Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H shutter not open	the H-PEM hardware has to be check
47986	I/1	EVENT_H_PEM_HK_OUT_OF_RANGE_IN_CALIBR Par1: Position of wrong H-PEM HK word Par2: empty (0x0000)	E	-H PEM-HK out of range in calibration	the H-PEM hardware has to be check

Event ID	Cat.	Event Name + Parameter (16bit)	Issued by	Description	Recommended Action by User
		Par3: empty (0x0000) Par4: empty (0x0000)			
47987	I/1	EVENT_H_PEM_HK_OUT_OF_RANGE_IN_SCIENCE Par1: Position of wrong H-PEM HK word Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	-H PEM-HK out of range in science mode	the H-PEM hardware has to be check
47988	IX	EVENT_H_CALIBR_SEQ_PHASE_FINALIZED Par1: Number of Phase Par2: empty (0x0000) Par3: empty (0x0000) Par4: empty (0x0000)	E	A –H calibration phase 1, 2, 3 or 4 is finalized 1=Slit_Spectral_Calibration (3 H_IMAGEs are transferred) 2=Telescop_Spectral_Calibration (2 H_IMAGEs are transferred) 3=Image_Slice_Rad_Calibration (2 H_IMAGEs are transferred) 4=Spectrum_Rad_Calibration (2 H_SPECTRA are transferred) 5=H_Simulation_Calibration	

Event List, 26.10.2001

Table A10-2: List of Events

Appendix 13a: Examples for Memory Load/Check incl. CRC result

The examples below represent TCs for loading different types of memory (TC_Load_Memory), for checking the memory or generating of a 16bit CRC (TC_Check_Memory) and TMs containing the 16bit CRC checksum (TM_Memory_Check_Report).

```
MemoryID=141 (48bit PM) memory content: 0x111122223333 0x444455556666

 TC_Load_Memory: PM (48bit), 2 Words, Address 0x7000
 0000: 1B3C C2AE 0019 1106 0200 8D01 0000 7000
 0010: 0002 1111 2222 3333 4444 5555 6666 1E0D

 TC_Check_Memory: PM (48bit), 2 Words, Address 0x7000
 0000: 1B3C C2AF 000D 1106 0900 8D01 0000 7000
 0010: 0002 28CE

 TM_Memory_Check_Report:
 returns CRC: 0x9161


MemoryID=142 (40bit DM) memory content: 0x1122223333 0x4455556666

 TC_Load_Memory: DM (40bit), 2 Words, Address 0x10000
 0000: 1B3C C2B0 0019 1106 0200 8E01 0001 0000
 0010: 0002 0011 2222 3333 0044 5555 6666 73BD

 TC_Check_Memory: DM (40bit), 2 Words, Address 0x10000
 0000: 1B3C C2B1 000D 1106 0900 8E01 0001 0000
 0010: 0002 B73B

 TM_Memory_Check_Report:
 returns CRC: 0xC9F5


MemoryID=143 (16bit DM) memory content: 0x2233 0x5566

 TC_Load_Memory: DM (16bit), 2 Words, Address 0x30001000
 0000: 1B3C C2B2 0019 1106 0200 8F01 3000 1000
 0010: 0002 2233 5566 3300 0000 0055 6600 9879

 TC_Check_Memory: DM (16bit), 2 Words, Address 0x30001000
 0000: 1B3C C2B3 000D 1106 0900 8F01 3000 1000
 0010: 0002 234B

 TM_Memory_Check_Report:
 returns CRC: 0x3F39
```

