# MODULUS Ptolemy

# Telecommand and Telemetry Definitions

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**Issue: 5.1**

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CHANGE RECORD

| DATE | CHANGE DETAILS | ISSUE |
|---|---|---|
| 04th February 2000 | Draft issue | draft |
| 23rd May 2000 | First issue | 1 |
| 1st June 2000 | hazadous funct. enable: masks only 16 bits<br>Some TM pkts type shown starting in word 8, corrected to 6 | 2 |
| 26th October 2000 | HK format updated (3.2, 3.3)<br>Some TC formats modified (2.x) | 3 |
| 8th January 2001 | | 4 |
| 26th February 2001 | Changes & additions to Event Data (3.6, 3.7)<br>Changes to Hazardous functions enable TC(2.25)<br>Changes to complete HK packet (3.3) | 5 |
| 26th February 2001 | Correct length of Hazardous function enable TC (2.25) | 5.1 |
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## CONTENTS

## 1. INTRODUCTION

This document describes structure and contents of the telecommands and telemetry packets foreseen for the Ptolemy experiment. The command and telemetry structures as received or output by the experiment are addressed, that is, the data structures exchanged by the Ptolemy electronics unit and the lander CDMS; the communication between the lander and spacecraft are outside the scope of this document.

### 1.1 Definitions, acronyms and abbreviations

#### *1.1.1 Definitions*

**Bit numbering:**

Bits are numbered with the least significant bit as bit 0 and most significant bit as bit 15. This is the numbering used in the HS-RTX-2010RH processor reference manual, in the schematics for the electronics and in other hardware documents:

| ms | | | | | | | | | | | | | | | ls |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

It should be noted that the software documentation (URD, SDD), numbers bits in the reverse order (most significant bit is bit 0, least significant bit is bit 15) as is usual with space data systems.

**Instrument/Experiment:**

As Roland is, itself, considered to be an instrument of the Rosetta spacecraft, this document refers to Ptolemy as an “experiment” or “subsystem”

### *1.1.2 Acronyms*

| | |
|---|---|
| ADC | Analogue to Digital Converter |
| ASIC | Applications Specific Integrated Circuit (i.e a custom chip) |
| CASE | Comet Atmosphere Sampling Experiment (special oven for atmosphere sampling) |
| CDMS | Command and Data Management System (Lander on-board computer) |
| DAC | Digital to Analogue Converter |
| DEU | Double Event Upset (two upsets occurring in EDAC memory an so uncorrectable) |
| EDAC | Error Detection And Correction (Memory that can correct for SEUs) |
| FPGA | Field Programmable Gate Array (such as the ACTEL chip on processor card) |
| HK | House Keeping - telemetry required to confirm correct operation of instrument |
| HT | High Tension (high voltage - ~2kV in this case) |
| HTO | High Temperature Oven |
| HV | High voltage (same as HT) |
| I2C | Inter-IC - a serial bus protocol for transferring data between ICs. |
| IC | Integrated Circuit |
| MIPS | Millon Instructions Per Second |
| MORSP | Modulus On-board Real-time Software (Ptolemy) |
| MS | Most significant (High) |
| MTO | Medium Temperature Oven |
| LS | Least significant (Low) |
| OU | Open University |
| RAL | Rutherford Appleton Laboratory |
| RICA | Rosetta Ion-Counter ASIC – one of the ASICs used to control & read the Ion-trap |
| SEU | Single Even Upset (a single bit in a register or memory location is corrupted) |
| SCIF | Space Craft Interface – FPGA that controls interface with the Lander CDMS |
| TC | Telecommands |
| Tlm | Telemetry |
| TM | Telemetry |
| WGA | Waveform Generator ASIC – the other ASIC used to control & read the Ion-trap |

## 1.2 References

### *1.2.1 Applicable Documents*

Mise en forme : Puces et numéros

| | | |
|---|---|---|
| AD1 | | REID-A |
| AD2 | ESA PSS 05 | Software Engineering Standards |
| AD3 | BSC(96)2 issue 1 | Guide to applying PSS 05 to small software projects |

### *1.2.2 Reference Documents*

Mise en forme : Puces et numéros

| | | |
|---|---|---|
| RD1 | RO-PTO-RS-0001/EID B | REID-B |
| RD2 | | Rosetta Lander Subsystems and Instruments Electrical Interface Definition and Generic Payload Control |

## 2. EXPERIMENT TELECOMANDS

### 2.1 Overview

Mise en forme : Puces et numéros

Ptolemy receives TC messages from the lander CDMS as a serial data stream containing an integral number of 16 bit words up to a maximum of 32 words. A description of the protocol for the exchange of this data is found in RD2 3.3.3, 3.3.4 and 3.3.5. In this document, the possible command messages are detailed together with Ptolemy's interpretation.

The Ptolemy TC messages have a format that complies with the PUS standards for Orbiter instruments as described in AD1 2.7.2.2. However, these messages are not treated as packets by the Orbiter DMS or the Lander CDMS but as data fields private to Ptolemy, to be passed on without checks or processing.

The first 5 words of a Ptolemy TC message (0 to 4) contain header information and identify the command type and subtype. The last word holds a CRC over the words in the packet which is calculated in the same way as for the PUS packets for Rosetta. The remaining words (5 to n-2 where the message is n words long) may be allocated to command parameters. A command may have from 0 to 26 parameters.

| Command | Type | Sub-type | No. params | |
|---|---|---|---|---|
| Command type 6 – Memory Management | | | | |
| Load Memory | 6 | 2 | 5-26 | 1-6 memory load blocks |
| Dump Memory | 6 | 5 | 4-25 | 1-8 memory dump blocks |
| Check Memory | 6 | 9 | 4-25 | 1-8 memory check blocks |
| Command Type 17 – Connection Test | | | | |
| Connection Test | 17 | 1 | 0 | |
| **Private commands** | | | | |
| Command type 192 – Ptolemy Memory Management | | | | |
| Copy memory | 192 | 1 | 6-26 | 1-5 memory copy blocks |
| Command type 193 – Ptolemy Mode Selection | | | | |
| Standby | 193 | 0 | 3 | page:offset:stored TC enb/dis |
| Ground Test | 193 | 1 | 1 | 1:He tank 1, 2:He tank 2 |
| Post Launch | 193 | 2 | 0 | |
| Cruise Phase | 193 | 3 | 0 | |
| Instrument Checkout | 193 | 4 | 0 | |
| HTO Conditioning | 193 | 5 | 1 | Oven ID |
| MTO Conditioning | 193 | 6 | 1 | Oven ID |
| CASE Conditioning | 193 | 7 | 1 | Oven ID |
| Survival Evaluation | 193 | 8 | 0 | |
| Helium Tank Rupture | 193 | 9 | 1 | 1:He tank 1, 2:He tank 2 |
| Dynamic Pre-operations | 193 | 10 | 1 | 1:He tank 1, 2:He tank 2 |
| Calibration | 193 | 11 | 1 | 1:He tank 1, 2:He tank 2 |
| Ice Core Analysis (HTO) | 193 | 12 | 1 | 1:He tank 1, 2:He tank 2 |
| Atmosphere Analysis | 193 | 13 | 1 | 1:He tank 1, 2:He tank 2 |
| Silicate Analysis | 193 | 14 | 1 | 1:He tank 1, 2:He tank 2 |
| Ice Core Analysis (MTO) | 193 | 15 | 1 | 1:He tank 1, 2:He tank 2 |
| Additional Science | 193 | 16 | 1 | 1:He tank 1, 2:He tank 2 |
| Safe | 193 | 255 | 0 | |
| Command type 194 – Ptolemy Hazardous Function | | | | |
| Hazardous Function | 194 | 1 | 6 | level ctl , PWM, on/off ctl masks |
| Command type 195 – Ptolemy Parameter Update | | | | |
| Parameter update | 195 | 1 | 4-26 | offset, length, parameters |

