2001 MARS SURVEYOR ORBITER

GAMMA RAY SPECTROMETER

FLIGHT SOFTWARE COMMAND DICTIONARY

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1 Introduction

1.1 Document Purpose

This document is intended to be used as a command dictionary to define all of the commands and their formats that can be generated for the GRS instrument.

1.2 Applicable Documents

1. HEND: Regimes Of Work, Telecommands And Telemetry Data
2. GRS Gamma Electronics Preliminary Command Set

2 GRS Commands

This section lists the format of the commands the GRS flight software processes.

2.1 GRS Command Header

The following is a header appended to all GRS commands sent from the ground the the S/C that are intended for the GRS. This header is to be removed by the S/C processing and the remainder of the command is to be passed to GRS. The external opcode is the opcode identifying this command as a GRS command and the length is the length of the command that follows.

External Opcode (16 bits)
Length (16 bits)

Commands originating from the S/C will not have this header appended.

2.2 General GRS Command Format

The following diagram shows the format of a general GRS command. It is composed of a time/orbit-pixel flag (1 bit), an opcode (15 bits), a relative/immediate flag (1 bit), a command id# (15 bits), a time or orbit-pixel combination (32 bits), and up to 124 data words. The last field is a 16-bit checksum taken over all of the n data words, opcode, command id and time.

Flag/Internal Opcode (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Data word 1 (16 bits)
• • •
Data word n (16 bits)
Checksum (16 bits)

2.3 Flag/Internal Opcode word

This 16 bit field has two parts. The opcode is in the lower 15 bits and signifies to the GRS flight software what type of command information is being sent. Bit sixteen (the highest bit) is used to specify wether the time field contains a time value or an orbit-pixel value. A 0 in the flag bit indicates time, a 1 indicates orbit-pixel.

The operation code will be between 0 and 255. Each opcode will have a defined format of the data to follow.

Each instrument of the GRS will have a range of opcodes assigned to it. Commands from the spacecraft will be in the range of 1-9, commands for the gamma sensor will be in the range of 10 – 19, commands for the Neutron Sensor will be in the range of 20 - 34, commands for the 35 - 44 will be in the range of and commands directed at the CEB and FSW will be in the range of 45 - 255. All ranges are inclusive.

2.4 FLAG/COMMAND ID#

This 16 bit field has two parts. The highest order bit is a flag as to the type of delay that is being used, either relative or absolute. A 0 in the flag bit indicates absolute, a 1 indicates relative. The remaining 15 bits are a command ID#. This is used to track the command through the flight software. It is used in messages concerning the command.

2.5 TIME/ORBIT-PIXEL

This 32 bit field either contains the time at which the command is to be executed or the orbit and pixel at which it is to be executed depending on the flag of the previous section.

2.5.1 Time

The command is to be executed at the time indicated. If the time field is all zeros, the command is to be executed when received.

2.5.2 Orbit-Pixel

This is actually two 16 bit fields that indicate the orbit and pixel at which the command is to be executed. If both the orbit and pixel are zero the command is to be executed when received.

2.6 DATA Words

All data words are 16 bits wide. Each command will define the number of data words that the command contains. This area will vary for individual commands. The only commands which will have variable number of words is are, memory write and sequence update commands. These commands will have as the first 16 bit word in the data secton, the number of words that are to follow.

2.7 CHECKSUM

The last word of a command is a checksum over the preceding bytes, (i.e., including the op code, command ID and time). The GRS Command Header used by the spacecraft is not used in the checksum calculation.

3 SPECIFIC COMMANDS

3.1 Orbiter (S/C) to GRS Software Commands

Flag/Command ID and Time/Orbit-Pixel fields are set to 0 for all S/C to GRS commands. All S/C commands are executed immediately.

3.1.1 Spacecraft Time – opcode = 1

SC_TIME_OPCODE (1) (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
S/C Time Seconds (32 bits)
S/C Time One Second (16 bits)
Checksum (16 bits)

- S/C Time Seconds – unsigned 32 bit value, S/C time in seconds
- S/C Time One Second – unsigned 16 bit value, sub-seconds of S/C time. Each count being 1/65636th of a second.

