TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

FSCM NO. 11982

TITLE

Faint Object Spectrograph
SOGS Notebook

DATE 2/28/86

NO. ND-1004C

SUPERSEDING: ND-1004B

PREPARED BY: J. L. Norton

APPROVAL SIGNATURES:

DATE DATE

DATE DATE

DATE DATE

REVISION/CHANGE RECORD

TRW SOGS NASA

FOR DOCUMENT NO. ND-1004, FOS SOGS Noteb

SYMBOL	DATE	AUTHORIZATION	REVISION/CHANGE DESCRIPTION	PA AFFE
C	2/28/86		Major changes to document	A

SYSTEMS 1392 REV. 3-81 (FILE DIRECTLY AFTER COVER SHEET)

LIST OF EFFECTIVE PAGES

(Insert latest changed pages. Destroy superseded pages.)

Dates of issue for original and changed pages are:
Original...0...28 February 1986

ORIGINAL ISSUE:
31 December 1982

REISSUE:
28 January 1984
28 July 1984
28 February 1986

Total number of pages in this document is 179, consisting of the following:

PAGE NO.	CHANGE NO.
i to ix	0
1 to 170	0

FOREWORD

This volume provides a compilation from various sources of factual information on certain aspects of the Faint Object Spectrograph, one of the five Science Instruments on the Edwin P. Hubble Space Telescope. It is one of a set of such documents prepared by TRW to aid in the design work for the Space Telescope Science Operations Ground System (SOGS).

This document (ND-1004C, 2/28/86) is a reissue of the previous FOS SOGS Notebook (ND-1004B, 28 July 1984) to incorporate some changes in engineering telemetry notations, as well as additional instrument information that has become available since the previous issue was generated.

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TABLES

FOS-Related Acronyms

Ø	Zero (used for mnemonics only)
ASCII	American Standard Code for Information Interchange
CCR	Configuration Change Request
CEA	Central Electronics Assembly
CLPS	Calibration Lamp Power Supply
CPU	Central Processing Unit
C&DH	Control and Data Handling (Subsystem)
DAC	Digital-to-Analog Converter
DCF	Data Capture Facility
ET	Engineering Telemetry
FGWA	Filter/Grating Wheel Assembly
FOS	Faint Object Spectrograph
FOV	Field Of View
GFE	Government Furnished Equipment
GO	General Observer
GSFC	Goddard Space Flight Center
HRS	High Resolution Spectrograph
HVPS	High Voltage Power Supply
ICD	Interface Control Document
IDT	Investigation Definition Team
IEB	Instruction Engineering Bit
IST	Instrument Science Team
K	For memory, 2^{10} (1024); otherwise, 10^3
LED	Light Emitting Diode
LMSC	Lockheed Missiles and Space Company, Incorporated
MEC	Mechanism
MHz	10^6 Hz
MOGS	Mission Operations Ground System
msec	Millisecond
nm	Nanometer (10^{-9} meters or 10 angstroms)
NSSC-1	NASA Standard Spacecraft Computer, Model 1
OSS	Observation Support System
OTA	Optical Telescope Assembly
PASS	POCC Application Software Support

PDCR	Preliminary Document Change Request
PDL	Program Design Language
PIT	Processor Interface Table
POCC	Payload Operations Control Center
PODPS	Post-Observation Data Processing System
PORTS	Preliminary Operations Requirements and Test Support
PROM	Programmable Read-Only Memory
RAM	Random Access Memory (read/write)
RIU	Remote Interface Unit
ROM	Read-Only Memory
RPI	Relay Position Indicator
s	[Subscript] SOGS-coined mnemonic
ScI	Science Institute (Johns Hopkins)
SDAS	Science Data Analysis Software
SDF	Science Data Formatter
SHP	Standard Header Packet
SI	Science Instrument
SLIB	SOGS (TRW) Library document identifier
SMC	Serial Magnitude Command
SOGS	Science Operations Ground System
SPSS	Science Planning and Scheduling System
SSC	Science Support Center
SSM	Support Systems Module
ST	Edwin P. Hubble Space Telescope
STOCC	ST Operations Control Center
STSOP	ST Science and Operations Project
TBD	To be determined
TM	Telemetry
UCSD	University of California, San Diego
usec	Microsecond
UTC	Universal Time Coordinated
UV	Ultraviolet
X'ab'	Hexadecimal (base 16) value for "ab"
Y	Conventional first letter for FOS parameters
Yxxx	Abbreviated LMSC ET Measurement Number

$Yxxx_c$	Abbreviated LMSC Command Number
Y.xxx	Coined Measurement Number
$Y.xxx_c$	Coined Command Number
???	Material needing determination/confirmation
:n	Bit number n (1 most significant)

1.0 INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF FOS NOTEBOOK

The purpose of this Faint Object Spectrograph (FOS) Notebook is to provide a compilation from various sources of factual information on certain aspects of the FOS necessary for design work on the Edwin P. Hubble Space Telescope (ST) Science Operations Ground System (SOGS). The contract for development of SOGS is managed by GSFC, and is performed by TRW. One of the main tasks of SOGS is the receipt, display, manipulation, and calibration of the FOS data (as well as the other instruments on the ST). To perform this task, a thorough understanding is necessary of the various formats in which data is received, where critical processing parameters are in both the science and engineering data streams, and what algorithms are to be applied to calibrate the science data for each instrument configuration.

The intended audience for this FOS Notebook is the TRW SOGS designers, rather than a general collection of diverse groups with equally diverse information desires. Because of its intended audience, there are numerous FOS-related topics that are <u>not</u> included in this Notebook. Section 8 (References) has a list of citations for some source documents on FOS that are in the TRW SOGS Library. Such documents have been assigned serial accession numbers (SLIB numbers) meaningful only to those with access to the TRW Library, so Section 8 provides information on originator, date, and title to identify the material more completely.

The organization of this FOS Notebook is the same as that for the other four ST instruments. After this introductory material, the various types of FOS modes are defined in Section 2 (since they are of major significance to the SOGS design effort). Sections 3 and 4 cover the FOS Science Telemetry and FOS Engineering Telemetry respectively. Algorithms for FOS Calibration, FOS Data Quality/Utility, and FOS Target Acquisition are in Sections 5 to 7 respectively (these relate to what is in Section 10 of the SOGS SE-06-1 specification, SLIB 799). Section 8 has References.

1.2 SUMMARY OF FOS NOTEBOOK UPDATES FOR THIS REISSUE

The changes in this reissue of the FOS Notebook (SLIB 865, SLIB 1204, and SLIB 1252 were the previous issues) are those necessary to reflect a collection of minor details concerning the instrument's performance. There should be no surprises in the changes that are incorporated in this reissue, which include:

1. Some telemetry identifier changes to agree with a new issue of LMSC's DM-02 (SLIB 1340).
2. Some command changes to agree with a new issue of LMSC's DM-01 (SLIB L98).
3. Several changes to the instrument's description, especially in areas concerned with targeting, as obtained from data provided by the IDT.
4. Addition of appropriate SOGS-originated mnemonics from SLIB T43 for keyword and other requirements, identified by an "s" subscript.
5. Incorporation of changes expected to the FOS-unique area of the Standard Header Packet for NSSC-1 Version 3.7 (based on SLIB L95 and SLIB L97).

The updating effort for this FOS Notebook has been a continuous process throughout the duration of the SOGS project. This reissue, however, is the first FOS Notebook change that has been generated since the 28 July 1984 ND-1004B issue. New information otherwise has been distributed among the TRW SOGS designers by means of SOGS memos. Particularly for those holders of the FOS Notebook outside of TRW, therefore, reliance on this FOS Notebook to reflect the "latest available" (anyplace) set of FOS data continues to be inappropriate.

1.3 INVESTIGATION DEFINITION TEAM

The Principal Investigator for the FOS experiment is:

Richard J. Harms, University of California, San Diego, CA.

Co-Investigators are:

Roger Angel, University of Arizona, Tucson, AZ;
Frank Bartko, Martin Marietta Corporation, Denver, CO;
Edward Beaver, University of California, San Diego, CA;
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Holland Ford, ST Science Institute, Baltimore, MD; and
Bruce Margon, University of Washington, Seattle, WA.

1.4 SCIENTIFIC OBJECTIVES

The following information was obtained from SLIB 118 and SLIB 810:

The FOS is being designed and built for use with the Space Telescope to provide digitized spectra of faint astronomical objects over the wavelength range from 115 to 850 nm at resolving powers of about 1200 and 200. A variety of concave gratings and prisms is employed to form nearly stigmatic spectra on either of two Digicon photon counting detectors that are optimized for two different but overlapping spectral ranges.

The FOS will address major scientific questions associated with quasars; active galaxies; normal, distant, and local group galaxies; a wide class of objects within our own and neighboring galaxies; and objects within our solar system. All of these studies will be conducted within the context of understanding the origin, structure, composition, and evolution of our universe.

Faint objects that will be studied include: 1) quasars; 2) nebulosity around or near quasars; 3) nuclei and other active areas in active galaxies; 4) objects in normal galaxies outside the Local Group, including small-scale structure in their central regions; 5) objects in galaxies in the Local Group; and finally, 6) objects in our galaxy. The UV coverage and spatial resolution will also be used for solar system studies such as, e.g., obtaining UV spectra of comets, and combining on-going high-spatial-resolution studies of planets and satellites with those of planetary exploration missions.

The list of scientific programs that the FOS will be able to undertake is very large; only a brief outline is given here. First, quasars and galaxies with active (explosive) nuclei raise some of the most exciting questions in both astrophysics and cosmology as well as in cosmogony or the problem of the origin of galaxies. Spectra in the far UV, as well as spectra at all wavelengths in faint nebulosity around quasars, spectroscopy at 0.1 arc sec scale in active galaxies and spectropolarimetry with the FOS should lead to an understanding of just what is happening in these objects where there are enormous outpourings of non-thermal energy from very small volumes. One question to be addressed is whether massive black holes exist in the centers of these galaxies and in quasars.

Study of stars, globular clusters, supernovae, planetary nebulae and other objects in external galaxies will be aimed toward obtaining a more accurate distance scale in the universe (the Hubble scale), toward determining the rate of deceleration of the expanding universe and, hence, what kind of universe we live in, and toward obtaining information on the evolution of galaxies, both chemical and structural. In our own galaxy, the FOS capability for spectropolarimetry and ten millisecond time-resolved spectrophotometry will be particularly important for elucidating the properties of interstellar dust, the extraordinary white dwarfs with very strong magnetic fields, and the rapidly varying, highly evolved stars, X-ray binaries, and pulsars.

1.5 PRINCIPLES OF OPERATION

See SLIB 411 for information on the principles of operation of the complete FOS instrument (including its mechanical layout and a functional block diagram). The material given below emphasizes those FOS aspects that are of particular significance for understanding the nature of its science data, and has been generated using the sources listed in Section 8.1.

Light enters the FOS through a pair of entrance ports. In their closed position (a fail-safe provision is available to force the ports open), the ports reflect light from either of two internal neon-filled spectral calibration lamps used for FOS wavelength calibration. The light from the object of interest then passes through one of two independent optical channels, each of which focuses nearly stigmatic spectral images on the photocathodes of photon-counting Digicon detectors. Selection of the desired optical channel is accomplished by pointing the telescope. These channels differ only in the wavelength sensitivity of their respective detectors. The Digicon output is then processed by a set of electronics (which is different for the two channels), and the resulting scientific data can then be sent on the downlink. The FOS is similar to the High Resolution Spectrograph (HRS) on the ST, since both instruments have essentially the same kind of detectors. The main difference between the two instruments is their spectral resolution and wavelength coverage. The detailed format of their scientific data, however, is considerably different. Only one FOS detector and set of electronics will be operational at a time, depending on the desired bandwidth and the detector range. The FOS is mounted in the [V2, -V3] quadrant of the spacecraft.

Five minutes are required to switch between detectors (for stability of about one diode), and their high voltage settles in about one minute. Such changes (to obtain the desired wavelength coverage) are expected to occur about 10-20% of the time. The overall instrument warmup time is constrained by its mechanical elements. During the first few hours of operation, as the electronics heat the electronics shelf, the enclosure will deform slightly shifting the cross-dispersion position of the optical bench. During this transition, use of the 0.1 arcsec aperture should be restricted to relatively short (3 hour) observations to avoid loss of lock on the target during data acquisition.

The FOS aperture wheel is placed at the ST focal surface. This wheel contains 11 (plus a blank for a light shield) sets of single or paired apertures (ranging in size from 0.1 to 4.3 arc seconds as projected on the sky). As a fail-safe provision, an "arm" command followed by a "fire" puts a pair of fail-safe entrance apertures in the light path. The 4.3 arc-second aperture is used for target acquisition, while the smaller ones (including two with an occulting capability) will allow diverse observations to be conducted efficiently. The individual aperture offsets are fairly close to zero (a calibration table will be available). The apertures for the two detectors, however, have a larger (constant) offset, so if the Digicons are switched a small ST maneuver must be carried out.

After passing through the aperture wheel, the light passes through the polarization analyzer. This device allows positioning of any of three elements into either optical path: a clear aperture, a thin-waveplate plus Wollaston prism assembly, or a thick-waveplate plus Wollaston prism assembly. One waveplate is permanently located in front of each Wollaston. Only a single motor is required to rotate the waveplates and to move either of the Wollaston/waveplate pairs from one entrance port to the other or out of the way. A drum contains the two Wollaston/waveplate pairs. The Wollastons are permanently fixed to the drum, but the waveplates are mounted in rotatable cylinders inside the drum. The waveplate cylinders have a 16-tooth gear on the outside that meshes with a 17-tooth fixed center gear inside the drum. One revolution of the drum rotates the Wollastons by 360° and the waveplates by [17/16 * 360° =] 382.5°, so each drum rotation increments the position angle of the waveplate fast axis by a net 22.5° (and 16 rotations return the mechanism to its starting configuration). Any of 48 positions (the three elements for any of the 16 rotations) can be commanded. A fail-safe provision causes the assembly to be rotated out of the light paths.

The light next passes (after a grazing incidence mirror) through an order-sorting filter (or a blank hole) in the FOS Filter/Grating Wheel Assembly (FGWA). The light is collimated by an off-axis paraboloidal mirror and reflected back to an element on the FWGA, which in turn both focuses and disperses (except for one imaging position) the beam onto one of the detectors. The FGWA has ten positions (only five of which have filters). It has six high-resolution (nominally 1200) gratings, two low-resolution (nominally 200) gratings, a low-resolution (nominally 100) prism, and a camera mirror. The FOS's high-resolution gratings resolve, for example, 0.2 nm at a wavelength of 240 nm. Changing gratings will be a fairly common FOS activity (estimated to be done for about half the observations). For interactive observations, the observer might want to look at an object with the prism and then study an interesting area in more detail with a higher-resolution element. Movement of the FGWA does not cause a spacecraft attitude perturbation. The fail-safe provision for the FGWA is a redundant stepper motor to operate the mechanism if the primary motor fails.

There are two independent detector assemblies, one for each optical channel. Each assembly consists of a Digicon tube, deflection coils, a permanent magnet focus assembly, magnetic shielding, mounting and alignment structure, heat pipes, temperature sensors, hybrid preamplifiers, and connectors. The two Digicon assemblies differ only in their photocathode and faceplate material. The red (also referred to as side "A" for "amber", and having a trialkali Digicon) detector covers the range of 180-850 nm, while the blue detector (side "B", having a bialkali Digicon) covers 115-500 nm. There is one LED flat-field lamp for each Digicon (the LED irradiates its corresponding photocathode directly without intervening optical elements). The lamp for each side is optically cross-strapped to the other side through a beam splitter that attenuates its brightness in the red by a factor of about 10.

Each incident photon (with a probability of about 30%) produces about 5000 electrons in the Digicon. These electrons are accelerated through a potential of about 22.5 KV, and then reach a linear array of 512 silicon diodes arranged along the "X" axis of the instrument (FOS axis terminology, although related by a transformation to the ST axes as shown in SLIB 706). These diodes are spaced 50 microns apart along the X axis, and have a size of 40 x 200 microns (a micron is 10^{-6} meter). The wavelength associated with diodes is in monotonic order by diode number, in accordance with the following rules (see SLIB L66):

1. Side A with the prism has shorter wavelengths at lower diode numbers;
2. Side A with elements other than the prism has shorter wavelengths at higher diode numbers; and
3. Side B is the opposite of side A (prism gives shorter wavelengths at higher diode numbers, other elements give shorter wavelengths at lower diode numbers)

The FOS diode numbering convention (see SLIB T30) numbers them from 0 to 511. When using the lower-resolution elements, the spectrum does not cover all 512 diodes, and commands are available to select the diode outputs that are processed and downlinked. The charge pulse generated in each diode is amplified and counted by one of 512 independent electronic channels, beginning with the hybrid preamplifier physically colocated with each Digicon. The signal is next passed through several feet of cable to the FOS Analog Signal Processor.

The electrons from the Digicon photocathode are focused by a magnetic field, and also can be magnetically deflected in the instrument's X axis (the direction of the dispersion) and perpendicular to it (the Y axis). The movement in the Y axis is needed because frequently there are two images on the photocathode (such as a star image and a background sky image), and it is necessary to examine both of them with the diode array. The X and Y axis magnetic deflection coils are both driven by 12-bit digital-to-analog converters (DACs).

The design of the FOS control parameters recognizes that observer-specified deflection parameters must be available that give well-defined observation effects. These observer quantities are specified in terms of "nominal" instrument performance (independent of the potential effects of, for example, component aging and temperature). To allow this interface to exist, nominals are defined based on the original FOS specification values of 32 DAC least increments per diode for deflections in the X direction (to span the diode-to-diode separation of 50 microns) and 256 DAC least increments per diode (to span the diode height of 200 microns) in the Y direction. These figures imply that the maximum nominal Y-axis deflection range in microns is half of the X-axis range. The actual scaling constants (the physical hardware's number of increments for these deflections) can be managed on a "facility" basis, and the observer in most cases should not be concerned about the values actually used during his/her observation. For example, the value of the flight X scaling constant (see SLIB 1106) probably will be about 24 DAC increments/diode-separation, but the design-baseline figure of 32 can nevertheless be used to specify the observer's FOS X-axis deflection parameters.

In the FOS Analog Signal Processor, the signal is shaped to a two-microsecond width. Each channel has a separate "low-level" discriminator with 8 bits of commandable discrimination: the setting value is in the $YYDDTBL_S$ ("Discriminator DAC/Disabled Diode Table") array available in the FOS-Unique Data Log (see Section 3). Some variations are expected during flight, particularly as the system "ages". This table, therefore, is the appropriate operational source for the status of the FOS diodes. There is no hardware "upper level" discriminator. The low-level discriminator in each channel is followed by a rate limiter (which uses 10 cycles of the 1.024 MHz spacecraft clock) to provide a single-value count output. Without such a device, the same output could result for a low pulse-rate input (where the counts would be precise) and a very high input (where due to "pulse pileup" several pulses would be interpreted as one). For 100,000 pulses/sec input, the device would give 50,000 output, and it provides monotonically decreasing outputs for inputs below that level.

The output of the rate limiter (again for each channel) is fed to a 16-bit hardware accumulator. This accumulator can operate in both the count mode and the timer mode (count is the dominant mode). In the count mode, the accumulator counts the incoming pulses from the rate limiter for an interval controlled by a command; in the timer mode, it counts the 1.024 MHz spacecraft clock, stopping when the first pulse is received. The accumulator, in turn, is fed to a buffer register (one for each channel) where it can be read out while the next sample is being acquired. Each channel (through to the buffer) is independently replicated. For failure isolation reasons (might tolerate 10 "scattered" channels not working, but not as readily 10 consecutive ones), hardware assignments such as pin and circuit partitions are "scrambled"; a "descramble PROM" is used to restore the data to the original channel sequence for the FOS microprocessor. It therefore is unnecessary for the ground software (contrary to the HRS) to compensate for this hardware "scrambling". The downlink data, however, must be rearranged in a monotonic wavelength sequence: this process is referred to as "reordering" or "unscrambling" (see Section 3.2.3.2).

The output of the FOS Analog Signal Processor is fed by two wires (for even and odd channels) to the FOS Central Electronics Assembly (CEA), where the FOS microprocessor and associated electronics are located. As mentioned previously, there are two sets of FOS electronics (including microprocessor systems), but only one can be operating at a given time. The CEA, in turn, interfaces with the Remote Interface Unit (RIU) of the SI C&DH (Control and Data Handling), including the Science Data Formatter (SDF).

The FOS microprocessor, a Texas Instrument SBP 9900A, is a parallel 16-bit monolithic CPU with integrated injection logic and 3 MHz operation (switchable to 1.5 MHz) capability. It has a byte-organized 16-bit memory which "typically" uses word operations. The address space is divided as follows ("X" means hexadecimal and the final character of "E" reflects words rather than bytes):

X'0000' to X'5FFE'	12K 16-bit words (24K bytes) of read-only memory (ROM);
X'6000' to X'7FFE'	Memory-mapped I/O (SDF, accumulators, etc); and
X'8000' to X'FFFE'	16K 16-bit words (32K bytes) of random access memory (RAM).

The ROM includes an executive, 10 application programs, and some tables of nominal values required for operation of FOS detectors. These tables can be copied into RAM at initialization. One table has 512 16-bit values for the $YYDDTBL_s$ array (channel enable/disable flag and discriminator DAC value); another has Mechanism Control Blocks for each of the four mechanisms (a total of 96 16-bit words, see Section 3.1.4). The two CEA ROMs (side "A" and side

"B") are unique with respect to these default table values. The operating system (the FOS microprocessor is programmed in polyFORTH) occupies about 5200 bytes of the 21000 ROM bytes currently assigned.

The FOS RAM consists of eight physical pages of 4K bytes (or 2K words, K = 1024) each, which are relocatable. The logical assigned position of any 4K RAM address space is automatically established during each instrument power on and reset, or can be specified by a serial magnitude command preceding power-on. Four 16-bit words of the FOS-Unique Data Log reflect this "RAM map". If a defective physical page is encountered, it will be mapped to the X'Fxxx' address area, so that the still-functioning RAM pages will remain in contiguous locations starting with X'8000'.

The first 2 logical RAM pages (addresses X'8000 to X'9FFE', or 8K bytes) are assigned to System Variables and Tables, with the last 965 words of this area used for the FOS-Unique Data Log. The remaining 24K bytes of RAM, starting at byte address X'A000' (or $10 * 16^3 = 40960_{10}$), are used strictly for temporary storage of science data. The maximum possible length of the science information (excluding the Science Header which comes from the FOS-Unique Data Log area) is 6 pages or 12K 16-bit words ($12{,}288_{10}$ words). The actual number of words that are meaningful, however, and the method for their interpretation, are under control of the FOS microprocessor (using input commands to set the required parameters). The microprocessor stores science data and the Reject Array (which is stored immediately following the last science data) according to observation (data acquisition) parameters; it transmits that data as requested by values of dump-control parameters set by a separate command. There is <u>no</u> connection between these two (except by convention).

The FOS microprocessor is an interrupt-driven system (with about 10 priority-ranked interrupt levels), so precise answers to timing questions (other than those directly associated with gathering the original observation data) do not exist. For example, if the FOS is doing data acquisition, and the time interval for the accumulators to be open expires, an interrupt is generated to read them out. Since this readout takes longer than 10 msec, it cannot be done while science data is being read out of the FOS data memory (since the SDF interface has a 10 msec timeout). The FOS must therefore stop data gathering while it is feeding science data to the downlink (or the tape recorder), a cyclic process involving the setting of a 16-bit word into an output register, sensing (via an interrupt that is less urgent than that for accumulator readout) that the word has been taken, and loading a new word. The elapsed time for this process to be completed depends on other activity (such as telemetry interrupts) that may also be taking place.

To understand the variability of the mechanism response times, the FOS microprocessor's firmware architecture needs to be recognized. There are five "background tasks" that are executed in a round-robin fashion when an interrupt is not being serviced. These tasks each suspend themselves by a polyFORTH "pause" command that allows the next background task in the sequence to receive CPU time. These background tasks are:

1. The "operator" task that handles the serial magnitude YKEY command. This command can be used in a manner closely analogous to the FORTH reserved word KEY ("Get a single character from the keyboard and push it on the stack").

2. The "terminal interface" task that uses an RS-232 interface. This interface should not be active after launch, although line terminations are being investigated to avoid spurious rubout characters that have been observed in testing.

3. The "data monitoring" task that is used to start target acquisition processing, clear the science data memory (when the proper flags are set), monitor for a data acquisition limit, and similar activities.

4. The "housekeeping" task that computes the ROM checksum, does an abbreviated check of the CPU instruction set, increments a speed-check parameter, and services the serial command watchdog timer (used to confirm that the command link with the NSSC-1 is operational).

5. The "mechanism control" task.

The results of the first three housekeeping-task actions are contained in three 16-bit words in the engineering telemetry that are also monitored by the NSSC-1:

1. Parameter YERRCHK has the ROM checksum result (which can be compared against the expected value).

2. Parameter YSELFCHK reflects the results of the check of the CPU instruction set. If the expected result is obtained, an "OK" (in ASCII) is set into the parameter; otherwise, the incorrect result of some arithmetic manipulations is stored in the word.

3. Parameter YARITHCHK has the value of the speed parameter. This quantity is reset to zero every 0.5 second. The maximum value observed in a sample set of FOS data was 192.

The elapsed time required to set the FOS mechanisms is determined by logic in the mechanism control background task. This task includes a provision to delay for one msec of CPU time before doing its polyFORTH "pause". The mechanism timing is defined (as described in Section 3.1.4) by the number of these delays, which are imposed between successive stepper motor phases. The corresponding elapsed time depends on the amount of other FOS microprocessor activity that is taking place. Test cases have been run (for a given environment of microprocessor operation) showing that a delay counter setting of 3 gives about 25 msec; a setting of 23 corresponds to about 100 msec; and a setting of 47 yields 200 msec.

The NSSC-1 has seven FOS processors:

1. Autonomous Saving Processor (YFASAF, processor #25). This processor completes and emulates the internal FOS safe state, so that the FOS is put in a safe mode while preserving the microprocessor contents.

2. Initialization Processor (YFINIT, processor #26). This processor brings one side of the FOS experiment to a state of readiness for the acceptance of operational parameters. Since this processor does not control the FOS heaters, any commands required to bring the FOS into the temperature range required for operation should precede YFINIT execution.

3. Turn Off Processor (YFOFF, processor #27). This processor controls planned FOS turn offs, leaving the FOS with both sides off.

4. Mode II Target Acquisition Processor (YFMOD2, processor #28). This processor performs a single centering operation for each period when execution is enabled. It uses YTARXCTR and YTARYCTR (see Section 3.1.5) to determine what should be fed to the SSM for movement, and also causes the NSSC-1 Standard Header Packet to be output. This processor is used when target identification, isolation, and location is done in the FOS microprocessor (without bringing raw science data into the NSSC-1).

5. Housekeeping Processor (YFHKPG, processor #30). This processor processes FOS engineering outputs for monitoring FOS health and safety, including YOVRLTMB|YOVRLTLB (see Section 2.1.5) from the engineering stream. YFHKPG can also initiate the periodic transmission of Standard Header Packets (see Section 3.2.1).

6. Science Data Storage Processor (YFSDST, processor #31). This processor provides the services required to transfer science data from the FOS into the NSSC-1.

7. Science Data Processor (YFSDPR, processor #32). This processor operates in conjunction with YFSDST to accomplish both binary search and peakup/peakdown target acquisition (depending on a control flag). It also causes the NSSC-1 Standard Header Packet and the FOS science data buffer in the NSSC-1 to be output.

Information concerning the results obtained by these processors is stored in the NSSC-1 Executive Status Buffer (see SLIB 1351). See SLIB L90, SLIB 763, and SLIB 1351 for more information on these NSSC-1 processors.

There are three independent ways of doing FOS Mode II autonomous target acquisition: NSSC-1 binary search, FOS firmware target acquisition, and NSSC-1 peakup/peakdown. The NSSC-1 binary search is controlled by YFSDPR. It starts (case 1) by performing target identification and isolation (aperture mapping). This is done by mapping the aperture with three Y steps (separated from one another by one diode height), and all objects within a window that are some multiple above the sky background are identified and ranked. If no objects are found, the ST can be repointed (if such a move is permitted). In its case 2 (accurate target location), the Y deflection is controlled in such a way that the nth brightest object ($n \leq 12$) is driven to the edge of the diode array through a geometrically decreasing sequence of binary steps. Offsets can be specified to be added to the measured position of the object before being passed to the SSM as an ST slew request, thus allowing the object to be centered in another aperture and/or an offset to some other object to be specified.

The FOS firmware target acquisition program is in the FOS microprocessor memory, and is controlled by parameters that are set by the NSSC-1. It uses a set of Y deflections to look for an object within a specified window (if more than one object is found, the target acquisition attempt is halted). The NSSC-1 supports this activity with its YFMOD2 processor, which uses the output from the FOS computations to generate an SSM slew request. YFMOD2 can also modify (within a specified range) the FOS window limits if no object was found. In addition, it can either notify the ground to invoke a pre-planned branch (if available) or invoke a raster scan about the original pointing direction (if allowed).

The NSSC-1 peakup/peakdown is also controlled by YFSDPR (using a control flag to determine that this mode, rather than a binary search, is desired). Its purpose is to position the object precisely with respect to one of the small FOS apertures or one of the occulting bars. The ST is commanded to move through a pre-specified pattern. The time of maximum|minimum counts is saved and at the end of the pattern the ST is repositioned to point to the step that gave the maximum|minimum counts. A combination of peakup and peakdown will be needed to center point sources on the occulting bar for the FOS's occulting apertures.

2.0 FOS MODES OF OPERATION

There are three kinds of FOS "modes" that need to be distinguished:

1. Instrument Modes (where control by the FOS electronics causes differences in the measured data due to data-gathering differences);

2. Science Data Modes (settings of Instrument Mode and/or the optics parameters cause different effects); and

3. Ground Software Modes (differences in ground processing that can be a function of the Instrument Mode and/or Science Data Mode).

These modes are treated in separate sections below. Throughout this document, bit 1 is the most significant (or sign) and bit 8 or bit 16 is the least significant (for 8-bit and 16-bit words respectively). The notation "Yxxx" means the LMSC engineering telemetry abbreviated measurement number (see Section 4), and "Y.xxx" refers to downlink quantities that lack an individual LMSC number. A subscript of "c" means a command number rather than a measurement number. Mnemonics having their first two characters set to "YY" include those coined for referencing convenience purposes in this document (they are <u>not</u> official FOS notations). The coined mnemonics with an "s" subscript (for "SOGS") include those listed in SLIB T43: the subscript is used to avoid confusion with the LMSC naming conventions. Tables 4.2-5 and 4.2-6 list all the FOS commands and telemetry in sequence by their number and by mnemonic, respectively.

