

## Table of Contents

|      |                                 |    |
|------|---------------------------------|----|
| 1.   | INTRODUCTION.....               | 3  |
| 2.   | LRS DATA.....                   | 3  |
| 2.1  | DescBlock .....                 |    |
| 2.2  | LRSEngData .....                | 3  |
| 2.3  | LRSAncillary.....               | 4  |
| 2.4  | LRSHousekeeping.....            | 4  |
| 2.5  | LRSBurst .....                  | 4  |
| 2.6  | BurstParams .....               | 5  |
| 2.7  | LRSTableData.....               | 5  |
| 3.   | INSTRUMENT COMMAND FORMATS..... | 6  |
| 3.1  | CommandBlock.....               | 6  |
| 3.2  | LDInitiateCmdFmt.....           | 6  |
| 3.3  | selectTableCmdFmt .....         | 6  |
| 3.4  | getDataCmdFmt .....             | 7  |
| 3.5  | passCommandCmdFmt.....          | 7  |
| 3.6  | passDataCmdFmt.....             | 7  |
| 3.7  | setFreqCmdFmt .....             | 7  |
| 3.8  | setDeviceCmdFmt .....           | 8  |
| 3.9  | selectCoolerCmdFmt.....         | 8  |
| 3.10 | performCoolStrCmdFmt.....       | 8  |
| 3.11 | performPMCCalCmdFmt .....       | 8  |
| 3.12 | performResetCmdFmt .....        | 9  |
| 3.13 | turnOnBurnCmdFmt .....          | 9  |
| 3.14 | sciDatCmdFmt.....               | 9  |
| 3.15 | performDevInitCmdFmt .....      | 9  |
| 3.16 | turnOnBurstCmdFmt .....         | 10 |
| 3.17 | moveMirrorCmdFmt.....           | 10 |
| 3.18 | setHeaterCmdFmt .....           | 10 |
| 3.19 | enableDetectorCmdFmt.....       | 10 |
| 3.20 | turnOnDeviceCmdFmt.....         | 11 |
| 3.21 | setCoolerTempCmdFmt .....       | 11 |
| 3.22 | setCoolerDiodeCmdFmt .....      | 11 |
| 3.23 | enableFuseCmdFmt .....          | 11 |

## Table of Contents (cont'd)

|           |                                    |           |
|-----------|------------------------------------|-----------|
| 3.24      | EEBurnCmdFmt .....                 | 12        |
| 3.25      | ScienceFlags.....                  | 12        |
| 3.26      | DumpHdr .....                      | 12        |
| 3.27      | IndexEntry .....                   | 12        |
| 3.28      | ActiveEntry .....                  | 13        |
| 3.29      | RamBits .....                      | 13        |
| 3.30      | SmallBlock .....                   | 13        |
| 3.31      | LimitTableEntry .....              | 13        |
| 3.32      | HeaterSettingEntry .....           | 14        |
| 3.33      | LRS_bits .....                     | 14        |
| <b>4.</b> | <b>TABLES .....</b>                | <b>15</b> |
| 4.1       | ICMConfig .....                    | 15        |
| 4.2       | ICMStatus .....                    | 15        |
| 4.3       | UpDownTable.....                   | 16        |
| 4.4       | StatisticTable.....                | 16        |
| 4.5       | EngHKTelemetryEntry .....          | 19        |
| 4.6       | TelemSchedule.....                 | 19        |
| 4.7       | SpmTable .....                     | 19        |
| 4.8       | TimingTable.....                   | 20        |
| 4.9       | PmcTable .....                     | 21        |
| 4.10      | StareHeader.....                   | 22        |
| 4.11      | ChannelHeader .....                | 22        |
| <b>5.</b> | <b>CRITICAL TELEMTRY .....</b>     | <b>23</b> |
| 5.1       | CriticalTelem .....                | 23        |
| <b>6.</b> | <b>HOUSEKEEPING TELEMTRY .....</b> | <b>23</b> |
| 6.1       | TelemBlock1.....                   | 25        |
| 6.2       | TelemBlock2.....                   | 29        |
| 6.3       | TelemBlock3.....                   | 32        |
| 6.4       | TelemBlock4.....                   | 33        |
| 6.5       | TelemBlock5.....                   | 35        |
| 6.6       | TelemBlock6.....                   | 36        |
| 6.7       | TelemBlock7.....                   | 37        |
| 6.8       | TelemBlock8.....                   | 38        |
| 6.9       | LastVoltage .....                  | 39        |
| 6.10      | EngTelem .....                     | 41        |

## 1. INTRODUCTION

This document lists data structures found in the MOPITT Instrument commands and telemetry. It is designed to be a reference for users who need detailed information about the actual word and bit structure of the MOPITT Instrument commands and telemetry. The data has been extracted from the C++ program structures used by the ICM code.