3.1.2 Ascending Equator Crossing - opcode = 2

EQ_CROSS_ASC_OPCODE (2)(16bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Ascending Crossing Time (32 bits)
Next Ascending Cross Time (32 bits)
Checksum (16 bits)

- Ascending Crossing Time – unsigned 32 bit value, the S/C time of the upcoming ascending equator crossing in seconds.
- Next Ascending Cross Time – unsigned 32 bit value, the S/C time of the following ascending equator crossing in seconds.

3.1.3 Anneal Door Enable - opcode = 3

ANNEAL_DOOR_OPCODE (3)(16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Enable/Disable (16 bits)
Checksum (16 bits)

- Enable/Disable – enable or disable anneal door movement.

3.1.4 Hend Power – opcode = 4

HEND_POWER_OPCODE (4)(16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
On or Off (16 bits)
Checksum (16 bits)

- On or Off – On is 1, Off is 0.

3.1.5 Shutdown – opcode = 5

SHUTDOWN_OPCODE (5)(16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.1.6 Safing – opcode = 6

IMED_SHUTDOWN_OPCODE (6)(16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.1.7 Anneal Enable - opcode = 7

ANNEAL_ENABLE_OPCODE (7)(16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Enable/Disable (16 bits)
Checksum (16 bits)

- Enable/Disable – enable or disable anneal.

3.2 Gamma Commands – opcode 10

All Gamma commands have the data and command id bytes passed to the gamma instrument as they are.

GAMMA_CMD_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
data (8 bits)
HEX commad (8 bits)
Checksum (16 bits)

- HEX Commad – the gamma cmd id, if the hi bit of this byte is on, the command is sent to the gamma instrument immediately otherwise the command is send at the beginning of the next collection interval.
- Data – the data byte read by the gamma instrument.

The following table lists all the commands that can be sent to the gamma sensor electronic.

Hex Command Id [15:8]	Hex Data Range [7:0]	Command Function	Notes
00	00	NOP	No Operation Command .
00	0A	Cmd_Reject Reset	Resets the command reject flag.
00	AA	Cmd_Counter Reset	Resets the command counter.
01	01	APPS Board Reset	Resets the APPS logic.
10	00 - FF	DAC 0 Level	LLD Threshold DAC.
11	00 – FF	DAC 1 Level	L1 Threshold DAC.
12	00 – FF	DAC 2 Level	L2 Threshold DAC.
13	00 – FF	DAC 3 Level	L3 Threshold DAC.
14	00 – FF	DAC 4 Level	ULD Threshold DAC.
15	00 – FF	DAC 5 Level	Spare channel in brassboard.
16	00 – FF	DAC 6 Level	Spare channel in brassboard.
17	00 - FF	DAC 7 Level	HVBS DAC (00 – FF -> 0V to 5000V)
18	01	DAC Clear All Command	Command bits [7:0] not used by cmd processor.
20	00 – FF	Shaping Amplifier Gain Control	Gain range ~ 4 MeV to 16 MeV over F.S. range
28	00 – 1F	Analog HK Mux Channel	Bits [7:5] are unused by command processor.
2A	00 - FF	HK Telemetry Command	Bits [3:0] set the digital multiplexer position. Bit [7] == 1 initiates a digital HK telemetry word transfer to the CEB. One telemetry word per cmd. Bit [7] == 0 changes the digital mux position but does not initiate a data transfer. Bits [6:4] are unused by command processor.
2B	00 or 07	Test Pulser Command	Bit [0] == 0 => test pulser is disabled. Bit [0] == 1 => test pulser is enabled. Bit [1] == 0 => disable 0.3 MeV Pulse Bit [1] == 1 => ensable 0.3 MeV Pulse Bit [2] == 0 => disable 3.8 MeV Pulse Bit [2] == 1 => ensable 3.8 MeV Pulse Bit [3] == 0 => disable 9.5 MeV Pulse Bit [3] == 1 => ensable 9.5 MeV Pulse Bits [4-7] ==are unused by command processor
2C	00 or 01	PHA Logic Command	Bit [0] == 0 => Nominal (enabled) PHA mode. Bit [0] == 1 => PHA stop/abort mode. Bits [7:1] are unused by command processor
2D	00 or 01	High Voltage Command	Bit [0] == 0 => HVBS disabled; output voltage driven of supply driven to ground. Bit [0] == 1 => HVBS enabled (DAC enabled, HVBS oscillator on). Bits [2:1] are latched into memory, but are otherwise unused in the brassboard. Bits [7:3] are unused by command processor
2E	00 or 01	Analog Telemetry Command	Disables or Enables analog telemetry. (default Enabled)
2F	00 or 01	Scalar Command	Disables or Enables scalar telemetry. (default Enabled)
Others	--	Invalid Commands	Should initiate a command reject flag.