2.1 FOS INSTRUMENT MODES

The FOS Instrument Mode is defined by engineering telemetry word YAQMD/Y711 (see Section 4). This word is loaded by command YACQMODE/Y049$_c$ ("Select Data Acquisition Mode"). The first six bits of the eight-bit word are assigned to the following (the others are spare):

1 YYSYNCS/Y.205, Synchronous Start;

2 YYTIMTG/Y.206, Time-Tag;

3 YYREJRE$_s$/Y.207, Reject/-Retry;

4 YYTARGA$_s$/Y.208, Target Acquisition;

5 YYDBLSN/Y.209, Double/-Single Precision Adder; and

6 YYAUTPO/Y.210, Automatic Polarizer Sequence.

2.1.1 Synchronous Start Instrument Mode

If this YYSYNCS/Y.205 bit is zero, data acquisition (the first time the FOS Analog Signal Processor's accumulators are turned on to measure outputs from the rate limiters in each channel) starts roughly two seconds after the Begin Data Acquisition command is recognized. The time delay is determined by the (somewhat variable) execution time taken by the FOS microprocessor to complete initialization.

If the bit is one, then a "synchronous start" is performed. This capability would be expected to be used in conjunction with the Time-Resolved Ground Software Mode, but has no impact on the reduction software. After the FOS microprocessor completes its initialization, it drops into a loop to wait for a specified minor frame, and so many oscillator counts (the least increment on the command is 7.8125 usec) after that minor frame begins. At this point, it begins the sampling of the rate limiters in each channel.

The FOS microprocessor initialization (what it does when a Begin Data Acquisition command is acted upon) is set by command YINIT/$Y041_c$, and reflected in measurement YINTMODE/Y547. Only the first five bits are assigned:

1 YYRSMNI/Y.213 is "Resume (no initialization)". The bit is set to cause the FOS microprocessor to "carry on where were." It might be used, for example, after have sent command YENDAC/$Y557_c$ ("End data acquisition at end of pattern").

2 YYINHSLT/Y.214 is "Inhibit slice table fill". The FOS microprocessor software has what corresponds to a set of transfer vectors that can control what is done at the start of each slice (see Section 3.1.1.5). The default value (same for all vectors) is set from ROM if the bit is 0; if the bit is 1, the setting from ROM is bypassed (meaning that the vectors could be loaded by command).

3 YYINHYDF/Y.215 is "Inhibit Y-deflection table fill". The FOS microprocessor normally computes the DAC Y (and X) 12-bit deflection values (based on the observer-specified control parameters and the DAC scaling) as part of its observation initialization. A value of 0 for this bit means that these

computed values for the Y axis should be loaded in the Y-deflection table for use during the observation; if the bit is 1, this loading is bypassed, thus allowing ground-commanded values to be used instead.

4 YYINHXDF/Y.216 is "Inhibit X-deflection table fill". See discussion with bit 3, applying similarly to the X axis.

5 YYINDFHY$_s$/Y.217 is "Do deflection hysteresis pattern at beginning of data acquisition". This pattern currently is expected to be required only at the beginning of each data acquisition. It is in the form of a "big square spiral" that is used for degaussing. Without it, hysteresis effects of the order of a diode width have been seen. Exercise of this option does not have a significant impact on the time line. If it should be necessary to do the pattern before each deflection, the YKEY command (see Section 1.5) could be used to uplink the FOS firmware augmentation.

2.1.2 Time-Tag Instrument Mode

If this YYTIMTG/Y.206 bit is zero, the accumulators in the FOS Analog Signal Processor count the output pulses from the rate limiters in each channel. If the bit is one, the accumulators instead count pulses from the 1.024 MHz spacecraft oscillator between "start" and when the first output pulse from the rate limiter is received. This way of operating the instrument is similar to some other current X-ray instrumentation. The bit must be one for the Time-Tagged Ground Software Mode, and zero for the others.

2.1.3 Reject/-Retry Instrument Mode

This YYREJRE$_s$/Y.207 bit controls what is to be done if a noise burst is received (above the noise limit value in measurement YNOISELM/Y544). The bit does not control the performance of the rejection logic itself. If YNOISELM is zero, the adder is disabled entirely (and therefore the computation of the overlight sum discussed in Section 2.1.5); a value of X'FFFF' makes the rejection limit unattainable, allowing the adder to still function. If the bit is 1 when Begin Data Acquisition is acted upon, the FOS microprocessor allocates RAM capacity for a Reject Array immediately following the last science data. The bit being 1 means that if a data sample above the noise limit is rejected, FOS should not attempt to retry the measurement. The bit should be 1 for the Time-Resolved, Rapid Readout, and Time-Tagged Ground Software Modes. The Reject Array is downlinked only if so commanded (downlinking, however, is expected to be the normal operating procedure).

If the bit is 0 and a noise burst is received, FOS repeats the measurement with the same value of the beam deflection parameters. The impact of this is that the measurement time tags can slip beyond the expected periods (such as "once/minute" for readouts).

2.1.4 Target Acquisition Instrument Mode

The YYTARGA$_S$/Y.208 bit must be 1 for the Target Acquisition Ground Software Mode, and zero for all the others. The FOS microprocessor stops at the end of a set of measurements and puts the newly computed coordinates of the target in the engineering telemetry stream. The NSSC-1 Mode II Target Acquisition processor (YFMOD2, see Section 1.5) uses these coordinates to generate a ST movement request to the SSM.

If the NSSC-1 is doing the targeting (see Section 1.5), this bit is not set. In contrast to the NSSC-1's approach of "looking at data and deciding what to do next," the FOS microprocessor has the approach of "taking data in a gulp and then figuring out from the data where the center is." YTAQIP/Y575 is used to inform the data monitoring background task that the targeting computations must occur. See Section 3.1.5 for the commands and parameters that are associated with FOS targeting.

2.1.5 Double/-Single Precision Adder Instrument Mode

The YYDBLSN/Y.209 bit controls the nature of the addition of the 512-diode output for YOVRLTMB/Y800|YOVRLTLB/Y801 (Y800 is for the top 3 bytes and Y801 is for the bottom byte). For a dim object with an integration time between samples of (for example) 20 msec, a single precision addition (bit set to 0) would be enough (the average output from each of the 2^9 diodes less than 2^6); if the integration time were 10 seconds, however, then a double-precision addition (bit set to 1) to form the 512-diode sum might have to be done. The disadvantage of doing a double precision addition is that additional CPU time is needed, so the sum is under control of this Instrument Mode bit. The bit has no effect on the processing needed for the other information on the downlink. The addition can be disabled (if it is necessary to save CPU time) by setting YNOISELM/Y544 to zero; the adder (and hence computation) is also disabled while FOS science dumps are being performed.

Regardless of how the diode sum is generated, it is added as a 32-bit quantity into YOVRLTMB|YOVRLTLB, which therefore has units of "diode counts". The YOVRLTMB|YOVRLTLB quantity is reset once a minute just after being sampled for insertion in the telemetry. This sampling (as is true for all other multi-byte quantities that are cleared as they are read for telemetry) is set up such that the entire quantity is read and stored in a temporary buffer (while clearing the quantity) at the time of the first byte to occur in the telemetry stream. Hence the entire value as read out in telemetry has an effective sampling time corresponding to the time of the first byte. The set of quantities that are zeroed when they are read, in addition to YOVRLTMB|YOVRLTLB, includes the following:

1. The words in minor frame 117 and 118 ("DAC" error bits and the bits for YACTMERR, YMECHTOC, YBEGINDA, YENDDA, YABORTDA, and YRESETMP);
2. The target acquisition results contained in YTARXCTR and YTARYCTR (see Section 3.1.5);
3. The serial magnitude error reporting quantities (flags in YSMCERRS and the command in YLASTCMD, see Section 3.1);
4. Bits 6 (YYSAFLKA/Y.202) and 7 (YYSAFTSL/Y.203) in YSAFING; and
5. YREJECTS (see Section 3.1.1.1).

The YOVRLTMB|YOVRLTLB value is used by the YFHKPG NSSC-1 processor (and can be on the ground) to monitor for excessive light intensity striking the instrument in one of the dispersion modes (it is comparatively ineffective if the mirror is used, since only about five diodes are illuminated then). Viewing the bright earth with the FOS is not allowable (if the mirror were used, a hole could be burned in the cathode); objects with a magnitude of $m_V = 6$ (or brighter) are otherwise of concern for the instrument.

2.1.6 Automatic Polarizer Sequence Instrument Mode

The YYAUTPO/Y.210 bit is used to specify, if 1, that the polarizer should be stepped during the course of the observation. This can be used to cause the polarizer at each slice to move to the next in a series of waveplate angles (the FOS microprocessor waits until the polarizer has reached the new position before taking measurements). Because of data memory capacity constraints, this will probably be used only with a subset of the instrument's total number of diodes (such as to examine a bright line); the YYINHSLT/Y.214 bit (see Section 2.1.1) is used to inhibit the default loading of the slice table (which is instead filled with commands to do the mechanism movement). The polarizer, of course, can be used even if this FOS Instrument Mode bit is set to 0, so the bit cannot be used to establish that the Spectropolarimetry Ground Software Mode is required.

2.2 FOS SCIENCE DATA MODES

The FOS has four Science Data Modes. They are:

1 Imaging,

2 Spectrophotometric,

3 Time-Resolved Spectrophotometric, and

4 Spectropolarimetric.

These classes of science data-taking modes were taken from SLIB 213. An equivalent view of the FOS operating modes could use the six Ground Software Modes (see Section 2.3) defined as such in SLIB 598 but discussed from the observer's viewpoint in SLIB 810. The sequence of presentation in this Section (as suggested in SLIB L64) parallels Sections 2.3.1-2.3.4 respectively. As explained in Section 2.2.3, the Ground Software Modes in Sections 2.3.5 and 2.3.6 are alternatives to Section 2.3.3.

2.2.1 Imaging Science Data Mode

The FOS FGWA has a position with a camera mirror, designed to form a non-dispersed target image on the photocathode. Although the basic purpose of this Science Data Mode is for target acquisition (see Section 2.3.1), it is conceivable that scientific requirements might arise that require data-taking in this Mode.

2.2.2 Spectrophotometric Science Data Mode

It is anticipated that about 90% of the FOS observations will be made in this Science Data Mode (see Section 2.3.2). The observer selects a Digicon sensor and one or more grating settings to provide the desired resolution and wavelength coverage for spectroscopy. The data may later be interpreted photometrically via comparison of the observed count rates with separate external observations of standard stars. Typical exposure times range from about one minute to many hours per selected configuration. The FOS instrument allows a minimum exposure time of about 125 usec (and no maximum exists). Spectra are expected (see SLIB L90) to be read out of the FOS microprocessor about every 4 minutes. The frequent readouts result in negligible loss of observing efficiency and protect against catastrophic losses of data.

2.2.3 Time-Resolved Spectrophotometric Science Data Mode

This Science Data Mode is a superset of the Spectrophotometric Mode, with the difference that the science requirements dictate rapid and phase-coherent data acquisition. Several operations options are available in this Science Data Mode. The FOS microprocessor memory may be used to store a number of synchronously phased and co-added spectra (see Section 2.3.3). In a variation of this Mode, when the 1 MHz telemetry downlink (or the on-board tape recorder) is available, there will occasionally be a requirement to transmit each individual 512-diode spectrum (without substepping) as quickly as it is read out, without co-addition (see Section 2.3.5). Programs that involve observations of rapidly varying objects of unknown or unstable periods are an example of candidates for this data-taking Mode. Finally, the Time-Tag Instrument Mode (see Section 2.3.6) permits one additional fast-timing Mode, where the channel accumulators are used to store the number of clock pulses elapsed between an enable pulse and the arrival of the first count in that diode. It is also possible that an observer may occasionally require time-resolved spectropolarimetry, i.e. a combination of the Spectropolarimetric and Time-Resolved Spectrophotometric Science Data Modes.

2.2.4 Spectropolarimetric Science Data Mode

This Science Data Mode is also a superset of the Spectrophotometric Mode. In addition to the sensor, grating, and filter configuration, the observer also specifies one of a pair of waveplates and a sequence of polarizer stepping motions. This can be done using the Automatic Polarizer Sequence Instrument Mode (see Section 2.1.6), but this is not necessary. See Section 2.3.4.

2.3 FOS GROUND SOFTWARE MODES

There were originally six FOS Ground Software Modes (see SLIB 598):

1 Target Acquisition,

2 Spectroscopy,

3 Time-Resolved,

4 Spectropolarimetry,

5 Rapid-Readout, and

6 Time-Tagged.

A seventh ground software mode, LED Flat Field Map, has recently been added with limited reduction requirements (invoked if YFFCPWR/Y580 is 1). This mode is not considered further in this document (except in Section 5.9). It is possible to determine if the FOS science data should be processed using the Target Acquisition Ground Software Mode (the only case in which $YYTARGA_S$/ Y.208 is 1) or the Time-Tagged Ground Software Mode (the only case in which YYTIMTG/Y.206 is 1). If one of the other four Ground Software Modes (which must have both these bits equal to zero) is necessary, however, the choice cannot be reliably determined from the downlink information. Instead, the desired (a user input) Ground Software Mode can be determined from the "Predicted Flags and Indicators" associated with the Proposal Management Data Base (see SLIB T34). As mentioned in Section 2.2, the FOS Ground Software Modes could also be considered as FOS operating modes. The order in which the modes are listed is that used by the IDT in SLIB 598 and SLIB 810.

2.3.1 Target Acquisition Ground Software Mode

For the Target Acquisition Ground Software Mode, the Instrument Mode (see Section 2.1.1) must have YYTIMTG/Y.206 equal to 0 and $YYTARGA_S$/Y.208 equal to 1. An FOS target acquisition picture will be constructed from a sequence of X-stepped and Y-stepped scans taken in the Imaging Science Data Mode (also referred to as the "direct imaging" mode) with an aperture of size 4.3 arc seconds. See Sections 5 and 7 for references to the processing required.

Faint red targets will usually be acquired and observed on side A, while faint ultraviolet targets imbedded in diffuse red sources will usually be acquired and observed with the bialkali (side B) Digicon. Acquisition on one side and observation on both sides (to get the necessary wavelength range) will be common. In unusual cases, acquisition on one side and observation only on the other will be done.

2.3.2 Spectroscopy Ground Software Mode

For the Spectroscopy Ground Software Mode, the Instrument Mode must have both the YYTIMTG/Y.206 and $YYTARGA_s$/Y.208 bits equal to 0. This will probably be the most commonly used Ground Software Mode. See Sections 5 and 6 for references to the processing required.

2.3.3 Time-Resolved Ground Software Mode

For the Time-Resolved Ground Software Mode, the Instrument Mode must have both the YYTIMTG/Y.206 and $YYTARGA_s$/Y.208 bits equal to 0 and the $YYREJRE_s$/Y.207 bit equal to 1. This Ground Software Mode will be used to study objects with known periodicity in about the 50 msec to 100 second range, and is expected to generate data comprising 5-10% of all FOS observations (a typical observation might last 60 minutes). Spectra are folded into a predetermined number of time bins (or slices) corresponding to phase, with four to ten samples per full period being typical. Interruptions of data acquisition to read out each frame of data are set by commands to last an integral number of periods, so that each frame of an observation has the same correspondence between phase and slice. The YYSYNCS/Y.205 bit will be set if the precise phase of the data is important to the observer (if it is not set, this absolute phase is not important). Ground processing is the same regardless of this bit. See Sections 5 and 6 for references to the processing required.

2.3.4 Spectropolarimetry Ground Software Mode

For the Spectropolarimetry Ground Software Mode, the Instrument Mode must have both the YYTIMTG/Y.206 and $YYTARGA_s$/Y.208 bits equal to 0. A polarimetry data set is normally composed of 16 or fewer (a minimum of four) independent frames of a single source, taken one after another. Each frame will have two Y-steps, one for each sense of polarization transmitted by one of the Wollaston/waveplate pairs in the polarizer mechanism. The first Y-step corresponds to the first pass direction and the second Y-step corresponds to the second pass direction. It is not necessary to have the YYAUTPO/Y.210 bit set for this Ground Software Mode. See Sections 5 and 6 for references to the processing required.

2.3.5 Rapid-Readout Ground Software Mode

For the Rapid-Readout Ground Software Mode, the Instrument Mode must have both the YYTIMTG/Y.206 and $YYTARGA_S$/Y.208 bits equal to 0 and the $YYREJRE_S$/Y.207 bit equal to 1. There are certain astronomical targets where rapid time variability is suspected, but the precise period of variability is unknown, or aperiodic rapid variability is expected. The Time-Resolved Ground Software Mode is unsuitable since the bin folding period (the period of the signal) must be set in advance. Instead, normal FOS data taking is used, but the spectra are read out at very frequent intervals, rather than the approximately four-minute integration times anticipated for normal FOS data-taking. The shortest integration time is estimated to be 20 msec. The rapid-readout capability requires the 1 MHz downlink (or use of the on-board tape recorder). This Ground Software Mode is expected to generate data comprising 2-5% of all FOS observations (a typical observation might last 60 minutes), but a disproportionately large data volume. See Sections 5 and 6 for references to the processing required.

2.3.6 Time-Tagged Ground Software Mode

For the Time-Tagged Ground Software Mode, the Instrument Mode must have the YYTIMTG/Y.206 and $YYREJRE_S$/Y.207 bits equal to 1, and the $YYTARGA_S$/Y.208 bit equal to 0. This will probably be the least used Ground Software Mode, but will allow study of the most rapid variability possible using the FOS. Periodic or aperiodic variability on timescales in the range of about 10 usec to 50 msec are well-suited to study in this Ground Software Mode, which is expected to generate data comprising 2-5% of FOS observing time, although far more than this percentage of FOS data. A typical observation might last 60 minutes. See Sections 5 and 6 for references to the processing required.

3.0 FOS SCIENCE TELEMETRY

3.1 FOS SCIENCE TELEMETRY OVERVIEW

As stated in SLIB 598:

> FOS data arrives in logical units denoted as "frames" at a commandable frequency typically about once per minute [the frame rate is now expected (see SLIB L90) to be about once every 4 minutes]. One or more frames constitute an observation, which will have been predefined to correspond to a scientifically logical unit of data.

The definition of an "observation", therefore, is significant for understanding how the FOS science data is to be processed. A normal science observation (as distinguished from data obtained for target acquisition) consists of the following:

a) The NSSC-1 (SI C&DH computer) Standard Header Packet. The transmission of the Standard Header Packet is commanded through the NSSC-1 (see Section 3.2.1).

b) The FOS-Unique Data Log (from the FOS microprocessor). Prior to the transmission of this log, the science telemetry format is changed to reflect 965 data words per line and one line per telemetry frame (see Section 3.2.4 for definitions of these terms). According to SLIB T23, the UDL may be dumped more frequently than once per observation.

c) One or more frames of science information (from the FOS microprocessor), each of which can contain a Science Header, a Science Data Array, and a Reject Array. Only the Science Data Array must be present in the data processed in all Ground Software Modes. Prior to the start of transmission of the science information, the science telemetry format is changed to reflect the science information's number of words/line and number of lines/frame.

For target acquisition data, several SHPs can occur, as well as FOS buffer data from the NSSC-1. The information presented in this document (unless otherwise specified, such as in Section 3.2.3.4), however, is concerned with normal science observation data from the FOS. There are typically many frames of science information in an FOS observation, usually spaced (for telemetry transmission) at one to five-minute centers. As mentioned in Section 1.5, there is no connection between the observation (data acquisition) parameters and the downlink control parameters (except what may happen to exist if conventions are followed). Further details on the transmission characteristics are provided below:

1. Command YSCIDMP/Y002 (see Section 3.1.2.1) can be used to specify the memory dump start address, the number of words/line, and the number of lines/frame. These quantities are all in the engineering telemetry.

2. The SDF and the FOS microprocessor must be compatible in their expectations of the number of words/line and lines/frame for the telemetry to function.

3. The maximum number of data words/line (see Section 3.2.4) is 965. For some observations (although this is <u>not</u> required), a convention may be used that keeps an association between the SDF (and hence FOS microprocessor) "line" and how the observer thinks of a "line". <u>If</u> this convention happens to be used, a typical FOS line size could be 516 words, corresponding to 512 channels (i.e., all the diodes being used) and an OVRSCN (see Section 3.1.1.3) value of 5.

4. The total number of words per frame can potentially be up to the full 12K words (address X'A000' to X'FFFE') allocated in the FOS RAM to science information (see Section 3.2.3), plus a line's worth of data (maximum 965 words) for the Science Header. An integral number of lines must be sent in a frame, and all lines in a frame must have the same number of words.

5. In some FOS applications, it may be necessary to reduce the line size to gain speed (would send fewer channels to the ground). Another technique to gain speed would be to eliminate the Science Header. Finally, the most efficient use of the telemetry format requires a line length of [50 + 61 * n] words (n an integer in the [0-15] range, 15 giving 965 words).

6. Because of the characteristics of the FOS/SDF interface (see Section 1.5), the FOS must stop data gathering while it is feeding information to the downlink (or tape recorder).

Control of the FOS instrument can be accomplished by "command sequences" (see SLIB 763 for examples) that are comprised of individual commands. There are three types of FOS-unique commands:

1. Discrete Relay Commands are used to control FOS input power to the various power supplies. They are also used to control critical failsafe hardware, the internal common bus, and science data port cross-strapping.

2. Discrete Logic Commands are used to reset the FOS microprocessor; start, end, and abort data acquisition; reset internal error flags; and select the FGWA motor.

3. Serial Magnitude Commands are used to initialize hardware parameters, control mechanisms, set up and control science data acquisition and readout, and perform diagnostics.

The commands in the first two types are listed in Table 3.1-1 (in the order they are presented in SLIB 753, but using the notation of SLIB L98 that omits the RIU designation), while the Serial Magnitude Commands (in the order shown graphically in SLIB 753, and described in SLIB 683) are listed in Table 3.1-2. These tables also give the section in this document where the command is discussed. The first seven commands in Table 3.1-2 are "Type 3 commands" (having a four-bit command code and a 12-bit data field); all others are "Type 4 commands", which have a four-bit command code, four-bit modifier field, and eight-bit data field.

Bits Y.219-Y.221 in the the command error flag word (YSMCERRS/Y649) distinguish between Type 3 and Type 4 commands. Bits Y.223-Y.226 of this word have reference in their definitions to "illegal path". If any of these bits are set, a malfunction of the FOS microprocessor is indicated. There is no combination of normal commands that should cause the indicated path to be taken, since the command parameters are checked before the branching based on them is taken. YSMCERRS and the associated command in YLASTCMD/Y543 are zeroed after being sampled for telemetry (see the list in Section 2.1.5).

For the purposes of this document, the FOS commands (except for most of the Discrete Relay ones, since their functions are self-evident) have been divided into the following categories:

1 Loop Control Commands,

2 Other Downlink Control Commands,

3 Digicon Commands,

4 Mechanism Commands,

5 Targeting Commands, and

6 Miscellaneous Commands.

These commands, with their associated telemetry, are covered in Sections 3.1.1-3.1.6 respectively. Section 3.1.7 lists the major FOS flags and indicators required for processing.

Table 3.1-1 FOS Discrete Commands

Cmd ID	Mnemonic	Role
		Discrete Relay Commands
Y505[c]	YSAFAP	Safe Aperture command. See Section 3.1.4.2
Y507[c]	YSAFED	Safe Entrance Port command. See Section 3.1.4.1
Y515[c]	YSAFPL	Safe Polarizer command. See Section 3.1.4.3
Y501[c]	YARMAP	Arm Aperture command. See Section 3.1.4.2
Y503[c]	YARMED	Arm Entrance Port command. See Section 3.1.4.1
Y511[c]	YARMPL	Arm Polarizer command. See Section 3.1.4.3
Y579[c]	YBUSA1	A-On, B-Off S1 command.
Y580[c]	YBUSB1	B-On, A-Off S1 command.
Y581[c]	YBUSA2	A-On, B-Off S2 command.
Y582[c]	YBUSB2	B-On, A-Off S2 command.
Y517[c]	YHVOFF	High Voltage Supply Off command.
Y519[c]	YHVON	High Voltage Supply On command.
Y521[c]	YQSOFF	Quiet Supply Off command.
Y523[c]	YQSON	Quiet Supply On command.
Y525[c]	YLSOFF	Logic Supply Off command.
Y527[c]	YHTON	Heater On command.
Y529[c]	YSDFB4	SDF B4 port to side select command.
Y531[c]	YSDFB2	SDF B2 port to side select command.
Y533[c]	YSDFB3	SDF B3 port to side select command.
Y535[c]	YSDFB1	SDF B1 port to side select command.
Y537[c]	YSDFA4	SDF A4 port to side select command.
Y539[c]	YSDFA2	SDF A2 port to side select command.
Y541[c]	YSDFA3	SDF A3 port to side select command.
Y543[c]	YSDFA1	SDF A1 port to side select command.
Y569[c]	YLSON	Logic Supply On command.
Y585[c]	YCALSB	Select Cal. Lamp B command. See Section 3.1.6.4
Y583[c]	YCALSA	Select Cal. Lamp A command. See Section 3.1.6.4
Y547[c]	YHTOFF	Heater Off command.
Y577[c]	YCALOF	Spectral Cal. Lamp Off command. See Section 3.1.6.4
Y575[c]	YCALON	Spectral Cal. Lamp On command. See Section 3.1.6.4
Y561[c]	YBLAPR	Blow Aperture command. See Section 3.1.4.2. Not in SLIB L98
Y563[c]	YBLENT	Blow Entrance Port command. See Section 3.1.4.1. Not in SLIB L98
Y567[c]	YBLPOL	Blow Polarizer command. See Section 3.1.4.3. Not in SLIB L98
Y600[c]	YIGON	Ion Gauge On.
Y601[c]	YIGOFF	Ion Gauge Off.
Y625[c]	YSTBY1A	RIU Standby 1-A; self on.
Y626[c]	YSTBY1B	RIU Standby 1-B; self on.
Y627[c]	YSTBY2A	RIU Standby 2-A; mate off.
Y628[c]	YSTBY2B	RIU Standby 2-B; mate off.

Table 3.1-1 FOS Discrete Commands (cont)

Cmd ID	Mnemonic	Role
		Discrete Logic Commands
Y571$_c$	YCMTRA	Select Motor A command. See Section 3.1.4.4
Y573$_c$	YCMTRB	Select Motor B command. See Section 3.1.4.4
Y545$_c$	YRESET	Reset Microprocessor command. See Section 3.1.6.5
Y549$_c$	YRIEBW	Reset IEB/Watchdog command. See Section 3.1.6.5
Y551$_c$	Y3MHZ	Select 3.0 MHz Clock command. See Section 3.1.6.5
Y553$_c$	Y1.5MZ	Select 1.5 MHz Clock command. See Section 3.1.6.5
Y555$_c$	YABACQ	Abort Data Acquisition command. See Section 3.1.2.3
Y557$_c$	YENDAC	End Data Acquisition command. See Section 3.1.2.3
Y559$_c$	YBEGAC	Begin Data Acquisition command. See Section 3.1.2.3

Table 3.1-2 FOS Serial Magnitude Commands

Cmd ID	Mnemonic	Role
		Type 3 Commands
Y024$_c$	YX-DEFL	Set X-deflection amplifier DAC. See Section 3.1.3
Y025$_c$	YY-DEFL	Set Y-deflection amplifier DAC. See Section 3.1.3
Y026$_c$	YX-BASE	Base value for X deflection computations. See Section 3.1.3
Y027$_c$	YY-BASE	Base value for Y deflection computations. See Section 3.1.3
Y028$_c$	YX-PITCH	Scaled X-deflection DAC value for one diode width in X. See Section 3.1.3
Y029$_c$	YY-PITCH	Scaled Y-deflection DAC value for one diode width in Y. See Section 3.1.3
Y030$_c$	YHVDAC	Set high voltage power supply DAC. See Section 3.1.3
		Data Commands
Y000$_c$	YRAMADDR	Load RAM storage address. See Section 3.1.6.3
Y001$_c$	YDATA	Data for type four commands.
Y002$_c$	YSCIDMP	Set dump parameters. See Section 3.1.2.1
Y004$_c$	YTARACQ	Set target acquisition parameters. See Section 3.1.5
Y006$_c$	YDISCADR	Load discriminator at address or set all values. See Section 3.1.6.2
Y008$_c$	YLIVETYM	Set accumulator open (live) time. See Section 3.1.1.1
Y010$_c$	YDEADTYM	Set accumulator closed (dead) time. See Section 3.1.1.1
Y012$_c$	YCHNLEN	Enable/inhibit channel(s). See Section 3.1.6.2
Y014$_c$	YREJLIM	Set noise rejection limit. See Section 3.1.1.1
Y016$_c$	YACQLIM	Set data acquisition limit. See Section 3.1.2.3
Y018$_c$	YSTRWRD	Store next commands as data. See Section 3.1.6.3
Y022$_c$	YMECHCAL	Set feedback code for mechanism. See Section 3.1.4
Y023$_c$	YSYNC	Set delay for starting synchronous acquisition. See Section 3.1.6.1
Y059$_c$	YSCIADDR	Set first RAM address for science data. See Section 3.1.6.5
		DAC Commands
Y031$_c$	YDISC	Set discriminator DAC table value. See Section 3.1.6.2
Y032$_c$	YREFDAC	Set common discriminator reference DAC. See Section 3.1.6.2
Y033$_c$	YFOCUS	Set focus trim DAC. See Section 3.1.3
Y038$_c$	YFFCAL	Set LED flat-field lamp on or off. See Section 3.1.6.4
		Mechanism Commands
Y034$_c$	YENTRNC	Set entrance port open or closed. See Section 3.1.4.1
Y035$_c$	YAPER	Set entrance aperture to position. See Section 3.1.4.2
Y036$_c$	YPLZR	Set polarizer mechanism to position. See Section 3.1.4.3
Y037$_c$	YFILTER	Set FGWA to position. See Section 3.1.4.4

Table 3.1-2 FOS Serial Magnitude Commands (cont)

Cmd ID	Mnemonic	Role
$Y087_c$	YMCHREG	Set mechanism register to drive signal. See Section 3.1.4
$Y056_c$	YMCHSTEP	Step mechanism. See Section 3.1.4
		Software Parameter Commands
$Y039_c$	YX-STEP	Select number of X deflection steps. See Section 3.1.1.2
$Y040_c$	YXFILW	Specify X filter width. See Section 3.1.5
$Y041_c$	YINIT	Set initialization mode. See Section 3.1.6.1
$Y042_c$	Y1STCHNL	Set first channel to be processed. See Section 3.1.2.2
$Y043_c$	YINTS	Set number of sub-integrations per X-step. See Section 3.1.1.1
$Y066_c$	YY-RNGE	Set range for Y deflection. See Section 3.1.1.4
$Y045_c$	YOUT-CLR	Set readouts/memory clear. See Section 3.1.1.7
$Y046_c$	YTAMOD	Set target acquisition mode. See Section 3.1.5
$Y047_c$	YY-STEP	Set number of Y deflection steps. See Section 3.1.1.4
$Y048_c$	YYFILW	Specify Y filter width. See Section 3.1.5
$Y049_c$	YACQMODE	Set data acquisition mode. See Section 3.1.6.1
$Y050_c$	YCHNLS	Set number of channels to be processed. See Section 3.1.2.2
$Y051_c$	YOVRSCAN	Set number of diodes overscan. See Section 3.1.1.3
$Y068_c$	YSLICES	Set number of memory slices. See Section 3.1.1.5
$Y053_c$	YCLEARS	Set number of memory clears/acquisition. See Section 3.1.1.8
$Y054_c$	YPTRNOUT	Set number of patterns/readout. See Section 3.1.1.6
		Diagnostic Commands
$Y052_c$	YRAM-MAP	Map physical to logical RAM page. See Section 3.1.6.5
$Y044_c$	YSTOPDMP	Stop science dump. See Section 3.1.2.3
$Y055_c$	YMEMCHK	Fill science memory with test pattern. See Section 3.1.6.3
$Y058_c$	YKPALVED	Enable/disable autonomous going safe. See Section 3.1.6.5
$Y057_c$	YSDERASE	Clear science memory locations. See Section 3.1.6.3
$Y070_c$	YSCIACT	Control science data dump. See Section 3.1.2.3
$Y071_c$	YKEY	Provide FORTH KEY capability. See Section 3.1.6.5
$Y083_c$	YDDCHK	Sample all discriminator DACs. See Section 3.1.6.1
$Y084_c$	YEFILL	Sample all serial digital telemetry. See Section 3.1.6.1
$Y085_c$	YPAUSE	Set/reset pause acquisition bit. See Section 3.1.2.3
$Y086_c$	YRANDOM	Fill science memory with pseudo-random sequence. See Section 3.1.6.3
$Y088_c$	YTA	Begin Mode II FOS Target Acquisition Calculations. See Section 3.1.5

3.1.1 Loop Control Commands

The FOS microprocessor has a set of control parameters used for its loop control. These parameters are commanded (rather than having the FOS microprocessor adaptively determine them), and all of them are in the engineering telemetry (and hence the Science Header and FOS-Unique Data Log) described in Section 4. In the sequence from the inner-most to outer-most loop, and using the notation of a figure in SLIB 753 (and SLIB 1219), these quantities are:

1 Number of Integrations (INTS),
2 Number of X-Steps per Diode (XSTEPS),
3 Number of X-Diodes (OVRSCN),
4 Number of Y-Steps (YSTEPS),
5 Number of Slices (SLICES),
6 Number of Patterns/Readout,
7 Number of Readouts/Memory Clear, and
8 Number of Memory Clears/Acquisition.