Appendix 13b: Examples: VIRTIS science default operation

Example: Execute the –M and –H science session/mode with default parameter

TC	TM	Remark
Power-ON VIRTIS (S/C action)		
TC_Accept_Time_Update		
	VTM_ME_Default_HK_Report	every 10 second
VTC_Enter_Idle_Mode		start Secondary Boot Software
	TM_TC_Acceptance_Report_Success	
	TM_Secondary_Boot_Completed	
TC_Reset_And_Start_HS_Link		start HS Link
	TM_TC_Acceptance_Report_Success	
MTC_Cooler(close loop)		switch on M Cooler
	TM_TC_Acceptance_Report_Success	
	MTM_ME_General_HK_Report	every 10 second
MTC_PEM(on)		switch on M PEM
	TM_TC_Acceptance_Report_Success	
	MTM_PEM_VIS_HK_Report	every 10 second
	MTM_PEM_IR_HK_Report	every 10 second
	TM_TC_Execution_Report_Success	after 40 seconds
HTC_Cooler(close loop)		switch on H Cooler
	TM_TC_Acceptance_Report_Success	
	HTM_ME_General_HK_Report	every 10 second
HTC_PEM(on)		switch on H PEM
	TM_TC_Acceptance_Report_Success	
	HTM_PEM_HK_Report	every 10 second
	TM_TC_Execution_Report_Success	after 40 seconds
Wait 1.5hours for cool down		
	MTM_Cool_Down_End_Success	after 1.5 hours
	HTM_Cool_Down_End_Success	
MTC_Cover(Open)		open the –M cover
	TM_TC_Acceptance_Report_Success	
	TM_TC_Execution_Report_Success	after 30 seconds
HTC_Cover(Open)		open the –H cover
	TM_TC_Acceptance_Report_Success	
	TM_TC_Execution_Report_Success	after 30 seconds
TC_Enable_Science_HS_Link(-M)		enable science M
	TM_TC_Acceptance_Report_Success	
	MTM_Dump_Data_Production_Parameter	Parameter Dump
	MTM_Dump_Functional_Parameter	...
	MTM_Dump_Operational_Parameter	...
	MTM_Dump_Calibration_Parameter	...
	MTM_Dump_Alternate_Parameter	...
	MTM_PEM_VIS_HK_Report	additional HK for each data acquisition
	MTM_PEM_IR_HK_Report	additional HK for each data acquisition
	MTM_Science_Report (via HS link)	one M_VIS_SLICE and one M_IR_SLICE lossless compressed is sent every 5sec by TM
		the M_SCIENCE_NOMINAL_1 mode is shown in VTM_ME_Default_HK_Report
TC_Enable_Science_HS_Link(-H)		enable science H
	TM_TC_Acceptance_Report_Success	
	HTM_Dump_Data_Production_Parameter	

	HTM_Dump_Functional_Parameter	
	HTM_Dump_Operational_Parameter	
	HTM_Dump_Pixel_Map_Parameter	
	HTM_Pix_Map_Check_Success	
	HTM_PEM_HK_Report	additional HK for each data acquisition
	HTM_Science_Report (via HS link)	one H_SPECTRA_SLICE lossless compressed is sent every 87,5s (64 x H_IRT=1,367s) by TM one H_SPECTRUM_DARK uncompressed is sent every 13,7s (H_DARK_RATE x 1,367s) by TM
		the H_SCIENCE_NOMINAL_DATA_RATE mode is shown in VTM_ME_Default_HK_Report
TC_Disable_Science_HS_Link(-M)		disable science M
	TM_TC_Acceptance_Report_Success	
	TM_TC_Execution_Report_Success	
TC_Disable_Science_HS_Link(-H)		disable science H
	TM_TC_Acceptance_Report_Success	
	TM_TC_Execution_Report_Success	
VTC_Enter_Idle_Mode		switch off the PEM's and the Cooler's

Appendix 13c: Examples: VIRTIS calibration operation

Example: Execute the -M and -H calibration sequences/modes with default parameter

TC	TM	Remark
VIRTIS power-ON (S/C action)		
TC_Accept_Time_Update		
	VTM_ME_Default_HK_Report	every 10 second
VTC_Enter_Idle_Mode		start Secondary Boot Software
	TM_TC_Acceptance_Report_Success	
	TM_Secondary_Boot_Completed	
TC_Reset_And_Start_HS_Link		start SHS Link
	TM_TC_Acceptance_Report_Success	
MTC_Cooler		switch on M Cooler
	TM_TC_Acceptance_Report_Success	
	MTM_ME_General_HK_Report	every 10 second
	MTM_Cool_Down_End_Success	
MTC_PEM		switch on M PEM
	TM_TC_Acceptance_Report_Success	
	MTM_PEM_VIS_HK_Report	every 10 second
	MTM_PEM_IR_HK_Report	every 10 second
	TM_TC_Execution_Report_Success	
HTC_Cooler		switch on H Cooler
	TM_TC_Acceptance_Report_Success	
	HTM_ME_General_HK_Report	every 10 second
	HTM_Cool_Down_End_Success	
HTC_PEM		switch on H PEM
	TM_TC_Acceptance_Report_Success	
	HTM_PEM_HK_Report	every 10 second
	TM_TC_Execution_Report_Success	
MTC_Change_Data_Product_Param_RAM		change M parameter for Calibration
	TM_TC_Acceptance_Report_Success	
MTC_Change_Operat_Param_RAM		full window and no compression
	TM_TC_Acceptance_Report_Success	
HTC_Change_Data_Product_Param_RAM		change H parameter for Calibration
	TM_TC_Acceptance_Report_Success	
HTC_Change_Operat_Param_RAM		no compression
	TM_TC_Acceptance_Report_Success	
TC_Enable_Science_HS_Link(-M)		enable science M
	TM_TC_Acceptance_Report_Success	
	MTM_Dump_Data_Production_Parameter	Parameter Dump
	MTM_Dump_Functional_Parameter	...
	MTM_Dump_Operational_Parameter	...
	MTM_Dump_Calibration_Parameter	...
	MTM_Dump_Alternate_Parameter	...
	MTM_PEM_VIS_HK_Report	additional HK for each data acquisition
	MTM_PEM_IR_HK_Report	additional HK for each data acquisition
TC_Enable_Science_HS_Link(-H)		enable science H
	TM_TC_Acceptance_Report_Success	