3.3 **LANL Neutron Commands** – opcode 20

3.3.1 LANL Command

This command can be used to issue any command to the Neutron Sensor. The data byte must be formatted exactly as the Neutron Sensor expects to see the byte, all bits must be set to the appropriate value.

LANL_CMD_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Data Byte (8 bits)
Code Byte (8 bits)
Checksum (16 bits)

The following table lists all of the commands that go to the LANL neutron sensor:

Command Code Byte	Bits	Data Byte Values	Description	Meaning
00	0-7	0-255	Early time lo	100ns per increment
01	0-7	0-255	Early time hi	100ns per increment
02	0-7	0-255	Late time lo	100ns per increment
03	0-7	0-255	Late time hi	100ns per increment
04	0-7	0-255	Prompt Energy Max	10kev per increment
05	0-7	0-255	Late Energy Max	10kev per increment
06	0	0-1	Prism1 Disabled	0- enabled, 1 disabled
06	1	0-1	Prism2 Disabled	0- enabled, 1 disabled
06	2	0-1	Prism3 Disabled	0- enabled, 1 disabled

06	3	0-1	Prism4 Disabled	0- enabled, 1 disabled
06	5-7	0-15	Modes	Disregarded
07	0	0-1	HVPS1	0 - off, 1 - 0n
07	1-3	0-7	HVPS1 Level	0 – max, 7- min
07	4	0-1	HVPS2	0 – Off, 1 – on
07	5-7	0-7	HVPS2 Level	0 – max, 7- min
08	0	0-1	MUX Enable	Disregarded
08	1-3	0-7	MUX Channel	Which reading
09	0	0-1	Prompt/Delay swap	
09	7	0-1	Run	1 – to send data 0 – to not send
10	0-7	0-255	Memory offset address	The address at which to store data
11	0	0-1	Memory offset addres	The address at which to store data
11	1-7	NA	Unused	NA

3.3.2 LANL Prism Command – opcode 21

Sets an individual prism on or off.

LANL_PRISM_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Which Prism (16 bits)
On or Off (16 bits)
Checksum (16 bits)

- Which Prism – prism 1, 2, 3, or 4
- On or Off – 1 or 0

3.3.3 LANL All Prism Command – opcode 22

Sets all prisms to a state.

LANL_ALL_PRISM_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Prism (16 bits)
Checksum (16 bits)

- Prism – prisms value

3.3.4 LANL Mode Command – opcode 23 (NOT USED)

Sets the mode.

LANL_MODE_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Mode (16 bits)
Checksum (16 bits)

- Which mode – Mode 0 - 15

3.3.5 LANL HVPS Command – opcode 24

Sets one of the HVPS on or off.

LANL_HVPS_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Which HVPS (16 bits)
On or Off (16 bits)
Checksum (16 bits)

- Which HVPS – HVPS 1 or 2
- On or Off – 1 or 0

3.3.6 LANL HVPS Control Command – opcode 25

Sets the HVPS control to a value.

LANL_HVPS_CNTL_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Which HVPS (16 bits)
Value (16 bits)
Checksum (16 bits)

- Which HVPS – the HVPS 1 or 2
- Value – 0 to 7, 7 being the minimum, 0 the max

3.3.7 LANL Mux Command – opcode 26

Sets the mux to a value

LANL_MUX_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Mux Channel (16 bits)
Checksum (16 bits)

- Mux Channel – The Mux channel to enable (0 – 7)

3.3.8 LANL Swap Prompt/Delay – opcode 27

Sets the Prompt/Delay bit on or off

LANL_SWAP_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
On or Off (16 bits)
Checksum (16 bits)

- On or Off – 1 or 0

3.3.9 LANL Run Command – opcode 28

Sets the Run bit on or off.