In principle, the starting channel and number of channels sampled could be considered as loop "0" (see Section 3.1.2.2). To the end of this list could also be added (conceptually, since of course it is not an explicit parameter) the quantity "Number of Acquisitions/Space Telescope Lifetime". Once the FOS microprocessor falls out of the "8" loop, aside from setting bit YNDAIP/Y571 it takes no further action pending another "Begin Data Acquisition" (command YBEGAC/$Y559_c$) that initiates the whole process again. Since these loop control parameters are so significant to FOS operation, they are discussed in detail below.

3.1.1.1 Number of Integrations (INTS)

INTS, the number of integrations, controls the number of open time/close time pairs of FOS Analog Signal Processor samples of the output from the rate limiter that are done with no changes in magnetic deflection. It is commanded by YINTS/$Y043_c$ and telemetered in YINTEG/Y546. A zero value means that 256 of these sub-integrations should be performed for each XSTEPS (see Section 3.1.1.2) value.

The accumulator "open time" (interval during which accumulator counting is enabled) is specified by command YLIVETYM/$Y008_c$ in units of 7.8125 usec (8 periods of the 1.024 MHz spacecraft oscillator). Although the command specifies this time directly, the telemetered value in $YLIVE_S$/Y.108 (which has components YLIVEHI/Y585 and YLIVELO/Y586) is, due to the hardware, in two's complement form. To convert the downlink value to the "true" time in microseconds, the 16-bit value can be converted to decimal, subtracted from 2^{16} (65536), and then multiplied by 7.8125.

The time interval is controlled by the spacecraft clock (and a high-urgency interrupt) rather than being dependent on FOS microprocessor background computing delay times (see Section 1.5). The minimum reasonable accumulator open time is about 3 msec (since a telemetry sync interrupt can take a couple of milliseconds to service). In special cases, the telemetry could be disabled, thus reducing the minimum to the about 800 clock ticks (781.25 usec) that are needed to service the interrupt. Since 16 bits are allocated, a maximum of 512 msec can be set for the time during which the accumulators are to count the FOS rate limiter outputs.

Similarly, the accumulator "close time" (interval during which accumulator counting is disabled) is specified by command $YDEADTYM/Y010_C$ in the same units (7.8125 usec). The telemetered value in $YDEAD_S$/Y.109 (components YDEADHI/Y587 and YDEADLO/Y588) again is in two's complement form. The accumulators are inhibited every timer cycle to allow for data readout. Other uses of the capability include while the magnetic deflection system is moving the beam to a new position or if, for some other reason, a "garbage" output would otherwise be expected. To allow for FOS microprocessor computations (including burst-noise rejection, updating the data in FOS memory, and evaluation of YOVRLTMB|YOVRLTLB), the dead time must be above a value that depends on the instrument mode and the number of diodes used (10 msec is a safe number if the Reject Array is used and 18 msec if it is not). In addition, the sum of the live and dead times must also be above a minimum (30 msec is a safe number if 512 diodes are read and 15 msec can be employed if only 8 diodes are read). If the accumulated counts per integration are small, then the Double/-Single Precision Adder Instrument Mode bit can be set to 0 (see Section 2.1.5), reducing the minimum value for the sum of live and dead times (for 512 diodes) by 5 msec. See SLIB L90 for more details.

A major application of INTS is to minimize the amount of data lost due to transients, since the FOS hardware can respond to relay glitches and could reasonably be expected for its usual setting of 512 msec to take cosmic ray "hits". If, rather than a single 512-msec interval, had 10 intervals of about 51 msec, then editing in the FOS microprocessor could detect inputs above a burst noise rejection limit (command YREJLIM/$Y014_c$, telemetered in YNOISELM/Y544) and reject them. For a faint object with an interval of 25-50 msec, the limit probably will be set to 2, since the overwhelming probability is a count of zero. A zero value for YREJLIM disables the adder entirely (and therefore the computation of the overlight sum, see Section 2.1.5), while a value of -1 (X'FFFF') makes the rejection limit unattainable (allowing the adder to still function). Rejection is of the complete sample from all channels for that particular interval: this is accompanied either by a "retry" or by an update of the Reject Array (the latter would be chosen if the time phasing of the measurements was critical). If $YYREJRE_s$/Y.207 is 1, the Reject Array is updated. The count of the number of rejects (cleared each time the value is sampled, see SLIB T30) is given in 16-bit measurement YREJECTS/Y652, which is incremented regardless of whether the Reject Array is being used. There is no limit in the FOS microprocessor software on the number of times a given measurement can be retried.

3.1.1.2 Number of X-Steps per Diode (XSTEPS)

The 12-bit FOS Digicon X-axis DAC deflection control has a nominal scaling (see Section 1.5) of 32 least increments between successive diodes (50 microns). The parameter XSTEPS (command YX-STEP/$Y039_c$, telemetered in YXSTEPS/Y524) specifies the number of steps to be done between successive diodes. For example, [XSTEPS = 4] would cause a measurement "at" the diode, then at [diode+0.25], [diode+0.50], and [diode+0.75]. This gives "quarter stepping", since the electrons would be placed on the next diode over after four steps. Steps go in the +X direction. Expected values for XSTEPS are 1, 2, 4, 8, and 16 (with 4 the typical value). There is no restriction that the quantity be a power of 2, however. A setting of 32 for XSTEPS is considered unreasonable, 16 gets to noise, 8 is overkill, 4 is about right, and 2 is coarse.

For speed reasons, the FOS microprocessor for a given scan of the diode-path buffer registers increments its RAM channel counters at successive addresses in the microprocessor memory. This means that, for a given XSTEPS-controlled offset (such as for [diode+0.50]), all the channel readouts are grouped together. For subsequent processing, however, it is necessary to arrange the information in meaningful wavelength order, so that the readouts must progress [element], [element+0.25], [element+0.50], and [element+0.75], followed by the next element's result for the four XSTEPS-controlled offsets. This reordering (or unscrambling) process is covered in Section 3.2.3.2.

3.1.1.3 Number of X-Diodes (OVRSCN)

XSTEPS controls the fractional diode X-axis step logic. OVRSCN (command YOVRSCAN/$Y051_C$, telemetered in YOVRSCAN/Y530) controls the number of integral X-axis diodes over which the X-axis deflection process is continued. For example, if [XSTEPS = 4] and [OVRSCN = 3], then a total of 12 successive X-axis measurements, each spaced (after the first) by 0.25 diode, would be taken. In the FOS microprocessor, the memory cell boosted from diode #3's output for the first of these 12 measurements would be boosted from diode #4's output for the fifth measurement, and from diode #5's output for the ninth, since (for perfect deflection hardware performance) these samples reflect a light stimulus of identical wavelength. It is this process that causes the FOS RAM cells to contain "element" information (in contrast to "channel" data that they would have in the special case of [OVRSCN = 1]). See Section 3.2.3.2 for the arrangement of the resulting words in FOS memory.

Having [OVRSCN > 1] causes a filtering on the output of the various diodes, as well as permitting compensation for a failed channel (that otherwise would produce a "gap" in the spectrum data). A commanded value of 0 is interpreted to be 256, but hardware limits meaningful use to values from 1 to 128. Although a value of 64 has been run, a more typical value is 5. Due to the OVRSCN parameter, the data at either end of the sampled group of channels must be compensated to recognize (even if the Reject Array is not involved) that fewer samples are collected for them (see Section 3.2.3.2).

3.1.1.4 Number of Y-Steps (YSTEPS)

The OVRSCN parameter is the last of the group of parameters controlling the FOS microprocessor's looping for the X axis. YSTEPS (command YY-STEP/$Y047_C$, telemetered in YYSTEPS/Y528) is used to control the deflection in the Y direction (perpendicular to the X-axis dispersion direction). A typical value is 2, allowing one value to be for the object and the other to reflect a sky background. A commanded value of 0 is interpreted to be 256.

In the FOS design, the X and Y axes were kept as symmetrical as possible. Deflections for both start at a "base" value (YXBASE and YYBASE in Section 3.1.3), and in both there is the concept of a "deflection range" and the "number of steps in that range." The deflection range for X is defined to be the separation between the diodes (50 microns), whereas for Y it is determined by a command. The number of steps for X is given by XSTEPS (see Section 3.1.1.2), and for Y it is YSTEPS. Since for X the steps are counted including the first point ([XSTEPS = 2] provides a measurement "at" the diode and at [diode + 0.5], with subsequent offsets controlled by OVRSCN as described in Section 3.1.1.3), a similar procedure is followed for the Y axis.

The YY-RNGE/$Y066_C$ command (telemetered in YRANGE/Y555) selects the range over which the Y deflection is to occur: for N YSTEPS, the bottom [(N-1)/N] fraction of the full area will be covered. Hence in the frequently useful case where need only two different Y deflections, YYBASE gives the first value, and [YRANGE/2] gives the offset for the second. This means that YRANGE must be set to twice the second Y value's desired offset from YYBASE. The scaling of YY-RNGE is such that a parameter value of 128 corresponds to the full nominal deflection capability, implying (since the DAC is 12 bits) that must scale the information by 2^5. Successive nominal increments are offset (always in the +Y direction) by:

(YRANGE * 32)/YSTEPS.

As discussed in Section 1.5, the observer can set the FOS deflection parameters based on the design-nominal deflection scaling; the actual values loaded into the DACs are scaled by the FOS microprocessor (using YXPITCH and YYPITCH discussed in Section 3.1.3).

The function of the various Y-step values in the observation, by convention, will be encoded in the first byte of the FOS data header field (YYASCIIH$_s$/ Y.403, see Section 3.2.2). In this byte, bits 7-8 are used for the first Y-step, bits 5-6 for the second, and bits 3-4 for the third (bits 1-2 are unassigned). For each of these pairs of bits, 00_2 means not specified|non-existent, 01_2 means an object measurement, 10_2 means a sky measurement, and 11_2 means a background measurement. An object measurement implies that it is a spectrum of the source of interest (and the sky around it); a sky measurement is a spectrum through the entrance hole of a paired aperture that does not contain the object of interest; and a background measurement is a spectrum from a part of the photocathode that has no image of an entrance hole on it (or one taken with the entrance door closed and no internal lamp on). If YSTEPS $\geq$ 4, each Y-step is to be treated as an object.

3.1.1.5 Number of Slices (SLICES)

SLICES (command YSLICES/Y068$_c$, telemetered in YMSLICES/Y576) is the final FOS microprocessor control parameter impacting the choice of RAM storage cells. It is used to cause a repetition (in a different area of the memory) of the XSTEPS-OVRSCN-YSTEPS collection of data. One application of the parameter is to segment the data for subsequent processing in the Time-Resolved Ground Software Mode to permit study of objects with known periodicity (each "slice" corresponds to a predicted phase). Another use of SLICES is in conjunction with the Automatic Polarizer Sequence Instrument Mode (see Section 2.1.6). A commanded value of 0 is interpreted to be 256. If a value above 1 is needed, typical settings are 4-8, with maximum expected value of 20. Alternatively, a large value of SLICES could be used with a small value for the number of channels to analyze aperiodic or unknown-period time variability.

3.1.1.6 Number of Patterns/Readout

The collection of data over the selected number of elements (including the effect of OVRSCN), for each XSTEP, for each YSTEP, and then for each SLICE constitutes a group of FOS RAM data that is referred to as a "pattern". Its physical significance, however, is merely a set of contiguous FOS microprocessor RAM cells. Patterns/readout (command YPTRNOUT/Y054$_c$, telemetered in YPTRNS/Y577) determines how many collection pattern sequences (for each

XSTEP, for each YSTEP, and then for each SLICE, each sequence incrementing the same FOS microprocessor RAM cells at the corresponding point) occur before a "frame" of science information is telemetered. A commanded value of 0 is interpreted as 256. A typical setting would be to cause a readout about once every 4 minutes. Comparatively frequent readouts are desirable to ensure against loss of data (due to data transmission problems), as well as to help permit compensation for possible radiation-induced transients in the FOS RAM (manual checks could reveal where an excessive discontinuity occurred). If the Reject Array is not used, the actual transmission period of the information can be variable, depending on the number of retries that are triggered by the burst noise rejection limit commanded by YREJLIM/$Y014_C$ (see Section 3.1.1.1).

3.1.1.7 Number of Readouts/Memory Clear

Readouts/memory clear (command YOUT-CLR/$Y045_C$, telemetered in YREADCYC/Y548) is used to determine how often the RAM cells reflecting the counts accumulated for each element are reset. Doing the readouts without memory clears means that a subsequent readout would have sufficient data to do the processing. If, for example, do a readout every 5 minutes, the readout after 60 minutes, if successful, would reflect all the data measurement results gathered for that hour. For high input rates or long sampling intervals, however, it is necessary to reset the RAM science information (with a nominal starting address of X'A000') cells to zero periodically so that the analysis will not be complicated by overflow of the 16-bit RAM word (see also command YACQLIM/$Y016_C$ in Section 3.1.2.3). If, for instance, there is a 5 hour observation, the specification might be to reset the memory every hour. This means that the analysis activity eventually would have to retrieve the final frame within each hour for processing, combining the counts with the corresponding ones in the other four hours. Clearing occurs after the last readout in the sequence. A commanded value of 0 would result in indefinitely long observations (continuing until otherwise stopped). If the time phasing of the measurements is critical, this quantity should have a value of 1, since the phasing cannot be guaranteed across the readout interval.

3.1.1.8 Number of Memory Clears/Acquisition

Memory clears/acquisition (command YCLEARS/$Y053_c$, telemetered in YMCLEARS/ Y542) is the final criterion determining when an "observation" is completed (with memory clears every hour, it would be set to 5 if the desired length of the complete observation was 5 hours). As with the other times, the values are "nominal" if the Reject Array is not used, because of the possibility of retries. A commanded value of 0 would result in indefinitely long observations (continuing until otherwise stopped). If any observing parameters are changed, or if a new target is selected, then taking new data is referred to as a new acquisition. There may be multiple acquisitions on a given object, not to be confused with "target acquisition" for that object.

3.1.2 Other Downlink Control Commands

As mentioned previously, the FOS science information is basically a dump of an area of the FOS microprocessor memory. In addition to the loop control quantities discussed in Section 3.1.1, commands in the following categories also control the output:

1 Dump Parameter Command,

2 Channel Selection Commands, and

3 Acquisition/Dump Commands.

These are discussed in the following sections.

3.1.2.1 Dump Parameter Command

Command YSCIDMP/$Y002_c$ can be used to specify the memory dump start address, the number of words per line, and the number of lines per frame. Depending on a command parameter, only the last two, or only the last, quantity can also be set by the same basic command. These quantities are telemetered in YMDMPADR/Y550 (components $YMDMPADH_s$/Y.110 and $YMDMPADL_s$/Y.111), YWRDSLIN/ Y551 (components $YWRDSLIH_s$/Y.101 and $YWRDSLIL_s$/Y.102), and YLINSFRM/Y552 (components $YLINSFRH_s$/Y.103 and $YLINSFRL_s$/Y.104) respectively.

As discussed in Section 3.2.3, the memory dump start address typically will be set to cause transmission of one line (YWRDSLIN) of Science Header data before the Science Data itself, although this constraint is not enforced by the on-board software. According to SLIB L99, however, at least 64 words of FOS header information will always precede the FOS science data (except for NSSC-1 binary-search target acquisition, for which the science header line is omitted).

The number of words/line is a maximum of 965 (a limit imposed by other ST systems, see Section 3.2.4), but for some observations probably will be set to:

M = CHNLS + OVRSCN - 1,

where CHNLS is the number of channels to be processed (see Section 3.1.2.2) and OVRSCN is the overscan parameter (see Section 3.1.1.3). For typical values of [CHNLS = 512] and [OVRSCN = 5], therefore, [M = 516]. There is no constraint on the operation of the FOS that requires this convention to be observed, since the downlinking process is fundamentally a dump of a part of the FOS microprocessor's memory, and therefore need have no simple relationship to the deflection sequence when the data was gathered.

If this convention is followed, then the number of lines/frame that are required can be determined from:

N = SHL + #SL + #STL,

where SHL is the number of lines for the Science Header (=1, see Section 3.2.3), #SL is the number of Science Lines, and #STL is the number of Science Trailer Lines. The value for #SL is determined from:

#SL = XSTEPS * YSTEPS * SLICES,

where XSTEPS, YSTEPS, and SLICES are discussed in Sections 3.1.1.2, 3.1.1.4, and 3.1.1.5 respectively. Note that the parameters in Sections 3.1.1.6-3.1.1.8 do not impact the format of the output. Finally, the value for #STL is determined from:

#STL = [(WRA + M - 1)/M],

where WRA is the number of words in the Reject Array (if it is needed, see Section 3.2.3.3), a truncated division is used, and M is the number of words/line computed above. WRA is given by:

WRA = XSTEPS * OVRSCN * YSTEPS * SLICES,

where the parameters have already been cited.

3.1.2.2 Channel Selection Commands

The first channel in the detector array to be processed is selected by command Y1STCHNL/Y042$_c$ (telemetered in Y1STCHNL/Y531). The first physical channel is numbered #0, and the actual channel to be used is given by two times the data field (in both the command and the telemetry). Hence before being used in computations, the value must be multiplied by 2.

CHNLS, the number of channels in the detector array to be processed, is specified by command YCHNLS/Y050$_c$ (telemetered in YNUMCHNL/Y532). The actual number of channels to be used is given by two times the data field (in both the command and the telemetry), except that a value of 0 means all 512 channels. Before being used in computations, these compensations must be made.

3.1.2.3 Acquisition/Dump Commands

There are several commands provided to control data acquisition and dumping. They include:

1. YBEGAC/Y559$_c$, used to Begin Data Acquisition. When it is received, telemetry bit YBEGINDA/Y567 is set 1 (the bit is zeroed when it is read out as part of minor frame 118, see Section 2.1.5).

2. YENDAC/Y557$_c$, used to End Data Acquisition (at the end of the next pattern). When it is received, telemetry bit YENDDA/Y568 is set 1 (the bit is zeroed when it is read out).

3. YABACQ/Y555$_c$, used to Abort Data Acquisition immediately. When it is received, telemetry bit YABORTDA/Y569 is set 1 (the bit is zeroed when it is read out).

4. YPAUSE/Y085$_c$, used to Pause Data Acquisition (without disturbing the data acquisition counters). The same command is used to resume data acquisition. When a pause is in progress, telemetry bit YPIP/Y573 is set 1.

5. YACQLIM/Y016$_c$, used to set the data acquisition limit (if any datum exceeds this peak limit, acquisition is ended at the next readout opportunity). Although this could give the FOS a capability similar to the "exposure meter" method of operating the HRS, it is not planned for use. The high-order byte of the value is telemetered in YDATALIM/Y549 (there is no downlink monitoring available of the value of the low byte).

6. YSTOPDMP/Y044$_c$, used to stop a science dump immediately and disable further automatic science dumps. Telemetry bit YSDIP/Y584 is set if a science dump is in progress.

7. YSCIACT/Y070$_c$, used to activate an immediate science data dump and disable or enable automatic science data dumps. Telemetry bit YSDIP/Y584 is set if a science dump is in progress.

3.1.3 Digicon Commands

There are eight commands provided to control the various Digicon DACs, as well as to provide data-base values for the FOS microprocessor to be used for its DAC-related computations. All except YFOCUS are "Type 3" commands in Table 3.1-2, meaning that they have a 12-bit data field. These commands are:

1. YX-DEFL/Y024$_c$ sets the X-deflection amplifier DAC to the 12-bit command value. After loading, the DAC is read and YXDACERR/Y558 set if an error is found. The DAC readback is in YXDAC/Y553. Both the command and the readback have the actual hardware setting (they are not impacted by YXPITCH).

2. Similarly, YY-DEFL/Y025$_c$ sets the Y-deflection amplifier DAC (YYDACERR/Y559 is set if an error is found on readback). The DAC readback is in YYDAC/Y521.

3. YX-BASE/Y026$_c$ sets the base deflection value for X deflection table computations to the 12-bit command value. The quantity is telemetered in YXBASE/Y523. The value is scaled using the nominal 32 DAC increments/diode separation (see Section 1.5). Negative values are expressed in two's complement form (sign extension occurs for the YXBASE telemetry value).

4. Similarly, YY-BASE/Y027$_c$ sets the base deflection value for Y deflection table computations (see Section 3.1.1.4). This quantity is telemetered in YYBASE/Y527. The value is scaled using the nominal 256 DAC increments/diode height (see Section 1.5). Negative values are expressed in two's complement form (sign extension occurs for the YYBASE telemetry value).

5. YX-PITCH/Y028$_c$ uses the 12-bit command value to set the scaled X-deflection DAC value which when added to the current deflection will produce 50 microns (the diode separation) deflection in the X direction. It is telemetered in YXPITCH/Y522. The least significant bit of this quantity corresponds to [1/64] of a DAC increment. For example, a value of X'0600' (decimal 1536) means that [1536/64 =] 24 DAC increments are required to deflect the beam from one diode to the next. This quantity is used to scale the other X-axis control parameters so they can be provided assuming the nominal 32 DAC increments/diode separation (a YXPITCH value of X'0800').

6. Similarly, YY-PITCH/Y029$_c$ sets the value for the Y axis (telemetered in YYPITCH/Y526) necessary to produce 200 microns (the diode height) deflection in the Y direction. The least significant bit of this quantity corresponds to [1/8] of a DAC increment. For example, a value of X'0800' (decimal 2048)

means that [2048/8 =] 256 Y-axis increments are required to span the diode's height. This quantity is used to scale the other Y-axis control parameters so they can be provided assuming the nominal 256 DAC increments/height.

7. YHVDAC/Y030$_c$ sets the high voltage power supply DAC to the right-most 10 bits of the command value. After loading, the DAC is read and YHVDACER/Y561 set if an error is found. The readback is in YHVDACRB/Y520. The instrument gain is a weak function of the high voltage (which ranges 18-25 KV). The voltage value is expected to be changed only rarely (such as to compensate for component aging effects).

8. YFOCUS/Y033$_c$ sets the focus trim DAC to the command value. After loading, the DAC is read and YFDACERR/Y560 set if an error is found. The readback is in YFOCUSRB/Y519.

YXDAC/Y553 and YYDAC/Y521 can be used to monitor the deflection voltages during the observation. Since the DAC has 12 bits, only the bottom 12 bits of these words are set. Negative values are expressed in two's complement form, meaning that if the 12-bit value corresponds to decimal 2048 or more, the "true" value is obtained by subtracting 4096. See SLIB 1106 for values from a sample FOS tape.

3.1.4 Mechanism Commands

There are four FOS mechanisms that can be controlled by commands:

1 Entrance Port Mechanism,

2 Entrance Aperture Mechanism,

3 Polarizer Mechanism, and

4 Filter/Grating Wheel Mechanism.

Two FOS mechanisms cannot be moved at the same time. If a second mechanism is commanded before the first is done, the instrument ignores the second mechanism command (commands to other devices, however, may be issued 50 msec after sending the mechanism command). Hence it is necessary to allow sufficient time between the commands so they are all acted upon. In addition to commands dedicated to each of these mechanisms (see below), there are also commands that can be used with any of the mechanisms (selected by a command field with values of 1, 2, 3, and 5 respectively for the mechanisms listed above). These general mechanism commands include:

1. YMECHCAL/$Y022_c$ provides the value of a mechanical calibration index and another parameter as the new feedback code for the mechanism position specified by the index.

2. YMCHREG/$Y087_c$ loads the mechanism register with the specified data field (a four-bit field giving the motor phase drive signals for the four-phase motor, with 1 being on and 0 being off).

3. YMCHSTEP/$Y056_c$ steps the indicated mechanism in either the clockwise ("forward") or counter-clockwise direction by 2**n steps (n is 4 bits, and if a value of 15 is specified, the mechanism motion is stopped).

The YDMECH/$Y.005_c$ command (which filled the science data memory area starting at X'A000' with mechanism encoder values by moving the indicated mechanism forward or backward) has been deleted from the system because it locked out other serial magnitude commands. This command (whose effects could be provided via the YKEY command if necessary) was used to see if the mechanism is "sticking".

Each mechanism has a Mechanism Control Block that is included in the parameters with the UDL (see Section 3.2.2). The layout of each of these blocks is as follows:

1. Word 1 is the current relative step position. It is set to 0 when the FOS microprocessor is reset and incremented or decremented with each step from then. The value determines which phases of the stepper motor are active (it is an index into the mechanism motor phase table, modulo the number of table entries). Since the timing of its clearing with respect to the current motor phase is not unique, specific values are not necessarily repeated for a given physical position of the mechanism.

2. Word 2 is the address of a table in memory giving the stepper motor phase table (the phase sequence of the stepper motor). This table typically has four entries (and probably will be the same for all mechanisms). It could be changed if motor torque requirements, for example, made it necessary.

3. Word 3 has the number of times that the mechanism background task (see Section 1.5) should be entered, do a delay loop that nominally occupies a millisecond, and then hand over control to the next background task in the round-robin sequence. After completion of the required number of delays, the stepper motor phase is changed. For large values, one test showed that the real-time delay is about four times the value in this word. The in-flight times that elapse between any pair of motor steps is heavily dependent on the interrupt activity (for example, servicing a telemetry sync interrupt requires 2 msec).

4. Word 4 is the time-out count, generally set to four more (for the end point) than the total number of steps in a complete cycle. When this setting procedure is used, the values are 36 for the entrance port, 16004 for the aperture, 6724 for the polarizer, and 364 for the FGWA. The mechanism time-out code is telemetered in YMECHTOC/Y566 (reset when it is read, see Section 2.1.5). The three bits in YMECHTOC are set to 1 for the entrance port, 2 for the aperture, 3 for the polarizer, and 5 for the FGWA (this internal numbering system is reflected in a number of places in the FOS hardware). A value for the three bits of 0 means that there is no problem.

5. Word 5 is the dead band for the aperture and polarizer mechanisms (it must be set zero for the entrance port and FGWA). Each hexadecimal digit of this 16-bit quantity is treated separately, and represents the negative and positive allowed deviations for the high and low encoders respectively. For example, an aperture value of X'0112' would mean [-0, +1] for the high encoder and [-1, +2] for the low encoder (see Section 3.1.4.2).

6. Word 6 is the number of encoder map entries (starting with word 7). Values are 2 for the entrance port, 12 for the aperture, 48 for the polarizer, and 10 for the FGWA, meaning that their total control-block sizes are 8, 18, 54, and 16 respectively, for a grand total of 96 words (see Table 3.2-2).

7. Word 7 is the first encoder map entry (the total number of entries is specified in word 6).

8. Word 8 (and subsequent words if needed) complete the encoder map.

Information on each of the individual mechanisms is provided in the following sections.

3.1.4.1 Entrance Port Mechanism

An entrance port assembly is provided at the point where light enters the FOS from the OTA. The assembly allows light to enter through both or neither opening in the bulkhead. The circular entrance ports are 0.290 $\pm$ 0.010 inches in diameter. The close direction is "forward" (the sense of the command is "go backwards until open") for the general mechanism commands. The entrance port is capable of 20,000 cycles (open and close is one cycle) during a five-year on-orbit life. In the closed position, a mirror is introduced to direct light from the wavelength calibration system to the entrance apertures. As a fail-safe provision, a burn-wire pin puller opens the port.

Command YENTRNC/$Y034_c$ is used to set the entrance port open or closed (depending on the argument in the data field). The position is indicated in the telemetry by YDOOR/Y503, with values of 01_2 for open and 10_2 for closed. The 00_2 value means "between". Words 7 and 8 of the Entrance Port Mechanism Control Block have X'40' for open and X'80' for closed respectively, corresponding to the YDOOR/Y503 bits shifted left 6 places. For the fail-safe provision, command YARMED/$Y503_c$ is used to arm the pin puller, YSAFED/$Y507_c$ to safe it, and YBLENT/$Y563_c$ to blow the pin puller. The armed/safe status is telemetered (1 means safe) in YENTFRPI/Y124.

