ISS Telemetry Information

ISS Data and Packet Types

ISS produces two types of data, science and housekeeping. Table 0-1 outlines the ISS data type by telemetry mode classification. ISS has five packet types which are given in Table 0-2.   Packet types are identical for the NAC and WAC. Definitions of each packet are as follows:

High Rate Science: contains the imaging data produced by the camera along with header data.

High Rate Memory Dump: contains the contents of the ISS memory and is emitted by ISS only is response to a READ MEMORY command within the camera(s).

Housekeeping: contains information on the state of the camera(s), voltages, temperatures, errors, and a brief description of previous images and commands.

HDE Monitor: contains multiple readings of a single measurement from the housekeeping data electronics (HDE).

Memory Monitor: contains multiple readings of up to six memory address locations.

The ISS housekeeping packet type telemetry mode is given in Table 0-3.   ISS has a housekeeping data rate of 17.5 bps for any type of ISS housekeeping packet.

Table 0-1   Telemetry Mode Classification and ISS Data Type

Classification	ISS Data Types
(1) Real-time Engineering (RTE)	Housekeeping
(2) Playback plus Real-time Engineering (PB&RTE)	Housekeeping
(3) Probe Checkout (PCHK)	N/A
(4) Probe Operations (Probe Relay) (PRLY)	Housekeeping
(5) Science and Engineering Record (S&ER)	Science & Housekeeping
(6) Real-time Engineering plus Science Playback (RTE&SPB)	Housekeeping
(7) SAF Instrument Checkout (SAF)	Science & Housekeeping

Table 0-2   ISS Packet Types

Type	Subaddress	Name	Size (bits)
Science	SCI Data	High Rate Science	7616
Science	SCI Data	High Rate Memory Dump	7616
Housekeeping	SCI HK	Housekeeping	1120
Housekeeping	SCI HK	HDE Monitor	1120
Housekeeping	SCI HK	Memory Monitor	1120

Table 0-3   Housekeeping Telemetry Mode

Subsystem	Subaddress	Rate (bits/sec)	Packet Size (bits)	Collection Repeat Cycle (sec)
ISS NAC	SCI HK	17.5	1120	64
ISS WAC	SCI HK	17.5	1120	64

Science packet types are produced in only one classification - for Science and Engineering Record. The names of the principle **and default** packets are the **High Rate Science** packet and the **Housekeeping** packet. In order to obtain the complete set of ISS science telemetry modes and packet types, please note that each SCI Data entry in the subaddress column of Table 0-4 can be either a High Rate Science or a High Rate Memory Dump packet type.

Within the Science and Engineering Record Classification (S&ER), seven of the ten telemetry modes are identified as having ISS actively taking data. Six of these are during the Optical Remote Sensing (ORS) Operational Mode and the remaining mode is the Optical Navigation Mode. ISS is in its Operating power state during any ORS mode.

Detailed Telemetry List

Every packet produced by ISS has the standard 96-bit CCSDS header defined by Cassini Project Document 3-281. Within this CCSDS header, in bits 11-16, is a Packet Type ID.   Each ISS telemetry packet type and the camera which produced it is identified by this Packet Type ID. The code is embedded into each packet as part of the Application Process ID (APID). The whole APID is an 11 bit number which is divided in two parts: (1) the Subsystem ID and (2) the Packet Type ID. The ISS Subsystem ID is 01100. The Packet Type IDs are given in Table 0-5.

ISS High Rate Science Packet

The ISS high rate science packet contains two types of information, header and image data. There are three types of headers: a standard science header, an extended science header, and line headers. The extended header is located in the first, last and every 50th packet of each image frame produced by the cameras. [Note: There can be over 2000 packets per image frame.] The standard science header is located in all remaining packets of the frame. The line headers are located at the beginning of each line of image data. There is only one standard or extended science header per packet. There may be multiple line headers in a single packet. The details of these headers are in Table 0-6, Table 0-7, and Table 0-8. The remainder of each packet is image data.

ISS High Rate Memory Dump Packet

The ISS high rate memory dump packet is used to read the contents of the entire or a specified area of ISS memory. The ISS command READ MEMORY will change the science packet to this type. Details of the packet are in x.

ISS Measurement Listings for Housekeeping Packets

The details of the ISS housekeeping packets are in Table 0-10 and Table 0-11. For all items identified as DIGITAL in the listing, a bit definition is provided following the NAC and WAC tables as Table 0-12.   The camera opcodes are in Table 0-13. The bit definitions apply to both cameras.

ISS Measurement Listings for HDE Monitor and Memory Monitor Packets

Details of the ISS HDE Packets are in Table 0-14, Table 0-15, and Table 0-16. Details of the ISS Memory Monitor Packets are inTable 0-17 and Table 0-18.

Table 0-4   Telemtry Mode Definition for S&ER Classification

ORS Submode	Subsystem	Subaddress	Rate (bits/sec)	Packet Size (bits)	Collection Repeat Cycle (sec)
Stellar Occultation	ISS NAC	SCI Data	121.9 K	7616	.125
	ISS WAC	SCI Data	See Note	7616	.125
	ISS NAC	SCI Data	60.9 K	7616	.125
	ISS WAC	SCI Data	60.9 K	7616	.125
	ISS NAC	SCI HK	See Table 0-3		
	ISS WAC	SCI HK	See Table 0-3		
Titan	ISS NAC	SCI Data	60.9 K	7616	.125
	ISS WAC	SCI Data	See Note	7616	.125
	ISS NAC	SCI HK	See Table 0-3		
	ISS WAC	SCI HK	See Table 0-3		
Saturn Mode 1	ISS NAC	SCI Data	243.7K	7616	.125
	ISS WAC	SCI Data	See Note	7616	.125
	ISS NAC	SCI Data	121.9 K	7616	.125
	ISS WAC	SCI Data	121.9 K	7616	.125
	ISS NAC	SCI HK	See Table 0-3		
	ISS WAC	SCI HK	See Table 0-3		
Saturn Mode 2	ISS NAC	SCI Data	60.9 K	7616	.125
	ISS WAC	SCI Data	See Note	7616	.125
	ISS NAC	SCI HK	See Table 0-3		
	ISS WAC	SCI HK	See Table 0-3		
Icy Satellite Mode 1	ISS NAC	SCI Data	365.6 K	7616	.125
	ISS WAC	SCI Data	See Note	7616	.125
	ISS NAC	SCI Data	182.8 K	7616	.125
	ISS WAC	SCI Data	182.8 K	7616	.125
	ISS NAC	SCI HK	See Table 0-3		
	ISS WAC	SCI HK	See Table 0-3		
Icy Satellite Mode 2	ISS NAC	SCI Data	304.6 K	7616	.125
	ISS WAC	SCI Data	See Note	7616	.125
	ISS NAC	SCI HK	See Table 0-3		
	ISS WAC	SCI HK	See Table 0-3		
Optical Navigation	ISS NAC	SCI Data	365.6	7616	.125
	ISS WAC	SCI Data	365.6	7616	.125

Note: The ISS has implemented the "BIU Address Swap" Option which allows the cameras to share the maximum data rate allocated by swapping the NAC and WAC BIU addresses. This swapping is transparent to the Spacecraft CDS and Ground Data Subsystem. When ISS BIU Swapping is in effect, the Spacecraft telemetry mode table will carry a non-zero entry for the NAC and a zero entry for the WAC.