	HTM_Dump_Data_Production_Parameter	
	HTM_Dump_Functional_Parameter	
	HTM_Dump_Operational_Parameter	
	HTM_Dump_Pixel_Map_Parameter	
	HTM_Pix_Map_Check_Success	
	HTM_PEM_HK_Report	additional HK for each data aquisition
	HTM_Calibr_Phase_Finalized	H Phase 0 finished (148s)
	MTM_Calibr_Phase_Finalized	M Phase 0 finished (151s)
	HTM_Calibr_Phase_Finalized	H Phase 1 finished (29s)
	HTM_Calibr_Phase_Finalized	H Phase 2 finished (33s)
	MTM_Calibr_Phase_Finalized	M Phase 1 finished (120s)
	HTM_Calibr_Phase_Finalized	H Phase 3 finished (64s)
	MTM_Calibr_Phase_Finalized	M Phase 2 finished (60s)
	MTM_Calibr_Phase_Finalized	M Phase 3 finished (180s)
	MTM_Calibr_Phase_Finalized	M Phase 4 finished (84s)
	MTM_Calibr_Phase_Finalized	M Phase 5 finished (120s)
	MTM_Calibr_Phase_Finalized	M Phase 6 finished (60s)
	MTM_Science_Report (via HS link) several times	35 M_VIS_SLICEs + 35 M_IR_SLICEs uncompressed are sent within 775sec by TM
	HTM_Science_Report (via HS link) several times	7 x H_IMAGE_SLICE + 2 x H_SPECTRUM uncompressed is sent within 274sec by TM
Wait > 775 sec since TC_Enable_Science_*(-M)		
TC_Disable_Science_HS_Link(-M)		disable science M
	TM_TC_Acceptance_Report_Success	
	TM_TC_Execution_Report_Success	
Wait > 274sec since TC_Enable_Science_*(-H)		
TC_Disable_Science_HS_Link(-H)		disable science H
	TM_TC_Acceptance_Report_Success	
	TM_TC_Execution_Report_Success	
VTC_Enter_Idle_Mode		switch off the PEM's and the Cooler's

Appendix 14: Frequently Ask Questions (FAQs)

Q1-Alenia:
For each mem ID I'd like to know if the checksum algorithm is custom defined or SGICD compliant.
A1-DLR:
I assume the question concerns the Memory Management Service 6, check memory. The TC checksum is not custom defined. It is 16bit CRC, the same as used for TCs.
But note there is a Request for Deviation about the format of the TM_Memory_Check_Report, see VIR-DLR-WV-003.

Q2-Alenia:
If patch and dump is supported for multiple blocks too
A2-DLR:
Patch and dump of multiple blocks are not supported.

Q3-Alenia:
For each mem ID I'd like to know the memory area where it is possible to patch safely.
A3-DLR:
MemID=140, EEPROM/8bit, please do not patch the EEPROM for safety reason at all
MemID=141, PM/48bit, address 0x006300...0x01FFFF is free for patching
MemID=142, DM/40bit, each valid address 0x00000000...0x0007FFFF is free for patching
(PROM SW runs only in PM RAM)
MemID=143, DM/16bit, each valid address 0x30000000...0x301FFFFF is free for patching
(PROM SW runs only in PM RAM)
MemID=144, PM/48bit, please do not patch a port for safety reason at all
MemID=145, DM/40bit, please do not patch a port for safety reason at all

Q4-OG:
Does the SCET (inside Science TM packets) refer to the time in which the frame data from PEM starts to be received by ME?
A4-DLR:
Yes, the reference is the detection of the first word of a frame in our IFE/PEM data buffer. Worst case is 20ms as maximum after receiving the first word. This is equal for all 3 channels independently.