Mise en forme : Puces et numéros

### 2.2 Load_memory – Patch one or more blocks of memory

This TC allows patching of RAM or EEPROM

| Summary | Hex | Decimal |
|---|---|---|
| Command type | 06 | 6 |
| Command subtype | 02 | 2 |
| Number of parameters | 05-19 | 5-26 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | n*2-7 | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1X06H | X=1 -> ack; X=0 -> no ack<br>06 – Memory Management |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0200H | 02 – Load Memory<br>00 – not used |
| 05 | Memory ID (MS byte)<br>Block count (LS byte) | NNMMH | NN – Mem ID:<br>96H – PROM<br>97H – EEPROM<br>98H – RAM<br>MM – block count (1-6) |
| 06 | Memory Page | 0004-000FH | Physical page number for 1st patch (EEPROM/RAM only) |
| 07 | Patch Offset | 0000-FFFEH | Offset into page for 1st patch |
| 08 | Patch length | 0000-0016H | Number of words in 1st patch |
| 09 | Patch data | 0000-FFFFH | 1st word of 1st patch |
| 10-n-2 | Further patch data/patch blocks | | Data of 1st patch may continue. Further blocks also allowed to max of 6. |
| n-1 | Checksum | CRC over 0-n-2 | Checksum for TC as used in PUS for Rosetta |

### 2.3 Dump_memory – Dump one or more blocks of memory

This TC allows dumping of any memory area.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | 06 | 6 |
| Command subtype | 05 | 5 |
| Number of parameters | 04-19 | 4-25 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | n*2-7 | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1X06H | X=1 -> ack; X=0 -> no ack<br>06 – Memory Management |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0500H | 05 – Dump Memory<br>00 – not used |
| 05 | Memory ID (MS byte)<br>Block count (LS byte) | NNMMH | NN – Mem ID<br>MM – block count |
| 06 | Memory Page | 0000-0001H<br>0004-000FH | Physical page number for 1st dump (excludes I/O pages) |
| 07 | Dump Offset | 0000-FFFEH | Offset into page for 1st dump |
| 08 | Dump length | 0000-00xxH | Number of words in 1st dump |
| 09 | [Memory page] | 0000-000FH | Physical page for 2nd dump, if any else 0 |
| 10 | [Dump Offset] | 0000-FFFEH | Offset into page for 2nd dump if any else 0 |
| 11 | [Dump length] | 0000-00xxH | Length of 2nd dump if any, else 0 |
| 12-(n-2) | [Further Dump blocks] | | May specify up to 6 further such blocks. Places for unused blocks set to all 0s |
| … | | | |
| (n-1) | Checksum | CRC over 0-(n-2) | Checksum for TC as used in PUS for Rosetta |

### 2.4 Check_memory – Perform checksum over one or more blocks of memory

This TC performs a simple checksum (sum of words in block, discarding carrys) over the specified blocks of memory.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | 06 | 6 |
| Command subtype | 09 | 9 |
| Number of parameters | 04-19 | 4-25 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | n*2-7 | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1X06H | X=1 -> ack; X=0 -> no ack<br>06 – Memory Management |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0900H | 09 – Check Memory<br>00 – not used |
| 05 | Memory ID (MS byte)<br>Block count (LS byte) | NNMMH | NN – Mem ID<br>MM – block count |
| 06 | Memory Page | 0000-0001H<br>0004-000FH | Physical page number for 1st block (excludes I/O pages) |
| 07 | Block Offset | 0000-FFFEH | Offset into page for 1st block |
| 08 | Block length | 0000-xxxxH | Number of words in 1st Block |
| 09-(n-2) | May specify further blocks in format as for words 6-8 | as words 6-8 | Total block length may not exceed 1 page (8000H words) |
| n-1 | Checksum | CRC over 0 -(n-2) | Checksum for TC as used in PUS for Rosetta |

### 2.5 Connection_test – To test that instrument is receiving TCs

This TC has no function except to verify that a TC/TM connection exists to the instrument.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | 11 | 17 |
| Command subtype | 01 | 1 |
| Number of parameters | 00 | 0 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 05H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1X11H | X=1 -> ack; X=0 -> no ack<br>11 – Connection test |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0100H | 01 – Connection test<br>00 – not used |
| 05 | Checksum | CRC over 0-4 | Checksum for TC as used in PUS for Rosetta |

### 2.6 Copy_memory – Copy memory from one block to another

This TC performs a copy of memory from one memory block (page, offset) to another.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C0 | 192 |
| Command subtype | 01 | 1 |
| Number of parameters | 06-1A | 6-26 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | n*2-7 | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC0H | X=1 -> ack; X=0 -> no ack<br>C0 – Ptolemy Memory Mangmt |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0100H | 01 – Copy Memory<br>00 – not used |
| 05 | Block count | 0001-0005H | Number of Memory copy blocks to expect |
| 06 | Source Page | 0000-0001H<br>0004-000FH | Source page number for 1st block (exclude I/O pages) |
| 07 | Source Offset | 0000-FFFEH | Offset into page of Source for 1st block |
| 08 | Destination Page | 0000H<br><br>0001H<br><br>0004-000FH | Destination page for 1st block is data page selected at start-up<br>Destination page for 1st block is program page selected at start-up<br>Destination page number for 1st block (in EEPROM or RAM) |
| 09 | Destination Offset | 0000-FFFEH | Offset into page of Destination for 1st block |
| 10 | Block length | 0000-00xxH | Number of words to copy in 1st Block |
| 11-(n-2) | may have further records as words 06-10 | | Total block length may not exceed 1 page (8000H words) |
| n-1 | Checksum | CRC over 0-(n-2) | Checksum for TC as used in PUS for Rosetta |

### 2.7 Start_standby – Select Instrument mode – Start standby from safe mode

This TC is sent to effect transition from safe (ROM) mode to science mode which is entered in Standby mode.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 00 | 0 |
| Number of parameters | 03 | 3 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 0BH | Total length in bytes-7 (=11 decimal) |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0000H | 00 – Standby |
| 05 | Science mode code page | 0000H<br><br>0001H<br><br>0008H-000FH | Page for science s/w entry point is code page in RAM as selected at start-up<br>Page for science s/w entry is 1 (execute in PROM)<br>Code page (in RAM) of entry point for science mode S/W |
| 06 | Science mode entry point | 0000H-FFFEH | Offset of entry point on code page (even address) |
| 07 | Stored TC enbl/disbl | 0000H-0001H | 0: Exec. stored TCs disabled<br>1: Exec. stored TCs enabled |
| 08 | Checksum | CRC over 0-7 | Checksum for TC as used in PUS for Rosetta |

### 2.8 Select_Ground_Test – Select Instrument mode – Ground Test

This TC is sent to effect transition from Standby mode to Ground Test mode

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 01 | 1 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 07H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0100H | 01 – Ground Test |
| 05 | Helium tank to use | 1 or 2 | 1: He tank1<br>2: He tank2 |
| 06 | Checksum | CRC over 0-5 | Checksum for TC as used in PUS for Rosetta |

### 2.9 Select_Post_Launch – Select Instrument mode – Post Launch

This TC is sent to effect transition from Standby mode to Post Launch mode

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 02 | 2 |
| Number of parameters | 00 | 0 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 05H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0200H | 02 – Post Launch |
| 05 | Checksum | CRC over 0-4 | Checksum for TC as used in PUS for Rosetta |

### 2.10 Select_Cruise_Phase – Select Instrument mode – Cruise Phase

This TC is sent to effect transition from Standby mode to Cruise Phase mode

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 03 | 3 |
| Number of parameters | 00 | 0 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 05H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0300H | 03 – Cruise Phase |
| 05 | Checksum | CRC over 0-4 | Checksum for TC as used in PUS for Rosetta |

### 2.11 Select_Instrument_Checkout – Select Instrument mode – Instrument Checkout

This TC is sent to effect transition from Standby mode to Instrument Checkout mode.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 04 | 4 |
| Number of parameters | 00 | 0 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 05H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0400H | 04 – Instrument Checkout |
| 05 | Checksum | CRC over 0-4 | Checksum for TC as used in PUS for Rosetta |

### 2.12 Select_HTO_Conditioning – Select Instrument mode – HTO conditioning

This TC is sent to effect transition from Standby mode to “High Temperature Oven Conditioning” mode. This mode is used to condition high temperature ovens