Table 0-5   ISS Detailed Packet Type

Packet Type ID	APID (Decimal)	Size	Packet Source	Packet Description
010001	2036.17	1120	SCI HK	ISS NAC Housekeeping
010010	2036.18	7616	SCI Data	ISS NAC Science
010111	2036.23	7616	SCI Data	ISS NAC Memory Dump
011101	2036.29	1120	SCI HK	ISS NAC HDE Monitor
011110	2036.30	1120	SCI HK	ISS NAC Memory Monitor
100001	2036.33	1120	SCI HK	ISS WAC Housekeeping
100010	2036.34	7616	SCI Data	ISS WAC Science
100111	2036.39	7616	SCI Data	ISS WAC Memory Dump
101101	2036.45	1120	SCI HK	ISS WAC HDE Monitor
101110	2036.46	1120	SCI HK	ISS WAC Memory Monitor

Table 0-6   ISS Standard Science Header

Description	Size	Values	Mask
Camera	1	v	1
Summation (0:1x1, 1:2x2, 2:4x4)	2	v	3
Compression Style	2	v	3
Conversion Type	2	v	3
Line Continue Flag	1	v	1
Science Header Type	2	v	3
Gain	2	0	3
Filter 1 Position	4	v	15
Filter 2 Position	4	v	15
Image Line #	12	v	4095
Last Packet Flag (image end flag)	1	v	1
blocks per GroupOfBlock - Lossy	7	v	3
compression rate (Lossy)	4	v	XF
Malgo (algothim Mode) (lossy)	1	v	1
TB (block Type) (Lossy)	1	v	1
Parity 1 (even parity bit)	1	v	1

Description	Size	Values	Mask
Count1(#ofBytes in packet for line)	15	v	X7FFF
Parity 2	1	v	1
Count 2 (duplicate of Count1)	15	v	X7FFF
Extended Pixel, if continueflag=0. Else,this has offset byte# of the line)	16	v	XFFFF
Overclock Pixel (see Extended)	16	v	XFFFF

Table 0-7   ISS Extended Science Header

Description	Size	Values	Mask
Camera	1	v	1
Summation (0:1x1, 1:2x2, 2:4x4)	2	v	2
Compression Style	2	v	2
Conversion Type	2	v	2
Line Continue Flag	1	v	1
SCIence Header Type	2	v	3
Gain	2	v	3
Filter 1 Position	4	v	15
Filter 2 Position	4	v	15
Image Line #	12	v	4095
Last Packet Flag	1	v	1
Lossy - Block per GroupOfBlock	7	v	X7F
Lossy - Compression Rate	4	v	F
Lossy - Malgo (algorithm)	1	v	1
Lossy -TB (Type Block)	1	v	1
Cal Lamp	1	v	1
Light Flood. Erase	1	v	1
TCE Heater	1	v	1
TCE Regulate	1	v	1
Optics Heater 1	1	v	1
Optics Heater 2	1	v	1
Anti-blooming State	1	v	1
Prepare Index	4	v	15
Readout Index	4	v	15
Table Id	4	v	15
Byte # of Table Entry	12	v	4095
Contents of Entry	16	v	XFFFF
Image #	16	v	XFFFF
+50v	16	v	XFFFF
+30v	16	v	XFFFF
+28v	16	v	XFFFF

Description	Size	Values	Mask
+12v	16	v	XFFFF
-12v	16	v	XFFFF
+5v	16	v	XFFFF
CCD Temperature	16	v	XFFFF
Optics 1 Temperature	16	v	XFFFF
Optics 2 Temperature	16	v	XFFFF
Optics 3 Temperature	16	v	XFFFF
Optics 4 Temperature	16	v	XFFFF
MEA 1 Temperature	16	v	XFFFF
MEA 2 Temperature	16	v	XFFFF
MEA 3 Temperature	16	v	XFFFF
Current (amperes)	16	v	XFFFF
ID of Last command Triggered	16	v	XFFFF
# of commands received	16	v	XFFFF
Current upload	16	v	XFFFF
FSW state	8	v	255
Exposure Index	8	v	255
Voltage Ref lo	16	v	XFFFF
Voltage Ref hi	16	v	XFFFF
spare	32	v	

Table 0-8   ISS Line Header

Description	Size	Values	Mask
Parity 1 (even parity bit)	1	v	1
Count1(#ofBytes in packet for line)	15	v	X7FFF
Parity 2	1	v	1
Count 2 (duplicate of Count1)	15	v	X7FFF
Extended Pixel, if continueflag=0. Else,this has offset byte# of the line)	16	v	XFFFF
Overclock Pixel (see Extended)	16	v	XFFFF

Table 0-9 ISS High Rate Memory Dump Packet

Description	Size	Values	Mask
Camera	1	v	1
Spare	7	0	127
Start Address	24	v	XFFFFFF
End Address	24	v	XFFFFFF
HRM Dump Time 1	32	v	X7FFFFFFF
HRM Dump Time 2	8	v	255
Data 1	16	v	XFFFF
Data 2	16	v	XFFFF
Data 3	16	v	XFFFF
•			

Description	Size	Values	Mask
•			
•			
Data 462	16	v	XFFFF
Data 463	16	v	XFFFF
Data 464	16	v	XFFFF

Table 0-10　　ISS NAC Housekeeping Packet

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0550	Present State 1	96	PRES_STATE_1	DIGITAL	n/a	ISS NAC FSW
S-0551	Present Filter 1	104	PRES_FILT_1	UNSIGNED	1-12	ISS NAC FSW
S-0552	Present Filter 2	108	PRES_FILT_2	UNSIGNED	1-12	ISS NAC FSW
S-0553	Present Shutter	112	PRES_SHUTTER	DIGITAL	n/a	ISS NAC FSW
S-0554	Present State 2	114	PRES_STATE_2	DIGITAL	n/a	ISS NAC FSW
S-0555	Error 1	128	SEU_COUNT	UNSIGNED	0-255	ISS NAC FSW
S-0556	Voltage 1	136	HK50V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0557	Voltage 2	148	HK30V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0558	Error 2	160	RECOV_ERRORS	UNSIGNED	0-255	ISS NAC FSW
S-0559	Voltage 3	168	HK28V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0560	Voltage 4	180	HK15V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0561	Error 3	192	FATAL_ERRORS	UNSIGNED	0-255	ISS NAC FSW
S-0562	Voltage 5	200	HKMIN15V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0563	Voltage 6	212	HK5V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0564	Recoverable Error Type	224	LAST_REC_ERR	UNSIGNED	0-255	ISS NAC FSW
S-0565	Temperature 1	232	CCD_MON	UNSIGNED	0-4076	ISS NAC HDE
S-0566	Temperature 2	244	HKOPT1_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0567	Fatal Error Type	256	LAST_FAT_ERR	UNSIGNED	0-255	ISS NAC FSW
S-0568	Temperature 3	264	HKOPT2_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0569	Temperature 4	276	HKOPT3_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0570	Software	288	SOFTWARE	DIGITAL	n/a	ISS NAC FSW
S-0571	Temperature 5	296	HKOPT4_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0572	Temperature 6	308	HKEFC1_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0573	Spare 1	320	SPARE_1	UNSIGNED	n/a	
S-0574	Temperature 7	328	HKEFC2_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0575	Temperature 8	340	HKME3_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0576	Spare 2	352	SPARE_2	UNSIGNED	n/a	
S-0577	Current	356	ISS_CSENS	UNSIGNED	0-4076	ISS NAC HDE
S-0578	Spare 3	368	SPARE_3	UNSIGNED	n/a	TBD
S-0579	RefLo	372	VREF_LOW	UNSIGNED	0-4076	ISS NAC HDE
S-0580	Spare 4	384	SPARE_4	UNSIGNED	n/a	
S-0581	Ref Hi	388	VREF_HIGH	UNSIGNED	0-4076	ISS NAC HDE
S-0582	Upload	400	UPLOAD_NUM	UNSIGNED	0-32767	ISS NAC FSW
S-0583	Image Number	416	IMAGE_NUM	UNSIGNED	0-32767	ISS NAC FSW
S-0584	Image 1	432	IMAGE_1	DIGITAL	n/a	ISS NAC FSW
S-0585	Image 2	448	IMAGE_2	DIGITAL	n/a	ISS NAC FSW
S-0586	Image 3	464	IMAGE_3	DIGITAL	n/a	ISS NAC FSW
S-0587	Image 4	480	IMAGE_4	DIGITAL	n/a	ISS NAC FSW
S-0588	Image 5	496	IMAGE_5	DIGITAL	n/a	ISS NAC FSW
S-0589	Image 6	512	IMAGE_6	DIGITAL	n/a	ISS NAC FSW
S-0590	Image 7	528	IMAGE_7	DIGITAL	n/a	ISS NAC FSW
S-0591	Image 8	544	IMAGE_8	DIGITAL	n/a	ISS NAC FSW
S-0592	Image 9	560	IMAGE_9	DIGITAL	n/a	ISS NAC FSW