## 2. LRS DATA

### 2.1 DescBlock

| Name       | Word | Bit | Width | Description                               |
|------------|------|-----|-------|-------------------------------------------|
| control    | 0    | 0   | 16    | control word                              |
| status_ptr | 1    | 0   | 16    | message status list pointer (word offset) |
| data_ptr   | 2    | 0   | 16    | data list pointer (word offset)           |
| reserved   | 3    | 0   | 16    | unused                                    |

### 2.2 LRSEngData

| Name     | Word | Bit | Width | Description                                     |
|----------|------|-----|-------|-------------------------------------------------|
| unused   | 0    | 0   | 8     | not used, always 0                              |
| msgType  | 0    | 8   | 8     | always 'E', most significant byte of word       |
| nwords   | 1    | 0   | 16    | number of total words in this block             |
| days     | 2    | 0   | 16    | days since Jan. 1, 1958                         |
| msec_msw | 3    | 0   | 16    | milliseconds of the day, most significant word  |
| msec_lsw | 4    | 0   | 16    | milliseconds of the day, least significant word |
| data     | 5    | 0   | 16    | actual engineering data                         |

### 2.3 LRSAncillary

| Name    | Word | Bit | Width | Description                          |
|---------|------|-----|-------|--------------------------------------|
| unused  | 0    | 0   | 8     | not used                             |
| msgType | 0    | 8   | 8     | STARE_HEADER, ('A' = Ancillary Data) |
| data    | 1    | 0   | 16    | actual ancillary data ...            |

### 2.4 LRSHousekeeping

| Name    | Word | Bit | Width | Description                             |
|---------|------|-----|-------|-----------------------------------------|
| unused  | 0    | 0   | 8     | not used                                |
| msgType | 0    | 8   | 8     | STARE_HEADER, ('H' = Housekeeping data) |
| data    | 1    | 0   | 16    | data ...                                |

### 2.5 LRSBurst

| Name       | Word | Bit | Width | Description                                               |
|------------|------|-----|-------|-----------------------------------------------------------|
| unused0    | 0    | 0   | 8     | not used                                                  |
| msgType    | 0    | 8   | 8     | always 'B'                                                |
| numSamples | 1    | 0   | 16    | Total # of 32 bit samples in burst data                   |
| packetLen  | 2    | 0   | 16    | Number of bytes of data in this CCSDS packet              |
| seqNum     | 3    | 0   | 14    | packet sequence number                                    |
| seqFlag    | 3    | 14  | 2     | sequence flag, 1 = first, 0 = cont., 2 = last, 3 = single |
| position   | 4    | 0   | 16    | actual mirror position (11 bits)                          |
| duration   | 5    | 0   | 4     | burst durations                                           |
| pixel      | 5    | 4   | 2     | pixel number                                              |
| channel    | 5    | 6   | 2     | channel number                                            |
| spmNumber  | 5    | 8   | 1     | spm used                                                  |
| unused     | 5    | 9   | 7     | not used                                                  |

## 2.6 BurstParams

| Name      | Word | Bit | Width | Description                                |
|-----------|------|-----|-------|--------------------------------------------|
| duration  | 0    | 0   | 16    | burst duration                             |
| channel   | 1    | 0   | 16    | channel number                             |
| pixel     | 2    | 0   | 16    | pixel number                               |
| table     | 3    | 0   | 16    | optical table number (0/1)                 |
| dma       | 4    | 0   | 16    | dma channel used for burst                 |
| time      | 5    | 0   | 16    | wait time in seconds                       |
| length    | 6    | 0   | 16    | total # of words to send                   |
| maxLength | 7    | 0   | 16    | maximum burst data bytes in a CCSDS packet |
| bufStart  | 8    | 0   | 32    | start of buffer                            |
| count     | 10   | 0   | 16    | # words read from SPM                      |
| ptr       | 11   | 0   | 32    | LRS buffer to hold data                    |
| header    | 13   | 0   | 96    | burst header                               |

## 2.7 LRSTableData

| Name     | Word | Bit | Width | Description                           |
|----------|------|-----|-------|---------------------------------------|
| tableNum | 0    | 0   | 8     | table number, TN_...                  |
| msgType  | 0    | 8   | 8     | always 'T'                            |
| nwords   | 1    | 0   | 16    | Number of words of data in this table |
| flags    | 2    | 0   | 8     | flags setting for this table          |
| primary  | 2    | 8   | 8     | primary table number                  |
| data     | 3    | 0   | 16    | actual table data                     |

### 3. INSTRUMENT COMMAND FORMATS

#### 3.1 CommandBlock

| Name | Word | Bit | Width | Description            |
|------|------|-----|-------|------------------------|
| cmd  | 0    | 0   | 16    | command id             |
| word | 1    | 0   | 16*31 | raw command data words |

#### 3.2 LDInitiateCmdFmt

| Name         | Word | Bit | Width | Description                                     |
|--------------|------|-----|-------|-------------------------------------------------|
| cmd          | 0    | 0   | 16    | command id                                      |
| number       | 1    | 0   | 8     | table number                                    |
| type         | 1    | 8   | 8     | load/dump type                                  |
| startSegment | 2    | 0   | 16    | load/dump address MSW, memory segment           |
| startOffset  | 3    | 0   | 16    | load/dump address LSW, memory offset            |
| wcountMSW    | 4    | 0   | 16    | word count MSW, unused                          |
| wcountLSW    | 5    | 0   | 16    | word count LSW, number of words to load/dump    |
| unused       | 6    | 0   | 16    | verification code MSW, unused                   |
| expectedCRC  | 7    | 0   | 16    | verification code MSW, crc16 value of load data |

#### 3.3 selectTableCmdFmt

| Name   | Word | Bit | Width | Description             |
|--------|------|-----|-------|-------------------------|
| cmd    | 0    | 0   | 16    | command id              |
| number | 1    | 0   | 8     | primary/alternate table |
| type   | 1    | 8   | 8     | table type              |

### 3.4      **getDataCmdFmt**

| Name    | Word | Bit | Width | Description                         |
|---------|------|-----|-------|-------------------------------------|
| cmd     | 0    | 0   | 16    | command id                          |
| type    | 1    | 0   | 16    | 0=memory, 1=I/O space               |
| address | 2    | 0   | 16    | memory offset or port address       |
| segment | 3    | 0   | 16    | memory segment or zero if I/O space |