The entrance port has a 90° stepper motor with a 10:1 reduction (meaning that it takes 9°/step). A total movement of 288° is required to open or close the port, meaning [288/9 =] 32 motor steps. Contrary to the polarizer and aperture mechanisms (which use pin encoders that can give spurious readings if their mechanisms are run "too fast"), the entrance port can be run at its advertised speed, which is a nominal 6.4 seconds for opening or closing (32 steps at 200 msec/step). On a sample tape (see SLIB 1106), word 3 of the Entrance Port Mechanism Control Block was set to 47 (which corresponds to about 200 msec, see Section 1.5). A time allocation of 10 seconds is considered (see SLIB T30) a good nominal upper limit, and 30 seconds is probably an absolute maximum. The value quoted in SLIB 1219 is 15 seconds, while the cycle time quoted in SLIB L90 for the entrance port to close or open is 6.4 seconds.

3.1.4.2 Entrance Aperture Mechanism

Two arrays of primary apertures are located around a wheel such that in each selectable wheel position the same aperture configuration lies in both the "A" (red) and "B" (blue) paths. The light path is selected by pointing the ST. The apertures are grouped to minimize the distance between the most frequently used apertures. The mechanism is capable of 30,000 aperture repositioning operations (averaging 90° each) during the five-year on-orbit life. Each aperture consists of a single hole or a pair of holes, with each hole being either round, square, or rectangular. Table 3.1-3 lists the FOS apertures that are available. A burn-wire pin puller allows torsion springs to rotate the aperture wheel out of the light paths, and causes a pair of fail-safe apertures to be placed in the paths.

Command YAPER/$Y035_C$ is used to set the entrance aperture to the position (1-12) specified, and also indicates whether the direction is forward (defined as towards the bottom of the list in Table 3.1-3, such as from B-1 to B-2) or backward. The decimal command values for the individual aperture IDs to command them in the forward direction are given in the "Fwd Cmd" column of Table 3.1-3. For the fail-safe provision, command YARMAP/$Y501_C$ is used to arm the pin puller, YSAFAP/$Y505_C$ to safe it, and YBLAPR/$Y561_C$ to blow the pin puller. The armed/safe status is telemetered (1 means safe) in YAPRFRPI/Y123.

Table 3.1-3 FOS Apertures

IDT ID	SLIB L90	Fwd Cmd	Hex T/M	Hex Map	Description
B-1	0.5	1	4C E2	DD16	Single, round, 0.5 arc second. Used in spectroscopy and spectropolarimetry.
B-2	0.3	2	6D 63	E3E8	Single, round, 0.3 arc second. Used in spectroscopy and spectropolarimetry.
B-3	1.0	3	62 18	E9BA	Single, round, 1.0 arc second. Used in spectroscopy and spectropolarimetry.
B-4	BLANK	4	67 35	EF8C	Blank. Used as light shield (and for dark count measurement).
A-1	4.3	5	F6 0A	0EA6	Single, square, 4.3 arc second. Used in target acquisition.
A-2	0.5-PAIR	6	E1 B3	1477	Pair, square, 0.5 arc second, 3.0 arc second separation (distance between pair centers). Used with object and sky.
A-3	0.25-PAIR	7	E8 90	1A4A	Pair, square, 0.25 arc second, 3.0 arc second separation. Used with object and sky.
A-4	0.1-PAIR	8	CF E9	201B	Pair, square, 0.1 arc second, 3.0 arc second separation. Used with object and sky.
C-1	1.0-PAIR	9	DF D0	3F35	Pair, square, 1.0 arc second, 3.0 arc second separation. Used with object and sky.
C-2	0.25x 2.0	10	98 FB	4507	Single, rectangular, 0.25 x 2.0 arc second (in-dispersion and cross-dispersion respectively). Used with extended objects.
C-3	2.0-BAR	11	91 4A	4BD9	Single, square, 2.0 arc second, with 0.3 arc second wide occulter bar in cross-dispersion direction. Used with faint sources surrounding bright objects.
C-4	0.7x 2.0-BAR	12	86 01	51AB	Single, rectangular, 0.7 x 2.0 arc second (in-dispersion and cross-dispersion respectively), with 0.3 arc second wide occulter bar in cross-dispersion direction. Used with faint sources surrounding bright objects.
FS-1	--	--	----	---	Single (Fail-safe aperture), square, 0.5 arc second, 4.4 arc second separation from FS-2. Used with target acquisition and spectroscopy.
FS-2	--	--	----	---	Single (Fail-safe aperture), square, 4.3 arc second, 4.4 arc second separation from FS-1. Used with target acquisition and spectroscopy.

Two eight-bit pin contact encoders (giving a one's complement Gray code output) are used to monitor the position of the aperture wheel. These are telemetered in measurement YAPERHOE/Y656 for the high-order encoder and YAPERLOE/Y657 for the low-order encoder. The first of the four 16-bit measurements (encompassing both encoders) each major frame is $YAPERP01_S$/Y.106. The telemetered values corresponding to individual aperture IDs are given in the "Hex T/M" column of Table 3.1-3 (obtained from SLIB L55). If the fail-safe mechanism provision is activated, the encoders remain connected and hence could read the same value as they did when the mechanism was in the optical path.

Since non-zero dead bands are allowed for the aperture (word 5 of the Aperture Mechanism Control Block), the downlink values need to be converted to the "binary" form given in the control block's encoder map (the map values corresponding to the "Hex T/M" column are quoted in the "Hex Map" column of Table 3.1-3). This conversion involves taking the one's complement of the downlink value, and then converting each byte (since the encoders are independent) separately from Gray to binary. For example, aperture B-1 has a nominal downlinked value of X'4CE2'. The conversion to the encoder map value can be done as follows:

1. Take the one's complement of the telemetered value (replace ones with zeros and conversely, subtract from X'FFFF', or the equivalent), meaning that X'4CE2' becomes X'B31D'.

2. Convert the first two hexadecimal digits of the result from Gray to binary as shown below. The "Working" row is the "Result" row shifted right one place; the Result row is the sum (without carries) of the original value and the Working row (the exclusive OR, or equivalent):

   X'B3' = 1011 0011
   Working = 110 1110
   Result = 1101 1101 = X'DD'

3. Repeat the process for the other two digits of the result:

   X'1D' = 0001 1101
   Working = 000 1011
   Result = 0001 0110 = X'16'

4. The final result is X'DD16', the encoder map entry in Table 3.1-3 for aperture B-1.

Since the encoder pins drag, the encoder value can jitter (as well as exhibit a hysteresis-type effect). Consequently, a non-zero deadband for the low-encoder output (word 5 of the mechanism control block) is provided. A change of a motor step (which gives several encoder increments) corresponds to about 0.1 diode, so is not significant for most observations. In addition, the high encoder at each desired aperture position is not necessarily near the middle of its range, so it could change value "near" the point where the desired aperture is located. Position ambiguities that in principle could result from this situation, however, have not yet been observed.

To establish the Aperture Mechanism Control Block encoder map values, a test was run using the capabilities of the former YDMECH command (see Section 3.1.4) to examine the encoder behavior near the desired aperture positions. This test, for example, found for position B-4 a encoder output corresponding to a map value of X'F08C'. This location, however, was close to the high encoder's transition from X'EF'. Hence the map value for B-4 in Table 3.1-3 is X'EF8C', but the dead band in word 5 of the Aperture Mechanism Control Block (see SLIB 1106) is set to X'0112' (allowing -0 and +1 count deviation in the high encoder). The FOS microprocessor will therefore recognize X'F08C' as a "match" for the B-4 encoder position. All these values, of course, are <u>after</u> convert the raw encoder output that is on the downlink (take one's complement and convert each byte from Gray to binary).

The aperture drive takes 16000 steps for a complete revolution. The originally specified speed was 7.4 msec/step for the motor, and since apertures are less than 180° apart (8000 steps), this gives a figure of [7.4 * 8 =] 59.2 seconds (probably where the 70-second figure in SLIB 706 came from). If the motor is run at this speed, however, the encoder pin readings because of "pin bounce" would not give a valid result. A better figure, allowing adequate encoder readings, is 25 msec/step, giving about 200 seconds for 180° (probably where the five-minute figure in SLIB T23 came from). The pin bounce problem does not physically damage the hardware, so one FOS aperture positioning procedure could be to step the wheel rapidly by a specified number of steps (using a low value for the dwell time in control block word 3), and then increase the dwell time and command the aperture to a specific opening (the mode in which the FOS microprocessor uses the encoder outputs). According to SLIB L90, the cycle time is 5.73 seconds between adjacent apertures in the same group (IDT IDs in Table 3.1.3 of A, B, or C), 28.65 seconds between adjacent apertures on different groups (such as B-4 to A-1 or A-4 to C-1), and a maximum of 109 seconds (from B-1 to C-4).

As had been determined from a least-squares fit, each aperture position is displaced from its neighbor by 382 motor steps (since the full 180° has 21 slots, this is in good agreement with a theoretical value of [8000/21 =] 380.95 steps). At 25 msec/step, this separation could be covered in about 9.55 seconds. The physical layout of the aperture wheel, however, has (for example) apertures [B-1, B-2, B-3, and B-4] for side "A", followed by [B-1, B-2, B-3, and B-4] for side "B" before reach the [A-1, A-2, A-3, and A-4] for side "A". Hence if start with B-1 on side "A" and step the wheel by [4 * 382] steps, will get a illegal side "A" location. The time values quoted in SLIB 1219 are 15 seconds between successive (see Table 3.1-3) B, A, or C positions, 75 seconds to go between [B-4 and A-1] or [A-4 and C-1], and five minutes to go in the "forward direction" between [C-4 and B-1].

3.1.4.3 Polarizer Mechanism

The FOS has a polarizer assembly with two sets of polarizer elements designed for different but overlapping spectral ranges. Each set of polarizer elements consists of a rotatable waveplate followed by a dedicated Wollaston prism. Either set of polarizer elements can be placed in either the "A" (red) or "B" (blue) light path, and either or both light paths can also be left clear. Each waveplate is rotatable with respect to its Wollaston prism in increments of 22.5°. The fail-safe provision is a burn-wire pin puller allowing torsion springs to rotate the polarizer out of the light paths. The mechanism is capable of rotating through one 22.5° increment of the waveplate 10^5 times during the five-year on-orbit life. It is also capable of operating up to one-third of the time for up to eight hours.

Command YPLZR/$Y036_C$ is used to set the polarizer mechanism to the position (1-48) specified, moving either forward (direction of increasing position number) or backward. Each of the two polarizers have 16 positions, as does the "clear" position. The decimal command value is the same as the position number quoted in Table 3.1-4. Polarizer "A" is thicker than Polarizer "B", and "Polarizer C" means "clear" (on both sides). The drum (see Section 1.5) is driven by a 90° permanent magnet stepper motor. The polarizer has 6720 motor steps for a complete "revolution". In these 6720 steps, the outer unit moves 16 revolutions (so 420 steps are required to move the drum one revolution). During these 420 steps, the inner unit moves (relatively) by 22.5° (such as from polarizer position A03 to A04). The setting quoted in SLIB 1106 for the Polarizer Mechanism Control Block word 5 corresponds to a real time of about 30 msec/step, meaning that about 12.6 seconds would be used for this 22.5° movement. The Automatic Polarizer Sequence Instrument Mode can be used to move the polarizer to successive positions and take data in individual slices (see Section 2.1.6). The value quoted in SLIB 1219 is 20 seconds between successive positions. According to SLIB L90, the cycle time from the Clear to the associated (for a given angle) Plate A position is 3.9 seconds, from Plate A to Plate B is 2.4 seconds, and from Plate B to Clear is 2.1 seconds. The maximum time is 67.2 seconds (such as from ID A01 to ID A09).

Two eight-bit pin encoders provide a unique output for each position of the polarizer. One revolution of the drum rotates encoder A 5 times and encoder B 5.0625 times (in 16 cycles, A rotates 80 times and B 81 times). Encoder A is telemetered in YPLZRHOE/Y658, and is also (see SLIB L66) referred to as the "slow" or "relative positions" encoder. It changes by [(5 * 2^8)/420], or about 3.04762, bits per motor step. Encoder B is telemetered in YPLZRLOE/Y659, and is also referred to as the "fast" or "waveplate angle" encoder. It changes by [(5.0625 * 2^8)/420], or about 3.08571, bits per motor step. Both encoders increase with a CCW rotation of the drum (as viewed from inside the FOS in direction of the entrance ports). The first of the four 16-bit measurements of the pair of encoders each major frame is $YPLRZP01_S$/Y.107).

The Polarizer Mechanism Control Block default encoder map values (which can be updated during flight) corresponding to the individual positions are given in hexadecimal in Table 3.1-4. To convert the downlink information to the form given in Table 3.1-4, it is necessary to take the one's complement of

Table 3.1-4 FOS Polarizer Information

Pos	ID	Encoder Map For Side A (Hex)	Encoder Map For Side B (Hex)
01	C01	B7 C6	B7 C6
02	A01	77 82	65 6C
03	B01	09 0F	F7 FA
04	C02	B7 B6	B7 B6
05	A02	77 72	65 5C
06	B02	09 FF	F7 EA
07	C03	B7 A6	B7 A6
08	A03	77 62	65 4C
09	B03	09 EF	F7 DA
10	C04	B7 96	B7 96
11	A04	77 52	65 3C
12	B04	09 DF	F7 CA
13	C05	B7 86	B7 86
14	A05	77 42	65 2C
15	B05	09 CF	F7 BA
16	C06	B7 76	B7 76
17	A06	77 32	65 1C
18	B06	09 BF	F7 AA
19	C07	B7 66	B7 66
20	A07	77 22	65 0C
21	B07	09 AF	F7 9A
22	C08	B7 56	B7 56
23	A08	77 12	65 FC
24	B08	09 9F	F7 8A
25	C09	B7 46	B7 46
26	A09	77 02	65 EC
27	B09	09 8F	F7 7A
28	C10	B7 36	B7 36
29	A10	77 F2	65 DC
30	B10	09 7F	F7 6A
31	C11	B7 26	B7 26
32	A11	77 E2	65 CC
33	B11	09 6F	F7 5A
34	C12	B7 16	B7 16
35	A12	77 D2	65 BC
36	B12	09 5F	F7 4A
37	C13	B7 06	B7 06
38	A13	77 C2	65 AC
39	B13	09 4F	F7 3A
40	C14	B7 F6	B7 F6
41	A14	77 B2	65 9C
42	B14	09 3F	F7 2A
43	C15	B7 E6	B7 E6
44	A15	77 A2	65 8C
45	B15	09 2F	F7 1A
46	C16	B7 D6	B7 D6
47	A16	77 92	65 7C
48	B16	09 1F	F7 0A

the downlink information (in YPLZRHOE/Y658|YPLZRLOE/Y659) and then convert each byte separately from Gray to binary (the process is the same as required for the aperture position information, see Section 3.1.4.2). The Polarizer Mechanism Control Block deadband (see SLIB 1106) was set to X'1112' on a sample tape, meaning the high encoder (after conversion to binary) had a tolerance of ± 1 count and the low encoder a tolerance of [-1 +2] counts. If the fail-safe mechanism provision is activated, there is no distinctive encoder value that appears on the downlink (the encoders remain connected).

The FOS only has one set of polarizer encoders, but the readouts from them are different for the two sides. This is accommodated by having different Polarizer Mechanism Control Blocks for the red (side A) and blue (side B) ROMs in their respective CEAs. For example, if position 2 is commanded for side A and then the FOS is switched to side B, the X'77 82' encoder map value will indicate that the polarizer is at position 2 on side A, and side B may be blocked. The IDT has pointed out (see SLIB L64) that powering down the FOS while the polarizer is moving between standard positions will cause confusion as to what command should be sent next and thus should be avoided. In the last two columns of Table 3.1-4, the first two hexadecimal digits are for YPLZRHOE (encoder A) and the other two are for YPLZRLOE (encoder B).

For the fail-safe provision, command $YARMPL/Y511_C$ is used to arm the polarizer pin puller, $YSAFPL/Y515_C$ to safe it, and $YBLPOL/Y567_C$ to blow the pin puller. The armed/safe status is telemetered (1 means safe) in YPOLFRPI/Y130.

3.1.4.4 Filter/Grating Wheel Mechanism

The filter/grating wheel is a rotatable wheel providing the support structure for the filter and dispersion optics. It allows transmission of the light bundle through the appropriate filter or blank hole. After striking a collimating mirror, the light is reflected back to one of the dispersion elements or the camera mirror on the wheel, and then to one of the detectors. The wheel has ten equally spaced positions. Each position places a set of optical elements in each of the two light paths. The mechanism is capable of 54,000 repositionings of 90° each during the five-year on-orbit life. Accurate positioning is determined by a spring-loaded ball bearing cam detent.

The FGWA has a 90° stepper motor with a 90:1 reduction gear, so each step corresponds to 1°. With a step delay setting corresponding to 100 msec (see SLIB 1106), this means that the wheel can move 180° in about 18 seconds (there are no encoder pin-bounce problems). The value quoted in SLIB 1219 is 10 seconds between successive positions. According to SLIB L90, the cycle time between adjacent positions is 7.2 seconds, and the maximum time is 64.8 seconds (such as between CAM and H78). For maximum repeatability, the FGWA should be moved in only one direction. Current plans are to drive it into position with an additional motor step, reducing the standard deviation in positioning (see SLIB L88) to 3.2 microns. A redundant stepper motor operates the mechanism if the primary motor fails.

Table 3.1-5 FOS FGWA Elements

Number	Type	IDT ID	SLIB L90	Resolution	Filter	Wavelength (nm)	Side A Cmd	Side A Encod	Side B Cmd	Side B Encod
-001	Grating	H13	G130H	1200	---	110-164	9	A	4	B
-002	Grating	H19	G190H	1200	---	153-228	7	7	2	9
-003	Grating	H27	G270H	1200	FH27	221-329	6	E	1	C
-004	Grating	H40	G400H	1200	FH40	319-474	10	6	5	3
-005	Grating	H57	G570H	1200	FH57	459-683	8	5	3	D
-006	Grating	H78	G780H	1200	FH78	626-931	4	B	9	A
-003	Grating	L15	G160L	200	---	115-230	1	C	6	E
	Prism	PRI	PRISM	100	---	250-700	3	D	8	5
-004	Grating	L65	G650L	200	FL65	400-800	2	9	7	7
	Mirror	CAM	---	1	---	110-900	5	3	10	6

There are 6 high-resolution gratings, two low-resolution gratings, a prism, and a mirror mounted on the FGWA. Table 3.1-5 above gives their characteristics (the resolution is measured at the central wavelength), in the sequence given in SLIB 810. See SLIB L90 for calibration results. Five order blocking filters are used (the other five elements have a blank hole) to attenuate grating orders higher than the first to the greatest practical extent consistent with high transmittance of the desired first order (they are not used for the shortest wavelengths where the Digicon faceplates block higher-order light).

Command YFILTER/$Y037_c$ is used to specify the FGWA position desired (in the range 1-10). Due to the mechanical layout of the FGWA, the element in the blue (side B) path is displaced 5 positions from the one for the red (side A) path: for example, command (and position) "1" puts element L15 in the red path; command "6" puts it in the blue path. Command YCMTRA/$Y571_c$ is used to select motor "A" and command YCMTRB/$Y573_c$ to select motor "B". The selected motor is indicated by measurement YCMTRST/Y101 (a 0 means B and a 1 means A).

The position of the wheel is read by a LED/phototransistor array and a coded cylinder. The four bits of the FGWA position are in telemetry measurement YFGWAPOS/Y506 (the first of the four measurements each major frame is $YFGWAPO1_s$/Y.105), and is given (in hexadecimal) in the "Encod[er]" columns of Table 3.1-5.

3.1.5 Targeting Commands

The FOS microprocessor has a capability (see Section 2.1.4) to do on-board targeting, using commands YTARACQ/$Y004_c$ (which sets target acquisition parameters) and YTAMOD/$Y046_c$. Their roles, as well as other commands and the resulting downlink quantities, are summarized below:

1. YTARACQ/$Y004_c$, if N (in the command) is 2, provides the upper and lower target acquisition limits; if N is 1, only the lower window limit is provided. The 16-bit upper limit is telemetered in YTAMAX/Y650 and the lower limit in YTAMIN/Y651. Both are in units of counts for a single data word. These values define the thresholds for processing the results of the FOS scan.

2. YTAMOD/$Y046_c$ specifies the target acquisition mode, and is telemetered in YTAMODE/Y515. This parameter controls the nature of the FOS targeting computations that are carried out. Individual bits of this word have the following significance:

   a) Bit 1 (YYFILTER/Y.228) is 1 if should filter the data before finding the peak (this is required to use either edge of the diode array in the Y direction).

   b) Bit 2 (YYFIX/Y.229) is 1 if should fix the data: the firmware corrects for dead diodes and frames that were rejected because the burst-noise-rejection threshold was exceeded, as well as for partial sampling at the ends of the diode array. If this bit is set, OVRSCN (see Section 3.1.1.3) should be above 1. YYFIX should be set if the reject mode is specified in YAQMD/Y711 (see Section 2.1) or if a section of the diode array having faulty diodes is used. Setting this bit, however, significantly increases the processing time. If the bit is set, the fixing is done before filtering (if the latter is specified by the YYFILTER bit).

c) Bit 3 (YYINYFFL/Y.230) is set 1 to suppress the automatic filling of the filter convolution kernel table for the Y axis (allowing different values to be set by the uplink).

d) Bit 4 (YYINXFFL/Y.231) is set 1 to suppress the automatic filling of the filter convolution kernel table for the X axis (allowing different values to be set by the uplink).

e) Bit 5 (YYDBBUF/Y.232) is set 1 to cause the FOS memory to be partitioned with the filtered data (if specified by the YYFILTER bit) to written into the latter part (after the Reject Array). Otherwise, the filtered data is be written over the unfiltered data. Either filtered or unfiltered data can be read to the NSSC-1; the Reject Array, of course, would not be needed for subsequent processing if the filtered data is read.

f) Bit 6 (YYSPR/Y.233) is unassigned.

g) Bit 7 (YYPYE/Y.234) is set 1 to specify that the Y-direction edge-finding (if specified by the YYMYE bit) should use the upper edge of the diode array. If it is 0, the lower edge of the diode array is used (if specified by the YYMYE bit).

h) Bit 8 (YYMYE/Y.235) is set 1 to specify that the Y-direction filter convolution kernel (if the YYINYFFL bit is 0) should be filled with values appropriate for diode edge finding. If it is 0, no edge finding is selected (instead, centering in Y is performed).

3. The 16-bit measurement YTARXCTR/Y510 has the high-order 4 bits giving information about the star field encountered. Bit 1 is set 1 if the target acquisition process was valid. Bit 2 is set 1 to mean "crowded field", signifying that a second relative maximum (between YTAMAX and YTAMIN) was detected that was too far from the first (the computations are abandoned). Bit 3 is set 1 to mean "bright object(s)", signifying that at least one data word with a value above YTAMAX was found. Bit 4 is initialized to 1, meaning "faint field". It is reset 0 if a data word above YTAMIN is found.

If the target acquisition process was valid, the 12 low-order bits represent the value to which one would set YXBASE (see Section 3.1.3) to center the chosen image on the "center" diode (presently defaults to diode #256). This setting is computed based on the nominal 32 DAC increments/diode separation.

4. The 16-bit measurement YTARYCTR/Y511 has the high-order 4 bits equal to the number of computation results that are included in the average target center reported (with an upper limit of 15). If a second (or subsequent) relative maximum is found within a tolerance of the current estimate (as well as between YTAMIN and YTAMAX), this value is merged with the current estimate and the counter is incremented. If the value is outside the tolerance, bit 2 of YTARXCTR is set instead.

   If the target acquisition process was valid, the 12 low-order bits represent the value to which one would set YYBASE (see Section 3.1.3) to center the target image on the row of diodes in the Y direction. This setting is computed based on the nominal 256 DAC increments/diode height.

5. YTA/Y088$_c$, used to instruct the FOS microprocessor to begin target acquisition calculations. These calculations may be initiated either by setting the appropriate bit(s) in YTAMOD causing calculations to be performed on completion of each data acquisition slice, or by the YTA command on previously acquired data (this can be performed repetitively if desired, perhaps with adjustment of target acquisition parameters). The YTA command itself has no parameters.

6. YXFILW/Y040$_c$ and YYFILW/Y048$_c$ specify the filter width in the X and Y directions. The eight-bit values they provide are the number of active data elements in the filter convolution kernel in these directions. They are telemetered in YXFLWID/Y509 and YYFLWID/Y705 respectively. These quantities are used to control the filtering of the target-acquisition data array before looking for peaks. The objective of the Y filtering is to mark the edge of a diode with a feature that can be accurately centered.

Information is not put in the downlink registers until after the computations are complete. YTARXCTR and YTARYCTR are zeroed (see Section 2.1.5) after being put on the downlink. The YFMOD2 NSSC-1 processor (see Section 1.5) uses these words to determine if the results are of sufficient validity; if so, the spacecraft is moved to cause the required centering to take place.

3.1.6 Miscellaneous Commands

In addition to the commands discussed above, there are several other commands that are also significant for operation of the FOS. These include:

1 Observation Initialization Commands,

2 Channel Control Commands,

3 FOS Microprocessor Memory Commands,

4 Light Source Commands, and

5 Internal FOS Microprocessor Commands.

These commands are described in the following sections.

3.1.6.1 Observation Initialization Commands

The observation initialization commands would be expected to be sent (if necessary) before the actual observation is begun. These commands are:

1. YSYNC/Y023$_c$ is used to specify the time when the observation should start if YYSYNCS/Y.205 (see Section 2.1.1) is set. A 16-bit parameter specifies the fine delay (in units of 7.8125 usec), and another parameter gives the starting minor frame (in range 0-119). Note that this start time is not included on the downlink. In addition, the FOS use of the Take Data Mode flag in the SSM PIT has (according to SLIB T39) not yet been determined, but may impact this time. The YPAUSE/Y085$_c$ command (see Section 3.1.2.3) can be used to suspend and subsequently resume an observation, so an NSSC-1 processor might look at the PIT flag and generate the proper FOS commands if desired.

2. YINIT/Y041$_c$ is used to specify the initialization to be performed by the Start Data Acquisition command (YBEGAC/Y559$_c$). Only the first five bits are assigned, and the quantity is telemetered in YINTMODE/Y547 (see Section 2.1.1 for a description of the bits).

3. YACQMODE/Y049$_c$ is used to select the data acquisition mode. Only the first six bits are assigned, and the quantity is telemetered in YAQMD/Y711 (see Section 2.1 for a description of the bits).

4. YDDCHK/Y083$_c$ is used to read, rewrite, and check all the discriminator DACs and store the result in the YYDDTBL$_s$ array at X'9AF8'. This array is included in the FOS-Unique Data Log (see Section 3.2.2). This command can take up to 2 seconds to perform, and any commands received in that interval will be ignored. The FOS microprocessor first checks for an error in

readback, using all eight bits. If any difference exists, bit YDDACERR/Y563 is set (it is reset when sampled for telemetry). In addition, the most significant seven bits of the readback value are set in bits 2-8 of the array (otherwise, those bits are set 0).

5. YEFILL/Y084$_c$ is used to sample all the serial digital telemetry (SI word 8) quantities and place their values in the engineering subcom table. This table is included in the FOS-Unique Data Log (see Section 3.2.2).

3.1.6.2 Channel Control Commands

There are four commands that can be used to control the performance of the individual channels. They are:

1. YDISCADR/Y006$_c$, used either to load the discriminator address (for a later command) or to set all discriminator values to the low 8 bits of the command. As discussed in Section 1.5, the discriminator is used to establish the threshold below which the diode output is suppressed.

2. YCHNLEN/Y012$_c$, used to enable a channel, inhibit a channel, or inhibit/enable all channels.

3. YDISC/Y031$_c$, used to load the discriminator DAC table (at the address initialized by YDISCADR/Y006$_c$) with the data field. After loading the table, the discriminator address is incremented by one.

4. YREFDAC/Y032$_c$, used to load the common discriminator reference DAC with the data field. After loading, the DAC is read back and YDRDACER/Y562 set 1 if an error is found.

3.1.6.3 FOS Microprocessor Memory Commands

There are five commands that can be used to set cells of the FOS microprocessor memory. They are:

1. YRAMADDR/Y000$_c$, used to specify a 16-bit RAM storage address. The address is telemetered in YRAMADDR/Y545. The initialization value for this word is X'A000'.

2. YSTRWRD/Y018$_c$, used to specify that the following N (in the command) words should be stored as data. The starting address specified by YRAMADDR/Y545 is incremented by 2 after each word.

3. YMEMCHK/Y055$_c$, used to fill memory (beginning at the start of the science data area) with a specified test pattern.

4. YSDERASE/$Y057_c$, used to set all memory locations from X'A000' to X'FFFE' to zero.

5. YRANDOM/$Y086_c$, used to fill the science data memory array (starting at X'A000') with a pseudo-random sequence (whose parameters are specified as part of the command).

3.1.6.4 Light Source Commands

There are two internal light sources associated with the FOS: a calibration source and a LED flat-field source. They are controlled as described below:

1. Command YCALON/$Y575_c$ is used to turn on the spectral calibration lamp and YCALOF/$Y577_c$ to turn it off. Its status is in telemetry measurement YCALRPI/Y102 (0 means on and 1 means off). Calibration lamp "A" is selected by YCALSA/$Y583_c$ and "B" by YCALSB/$Y585_c$. The lamp selection is telemetered in YCALSELR/Y133 (a 0 is B and a 1 is A).

2. Command YFFCAL/$Y038_c$ is used to set the LED flat-field lamp on or off (there is only one LED per Digicon). Telemetry measurement YFFCPWR/Y580 is 1 if the lamp power is on.

Measurement YCDACERR/Y578 has an identification in SLIB 1340 of "Calibration DAC readback error." The notation "DAC" is somewhat of a misnomer for this bit, but arises due to the design of the FOS microprocessor interfaces. A common set of code is used to load the "real" DACs, as well as the three-bit register associated with this bit. That register has the two power control bits for the descrambling PROMs, as well as the bit used to control the calibration flat-field lamp. Any time the bit controlling the flat-field lamp is updated, the two bits for the PROMs are reasserted; if a readback of the resulting three bits disagrees with what was specified, then bit YCDACERR/Y578 is set.

3.1.6.5 Internal FOS Microprocessor Commands

The commands given in this section are associated with the operation of the FOS microprocessor. They are:

1. YSCIADDR/$Y059_c$ is used to specify the first RAM address for science data processing. Except for failure or reprogramming situations, this address is expected to be X'A000'. Changes to this quantity (note that it is not on the downlink) should be carefully coordinated with the ground processing that must be accomplished.

2. YRAM-MAP/Y052$_c$ maps the physical RAM page specified in the command to the address range specified by the logical page. Each page has a capacity of 2K 16-bit words. The map information is in YYRAMMAP/Y.402 of the FOS-Unique Data Log.