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0593	Image 10	576	IMAGE_10	DIGITAL	n/a	ISS NAC FSW
S-0594	Image 11	592	IMAGE_11	DIGITAL	n/a	ISS NAC FSW
S-0595	Image 12	608	IMAGE_12	DIGITAL	n/a	ISS NAC FSW
S-0596	Image 13	624	IMAGE_13	DIGITAL	n/a	ISS NAC FSW
S-0597	Image 14	640	IMAGE_14	DIGITAL	n/a	ISS NAC FSW
S-0598	Image 15	656	IMAGE_15	DIGITAL	n/a	ISS NAC FSW
S-0599	Image 16	672	IMAGE_16	DIGITAL	n/a	ISS NAC FSW
S-0600	Image 17	688	IMAGE_17	DIGITAL	n/a	ISS NAC FSW
S-0601	Image 18	704	IMAGE_18	DIGITAL	n/a	ISS NAC FSW
S-0602	Image 19	720	IMAGE_19	DIGITAL	n/a	ISS NAC FSW
S-0603	Image 20	736	IMAGE_20	DIGITAL	n/a	ISS NAC FSW
S-0604	Command Number Received	752	COMMAND_REC	UNSIGNED	0-32767	ISS NAC FSW
S-0605	Command Number Executed	768	COMMAND_EXEC	UNSIGNED	0-32767	ISS NAC FSW
S-0606	Macro	784	LAST_MACRO	UNSIGNED	0-32767	ISS NAC FSW
S-0607	Trigger	800	LAST_TRG_CMD	UNSIGNED	0-32767	ISS NAC FSW
S-0609	Spare 5	880	SPARE_5	UNSIGNED	n/a	
S-0616	Command 1	816	LAST_OPCODE1	DIGITAL	n/a	ISS NAC FSW
S-0617	Command 2	824	LAST_OPCODE2	DIGITAL	n/a	ISS NAC FSW
S-0618	Command 3	832	LAST_OPCODE3	DIGITAL	n/a	ISS NAC FSW
S-0619	Command 4	840	LAST_OPCODE4	DIGITAL	n/a	ISS NAC FSW
S-0620	Command 5	848	LAST_OPCODE5	DIGITAL	n/a	ISS NAC FSW
S-0621	Command 6	856	LAST_OPCODE6	DIGITAL	n/a	ISS NAC FSW
S-0622	Command 7	864	LAST_OPCODE7	DIGITAL	n/a	ISS NAC FSW
S-0623	Command 8	872	LAST_OPCODE8	DIGITAL	n/a	ISS NAC FSW

Table 0-11   ISS WAC Housekeeping Packet

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0700	Present State 1	96	PRES_STATE_1	DIGITAL	n/a	ISS NAC FSW
S-0701	Present Filter 1	104	PRES_FILT_1	UNSIGNED	1-12	ISS NAC FSW
S-0702	Present Filter 2	108	PRES_FILT_2	UNSIGNED	1-12	ISS NAC FSW
S-0703	Present Shutter	112	PRES_SHUTTER	DIGITAL	n/a	ISS NAC FSW
S-0704	Present State 2	114	PRES_STATE_2	DIGITAL	n/a	ISS NAC FSW
S-0705	Error 1	128	SEU_COUNT	UNSIGNED	0-255	ISS NAC FSW
S-0706	Voltage 1	136	HK50V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0707	Voltage 2	148	HK30V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0708	Error 2	160	RECOV_ERRORS	UNSIGNED	0-255	ISS NAC FSW
S-0709	Voltage 3	168	HK28V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0710	Voltage 4	180	HK15V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0711	Error 3	192	FATAL_ERRORS	UNSIGNED	0-255	ISS NAC FSW
S-0712	Voltage 5	200	HKMIN15V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0713	Voltage 6	212	HK5V_TEL	UNSIGNED	0-4076	ISS NAC HDE
S-0714	Recoverable Error Type	224	LAST_REC_ERR	UNSIGNED	0-255	ISS NAC FSW
S-0715	Temperature 1	232	CCD_MON	UNSIGNED	0-4076	ISS NAC HDE
S-0716	Temperature 2	244	HKOPT1_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0717	Fatal Error Type	256	LAST_FAT_ERR	UNSIGNED	0-255	ISS NAC FSW
S-0718	Temperature 3	264	HKOPT2_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0719	Temperature 4	276	HKOPT3_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0720	Software	288	SOFTWARE	DIGITAL	n/a	ISS NAC FSW
S-0721	Temperature 5	296	HKOPT4_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0722	Temperature 6	308	HKEFC1_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0723	Spare 1	320	SPARE_1	UNSIGNED	n/a	
S-0724	Temperature 7	328	HKEFC2_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0725	Temperature 8	340	HKME3_TEMP	UNSIGNED	0-4076	ISS NAC HDE
S-0726	Spare 2	352	SPARE_2	UNSIGNED	n/a	
S-0727	Current	356	ISS_CSENS	UNSIGNED	0-4076	ISS NAC HDE
S-0728	Spare 3	368	SPARE_3	UNSIGNED	n/a	TBD
S-0729	RefLo	372	VREF_LOW	UNSIGNED	0-4076	ISS NAC HDE
S-0730	Spare 4	384	SPARE_4	UNSIGNED	n/a	
S-0731	Ref Hi	388	VREF_HIGH	UNSIGNED	0-4076	ISS NAC HDE
S-0732	Upload	400	UPLOAD_NUM	UNSIGNED	0-32767	ISS NAC FSW
S-0733	Image Number	416	IMAGE_NUM	UNSIGNED	0-32767	ISS NAC FSW
S-0734	Image 1	432	IMAGE_1	DIGITAL	n/a	ISS NAC FSW
S-0735	Image 2	448	IMAGE_2	DIGITAL	n/a	ISS NAC FSW
S-0736	Image 3	464	IMAGE_3	DIGITAL	n/a	ISS NAC FSW
S-0737	Image 4	480	IMAGE_4	DIGITAL	n/a	ISS NAC FSW
S-0738	Image 5	496	IMAGE_5	DIGITAL	n/a	ISS NAC FSW
S-0739	Image 6	512	IMAGE_6	DIGITAL	n/a	ISS NAC FSW
S-0740	Image 7	528	IMAGE_7	DIGITAL	n/a	ISS NAC FSW
S-0741	Image 8	544	IMAGE_8	DIGITAL	n/a	ISS NAC FSW
S-0742	Image 9	560	IMAGE_9	DIGITAL	n/a	ISS NAC FSW