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 05 | 5 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 0BH | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0500H | 05 – HTO Conditioning |
| 05 | Oven ID | valid HTO ID | Oven to be conditioned |
| 06 | Carousel Position | 0-21600 Dec. | Position of carousel for specified oven ID (arcmins) |
| 07 | Position tolerance | 0-FFFFH | Tolerance of sepcified carousel position (arcmins) |
| 08 | Checksum | CRC over 0-7 | Checksum for TC as used in PUS for Rosetta |

### 2.13 Select_MTO_Conditioning – Select Instrument mode – MTO conditioning

This TC is sent to effect transition from Standby mode to “Medium Temperature Oven Conditioning” mode. This mode is used to condition medium temperature ovens

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 06 | 6 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 0BH | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0600H | 06 – MTO conditioning |
| 05 | Oven ID | valid MTO ID | Oven to be conditioned |
| 06 | Carousel Position | 0-21600 Dec. | Position of carousel for specified oven ID (arcmins) |
| 07 | Position tolerance | 0-FFFFH | Tolerance of sepcified carousel position (arcmins) |
| 08 | Checksum | CRC over 0-7 | Checksum for TC as used in PUS for Rosetta |

### 2.14 Select_CASE_Conditioning Select Instrument Mode – CASE conditioning

This TC is sent to effect transition from Standby mode to "Comet Atmosphere Sampling Experiment Conditioning" mode. This mode is used to condition the CASE oven.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 07 | 7 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 0BH | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0700H | 07 – CASE conditioning |
| 05 | Oven ID | CASE oven ID | Oven to be conditioned |
| 06 | Carousel Position | 0-21600 Dec. | Position of carousel for specified oven ID (arcmins) |
| 07 | Position tolerance | 0-FFFFH | Tolerance of sepcified carousel position (arcmins) |
| 08 | Checksum | CRC over 0-7 | Checksum for TC as used in PUS for Rosetta |

### 2.15 Select_Survival_Evaluation – Select Instrument mode – Survival Evaluation

This TC is sent to effect transition from Standby mode to Survival Evaluation mode.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 08 | 8 |
| Number of parameters | 00 | 0 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 05H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0800H | 08 – Survival Evaluation |

| | | | |
|---|---|---|---|
| 05 | Checksum | CRC over 0-4 | Checksum for TC as used in PUS for Rosetta |

### 2.16 Select_He_Rupture – Select Instrument mode – He Tank Rupture

This TC is sent to effect transition from Standby mode to Dynamic Pre-operations mode.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 09 | 9 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 07H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0900H | 09 – He tank rupture |
| 05 | Helium tank selection | 0001-0002H | 1: He tank 1<br>2: He tank 2 |
| 06 | Checksum | CRC over 0-5 | Checksum for TC as used in PUS for Rosetta |

### 2.17 Select_Dynamic_Preops – Select Instrument mode – Dynamic Pre-operations

This TC is sent to effect transition from Standby mode to Dynamic Pre-operations mode.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 0A | 10 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 07H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0A00H | 0A – Dynamic Pre-operations |
| 05 | Helium tank selection | 0001-0002H | 1: He tank 1<br>2: He tank 2 |

| | | | |
|---|---|---|---|
| 06 | Checksum | CRC over 0-5 | Checksum for TC as used in PUS for Rosetta |

### 2.18 Select_Calibration – Select Instrument mode – Calibration

This TC is sent to effect transition from Standby mode to Calibration mode.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 0B | 0B |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 07H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0B00H | 0B – calibration |
| 05 | Helium tank selection | 0001-0002H | 1: He tank 1<br>2: He tank 2 |
| 06 | Checksum | CRC over 0-5 | Checksum for TC as used in PUS for Rosetta |

### 2.19 Select_Ice_Core_analysis_HTO – Select Instrument mode – Ice core anal (HTO)

This TC is sent to effect transition from Standby mode to Ice Core Analysis (High Temperature Ovens) mode. This mode is also known as “Science 1” and is currently projected as the first (and highest Priority) science measurement to be made by Ptolemy after landing.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 0C | 12 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 07H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0C00H | 0C – Ice Core Analysis (HTO) |

| | | | |
|---|---|---|---|
| 05 | Helium tank selection | 0001-0002H | 1: He tank 1<br>2: He tank 2 |
| 06 | Checksum | CRC over 0-5 | Checksum for TC as used in PUS for Rosetta |

### 2.20 Select_Atmosphere_Analysis – Select Instrument mode – Atmosphere Analysis

This TC is sent to effect transition from Standby mode to Atmosphere Analysis mode.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 0D | 13 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 07H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0D00H | 0D – Atmosphere Analysis |
| 05 | Helium tank selection | 0001-0002H | 1: He tank 1<br>2: He tank 2 |
| 06 | Checksum | CRC over 0-5 | Checksum for TC as used in PUS for Rosetta |

### 2.21 Select_Silicate_Analysis – Select Instrument mode – Silicate Analysis

This TC is sent to effect transition from Standby mode to Silicate Analysis mode.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 0E | 14 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 07H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0E00H | 0E – Silicate Analysis |
| 05 | Helium tank selection | 0001-0002H | 1: He tank 1<br>2: He tank 2 |

| | | | |
|---|---|---|---|
| 06 | Checksum | CRC over 0-5 | Checksum for TC as used in PUS for Rosetta |

### 2.22 Select_Ice_Core_Analysis_MTO – Select Instrument mode – Ice Core Anal. (MTO)

This TC is sent to effect transition from Standby mode to Ice Core Analysis (Medium Temperature Ovens) mode.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 0F | 15 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 07H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0F00H | 0F – Ice core Analysis (MTO) |
| 05 | Helium tank selection | 0001-0002H | 1: He tank 1<br>2: He tank 2 |
| 06 | Checksum | CRC over 0-5 | Checksum for TC as used in PUS for Rosetta |

### 2.23 Select_Additional_Science – Select Instrument mode – Additional Science

This TC is sent to effect transition from Standby mode to Additional Science mode

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | 10 | 16 |
| Number of parameters | 01 | 1 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 07H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 1000H | 10 – Survival Evaluation |
| 05 | Helium tank selection | 0001-0002H | 1: He tank 1<br>2: He tank 2 |

| | | | |
|---|---|---|---|
| 06 | Checksum | CRC over 0-5 | Checksum for TC as used in PUS for Rosetta |

### 2.24 Select_safe – Select Instrument Mode – Return to safe mode

This TC is sent to effect transition to safe (ROM) mode

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C1 | 193 |
| Command subtype | FF | 255 |
| Number of parameters | 00 | 0 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 05H | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC1H | X=1 -> ack; X=0 -> no ack<br>C1 – Ptolemy Mode Selection |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | FF00H | FF – start safe mode |
| 05 | Checksum | CRC over 0-4 | Checksum for TC as used in PUS for Rosetta |

### 2.25 Hazardous_function_Enable – Enable/disable hazardous functions

This TC loads a (16 bit) masks of enable/disable bits for hazardous functions. These masks are copied into hardware registers where they electrically enable and disable the switching on of hazardous controls. The flight software never autonomously enables any of these lines.