3. YKPALVED/Y058$_c$ enables/disables autonomous going safe. It controls the value of YYSAFED/Y.204. If YYSAFED is 1, then if YYSAFLKA/Y.202 or YYSAFTSL/Y.203 are found set then a "safe" transition is initiated. YYSAFLKA is set by the housekeeping background task (see Section 1.5) if lose the keep-alive Serial Magnitude Command. This bit (in common with YYSAFTSL that is set if lose telemetry sync) may indicate valid auto safing conditions even if auto safe mode transitions are disabled (YYSAFED/Y.204 is zero).

4. YKEY/Y071$_c$ is normally used to provide a FORTH KEY capability (see the operator background task description in Section 1.5). If its data field is an ASCII "ACK" (X'06'), however, the operator task clears a keep-alive counter that is incremented each major frame by the housekeeping background task. The NSSC-1 normally sends YKEY with a data field of X'06' once a minute; if the counter gets above a threshold (typically 2), then YYSAFLKA/Y.202 is set. The NSSC-1 transmission of this YKEY pattern can be inhibited to avoid interference with other outputs from the NSSC-1 to the FOS.

5. YRESET/Y545$_c$ causes a computer reset to take place. If a reset is commanded, telemetry bit YRESETMP/Y570 is set 1 (the bit is zeroed when it is read out as part of minor frame 118).

6. YRIEBW/Y549$_c$ causes the Instruction Engineering Bit (set when the microprocessor attempts to fetch an instruction from a non-resident RAM memory space) to be reset to 0. The watchdog timer error bit is also reset. These bits are telemetered in YINSENG/Y104 and YWTCHDOG/Y103 respectively.

7. Y3MHZ/Y551$_c$ is used to select the 3.0 MHz clock rate (the normal operation mode) for the microprocessor. If this rate is selected, telemetry bit YCLKMON/Y134 is 0.

8. Y1.5MZ/Y553$_c$ is used to select the 1.5 MHz clock rate (the "slow mode") for the microprocessor. If this rate is selected, telemetry bit YCLKMON/Y134 is 1.

3.1.7 Major FOS Flags and Indicators

Table 3.1-6 summarizes the major FOS flags and indicators used in the FOS equations of SLIB 799 (see Sections 5-7), together with their telemetry notations. The "Equation" column gives the notation in SLIB 799 (or SLIB 598) for the quantity; the "Byte" column indicates (as in SLIB 799) the byte

Table 3.1-6 Major FOS Flags and Indicators

Equation	TM No	Byte	Mnemonic	Role
Detector	Y.201	1	$YYPATH_s$	Bit is 0 for red and 1 for blue.
NDISP	Y.105	8	$YFGWAP01_s$	FGWA encoder position (first of 4 values of YFGWAPOS/Y506).
Aperture	Y.106	9-10	$YAPERP01_s$	Aperture position (first of 4 values of YAPERHOE/Y656|YAPERLOE/Y657). Down-linked value in one's complement Gray code.
Waveplate	Y.107	11-12	$YPLRZP01_s$	Polarizer position (first of 4 values of YPLZRHOE/Y658|YPLZRLOE/Y659). Down-linked value in one's complement Gray code.
X-base	Y523	48-49	YXBASE	X base.
NXSTEPS	Y524	50	YXSTEPS	X step.
NYSTEPS	Y528	57	YYSTEPS	Y step.
NSLICES	Y576	59	YMSLICES	Number of memory slices.
NSCAN	Y530	60	YOVRSCAN	Overscan.
1STCHNL	Y531	61	Y1STCHNL	First channel to be processed. Multiply telemetry value by 2 to obtain true number.
NCHNLS	Y532	62	YNUMCHNL	Number of channels to be processed. Multiply telemetry value by 2 to obtain true number (if value is 0, use 512).
LIVETIME	Y.108	63-64	$YLIVE_s$	Accumulator open time (units of 7.8125 usec in two's complement). Same as YLIVEHI/Y585 & YLIVELO/Y586
DEADTIME	Y.109	65-66	$YDEAD_s$	Accumulator close time (units of 7.8125 usec in two's complement). Same as YDEADHI/Y587 & YDEADLO/Y588
ACQ MODE	Y711	67	YAQMD	Acquisition mode.
INTS	Y546	110	YINTEG	Number of integrations/X-step.
NPAT	Y577	111	YPTRNS	Number of patterns per readout.
NREAD	Y.406	122-123	$YYNREAD_s$	Readout number.

number in the "header data list" (origin of 0 at the start of the engineering telemetry material, 16-bit word 902 of the FOS-Unique Data Log in Section 3.2.2).

3.2 FOS SCIENCE TELEMETRY MODE-INDEPENDENT INFORMATION

For FOS, the science telemetry information is basically the same regardless of the Instrument Mode (the arrangement of information in the FOS microprocessor RAM memory causes the detailed layout of the Science Data Array to vary, but this is only an indirect consequence of the Science Data mode and Instrument Mode). As discussed in Section 3.1, the set of data comprising a normal FOS science observation (as distinguished from target acquisition data) consists of:

1. One or more NSSC-1 Standard Header Packets;
2. One or more FOS-Unique Data Logs; and
3. One or more frames of science information, each of which can consist of a Science Header, a Science Data Array, and a Reject Array.

These topics are covered in Sections 3.2.1-3.2.3. The science telemetry protocol that requires division of the science information into "Packets", each of which in turn is divided into "Segments", is covered in Section 3.2.4. All words in this discussion are 16 bits long (bits numbered from 1, the most significant, to 16), and are positive numbers.

3.2.1 FOS-Related Quantities in Standard Header Packet

By ST convention, the NSSC-1 computer generally sends a Standard Header Packet (SHP) to mark the beginning of an observation. For FOS, the NSSC-1 targeting processors (YFMOD2 and YFSDPR, see Section 1.5) also initiate SHP transmissions in order to make available to the ground the FOS-Unique data in the SHP (see Table 3.2-1). In addition, the FOS Housekeeping Processor (YFHKPG) can request the output of an SHP at ground-specified intervals during continuous FOS science data acquisition. NSSC-1 memory cell YMFSHP, with a least increment of 1 minute, is used to control this periodic output. The 965 data words (see Section 3.2.4 for the ancillary data that consumes another 59 words) in this SHP have the following divisions:

Words	Assignment
1	SOURCEID$_S$/Y.901, SI ID in SHP. It is in bits 1-8 of the first SHP word, and gives the SI identification (for FOS, a value of X'DC').

Words	Assignment
1.5	DCFOBSN$_s$/Y.902, Observation number in SHP. It is in bits 9-16 of the first SHP word, and gives the observation number. This number is the same as in the science data's ancillary word 11 (this ancillary word is zero for the SHP). It is incremented with each observation that is taken, and is one of the parameters that must be specified when configuring the CU/SDF for data readout. There is no need for this number to be in any way related to the data in words 800-803 of the SHP.
2-130	Assigned to other functions.
131-259	FOS Current Value Table (total of 129 words).
260-799	Assigned to other functions.
800	FOSPRGØ1$_s$/Y.903, First ASCII character of forward-linked FOS Program Number (per SLIB L74). This character is in bits 1-8 of SHP word 800. If the Program Number is ABC, then this byte would be X'41'.
800.5	FOSPRGØ2$_s$/Y.904, Second ASCII character of forward-linked FOS Program Number (per SLIB L74). This character is in bits 9-16 of SHP word 800. If the Program Number is ABC, then this byte would be X'42'.
801	FOSPRGØ3$_s$/Y.905, Third ASCII character of forward-linked FOS Program Number (per SLIB L74). This character is in bits 1-8 of SHP word 801. If the Program Number is ABC, then this byte would be X'43'.
801.5	YYSPR/Y.906, Spare in SHP. This quantity is in bits 9-16 of SHP word 801, and has a value of X'00' per SLIB L74.
802	FOSOBSØ1$_s$/Y.907, First ASCII character of forward-linked FOS Observation Set Number (per SLIB L74). This character is in bits 1-8 of SHP word 802. If the Observation Set Number is DE, then this byte would be X'44'.
802.5	FOSOBSØ2$_s$/Y.908, Second ASCII character of forward-linked FOS Observation Set Number (per SLIB L74). This character is in bits 9-16 of SHP word 802. If the Observation Set Number is DE, then this byte would be X'45'.
803	FOSOBNØ1$_s$/Y.909, First ASCII character of forward-linked FOS Observation Number (per SLIB L74). This character is in bits 1-8 of SHP word 803. If the Observation Number is FG, then this byte would be X'46'.

Words	Assignment
803.5	FOSOBNØ2$_s$/Y.910, Second ASCII character of forward-linked FOS Observation Number (per SLIB L74). This character is in bits 9-16 of SHP word 803. If the Observation Number is FG, then this byte would be X'47'.
804-820	Assigned to other functions.
821-822	UTC02$_s$/Y.911, First four bytes of UTCO, the reference UTC (in VAX 64-bit time format) at which the spacecraft clock count was SPCLINCN$_s$/Y.913. All 8 bytes are referred to as UTCO$_s$/Y.917.
823-824	UTC01$_s$/Y.912, Last four bytes of UTCO, the reference UTC (in VAX 64-bit time format) at which the spacecraft clock count was SPCLINCN$_s$/Y.913. All 8 bytes are referred to as UTCO$_s$/Y.917.
825-826	SPCLINCN$_s$/Y.913, Spacecraft clock at UTCO (in 32-bit SSM vehicle time code). This quantity is T_0 in SLIB L74. SHP word 825 corresponds to word 8 of the packet ancillary data (see Section 3.2.4) and SHP word 826 corresponds to word 9 of the packet ancillary data. Hence bit 16 of SHP word 826 (the least increment of the 32-bit quantity) has a nominal significance of 125.000 msec.
827-830	CLKRATE$_s$/Y.914, Clock rate in seconds/count (in R*8 VAX format). This quantity is R_0 in SLIB L74, and has a nominal decimal value of 0.125000.
831-834	CLKDRFTR$_s$/Y.915, Clock drift rate in seconds/count^2 (in R*8 VAX format). This quantity is D_0 in SLIB L74.
835-877	Assigned to other functions.
878-899	FOS Unique Data (total of 22 words).
900-965	Assigned to other functions.

The information in the FOS Current Value Table reflects the last-sampled versions of some Engineering Telemetry (see Section 4) values. For FOS data processing purposes, all the necessary data is available elsewhere, such as in the FOS-Unique Data Log. For FOS, only words 131-174 of the Current Value Table are occupied (words 175-259 are spares that are set 0). These words are used for the FOS analog and bilevel telemetry (see Tables 4.2-1 and 4.2-2). Since the 8-bit words are telemetered right-justified, their SHP location is shown as being in words "131.5" through "174.5" (the extra 0.5 flags that the eight-bit data appears in bits 9-16 of the word).

Using T for the current clock time (in words 8-9 of the packet ancillary data, see Section 3.2.4) and UTC for the corrected Universal Time, the quantities in SHP words 821-834 are used in the following equation:

$$UTC = UTCO + R_0 * (T - T_0) + 0.5 * D_0 * (T - T_0)^2$$

The 64-bit VAX time format for UTCO (and, therefore, UTC) is a binary number in 100-nanoseconds units measured from the base time of 00:00 o'clock, November 17, 1858 (the Smithsonian base date and time for the astronomical calendar).

The 22 words assigned to the FOS-Unique data in the SHP are described in Table 3.2-1. These words should not be confused with the FOS-Unique Data Log described in Section 3.2.2. The 22 words can have five possible sets of information, as defined by YYSHUID/Y.001 (which is always in the first word of the 22). Depending on YYSHUID, the total number of words used ranges from 14 to 21, with the unused words retaining??? previous values (rather than being zeroed or otherwise filled). The information in Table 3.2-1 reflects NSSC-1 Version 3.7 information obtained from SLIB L97, augmented by data in SLIB 1351.

The significance of the values of YYSHUID are:

1. A value of 2 means data is from the NSSC-1 YFMOD2 FOS Mode II Target Acquisition Processor (#28).

2. A value of 3 means data is from the NSSC-1 YFSDPR FOS Science Data Processor (#32), binary search case 1 processing (the first part of NSSC-1 controlled, Mode II target acquisition).

3. A value of 4 means data is from the NSSC-1 YFSDPR FOS Science Data Processor (#32), binary search case 2 processing (the last part of NSSC-1 controlled, Mode II target acquisition).

4. A value of 5 means data is from the NSSC-1 YFSDPR FOS Science Data Processor (#32), peakup mode.

5. A value of 6 means that data is from the NSSC-1 YFSDPR FOS Science Data Processor (#32), setup command block (YS32TA). According to SLIB L88, these parameters are uplinked twice, once as commands and again for the SHP.

An YYSHUID value of 1, previously assigned to the NSSC-1 YFHKPG FOS Housekeeping Processor (#30), no longer is used. The assignment of word 899 for use by the Take-Data-Flag RTCS (mentioned in SLIB L95) is not included in Table 3.2-1 because it was missing from SLIB L97.

Table 3.2-1 FOS-Unique Data in SHP

SHP Wd	Meas ID	Contents
		YYSHUID = 2
878	Y.001	YYSHUID, Identifier for FOS-Unique SHP data. See text.
879	Y624	YTACMP, Mode 2 target acquisition completion indicator. A 0 means no target acquisition has occurred since NSSC-1 initialization; a 1 means target acquisition complete; a 2 is set by initialization of NSSC-1 processors YFMOD2 and YFSDPR.
880	Y622	YGIVUP, Mode 2 target acquisition error indicator. A 0 is set by initialization of NSSC-1 processors 28 and 32; 1 means field too crowded; 2 means YFM2CF had invalid value in YFM2PR; 3 means YSDPRC had invalid value in YFSDPR; 4 means YFSDFL had invalid value in YFBSPR; 5 means field too crowded (too many peaks were detected by YFPKFD for YFMSSV to handle); 6 means science data failed validity test in YFDVCK; 7 means YEDGE had invalid value in YFBSC2; 8 means binary search exhausted without success; 9 means raster scan exhausted; 10 means target not identified and neither the pre-planned branch nor raster scan were available; 11 means arithmetic overflow of YISUM occurred in YFBSC2.
881	Y620	YFM2FL, Action indicator for YFM2PR module. Has a record of the action to be taken by YFM2PR to acquire the next frame of science data to be analyzed. A 1 is used during aperture scan, meaning to increment the Y-BASE data field by a pre-defined value; a 2 means to increment Y-BASE by a geometrically decreasing step; a 3 means decrement Y-BASE by a geometrically decreasing step; a 4 means lower the minimum window count; a 5 means raise the maximum window count; a 6 means get the initial value of YTAMIN from FOS ED; a 7 means get the initial value of YTAMAX from FOS ED.
882	Y.007	YYNMINOR, Minor frame number. Minor frame number obtained from the system software. The SLIB L97 notation is NMINOR.
883	Y.010	YYFVCTR1 HI, First element for coordinate transformation HI. The two high-order bits (right-justified) of the first element of the two-element vector used for coordinate transformation by the system software. SLIB L97 notation is YFVCTR(1).
884	Y.010	YYFVCTR1 LO, First element for coordinate transformation LO. The 16 low-order bits of the first element of the two-element vector used for coordinate transformation by the system software. SLIB L97 notation is YFVCTR(1).

Table 3.2-1 FOS-Unique Data in SHP (cont)

SHP Wd	Meas ID	Contents
885	Y.011	YYFVTCR2 HI, Second element for coordinate transformation HI. The two high-order bits (right-justified) of the second element of the two-element vector used for coordinate transformation by the system software. SLIB L97 notation is YFVCTR(2).
886	Y.011	YYFVTCR2 LO, Second element for coordinate transformation LO. The 16 low-order bits of the second element of the two-element vector used for coordinate transformation by the system software. SLIB L97 notation is YFVCTR(2).
887	Y.033	YPPB, Flag for pre-planned branch availability. A value of 1 means pre-planned branch is available; a value of 2 means pre-planned branch is not available.
888	Y708	YPPINV, Preplanned branch request status. A 1 means active processor requesting pre-planned branch (ground action is required); 2 means not requested; 0 otherwise.
889	Y709	YRSINV, Raster scan request status. A 1 means scan in progress; 2 not been started; above 2 not permitted.
890	Y.034	YRSMVS, Maximum moves during a raster scan.
891	Y636	YSCNUM, Count steps in raster scan.
892	Y.035	YTALIM, Number (+ 1) of window limit changes allowed by YFMOD2.
893	Y637	YTACNT, Count window limit changes for Processor 28.
894	Y.036	YYNEDM4, Most recent high-order word of FOS engineering telemetry word YTARXCTR. The most significant 4 bits of this number are target acquisition status bits (see Section 3.1.5). SLIB L97 notation is NEDM4.
895	Y.037	YYNEDM2, Most recent high-order word of FOS engineering telemetry word YTARYCTR. The most significant 4 bits of this number indicate presence/absence of something within the counts window (see Section 3.1.5). SLIB L97 notation is NEDM2.
896	Y625	YFM2ST, Mode 2 target acquisition processor status. A 1 means processor 28 is executing normally; 2 means terminated on an error; 4 means successful completion; 0 otherwise.

Table 3.2-1 FOS-Unique Data in SHP (cont)

SHP Wd	Meas ID	Contents
897	Y.038	YYTAMOD, Sampled value of FOS engineering telemetry word YTAMODE. The word has target acquisition processing parameters for the FOS firmware (see Section 3.1.5), some of which are used by YFMOD2 to control branching. SLIB L97 notation is YTAMOD ($Y046_c$).
898	Y.032	YTAINV, Maneuver direction inversion flag. When 1, used to invert the offset vector when acquisition is performed; a 0 means do not invert. The NSSC-1 default is 0.
		YYSHUID = 3
878	Y.001	YYSHUID, Identifier for FOS-Unique SHP data. See text.
879	Y622	YGIVUP, Mode 2 target acquisition error indicator. A 0 is set by initialization of NSSC-1 processors 28 and 32; 1 means field too crowded; 2 means YFM2CF had invalid value in YFM2PR; 3 means YSDPRC had invalid value in YFSDPR; 4 means YFSDFL had invalid value in YFBSPR; 5 means field too crowded (too many peaks were detected by YFPKFD for YFMSSV to handle); 6 means science data failed validity test in YFDVCK; 7 means YEDGE had invalid value in YFBSC2; 8 means binary search exhausted without success; 9 means raster scan exhausted; 10 means target not identified and neither the pre-planned branch nor raster scan were available; 11 means arithmetic overflow of YISUM occurred in YFBSC2.
880	Y621	YFRCTR, Count frames for part 1 of YFSDPR processor. It is the frame counter for science data acquired during aperture mapping, with value (range 0-3) corresponding to the science data frame that was just analyzed.
881	Y.039	YFOUND, Total number of peaks found in the aperture map.
882	Y.013	YYCHPK1, First channel where peak found. Channel number where qualifying peak found. Maximum is four, can be less. Array not zeroed out. SLIB L97 notation M(1,YFRCTR).
883	Y.014	YYCHPK2, Second channel where peak found. Channel number where qualifying peak found. Maximum is four, can be less. Array not zeroed out. SLIB L97 notation M(2,YFRCTR).
884	Y.015	YYCHPK3, Third channel where peak found. Channel number where qualifying peak found. Maximum is four, can be less. Array not zeroed out. SLIB L97 notation M(3,YFRCTR).
885	Y.016	YYCHPK4, Fourth channel where peak found. Channel number where qualifying peak found. Maximum is four, can be less. Array not zeroed out. SLIB L97 notation M(4,YFRCTR).

Table 3.2-1 FOS-Unique Data in SHP (cont)

SHP Wd	Meas ID	Contents
886	Y.033	YPPB, Flag for pre-planned branch availability. A value of 1 means pre-planned branch is available; a value of 2 means pre-planned branch is not available.
887	Y708	YPPINV, Preplanned branch request status. A 1 means active processor requesting pre-planned branch (ground action is required); 2 means not requested; 0 otherwise.
888	Y709	YRSINV, Raster scan request status. A 1 means scan in progress; 2 not been started; above 2 not permitted.
889	Y.034	YRSMVS, Maximum moves during a raster scan.
890	Y636	YSCNUM, Count steps in raster scan.
891	Y.019	YBASKP, Y-BASE for current data. Y-BASE used by FOS to acquire current data. Has a range of ± 256 about a (nominal) zero value, and is 11 bits plus sign (right-justified with sign extended).
892	Y.020	YNBCTR, Brightness rank. The peak chosen for the binary search is the YNBCTRth brightest peak in the field.
893	Y.021	YOBSJ, Peak matrix number. The index (in the singly dimensioned equivalent of the 4x3 part of map) of the peak selected for the binary search (range 1-12).
894	Y.022	YBSM, Channel number of peak. Gives channel number for the diodes sampled (≠ diode number) of peak chosen for binary search.
895	Y.023	YNMAX, Number of counts in peak (scaled program value). The total counts above the mean sky background in the peak selected for the binary search.
896	Y.024	YNMEAN, Computed mean sky background (scaled program value).
897	Y.025	YVARI1, Sky variance (scaled program value). Computed sky variance (standard deviation of the mean sky background).
898	Y620	YFM2FL, Action indicator for YFM2PR module. Has a record of the action to be taken by YFM2PR to acquire the next frame of science data to be analyzed. A 1 is used during aperture scan, meaning to increment the Y-BASE data field by a pre-defined value; a 2 means to increment Y-BASE by a geometrically decreasing step; a 3 means decrement Y-BASE by a geometrically decreasing step; a 4 means lower the minimum window count; a 5 means raise the maximum window count; a 6 means get the initial value of YTAMIN from FOS ED; a 7 means get the initial value of YTAMAX from FOS ED.

Table 3.2-1 FOS-Unique Data in SHP (cont)

SHP Wd	Meas ID	Contents
		YSHUID = 4
878	Y.001	YYSHUID, Identifier for FOS-Unique SHP data. See text.
879	Y624	YTACMP, Mode 2 target acquisition completion indicator. A 0 means no target acquisition has occurred since NSSC-1 initialization; a 1 means target acquisition complete; a 2 is set by initialization of NSSC-1 processors YFMOD2 and YFSDPR.
880	Y622	YGIVUP, Mode 2 target acquisition error indicator. A 0 is set by initialization of NSSC-1 processors 28 and 32; 1 means field too crowded; 2 means YFM2CF had invalid value in YFM2PR; 3 means YSDPRC had invalid value in YFSDPR; 4 means YFSDFL had invalid value in YFBSPR; 5 means field too crowded (too many peaks were detected by YFPKFD for YFMSSV to handle); 6 means science data failed validity test in YFDVCK; 7 means YEDGE had invalid value in YFBSC2; 8 means binary search exhausted without success; 9 means raster scan exhausted; 10 means target not identified and neither the pre-planned branch nor raster scan were available; 11 means arithmetic overflow of YISUM occurred in YFBSC2.
881	Y623	YGPCTR, Count frames for part 2 of YFSDPR processor. The frame counter (range 0-9) for science data acquired during binary search. The value corresponds to the science data frame that has just been analyzed (the value of 9 appears only when [YGIVUP = 8]).
882	Y.012	YPKCT1, Objects found in field. Number of peaks found in the latest frame of science data.
883	Y.013	YYCHPK1, First channel where peak found. Channel number where qualifying peak found. Maximum is four, can be less. Array not zeroed out. SLIB L97 notation M1(1).
884	Y.014	YYCHPK2, Second channel where peak found. Channel number where qualifying peak found. Maximum is four, can be less. Array not zeroed out. SLIB L97 notation M1(2).
885	Y.015	YYCHPK3, Third channel where peak found. Channel number where qualifying peak found. Maximum is four, can be less. Array not zeroed out. SLIB L97 notation M1(3).
886	Y.016	YYCHPK4, Fourth channel where peak found. Channel number where qualifying peak found. Maximum is four, can be less. Array not zeroed out. SLIB L97 notation M1(4).

Table 3.2-1 FOS-Unique Data in SHP (cont)

SHP Wd	Meas ID	Contents
887	Y.019	YBASKP, Y-BASE for current data. Y-BASE used by FOS to acquire current data. Has a range of ± 256 about a (nominal) zero value, and is 11 bits plus sign (right-justified with sign extended).
888	Y620	YFM2FL, Action indicator for YFM2PR module. Has a record of the action to be taken by YFM2PR to acquire the next frame of science data to be analyzed. A 1 is used during aperture scan, meaning to increment the Y-BASE data field by a pre-defined value; a 2 means to increment Y-BASE by a geometrically decreasing step; a 3 means decrement Y-BASE by a geometrically decreasing step; a 4 means lower the minimum window count; a 5 means raise the maximum window count; a 6 means get the initial value of YTAMIN from FOS ED; a 7 means get the initial value of YTAMAX from FOS ED.
889	Y.027	YEDGE, Result of edge test. A value of 1 means target is on edge of diode array (the binary search is finished); a value of 2 means target is still on (or back on) the diode array; and a value of 3 means target off diode array.
890	Y.028	YNTARG, Counts in target channels (scaled program value). Gives number of counts above the mean sky for the target peak in the current frame of science data.
891	Y.024	YNMEAN, Computed mean sky background (scaled program value).
892	Y.025	YVARI1, Sky variance (scaled program value). Computed sky variance (standard deviation of the mean sky background).
893	Y.010	YYFVCTR1 HI, First element for coordinate transformation HI. The two high-order bits (right-justified) of the first element of the two-element vector used for coordinate transformation by the system software. SLIB L97 notation is YFVCTR(1).
894	Y.010	YYFVCTR1 LO, First element for coordinate transformation LO. The 16 low-order bits of the first element of the two-element vector used for coordinate transformation by the system software. SLIB L97 notation is YFVCTR(1).
895	Y.011	YYFVTCR2 HI, Second element for coordinate transformation HI. The two high-order bits (right-justified) of the second element of the two-element vector used for coordinate transformation by the system software. SLIB L97 notation is YFVCTR(2).

Table 3.2-1 FOS-Unique Data in SHP (cont)

SHP Wd	Meas ID	Contents
896	Y.011	YYFVTCR2 LO, Second element for coordinate transformation LO. The 16 low-order bits of the second element of the two-element vector used for coordinate transformation by the system software. SLIB L97 notation is YFVCTR(2).
897	Y.032	YTAINV, Maneuver direction inversion flag. When 1, used to invert the offset vector when acquisition is performed; a 0 means do not invert. The NSSC-1 default is 0.
		YYSHUID = 5
878	Y.001	YYSHUID, Identifier for FOS-Unique SHP data. See text.
879	Y624	YTACMP, Mode 2 target acquisition completion indicator. A 0 means no target acquisition has occurred since NSSC-1 initialization; a 1 means target acquisition complete; a 2 is set by initialization of NSSC-1 processors YFMOD2 and YFSDPR.
880	Y630	YFDWCT, Dwell counter for YFPKUP. Ranges from 0 to YDWELS, dependent on dwell scan set up for SSM.
881	Y.040	YDWELS, Total number of dwells in this ST dwell-scan.
882	Y.029	YACSI21 HI, Bits 1-2 of 36-bit accumulated science data for successful dwell. The NSSC-1 has a double-word (36-bit) YACSAV quantity, containing the accumulated science data for the dwell that satisfies the criteria of the peakup mode target acquisition. This has in the bottom two bits (the other bits are zero) bits 1-2 of this quantity (SLIB L97 notation is YACSI2(1)).
883	Y.029	YACSI21 LO, Bits 3-18 of 36-bit accumulated science data for successful dwell. The NSSC-1 has a double-word (36-bit) YACSAV quantity, containing the accumulated science data for the dwell that satisfies the criteria of the peakup mode target acquisition. This has bits 3-18 of this quantity (SLIB L97 notation is YACSI2(1)).
884	Y.029	YACSI22 HI, Bits 19-20 of 36-bit accumulated science data for successful dwell. The NSSC-1 has a double-word (36-bit) YACSAV quantity, containing the accumulated science data for the dwell that satisfies the criteria of the peakup mode target acquisition. This has in the bottom two bits (the other bits are zero) bits 19-20 of this quantity (SLIB L97 notation is YACSI2(2)).

Table 3.2-1 FOS-Unique Data in SHP (cont)

SHP Wd	Meas ID	Contents
885	Y.029	YACSI22 LO, Bits 21-36 of 36-bit accumulated science data for successful dwell. The NSSC-1 has a double-word (36-bit) YACSAV quantity, containing the accumulated science data for the dwell that satisfies the criteria of the peakup mode target acquisition. This has bits 21-36 of this quantity (SLIB L97 notation is YACSI2(2)).
886	Y.031	YACAI21 HI, Bits 1-2 of 36-bit accumulated science data for current dwell. The NSSC-1 has a double-word (36-bit) YACACC quantity, containing the accumulated science data for the current dwell. This has in the bottom two bits (the other bits are zero) bits 1-2 of this quantity (SLIB L97 notation is YACAI2(1)).
887	Y.031	YACAI21 LO, Bits 3-18 of 36-bit accumulated science data for current dwell. The NSSC-1 has a double-word (36-bit) YACACC quantity, containing the accumulated science data for the current dwell. This has bits 3-18 of this quantity (SLIB L97 notation is YACAI2(1)).
888	Y.031	YACAI22 HI, Bits 19-20 of 36-bit accumulated science data for current dwell. The NSSC-1 has a double-word (36-bit) YACACC quantity, containing the accumulated science data for the current dwell. This has in the bottom two bits (the other bits are zero) bits 19-20 of this quantity (SLIB L97 notation is YACAI2(2)).
889	Y.031	YACAI22 LO, Bits 21-36 of 36-bit accumulated science data for current dwell. The NSSC-1 has a double-word (36-bit) YACACC quantity, containing the accumulated science data for the current dwell. This has bits 21-36 of this quantity (SLIB L97 notation is YACAI2(2)).
890	Y.030	YFPUTT HI, Saved dwell time HI. Top 16 bits of spacecraft time tag of the dwell that satisfies the criteria of the peakup mode target acquisition (YACSI21|YACSI22 is the accumulated data corresponding to this time).
891	Y.030	YFPUTT LO, Saved dwell time LO. Bottom 16 bits of spacecraft time tag of the dwell that satisfies the criteria of the peakup mode target acquisition (YACSI21|YACSI22 is the accumulated data corresponding to this time).
		YYSHUID = 6
878	Y.001	YYSHUID, Identifier for FOS-Unique SHP data. See text.