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0743	Image 10	576	IMAGE_10	DIGITAL	n/a	ISS NAC FSW
S-0744	Image 11	592	IMAGE_11	DIGITAL	n/a	ISS NAC FSW
S-0745	Image 12	608	IMAGE_12	DIGITAL	n/a	ISS NAC FSW
S-0746	Image 13	624	IMAGE_13	DIGITAL	n/a	ISS NAC FSW
S-0747	Image 14	640	IMAGE_14	DIGITAL	n/a	ISS NAC FSW
S-0748	Image 15	656	IMAGE_15	DIGITAL	n/a	ISS NAC FSW
S-0749	Image 16	672	IMAGE_16	DIGITAL	n/a	ISS NAC FSW
S-0750	Image 17	688	IMAGE_17	DIGITAL	n/a	ISS NAC FSW
S-0751	Image 18	704	IMAGE_18	DIGITAL	n/a	ISS NAC FSW
S-0752	Image 19	720	IMAGE_19	DIGITAL	n/a	ISS NAC FSW
S-0753	Image 20	736	IMAGE_20	DIGITAL	n/a	ISS NAC FSW
S-0754	Command Number Received	752	COMMAND_REC	UNSIGNED	0-32767	ISS NAC FSW
S-0755	Command Number Executed	768	COMMAND_EXEC	UNSIGNED	0-32767	ISS NAC FSW
S-0756	Macro	784	LAST_MACRO	UNSIGNED	0-32767	ISS NAC FSW
S-0757	Trigger	800	LAST_TRG_CMD	UNSIGNED	0-32767	ISS NAC FSW
S-0759	Spare 5	880	SPARE_5	UNSIGNED	n/a	
S-0766	Command 1	816	LAST_OPCODE1	DIGITAL	n/a	ISS NAC FSW
S-0767	Command 2	824	LAST_OPCODE2	DIGITAL	n/a	ISS NAC FSW
S-0768	Command 3	832	LAST_OPCODE3	DIGITAL	n/a	ISS NAC FSW
S-0769	Command 4	840	LAST_OPCODE4	DIGITAL	n/a	ISS NAC FSW
S-0770	Command 5	848	LAST_OPCODE5	DIGITAL	n/a	ISS NAC FSW
S-0771	Command 6	856	LAST_OPCODE6	DIGITAL	n/a	ISS NAC FSW
S-0772	Command 7	864	LAST_OPCODE7	DIGITAL	n/a	ISS NAC FSW
S-0773	Command 8	872	LAST_OPCODE8	DIGITAL	n/a	ISS NAC FSW

Table 0-12   ISS Housekeeping Packet Measurement Bit Definitions, (1) - (25)

(1)

S-0550 or S-0700	Present State 1	
Bit	**Title**	**Definition**
0	Camera	0: NAC 1: WAC
1-2	Summation	00: 1X1 01: 2x2 10: 4x4 11: illegal
3-4	Compression	00: no compression 01: lossless 10: lossy 11: illegal
5-6	Conversion	00: no conversion 01: 8 lsb 10: 12 to 8 11: illegal

S-0550 or S-0700	Present State 1	
Bit	Title	Definition
7	Cal Lamp	0: off 1: on

(2)

S-0553 or S-0703	Present Shutter	
Bit	Title	Definition
0	Blade A	0: reset 1: activated
1	Blade B	0: reset 1: activated

(3)

S-0554 or S-0704	Present State 2	
Bit	Title	Definition
0 - 1	Gain	00: low 01: high 10: 2x2 sum 11: 4x4 sum
2-5	Data Rate	TBD
6-7	MP State	00: illegal 01: Sleep 10: Idle 11: Active
8	Light Flood	0: off 1: on
9	Anti-Blooming	0: off 1: on
10	Optics Heater 1	0: off 1: on
11	Optics Heater 2	0: off 1: on
12-13	TCE State	00: off 01: on/no regulate 10: off 11: on/regulate

(4)

S-0570 or S-0720	Software	
Bit	**Title**	**Definition**
0 - 1	Software	00: upload empty 01: uplead full 10: no recent POR 11: POR in last hkp interval
2 - 7		TBD

Note: The following measurement bit definition describe the previous 20 images returned by the camera since POR.

(5)

S-0584 or S-0734	Image 1	
Bit	**Title**	**Definition**
0 - 1	Compression	00: no compression 01: lossless 10: lossy 11: illegal
2 -5	Filter Pos 1	[Unsigned]
6 - 9	Filter Pos 2	[Unsigned]
10 - 11	Gain	00: low 01: high 10: 2x2 sum 11: 4x4 sum
12 - 13	Conversion	00: no conversion 01: 8 lsb 10: 12 to 8 11: illegal

(6)

S-05845or S-0735	Image 2	
Bit	**Title**	**Definition**
0 - 1	Compression	00: no compression 01: lossless 10: lossy 11: illegal
2 -5	Filter Pos 1	[Unsigned]
6 - 9	Filter Pos 2	[Unsigned]
10 - 11	Gain	00: low 01: high 10: 2x2 sum 11: 4x4 sum
12 - 13	Conversion	00: no conversion 01: 8 lsb 10: 12 to 8 11: illegal

(7)

S-0586 or S-0736	Image 3	
Bit	**Title**	**Definition**
0 - 1	Compression	00: no compression 01: lossless 10: lossy 11: illegal
2 - 5	Filter Pos 1	[Unsigned]
6 - 9	Filter Pos 2	[Unsigned]
10 - 11	Gain	00: low 01: high 10: 2x2 sum 11: 4x4 sum
12 - 13	Conversion	00: no conversion 01: 8 lsb 10: 12 to 8 11: illegal

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(24)

S-0603 or S-0753	Image 20	
Bit	**Title**	**Definition**
0 - 1	Compression	00: no compression 01: lossless 10: lossy 11: illegal
2 - 5	Filter Pos 1	[Unsigned]
6 - 9	Filter Pos 2	[Unsigned]
10 - 11	Gain	00: low 01: high 10: 2x2 sum 11: 4x4 sum
12 - 13	Conversion	00: no conversion 01: 8 lsb 10: 12 to 8 11: illegal

Note: The following measurement bit definition describe the opcodes of the last 8 commands since POR.