### 3.5      **passCommandCmdFmt**

| Name   | Word | Bit | Width | Description   |
|--------|------|-----|-------|---------------|
| cmd    | 0    | 0   | 16    | command id    |
| device | 1    | 0   | 8     | device number |
| unused | 1    | 8   | 8     | not used      |
| value  | 2    | 0   | 16    | command       |

### 3.6      **passDataCmdFmt**

| Name    | Word | Bit | Width | Description                         |
|---------|------|-----|-------|-------------------------------------|
| cmd     | 0    | 0   | 16    | command id                          |
| type    | 1    | 0   | 16    | 0=memory, 1=I/O space               |
| address | 2    | 0   | 16    | memory offset or port address       |
| segment | 3    | 0   | 16    | memory segment or zero if I/O space |
| value   | 4    | 0   | 16    | data word                           |

### 3.7      **setFreqCmdFmt**

| Name   | Word | Bit | Width | Description           |
|--------|------|-----|-------|-----------------------|
| cmd    | 0    | 0   | 16    | command id            |
| bus    | 1    | 0   | 1     | bus to use (0=A, 1=B) |
| unused | 1    | 1   | 15    |                       |

### 3.8 setDeviceCmdFmt

| Name   | Word | Bit | Width | Description   |
|--------|------|-----|-------|---------------|
| cmd    | 0    | 0   | 16    | command id    |
| number | 1    | 0   | 16    | device number |
| state  | 2    | 0   | 2     | device state  |
| unused | 2    | 2   | 14    |               |

### 3.9 selectCoolerCmdFmt

| Name   | Word | Bit | Width | Description           |
|--------|------|-----|-------|-----------------------|
| cmd    | 0    | 0   | 16    | command id            |
| number | 1    | 0   | 16    | command string number |

### 3.10 performCoolStrCmdFmt

| Name   | Word | Bit | Width | Description                             |
|--------|------|-----|-------|-----------------------------------------|
| cmd    | 0    | 0   | 16    | command id                              |
| string | 1    | 0   | 8*62  | command string string - \n\0 terminated |

### 3.11 performPMCCalCmdFmt

| Name      | Word | Bit | Width | Description                        |
|-----------|------|-----|-------|------------------------------------|
| cmd       | 0    | 0   | 16    | command id                         |
| pmcNumber | 1    | 0   | 16    | PMC number, 1 or 2                 |
| numSteps  | 2    | 0   | 16    | number of steps in the sweep, [11] |
| startFreq | 3    | 0   | 16    | start frequency, 452 = 22 Hz       |
| stepSize  | 4    | 0   | 16    | step size, 10 = 0.5 Hz             |
| lowAmp    | 5    | 0   | 16    | low amplitude, 20% of high         |
| highAmp   | 6    | 0   | 16    | high amplitude, ??                 |



### 3.12 performResetCmdFmt

| Name    | Word | Bit | Width | Description     |
|---------|------|-----|-------|-----------------|
| cmd     | 0    | 0   | 16    | command id      |
| segment | 1    | 0   | 16    | restart segment |
| offset  | 2    | 0   | 16    | restart offset  |

### 3.13 turnOnBurnCmdFmt

| Name       | Word | Bit | Width | Description                             |
|------------|------|-----|-------|-----------------------------------------|
| cmd        | 0    | 0   | 16    | command id                              |
| srcSeg     | 1    | 0   | 16    | source segment                          |
| srcOffset  | 2    | 0   | 16    | source offset                           |
| destSeg    | 3    | 0   | 16    | destination segment                     |
| destOffset | 4    | 0   | 16    | destination offset                      |
| number     | 5    | 0   | 16    | number of words to burn or table number |
| options    | 6    | 0   | 16    | burn options (see above)                |

### 3.14 sciDatCmdFmt

| Name    | Word | Bit | Width | Description     |
|---------|------|-----|-------|-----------------|
| cmd     | 0    | 0   | 16    | command id      |
| lrsBits | 1    | 0   | 16    | LRS categories: |

### 3.15 performDevInitCmdFmt

| Name   | Word | Bit | Width | Description   |
|--------|------|-----|-------|---------------|
| cmd    | 0    | 0   | 16    | command id    |
| number | 1    | 0   | 8     | device number |
| unused | 1    | 8   | 8     |               |

### 3.16 turnOnBurstCmdFmt

| Name      | Word | Bit | Width | Description       |
|-----------|------|-----|-------|-------------------|
| cmd       | 0    | 0   | 16    | command id        |
| duration  | 1    | 0   | 4     | duration (0-15)   |
| pixel     | 1    | 4   | 2     | pixel (0-3)       |
| channel   | 1    | 6   | 2     | SPM channel (0-3) |
| spmNumber | 1    | 8   | 1     | SPM 1 or 2        |
| unused    | 1    | 9   | 7     | not used          |

### 3.17 moveMirrorCmdFmt

| Name     | Word | Bit | Width | Description          |
|----------|------|-----|-------|----------------------|
| cmd      | 0    | 0   | 16    | command id           |
| mirror   | 1    | 0   | 8     | mirror device number |
| unused   | 1    | 8   | 8     | unused               |
| position | 2    | 0   | 16    | mirror position      |