Table 3.2-1 FOS-Unique Data in SHP (cont)

SHP Wd	Meas ID	Contents
879	Y.041	YSDPRC, Science data processing flag. Flag to control NSSC-1 processor YFSDPR. A 1 means process science data by using binary search; a 2 means process it using peakup/peakdown (see Section 1.5). The NSSC-1 default value is 1.
880	Y.042	YFNMAX, Upper count for star field window. Has maximum allowable peak counts for selecting peaks in a frame of science data for NSSC-1 processor YFSDPR. The NSSC-1 default value is 65535. Is in SHP only if [YSDPRC = 1] (otherwise, have YDWELS).
	Y.040	YDWELS, Total number of dwells in this ST dwell-scan. Is in SHP for [YYSHUID = 6] only if [YSDPRC = 2] (otherwise, have YFNMAX).
881	Y.043	YFNMIN, Lower count limit for star field window. Has minimum allowable peak counts for selecting peaks in a frame of science data for NSSC-1 processor YFSDPR. The NSSC-1 default value is 50. Is in SHP only if [YSDPRC = 1] (otherwise, have YUPDWN).
	Y.051	YUPDWN, Direction of Peakup/Peakdown search. The direction of peakup/peakdown search: 1 means peakup and 2 means peak-down. Is in SHP only if [YSDPRC = 2] (otherwise, have YFNMIN).
882	Y.052	YSMOTSV, Multiple of sky variance. Has the multiple of the sky variance that is added to the sky mean value to create the peak detect minimum count value used by YFSDPR. The NSSC-1 default is 2.
883	Y.044	YNPEAK, Peak mapping indicator. A value of 1 means stop aperture mapping when first peak is found; a 2 means map the entire aperture. The NSSC-1 default value is 2.
884	Y.045	YHWHM, Width for merging peaks. Has the expected half-detected peak width at half-peak maximum height value, expressed in channels. The NSSC-1 default value of 4 applies if X-step is 4.
885	Y.046	YNBRT, Peak number to choose. Has the serial number of the brightest peak to be selected (1 means brightest, and maximum allowed value is 12).
886	Y.033	YPPB, Flag for pre-planned branch availability. A value of 1 means pre-planned branch is available; a value of 2 means pre-planned branch is not available.

Table 3.2-1 FOS-Unique Data in SHP (cont)

SHP Wd	Meas ID	Contents
887	Y.047	YSTAT, Scaling of statistical fluctuation. Has the square root statistical fluctuation allowance indicator used by YFSDPR, expressed in percent. The NSSC-1 default value is 35.
888	Y.048	YTOLER, Tolerance for edge centering. Has the tolerance for putting the selected peak on the edge of the diode array during binary search using YFSDPR, expressed in percent. The NSSC-1 default value is 100.
889	Y.019	YBASKP, Y-BASE for current data. Y-BASE used by FOS to acquire current data. Has a range of ± 256 about a (nominal) zero value, and is 11 bits plus sign (right-justified with sign extended).
890	Y.049	YOFFST, Y offset for target acquisition centering. Has the Y-axis offset in 32nds of a micron at the photocathode to go from the reference target to the target of interest (and from the center of the large aperture to the science aperture).
891	Y.050	YXOFST, X offset for target acquisition centering. Has the X-axis offset in 32nds of a micron at the photocathode to go from the reference target to the target of interest (and from the center of the large aperture to the science aperture).
892	Y709	YRSINV, Raster scan request status. A 1 means scan in progress; 2 not been started; above 2 not permitted.
893	Y.034	YRSMVS, Maximum moves during a raster scan.
894	Y.032	YTAINV, Maneuver direction inversion flag. When 1, used to invert the offset vector when acquisition is performed; a 0 means do not invert. The NSSC-1 default is 0

3.2.2 FOS-Unique Data Log Contents

There are 965 data words in the FOS-Unique Data Log. These words are stored in the FOS microprocessor RAM in the area immediately preceding address X'A000', which as explained in Section 1.5 is the beginning of the Science Data Array storage area. The data in the FOS-Unique Data Log is shown in Table 3.2-2.

Table 3.2-2 FOS-Unique Data Log

Words	Assignment
1-225	YYSPR/Y.400, Spare (total of 225 16-bit words, starting at address X'9876'). Since these words lie in the upper part of the RAM area allocated to System Tables, some of them may contain such information as FORTH (the language for the FOS microprocessor) dictionary data. There is no need to provide a data reduction/analysis capability for these words, but it should be realized that they will not necessarily be zero.
226-233	YYEPMC/Y.409, Entrance Port Mechanism Control Block (see Section 3.1.4.1).
234-251	YYAPMC$_s$/Y.410, Aperture Mechanism Control Block (see Section 3.1.4.2).
252-305	YYPLMC$_s$/Y.411, Polarizer Mechanism Control Block (see Section 3.1.4.3).
306-321	YYFGMC$_s$/Y.412, FGWA Mechanism Control Block (see Section 3.1.4.4).
322-833	YYDDTBL$_s$/Y.401, Discriminator DAC/Disabled Diode Table, total of 512 16-bit words, starting at address X'9AF8'. Contains discriminator and channel enable information for each channel. Bit 1 is 1 to inhibit use of the channel and is 0 to enable it. Bits 2-8 are the seven most significant bits of the readback from the DAC used to set the low-level discriminator in the FOS Analog Signal Processor for that channel if an error was encountered (see Section 3.1.6.1). Bits 9-16 have the eight bits reflecting the desired setting of the DAC. This array can be set by command YDDCHK/Y083$_c$.
834-837	YYRAMMAP/Y.402, RAM map (total of 4 16-bit words starting at address X'9EF8'). Has the logical mapping for each of the 8 physical pages of RAM memory (8 bits each). The information provided is the logical page number for each physical page (in range 0-7). Note that only the three least significant bits of each byte are actually used.

Table 3.2-2 FOS-Unique Data Log (cont)

Words	Assignment
838-901	$YYASCIIH_s$/Y.403, ASCII header (total of 64 16-bit words starting at address X'9F00'). Assigned for observer comments (that can be uplinked with each observation). The first byte is used to specify the nature of the Y-steps (see Section 3.1.1.4). On an early test tape, the cells were observed to be initialized to X'FFFF'; on a more recent tape, they were X'2020' (ASCII blanks).
902-961	Total of 60 16-bit words starting at X'9F80'. They contain an image of the serial digital data (SI word 8) in engineering telemetry for each minor frame (see Section 4). Each 16-bit word has two consecutive eight-bit minor frame readouts. Word number is given by: $$WN = 902 + [SI/2],$$ where SI is the SI subframe number (range 0-119). If SI is even, then bits 1-8 have the data; otherwise, bits 9-16 have it. The value of WN (with a ".0" to indicate bits 1-8 and a ".5" to indicate bits 9-16) is shown in the tables of Section 4.2 in the "UDL" column. New values are loaded into this area as they are placed in the engineering telemetry. Command $YEFILL/Y084_c$ can be used to fill all these words from their current values, rather than waiting for the 60-second major frame time (see Section 4) to elapse. This command probably will be issued before the FOS-Unique Data Log is telemetered at the start of the observation.
962.0	YYMIF/Y.404, minor frame number, in bits 1-8 of word 962 (address X'9FF8').
962.5	YYMAF/Y.405, major frame number, in bits 9-16 of word 962 (address X'9FF9'). This number is counted since the last FOS reset.
963	$YYNREAD_s$/Y.406, readout number (16-bit word at address X'9FFA'). This quantity is used in the processing of the data results (Section 10.2.2.1.1.1 of SLIB 799), and is a count of the actual number of readouts that have taken place during the current observation. The number returned is the [count - 1]. When telemetered as part of the FOS-Unique Data Log at the start of the observation, therefore, the value is not meaningful (probably a residual value related to the previous observation). Typical value at startup is X'7A7B' ("subframe" 122 and 123).

Table 3.2-2 FOS-Unique Data Log (cont)

Words	Assignment
964	YYNMEMCL/Y.407, memory clear number (16-bit word at address X'9FFC'). This quantity is a count of the number of memory clears that have taken place during the current observation. The number returned is the [count - 1]. When telemetered as part of the FOS-Unique Data Log at the start of the observation, therefore, the value is not meaningful (probably a residual value related to the previous observation). Typical value at startup is X'7C7D' ("subframe" 124 and 125).
965	YYSPR/Y.408, spare (16-bit word at X'9FFE'). Typical value is X'7EFF' ("subframe" 126 and 255).

3.2.3 FOS Science Data Contents

For FOS, the material telemetered in each frame of science information is merely a dump of a set of RAM (or ROM, if so specified) cells from the FOS microprocessor, as discussed in Section 3.1. FOS science data can also be downlinked from the NSSC-1 rather than from the FOS microprocessor, as discussed in Section 3.2.3.4. The remainder of this material is concerned with normal FOS science observation data from the FOS itself. The FOS science downlink may also include several SHPs and UDLs for a given observation. Commands are used to control the logical partitioning of the RAM in the FOS microprocessor. The values actually used are available in the engineering telemetry (and hence in the FOS-Unique Data Log and the Science Header), thus allowing the information to be interpreted. Since the red and blue Digicon devices are processed by separate FOS hardware, measurement $YYPATH_s$/Y.201 (0 for the "A" or amber/red channel and 1 for the "B" or blue channel) can be used to determine the source of the data. As discussed in Section 1.5, there is no connection between the observation (data acquisition) and downlink dump parameters except that which might be established by conventions.

The number of words/line is given in measurement YWRDSLIN/Y551 (components $YWRDSLIH_s$/Y.101 and $YWRDSLIL_s$/Y.102), the number of lines/frame in YLINSFRM/Y552 (components $YLINSFRH_s$/Y.103 and $YLINSFRL_s$/Y.104), and the starting memory dump byte address in YMDMPADR/Y550 (components $YMDMPADH_s$/Y.110 and

$YMDMPADL_s$/Y.111). The Instrument Mode is defined by YAQMD/Y711 (individual bits are in Y.205 through Y.210, see Section 2.1). With these quantities, it is possible to determine the major features of the science frame:

1. In general, the memory dump address will be set to cause transmission of one line's worth (YWRDSLIN) of Science Header data before the Science Data itself. This means that:

   YMDMPADR = X'A000' - 2 * YWRDSLIN,

   where the factor of 2 is because YWRDSLIN is in units of 16-bit words, not bytes. If this relationship is true, then a Science Header appears at the start of each science frame. The constant X'A000' is the start of the Science Data Array. Although this constant can be updated by a command, such an update (see #1 of Section 3.1.6.5) should be done only after careful coordination with the ground processing.

2. If YMDMPADR = X'A000', this means that there is no Science Header.

3. If $YYREJRE_s$/Y.207 (the Reject/-Retry bit) is 1, this means that there is a Reject Array needed for processing of the data. The Reject Array is stored immediately after the Science Data Array in the FOS memory. As noted in Section 2.1.3, however, its transmission is not controlled by this bit.

3.2.3.1 Science Header

The information in the Science Header for the science frame, if it is transmitted, is the same as the latter portion of the FOS-Unique Data Log (with, however, updates to reflect the changing data values as the material is telemetered). As mentioned in Section 3.1.2.1, the FOS Header is expected to be sent before all science data frames from the FOS (except for target-acquisition data for the NSSC-1). By FOS convention, there is one line (YWRDSLIN words) of the Science Header transmitted, so the last YWRDSLIN words of the FOS-Unique Data Log appear as the Science Header. For example, if [YWRDSLIN = 516], this means that the last 516 words (or words 450-965) of the Log are sent. More importantly, if [YWRDSLIN > 63], a complete image of the Serial Digital engineering telemetry data will be available in the Science Header. Caution must be exercised, however, in using the data in the Science Header to control processing, for reasons explained in Section 4.1.

3.2.3.2 Science Data Array

Commands are provided to the FOS microprocessor to control the sampling of the diode-path registers and the arrangement of data in its RAM memory from where it is subsequently telemetered. These commands, with their command mnemonic, data base ID, engineering telemetry slot, and role are summarized in Table 3.2-3.

Table 3.2-3 FOS Commands with Data Format Impact

Command	Eng'g TM	Command Role
YINTS/ $Y043_c$	YINTEG/ Y546	Set number of integrations per X-Step. See Section 3.1.1.1.
Y1STCHNL/ $Y042_c$	Y1STCHNL/ Y531	Load first channel to be processed. See Section 3.1.2.2.
YCHNLS/ $Y050_c$	YNUMCHNL/ Y532	Set number of channels processed. See Section 3.1.2.2.
YX-STEP/ $Y039_c$	YXSTEPS/ Y524	Load number of X-Steps. See Section 3.1.1.2.
YOVRSCAN/ $Y051_c$	YOVRSCAN/ Y530	Set channel overscan number. See Section 3.1.1.3.
YY-STEP/ $Y047_c$	YYSTEPS/ Y528	Load number of Y-Steps. See Section 3.1.1.4.
YSLICES/ $Y068_c$	YMSLICES/ Y576	Set number of memory slices. See Section 3.1.1.5.

As previously discussed, the FOS microprocessor memory has a dedicated area of memory for science information, and it is from this area of memory that the Science Data Array is telemetered. Consecutive cells in the memory are loaded with successive channel outputs, starting with the Y1STCHNL channel and ending with:

$$OMEG = Y1STCHNL + YCHNLS + YOVRSCAN - 2$$

(sum of true first channel, [true number of channels - 1], and [overscan number - 1]). This gives a total of:

$$M = YCHNLS + YOVRSCAN - 1$$

data values for the inner-most loop of the sampling process. For some FOS observations (see Section 3.1.2.1), this could be the line length (YWRDSLIN/Y551), although this constraint is not imposed by the instrument. Cells in the "middle" of the science array are normally incremented by the output of YOVRSCAN diodes.

For example, word 107 (counting from 0) for [YOVRSCAN = 5] would be incremented by the output of diode 103 (counting from 0), then diode 104, then 105, then 106, and finally 107 as successively larger offsets (controlled by YOVRSCAN) are used. Similarly, word 4 would be incremented by diodes 0, 1, 2, 3, and 4 in that order. Word 0 is incremented (by diode 0) only at the "final" offset (other increments would be by diodes "-4", "-3", "-2", and "-1", which do not exist). If Y1STCHNL is set zero (meaning the first channel), and YCHNLS corresponds to all 512 diodes, then [M = 516] for this YOVRSCAN. Word 511 (again numbering from 0) would be incremented by diodes 507, 508, 509, 510, and 511 in that order. Word 515, the last of the area, is incremented by diode 511 at the first offset (the only time it is changed, since diodes "512", "513", "514", and "515" otherwise required do not exist). See SLIB 1106 for examples.

If [YX-STEP > 1], the next M words in the FOS microprocessor RAM reflect an X offset (done by the magnetic focusing hardware) so as to allow the diodes to sense spectrographic information for a slightly offset group of wavelengths. For example, if [YX-STEP = 2] and [M = 10], and using Fortran indexing, then the FOS microprocessor RAM cells would have to be sampled in the sequence:

1,11, 2,12, 3,13, 4,14, 5,15, 6,16, 7,17, 8,18, 9,19, 10,20

in order to present the data in a monotonic wavelength sequence. As mentioned in Section 1.5, the relationship between diode number and wavelength is different for the two detectors and also depends on the optical element in use. Similarly, if [YX-STEP = 4], then points would have to be read as:

1,11,21,31, 2,12,22,32, 3,13,23,33, ...

where again the grouping indicates that, for example, points [1,11,21,31] are all read from the same diode, but with different magnetic deflection values. Since the telemetry is of successive RAM cells, however, this unshuffling must be done as part of the ground processing.

After reading the data for the channels a total of YX-STEP times, the FOS instrument can deflect the beam in the Y axis direction (perpendicular to the diode array) and generate exactly the same information. Continuing the example, if [YY-STEP = 3] then the RAM would have words 1-40 for the first collection (interleaved as described above), words 41-80 for the second, and words 81-120 for the third Y-axis step. Words 1, 11, 21, 31, 41, 51, 61,...111 would all contain information from the Y1STCHNL diode.

Finally, to gather data for some Ground Software Modes (such as Time-Resolved), the complete set of measurements must be repeated several times, as controlled by the YSLICES command. For [YSLICES = 4], but otherwise the above scenario, words 1-120 would have the first slice, 121-240 the second, 241-360 the third, and 361-480 the fourth slice. In this situation, the total size of the FOS "pattern" would reflect a Science Data Array length of 480 words.

Using the command (and engineering telemetry) values previously presented, the Science Data Array in the FOS microprocessor can also be visualized as having elements

$$S_{i,j,k,l}$$

where:

- i varies from Y1STCHNL to [Y1STCHNL + YCHNLS + YOVRSCAN - 2],
- j varies from 0 to [YX-STEP - 1],
- k varies from 0 to [YY-STEP - 1], and
- l varies from 0 to [YSLICES - 1].

Using the values previously presented, and having [Y1STCHNL = 0], the first element would be $S_{0,0,0,0}$ and the last $S_{9,3,2,3}$, for a total of [10*4*3*4=] 480 words.

3.2.3.3 Reject Array

If the $YYREJRE_s$/Y.207 (see Section 2.1.3) bit is 1, then the Reject Array is used to count the number of rejected measurements (the output from all 512 channels is ignored, rather than being used to update the FOS microprocessor RAM). As discussed in Section 2.1.3, the actual use of the rejection logic is controlled by the threshold value. The process for using the Reject Array is given in Section 10.2.2.1.1.1 of SLIB 799. The array has the general form:

$$NR_{j,m,k,l}$$

where:

- j varies from 0 to [YX-STEP - 1],
- m varies from 0 to [YOVRSCAN - 1],
- k varies from 0 to [YY-STEP - 1], and
- l varies from 0 to [YSLICES - 1].

The only parameter different from the normal science data is "m". Contrary to the Science Data Array, no rearrangement prior to subsequent use is necessary.

The Reject Array is stored in the FOS microprocessor immediately after the Science Data Array. There is no constraint imposed that it be telemetered starting with a separate downlink packet. All packets must have the same number of words: those after the end of the Reject Array are not meaningful for the current observation, and should be ignored.

3.2.3.4 FOS Science Data from NSSC-1

It is also possible to obtain FOS science data from the NSSC-1 buffer that has been used by NSSC-1 processor YFSDPR (see Section 1.5) in support of FOS target acquisition. YFSDPR (which does not modify the data it receives from the FOS) requests an output of each frame of science data after it has been processed. To save NSSC-1 resources, this downlinked science data consists of one line (a maximum of 965 words) that can incorporate the Science Header, the Science Data Array, and the Reject Array. The FOS microprocessor for target acquisition processes data from only 20 diodes (the aperture itself images onto 12 diodes), so this limitation is not a severe one. Since the nominal values for XSTEPS and OVRSCN are 4 and 5 respectively, the nominal dimensions of the target-acquisition data array are [m * 96], where m is the number of Y-steps.

In order to interpret this information, the NSSC-1 needs to obtain the number of words in its buffer before the science measurement begins (WDBSM). Since the Science Data Array conventionally starts (see Section 3.2.3) at FOS microprocessor address X'A000', the NSSC-1 accomplishes this by retrieving YMDMPADR/Y550 from the engineering stream and then computing:

WDBSM = (X'A000' - YMDMPADR)/2

where the division by 2 is necessary because byte addresses are used. According to SLIB L85, "The only way this data would be available at the SOGS level is to make sure [YMDMPADR] is included in the Proposal Data Base information" for the FOS target acquisition output to the NSSC-1.

The science data from the NSSC-1 will have packet ancillary data word 6 (the frame start count) equal to zero. To determine uniquely that the data is from the NSSC-1, according to SLIB L88 the packet format code can be used (see Section 3.2.4).

3.2.4 Arrangement of Science Data into Packets

The FOS science data, in common with the other ST instruments, is divided for telemetry interface purposes into "lines" and "frames". A "line" is a maximum of 965 16-bit words of science data, and a "frame" is a collection of one or more "lines". A set of one or more "frames" constitutes an "observation". The number of words in a line, and the number of lines in a frame, must be consistent between the SDF and the originating SI. The complete interface involves a six-signal protocol.

For transmission purposes, a line of data is accommodated in a "packet", which in turn is divided into from 1 to 16 "segments" (each of which has 64 16-bit words). In the first segment (by ST convention, "segment 0"), 50 data words are available to the user, with the other 14 occupied by ancillary information; in the other segments, 61 data words are available to the user. Since each segment of a packet must contain exactly 64 words, words of fill may be required to complete the last segment in the packet. These words are all set to X'5569'. For subsequent processing, it would be expected that the data words would be extracted from the individual segments. The data locations quoted in this document, therefore, assume that the transmission-protocol ancillary words have been removed and the data words compacted.

The information in the ancillary (non-data) words is defined in SLIB 204 and SLIB L65, and summarized in Table 3.2-4. Following the convention of SLIB 204, segments are numbered 0-15 and words 0-63. Words 0-2 are reflected in all segments, while words 3-13 are only in the first segment (segment 0). As elsewhere in this document, bits are numbered 1-16 (1 is most significant).

Table 3.2-4 Packet Ancillary Data

Word	Significance
0	Top 16 bits of sync pattern, X'05BB'.
1	Bottom 8 bits of sync pattern, X'2E', in bits 1-8 of the word.
	Segment number of this segment (range 0-15) in bits 9-16 of the word.

Table 3.2-4 Packet Ancillary Data (cont)

Word	Significance
2	Packet count (a running 16-bit count of the number of non-filler packets output by the SI C&DH).
3	Source ID in bits 1-8 of the word. For FOS, value is X'DC'. When the SHP is sent, the value in this byte is 0. Mission ID in bits 9-16 of the word. Value is X'3A'.
4	Coded packet length in bits 1-8 of the word (units of segments). Values are X'30'(1 segment), X'40'(2), X'48'(3), X'50'(4), X'54'(5), X'58'(6), X'5C'(7), X'60'(8), X'62'(9), X'64'(10), X'66'(11), X'68'(12), X'6A'(13), X'6C'(14), X'6E'(15), X'70'(16). For the SHP and the FOS Unique Data Log, 16 segments (a coded value of X'70') are required. The number of segments required for science data depends on the specified number of words (see Section 3.1.2.1). Secondary header length in bits 9-16 of the word (number of 8-bit bytes in words 6-13 of segment 0). Value is decimal 16, or X'10'.
5	Packet format code in bits 1-8 of the word. For the SHP, a value of X'AA' is used, and for NSSC-1 Executive Status Buffer dumps, a value of X'BB'. The FOS UDL has a value of X'10'; FOS calibration data has values in the range X'20' to X'24' and X'40' to X'44'; and FOS science data has values in the range X'60' to X'65', as well as X'70', X'71', X'80', and X'81'. According to SLIB L88, values in the range X'60 - X'65' mean the data is from the FOS microprocessor; values of X'70' and X'71' mean it is target acquisition data from the FOS microprocessor; and values of X'80' and X'81' mean it is NSSC-1 (target acquisition) buffered data. FOS microprocessor memory dumps have a value of X'D0'. The memory dump from the autonomous safing processor (see SLIB T39), formerly assigned X'D1', no longer is planned for use. See SLIB L96 for the significance of other values. Source ID parity in bits 9-16 of the word. For FOS, value is X'A7'. When the SHP is sent, the value in this byte is 0.
6	Frame start count (a running 16-bit counter of the number of Frame Start signals received from the SI that is the source of the data in the packet). The count is kept in the SDF hardware, and when the SDF is reset, this counter is also reset. When the SHP or science data from the NSSC-1 is sent, the value in this word will be 0. For data sent from the instrument itself (UDL, science, and dump data), this word can be non-zero (it is incremented in conjunction with the transmission of each UDL as well as for each frame of science/dump data).

Table 3.2-4 Packet Ancillary Data (cont)

Word	Significance
7	Line count. For multi-line formats, the number of the line of science data contained in the packet, starting at 0. It is always zero for the SHP and UDL. For science and dump data, it ranges from 0 to one less than the packets/frame contained in ancillary data word 12 (hence it is always zero for single-line formats).
8	The most significant 16 bits of time code value, the spacecraft time of transmission of the Line Start signal or start of the DMA transfer that produced the data for the packet. Words 8 and 9 together (which have been assigned the notation $TIMECODE_S$/Y.916) correspond to the NSSC-1 held spacecraft clock with a least increment of 125.000 msec. The entire 42 bits (including word 10) represent the SDF clock with a least increment of 125/1.024 usec (122.0703125 usec).
9	The next most significant 16 bits of time code value (see word 8).
10	The least significant 10 bits of time code value (left justified). See word 8. Bits 11-16 are 0.
11	Observation number. Bits 1-8 of this word are zero. For the FOS UDL and science data, bits 9-16 have the value that is also contained in bits 9-16 of data word 1 of the SHPs (see Section 3.2.1) that are associated with the observation. In the SHP, this complete word is 0.
12	Number of packets per frame. This is the number of packets that the SI C&DH outputs as a result of the invocation of this format. It is 1 for the Standard Header Packet and FOS-Unique Data Log. The value for FOS science data is downlinked in YLINSFRM/Y552 (see Section 3.1.2.1). Since the line count in ancillary data word 7 starts at 0, this word 12 value is one greater than the final (last packet in frame) value in word 7.
13	Number of data words per packet. Has number of data words (as opposed to ancillary or fill words) in each packet of the frame of which this packet is a part. The maximum value is 965 (X'3C5'), the value for the Standard Header Packet and the FOS-Unique Data Log. The value for FOS science data is downlinked in YWRDSLIN/Y551 (see Section 3.1.2.1).

4.0 FOS ENGINEERING TELEMETRY

4.1 FOS ENGINEERING TELEMETRY OVERVIEW

The FOS engineering telemetry consists of four types of data:

1. Analog data (such as temperatures and voltages),
2. Bilevel data (contact closures),
3. Serial digital data (from the FOS microprocessor), and
4. Digital data from the FOS NSSC-1 processors.

All ST Engineering Telemetry measurements have an associated eight-character LMSC (SLIB 1340) measurement number, as well as an abbreviated (but still unique) four-character number. The full eight-character measurement number is divided into five fields:

1. Field 1, the first character, identifies the major ST element. A "Y" is assigned to the FOS.

2. Field 2, characters 2-3, identify the component code. For FOS, the reserved codes are:

01	MEC
02	CEA
03	CPS
04	Signal Processor
05	HVPS
06	PSA (not used)
07	PSB (not used)
08	CLPS
09	RIU A
10	RIU B
11	General FOS.

3. Field 3, character 4, is a letter code for the measurement parameter. For FOS, values of C (current), H (position), J (logic status/computer address), P (pressure), Q (counters/ quantity), T (temperature), V (voltage), W (time), X (bilevel/ multilevel), and Z (spare) are used.

4. Field 4, characters 5-7, uniquely identifies each measurement within the category identified by Field 1. For FOS, the numbers are further divided:

101-134	Bilevel
301-338	Analog
500-588	Serial Digital Data
600-648	Data from NSSC-1 Processors (in word 9)

649-659	Serial Digital Data
700-704	Analog Spares
705-707	Serial Digital Data
708-710	Data from NSSC-1 Processors (in word 9)
711	Serial Digital Data
712-716	Data from NSSC-1 Processors (in word 9)
800-801	Serial Digital Data
926	Bilevel

For the purposes of this document, the numbering system in this field has been extended to include those parameters that are not otherwise identified. To avoid ambiguity (while still permitting useful presentation in numerical order), these extensions have been made as fractions, using the following assignments:

.001-.052	FOS-Unique data in SHP (see Table 3.2-1)
.101-.111	Engineering-stream quantities having LMSC numbers for different byte groupings
.201-.235	Divisions in word 8 (alternative groups of bits for words already assigned)
.301-.302	Spare bilevel bits
.400-.412	Quantities in FOS-Unique Data Log (Section 3.2.2)
.648	Spares in word 9
.901-.917	Quantities generally associated with SHP (having an "s" mnemonic subscript).

It should be noted that commands are also identified with similar notations:

000_c-088_c	Serial magnitude commands
501_c-628_c	Discrete commands.

5. Field 5, character 8, is an indicator of ground processing required. Values for FOS are:

   A	Analog (where have calibration curve) or conversion to numerical value;
   B	Bilevels (single bits): each of the two states can have an equivalent English statement (8 characters maximum); and
   D	Multi-level data having a maximum of up to 32 discrete output states (otherwise as for B).

   Solely for presentation purposes in this document, a lower-case alphabetical suffix (a, b, c, etc.) has been added to Field 5 to distinguish successive parts of the Serial Digital Data requiring more than eight bits to telemeter ("a" is appended to the most significant part, "b" to the next most, etc).

The abbreviated measurement number uses Fields 1 and 4.

As mentioned in Section 3.2.3.1, users of the engineering telemetry information must be aware of the sampling done internally by the FOS microprocessor for control purposes, as well as that done by the microprocessor for output of the Serial Digital Data. The FOS command philosophy is based on an "Arm and Fire" technique, whereby the necessary commands to set up the parameters are carried out (such as those used for FOS microprocessor loop control). A "Fire" command (or, more precisely, Begin Data Acquisition, YBEGAC/$Y559_c$) is used to start the actual activity. There is a command to abort the data acquisition immediately (YABACQ/$Y555_c$), or to end data acquisition at the end of the pattern (YENDAC/$Y557_c$). See Section 3.1.2.3.

At the start of data acquisition, the FOS microprocessor (in an activity that takes a total of a couple of seconds) samples many of the commanded parameters (such as the INTS, XSTEPS, and OVRSCN controls for the X-axis activity) from their telemetered cells and puts them into other cells for use throughout the observation. The telemetered cells, however, will reflect any subsequent command activity (a primary purpose of telemetering them, of course, is for command verification). The commands whose data is sampled in this fashion are called "Software Parameter Commands" in Table 3.1-2. For data reduction purposes, it would be more conservative to sample these parameters from the FOS-Unique Data Log information.

Some commands, however (such as YREJLIM/$Y014_c$, the one controlling the burst noise level for rejecting an integration value from the diodes' accumulators) are in the "Data Commands" category in Table 3.1-2, meaning that they can be updated "on the fly" and will have an effect. Although these commands do not impact the partitioning of the RAM memory, they can impact the processing. One example is YLIVETIM/$Y008_c$ and YDEADTYM/$Y010_c$, the commands used to control the diode-path accumulator sampling interval: these cells are specified in SLIB 598 for alternative use in reducing time-tagged data. The "Data" category commands, therefore, should be obtained from the Science Header if possible. It is expected (see SLIB 814) that the observer will take care not to change parameters or issue data commands during an acquisition, since such changes can result in meaningless data.

The memory area preceding the X'A000' address (the nominal address where the Science Data Array starts) has the image of the Serial Digital Data. Individual bytes in this area are loaded at the same time that they are presented to the telemetry, meaning the 120 bytes comprising this data (for "normal" telemetry, see Section 4.3) take a minute to get refreshed. Because of this delay, command YEFILL/$Y104_c$ will probably be used to sample all 120 values and place them in this area of memory. An expected command sequence, therefore, would be to abort the previous acquisition activity, provide the YEFILL command, and then generate the NSSC-1 Standard Header Packet and the FOS-Unique Data Log information.

The sequence of FOS engineering telemetry flow through the ST systems is shown in Figure 2 of SLIB 1340.