(25)

S-0616 or S-0766	Command	
Bit	**Title**	**Definition**
0 - 7	Opcode 1	Various (TBS)
8 - 15	Opcode 2	Various (TBS)

S-0616 or S-0766	Command	
Bit	**Title**	**Definition**
16 - 23	Opcode 3	Various (TBS)
24 - 31	Opcode 4	Various (TBS)
32 - 39	Opcode 5	Various (TBS)
40 - 47	Opcode 6	Various (TBS)
48- 55	Opcode 7	Various (TBS)
56 - 63	Opcode 8	Various (TBS)

Table 0-13   ISS Command Opcodes

Opcode	ISS Command
0x10	WAKE
0xe0	HALT
0x33	SET_CAMERA
0x43	CAL_LAMP
0x44	HDE
0x4a	FILTER
0x4c	FLOOD_LIGHT
0x51	UPLOAD
0x53	MONITOR_MEMORY
0x54	TCE
0x57	WAIT
0x59	SHUTTER
0x5a	PORT
0x5b	READ_MEMORY
0x5c	LOAD_MEMORY
0x5e	NOOP
0x60	LOAD_MACRO
0x64	LOAD_PMACRO
0x65	END_MACRO
0x70	SET_COMP1
0x76	SET_COMP2
0x78	SET_COMP3
0x7c	HEATER
0x80	TRIGGER
0x84	IMAGE_EVENT
0x85	ITERATION
0x86	INSTANT
0xf0	END_UPLOAD
0xf1	XSUB

Table 0-14   ISS NAC HDE Monitor Packet

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0610	NAC/WAC	96	CAMERA	DIGITAL	n/a	ISS NAC FSW
S-0611	Spare 1	97	SPARE_1	UNSIGNED	n/a	TBD
S-0612	Code	104	HDE_CODE	DIGITAL	???	ISS NAC FSW
S-0613	Count	112	NUM_VALID	UNSIGNED	0-62	ISS NAC FSW
S-0614	Rate	120	SAMP_RATE	UNSIGNED	0-255	ISS NAC FSW
S-0615	HDE monitor value	128	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	144	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	160	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	176	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	192	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	208	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	224	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	240	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	256	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	272	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	288	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	304	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	320	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	336	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	352	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	368	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	384	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	400	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	416	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	432	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	448	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	464	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	480	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	496	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	512	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	528	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	544	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	560	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	576	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	592	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	608	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	624	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	640	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	656	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	672	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	688	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	704	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	720	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	736	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0615	HDE monitor value	752	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	768	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	784	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	800	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	816	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	832	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	848	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	864	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	880	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	896	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	912	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	928	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	944	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	960	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	976	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	992	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	1008	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	1024	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	1040	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	1056	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	1072	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	1088	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0615	HDE monitor value	1104	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW

Table 0-15   ISS WAC HDE Monitor Packet

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0760	NAC/WAC	96	CAMERA	DIGITAL	n/a	ISS NAC FSW
S-0761	Spare 1	97	SPARE_1	UNSIGNED	n/a	TBD
S-0762	Code	104	HDE_CODE	DIGITAL	10227	ISS NAC FSW
S-0763	Count	112	NUM_VALID	UNSIGNED	0-62	ISS NAC FSW
S-0764	Rate	120	SAMP_RATE	UNSIGNED	0-255	ISS NAC FSW
S-0765	HDE monitor value	128	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	144	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	160	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	176	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	192	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	208	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	224	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	240	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	256	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	272	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	288	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	304	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	320	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0765	HDE monitor value	336	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	352	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	368	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	384	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	400	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	416	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	432	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	448	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	464	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	480	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	496	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	512	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	528	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	544	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	560	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	576	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	592	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	608	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	624	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	640	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	656	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	672	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	688	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	704	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	720	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	736	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	752	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	768	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	784	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	800	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	816	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	832	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	848	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	864	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	880	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	896	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	912	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	928	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	944	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	960	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	976	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	992	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	1008	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	1024	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	1040	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	1056	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0765	HDE monitor value	1072	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	1088	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW
S-0765	HDE monitor value	1104	HDE Mon Val	DIGITAL	0-FFFF	ISS NAC FSW

Table 0-16   ISS HDE Packet Measurement Bit Definitions, (1) - (2)

(1)

S-0610 or S-0760	NAC/WAC	
Bit	**Title**	**Definition**
0	Camera	0: NAC 1: WAC

(2)

S-0612 or S-0762	Code
Value	**Definition**
0	HKTBD3_TEMP
1	HKTBD4_TEMP
2	CCD_MON
3	HKREF_LOW
4	HRREF_HIGH
5	HK50V_TEL
6	HK30V_TEL
7	HK28V_TEL
8	HK15V_TEL
9	HKMIN15V
10	HK5V_TEL
11	ISS_CSENS
12	HKRAD_TEMP
13	HKSHE_TEMP
14	HKOPT1_TEMP
15	HKOPT2_TEMP
16	HKME1_TEMP
17	HKME2_TEMP
18	HKME3_TEMP
19	HKTBD1_TEMP
20	HKTBD2_TEMP

Table 0-17   ISS NAC Memory Monitor Packet

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0637	Address Count	96	ADDRS_COUNT	UNSIGNED	1-6	ISS NAC FSW
S-0638	Count	104	NUM_VALID	UNSIGNED	0-53	ISS NAC FSW
S-0639	Rate	112	SAMP_RATE	UNSIGNED	0-255	ISS NAC FSW
S-0640	Spare	120	SPARE	UNSIGNED	n/a	TBD
S-0641	Location 1	128	MEM-ADDRS_1	UNSIGNED	0-524287	ISS NAC FSW
S-0642	Location 2	152	MEM-ADDRS_2	UNSIGNED	0-524287	ISS NAC FSW
S-0643	Location 3	176	MEM-ADDRS_3	UNSIGNED	0-524287	ISS NAC FSW
S-0644	Location 4	200	MEM-ADDRS_4	UNSIGNED	0-524287	ISS NAC FSW
S-0645	Location 5	224	MEM-ADDRS_5	UNSIGNED	0-524287	ISS NAC FSW
S-0646	Location 6	248	MEM-ADDRS_6	UNSIGNED	0-524287	ISS NAC FSW
S-0520	1st & 2nd Mem R/O Values	272	Vals 1 + 2	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0521	3rd & 4th Mem R/O Values	304	Vals 3 + 4	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0522	5th & 6th Mem R/O Values	336	Vals 5 + 6	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0523	7th & 8th Mem R/O Values	368	Vals 7 + 8	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0524	9th & 10th Mem R/O Values	400	Vals 9 + 10	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0525	11th & 12th Mem R/O Values	432	Vals 11 + 12	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0526	13th & 14th Mem R/O Values	464	Vals 13 + 14	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0527	15th & 16th Mem R/O Values	496	Vals 15 + 16	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0528	17th & 18th Mem R/O Values	528	Vals 17 + 18	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0529	19th & 20th Mem R/O Values	560	Vals 19 + 20	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0530	21st & 22nd Mem R/O Values	592	Vals 21 + 22	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0531	23rd & 24th Mem R/O Values	624	Vals 23 + 24	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0532	25th & 26th Mem R/O Values	656	Vals 25 + 26	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0533	27th & 28th Mem R/O Values	688	Vals 27 + 28	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0534	29th & 30th Mem R/O Values	720	Vals 29 + 30	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0535	31st & 32nd Mem R/O Values	752	Vals 31 + 32	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0536	33rd & 34th Mem R/O Values	784	Vals 33 + 34	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0537	35th & 36th Mem R/O Values	816	Vals 35 + 36	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0538	37th & 38th Mem R/O Values	848	Vals 37 + 38	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0539	39th & 40th Mem R/O Values	880	Vals 39 + 40	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0540	41st & 42nd Mem R/O Values	912	Vals 41 + 42	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0541	43rd & 44th Mem R/O Values	944	Vals 43 + 44	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0542	45th & 46th Mem R/O Values	976	Vals 45 + 46	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0543	47th & 48th Mem R/O Values	1008	Vals 47 + 48	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0544	49th & 50th Mem R/O Values	1040	Vals 49 + 50	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0545	51st & 52nd Mem R/O Values	1072	Vals 51 + 52	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0546	53rd Mem R/O Value	1104	Val 53	DIGITAL	0-FFFF	ISS NAC FSW