### 3.18 setHeaterCmdFmt

| Name   | Word | Bit | Width | Description           |
|--------|------|-----|-------|-----------------------|
| cmd    | 0    | 0   | 16    | command id            |
| number | 1    | 0   | 16    | heater device number  |
| coarse | 2    | 0   | 16    | coarse/normal setting |
| fine   | 3    | 0   | 16    | fine setting          |

### 3.19 enableDetectorCmdFmt

| Name     | Word | Bit | Width | Description           |
|----------|------|-----|-------|-----------------------|
| cmd      | 0    | 0   | 16    | command id            |
| detector | 1    | 0   | 16    | detector number (1-8) |

### 3.20 turnOnDeviceCmdFmt

| Name   | Word | Bit | Width | Description   |
|--------|------|-----|-------|---------------|
| cmd    | 0    | 0   | 16    | command id    |
| number | 1    | 0   | 8     | device number |
| unused | 1    | 8   | 8     | not used      |

### 3.21 setCoolerTempCmdFmt

| Name    | Word | Bit | Width | Description         |
|---------|------|-----|-------|---------------------|
| cmd     | 0    | 0   | 16    | command id          |
| setting | 1    | 0   | 16    | temperature setting |

### 3.22 setCoolerDiodeCmdFmt

| Name   | Word | Bit | Width | Description        |
|--------|------|-----|-------|--------------------|
| cmd    | 0    | 0   | 16    | command id         |
| source | 1    | 0   | 8     | cooler diode (0/1) |
| unused | 1    | 8   | 8     |                    |

### 3.23 enableFuseCmdFmt

| Name     | Word | Bit | Width | Description                 |
|----------|------|-----|-------|-----------------------------|
| cmd      | 0    | 0   | 16    | command id                  |
| number   | 1    | 0   | 16    | device number               |
| detector | 2    | 0   | 16    | detector #, 0-3 (SPMs only) |

### 3.24 EEBurnCmdFmt

| Name       | Word | Bit | Width | Description                                |
|------------|------|-----|-------|--------------------------------------------|
| cmd        | 0    | 0   | 16    | command id                                 |
| port       | 1    | 0   | 8     | primary/secondary eeprom (port 0x30, 0x32) |
| enableCode | 1    | 8   | 8     | enable code to send to hardware            |

### 3.25 ScienceFlags

| Name    | Word | Bit | Width | Description                          |
|---------|------|-----|-------|--------------------------------------|
| chopper | 0    | 0   | 1     | chopper open/closed, 1 = closed      |
| sector  | 0    | 1   | 2     | sector/phase, 0-3 LMC, 0-1 PMC       |
| pixel   | 0    | 3   | 2     | pixel 0-3, (1-4)                     |
| channel | 0    | 5   | 3     | channel 0-7 (1-8), top bit = optical |

### 3.26 DumpHdr

| Name      | Word | Bit | Width | Description                                  |
|-----------|------|-----|-------|----------------------------------------------|
| index     | 0    | 0   | 8     | table index number (table dump only)         |
| type      | 0    | 8   | 8     | type of dump                                 |
| flags     | 1    | 0   | 8     | table flags (table dump only)                |
| not_used  | 1    | 8   | 8     | not used                                     |
| wcountMSW | 2    | 0   | 16    | word count MSW, unused                       |
| wcountLSW | 3    | 0   | 16    | word count LSW, number of words to load/dump |

### 3.27 IndexEntry

| Name    | Word | Bit | Width | Description                      |
|---------|------|-----|-------|----------------------------------|
| address | 0    | 0   | 16    | address of table (segment is DS) |
| nwords  | 1    | 0   | 16    | total size of table in words     |
| flags   | 2    | 0   | 8     | table flags                      |
| primary | 2    | 8   | 8     | primary table number             |

### 3.28 ActiveEntry

| Name   | Word | Bit | Width | Description                     |
|--------|------|-----|-------|---------------------------------|
| prime  | 0    | 0   | 8     | primary table number            |
| alt    | 0    | 8   | 8     | alternate table number          |
| flag   | 1    | 0   | 1     | prime/alt flag (0=prime, 1=alt) |
| unused | 1    | 1   | 15    | unused                          |

### 3.29 RamBits

| Name | Word | Bit | Width | Description              |
|------|------|-----|-------|--------------------------|
| bad  | 0    | 0   | 16*33 | ram block status (1=bad) |
| used | 33   | 0   | 16*33 | blocks in use (1=used)   |

### 3.30 SmallBlock

| Name | Word | Bit | Width | Description                                       |
|------|------|-----|-------|---------------------------------------------------|
| bBlk | 0    | 0   | 16    | base block number of C&T or LRS ram               |
| blk  | 1    | 0   | 16    | block # of small malloc requests                  |
| base | 2    | 0   | 16    | first allocatable byte, segment relative to base  |
| end  | 3    | 0   | 16    | last allocatable byte+1, segment relative to base |

### 3.31 LimitTableEntry

| Name       | Word | Bit | Width | Description                               |
|------------|------|-----|-------|-------------------------------------------|
| redHi      | 0    | 0   | 16    | high limit, red zone                      |
| yellowHi   | 1    | 0   | 16    | high limit, yellow zone                   |
| yellowLo   | 2    | 0   | 16    | low limit, yellow zone                    |
| redLo      | 3    | 0   | 16    | low limit, red zone                       |
| validLimit | 4    | 0   | 8     | sensor valid/invalid (0=invalid, 1=valid) |
| not_used   | 4    | 8   | 8     | not used                                  |

### 3.32 HeaterSettingEntry

| Name      | Word | Bit | Width | Description                               |
|-----------|------|-----|-------|-------------------------------------------|
| normal    | 0    | 0   | 8     | normal heater setting                     |
| alternate | 0    | 8   | 8     | alternate setting (e.g., fine or bakeout) |