LANL_RUN_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
On or Off (16 bits)
Checksum (16 bits)

- On or Off – 1 or 0

3.4 HEND Neutron Commands

This represents the command format that the GRS expects to receive from the orbiter for HEND Neutron Commands

3.4.1 Hend Command – opcode 35

HEND_CMD_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Comand id (8 bits)
data (8 bits)
checksum (8 bits)
SPARE (8 bits)
Checksum (16 bits)

HEND receives commands from CEB by RS-422 interface. Each command contains 3 bytes:

- 1st byte: codes;
- 2nd byte: parameter;
- 3rd byte: checksum

3.4.2 Codes

1. Regimes selection 01000001 – 0x41
2. Anti-coincidence 01000010 – 0x42
3. HV levels 01000100 – 0x44
4. Discriminators levels 01001000 – 0x48
5. Triggering levels 0101 0000 – 0x50
6. Triggering logic 0110 0000 – 0x60

In MEASUREMENTS and DUTY regime commands are executed at the moment of the next SYNH signal from CEB.

3.4.3 Regimes selection (01000001 – 0x63)

Bits	8	7	6	5	4	3	2	1
DUTY with default	1	0	0	0	0	0	0	1
DUTY with measurement default	1	0	0	0	0	0	1	0
Output of STATUS for next SYNH	1	0	0	0	0	1	0	0
Measurement	1	0	0	0	1	0	0	0
Measurement with burst	1	0	0	1	0	0	0	0

3.4.4 Anti-coincidence

Bits	8	7	6	5	4	3	2	1
Meanings	1	0	0	0	0	1 or 0	1 or 0	1 or 0

- Bit 1 switch ON (1) or switch OFF (0) anti-coincidence veto from OUTER scintillator signal to neutrons from INNER scintillator.
- Bit 2 switch ON (1) or switch OFF (0) anti-coincidence veto from OUTER scintillator signal to background from INNER scintillator.
- Bit 3 switch ON (1) or switch OFF (0) anti-coincidence veto from INNER scintillator signal to background from OUTER scintillator.

3.4.5 HV levels

Bites	8	7	6	5	4	3	2	1
HV1 (LD)	1	0	0	0	0	1	1 or 0	1 or 0
HV2 (MD)	1	0	0	0	1	0	1 or 0	1 or 0

HV3 (SD)	1	0	0	1	0	0	1 or 0	1 or 0
HV4 (INNER)	1	0	1	0	0	0	1 or 0	1 or 0
HV5 (OUTER)	1	1	0	0	0	0	1 or 0	1 or 0

- Bits 1 and 2 define levels (00 - OFF, 01 - minimal level, 10 - optimal level, 11 - maximal level).

3.4.6 Discriminator levels

Bites	8	7	6	5	4	3	2	1
Discriminator LD	1	0	0	0	0	1	0	1 or 0
Discriminator MD	1	1	0	0	1	0	0	1 or 0
Discriminator SD	1	0	0	1	0	0	0	1 or 0
Discriminator of INNER Scintillator	1	0	1	0	0	0	0	1 or 0
Discriminator of OUTER Scintillator	1	1	0	0	0	0	1 or 0	1 or 0

3.4.7 Triggering logic

Bits	8	7	6	5	4	3	2	1
Logic	1	1 or 0	0	0	0	1 or 0	1 or 0	1 or 0

Bits 3, 2, 1 determine coefficient K1, as total number of permitted triggering

000 – arbitrary number of successive triggering
001 – 1 permitted triggering
010 – 2 permitted successive triggering

111 – 7 permitted successive triggering

Permission for triggering after the set of permitted triggering will take place after 128 intervals of data accumulation.

Bit 7 determines logic of triggering for Criteria C1 and C2: 1 corresponds to AND, 0 corresponds to OR.

3.4.8 Check Sum (3rd byte)

Determined as the sum of modules of corresponding bits of 1st and 2nd bytes.

Examples:

1st byte	2nd byte	3rd byte
01100001	10010001	11110000
01101000	11000010	10101010

3.5 Ground to CEB/FSW Commands

3.5.1 Reset Gamma – opcode 11

Reset the gamma board.

GAMMA_RESET_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.5.2 Change GPA Heater State – opcode 12

Turns the GPA heater on or off.

CHG_GPA_HTR_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Heater Control (16 bits)
Checksum (16 bits)

3.5.3 Ramp Gamma High Voltage – opcode 13

This command is used to gamma high voltage up or down.

RAMP_GAMMA_OPCODE(16bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Up/Down (16 bits)
Max DAC Setting (16 bits)
Pause (16 bits)
Checksum (16 bits)

- Up/Down – ramp up or down.
- Max DAC Setting – the DAC setting to ramp to.
- Pause – the seconds between each ramp.