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C2 | 194 |
| Command subtype | 01 | 1 |
| Number of parameters | 03 | 3 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | 0BH | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC2H | X=1 -> ack; X=0 -> no ack<br>C2 – Hazardous function |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0100H | 01 – Enable/Disable |
| 05 | PWM enbl/disbl mask | XXXXH | enable/disable mask for software PWM |
| 06 | Valve enbl/disbl mask | XXXXH | enable disable mask for the valve (on/off) outputs. |
| 07 | Critical function enable/disable mask | XXXXH | enable/disable mask for the critical function outputs |
| 08 | Checksum | CRC over 0-7 | Checksum for TC as used in PUS for Rosetta |

Supprimé : is
Supprimé : is
Supprimé : a
Supprimé : it
Supprimé : s
Supprimé : s
Supprimé : 2
Supprimé : 2
Supprimé : D
Supprimé : 7
Supprimé : 8
Supprimé : 9
Supprimé : 8

### 2.26 Parameter_Update – Update Software Parameters

This TC allows updating of entries in a table of software parameters (sometimes called "variable constants").

| Summary | Hex | Decimal |
|---|---|---|
| Command type | C3 | 195 |
| Command subtype | 01 | 1 |
| Number of parameters | 04-1A | 4-26 |

| Word | Description | Contents | Comment |
|---|---|---|---|
| 00 | Packet ID | 1F3CH | |
| 01 | Packet sequence control | C000H to C7FFH | Top 5 bits always 11000B |
| 02 | Packet length | n*2-7 | Total length in bytes-7 |
| 03 | Administration (MS byte)<br>Type (LS byte) | 1XC3H | X=1 -> ack; X=0 -> no ack<br>C3 – Parameter update |
| 04 | Subtype (MS byte)<br>Pad byte (LS byte) | 0100H | 01 – Parameter update |
| 05 | Offset into Table | 0-Range-1 | Range shall be determined at compile time. <FFFEH |
| 06 | Number of parameters | 0001-0018H | number of consecutive paramers to update; 1-24 |
| 07 | First Parameter value | 0000-FFFFH | new value for 1st parameter (at Table+Offset) |
| 08-(n-2) | [Possible Further Parameters] | [0000-FFFFH] | Up to 23 further parameters |
| n-1 | Checksum | CRC over 0-(n-2) | Checksum for TC as used in PUS for Rosetta |

## 3. EXPERIMENT TELEMETRY

### 3.1 Overview

Mise en forme : Puces et numéros

The lander acquires two distinct types of telemetry:

- Housekeeping data (HK)
- Science Data

Both types of data are transmitted from the Lander in a packet containing either 128 words of HK data or 128 words of science data.

The housekeeping packet contains a number of the following:

- Ptolemy HK packets (digital and analogue status)
- Ptolemy TC acknowledge packets
- Ptolemy event packets

The first 32 words always contain either a Ptolemy concise HK packet or the first 32 words of a Ptolemy complete HK packet (format of 1st 32 words is the same).

The science packet contains one of the following

- A measurement data packet – part or all of a mass spectrum
- An auxiliary data packet – time tagged non-measurement analogue data
- A memory dump packet

The Ptolemy packets have a format that complies with the PUS standards for Orbiter instruments as described in AD1 2.7.2.2. However, these packets are not handled as such by the lander and orbiter but are embedded in Lander HK and Science packets.

| Packet | Packet ID | Type | Sub-type | Length (bytes) | Struct. ID | |
|---|---|---|---|---|---|---|
| Ptolemy Concise HK | 0F34H | 3 | 25 | 64 | 1 | |
| Ptolemy Complete HK | 0F34H | 3 | 25 | 96 | 2 | |
| Ptolemy TC Acceptance | 0F31H | 1 | 1 | 32 | - | |
| Ptolemy TC Acceptance failure | 0F31H | 1 | 2 | 32 | - | |
| Ptolemy Normal Progress Event | 0F37H | 5 | 1 | 64 | - | |
| Ptolemy Warning Event | 0F37H | 5 | 2 | 64 | - | |
| Ptolemy Memory Dump | 0F39H | 6 | 6 | 256 | - | |
| Ptolemy Aux Data | 0F3CH | 20 | 3 | 256 | 1 | |
| Ptolemy Summary Spectrum | 0F3CH | 20 | 3 | 256 | 2 | 56 highest points |
| Ptolemy Complete Spectrum | 0F3CH | 20 | 3 | 256 | 3 | part of <=1024 point spectrum |

## 3.2 Ptolemy Concise HK Packet Contents

Mise en forme : Puces et numéros

| Data Field | Field Structure | | | Remarks |
|---|---|---|---|---|
| | Word | Start bit | No. bits | |
| Packet ID | 0 | 0 | 16 | version, type, APID, category =0F34H |
| Seq control | 1 | 0 | 16 | =C000H ORed with 14 bit sequence count |
| Length | 2 | 0 | 15 | =39H: (Packet length in bytes –7) |
| Time | 3 | 0 | 48 | Time code at which sensor acquisition initiated |
| PUS | 6 | 0 | 8 | =64: PUS/chksum flag |
| Packet type | 6 | 8 | 8 | packet type |
| Subtype | 7 | 0 | 8 | Packet subtype |
| | 7 | 8 | 8 | =0 – not used |
| Structure ID | 8 | 0 | 16 | =1 (concise packet) Packet structure ID |
| Ptl mode | 9 | 0 | 8 | Ptolemy Operating mode |
| TC mode | 9 | 8 | 8 | TC mode (zero in safe mode) |
| Line number | 10 | 0 | 16 | Line number for current mode event (zero in safe mode) |
| St TCs rqd | 11 | 0 | 16 | Number of stored TCs requested (zero in safe mode) |
| St TCs rcvd | 12 | 0 | 16 | Number of stored TCs received (zero in safe mode) |
| TCtype | 13 | 0 | 8 | Type of last received TC (zero if no TC received) |
| TCsubtype | 13 | 8 | 8 | Subtype of last TC received (zero if no TC received) |
| tR1 | 14 | 0 | 8 | reactor R1 thermocouple reading |
| tR2 | 14 | 8 | 8 | reactor R2 thermocouple reading |
| tR4 | 15 | 0 | 8 | reactor R4 thermocouple reading |
| tR5 | 15 | 8 | 8 | reactor R5 thermocouple reading |
| tR6 | 16 | 0 | 8 | reactor R6 thermocouple reading |
| tR7 | 16 | 8 | 8 | reactor R7 thermocouple reading |
| tR8 | 17 | 0 | 8 | reactor R8 thermocouple reading |
| tR9 | 17 | 8 | 8 | reactor R9 thermocouple reading |
| tR13 | 18 | 0 | 8 | reactor R13 thermocouple reading |
| tR15 | 18 | 8 | 8 | reactor R15 thermocouple reading |
| tLV1 | 19 | 0 | 8 | Lindau valve 1 thermocouple reading |
| tLV2 | 19 | 8 | 8 | Lindau valve 2 thermocouple reading |
| tLV5 | 20 | 0 | 8 | Lindau valve 5 thermocouple reading |
| tLV6 | 20 | 8 | 8 | Lindau valve 6 thermocouple reading |
| tLV7 | 21 | 0 | 8 | Lindau valve 7 thermocouple reading |
| tGC | 21 | 8 | 8 | Thermocouple reading for Gas Chromatograph columns |
| tENCA | 22 | 0 | 8 | Thermal Enclosure A thermocouple reading |
| tENCB | 22 | 8 | 8 | Thermal Enclosure B thermocouple reading |
| tION | 23 | 0 | 8 | Ion Trap thermocouple reading |
| tOVEN | 23 | 8 | 8 | Oven thermocouple reading |
| tPIPE | 24 | 0 | 8 | Pipe heater thermocouple reading |
| pG1 | 24 | 8 | 8 | Pressure of Helium as indicated by sensor G1 |
| pG2 | 25 | 0 | 8 | Pressure of Helium as indicated by sensor G2 |
| pG3 | 25 | 8 | 8 | Absolute pressure as indicated by sensor G3 |
| pG4 | 26 | 0 | 8 | Pressure of Helium as indicated by sensor G4 |
| pG5 | 26 | 8 | 8 | Differential pressure as indicated by sensor G5 |
| tR14 | 27 | 0 | 8 | Reactor R14 thermocouple reading |
| AD590 | 27 | 8 | 8 | Reference junction thermometer (AD590) |
| vDS | 28 | 0 | 8 | Docking station potentiometer |
| iNT | 28 | 8 | 8 | Nanotip drive current |
| vDET | 29 | 0 | 8 | Detector Bias |
| v5V | 29 | 8 | 8 | 5V voltage monitor |
| v28V | 30 | 0 | 8 | 28V voltage monitor |
| i5V | 30 | 8 | 8 | Current monitored on 5 volt rail |
| i28V | 31 | 0 | 8 | Current monitored on 28V bus |
| vRFCAL | 31 | 8 | 8 | RF calibration |