### 3.33 LRS\_bits

| Name           | Word | Bit | Width | Description                          |
|----------------|------|-----|-------|--------------------------------------|
| sciDat_anc     | 0    | 0   | 1     | Ancillary Data                       |
| sciDat_hk      | 0    | 1   | 1     | H/K Telemetry                        |
| spare1         | 0    | 2   | 2     |                                      |
| sciDat_test    | 0    | 4   | 1     | test packet                          |
| sciDat_table   | 0    | 5   | 1     | table data                           |
| sciDat_eng     | 0    | 6   | 1     | eng data                             |
| sciDat_sci     | 0    | 7   | 1     | science data                         |
| spare2         | 0    | 8   | 4     |                                      |
| testQuickLook  | 0    | 12  | 1     | Quick look flag, test packets        |
| tableQuickLook | 0    | 13  | 1     | Quick look flag, table packets       |
| engQuickLook   | 0    | 14  | 1     | Quick look flag, engineering packets |
| sciQuickLook   | 0    | 15  | 1     | Quick look flag, science packets     |

## 4. TABLES

### 4.1 ICMConfig

| Name             | Word | Bit | Width | Description                           |
|------------------|------|-----|-------|---------------------------------------|
| icmPort          | 0    | 0   | 16    | ICM control port settings             |
| bits             | 1    | 0   | 16    | bit field definitions                 |
| allBits          | 1    | 0   | 16    | word access                           |
| fdir             | 2    | 0   | 1     | fdir                                  |
| safe             | 2    | 1   | 1     | safe mode auto entry                  |
| tmf              | 2    | 2   | 1     | time mark freq bus                    |
| cooler_on        | 2    | 3   | 1     | cooler init in Safe Mode              |
| bootToSafe       | 2    | 4   | 1     | Auto boot to safe mode transition     |
| spare            | 2    | 5   | 11    | not used                              |
| maxRetry         | 3    | 0   | 16    | maximum retry limit (0=no retries)    |
| maxLoopCount     | 4    | 0   | 16    | maximum count to wait for return data |
| scaleFactorPS24  | 5    | 0   | 16    | scaling factor for 24 bit sum data    |
| scaleFactorPMC24 | 6    | 0   | 16    | scaling factor for 24 bit sum data    |
| scaleFactorPD24  | 7    | 0   | 16    | scaling factor for 24 bit delta data  |
| scaleFactorPD16  | 8    | 0   | 16    | scaling factor for 16 bit delta data  |
| maxNadirError    | 9    | 0   | 16*4  | zero disables nadir check             |

### 4.2 ICMStatus

| Name        | Word | Bit | Width | Description                              |
|-------------|------|-----|-------|------------------------------------------|
| RamStatus   | 0    | 0   | 1056  | RAM bit status strings                   |
| heapbase    | 66   | 0   | 16    | block number of local heap base          |
| heaptop     | 67   | 0   | 16    | block number of local top of heap        |
| farheapbase | 68   | 0   | 16    | block number of far heap (if any)        |
| farheaptop  | 69   | 0   | 16    | block number of top of far heap (if any) |
| smallBlk    | 70   | 0   | 64*3  | small block ptrs for system, C&T and LRS |
| dataStart   | 82   | 0   | 16    | starting block # of data segment         |
| dataSize    | 83   | 0   | 16    | # blocks used by data (includes bss)     |

| Name       | Word | Bit | Width | Description                       |
|------------|------|-----|-------|-----------------------------------|
| stackStart | 84   | 0   | 16    | starting block # of stack segment |
| stackSize  | 85   | 0   | 16    | # blocks used by stack            |
| codeStart  | 86   | 0   | 16    | starting block # of code segment  |
| codeSize   | 87   | 0   | 16    | # blocks used by code             |
| bootCRC    | 88   | 0   | 16    | Boot EEPROM CRC residue           |
| spareCRC   | 89   | 0   | 16    | Spare EEPROM CRC residue          |
| bootStatus | 90   | 0   | 16    |                                   |
| romdata    | 91   | 0   | 16    |                                   |

#### 4.3 UpDownTable

| Name         | Word | Bit | Width | Description                            |
|--------------|------|-----|-------|----------------------------------------|
| command      | 0    | 0   | 16    |                                        |
| actualCRC    | 1    | 0   | 16    | actual crc of loaded code/table        |
| destAddr     | 2    | 0   | 32    | pointer to destination address         |
| sourceAddr   | 4    | 0   | 32    | pointer to source address              |
| LoadBuffer   | 6    | 0   | 16    | table upload buffer                    |
| startAddress | 7    | 0   | 32    | start address of load                  |
| wcount       | 9    | 0   | 32    | requested number of words to load/dump |
| nwords       | 11   | 0   | 32    | number of words left to dump           |