3.5.4 Abort Gamma High Voltage Ramp – opcode 14

This command is used to abort a gamma high voltage ramp, either up or down.

RAMP_GAMMA_OPCODE(16bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.5.5 Reset LANL – opcode 29

Reset the LANL board.

LANL_RESET_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.5.6 Change HEND Status – opcode 36

Change one of the HEND Output Status bits.

CHG_HEND_STATUS_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Bit (16 bit)
On or Off (16 bit)
Checksum (16 bits)

- Bit – A, B, C, D
- On or Off – set it hi or lo.

3.5.7 Change Operating Mode – opcode 45

CHG_MODE_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Mode (16 bits)
Checksum (16 bits)

- Mode – the new mode to go to (Cruise, Mapping).

3.5.8 Update Engineering Table – opcode 46

This command is used to change a field in the analog table. Refer to the housekeeping document for a complete list of all possible values for the fields in this command.

CHG_ANALOG_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Parameter (16 bits)
Section (16 bits)
Value (16 bits)
Checksum (16 bits)

- Parameter – the entry in the Analog table which is to be changed.
- Section – the section of the entry to change.
- Value – the value to change the entry to.

3.5.9 Parameter Updates – opcode 47

CHG_PARAM_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Parameter (16 bits)
Value (16 bits)
Checksum (16 bits)

- Parameter – 0 – TBD, from the paramter list found in GRS_parameters.xls:

3.5.10 Reload Parameter or Analog Table – opcode 48

Reads the Parameter or analog tables out of specified EEPROM and loads it into RAM.

RELOAD_TABLE_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Which Table (16 bits)
Which EERPOM (16 bits)
Checksum (16 bits)

- Which Table – which table to update (PARAM = 0, ANALOG = 1)
- Which EEPROM – which eeprom to read from A = 0 or B = 1

3.5.11 Control Door Power – opcode 49

This command is used to override the standard door operations. It enables turning the various door powers on independent of each other.

DOOR_PWR_CNTRL_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Power (16 bits)
On/Off (16 bits)
Checksum (16 bits)

- Power – the power bit to be changed.
- On/Off – the postion to change to.

3.5.12 Control Anneal Heaters – opcode 50

This command is used to override the standard anneal operations. It enables turning the various heaters on independent of each other.

ANNEAL_PWR_CNTRL_OPCODE(16bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Heater (16 bits)
On/Off (16 bits)
Checksum (16 bits)

- Heater – the heater bit to be changed.
- On/Off – the postion to change to.

3.5.13 Set Calibration Current Control Power – opcode 51

Turn on or off the Calibration Current.

CAL_CURR_CNTRL_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
On/Off (16 bits)
Checksum (16 bits)

- On/Off – the postion to change to.

3.5.14 Control Operational Heater – opcode 52

Turn on or off the Operational Heater.

OP_HTR_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
On/Off (16 bits)
Checksum (16 bits)

- On/Off – the postion to change to.

3.5.15 Control CEB Heater – opcode 53

Turn on or off the CEB Heater.

OP_HTR_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
On/Off (16 bits)
Checksum (16 bits)

- On/Off – the postion to change to.

3.5.16 Change Instrument State – opcode 55

This command is used to turn instruments on and off.

CHG_STATE_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Instrument (16 bits)
State (16 bits)
Checksum (16 bits)

- Instrument – the instrument for which to change state. (Gamma = 0, Lanl = 1, Hend = 2, and Gamma Pulser = 3)
- State – On = 1 or Off = 0.

3.5.17 Update Command Sequence – opcode 56

There are upto 100 stored command sequences in EEPROM. These sequences can be changed. This command will allow any of the sequences to be rewritten with the sequence sent with this command. The sequence is only updated, not activated. To activate the sequence the ACTIVATE SEQUENCE Command must be used.

CHG_SEQ_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Length (16 bits)
EEPROM side and Seq # (16 bits)
Cmds (16 bits)
Cmd Words
Checksum (16 bits)

- Length – the length of the Cmd Words.

- Seq # - the Sequence to update. The highest bit determines the EEPROM side the sequence goes into, the low byte contains the sequence number.
- # Cmds – the number of commands in the new sequence.
- Cmd Words – the actual commands (this is always 1002 bytes).

3.5.18 Activate Command Sequence – opcode 57

This command activates a stored command sequence. All commands in the sequence will be placed into the delayed command list and executed at some delta to when this command arrived. Each command in the sequence will get a Command ID starting at this commands ID plus one.