Mis en forme : Français (France)

| | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00 | Version/type = 1 | | | | | Application ID | | | | | | | | | | |
| 01 | Seg bits | | Packet sequence count | | | | | | | | | | | | | |
| 02 | Packet length | | | | | | | | | | | | | | | |
| 03 | Time code 0 | | | | | | | | | | | | | | | |
| 04 | Time code 1 | | | | | | | | | | | | | | | |
| 05 | Time code 2 | | | | | | | | | | | | | | | |
| 06 | PUS/cksum = 64 | | | | | | | | Packet type | | | | | | | |
| 07 | Packet subtype | | | | | | | | Not used = 0 | | | | | | | |
| 08 | Structure ID =1 | | | | | | | | | | | | | | | |
| 09 | Operating mode | | | | | | | | TC mode | | | | | | | |
| 10 | Line number for current mode event | | | | | | | | | | | | | | | |
| 11 | Number of stored TCs requested | | | | | | | | | | | | | | | |
| 12 | Number of stored TCs received | | | | | | | | | | | | | | | |
| 13 | TCtype | | | | | | | | TCsubtype | | | | | | | |
| 14 | tR1 | | | | | | | | tR2 | | | | | | | |
| 15 | tR4 | | | | | | | | tR5 | | | | | | | |
| 16 | tR6 | | | | | | | | tR7 | | | | | | | |
| 17 | tR8 | | | | | | | | tR9 | | | | | | | |
| 18 | tR13 | | | | | | | | tR15 | | | | | | | |
| 19 | tLV1 | | | | | | | | tLV2 | | | | | | | |
| 20 | tLV5 | | | | | | | | tLV6 | | | | | | | |
| 21 | tLV7 | | | | | | | | tGC | | | | | | | |
| 22 | tENCA | | | | | | | | tENCB | | | | | | | |
| 23 | tION | | | | | | | | tOVEN | | | | | | | |
| 24 | tPIPE | | | | | | | | pG1 | | | | | | | |
| 25 | pG2 | | | | | | | | pG3 | | | | | | | |
| 26 | pG4 | | | | | | | | pG5 | | | | | | | |
| 27 | tR14 | | | | | | | | AD590 | | | | | | | |
| 28 | vDS | | | | | | | | iNT | | | | | | | |
| 29 | vDET | | | | | | | | v5V | | | | | | | |
| 30 | v28V | | | | | | | | i5V | | | | | | | |
| 31 | i28V | | | | | | | | vRFCAL | | | | | | | |

### 3.3 Ptolemy Complete HK Packet Contents

| Data Field | Field Structure | | | Remarks |
|---|---|---|---|---|
| | Word | Start bit | No. bits | |
| Packet ID | 0 | 0 | 16 | version, type, APID, category =0F34H |
| Seq control | 1 | 0 | 16 | =C000H ORed with 14 bit sequence count |
| Length | 2 | 0 | 15 | =39H: (Packet length in bytes –7) |
| Time | 3 | 0 | 48 | Time code at which sensor acquisition initiated |
| PUS | 6 | 0 | 8 | =64: PUS/chksum flag |
| Packet type | 6 | 8 | 8 | packet type |
| Subtype | 7 | 0 | 8 | Packet subtype |
| | 7 | 8 | 8 | =0 – not used |
| Structure ID | 8 | 0 | 16 | =1 (concise packet) Packet structure ID |
| Ptl mode | 9 | 0 | 8 | Ptolemy Operating mode |
| TC mode | 9 | 8 | 8 | TC mode (zero in safe mode) |
| Line number | 10 | 0 | 16 | Line number for current mode event (zero in safe mode) |
| St TCs rqd | 11 | 0 | 16 | Number of stored TCs requested (zero in safe mode) |
| St TCs rcvd | 12 | 0 | 16 | Number of stored TCs received (zero in safe mode) |
| TCtype | 13 | 0 | 8 | Type of last received TC (zero if no TC received) |
| TCsubtype | 13 | 8 | 8 | Subtype of last TC received (zero if no TC received) |
| tR1 | 14 | 0 | 8 | reactor R1 thermocouple reading |
| tR2 | 14 | 8 | 8 | reactor R2 thermocouple reading |
| tR4 | 15 | 0 | 8 | reactor R4 thermocouple reading |
| tR5 | 15 | 8 | 8 | reactor R5 thermocouple reading |
| tR6 | 16 | 0 | 8 | reactor R6 thermocouple reading |
| tR7 | 16 | 8 | 8 | reactor R7 thermocouple reading |
| tR8 | 17 | 0 | 8 | reactor R8 thermocouple reading |
| tR9 | 17 | 8 | 8 | reactor R9/R14 thermocouple reading |
| tR13 | 18 | 0 | 8 | reactor R13 thermocouple reading |
| tR15 | 18 | 8 | 8 | reactor R15 thermocouple reading |
| tLV1 | 19 | 0 | 8 | Lindau valve 1 thermocouple reading |
| tLV2 | 19 | 8 | 8 | Lindau valve 2 thermocouple reading |
| tLV5 | 20 | 0 | 8 | Lindau valve 5 thermocouple reading |
| tLV6 | 20 | 8 | 8 | Lindau valve 6 thermocouple reading |
| tLV7 | 21 | 0 | 8 | Lindau valve 7 thermocouple reading |
| tGC | 21 | 8 | 8 | Thermocouple reading for Gas Chromatograph columns |
| tENCA | 22 | 0 | 8 | Thermal Enclosure A thermocouple reading |
| tENCB | 22 | 8 | 8 | Thermal Enclosure B thermocouple reading |
| tION | 23 | 0 | 8 | Ion Trap thermocouple reading |
| tOVEN | 23 | 8 | 8 | Oven thermocouple reading |
| tPIPE | 24 | 0 | 8 | Pipe heater thermocouple reading |
| pG1 | 24 | 8 | 8 | Pressure of Helium as indicated by sensor G1 |
| pG2 | 25 | 0 | 8 | Pressure of Helium as indicated by sensor G2 |
| pG3 | 25 | 8 | 8 | Absolute pressure as indicated by sensor G3 |
| pG4 | 26 | 0 | 8 | Pressure of Helium as indicated by sensor G4 |
| pG5 | 26 | 8 | 8 | Differential pressure as indicated by sensor G5 |
| tR14 | 27 | 0 | 8 | Reactor R14 thermocouple reading |
| AD590 | 27 | 8 | 8 | Reference junction thermometer (AD590) |
| vDS | 28 | 0 | 8 | Docking station potentiometer |
| iNT | 28 | 8 | 8 | Nanotip drive current |
| vDET | 29 | 0 | 8 | Detector Bias |
| v5V | 29 | 8 | 8 | 5V voltage monitor |
| v28V | 30 | 0 | 8 | 28V voltage monitor |
| i5V | 30 | 8 | 8 | Current monitored on 5 volt rail |
| i28V | 31 | 0 | 8 | Current monitored on 28V bus |
| vRFCAL | 31 | 8 | 8 | RF calibration |
| BG Task | 32 | 0 | 16 | Duration of background task execution (units of 0.5s) |
| Valve enable | 33 | 0 | 16 | last value written to Valve Enable Register |
| CF enable | 34 | 0 | 16 | last value written to Critical Functions Enable Register |

Mis en forme : Français (France)

Supprimé : Valve enable

Supprimé : last value written to Valve Enable Register

Supprimé : DAC

Supprimé : DAC

| | | | | |
|---|---|---|---|---|
| PWM enable | 35 | 0 | 16 | last value written to PWM enable register |
| DAC control | 36 | 0 | 16 | last value written to DAC control register |
| Valve control | 37 | 0 | 16 | last value written to Valve control register |
| CF control | 38 | 0 | 16 | last value written to Critical functions control register |
| PWM control | 39 | 0 | 16 | last value written to PWM control register |
| RIU status | 40 | 0 | 16 | sampled contents of RIU status register |
| SReq raised | 41 | 0 | 16 | Last service request code word raised |
| SReq sent | 42 | 0 | 16 | Last service request code word sent to CDMS |
| MES state | 43 | 0 | 16 | Mode Event Sequence State |
| Sci data state | 44 | 0 | 16 | Science data transmission state |
| Mem test addr | 45 | 0 | 16 | Current memory test address |
| TC Verify | 46 | 0 | 16 | Number of TC verify packets awaiting transmission |
| Events | 47 | 0 | 16 | Number of Event packets awaiting transmission |