#### 4.4 StatisticTable

| Name          | Word | Bit | Width | Description                    |
|---------------|------|-----|-------|--------------------------------|
| events        | 0    | 0   | 16    | main event queue counter       |
| secondsEvents | 1    | 0   | 16    | seconds event queue counter    |
| majorEvents   | 2    | 0   | 16    | major cycle events             |
| scanEvents    | 3    | 0   | 16    | scan cycle events              |
| commands      | 4    | 0   | 16    | command counter                |
| idleTime      | 5    | 0   | 16    | idle counter                   |
| diagRxError   | 6    | 0   | 16    | Diagnostic Port Receive Errors |
| coolerRxError | 7    | 0   | 16    | Cooler Port Receive Errors     |



| Name                        | Word | Bit | Width | Description                                      |
|-----------------------------|------|-----|-------|--------------------------------------------------|
| coolerTxError               | 8    | 0   | 16    | Cooler Port Transmit Errors                      |
| lastHouseTelemCycle         | 9    | 0   | 16    | major/minor cycle of last telemetry              |
| lastCriticalTelemCycle      | 10   | 0   | 16    | major/minor cycle of last critical telemetry     |
| spmRaw                      | 11   | 0   | 16*2  | SPM 1 & 2 - number of raw data words transferred |
| hkTelemetryEvent            | 13   | 0   | 16    | H/K event counter                                |
| ct_rt_hi_pri_ints           | 14   | 0   | 16    |                                                  |
| ct_rt_msg_errors            | 15   | 0   | 16    |                                                  |
| ct_rt_retransmits           | 16   | 0   | 16    |                                                  |
| ct_rt_valid_msgs            | 17   | 0   | 16    |                                                  |
| ct_rt_out_of_free_msgs      | 18   | 0   | 16    |                                                  |
| ct_rt_msgs_queued           | 19   | 0   | 16    |                                                  |
| ct_refresh_telemetry        | 20   | 0   | 16    |                                                  |
| lrs_rt_hi_pri_ints          | 21   | 0   | 16    | # of high priority interrupts                    |
| lrs_rt_msg_errors           | 22   | 0   | 16    | # of message errors                              |
| lrs_rt_valid_msgs           | 23   | 0   | 16    | # of valid messages received                     |
| lrs_rt_ints_serviced        | 24   | 0   | 16    | # of interrupts serviced                         |
| lrs_rt_out_of_free_packets  | 25   | 0   | 16    | # of times no packets available                  |
| lrs_rt_packets_reserved     | 26   | 0   | 16    | # of currently reserved packets                  |
| lrs_rt_ints_expected        | 27   | 0   | 16    | # of interrupts expected                         |
| lrs_rt_packets_made_pending | 28   | 0   | 16    | # of times a packet must wait in queue           |
| lrs_rt_packets_service_req  | 29   | 0   | 16    | # of times service request bit is set            |
| lrs_science_seq_count       | 30   | 0   | 16    | LRS Science CCSDS packet sequence #              |
| lrs_eng_seq_count           | 31   | 0   | 16    | LRS Eng CCSDS packet sequence #                  |
| lrs_test_seq_count          | 32   | 0   | 16    | LRS Test CCSDS packet sequence #                 |
| lrs_burst_seq_count         | 33   | 0   | 16    | LRS Burst CCSDS packet sequence #                |
| lrs_table_seq_count         | 34   | 0   | 16    | LRS Table CCSDS packet sequence #                |
| coolerMsg                   | 35   | 0   | 16    | # of message received from the cooler            |
| spm1_errors                 | 36   | 0   | 16    | # SPM1 communications errors                     |
| spm2_errors                 | 37   | 0   | 16    | # SPM2 communications errors                     |
| pcdm_errors                 | 38   | 0   | 16    | # port cover communications errors               |
| scdm_errors                 | 39   | 0   | 16    | # scan mirror/chopper comm. errors               |

| Name            | Word | Bit | Width | Description                               |
|-----------------|------|-----|-------|-------------------------------------------|
| pldm_errors     | 40   | 0   | 16    | # PMC/LMC communications errors           |
| tcmm_errors     | 41   | 0   | 16    | # TCMM communications errors              |
| plus_ticks      | 42   | 0   | 16    | # of + ticks added                        |
| minus_ticks     | 43   | 0   | 16    | # of - ticks removed                      |
| jump_ticks      | 44   | 0   | 16    | # of times the counter jumped             |
| jump_delta      | 45   | 0   | 16    | delta ticks for last jump                 |
| missed_sync     | 46   | 0   | 16    | missing sync with data word 1553 message  |
| sciStartTime    | 47   | 0   | 16    | Major Minor cycle of last scan            |
| sciDeltaTime    | 48   | 0   | 16    | time to process science data              |
| ramTestBad      | 49   | 0   | 16    | # bad blocks found by background ram test |
| ramTestBadBlock | 50   | 0   | 16    | last bad block found                      |
| freeCall        | 51   | 0   | 16    | call to dummy free() function (should     |
| eeepromBusy     | 52   | 0   | 16    | eeeprom busy writing                      |
| allocateError   | 53   | 0   | 16    | memory allocation error                   |
| argumentError   | 54   | 0   | 16    | bad argument passed to routine            |
| deviceIndex     | 55   | 0   | 16    | current device index                      |
| nmiCounter      | 56   | 0   | 16    | count the number of NMIs seen             |

#### 4.5 EngHKTelemetryEntry

| Name      | Word | Bit | Width | Description                              |
|-----------|------|-----|-------|------------------------------------------|
| copy      | 0    | 0   | 8     | copy this entry: 0=no, 1=yes             |
| hkOffset  | 0    | 8   | 8     | block 7 word offset (only 3-31 is valid) |
| engOffset | 1    | 0   | 16    | engineering data word offset             |