EXEC_SEQ_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Seq # (16 bits)
Side (16 bits)
Checksum (16 bits)

- Seq # - the stored sequence to activate, The highest bit determines the EEPROM side the sequence goes into, the low byte contains the sequence number.
- Side – the side of EEPROM the sequence is on.

3.5.19 Change Pixel Interval – opcode 58

All instruments can be set to different collection intervals. This command allows one instruments collection interval to be changed. The intervals are based on the orbit duration, ie. 360 intervals per 2hr orbit would yield 20 second intervals.

CHG_INTERVAL_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Instrument (16 bits)
Interval Count (16 bits)
Intervals (16 bits)
Checksum (16 bits)

- Instrument – the instrument for which to change collection interval.(Gamma = 0, LANL = 1, HEND = 2)
- Interval Count – the number of times to collect before sending. By setting this to a value greater than one the collection period can be changed to multiples of the interval, ie. If interval is set to 120 with a 2 hr orbit and interval count is set to 2 one data would be collected for 120 seconds before it was sent down.

- Interval – the new number of intervals to change to. (540, 480, 360, 240, 120)

3.5.20 Change Data Collection State – opcode 59

Data collection can be disabled for the three instruments in hardware, for pulser and profile it can be disabled in software.

CHG_CLCT_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Data Type (16 bits)
State (16 bits)
Checksum (16 bits)

- Data Type – the data type which to start or stop collecting. (Gamma = 0, LANL = 1, HEND = 2, Gamma Pulser = 3, Gamma Profile = 4)
- State – On or Off.

3.5.21 Change CEB Interrupt Time – opcode 60

CEB interrupts are used to control the time between collecting analog values. Each of the entries in the Analog Table are linked to one of the CEB timers.

CHG_CEB_INT_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Interrupt # (16 bits)
Time (16 bits)
Every # (16 bits)
Checksum (16 bits)

- Interrupt – the number of the ceb timer interrupt to change.
- Time – the new time to set it to.
- Every – the number of times the interrupt should pass before the timer's tasks are executed.

3.5.22 Change Receive/Xmit Timeout – opcode 61

Change the hardware timeouts declaring the end of receipt or transmit to the S/C or HEND.

CHG_TIMEOUT_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Which (16 bits)
Timeout (16 bits)
Value (16 bits)
Checksum (16 bits)

- Which – which to change, spacecraft = 5 or hend = 2
- Timeout – which timeout to change, receive = 0 or xmit = 1
- Value – the new value of the timeout period.

3.5.23 Delete Command Sequence – opcode 62

Deletes one of the command sequences.

DELETE_SEQ_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Seq # (16 bits)
Side (16 bits)
Checksum (16 bits)

- Seq # - the Sequence to delete, The highest bit determines the EEPROM side the sequence goes into, the low byte contains the sequence number
- Side – EEPROM side the sequence is on.

3.5.24 Delete Command From Delayed Command List – opcode 65

Deletes only the command with the specified Command ID from the delayed list. A memory dump of the deleted command will be sent down.

DELETE_ONE_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Command ID (16 bits)
Checksum (16 bits)

- Command ID – the ID of the command which to remove from the delayed list.

3.5.25 Delete All Commands From Delayed Command List – opcode 66

Deletes all commands from the Delayed list. A memory dump of the deleted commands will be sent down.

DELETE_ALL_OPCODE (16 bits)
Flag/Command ID# (16 bits
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.5.26 Move Anneal Door – opcode 67

Opens or closes the anneal door.

DOOR_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Open/Close (16 bits)
Door control (16 bits)
Latch control (16 bits)
Checksum (16 bits)

3.5.27 Reset – opcode 69

Allow the watchdog timer to expire to reset the CPU board.

RESET_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.5.28 Anneal – opcode 70

Sets the state of the anneal process.

ANNEAL_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
State (16 bits)
Checksum (16 bits)

- State – the anneal state to move to. (Done, Start, Warmup1, Warmup2, Warmup3, Steady, Monitor)

3.5.29 Change EEPROM Protection State – opcode 71

Change the state of EEPROM protection.

EEPROM_EN_DIS_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Side (16 bits)
State (16 bits)
Checksum (16 bits)

- Side – the EEPROM side to change
- State – Enable or Disable the protection.

3.5.30 Code Upload – opcode 75

This command is used to modify the small sections of fsw code and tables.