Table 0-18   ISS WAC Memory Monitor Packet

Channel ID	Description	Position	DMD Title	Type	Range	Source
S-0787	Address Count	96	ADDRS_COUNT	UNSIGNED	1-6	ISS NAC FSW
S-0788	Count	104	NUM_VALID	UNSIGNED	0-53	ISS NAC FSW
S-0789	Rate	112	SAMP_RATE	UNSIGNED	0-255	ISS NAC FSW
S-0790	Spare	120	SPARE	UNSIGNED	n/a	TBD
S-0791	Location 1	128	MEM-ADDRS_1	UNSIGNED	0-524287	ISS NAC FSW
S-0792	Location 2	152	MEM-ADDRS_2	UNSIGNED	0-524287	ISS NAC FSW
S-0793	Location 3	176	MEM-ADDRS_3	UNSIGNED	0-524287	ISS NAC FSW
S-0794	Location 4	200	MEM-ADDRS_4	UNSIGNED	0-524287	ISS NAC FSW
S-0795	Location 5	224	MEM-ADDRS_5	UNSIGNED	0-524287	ISS NAC FSW
S-0796	Location 6	248	MEM-ADDRS_6	UNSIGNED	0-524287	ISS NAC FSW
S-0670	1st & 2nd Mem R/O Values	272	Vals 1 + 2	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0671	3rd & 4th Mem R/O Values	304	Vals 3 + 4	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0672	5th & 6th Mem R/O Values	336	Vals 5 + 6	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0673	7th & 8th Mem R/O Values	368	Vals 7 + 8	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0674	9th & 10th Mem R/O Values	400	Vals 9 + 10	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0675	11th & 12th Mem R/O Values	432	Vals 11 + 12	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0676	13th & 14th Mem R/O Values	464	Vals 13 + 14	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0677	15th & 16th Mem R/O Values	496	Vals 15 + 16	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0678	17th & 18th Mem R/O Values	528	Vals 17 + 18	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0679	19th & 20th Mem R/O Values	560	Vals 19 + 20	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0680	21st & 22nd Mem R/O Values	592	Vals 21 + 22	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0681	23rd & 24th Mem R/O Values	624	Vals 23 + 24	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0682	25th & 26th Mem R/O Values	656	Vals 25 + 26	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0683	27th & 28th Mem R/O Values	688	Vals 27 + 28	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0684	29th & 30th Mem R/O Values	720	Vals 29 + 30	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0685	31st & 32nd Mem R/O Values	752	Vals 31 + 32	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0686	33rd & 34th Mem R/O Values	784	Vals 33 + 34	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0687	35th & 36th Mem R/O Values	816	Vals 35 + 36	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0688	37th & 38th Mem R/O Values	848	Vals 37 + 38	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0689	39th & 40th Mem R/O Values	880	Vals 39 + 40	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0690	41st & 42nd Mem R/O Values	912	Vals 41 + 42	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0691	43rd & 44th Mem R/O Values	944	Vals 43 + 44	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0692	45th & 46th Mem R/O Values	976	Vals 45 + 46	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0693	47th & 48th Mem R/O Values	1008	Vals 47 + 48	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0694	49th & 50th Mem R/O Values	1040	Vals 49 + 50	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0695	51st & 52nd Mem R/O Values	1072	Vals 51 + 52	DIGITAL	0-FFFF FFFF	ISS NAC FSW
S-0696	53rd Mem R/O Value	1104	Val 53	DIGITAL	0-FFFF	ISS NAC FSW

Bus Interface Unit (BIU) Discrete Data

ISS uses the BIU discrete bits in various ways to report status for ISS PROM events. The following is an explanation of the tables and when they should be used.

The table titled: ISS Summary Status of Discrete Data - Maintenance Activity is a summary of the fault codes that were detected during ISS maintenance (exercising the filter wheel and shutter). A status of 000000 in bits 10-15 indicates that maintenance was performed with no faults. This table will be used whenever the ISS performs its maintenance activity. Maintenance occurs primarily during the cruise period.

The table titled: ISS Summary Status of Discrete Data - Program Loading Activity is a summary of the fault codes that were detected during ISS flight software. A non-zero status in any of bits 10-15 indicates that the flight software loading process had an error(s). The summary status will remain in place for 512 seconds before the flight software attempts to execute. [Note: For this table, if the loading activity occurs with no faults, the flight software will begin execution immediately and the BIU status is not summarized. After the flight software finishes configuration, it places a code of 000000 in the BIU discrete bits 10-15.] This table will be used whenever the ISS is turned on and being prepared to take images. Program loading is currently planned to occur at launch+14 months (checkout) and at approximately SOI-2 years (science cruise). However, other spacecraft activities may require this activity.

The above referenced tables define only two of the seven PROM activities. If an unknown anomaly occurs outside of maintenance or program loading, the table titled: ISS Status of Discrete Data During Execution of PROM Activities needs to be used. However, the only way this table can be used is if CDS is _recording_ BIU discrete status once per second. [Note: Currently, the CDS design only records BIU data once per 512 seconds.] A troubleshooting activity would need to be initiated to acquire this data where ISS is restarted (from the OFF power state) and its discrete data is recorded continuously until all PROM events are completed. The total time for completion is unknown at this time since it depends on the frequency of other non-ISS spacecraft activities.

4-19   ISS Summary Status of Discrete Data - Maintenance Activity

Bit	Title	Definition
0	Spare	0 = "0" 1 = "1"
1	Instrument Mode	0 = sleep 1 = active
2	Operational Mode	0 = nosafe 1 = safe
3-7	Spare	0 = "0" 1 = "1"
8	Discrete Status 0 : Valid Desdriptor Table Load	0 = false 1 = true
9	Discrete Status 1 : FSW is Running	0 = false 1 = true
10	Discrete Status 2	0 = Filter Wheel 2 returned home 1 = Filter Wheel 2 couldn't get back to home

Bit	Title	Definition
11	Discrete Status 3	0 = Filter Wheel 2 left home
		1 = Filter Wheel 2 couldn't get off home
12	Discrete Status 4	0 = Filter Wheel 2 found home
		1 = Filter Wheel 2 couldn't find home
13	Discrete Status 5	0 = Filter Wheel 1 returned home
		1 = Filter Wheel 1 couldn't get back to home
14	Discrete Status 6	0 = Filter Wheel 1 left home
		1 = Filter Wheel 1 couldn't get off home
15	Discrete Status 7	0 = Filter Wheel 1 found home
		1 = Filter Wheel1 couldn't find home