#### 4.6 TelemSchedule

| Name                   | Word | Bit | Width | Description                        |
|------------------------|------|-----|-------|------------------------------------|
| IMOK_message           | 0    | 0   | 16    | IMOK minor cycle                   |
| time_code_message      | 1    | 0   | 16    | Time Code minor cycle              |
| ancillary_message      | 2    | 0   | 16    | Ancillary message minor cycle      |
| critical_telemetry     | 3    | 0   | 16    | critical telem minor cycle         |
| housekeeping_telemetry | 4    | 0   | 16    | housekeeping minor cycle           |
| sync_with_data_word    | 5    | 0   | 16*4  | sync minor cycle                   |
| critical_gather        | 9    | 0   | 16    | critical telem gather cycle        |
| housekeeping_gather    | 10   | 0   | 16    | house telem gather cycle           |
| lrs_gather             | 11   | 0   | 16    | lrs engineering telem gather cycle |
| housekeeping_collect   | 12   | 0   | 16    | hkTelemetryEvent cycle             |

#### 4.7 SpmTable

| Name               | Word | Bit | Width | Description                                           |
|--------------------|------|-----|-------|-------------------------------------------------------|
| blankChop1Open     | 0    | 0   | 8     | # A/D samples to blank for chopper 1/3 open state     |
| processChop1Open   | 0    | 8   | 8     | # A/D samples to process for chopper 1/3 open state   |
| blankChop1Closed   | 1    | 0   | 8     | # A/D samples to blank for chopper 1/3 closed state   |
| processChop1Closed | 1    | 8   | 8     | # A/D samples to process for chopper 1/3 closed state |
| blankChop2Open     | 2    | 0   | 8     | # A/D samples to blank for chopper 2/4 open state     |

| Name               | Word | Bit | Width | Description                                           |
|--------------------|------|-----|-------|-------------------------------------------------------|
| processChop2Open   | 2    | 8   | 8     | # A/D samples to process for chopper 2/4 open state   |
| blankChop2Closed   | 3    | 0   | 8     | # A/D samples to blank for chopper 2/4 closed state   |
| processChop2Closed | 3    | 8   | 8     | # A/D samples to process for chopper 2/4 closed state |
| blankLmc1          | 4    | 0   | 8     | # chopper cycles to blank for each LMC 1/3 sector     |
| processLmc1        | 4    | 8   | 8     | # chopper cycles to process for each LMC 1/3 sector   |
| blankLmc2          | 5    | 0   | 8     | # chopper cycles to blank for each LMC 2/4 sector     |
| processLmc2        | 5    | 8   | 8     | # chopper cycles to process for each LMC 2/4 sector   |
| processPmc         | 6    | 0   | 8     | # chopper cycles to process for each PMC sector       |
| Lmc1Stare          | 6    | 8   | 8     | # LMC 1/3 sectors to process for each stare           |
| Lmc2Stare          | 7    | 0   | 8     | # LMC 2/4 sectors to process for each stare           |
| PmcStare           | 7    | 8   | 8     | # PMC sectors to process for each stare               |

#### 4.8 TimingTable

| Name                  | Word | Bit | Width | Description |
|-----------------------|------|-----|-------|-------------|
| chopper1_divider      | 0    | 0   | 16    |             |
| chopper1_freq_delay   | 1    | 0   | 16    |             |
| chopper2_divider      | 2    | 0   | 16    |             |
| chopper2_freq_delay   | 3    | 0   | 16    |             |
| chopper3_divider      | 4    | 0   | 16    |             |
| chopper3_freq_delay   | 5    | 0   | 16    |             |
| chopper4_divider      | 6    | 0   | 16    |             |
| chopper4_freq_delay   | 7    | 0   | 16    |             |
| lmc1_rotation_divider | 8    | 0   | 16    |             |
| lmc1_sector_divider   | 9    | 0   | 16    |             |
| lmc1_clock_delay      | 10   | 0   | 16    |             |
| lmc2_rotation_divider | 11   | 0   | 16    |             |

| Name                  | Word | Bit | Width | Description |
|-----------------------|------|-----|-------|-------------|
| lmc2_sector_divider   | 12   | 0   | 16    |             |
| lmc2_clock_delay      | 13   | 0   | 16    |             |
| lmc3_rotation_divider | 14   | 0   | 16    |             |
| lmc3_sector_divider   | 15   | 0   | 16    |             |
| lmc3_clock_delay      | 16   | 0   | 16    |             |
| lmc4_rotation_divider | 17   | 0   | 16    |             |
| lmc4_sector_divider   | 18   | 0   | 16    |             |
| lmc4_clock_delay      | 19   | 0   | 16    |             |
| pmc1_freq_divider     | 20   | 0   | 16    |             |
| pmc1_ref_delay        | 21   | 0   | 16    |             |
| pmc2_freq_divider     | 22   | 0   | 16    |             |
| pmc2_ref_delay        | 23   | 0   | 16    |             |
| chop12_cmd_ppo        | 24   | 0   | 16    |             |
| chop34_cmd_ppo        | 25   | 0   | 16    |             |

#### 4.9

#### PmcTable

| Name      | Word | Bit | Width | Description                      |
|-----------|------|-----|-------|----------------------------------|
| delayTime | 0    | 0   | 8*2   | PMC1 and PMC2 startup delay      |
| minAmp    | 1    | 0   | 8*2   | PMC1 and PMC2 startup amplitudes |
| amplitude | 2    | 0   | 8*2   | PMC1 and PMC2 amplitudes         |