4.2 ENGINEERING TELEMETRY OUTPUT FROM FOS

The FOS Engineering Telemetry is described in this section from the viewpoint of the FOS instrument (and, therefore, documentation). The actual structure of the engineering telemetry stream (major frames, minor frames, subcommutation, and related matters) is discussed in Section 4.3.

Four kinds of telemetry are provided: Analog, Bilevel, Serial Digital, and Digital from FOS NSSC-1 processors. The tables on the following pages provide a summary of the telemetry assignments arranged in different sequences and formats for ease of reference (they are derived from the same basic set of data). The following information is supplied:

1. Table 4.2-1 lists the FOS Analog Telemetry sequenced by location. The "SHP" column gives the SHP (Current Value Table area, see Section 3.2.1) location where the value is stored, with the ".5" meaning that it is in bits 9-16 of the word.

2. Table 4.2-2 lists the FOS Bilevel Telemetry sequenced by location. The SHP column has the same significance as for Table 4.2-1.

3. Table 4.2-3 lists the FOS Serial Digital Telemetry sequenced by location. The FOS-Unique Log word location ("UDL" column) is determined as described in Section 3.2.2 (a ".0" means bits 1-8 and ".5" means bits 9-16).

4. Table 4.2-4 lists the FOS NSSC-1 Processor Digital Telemetry sequenced by location. See Section 1.5 for NSSC-1 processor identifications. The "SHP" column refers to the word location in the Standard Header Packet. The subscripts in this column reflect the conditions under which the quantity appears (the value of YYSHUID/Y.001, see Section 3.2.1).

5. Table 4.2-5 lists all the FOS commands and telemetry sequenced by their abbreviated command (with subscript "c") or TM number. The "SHP" column is the same as for Table 4.2-4 (no subscript means the quantity does not depend on YYSHUID/Y.001), and the "UDL" column gives the location in the FOS-Unique Data Log.

6. Table 4.2-6 provides the same information as in Table 4.2-5, but sequenced by mnemonic. Mnemonics having their first two characters set to "YY" include those coined for the purposes of this document. Mnemonics with an "s" subscript indicate those defined for SOGS purposes (see SLIB T43).

In these tables, the notation a/b:c-d in the WD/SF column implies that the quantity is in FOS output engineering telemetry word #a (range 0-9), subframe slot b (range 0 to [length - 1]), and bits c-d (bit 1 is most significant and bit 8 is least significant). See Section 4.3 for additional information on the engineering telemetry.

Table 4.2-1 FOS Analog Telemetry by Location

WD/SF	SHP	TM No	Significance
0/0	131.5	Y319	YHVVLT, High voltage supply voltage.
1/0	132.5	Y325	YHVCUR, High voltage supply current.
2/0	133.5	Y321	YXDEFCUR, X-Deflection coil driver current.
3/0	134.5	Y322	YYDEFCUR, Y-Deflection coil driver current.
4/0	135.5	Y323	YTRMFCUR, Trim focus coil driver current.
5/0	136.5	Y324	YDSCRVLT, Discriminator reference voltage.
6/0	137.5	Y320	YCALVLT, Calibration lamp supply voltage.
0/1	138.5	Y328	YCLSCUR, Calibration lamp supply current.
2/1	140.5	Y338	YINTPRES, Vacuum gauge reading.
5/1	143.5	Y332	Y8VQPSV, Plus 8 volt quiet power supply voltage.
6/1	144.5	Y337	Y5VLPSV, Plus 5 volt logic power supply voltage.
7/0	145.5	Y301	Y1OBTMP, Optical bench temperature location 1.
7/1	146.5	Y302	Y2OBTMP, Optical bench temperature location 2.
7/2	147.5	Y303	Y3OBTMP, Optical bench temperature location 3.
7/3	148.5	Y304	Y4OBTMP, Optical bench temperature location 4.
7/4	149.5	Y305	YPCATMP, Photocathode A temperature.
7/5	150.5	Y306	YPAMATMP, Pre-Amp assembly A temperature.
7/6	151.5	Y307	YPMFATMP, Permanent magnet focus assembly A temperature.
7/7	152.5	Y308	Y1OATMP, Optics area temperature location 1.
7/8	153.5	Y309	Y2OATMP, Optics area temperature location 2.
7/9	154.5	Y310	YSIGPTMP, Signal processor temperature.
7/10	155.5	Y311	YCEATMP, Central electronics temperature.
7/11	156.5	Y312	YDOORTMP, Entrance door mechanism temperature.
7/12	157.5	Y313	YAPERTMP, Aperture mechanism temperature.
7/13	158.5	Y314	YPOLRTMP, Polarizer mechanism temperature.
7/14	159.5	Y315	YFGMATMP, Filter/Grating Wheel motor A temperature.
7/15	160.5	Y316	YHVTMP, High voltage supply temperature.
7/16	161.5	Y326	YARIUTMP, RIU-A temperature.
7/17	162.5	Y327	YBRIUTMP, RIU-B temperature.
7/18	163.5	Y318	YCPSTMP, Central power supply temperature.
7/19	164.5	Y329	YFGMBTMP, Filter/Grating Wheel motor B temperature.
7/20	165.5	Y330	YPCBTMP, Photocathode B temperature.
7/21	166.5	Y331	YPAMBTMP, Pre-Amp assembly B temperature.
7/22	167.5	Y333	YPMFBTMP, Permanent magnet focus assembly B temperature.
7/23	168.5	Y334	YXYDFTMP, X Y deflection focus DAC temperature.
7/24	169.5	Y700	YASPARE1, Analog spare 1.
7/25	170.5	Y701	YASPARE2, Analog spare 2.
7/26	171.5	Y702	YASPARE3, Analog spare 3.
7/27	172.5	Y703	YASPARE4, Analog spare 4.
7/28	173.5	Y704	YASPARE5, Analog spare 5.

Table 4.2-2 FOS Bilevel Telemetry by Location

WD/SF	SHP	TM No	Significance
1/1:1	139.5	Y125	Y1SDFPRT, SD CEA A K1-K6 status. A 0 is AB and 1 is AA
1/1:2	139.5	Y126	Y2SDFPRT, SD CEA A K7-K11 status. A 0 is AB and 1 is AA
1/1:3	139.5	Y127	Y3SDFPRT, SD CEA B K1-K6 status. A 0 is BB and 1 is BA
1/1:4	139.5	Y128	Y4SDFPRT, SD CEA B K7-K11 status. A 0 is BB and 1 is BA
1/1:5	139.5	Y123	YAPRFRPI, Aperture failsafe arm/safe status. A 0 is Arm and 1 is Safe. See Section 3.1.4.2
1/1:6	139.5	Y124	YENTFRPI, Entrance door failsafe arm/safe status. A 0 is Arm and 1 is Safe. See Section 3.1.4.1
1/1:7	139.5	Y130	YPOLFRPI, Polarizer failsafe arm/safe status. A 0 is Arm and 1 is Safe. See Section 3.1.4.3
1/1:8	139.5	Y118	YHTRRPI, Heater control relay position. A 0 is HTON (on) and 1 is HTOF (off)
3/1:1	141.5	Y105	YRESETST, Reset status. A 0 is reset and a 1 is not reset
3/1:2	141.5	Y134	YCLKMON, Microprocessor clock monitor. A 0 is 3 MHz and 1 is 1.5 MHz. See Section 3.1.6.5
3/1:3	141.5	Y103	YWTCHDOG, Watchdog timer status. A 0 is OK and 1 is error. See Section 3.1.6.5
3/1:4	141.5	Y104	YINSENG, Instruction engineering bit status. A 0 is OK and 1 is error. See Section 3.1.6.5
3/1:5	141.5	Y106	YODSCRAM, Descramble PROM power status odd. A 0 is off and 1 is on
3/1:6	141.5	Y107	YEDSCRAM, Descramble PROM power status even. A 0 is off and 1 is on
3/1:7	141.5	Y133	YCALSELR, Calibration lamp select RPI. A 0 is B and a 1 is A. See Section 3.1.6.4
3/1:8	141.5	Y101	YCMTRST, Carrousel motor status. A 0 is B and a 1 is A. See Section 3.1.4.4
4/1:1-2	142.5	Y131	YRIUS2, RIU standby status. Bit 1 is for RIU A and bit 2 for RIU B. A 0 means STBY1 and a 1 means STBY2
4/1:3	142.5	Y119	YQSRPI, Quiet supply relay position. A 0 is +QPS (on) and 1 is -QPS (off)
4/1:4	142.5	Y120	YLSRPI, Logic supply relay status. A 0 is +LPS (on) and 1 is -LPS (off)
4/1:5	142.5	Y117	YHVRPI, High voltage relay position. A 0 is HVON (on) and 1 is HVOF (off)
4/1:6	142.5	Y102	YCALRPI, Calibration lamp supply RPI. A 0 is on and 1 is off. See Section 3.1.6.4
4/1:7	142.5	Y121	Y1BUSRPI, Common bus relay #1 status. A 0 is B On/A Off1 and a 1 is A On/B Off1
4/1:8	142.5	Y122	Y2BUSRPI, Common bus relay #2 status. A 0 is B On/A Off2 and a 1 is A On/B Off2
7/29:1	174.5	Y.301	YYSPR, Spare bit.
7/29:2	174.5	Y926	YIONRPI, Vacuum gauge power RPI.
7/29:3-8	174.5	Y.302	YYSPR, Spare bits.

Table 4.2-3 FOS Serial Digital Data by Location

WD/SF	UDL	TM No	Significance
8/0	902.0	Y500	YENGSYNC, MP serial engr data packet sync. Value is X'A5'
8/1	902 5	Y501	YFIRMVER, Firmware version number. Has Y.201
8/1:8	902.5	Y.201	YYPATH$_s$, Path identification. A 0 is "A" (amber or red) and 1 is "B" (blue). See Section 3.2.3
8/2	903.0	Y502	YERRCHK HI, Firmware check character HI. See Section 1.5
8/3	903.5	Y502	YERRCHK LO, Firmware check character LO. See Section 1.5
8/4	904.0	Y551	YWRDSLIN HI, Words per line HI. See Section 3.1.2.1
8/4	904.0	Y.101	YWRDSLIH$_s$, Same as YWRDSLIN HI.
8/5	904.5	Y551	YWRDSLIN LO, Words per line LO. See Section 3.1.2.1
8/5	904.5	Y.102	YWRDSLIL$_s$, Same as YWRDSLIN LO.
8/6	905.0	Y552	YLINSFRM HI, Lines per frame HI. See Section 3.1.2.1 .
8/6	905.0	Y.103	YLINSFRH$_s$, Same as YLINSFRM HI.
8/7	905.5	Y552	YLINSFRM LO, Lines per frame LO. See Section 3.1.2.1
8/7	905.5	Y.104	YLINSFRL$_s$, Same as YLINSFRM LO.
8/8:1-4	906.0	Y506	YFGWAPOS, Filter/Grating Wheel Assembly position. See Section 3.1.4.4
8/8:1-4	906.0	Y.105	YFGWAPO1$_s$, Same as first YFGWAPOS.
8/8:5	906.0	Y504	YFGWASTR, FGWA encoder strobe bit.
8/8:6	906.0	Y508	YFGWASP, FGWA spare.
8/8:7-8	906.0	Y503	YDOOR, Entrance door position. See Section 3.1.4.1
8/9	906.5	Y656	YAPERHOE, Aperture high-order encoder. See Section 3.1.4.2
8/9	906.5	Y.106	YAPERPO1$_s$ HI, Same as first YAPERHOE.
8/10	907.0	Y657	YAPERLOE, Aperture low-order encoder. See Section 3.1.4.2
8/10	907.0	Y.106	YAPERPO1$_s$ LO, Same as first YAPERLOE.
8/11	907.5	Y658	YPLZRHOE, Polarizer high-order encoder. See Section 3.1.4.3
8/11	907.5	Y.107	YPLRZPO1$_s$ HI, Same as first YPLZRHOE.
8/12	908.0	Y659	YPLZRLOE, Polarizer low-order encoder. See Section 3.1.4.3
8/12	908.0	Y.107	YPLRZPO1$_s$ LO, Same as first YPLZRLOE.
8/13	908.5	Y553	YXDAC HI, X DAC readback HI. See Section 3.1.3
8/14	909.0	Y553	YXDAC LO, X DAC readback LO. See Section 3.1.3
8/15	909.5	Y509	YXFLWID, Target acquisition X filter width.
8/16	910.0	Y510	YTARXCTR HI, Target Acq X-center HI. See Section 3.1.5
8/17	910.5	Y510	YTARXCTR LO, Target Acq X-center LO. See Section 3.1.5
8/18	911.0	Y511	YTARYCTR HI, Target Acq Y-center HI. See Section 3.1.5
8/19	911.5	Y511	YTARYCTR LO, Target Acq Y-center LO. See Section 3.1.5

Table 4.2-3 FOS Serial Digital Data by Location (cont)

WD/SF	UDL	TM No	Significance
8/20	912.0	Y650	YTAMAX HI, Upper target/acq window HI. See Section 3.1.5
8/21	912.5	Y650	YTAMAX LO, Upper target/acq window LO. See Section 3.1.5
8/22	913.0	Y800	YOVRLTMB B1, Overlight sum MS byte. Total of 32 bits (see Section 2.1.5)
8/23	913.5	Y800	YOVRLTMB B2, Overlight sum NMS byte. Total of 32 bits (see Section 2.1.5)
8/24	914.0	Y800	YOVRLTMB B3, Overlight sum NLS byte. Total of 32 bits (see Section 2.1.5)
8/25	914.5	Y801	YOVRLTLB, Overlight sum LS byte. Total of 32 bits (see Section 2.1.5)
8/26	915.0	Y514	YSAFING, Auto safe mode transition. Has Y.202-Y.204 (bits 1-5 unused). Bits 6-7 zeroed when sampled
8/26:6	915.0	Y.202	YYSAFLKA, Auto safe due to loss of keep-alive SMC. See Section 3.1.6.5
8/26:7	915.0	Y.203	YYSAFTSL, Auto safe due to loss of telemetry sync. See Section 3.1.6.5
8/26:8	915.0	Y.204	YYSAFED, Auto safing enabled/disabled. See Section 3.1.6.5
8/27	915.5	Y515	YTAMODE, Target acquisition mode. See Section 3.1.5
8/27:1	915.5	Y.228	YYFILTER, Filter data before finding peak. See Section 3.1.5
8/27:2	915.5	Y.229	YYFIX, Fix the target acquisition data. See Section 3.1.5
8/27:3	915.5	Y.230	YYINYFFL, Inhibit filter filling for Y. See Section 3.1.5
8/27:4	915.5	Y.231	YYINXFFL, Inhibit filter filling for X. See Section 3.1.5
8/27:5	915 5	Y.232	YYDBBUF, Double buffer FOS memory. See Section 3.1.5
8/27:6	915.5	Y.233	YYSPR, Spare bit.
8/27:7	915.5	Y.234	YYPYE, Find the Y direction upper edge. See Section 3.1.5
8/27:8	915.5	Y.235	YYMYE, Do Y direction edge finding. See Section 3.1.5
8/28	916.0	Y516	YARITHCK HI, Arithmetic self-check (speed) results HI. See Section 1.5
8/29	916.5	Y516	YARITHCK LO, Arithmetic self-check (speed) results LO. See Section 1.5
8/30	917.0	Y517	YSELFCHK HI, Processor self-check results HI. See Section 1.5
8/31	917.5	Y517	YSELFCHK LO, Processor self-check results LO. See Section 1.5
8/32	918.0	Y518	YDREFDAC, Discriminator reference DAC.
8/33	918.5	Y519	YFOCUSRB, Focus trim coil DAC readback. See Section 3.1.3
8/34:1-2	919.0	Y579	YDPRMPWR, Descramble PROM power status. A 00 is off, 01 is even, 10 is odd, and 11 is both

Table 4.2-3 FOS Serial Digital Data by Location (cont)

WD/SF	UDL	TM No	Significance
8/34:3	919.0	Y581	YHVSPAR, Spare bit.
8/34:4	919.0	Y580	YFFCPWR, Flat field cal lamp power. A zero is off and a 1 is on. See Section 3.1.6.4
8/34:5-6	919.0	Y.227	YYSPR, Spare bits.
8/34:7-8	919.0	Y520	YHVDACRB HI, High voltage DAC readback HI. See Section 3.1.3
8/35	919.5	Y520	YHVDACRB LO, High voltage DAC readback LO. See Section 3.1.3
8/36	920.0	Y521	YYDAC HI, Y DAC readback HI. See Section 3.1.3
8/37	920.5	Y521	YYDAC LO, Y DAC readback LO. See Section 3.1.3
8/38:1-4	921.0	Y506	YFGWAPOS, Filter/Grating Wheel Assembly position. See Section 3.1.4.4
8/38:5	921.0	Y504	YFGWASTR, FGWA encoder strobe bit.
8/38:6	921.0	Y508	YFGWASP, FGWA spare.
8/38:7-8	921.0	Y503	YDOOR, Entrance door position. See Section 3.1.4.1
8/39	921.5	Y656	YAPERHOE, Aperture high-order encoder. See Section 3.1.4.2
8/40	922.0	Y657	YAPERLOE, Aperture low-order encoder. See Section 3.1.4.2
8/41	922.5	Y658	YPLZRHOE, Polarizer high-order encoder. See Section 3.1.4.3
8/42	923.0	Y659	YPLZRLOE, Polarizer low-order encoder. See Section 3.1.4.3
8/43	923.5	Y553	YXDAC HI, X DAC readback HI. See Section 3.1.3
8/44	924.0	Y553	YXDAC LO, X DAC readback LO. See Section 3.1.3
8/45	924.5	Y705	YYFLWID, Target acquisition Y filter width.
8/46	925.0	Y522	YXPITCH HI, X deflection pitch between diodes HI. See Section 3.1.3
8/47	925.5	Y522	YXPITCH LO, X deflection pitch between diodes LO. See Section 3.1.3
8/48	926.0	Y523	YXBASE HI, X deflection base HI. See Section 3.1.3
8/49	926.5	Y523	YXBASE LO, X deflection base LO. See Section 3.1.3
8/50	927.0	Y524	YXSTEPS, X deflection sub-steps. See Section 3.1.1.2
8/51	927.5	Y652	YREJECTS HI, Number of adder rejects HI. See Section 3.1.1.1
8/52	928.0	Y555	YRANGE, Y range. See Section 3.1.1.4
8/53	928.5	Y526	YYPITCH HI, Y deflection pitch between diodes HI. See Section 3.1.3
8/54	929.0	Y526	YYPITCH LO, Y deflection pitch between diodes LO. See Section 3.1.3
8/55	929.5	Y527	YYBASE HI, Y deflection base HI. See Section 3.1.3
8/56	930.0	Y527	YYBASE LO, Y deflection base LO. See Section 3.1.3
8/57	930.5	Y528	YYSTEPS, Y deflection sub-steps. See Section 3.1.1.4
8/58	931.0	Y652	YREJECTS LO, Number of adder rejects LO. See Section 3.1.1.1
8/59	931.5	Y576	YMSLICES, Number of memory slices. See Section 3.1.1.5

Table 4.2-3 FOS Serial Digital Data by Location (cont)

WD/SF	UDL	TM No	Significance
8/60	932.0	Y530	YOVRSCAN, X deflection overscan. See Section 3.1.1.3
8/61	932.5	Y531	Y1STCHNL, First channel to be processed. See Section 3.1.2.2
8/62	933.0	Y532	YNUMCHNL, Number of channels to be processed. See Section 3.1.2.2
8/63	933.5	Y585	YLIVEHI, Accumulator open time high byte. See Section 3.1.1.1
8/63	933.5	Y.108	YLIVE$_s$ HI, Same as YLIVEHI.
8/64	934.0	Y586	YLIVELO, Accumulator open time low byte. See Section 3.1.1.1
8/64	934.0	Y.108	YLIVE$_s$ LO, Same as YLIVELO.
8/65	934.5	Y587	YDEADHI, Accumulator close time high byte. See Section 3.1.1.1
8/65	934.5	Y.109	YDEAD$_s$ HI, Same as YDEADHI.
8/66	935.0	Y588	YDEADLO, Accumulator close time low byte. See Section 3.1.1.1
8/66	935.0	Y.109	YDEAD$_s$ LO, Same as YDEADLO.
8/67	935.5	Y711	YAQMD$_s$, Acquisition mode. Has Y.205-Y.212
8/67:1	935.5	Y.205	YYSYNCS, Synchronous start instrument mode. See Section 2.1.1
8/67:2	935.5	Y.206	YYTIMTG, Time-Tag instrument mode. See Section 2.1.2
8/67:3	935.5	Y.207	YYREJRE$_s$, Reject/-Retry instrument mode. See Section 2.1.3
8/67:4	935.5	Y.208	YYTARGA$_s$, Target acquisition instrument mode. See Section 2.1.4
8/67:5	935.5	Y.209	YYDBLSN, Double/-Single precision adder instrument mode. See Section 2.1.5
8/67:6	935.5	Y.210	YYAUTPO, Automatic polarizer sequence instrument mode. See Section 2.1.6
8/67:7	935.5	Y.211	YYSPR, Spare bit.
8/67:8	935.5	Y.212	YYSPR, Spare bit.
8/68:1-4	936.0	Y506	YFGWAPOS, Filter/Grating Wheel Assembly position. See Section 3.1.4.4
8/68:5	936.0	Y504	YFGWASTR, FGWA encoder strobe bit.
8/68:6	936.0	Y508	YFGWASP, FGWA spare.
8/68:7-8	936.0	Y503	YDOOR, Entrance door position. See Section 3.1.4.1
8/69	936.5	Y656	YAPERHOE, Aperture high-order encoder. See Section 3.1.4.2
8/70	937.0	Y657	YAPERLOE, Aperture low-order encoder. See Section 3.1.4.2
8/71	937.5	Y658	YPLZRHOE, Polarizer high-order encoder. See Section 3.1.4.3
8/72	938.0	Y659	YPLZRLOE, Polarizer low-order encoder. See Section 3.1.4.3
8/73	938.5	Y553	YXDAC HI, X DAC readback HI. See Section 3.1.3
8/74	939.0	Y553	YXDAC LO, X DAC readback LO. See Section 3.1.3
8/75	939.5	Y706	YSPRBYT1, Spare byte 1. Typical value X'4B' (subframe)

Table 4.2-3 FOS Serial Digital Data by Location (cont)

WD/SF	UDL	TM No	Significance
8/76	940.0	Y510	YTARXCTR HI, Target Acq X-center HI. See Section 3.1.5
8/77	940.5	Y510	YTARXCTR LO, Target Acq X-center LO. See Section 3.1.5
8/78	941.0	Y511	YTARYCTR HI, Target Acq Y-center HI. See Section 3.1.5
8/79	941.5	Y511	YTARYCTR LO, Target Acq Y-center LO. See Section 3.1.5
8/80	942.0	Y651	YTAMIN HI, Lower target/acq window HI. See Section 3.1.5
8/81	942.5	Y651	YTAMIN LO, Lower target/acq window LO. See Section 3.1.5
8/82	943.0	Y536	YFWSTAT1 HI, Firmware status group 1 HI. Typically ASCII (interpretation depends on use)
8/83	943.5	Y536	YFWSTAT1 LO, Firmware status group 1 LO. Typically ASCII (interpretation depends on use)
8/84	944.0	Y537	YFWSTAT2 HI, Firmware status group 2 HI. Typically ASCII (interpretation depends on use)
8/85	944.5	Y537	YFWSTAT2 LO, Firmware status group 2 LO. Typically ASCII (interpretation depends on use)
8/86	945.0	Y538	YFWSTAT3 HI, Firmware status group 3 HI. Typically ASCII (interpretation depends on use)
8/87	945.5	Y538	YFWSTAT3 LO, Firmware status group 3 LO. Typically ASCII (interpretation depends on use)
8/88	946.0	Y539	YFWSTAT4 HI, Firmware status group 4 HI. Typically ASCII (interpretation depends on use)
8/89	946.5	Y539	YFWSTAT4 LO, Firmware status group 4 LO. Typically ASCII (interpretation depends on use)
8/90	947.0	Y540	YFWSTAT5 HI, Firmware status group 5 HI. Typically ASCII (interpretation depends on use)
8/91	947.5	Y540	YFWSTAT5 LO, Firmware status group 5 LO. Typically ASCII (interpretation depends on use)
8/92	948.0	Y541	YFWSTAT6 HI, Firmware status group 6 HI. Typically ASCII (interpretation depends on use)
8/93	948.5	Y541	YFWSTAT6 LO, Firmware status group 6 LO. Typically ASCII (interpretation depends on use)
8/94	949.0	Y542	YMCLEARS, Memory clears/data acquisition. See Section 3.1.1.8
8/95	949.5	Y649	YSMCERRS, Serial magnitude command error report flags. Has Y.219-Y.226. Word zeroed when sampled
8/95:1	949.5	Y.219	YYILT3CC, Illegal Type-3 command code. See Section 3.1
8/95:2	949.5	Y.220	YYILT4CC, Illegal Type-4 command code. See Section 3.1
8/95:3	949.5	Y.221	YYILT4MO, Illegal Type-4 command modifier. See Section 3.1
8/95:4	949.5	Y.222	YYDCMOF, Data command overflow.
8/95:5	949.5	Y.223	YYDCMIP, Data command illegal path. See Section 3.1
8/95:6	949.5	Y.224	YYSSCIP, Synchronous start command illegal path. See Section 3.1

Table 4.2-3 FOS Serial Digital Data by Location (cont)

WD/SF	UDL	TM No	Significance
8/95:7	949.5	Y.225	YYTAWCIP, Target acquisition window command illegal path. See Section 3.1
8/95:8	949.5	Y.226	YYSDCIP, Science dump command illegal path. See Section 3.1
8/96	950.0	Y543	YLASTCMD HI, Last command at SMC error HI. See Section 3.1
8/97	950.5	Y543	YLASTCMD LO, Last command at SMC error LO. See Section 3.1
8/98:1-4	951.0	Y506	YFGWAPOS, Filter/Grating Wheel Assembly position. See Section 3.1.4.4
8/98:5	951.0	Y504	YFGWASTR, FGWA encoder strobe bit.
8/98:6	951.0	Y508	YFGWASP, FGWA spare.
8/98:7-8	951.0	Y503	YDOOR, Entrance door position. See Section 3.1.4.1
8/99	951.5	Y656	YAPERHOE, Aperture high-order encoder. See Section 3.1.4.2
8/100	952.0	Y657	YAPERLOE, Aperture low-order encoder. See Section 3.1.4.2
8/101	952.5	Y658	YPLZRHOE, Polarizer high-order encoder. See Section 3.1.4.3
8/102	953.0	Y659	YPLZRLOE, Polarizer low-order encoder. See Section 3.1.4.3
8/103	953.5	Y553	YXDAC HI, X DAC readback HI. See Section 3.1.3
8/104	954.0	Y553	YXDAC LO, X DAC readback LO. See Section 3.1.3
8/105	954.5	Y707	YSPRBYT1, Spare byte 2. Typical value X'69' (subframe)
8/106	955.0	Y544	YNOISELM HI, Burst noise rejection limit HI. See Section 3.1.1.1
8/107	955.5	Y544	YNOISELM LO, Burst noise rejection limit LO. See Section 3.1.1.1
8/108	956.0	Y545	YRAMADDR HI, RAM address pointer HI. See Section 3.1.6.3
8/109	956.5	Y545	YRAMADDR LO, RAM address pointer LO. See Section 3,1.6.3
8/110	957.0	Y546	YINTEG, Number of integrations/X-step. See Section 3.1.1.1
8/111	957.5	Y577	YPTRNS, Patterns per readout. See Section 3.1.1.6
8/112	958.0	Y547	YINTMODE, Initialization mode. Has Y.213-Y.218
8/112:1	958.0	Y.213	YYRSMNI, Resume (no initialization). See Section 2.1.1
8/112:2	958.0	Y.214	YYINHSLT, Inhibit slice table fill. See Section 2.1.1
8/112:3	958.0	Y.215	YYINHYDF, Inhibit Y-deflection table fill. See Section 2.1.1
8/112:4	958.0	Y.216	YYINHXDF, Inhibit X-deflection table fill. See Section 2.1.1
8/112:5	958.0	Y.217	YYINDFHYS, Do deflection hysteresis pattern at beginning of data acquisition. See Section 2.1.1
8/112:6-8	958.0	Y.218	YYSPR, Spare bits.
8/113	958.5	Y548	YREADCYC, Readouts/memory clear. See Section 3.1.1.7

Table 4.2-3 FOS Serial Digital Data by Location (cont)

WD/SF	UDL	TM No	Significance
8/114	959.0	Y549	YDATALIM, High byte of acquisition limit. See Section 3.1.2.3
8/115	959.5	Y550	YMDMPADR HI, Memory dump address HI. See Section 3.1.2.1
8/115	959.5	Y.110	$YMDMPADH_s$, Same as YMDMPADR HI.
8/116	960.0	Y550	YMDMPADR LO, Memory dump address LO. See Section 3.1.2.1
8/116	960.0	Y.111	$YMDMPADL_s$, Same as YMDMPADR LO.
8/117:1	960.5	Y556	YSPRBIT1, Spare bit. All bits in word zeroed when sampled
8/117:2	960.5	Y560	YFDACERR, Focus DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
8/117:3	960.5	Y563	YDDACERR, Discriminator DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.6.1
8/117:4	960.5	Y558	YXDACERR, X DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
8/117:5	960.5	Y578	YCDACERR, Calibration DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.6.4
8/117:6	960.5	Y559	YYDACERR, Y DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
8/117:7	960.5	Y561	YHVDACER, HV DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
8/117:8	960.5	Y562	YDRDACER, Discriminator reference DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.6.2
8/118:1	961.0	Y564	YACTMERR, Accumulator timer set error. A 0 is OK and a 1 is error
8/118:2-4	961.0	Y566	YMECHTOC, Mechanism time-out code. See Section 3.1.4
8/118:5	961.0	Y567	YBEGINDA, Begin data acquisition command flag. A 1 means begin. See Section 3.1.2.3
8/118:6	961.0	Y568	YENDDA, End data acquisition command flag. A 1 means end. See Section 3.1.2.3
8/118:7	961.0	Y569	YABORTDA, Abort data acquisition command flag. A 1 means abort. See Section 3.1.2.3
8/118:8	961.0	Y570	YRESETMP, Reset microprocessor command flag. A 1 means reset. See Section 3.1.6.5
8/119:1	961.5	Y571	YNDAIP, Data acquisition not in progress. A 1 means not in progress. See Section 3.1.1
8/119:2	961.5	Y572	YRIP, Resting in peace.
8/119:3	961.5	Y573	YPIP, Pause in progress. A 1 means pause in progress. See Section 3.1.2.3
8/119:4	961.5	Y574	YCPIP, CEA plot in progress. A 1 means plot in progress
8/119:5	961.5	Y575	YTAQIP, Target acquisition in progress. A 1 means acquisition in progress. See Section 2.1.4
8/119:6	961.5	Y582	YMMIP, Mechanism motion in progress. A 1 means motion in progress