**Supprimé :** Valve

**Supprimé :** Valve

**Supprimé :** DAC

**Supprimé :** DAC

**Supprimé :** BG Task

**Supprimé :** Background task duration (units of 0.5s)

**Supprimé :** Spare

| | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00 | Version/type = 1 | | | | | Application ID | | | | | | | | | | |
| 01 | Seg bits | | Packet sequence count | | | | | | | | | | | | | |
| 02 | Packet length | | | | | | | | | | | | | | | |
| 03 | Time code 0 | | | | | | | | | | | | | | | |
| 04 | Time code 1 | | | | | | | | | | | | | | | |
| 05 | Time code 2 | | | | | | | | | | | | | | | |
| 06 | PUS/cksum = 64 | | | | | | | | Packet type | | | | | | | |
| 07 | Packet subtype | | | | | | | | Not used = 0 | | | | | | | |
| 08 | Structure ID =2 | | | | | | | | | | | | | | | |
| 09 | Operating mode | | | | | | | | TC mode | | | | | | | |
| 10 | Line number for current mode event | | | | | | | | | | | | | | | |
| 11 | Number of stored TCs requested | | | | | | | | | | | | | | | |
| 12 | Number of stored TCs received | | | | | | | | | | | | | | | |
| 13 | TCtype | | | | | | | | TCSubtype | | | | | | | |
| 14 | tR1 | | | | | | | | tR2 | | | | | | | |
| 15 | tR4 | | | | | | | | tR5 | | | | | | | |
| 16 | tR6 | | | | | | | | tR7 | | | | | | | |
| 17 | tR8 | | | | | | | | tR9 | | | | | | | |
| 18 | tR13 | | | | | | | | tR15 | | | | | | | |
| 19 | tLV1 | | | | | | | | tLV2 | | | | | | | |
| 20 | tLV5 | | | | | | | | tLV6 | | | | | | | |
| 21 | tLV7 | | | | | | | | tGC | | | | | | | |
| 22 | tENCA | | | | | | | | tENCB | | | | | | | |
| 23 | tION | | | | | | | | tOVEN | | | | | | | |
| 24 | tPIPE | | | | | | | | pG1 | | | | | | | |
| 25 | pG2 | | | | | | | | pG3 | | | | | | | |
| 26 | pG4 | | | | | | | | pG5 | | | | | | | |
| 27 | tR14 | | | | | | | | AD590 | | | | | | | |
| 28 | vDS | | | | | | | | iNT | | | | | | | |
| 29 | vDET | | | | | | | | v5V | | | | | | | |
| 30 | v28V | | | | | | | | i5V | | | | | | | |
| 31 | i28V | | | | | | | | vRFCAL | | | | | | | |
| 32 | BG Task | | | | | | | | | | | | | | | |
| 33 | Valve enable | | | | | | | | | | | | | | | |
| 34 | CF enable | | | | | | | | | | | | | | | |
| 35 | PWM enable | | | | | | | | | | | | | | | |
| 36 | DAC control | | | | | | | | | | | | | | | |
| 37 | Valve control | | | | | | | | | | | | | | | |
| 38 | CF control | | | | | | | | | | | | | | | |
| 39 | PWM control | | | | | | | | | | | | | | | |
| 40 | RIU status | | | | | | | | | | | | | | | |
| 41 | SReq raised | | | | | | | | | | | | | | | |
| 42 | SReq sent | | | | | | | | | | | | | | | |
| 43 | MES state | | | | | | | | | | | | | | | |
| 44 | Sci data state | | | | | | | | | | | | | | | |
| 45 | Mem test addr | | | | | | | | | | | | | | | |
| 46 | TC verify | | | | | | | | | | | | | | | |
| 47 | Events | | | | | | | | | | | | | | | |

**Supprimé :** Valve enable

**Supprimé :** DAC

**Supprimé :** Valve

**Supprimé :** DAC

**Supprimé :** BG Task

**Supprimé :** TBD

### 3.4 Ptolemy TC Acceptance

| Data Field | Field Structure | | | Remarks |
|---|---|---|---|---|
| | Word | Start bit | No. bits | |
| Packet ID | 0 | 0 | 16 | =0F31H: version, type, APID, category |
| Seq control | 1 | 0 | 16 | =C000H ORed with 14 bit sequence count |
| Length | 2 | 0 | 15 | =19H: (Packet length in bytes-7) |
| Time | 3 | 0 | 48 | Time code |
| PUS | 6 | 0 | 8 | =64: PUS/chksum flag |
| Packet type | 6 | 8 | 8 | =1: Packet type |
| Subtype | 7 | 0 | 8 | =1: Packet subtype – acceptance success |
| | 7 | 8 | 8 | =0 – not used |
| TC packet ID | 8 | 0 | 16 | The Packet ID of the accepted TC |
| TC Seq. Ctrl | 9 | 0 | 16 | The sequence control field for the accepted TC |
| Unused | 10 | 0 | 96 | 6 unused words, all set to 0 |

### 3.5 Ptolemy TC Acceptance Failure

| Data Field | Field Structure | | | Remarks |
|---|---|---|---|---|
| | Word | Start bit | No. bits | |
| Packet ID | 0 | 0 | 16 | =0F31H: version, type, APID, category |
| Seq control | 1 | 0 | 16 | =C000H ORed with 14 bit sequence count |
| Length | 2 | 0 | 15 | =19H: (Packet length in bytes-7) |
| Time | 3 | 0 | 48 | Time code |
| PUS | 6 | 0 | 8 | =64: PUS/chksum flag |
| Packet type | 6 | 8 | 8 | =1: Packet type |
| Subtype | 7 | 0 | 8 | =2: Packet subtype – acceptance failure |
| | 7 | 8 | 8 | =0 – not used |
| TC packet ID | 8 | 0 | 16 | The Packet ID of the rejected TC |
| TC Seq. Ctrl | 9 | 0 | 16 | The sequence control field for the rejected TC |
| Failure code | 10 | 0 | 16 | Failure code |
| TC pkt type | 11 | 0 | 8 | Packet type of rejected TC |
| TC pkt subtype | 11 | 8 | 8 | Packet subtype of rejected TC |
| Param 3 | 12 | 0 | 16 | 3rd parameter – depends on failure code |
| Param 4 | 13 | 0 | 16 | 4th parameter – depends on failure code |
| Unused | 12 | 0 | 32 | 6 unused words, all set to 0 |

Failure code dependent parameters:

| **Failure code** | **Reason for rejection** | **Parameter 3** | **Parameter 4** | **additional parameters** |
|---|---|---|---|---|
| 1 | Incomplete packet | number of bytes in packet header | number of bytes actually received | No |
| 2 | Incorrect checksum | checksum received in TC packet | expected (calculated) checksum | No |
| 3 | Incorrect Application ID | not used (=0) | not used (=0) | No |
| 4 | Invalid command code | always =0 | always =0 | No |
| 5 | Not allowed in this mode/state | current operating mode or SD2 status | always =0 | No |
| 6 | Packet data field inconsistent | word postion (offset 0) of first field error | Erroneous word value | see following table |

| Additional Parameters for failure code 6 | | | | |
|---|---|---|---|---|
| TC Type | TC Subtype | TC Name | Parameter 5 | Parameter 6 |
| 193 | 5<br>6<br>7 | HTO Conditioning<br>MTO Conditioning<br>CASE Conditioning | SD2 Oven No.<br>SD2 Oven No.<br>Position tolerance | -<br>-<br>SD2 carousel Position |
| 193 | 1<br>9-16 | Ground Test<br>Tank Rupture – Additional Science | Lowest valid tank no.<br>Lowest valid tank no. | Highest valid tank no.<br>Highest valid tank no. |
| 195 | 1 | Parameter Update | Lowest valid number of parameters | Highest valid number of parameters |