#### 4.10 StareHeader

Byte  
0  
1  
2-3  
4-7  
8-11  
12-19  
20-23

| Name           | Word | Bit | Width | Description                           |
|----------------|------|-----|-------|---------------------------------------|
| channels       | 0    | 0   | 8     | bit mask for active channels,         |
| msgType        | 0    | 8   | 8     | STARE_HEADER = 'S'                    |
| length         | 1    | 0   | 16    | message length = sizeof(StareHeader)  |
| timeStamp      | 2    | 0   | 32    | time of start of stare, milliseconds  |
| rawDataLength  | 4    | 0   | 16*2  | DMA transfers per DMA channel (words) |
| mirrorPosition | 6    | 0   | 16*4  | mirror position telemetry word        |
| mirrorStatus   | 10   | 0   | 8*4   | status bits for the mirrors           |

#### 4.11 ChannelHeader

| Name       | Word | Bit | Width | Description                            |
|------------|------|-----|-------|----------------------------------------|
| algorithm  | 0    | 0   | 8     | compression algorithm                  |
| msgType    | 0    | 8   | 8     | channel identifier                     |
| length     | 1    | 0   | 16    | message length = sizeof(ChannelHeader) |
| lastSector | 2    | 0   | 8     | last LMC sector/PMC half cycle         |
| numSector  | 2    | 8   | 8     | number of LMC sectors/PMC half cycles  |

## 5. CRITICAL TELEMETRY

This is a listing of the telemetry points in the critical telemetry data. This table has been extracted from information contained in the ICM source file "telem.dat". The source file is the controlling document for telemetry information, the following is provided for reference only.

The C&T bus housekeeping telemetry consists of normal Housekeeping (H/K) Telemetry and Critical Health and Safety (H&S) Telemetry. The H&S Telemetry is included in each block of the H/K Telemetry as the first 2 words. The H/K Telemetry is sub-commutated into 8 blocks.

The format of the H/K Telemetry and H&S Telemetry is shown below:

### 5.1 CriticalTelem

| Name           | Word | Bit | Width | Description                                    |
|----------------|------|-----|-------|------------------------------------------------|
| BS_TEMP_TOL    | 0    | 0   | 1     | Temperature out of tolerance (1=fail)          |
| BS_CURRENT_TOL | 0    | 1   | 1     | Current out of tolerance (1=fail)              |
| BS_VOLTAGE_TOL | 0    | 2   | 1     | Voltage out of tolerance (1=fail)              |
| BS_DEVICES_OK  | 0    | 3   | 1     | Devices status (1=ok)                          |
| BS_PROM_BANK   | 0    | 4   | 1     | Prom bank selection<br>(0=primary/1=secondary) |
| spare_0        | 0    | 5   | 3     | Spare, always 0                                |
| BS_TMF_BUS     | 0    | 8   | 1     | TMF Bus Status (1=ok)                          |
| BS_SCIENCE_BUS | 0    | 9   | 1     | Science Bus Status (1=ok)                      |
| BS_CT_BUS      | 0    | 10  | 1     | C&T Bus Status (1=ok)                          |
| CR_INST_AB     | 0    | 11  | 1     | ICM ID jumper (0=Primary, 1=Backup)            |
| SS_ICM_STATUS  | 0    | 12  | 2     | ICM Status (0=unknown, 1=not sync, 2=ok)       |
| BS_ICM_SEU     | 0    | 14  | 1     | ICM SEU Indicator (1=SEU)                      |
| BS_FATAL       | 0    | 15  | 1     | Fatal ICM Condition Detected (1=yes)           |
| SS_CMD_ERROR   | 1    | 0   | 8     | Instrument Command Error Code (0=ok)           |
| SS_CMD_TOGGLE  | 1    | 8   | 4     | Instrument Command Toggle count                |
| SS_INST_MODE   | 1    | 12  | 3     | Instrument Mode (0-6)                          |
| BS_CMD_STATUS  | 1    | 15  | 1     | Instrument Command Status (1=busy)             |

## 6. HOUSEKEEPING TELEMETRY

This is a listing of the telemetry points in the housekeeping telemetry data. This table has been extracted from information contained in the ICM source file "telem.dat". The source file is the controlling document for telemetry information, the following is provided for reference only.

The housekeeping data is subcommutated on the C&T bus every 8 major cycles. Each of the 8 block is exactly 32 words, with the first two words containing a copy of the current critical telemetry.

The instrument telemetry mnemonic format is defined as being 16 characters with:

char 1:

- I - Current
- V - Voltage
- T - Temperature
- B - Bi-level Status, 0 or 1
- P - Power
- C - Configuration Information
- S - Status Information
- N - Numeric Data

char 2:

- R - Real or raw Data, data unmodified by software
- S - Flight Software Generated Data, data generated using raw data inputs
- P - Pseudo or Derived Data, data generated by ground software or flight software using generated data

char 3: Always "\_".

char 4-16: Telemetry point name.

The following is a summary of the expected default return values for the various type of telemetry.

|                  |        |                                     |
|------------------|--------|-------------------------------------|
| BS_x (PASS/FAIL) | 0      | FAIL                                |
|                  | 1      | PASS                                |
| SS_BOOT_STATUS   | 0x0001 | Startup Stack Failure               |
|                  | 0x0002 | 80C186 DMA 0 Failure                |
|                  | 0x0004 | 80C186 DMA 1 Failure                |
|                  | 0x0008 | 80C186 Timer 0 Failure              |
|                  | 0x0010 | 80C186 Timer 1 Failure              |
|                  | 0x0020 | 80C186 Timer 2 Failure              |
|                  | 0x0040 | 80C186 Interrupt Controller Failure |
|                  | 0x0080 | Interrupts stuck on                 |
|                  | 0x0100 | Boot EEPROM bank CRC error          |
|                  | 0x0200 | Spare EEPROM bank CRC error         |