Q5-OG:
And is the SCET equal for all the packets composing a slice? If not, how the SCET time is managed?
A5-DLR:
The TM SCET is equal inside a M-VIS slice, a M-IR slice, a H_IMAGE_SLICE or a H_SPECTRUM for all TM packets and corresponds to the first word of Slice or Spectrum acquisition. For a H_SPECTRA_SLICE the TM SCET is equal in all TM packets but corresponds to the ME SCET of the last (from 64) acquired H_SPECTRUM within the H_SPECTRA_SLICE.

Q6-OG:
Does the SCET (inside PEM-HK TM packets) refers to the time in which the HK data from PEM starts to be received? If not, how the SCET time is managed?
A6-DLR:
If Science Data+HK are requested from the PEM (not only HK), the SCET of the HK TM packet is the same (identical) as for the Science TM packets. If only HK are acquired, of course the HK TM packet contains a time when is requested (max.+20msec tolerance) asynchronously.

Q7-OG:
What is the order of TM science data in TM steam?
A7-DLR:
For TM data transferred by HS link, sub-slices are transferred with successive TM packet by TM packet. But M-VIS, M-IR and –H sub-slices are transferred mixed together (e.g. M-VIS SSL1, M-IR SSL1, -H SS1, -H SSL2, M-VIS SSL2, ...).

Q8-OG:
Can you confirm, that the –M Scan Unit and the M-IR detector is switch-off using the parameter M_SU_MODE and M_IR_DET_OFF? This option is needed for debugging the System Functional Test procedure to be used for VIRTIS / Rosetta thermal/vacuum tests.
A8-DLR:
Yes, the –M Scan Unit and the M-IR detector is not switched-on using the parameter M_SU_MODE=off and M_IR_DET_OFF.

Q9-IAS:
What are the most important CAT V/* events to be monitored by the S/C to perform on-board actions. The implemented number of CAT V/* events are to high. The S/C is able to monitor only 10...20 events for VIRTIS.
A9-DLR:
These are the most important CAT V/* events which should be monitored by the S/C.
47601, 47603, 47604, 47609, 47610, 47653, 47654, 47661, 47664, 47665, 47667, 47668, 47674, 47693, 47695

Q10-LESIA:
What happens in HS_Nominal_Observation mode?

A10-DLR:
The "HS_Nominal_Observation" ist performed as follows after TC_Enter_Science and assumed that the cover is already open.

HSET_SHUTTER_STATUS|ON
HSET_BIAS|h_v_bias
HSET_I_SHUTTER|h_i_shutter
Wait: h_func_param.h_stab_det_time
HSET_SHUTTER_STATUS|ON
HSET_DET_OFF
Wait: h_func_param.h_stab_det_time
HS_LOAD_PIXEL_MAP
HSET_INT_NUM1
HSET_INT_NUM2
HSET_PEM_MODE_OBSERVATION_8ORDERS
HSET_DET_ON
Wait: h_func_param.h_stab_det_time
HSTART_HK
HRESYNC
Wait: h_frame_period
Loop:
  Wait: H_IRT (h_frame_period, but considering H_N_FRAME)
  HSTART_S

The time is depending from the -H parameters and first time from the execution of pixel map upload.

Summarized the time is calculated:
t = 3*h_stab_det_time + 2*h_frame_period + LOAD_PIXEL_MAP
For the first TC_Enable_Science LOAD_PIXEL_MAP = about 60...120sec depends on the -M mode.
For the second TC_Enable_Science LOAD_PIXEL_MAP is zero.
Note, an event "EVENT_ID_H_PIX_MAP_CHECK_SUCCESS" is sent when the upload is finished.
h_stab_det_time = 10sec (Default)
h_frame_period = H_INT_SCIENCE + H_READOUT_TIME + H_HK_READ_OUT_TIME + H_IDLE_TIME
The calculation and examples of h_frame_period is shown in the SUM (see attachment).
Example for first time TC_Enable_Science with H_N_FRAME=1, H_INT=1sec until the spectra collection is started:
3*10sec + 2*1,4sec + 120sec = 152,8sec (worst case for H_N_FRAME=1, H_INT=1sec).
After that it takes e.g. 1,4sec to collect/generate one spectrum, e.g. 64*1,4sec to have a slice.