### 3.6 Ptolemy Normal Progress Event

| Data Field | Field Structure | | | Remarks |
|---|---|---|---|---|
| | Word | Start bit | No. bits | |
| Packet ID | 0 | 0 | 16 | =0F37H: version, type, APID, category |
| Seq control | 1 | 0 | 16 | =C000H ORed with 14 bit sequence count |
| Length | 2 | 0 | 15 | =39H: (Packet length in bytes-7) |
| Time | 3 | 0 | 48 | Time code |
| PUS | 6 | 0 | 8 | =64: PUS/chksum flag |
| Packet type | 6 | 8 | 8 | =5: Packet type - event |
| Subtype | 7 | 0 | 8 | =1: Packet subtype – normal progress |
| | 7 | 8 | 8 | =0 – not used |
| Event ID | 8 | 0 | 16 | ID for event |
| Event Params | 9 | 0 | 352 | parameters describing event – depends on event ID |

| Normal Progress Events | | |
|---|---|---|
| Event ID (dec.) | Event description | Parameters |
| 55103 | WGA memory check status as produced by WGA memory check Mode Event | 3 words: Spacecraft time when the check was started<br>1 word: number of memory locations with DEU corruption:<br>Special values for this are:<br>FFFFH – All table start addresses are corrupt<br>FFFEH – All or all but one wave start/stop address combinations are corrupt<br>FFFDH – All but 2 or more of table RAM addresses are corrupt<br>FFFCH – All but 7 or more wave RAM addresses are corrupt.<br>If none of the above values, the following parameters are also included:<br>1 word containing the number of locations in the memory that are SEU corrupted<br>18 words or fewer containing a part of the WGA Error Memory Map (this is 192 words long) Each 2 bit field represents the state of a memory location:<br>0 – Error free<br>1 – SEU corrupted<br>2 – DEU corrupted<br><br>11 of these packets make up a WGA memory report. |
| 55107 | Mode Execution Completed | 1 word containing the operating mode just completed. |

| | | | |
|---|---|---|---|
| 55001 | Ptolemy Power-on Start | Param<br>1 (MSbyte)<br>1 (LSbyte)<br>2<br>3<br>4<br>5<br>6<br>7<br>8<br>9,10,11<br>12<br>13<br>14, 15, 16, 17<br>18<br>18 (MSB)<br>18 (15:14)<br><br><br><br><br>18 (13:08)<br>18 (LSB)<br><br>19<br>20 | <br>Startup Type=Start (AAh)<br>Startup Cause= Power-On (00H)<br>DAC control register<br>PWM control register<br>Valve control register<br>Critical functions control register<br>Data bus test result lower RAM devices [1]<br>Address bus test result lower RAM devices [1]<br>Memory locations test result, first page<br>Memory locations test result, remaining pages<br>Data bus test result, upper RAM devices [1]<br>Address bus test result, lower RAM devices [1]<br>Memory locations test result, upper RAM devices<br>Page selection word:<br>Upper RAM device<br>Page 3 test results:<br>00 – all test passed<br>01 – failed memoryl locations test<br>10 – failed address bus test<br>11 – failed data bus test<br>Results for remaining pages as for page 3<br>Lower RAM device – results as for upper RAM device<br>Selected RAM data page<br>Selected RAM code page |
| 55005 | Operating Mode Selection | Parameter:<br>1: Current Operating Mode<br>2: Selected Operating mode<br>3: Mode Selection TC parameter 1<br>4: Mode Selection TC parameter 2<br>5: Mode Selection TC parameter 3 | |
| 55010 | SD2 Backup RAM Received | Parameter:<br>1: SD2 Status<br>2: SD2 Drill Depth<br>3: SD2 Carousel Position<br>4: SD2 Oven Number | |
| 55011 | Ptolemy Backup RAM received | Parameter:<br>1: Carousel Use State<br>2: RF Calibration Word<br>3: Docking station motor upper position<br>4: Docking station motor lower position<br>5: Docking station undocked sensor value<br>6: Docking station docked sensor value | |
| 55113 | RF Frequency Calibration Report | RF calibration word | |
| 55114 | Docking Station Sensor Data | 1-23 words of docking station porentiometer readings used for docking station calibration. Unused (trailing) words filled with zeros. | |

Mis en forme : Italien (Italie)

Mis en forme : Français (France)

Supprimé : Docking Station

Supprimé : RF Calibration Word

| | | |
|---|---|---|
| 55115 | Docking Station Calibration Data | 1: Lowest sensor value<br>2: Highest sensor value<br>3: Docking Station Motor Upper Position<br>4: Docking Station Motor Lower Position<br>5: DAC Maximum value recorded during calibration<br>ADC Maximum value recorded during calibration |

1 – Set bit indicates bus failure for that line

### 3.7 Ptolemy Warning Anomalous Event

| Data Field | Field Structure | | | Remarks |
|---|---|---|---|---|
| | Word | Start bit | No. bits | |
| Packet ID | 0 | 0 | 16 | =0F37H: version, type, APID, category |
| Seq control | 1 | 0 | 16 | =C000H ORed with 14 bit sequence count |
| Length | 2 | 0 | 15 | =39H: (Packet length in bytes-7) |
| Time | 3 | 0 | 48 | Time code |
| PUS | 6 | 0 | 8 | =64: PUS/chksum flag |
| Packet type | 6 | 8 | 8 | =5: Packet type - event |
| Subtype | 7 | 0 | 8 | =2: Packet subtype – normal progress |
| | 7 | 8 | 8 | =0 – not used |
| Event ID | 8 | 0 | 16 | ID for event |
| Event Params | 9 | 0 | 352 | parameters describing event – depends on event ID |

| Anomalous Events | | |
|---|---|---|
| Event ID (dec.) | Event description | Parameters |
| 55101 | Monitor Mode Event Timed out | 6 byte field describing mode event that has timed out<br>1 word containing the sensor value at timeout |
| 55102 | WGA communication error | 6 byte field describing the mode event in which this occurred |
| 55104 | Scan function in WGA does not match that written | 6 byte field describing the mode event in which this occurred |
| 55105 | HT did not ramp to required value within timeout period | 6 byte field describing the mode event in which this occurred<br>1 word containing the reading of the HT voltage sensor at timeout |
| 55106 | Docking station failed to dock/undock within timeout period | 1: Last potientiometer value at timeout<br>2: Target potentiometer value<br>3: Tolerance on target potentiometer value |
| 55108 | Parameters for a mode event are incorrect | 1 word containing the current operating mode<br>1 word containing the line number of the current mode event in the mode event sequence<br>up to 6 bytes describing the mode event in question |
| 55109 | No RAM page available for Science Spectra storeage | 6 byte field describing the mode event in which this occurred |
| 55110 | Spectra storeage data page is full | 6 byte field describing the mode event in which this occurred |
| 55111 | Science data packets buffer is full | 6 byte field describing the mode event in which this occurred |
| 55112 | No RAM page available for Science | 6 byte field describing the mode event in which this occurred |

**Supprimé :** 2 byte field describing the mode event in which this occurred.¶
1 word containing the docking station potentiometer reading at timeout

| | | |
|---|---|---|
| | data packet storeage | |
| 55002 | Ptolemy Failure | 1 (MSB) – Startup Type = Restart (55H)<br>1 (LSB) – Startup Cause = Failure (20H)<br>2: DAC control register<br>3: PWM control register<br>4: Valve control register<br>5: Critical functions control register |
| | | |
| 55003 | Ptolemy Timeout | 1 MSB: Startup Type = Restart (55H0<br>LSB: Startup Cause = Timeout (04H)<br>2 DAC control register<br>3 PWM control register<br>4 Valve control register<br>5 Critical functions control register<br>6 DPR (Data page register)<br>7 UPR (User page register)<br>8 UBR (User base register)<br>9 SPR (Stack pointer register)<br>10 SVR (Stack overflow limits register)<br>11 IVR (Interrupt vector register)<br>12 IBC (Interrupt base/control register)<br>13 IMR (Interrupt mask register)<br>14 CR (Configuration register)<br>15 - 23 first 9 words from return stack |
| 55004 | RSST checksum failure | 1-22 First 22 words of the Receive Service System Status command Message<br>23 Calculated checksum |
| 55006 | Memory check failure | 1: Start address of memory test<br>2: End address of memory test<br>3: Checksum accumulated during memory test<br>4: Checksum expected for memory test |
| 55007 | Safe limit violation | 1: TM channel<br>2: Value from ADC<br>3: Upper safe limit for this channel<br>4: Lower safe limit for this channel |
| 55008 | Operating Limit Excursion | 1: TM channel<br>2: Value from ADC<br>3: Upper operating limit for this channel<br>4: Lower operating limit for this channel |
| 55009 | Operating Limit Return | 1: TM channel<br>2: Value from ADC<br>3: Upper operating limit for this channel<br>4: Lower operating limit for this channel |