MEM_LOAD_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Length (16 bits)
Starting Address (32 bits)
Length number of Code bytes
Checksum (16 bits)

- Length – the length of the code in bytes which is to be uploaded.
- Starting Address – the address in EEPROM or RAM at which to start writing the code.
- Code – the actual bytes to write.

3.5.31 Dump Parameters – opcode 76

This initiates a memory dump of the parameter table.

DUMP_PARAMS_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.5.32 Dump Analog Table – opcode 77

This initiates a memory dump of the analog table.

DUMP_ANALOG_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.5.33 Dump FPGA Registers – opcode 78

This initiates a memory dump of the hardware registers.

DUMP_FPGA_REGS_OPCODE(16bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Which (16 bits)
Checksum (16 bits)

- Which – the registers to dump A or B

3.5.34 Dump DMA Registers – opcode 79

This initiates a memory dump of the DMA hardware registers.

DUMP_DMA_REGS_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.5.35 Memory Dump – opcode 80

This initiates a memory dump of any section of memory.

MEM_DUMP_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Starting Address (32 bits)
Length (16 bits)
Checksum (16 bits)

- Starting Address – the address at which to start the dump
- Length - number of bytes to dump.

3.5.36 Dump Sequence – opcode 81

This initiates a memory dump of the specified sequence.

DUMP_SEQ_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Sequence # (16 bits)
Side (16 bits)
Checksum (16 bits)

- Sequence # - the number of the sequence to dump.
- Side – EEPROM side the sequence is on.

3.5.37 Dump Telemetered Data Counts – opcode 82

This initiates a memory dump of the telemetered data counts.

DUMP_COUNTS_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.5.38 Padded Code Upload – opcode 83

This command is used to modify the large sections of fsw code and tables.

FILE_MEMLOAD_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Length (16 bits)
Starting Address (32 bits)
Code (1000 bytes)
Checksum (16 bits)

- Length – the length of the code in bytes which is to be uploaded.
- Starting Address – the address in EEPROM or RAM at which to start writing the code.
- Code – the actual bytes to write (this section will always be 1000 bytes, all bytes after length will be 0).

3.5.39 Save Data to EEPROM – opcode 85

Writes the specified table to EEPROM location.

SAVE_TO_EE_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
What (16 bits)
Checksum (16 bits)

- What – the table to be saved. (Parameters, Analog, State)

3.5.40 Change Debug Level – opcode 86

Messages are sent down according to the current debug level. The higher the level the more messages will be sent.

CHG_TRACE_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Level (16 bits)
Checksum (16 bits)

- Level – the new level to set debug to.

3.5.41 Start FSW – opcode 87

Causes the Loader to jump to the Flight Software.

START_FSW_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Starting Address (32 bits)
Checksum (16 bits)

3.5.42 Pass-Through – opcode 98

Command which can accomidate data which is to be acted upon by the flight software.

PASS_THRU_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Data Word (16 bits)
Data Word (16 bits)
Data Word (16 bits)
Data Word (16 bits)
Checksum (16 bits)

3.6 Debug Commands

3.6.1 Get Version – opcode 100

Returns the version number of the Flight Software.

GET_VERSION_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.6.2 Write To Hardware Register – opcode 101

A means of writing a 16 bit value to any memory location.

WRITE_REG_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Address (32 bits)
Value (16 bits)
Checksum (16 bits)

- Address – the address of the register to write to.
- Value – the value to place in the register.

3.6.3 Set Orbit Duration – opcode 102

A manual means of changing the orbit duration. This will affect the pixel intervals for all data collections.

SET_ORB_DURATION_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Time (32 bits)
Checksum (16 bits)

3.6.4 Trigger Burst – opcode 103

Forces Profile data to be sent down without a burst occuring.

TRIGGER_BURST_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Big or Little (16 bits)
Checksum (16 bits)

- Big or Little – trigger the big or little burst

3.6.5 No Operation – opcode 104

Does nothing but causes a completion message to be generated.

NO_OP_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.6.6 Error – opcode 105

Causes an error message to be generated.

ERROR_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)

3.6.7 Get Heartbeat Count – opcode 106

Returns the number of heartbeats sent.

GET_HEARTBEAT_CNT_OPCODE (16 bits)
Flag/Command ID# (16 bits)
Time/Orbit-Pixel (32 bits)
Checksum (16 bits)