Appendix 15: 1355/TM High Speed Interface performance

The performance of the high speed 1355 interface to the S/C SSMM is shown below and is based on analysis by calculation and partially by measurements. It is needed for analysing the SSMM interface to performance to VIRTIS. The parameters below are requirements to the S/C (SSMM) to operate VIRTIS in worst case modes. The following interface performance parameters are applicable:

Interface frequency (data rate):	10MBit/s
Short peak TM data rate during TM packet transfer:	> 6MBit/s
Data rate nominal science modes:	M_SCIENCE_NOMINAL_1 H_DATA_NOMINAL_OBSERVATION
Data rate maximum (worst case) modes:	M_Test(M_ERT=5sec, No_Compression) or M_CALIBRATION(No_Compression) H_SCIENCE_MAXIMUM_DATA_RATE (H_IRT=700ms, No_Compression) or H_SCIENCE_BACKUP (H_IRT=5000msec, No_Compression)
Average TM rate over long time in –M and –H nominal science modes (up to hours):	< 57KBit/s (see also Appendix 8 + 11)
Average TM rate over long time in –M and –H maximum (worst case) modes (up to hours):	< 1084KBit/s (see also Appendix 8 + 11)
TM packet maximum size during a TM packet burst:	512 words of each TM Packet (except last packet) during 1...25msec
TM minimum packet size during a TM packet burst:	>14words of last TM packet during 1...25msec
TM packet frequency during a TM packet burst: (Burst = a Sub-Slice with 512words / TM packet)	2...19 TM packets during 1...25msec
TM packet average frequency during External Repetition Time (ERT):	< 3,5msec during >5sec
SSMM allowed peak latency once between TM packets within External Repetition Time (ERT): (S/W timeout for TM packet transfer before TM packet data loss and event issue)	< 500msec during >5sec
SSMM allowed average latency between end of TM packet 1 to start of TM packet 2 during External Repetition Time (ERT):	< 2,1msec during >5sec

S/C latency / packet = Available Transfer Time / packet - Archived Transfer Time / packet
Archived Transfer Time/packet = 512words/TM packet * 16bit/word/6Mbit/s = 1,4msec/TM packet
Available Transfer Time / packet = 800ms / 228 packets = 3,5ms / packet
S/C latency / packet = 3,5ms / packet – 1,4ms / packet = 2,1ms / packet
Worst case is M-VIS Slice transfer without binning, without compression
max. time for M-VIS Slice transfer(0,8s) = M-VIS acquisition time(3,5s) + processing time (0,7s)
Note, measured with SIS: latency = 0,2ms, TM packet transfer time (incl. latency) = 1,3ms

Long peak TM rate during about < 600ms interface transfer time:	> 2,34MBit/s

3,5msec/packet = 3,5msec/512words/16bit/word = 2,34Mbit/s

Appendix 16: -H Dead Pixel Map – Image Positions

Ref.: **DeadPXMap04-07-08.dat** ; **DeadPXMapTxt04-07-08.txt**

Pixel number	X-Pos.	Y-Pos.
1	0	136
2	0	140
3	0	141
4	0	144
5	0	148
6	0	206
7	0	218
8	95	133
9	95	134
10	95	135
11	96	132
12	96	133
13	96	134
14	96	135
15	96	136
16	97	133
17	97	134
18	97	135
19	97	136
20	97	137
21	98	133
22	98	134
23	98	135
24	98	136
25	98	137
26	99	134
27	99	135
28	99	136
29	99	137
30	100	133
31	100	134
32	100	135
33	100	136
34	101	133
35	101	134
36	101	135
37	101	136
38	101	137
39	102	133
40	102	134

Pixel number	X-Pos.	Y-Pos.
41	102	135
42	102	136
43	102	137
44	103	133
45	103	134
46	106	101
47	106	102
48	107	101
49	107	102
50	109	46
51	127	102
52	137	103
53	143	220
54	169	117
55	213	264
56	216	157
57	217	156
58	217	157
59	217	158
60	218	157
61	233	150
62	239	220
63	255	43
64	255	148
65	295	221
66	340	87
67	340	88
68	340	89
69	340	90
70	341	87
71	341	88
72	341	89
73	341	90
74	342	87
75	342	88
76	342	89
77	343	85
78	343	86
79	343	87
80	343	88

Pixel number	X-Pos.	Y-Pos.
81	343	89
82	344	85
83	344	86
84	344	87
85	344	88
86	345	78
87	345	85
88	345	86
89	345	88
90	373	52
91	394	27
92	394	28
93	395	26
94	395	27
95	395	28
96	395	29
97	396	26
98	396	27
99	396	28
100	396	29
101	397	25
102	397	26
103	397	27
104	397	28
105	398	24
106	398	25
107	398	26
108	398	27
109	398	28
110	398	29
111	399	24
112	399	25
113	399	26
114	399	27
115	399	28
116	400	25
117	400	26
118	400	27
119	400	189
120	410	192