Mis en forme : Italien (Italie)

Mis en forme : Italien (Italie)

### 3.8 Ptolemy Memory Dump

| Data Field | Field Structure | | | Remarks |
|---|---|---|---|---|
| | Word | Start bit | No. bits | |
| Packet ID | 0 | 0 | 16 | =0F39H: version, type, APID, category |
| Seq control | 1 | 0 | 16 | =C000H ORed with 14 bit sequence count |
| Length | 2 | 0 | 15 | =F9H: (Packet length in bytes-7) |
| Time | 3 | 0 | 48 | Time code |
| PUS | 6 | 0 | 8 | =64: PUS/chksum flag |
| Packet type | 6 | 8 | 8 | =6: Packet type – Memory Management |
| Subtype | 7 | 0 | 8 | =6: Packet subtype – Memory dump/absolute addressing |
| | 7 | 8 | 8 | =0 – not used |
| Memory ID | 8 | 0 | 8 | ID for memory type as follows:<br>96H – PROM<br>97H – EEPROM<br>98H - RAM |
| No. Blocks | 9 | 8 | 8 | Number of memory dump blocks in packet |
| Start Address 0 | 10 | 0 | 32 | 32 bit start address of 1st memory dump block in packet |
| Block Length 0 | 12 | 0 | 16 | 16 bit length of 1st memory dump block |
| Dump data 0 | 13 | 0 | 16n | n 16 bit words of dump data |
| [further dump blockd] | | | | further memory dump blocks in the same format |
| [zero fill] | | | | Unused space in the packet is filled with words containing 0 |

### 3.9 Ptolemy Auxiliary data

| Data Field | Field Structure | | | Remarks |
|---|---|---|---|---|
| | Word | Start bit | No. bits | |
| Packet ID | 0 | 0 | 16 | =0F3CH: version, type, APID, category |
| Seq control | 1 | 0 | 16 | =C000H ORed with 14 bit sequence count |
| Length | 2 | 0 | 15 | =F9H: (Packet length in bytes-7) |
| Time | 3 | 0 | 48 | Time code – time of first aux data point |
| PUS | 6 | 0 | 8 | =0: PUS/chksum flag |
| Packet type | 6 | 8 | 8 | =20: Packet type – Science |
| Subtype | 7 | 0 | 8 | =3: Packet subtype – Science data packet |
| | 7 | 8 | 8 | =0 – not used |
| Structure ID | 8 | 0 | 16 | =1 Structure ID: Aux data packet |
| No. aux records | 9 | 0 | 16 | Number of aux data records (1-29) |
| Aux time 0 | 10 | 0 | 32 | MS 32 bits of time for collection of aux data point 0 |
| Channel ID 0 | 12 | 0 | 16 | Identifier for analogue channel for aux data point 0 |
| Aux value 0 | 13 | 0 | 16 | 16 bit ADC reading for aux data point 0 |
| [Aux time 1] | 14 | 0 | 32 | MS 32 bits of time for collection of aux data point 1 |
| [Channel ID 1] | 16 | 0 | 16 | Identifier for analogue channel for aux data point 1 |
| [Aux value 1] | 17 | 0 | 16 | 16 bit ADC reading for aux data point 1 |
| [Further records] | 18 | 0 | | further aux data records up to a total of 29 |
| zero fill | | | | unused space in the aux packet is filled with words containing 0 |

### 3.10 Ptolemy Summary Spectrum – 56 highest bins from a spectrum

This packet transfers the compressed (4 bit shift count + 12 bit mantissa) counts for the 56 highest bins in a GC spectrum.

| Data Field | Field Structure | | | Remarks |
|---|---|---|---|---|
| | Word | Start bit | No. bits | |
| Packet ID | 0 | 0 | 16 | =0F3CH: version, type, APID, category |
| Seq control | 1 | 0 | 16 | =C000H ORed with 14 bit sequence count |
| Length | 2 | 0 | 15 | =F9H: (Packet length in bytes-7) |
| Time | 3 | 0 | 48 | Time code – time of first aux data point |
| PUS | 6 | 0 | 8 | =0: PUS/chksum flag |
| Packet type | 6 | 8 | 8 | =20: Packet type – Science |
| Subtype | 7 | 0 | 8 | =3: Packet subtype – Science data packet |
| | 7 | 8 | 8 | =0 – not used |
| Structure ID | 8 | 0 | 16 | =2 Structure ID: GC1 spectrum |
| DEU termination | 9 | 0 | 1 | set if spectrum terminated by double-event upset |
| Poss Data Loss | 9 | 1 | 1 | RICA FIFO was full at least once during spec. collection some measurement data may have been lost |
| | 9 | 1 | 14 | Spare spectrum status bits |
| Overflows | 10 | 0 | 16 | Number of bin overflows in RICA for this spectrum |
| First overflow | 11 | 0 | 16 | Bin number for first bin overflow for this spectrum |
| DEUs | 12 | 0 | 16 | Number of bins corrupted by DEUs |
| First DEU | 13 | 0 | 16 | First bin in spectrum that suffered a DEU |
| | 14 | 0 | 32 | two spare words |
| Bin no. 1st bin | 15 | 0 | 16 | bin number for 1st of 56 highest bins |
| shift count | 16 | 0 | 4 | 4 bit shift count for first bin |
| mantissa 1st bin | 16 | 4 | 12 | mantissa for first bin |
| Bin no. 2nd bin | 17 | 0 | 16 | bin number for 2nd of 56 highest bins |
| shift count | 18 | 0 | 4 | 4 bit shift count for 2nd of 56 highest bins |
| mantissa | 18 | 4 | 12 | 12 bit mantissa for 2nd of 56 highest bins |
| 54 further bins | 19 | 0 | 1728 | bin number, shift count and mantissa for the remaining 54 of the 56 highest bins |

### 3.11 Ptolemy Complete Spectrum – Packet contains part of a complete spectrum

This packet contains part of a GC spectrum. The full spectrum may have up to 1024 bins

| Data Field | Field Structure | | | Remarks |
|---|---|---|---|---|
| | Word | Start bit | No. bits | |
| Packet ID | 0 | 0 | 16 | =0F3CH: version, type, APID, category |
| First pkt flag | 1 | 0 | 1 | If set, this is 1st packet of spectrum |
| Last pkt flag | 1 | 1 | 1 | If set, this is last packet of spectrum |
| Seq. count | 12 | 2 | 14 | Packet sequence count |
| Length | 2 | 0 | 15 | =F9H: (Packet length in bytes-7) |
| Time | 3 | 0 | 48 | Time code – time of first aux data point |
| PUS | 6 | 0 | 8 | =0: PUS/chksum flag |
| Packet type | 6 | 8 | 8 | =20: Packet type – Science |
| Subtype | 7 | 0 | 8 | =3: Packet subtype – Science data packet |
| | 7 | 8 | 8 | =0 – not used |
| Structure ID | 8 | 0 | 16 | =3 Structure ID: GC2, part of spectrum |
| DEU termination | 9 | 0 | 1 | set if spectrum terminated by double-event upset |
| Poss Data Loss | 9 | 1 | 1 | RICA FIFO was full at least once during spec. collection some measurement data may have been lost |
| | 9 | 1 | 14 | Spare spectrum status bits |
| Overflows | 10 | 0 | 16 | Number of bin overflows in RICA for this spectrum |
| First overflow | 11 | 0 | 16 | Bin number for first bin overflow for this spectrum |
| DEUs | 12 | 0 | 16 | Number of bins corrupted by DEUs |
| First DEU | 13 | 0 | 16 | First bin in spectrum that suffered a DEU |
| First bin | 14 | 0 | 16 | bin number of first bin in this packet |
| No bins | 15 | 0 | 16 | Number of bins reported in this packet |
| Bin contents | 16 | 0 | 1792 | the values of the identified bins in compressed format (4 bit shift count with 12 bit mantissa) Unused words (in last packet only) are set to 0. May contain up to 112 values. |