4-20   ISS Summary Status of Discrete Data - Program Loading Activity

Bit	Title	Definition
0	Spare	0 = "0"
		1 = "1"
1	Instrument Mode	0 = sleep
		1 = active
2	Operational Mode	0 = nosafe
		1 = safe
3-7	Spare	0 = "0"
		1 = "1"
8	Discrete Status 0 : Valid Desdriptor Table Load	0 = false
		1 = true
9	Discrete Status 1 : FSW is Running	0 = false
		1 = true
10	Discrete Status 2	0 = ALF packet in sequence
		1 = ALF packet out of sequence
11	Discrete Status 3	0 = ALF packet message id correct
		1 = ALF packet message id bad
12	Discrete Status 4	0 = Checksum correct in ALF packet
		1 = Checksum error in ALF packet
13	Discrete Status 5	0 = Command packet word count correct
		1 = Command packet word count wrong
14	Discrete Status 6	0 = Total ALF packets correct
		1 = Total ALF packets wrong
15	Discrete Status 7	0 = Command packet received
		1 = Command packet timeout

4-21   ISS Status of Discrete Data During Execution of PROM Activities

Bit	Title	Definition			
0	Spare	0 = "0" 1 = "1"			
1	Instrument Mode	0 = sleep 1 = active			
2	Operational Mode	0 = nosafe 1 = safe			
3-7	Spare	0 = "0" 1 = "1"			
8	Discrete Status 0 : Valid Desdriptor Table Load	0 = false 1 = true			
9	Discrete Status 1 : FSW is Running	0 = false 1 = true			
10-12	Discrete Status 2 - 4 : SUROM Non-Fault Status Code	000 = Initial Condition 010 = Verifying FSW 011 = Exercise Shutter & Filter Wheels 100 = Moving Filter Whl to X Filter Pos 101 = Loading FSW from CDS 110 = Funning FSW 111 = Wait for command			
		If Bits 12:10 =			
		000	010	011	101	110
13-15	Discrete Status 5 - 7 : SUROM Fault Status Code	111 - Memory Error on Initialization	001 - Checksum Error 111 - Memory Error on Initialization	001 - Filter Wheel 1 couldn't find home 010 - Filter Wheel 1 couldn't get off home 011 - Filter Wheel 1 counldn't get back home 100 - Filter Wheel 2 couldn't find home 101 - Filter Wheel 2 couldn't get off home 110 - Filter Wheel 2 counldn't get back home	001- ALF packet out of sequence 010 - ALF packet message ID bad 011 - Checksum error in ALF packet 100 - Command packet word count wrong 101 - Total ALF packets wrong 110 - Command packet timeout	xxx - flight software loaded but will not run Note: All codes except 000 indicate a fault

Camera Operations

Operating States

Sleep State

How ISS is commanded into SLEEP state

Each camera can be commanded into the sleep state in two ways. The HALT command can be sent from CDS and the camera will prepare to enter the sleep state.   A controlled shutdown sequence will be executed if the camera is to transition from an operating state to sleep. This same response can also be initiated via a discrete sleep bit in the BIU hardware which acts as a continuous flag to assure sleep will be initiated even if command capabilities are lost.

How ISS is commanded out of SLEEP state

To exit the sleep state, the sleep bit must be reset and the WAKE command must be sent from CDS.

Thermal Control

Thermal control of ISS is accomplished via a combination of electrical resistance heaters, thermal insulation, and a passive flat plate radiator. In sleep mode, power dissipation within the ISS electronics should provide sufficient heat to maintain a safe operating temperature without the use of the resistance heaters.

Memory Contents

The program memory can be loaded from CDS in sleep mode, but the command memory used to execute command sequences is not active and commands cannot be executed in sleep mode.

Telemetry

Housekeeping packets are transmitted in sleep. Science data telemetry is inactive in this mode.

Idle State

The primary distinction between sleep and idle is the ability in idle mode to load and parse commands.   Commands are executed in the active state, and once executed, the software returns to idle. (The order of execution is immediate commands first, then triggerable commands in sequence).

Memory Contents

The IDLE state is first entered following RAM program load from the CDS.   At a minimum, the Flight Program is present in memory along with any commands which have not yet been executed.   Other memory locations will have been scrubbed during initialization. The idle state is also entered from the active state, where residual data may have accumulated in the memory during command execution.

Thermal Control

Thermal control is provided in the IDLE state in background processing.   Temperature is monitored and the performance heaters are actively controlled to achieve desired operating temperatures within the camera.

Telemetry

Housekeeping packets are transmitted in IDLE. Science data telemetry is inactive in this mode.

Active State

Executing the Sequence

The command sequence is executed in the active state. IMMEDIATE commands are executed in the order in which they are received. TRIGGER commands are placed in a temporary command buffer and executed each in sequence at a later time as dictated by CDS. PMACRO (Permanent MACRO) commands are placed in a "permanent" command buffer and can be executed (as a sequence) multiple times.

Commanding

The ISS accepts and acts upon commands transferred from CDS that contain ISS imaging modes, parameters, and timing. Commands are transferred as blocks of commands which will be stored in ISS memory. The minimum size of the transferred blocks is 5 kilowords. Each block contains imaging commands which are expanded in the ISS into camera electronics commands specifying camera mode, timing and data taking parameters for several frames of ISS data. The material presented here is introductory in nature. Details on ISS COMMANDING can be found in the ISS FLIGHT SOFTWARE Architectural Design Document (JPL D-12626). A command list can also be found later in this document in section 3.2.

Frame time

ISS science commanding is on a frame basis which has an associated frame time. The frame time is split into two major cycles, the prepare cycle and the readout cycle. The prepare cycle time is used to perform ISS mode changes, filter wheel stepping, heater operation, light flooding, and any other defined functions to prepare for an exposure. The prepare cycle includes the exposure time. The ISS also has the ability to take and transmit images with zero exposure time. The readout cycle is used to collect pixel data, encode or compress the data, and packetize the data.

The ISS prepare cycle is constructed in a structured manner, allowing specific windows of time for performing functions as shown in a simplified timing diagram (Figure 0-1). Sixteen possible time intervals are available in the prepare cycle.

Figure 0-1   Simplified Timing Diagram
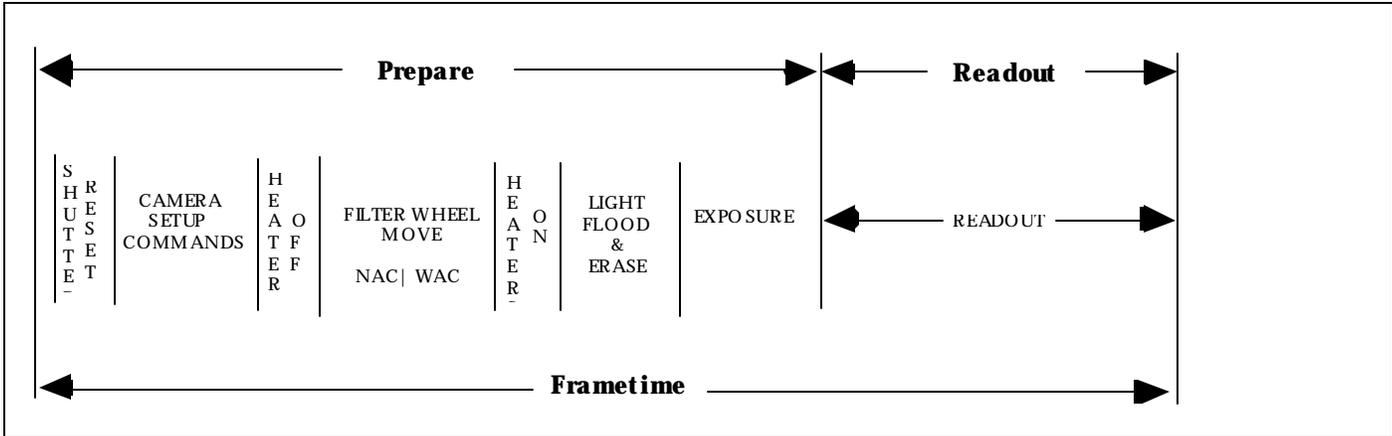
The total frametime can be determined from a summation of the total time necessary to execute the elements of the two cycles. The constituent elements are as follows:

PREPARE   READOUT

Shutter Reset   WAC Readout
NAC Filter Wheel Move   NAC Readout
WAC Filter Wheel Move   .625 Sec. Pad
Flood / Erase
Expose
.625 Sec. Pad

The Prepare Cycle

The ISS prepare cycle timing is dominated by three items: the NAC and WAC filter wheel moves and the exposure time. There are sixteen (16) selections for the prepare cycle which can be made. These selections, with the associated index used in commanding the camera, are given in Table 0-1.

Table 0-1   ISS Prepare Cycle Index

Index	NAC Filter Wheel (seconds)	Wac Filter Wheel (seconds)	Exposure (seconds)
0	1	1	2
1	2	2	2
2	3	3	2
3	5	5	2
4	5	5	5
5	5	5	13
6	5	5	21
7	5	5	37
8	5	5	53
9	5	5	85
10	5	5	117
11	5	5	181
12	5	5	245
13	5	5	501

| 14 | 5 | 5 | 1013 |
| 15 | 5 | 5 | 1201 |

The Readout Cycle

The ISS readout cycle timing is split into two windows: a NAC readout window and a WAC readout window. There are sixteen selections for the readout cycle which can be made. These selections, with the associated index used in commanding the camera, are given in Table 0-2. This table is valid for a telemetry rate of 48 packets per second (ISS' highest data rate). Readout window times in seconds at the other telemetry rates can be calculated by the formula:

$$NewTime = \frac{48}{pkts/s(@\ NewRate)} * Time\ (@\ 48\ pkts/s)$$

Table 0-2 ISS Readout Cycle Index

Index	NAC Readout (seconds)	WAC Readout (seconds)
0	50	50
1	50	25
2	50	12
3	50	6
4	25	50
5	25	25
6	25	12
7	25	6
8	12	50
9	12	25
10	12	12
11	12	6
12	6	50
13	6	25
14	6	12
15	6	6

Telemetry

In the active state, both housekeeping and science telemetry can be transmitted to CDS via the ISS BIU's. Transmittal of science packets via "BIU Swapping" is described in section 2.3.4.2.

Data Rates

Five science data rates are available for transmission of ISS science data as given in x-x. The rate is commanded via CDS and is selected based on a combination of available spacecraft telemetry bandwidth and instrument data priority.

Table 0-3 ISS Data Rates and Associated Packets/RTI

Data Rate	Packets/RTI
365.6	6

304.6 ?	5 ?
182.8	3
121.9	2
60.9	1

BIU Swapping

In the active state, science packets can be transmitted. It is a requirement that ALL science packets come from the same BIU address '17'.   This address is associated with the NAC telemetry. When the WAC sends science packets, theWAC BIU address is temporarily swapped (from '18' to '17') with the NAC BIU address. The BIU address is only swapped when the camera requiring bus access requests address '17' (See Section 0).

Packet Types

In the active state, there are three major types of packets which ISS transmits to CDS: (1) Zero-length   packets, (2) housekeeping packets, and (3) Science packets. Zero length packets are used as fill packets for bus transmission continuity. When CDS detects that a zero length packet has been received, it discards the packet. For detail on the ISS Housekeeping and Science packets, see section 4.0 of this document.

Decontamination

TBD

Camera Features

Summation
Gain States
Anti-Blooming
Light Flood and Erase
PC Voltage
Offset Voltage
12 to 8 Bit Conversion
Compression
WAC Calibration Lamp
Temperature Control
Optical Heaters
CCD Heater

Other Camera Values

Extended and Overclocked Pixels
Light Flood Duration to Control Residual Bulk Image Effect
Coefficients for Resistance to Temperature Conversions

Commanding the Cameras

Turning On and Waking Up the Cameras
Loading the Flight Software
Setting Up the Camera
The Image Event Command
Calculating Prepare and Readout Times
Macros and PMacros
Loading and Triggering Images
Commanding Individual Camera Options (Immediate Commands)
Two Camera Operations
Shutting Down the Cameras
Safing the Filter Wheel and Shutters
Entering Sleep Mode/Turning Off
Other Spacecraft Commands for ISS

Interpreting Camera Telemetry

Spacecraft Telemetry
Temperature Red and Yellow Alarm Limits
BIU Discrete Information During Maintenance
ISS Packet Telemetry
ISS Time Tagging
     See Claude Hildebrand's memo

Idosyncracies

Filter Wheel Home Position

The ISS filter wheel was designed with two sensors on each wheel. Since the camera only gets feedback on the filter wheel's position when it is at "home", the camera's software needs to keep track of the wheel's absolute position. This is done by counting the number of steps that the stepper motor, driving the filter wheels, is commanded to move. With this information the software anticipates when the filter wheels are either going to stop or pass through "home" and will check the sensors output to verify that the step count is correct. When this takes place one of three things can happen: 1) the two sensors turn on when the filter wheel passes through or stops on what the software thinks is "home" and no error message is returned, 2) only one of the sensors turns on when the filter wheel passes through or stops on what the software thinks is "home" and an error message is is returned that says which sensor failed the home test, or 3) neither sensor turns on when the filter wheel passes through or stops on what the software thinks is "home" and an error message is returned that says both sensors failed the home test.

Scenario 2 may happen but should be taken as an idiosyncracy not a failure of the filter wheel. The filter wheel is driven by a stepper motor and the tolerance requirement for each sensor was that 'it indicate "home" with the clear filter in position ± one motor step'. This means that each sensor could indicate "home" for three steps: actual "home" and home ± one motor step. Because of the sensitivity of adjusting the sensors and the dynamic behavior of the filter wheels, the two sensors on the same filter wheel might not agree when a filter wheel was at "home" + 1 step or "home" - 1 step. This situation was observed during component and subsystem testing on the ground.

BIU Swapping Final Position and Implications for Follow-on Triggered Images

When the cameras are swapping the BIU address to share the allocated ISS data rate, the addresses are left in the positions of the final swap request. For example, when performing two camera operations which alternate between the NAC and WAC readouts, the WAC will be the last camera to request a swap. The address assigned to the WAC, therefore, will be '17'. If the follow-on images are from the NAC, or if a new sequence which requests the NAC be read out first is initiated, the BIU addresses must be swapped before starting this new sequence. The method to accomplish this is to send the command:

[COMMAND]

Lossy Compression Commanding

Flight Rules and Constraints