Table 4.2-3 FOS Serial Digital Data by Location (cont)

WD/SF	UDL	TM No	Significance
8/119:7	961.5	Y583	YAMCIP, Auto memory clear in progress. A 1 means clear to be done (interface with data monitoring background task)
8/119:8	961.5	Y584	YSDIP, Science dump in progress. A 1 means dump in progress. See Section 3.1.2.3

Table 4.2-4 FOS NSSC-1 Processor Telemetry by Location

WD/SF	SHP	TM No	Significance
9/0		Y600	YSTBUF, Number of FOS status buffer entries. Measured since last time the counter reset
9/1		Y601	YONOFF, FOS on/off indicator. Is 1 if FOS turned off via processor 27; is 2 if turned on via processor 26; 0 otherwise
9/2		Y602	YFINST, Status of INIT processor. Is 1 if processor 30 executing; 2 if terminated on error; 4 if disabled by another processor; 0 otherwise
9/3		Y603	YFSDST, Science data storage status. Is 1 if procesor 31 executing; 2 if terminated on error; 4 if termination normal; 0 otherwise
9/4		Y604	YFPRST, Science data processing status. Is 1 if processor 32 executing; 2 if terminated on error, 4 if termination normal; 0 otherwise
9/5		Y605	YSPRØ, Spare 0.
9/6		Y606	YLINCT, Line number within a frame.
9/7		Y607	YFHKST, Housekeeping status. Is 1 if processor 30 executing; 2 if terminated on error; 4 if disabled by another processor; 0 otherwise
9/8		Y608	YFASST, Autonomous safe status. Is 1 if processor 25 executing; 2 if terminated abnormally; 4 if termination normal; 0 otherwise
9/9		Y609	YFTOST, Turn off status. Is 1 if processor 27 executing; 2 if terminated abnormally; 4 if termination normal; 0 otherwise
9/10		Y610	YFL81, Data items 1-8. FOS limit check flags B1
9/11		Y611	YFL169, Data items 9-16. FOS limit check flags B2
9/12		Y612	YFL241, Data items 17-24. FOS limit check flags B3
9/13		Y613	YFL322, Data items 25-32. FOS limit check flags B4
9/14		Y614	YSPR1, Spare 1.
9/15		Y615	YSPR2, Spare 2.
9/16		Y616	YKEEP, Counts main frame keep-alive failures. Counter of consecutive major frames in which YENGSYNC (in serial ED) fails keep-alive test
9/17		Y617	YFLGCT, Counts main frame limit check failures. Counter of consecutive major frames in which the same FOS limit check flag is set
9/18		Y618	YSFFLG, Autonomous safe flag. Is 1 if processor 25 has been invoked by processor 30; 2 if not requested after reinitialization of processor 30; 0 otherwise
9/19		Y619	YTOFLG, Turn off flag. Is 1 if processor 27 has been invoked by processor 30; 2 if not requested after re-initialization of processor 30; 0 otherwise
9/20	881_2 898_3 888_4	Y620	YFM2FL, Action indicator for YFM2PR module. See Section 3.2.1
9/21	880_3	Y621	YFRCTR, Count frames for part 1 of YFSDPR processor. See Section 3.2.1
9/22	880_2 879_3 880_4	Y622	YGIVUP, Mode 2 target acquisition error indicator. See Section 3.2.1

Table 4.2-4 FOS NSSC-1 Processor Telemetry by Location (cont)

WD/SF	SHP	TM No	Significance
9/23	881_4	Y623	YGPCTR, Count frames for part 2 of YFSDPR processor. See Section 3.2.1
9/24	879_2 879_4 879_5	Y624	YTACMP, Mode 2 target acquisition completion indicator. See Section 3.2.1
9/25	896_2	Y625	YFM2ST, Mode 2 target acquisition processor status. A 1 means processor 28 is executing normally; 2 means terminated on an error; 4 means successful completion; 0 otherwise
9/26		Y710	YFWSCT, Count major frames with firmware status errors.
9/27		Y627	YOVPRO, NSSC-1 overlight protection flag. A 1 means NSSC-1 overlight sum test is enabled
9/28	889_2 888_3 892_6	Y709	YRSINV, Raster scan request status. See Section 3.2.1
9/29	888_2 887_3	Y708	YPPINV, Preplanned branch request status. See Section 3.2.1
9/30	880_5	Y630	YFDWCT, Dwell counter for YFPKUP. See Section 3.2.1
9/31		Y712	YACMSB, Accumulated science data (8 MSBs). From YACACC (summation of science data in current frame)
9/32		Y713	YACNMS, Accumulated science data (second 8 MSBs). From YACACC (summation of science data in current frame)
9/33		Y714	YACNLS, Accumulated science data (third 8 MSBs). From YACACC (summation of science data in current frame)
9/34		Y715	YACLSB, Accumulated science data (fourth 8 MSBs). From YACACC (summation of science data in current frame)
9/35		Y716	YSPDOK, Enable speed check test in Processor 30. A 1 means speed check test permitted; 2 means not permitted; 0 otherwise
9/36	891_2 890_3	Y636	YSCNUM, Count steps in raster scan. Ranges from 0 to YRSMVS
9/37	893_2	Y637	YTACNT, Count window limit changes for Processor 28. Ranges from 0 to YTALIM
9/38		Y638	YFSCTR, Number of tests by YFHKPG where fail-safe armed. Counter indicating number of tests since YFHKPG was initialized where one or more of the fail-safe RPIs was armed
9/39		Y639	YERCTR, Consecutive major frames with error check error. Counter indicating consecutive major frames in which an error check error is indicated
9/40		Y640	YFWCTR, Consecutive major frames with firmware version error. Counter indicating consecutive major frames in which a firmware version error is indicated
9/41		Y641	YMFCCT, Counter of major frame fail-safe RPI test. Major frame counter used for fail-safe RPI test. It is reset 0 after reaches YDSARM
9/42		Y642	YMFECT, Counter of major frame output for data log. Major frame counter tested for output of SHPs during data acquisition. It is reset 0 after reaching YMFSHP or when [YNDAIP = 1]

Table 4.2-4 FOS NSSC-1 Processor Telemetry by Location (cont)

WD/SF	SHP	TM No	Significance
9/43		Y643	YSAFCR, Consecutive major frames gone safe autonomously. Number of consecutive major frames in which FOS indicated (via YSAFING) it has gone safe autonomously
9/44		Y644	YOVCTR, Counter of failed overlight sum tests. Number of consecutive major frames in which FOS overlight sum test has failed
9/45		Y645	YSCCTR, Counter of failed self-check tests. Number of consecutive major frames in which the FOS has failed the self-check test (in YSELFCHK)
9/46		Y646	YSPCTR, Counter of speed check errors. Counter indicating consecutive major frames in which a speed check error is indicated (YARITHCHK below NSSC-1 YBUSY value)
9/47		Y647	YSPR6, Spare 6.
9/48		Y648	YSPR7, Spare 7.
9/49		Y.648	YYSPR8 B1, Spare.
9/50		Y.648	YYSPR8 B2, Spare.
9/51		Y.648	YYSPR8 B3, Spare.
9/52		Y.648	YYSPR8 B4, Spare.
9/53		Y.648	YYSPR8 B5, Spare.
9/54		Y.648	YYSPR8 B6, Spare.
9/55		Y.648	YYSPR8 B7, Spare.
9/56		Y.648	YYSPR8 B8, Spare.
9/57		Y.648	YYSPR8 B9, Spare.
9/58		Y.648	YYSPR8 B1Ø, Spare.
9/59		Y.648	YYSPR8 B11, Spare.

Table 4.2-5 All FOS Commands and Telemetry by Number

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y000	YRAMADDR	/			Load RAM storage address. See Section 3.1.6.3
Y.001	YYSHUID	/		878	Identifier for FOS-Unique SHP data. See Section 3.2.1
Y.007	YYNMINOR	/		882_2	Minor frame number. See Section 3.2.1
Y.010	YYFVCTR1 HI	/		883_2 893_4	First element for coordinate transformation HI. See Section 3.2.1
Y.010	YYFVCTR1 LO	/		884_2 894_4	First element for coordinate transformation LO. See Section 3.2.1
Y.011	YYFVTCR2 HI	/		885_2 895_4	Second element for coordinate transformation HI. See Section 3.2.1
Y.011	YYFVTCR2 LO	/		886_2 896_4	Second element for coordinate transformation LO. See Section 3.2.1
Y.012	YPKCT1	/		882_4	Objects found in field. See Section 3.2.1
Y.013	YYCHPK1	/		882_3 883_4	First channel where peak found. See Section 3.2.1
Y.014	YYCHPK2	/		883_3 884_4	Second channel where peak found. See Section 3.2.1
Y.015	YYCHPK3	/		884_3 885_4	Third channel where peak found. See Section 3.2.1
Y.016	YYCHPK4	/		885_3 886_4	Fourth channel where peak found. See Section 3.2.1
Y.019	YBASKP	/		891_3 887_4 889_6	Y-BASE for current data. See Section 3.2.1
Y.020	YNBCTR	/		892_3	Brightness rank. See Section 3.2.1
Y.021	YOBSJ	/		893_3	Peak matrix number. See Section 3.2.1
Y.022	YBSM	/		894_3	Channel number of peak. See Section 3.2.1
Y.023	YNMAX	/		895_3	Number of counts in peak (scaled program value). See Section 3.2.1
Y.024	YNMEAN	/		896_3 891_4	Computed mean sky background (scaled program value).
Y.025	YVARI1	/		897_3 892_4	Sky variance (scaled program value). See Section 3.2.1
Y.027	YEDGE	/		889_4	Result of edge test. See Section 3.2.1
Y.028	YNTARG	/		890_4	Counts in target channels (scaled program value). See Section 3.2.1
Y.029	YACSI21 HI	/		882_5	Bits 1-2 of 36-bit accumulated science data for successful dwell. See Section 3.2.1
Y.029	YACSI21 LO	/		883_5	Bits 3-18 of 36-bit accumulated science data for successful dwell. See Section 3.2.1
Y.029	YACSI22 HI	/		884_5	Bits 19-20 of 36-bit accumulated science data for successful dwell. See Section 3.2.1
Y.029	YACSI22 LO	/		885_5	Bits 21-36 of 36-bit accumulated science data for successful dwell. See Section 3.2.1
Y.030	YFPUTT HI	/		890_5	Saved dwell time HI. See Section 3.2.1
Y.030	YFPUTT LO	/		891_5	Saved dwell time LO. See Section 3.2.1
Y.031	YACAI21 HI	/		886_5	Bits 1-2 of 36-bit accumulated science data for current dwell. See Section 3.2.1
Y.031	YACAI21 LO	/		887_5	Bits 3-18 of 36-bit accumulated science data for current dwell. See Section 3.2.1

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y.031	YACAI22 HI	/		888_5	Bits 19-20 of 36-bit accumulated science data for current dwell. See Section 3.2.1
Y.031	YACAI22 LO	/		889_5	Bits 21-36 of 36-bit accumulated science data for current dwell. See Section 3.2.1
Y.032	YTAINV	/		898_1 897_4 894_6	Maneuver direction inversion flag. See Section 3.2.1
Y.033	YPPB	/		887_2 886_3 886_6	Flag for pre-planned branch availability. See Section 3.2.1
Y.034	YRSMVS	/		890_2 889_3 893_6	Maximum moves during a raster scan.
Y.035	YTALIM	/		892_2	Number (+ 1) of window limit changes allowed by YFMOD2.
Y.036	YYNEDM4	/		894_2	Most recent high-order word of FOS engineering telemetry word YTARXCTR. See Section 3.2.1
Y.037	YYNEDM2	/		895_2	Most recent high-order word of FOS engineering telemetry word YTARYCTR. See Section 3.2.1
Y.038	YYTAMOD	/		897_2	Sampled value of FOS engineering telemetry word YTAMODE. See Section 3.2.1
Y.039	YFOUND	/		881_3	Total number of peaks found in the aperture map.
Y.040	YDWELS	/		881_5 880_6	Total number of dwells in this ST dwell-scan. See Section 3.2.1
Y.041	YSDPRC	/		879_6	Science data processing flag. See Section 3.2.1
Y.042	YFNMAX	/		880_6	Upper count for star field window. See Section 3.2.1
Y.043	YFNMIN	/		881_6	Lower count limit for star field window. See Section 3.2.1
Y.044	YNPEAK	/		883_6	Peak mapping indicator. See Section 3.2.1
Y.045	YHWHM	/		884_6	Width for merging peaks. See Section 3.2.1
Y.046	YNBRT	/		885_6	Peak number to choose. See Section 3.2.1
Y.047	YSTAT	/		887_6	Scaling of statistical fluctuation. See Section 3.2.1
Y.048	YTOLER	/		888_6	Tolerance for edge centering. See Section 3.2.1
Y.049	YOFFST	/		890_6	Y offset for target acquisition centering. See Section 3.2.1
Y.050	YXOFST	/		891_6	X offset for target acquisition centering. See Section 3.2.1
Y.051	YUPDWN	/		881_6	Direction of Peakup/Peakdown search. See Section 3.2.1
Y.052	YSMOTSV	/		882_6	Multiple of sky variance. See Section 3.2.1
Y.101	$YWRDSLIH_s$	8/4	904.0		Same as YWRDSLIN HI.
Y.102	$YWRDSLIL_s$	8/5	904.5		Same as YWRDSLIN LO.
Y.103	$YLINSFRH_s$	8/6	905.0		Same as YLINSFRM HI.
Y.104	$YLINSFRL_s$	8/7	905.5		Same as YLINSFRM LO.
Y.105	$YFGWAPO1_s$	8/8:1-4	906.0		Same as first YFGWAPOS.
Y.106	$YAPERPO1_s$ HI	8/9	906.5		Same as first YAPERHOE.
Y.106	$YAPERPO1_s$ LO	8/10	907.0		Same as first YAPERLOE.

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y.107	$YPLRZPO1_s$ HI	8/11	907.5		Same as first YPLZRHOE.
Y.107	$YPLRZPO1_s$ LO	8/12	908.0		Same as first YPLZRLOE.
Y.108	$YLIVE_s$ HI	8/63	933.5		Same as YLIVEHI.
Y.108	$YLIVE_s$ LO	8/64	934.0		Same as YLIVELO.
Y.109	$YDEAD_s$ HI	8/65	934.5		Same as YDEADHI.
Y.109	$YDEAD_s$ LO	8/66	935.0		Same as YDEADLO.
Y.110	$YMDMPADH_s$	8/115	959.5		Same as YMDMPADR HI.
Y.111	$YMDMPADL_s$	8/116	960.0		Same as YMDMPADR LO.
Y.201	$YYPATH_s$	8/1:8	902.5		Path identification. A 0 is "A" (amber or red) and 1 is "B" (blue). See Section 3.2.3
Y.202	YYSAFLKA	8/26:6	915.0		Auto safe due to loss of keep-alive SMC. See Section 3.1.6.5
Y.203	YYSAFTSL	8/26:7	915.0		Auto safe due to loss of telemetry sync. See Section 3.1.6.5
Y.204	YYSAFED	8/26:8	915.0		Auto safing enabled/disabled. See Section 3.1.6.5
Y.205	YYSYNCS	8/67:1	935.5		Synchronous start instrument mode. See Section 2.1.1
Y.206	YYTIMTG	8/67:2	935.5		Time-Tag instrument mode. See Section 2.1.2
Y.207	$YYREJRE_s$	8/67:3	935.5		Reject/~Retry instrument mode. See Section 2.1.3
Y.208	$YYTARGA_s$	8/67:4	935.5		Target acquisition instrument mode. See Section 2.1.4
Y.209	YYDBLSN	8/67:5	935.5		Double/~Single precision adder instrument mode. See Section 2.1.5
Y.210	YYAUTPO	8/67:6	935.5		Automatic polarizer sequence instrument mode. See Section 2.1.6
Y.211	YYSPR	8/67:7	935.5		Spare bit.
Y.212	YYSPR	8/67:8	935.5		Spare bit.
Y.213	YYRSMNI	8/112:1	958.0		Resume (no initialization). See Section 2.1.1
Y.214	YYINHSLT	8/112:2	958.0		Inhibit slice table fill. See Section 2.1.1
Y.215	YYINHYDF	8/112:3	958.0		Inhibit Y-deflection table fill. See Section 2.1.1
Y.216	YYINHXDF	8/112:4	958.0		Inhibit X-deflection table fill. See Section 2.1.1
Y.217	$YYINDFHY_s$	8/112:5	958.0		Do deflection hysteresis pattern at beginning of data acquisition. See Section 2.1.1
Y.218	YYSPR	8/112:6-8	958.0		Spare bits.
Y.219	YYILT3CC	8/95:1	949.5		Illegal Type-3 command code. See Section 3.1
Y.220	YYILT4CC	8/95:2	949.5		Illegal Type-4 command code. See Section 3.1
Y.221	YYILT4MO	8/95:3	949.5		Illegal Type-4 command modifier. See Section 3.1
Y.222	YYDCMOF	8/95:4	949.5		Data command overflow.
Y.223	YYDCMIP	8/95:5	949.5		Data command illegal path. See Section 3.1
Y.224	YYSSCIP	8/95:6	949.5		Synchronous start command illegal path. See Section 3.1
Y.225	YYTAWCIP	8/95:7	949.5		Target acquisition window command illegal path. See Section 3.1

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y.226	YYSDCIP	8/95:8	949.5		Science dump command illegal path. See Section 3.1
Y.227	YYSPR	8/34:5-6	919.0		Spare bits.
Y.228	YYFILTER	8/27:1	915.5		Filter data before finding peak. See Section 3.1.5
Y.229	YYFIX	8/27:2	915.5		Fix the target acquisition data. See Section 3.1.5
Y.230	YYINYFFL	8/27:3	915.5		Inhibit filter filling for Y. See Section 3.1.5
Y.231	YYINXFFL	8/27:4	915.5		Inhibit filter filling for X. See Section 3.1.5
Y.232	YYDBBUF	8/27:5	915.5		Double buffer FOS memory. See Section 3.1.5
Y.233	YYSPR	8/27:6	915.5		Spare bit.
Y.234	YYPYE	8/27:7	915.5		Find the Y direction upper edge. See Section 3.1.5
Y.235	YYMYE	8/27:8	915.5		Do Y direction edge finding. See Section 3.1.5
Y.301	YYSPR	7/29:1		174.5	Spare bit.
Y.302	YYSPR	7/29:3-8		174.5	Spare bits.
Y.400	YYSPR	/	1		Spare (225 words). See Section 3.2.2
Y.401	$YYDDTBL_s$	/	322		Discriminator DAC/Disabled Diode Table (512 words). See Section 3.2.2
Y.402	YYRAMMAP	/	834		RAM map (4 words). See Section 3.2.2
Y.403	$YYASCIIH_s$	/	838		ASCII header (64 words). See Section 3.2.2
Y.404	YYMIF	/	962		Minor frame number (8 bits). See Section 3.2.2
Y.405	YYMAF	/	962.5		Major frame number (8 bits). See Section 3.2.2
Y.406	$YYNREAD_s$	/	963		Readout number (16 bits). See Section 3.2.2
Y.407	$YYNMEMCL_s$	/	964		Memory clear number (16 bits). See Section 3.2.2
Y.408	YYSPR	/	965		Spare word.
Y.409	YYEPMC	/	226		Entrance Port Mechanism Control Block (8 words). See Section 3.2.2
Y.410	$YYAPMC_s$	/	234		Aperture Mechanism Control Block (18 words). See Section 3.2.2
Y.411	$YYPLMC_s$	/	252		Polarizer Mechanism Control Block (54 words). See Section 3.2.2
Y.412	$YYFGMC_s$	/	306		FGWA Mechanism Control Block (16 words). See Section 3.2.2
Y.648	YYSPR8 B1	9/49			Spare.
Y.648	YYSPR8 B2	9/50			Spare.
Y.648	YYSPR8 B3	9/51			Spare.
Y.648	YYSPR8 B4	9/52			Spare.
Y.648	YYSPR8 B5	9/53			Spare.
Y.648	YYSPR8 B6	9/54			Spare.
Y.648	YYSPR8 B7	9/55			Spare.
Y.648	YYSPR8 B8	9/56			Spare.
Y.648	YYSPR8 B9	9/57			Spare.

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y.648	YYSPR8 B1Ø	9/58			Spare.
Y.648	YYSPR8 B11	9/59			Spare.
Y.901	SOURCEID$_s$	/		1	SI ID in SHP. Value of X'DC' for FOS
Y.902	DCFOBSN$_s$	/		1.5	Observation number in SHP. See Section 3.2.1
Y.903	FOSPRGØ1$_s$	/		800	First ASCII FOS Program Number character in SHP.
Y.904	FOSPRGØ2$_s$	/		800.5	Second ASCII FOS Program Number character in SHP.
Y.905	FOSPRGØ3$_s$	/		801	Third ASCII FOS Program Number character in SHP.
Y.906	YYSPR	/		801.5	Spare in SHP. Value of X'00'
Y.907	FOSOBSØ1$_s$	/		802	First ASCII FOS Observation Set Number character in SHP.
Y.908	FOSOBSØ2$_s$	/		802.5	Second ASCII FOS Observation Set Number character in SHP.
Y.909	FOSOBNØ1$_s$	/		803	First ASCII FOS Observation Number character in SHP.
Y.910	FOSOBNØ2$_s$	/		803.5	Second ASCII FOS Observation Number character in SHP.
Y.911	UTCO2$_s$ B1	/		821	Byte 1 of UTCO. See Section 3.2.1
Y.911	UTCO2$_s$ B2	/		821.5	Byte 2 of UTCO.
Y.911	UTCO2$_s$ B3	/		822	Byte 3 of UTCO.
Y.911	UTCO2$_s$ B4	/		822.5	Byte 4 of UTCO.
Y.912	UTCO1$_s$ B1	/		823	Byte 5 of UTCO. See Section 3.2.1
Y.912	UTCO1$_s$ B2	/		823.5	Byte 6 of UTCO.
Y.912	UTCO1$_s$ B3	/		824	Byte 7 of UTCO.
Y.912	UTCO1$_s$ B4	/		824.5	Byte 8 of UTCO.
Y.913	SPCLINCN$_s$ B1	/		825	Byte 1 of spacecraft clock at UTCO. See Section 3.2.1
Y.913	SPCLINCN$_s$ B2	/		825.5	Byte 2 of spacecraft clock at UTCO.
Y.913	SPCLINCN$_s$ B3	/		826	Byte 3 of spacecraft clock at UTCO.
Y.913	SPCLINCN$_s$ B4	/		826.5	Byte 4 of spacecraft clock at UTCO.
Y.914	CLKRATE$_s$ B1	/		827	Byte 1 of clock rate. See Section 3.2.1
Y.914	CLKRATE$_s$ B2	/		827.5	Byte 2 of clock rate.
Y.914	CLKRATE$_s$ B3	/		828	Byte 3 of clock rate.
Y.914	CLKRATE$_s$ B4	/		828.5	Byte 4 of clock rate.
Y.914	CLKRATE$_s$ B5	/		829	Byte 5 of clock rate.
Y.914	CLKRATE$_s$ B6	/		829.5	Byte 6 of clock rate.
Y.914	CLKRATE$_s$ B7	/		830	Byte 7 of clock rate.
Y.914	CLKRATE$_s$ B8	/		830.5	Byte 8 of clock rate.
Y.915	CLKDRFTR$_s$ B1	/		831	Byte 1 of clock drift rate. See Section 3.2.1
Y.915	CLKDRFTR$_s$ B2	/		831.5	Byte 2 of clock drift rate.
Y.915	CLKDRFTR$_s$ B3	/		832	Byte 3 of clock drift rate.
Y.915	CLKDRFTR$_s$ B4	/		832.5	Byte 4 of clock drift rate.
Y.915	CLKDRFTR$_s$ B5	/		833	Byte 5 of clock drift rate.
Y.915	CLKDRFTR$_s$ B6	/		833.5	Byte 6 of clock drift rate.
Y.915	CLKDRFTR$_s$ B7	/		834	Byte 7 of clock drift rate.
Y.915	CLKDRFTR$_s$ B8	/		834.5	Byte 8 of clock drift rate.

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y.916	TIMECODE$_S$	/	-5		Words 8 and 9 of packet ancillary data. See Section 3.2.4
Y.916	TIMECODE$_S$	/		-5	Words 8 and 9 of packet ancillary data. See Section 3.2.4
Y.917	UTCO$_S$ B1	/		821	Byte 1 of UTCO. Same as UTCO2$_S$ B1
Y.917	UTCO$_S$ B2	/		821.5	Byte 2 of UTCO. Same as UTCO2$_S$ B2
Y.917	UTCO$_S$ B3	/		822	Byte 3 of UTCO. Same as UTCO2$_S$ B3
Y.917	UTCO$_S$ B4	/		822.5	Byte 4 of UTCO. Same as UTCO2$_S$ B4
Y.917	UTCO$_S$ B5	/		823	Byte 5 of UTCO. Same as UTCO1$_S$ B1
Y.917	UTCO$_S$ B6	/		823.5	Byte 6 of UTCO. Same as UTCO1$_S$ B2
Y.917	UTCO$_S$ B7	/		824	Byte 7 of UTCO. Same as UTCO1$_S$ B3
Y.917	UTCO$_S$ B8	/		824.5	Byte 8 of UTCO. Same as UTCO1$_S$ B4
Y001$_C$	YDATA	/			Data for type four commands.
Y002$_C$	YSCIDMP	/			Set dump parameters. See Section 3.1.2.1
Y004$_C$	YTARACQ	/			Set target acquisition parameters. See Section 3.1.5
Y006$_C$	YDISCADR	/			Load discriminator at address or set all values. See Section 3.1.6.2
Y008$_C$	YLIVETYM	/			Set accumulator open (live) time. See Section 3.1.1.1
Y010$_C$	YDEADTYM	/			Set accumulator closed (dead) time. See Section 3.1.1.1
Y012$_C$	YCHNLEN	/			Enable/inhibit channel(s). See Section 3.1.6.2
Y014$_C$	YREJLIM	/			Set noise rejection limit. See Section 3.1.1.1
Y016$_C$	YACQLIM	/			Set data acquisition limit. See Section 3.1.2.3
Y018$_C$	YSTRWRD	/			Store next commands as data. See Section 3.1.6.3
Y022$_C$	YMECHCAL	/			Set feedback code for mechanism. See Section 3.1.4
Y023$_C$	YSYNC	/			Set delay for starting synchronous acquisition. See Section 3.1.6.1
Y024$_C$	YX-DEFL	/			Set X-deflection amplifier DAC. See Section 3.1.3
Y025$_C$	YY-DEFL	/			Set Y-deflection amplifier DAC. See Section 3.1.3
Y026$_C$	YX-BASE	/			Base value for X deflection computations. See Section 3.1.3
Y027$_C$	YY-BASE	/			Base value for Y deflection computations. See Section 3.1.3
Y028$_C$	YX-PITCH	/			Scaled X-deflection DAC value for one diode width in X. See Section 3.1.3
Y029$_C$	YY-PITCH	/			Scaled Y-deflection DAC value for one diode width in Y. See Section 3.1.3
Y030$_C$	YHVDAC	/			Set high voltage power supply DAC. See Section 3.1.3

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
$Y031_c$	YDISC	/			Set discriminator DAC table value. See Section 3.1.6.2
$Y032_c$	YREFDAC	/			Set common discriminator reference DAC. See Section 3.1.6.2
$Y033_c$	YFOCUS	/			Set focus trim DAC. See Section 3.1.3
$Y034_c$	YENTRNC	/			Set entrance port open or closed. See Section 3.1.4.1
$Y035_c$	YAPER	/			Set entrance aperture to position. See Section 3.1.4.2
$Y036_c$	YPLZR	/			Set polarizer mechanism to position. See Section 3.1.4.3
$Y037_c$	YFILTER	/			Set FGWA to position. See Section 3.1.4.4
$Y038_c$	YFFCAL	/			Set LED flat-field lamp on or off. See Section 3.1.6.4
$Y039_c$	YX-STEP	/			Select number of X deflection steps. See Section 3.1.1.2
$Y040_c$	YXFILW	/			Specify X filter width. See Section 3.1.5
$Y041_c$	YINIT	/			Set initialization mode. See Section 3.1.6.1
$Y042_c$	Y1STCHNL	/			Set first channel to be processed. See Section 3.1.2.2
$Y043_c$	YINTS	/			Set number of sub-integrations per X-step. See Section 3.1.1.1
$Y044_c$	YSTOPDMP	/			Stop science dump. See Section 3.1.2.3
$Y045_c$	YOUT-CLR	/			Set readouts/memory clear. See Section 3.1.1.7
$Y046_c$	YTAMOD	/			Set target acquisition mode. See Section 3.1.5
$Y047_c$	YY-STEP	/			Set number of Y deflection steps. See Section 3.1.1.4
$Y048_c$	YYFILW	/			Specify Y filter width. See Section 3.1.5
$Y049_c$	YACQMODE	/			Set data acquisition mode. See Section 3.1.6.1
$Y050_c$	YCHNLS	/			Set number of channels to be processed. See Section 3.1.2.2
$Y051_c$	YOVRSCAN	/			Set number of diodes overscan. See Section 3.1.1.3
$Y052_c$	YRAM-MAP	/			Map physical to logical RAM page. See Section 3.1.6.5
$Y053_c$	YCLEARS	/			Set number of memory clears/acquisition. See Section 3.1.1.8
$Y054_c$	YPTRNOUT	/			Set number of patterns/readout. See Section 3.1.1.6
$Y055_c$	YMEMCHK	/			Fill science memory with test pattern. See Section 3.1.6.3
$Y056_c$	YMCHSTEP	/			Step mechanism. See Section 3.1.4
$Y057_c$	YSDERASE	/			Clear science memory locations. See Section 3.1.6.3
$Y058_c$	YKPALVED	/			Enable/disable autonomous going safe. See Section 3.1.6.5

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
$Y059_c$	YSCIADDR	/			Set first RAM address for science data. See Section 3.1.6.5
$Y066_c$	YY-RNGE	/			Set range for Y deflection. See Section 3.1.1.4
$Y068_c$	YSLICES	/			Set number of memory slices. See Section 3.1.1.5
$Y070_c$	YSCIACT	/			Control science data dump. See Section 3.1.2.3
$Y071_c$	YKEY	/			Provide FORTH KEY capability. See Section 3.1.6.5
$Y083_c$	YDDCHK	/			Sample all discriminator DACs. See Section 3.1.6.1
$Y084_c$	YEFILL	/			Sample all serial digital telemetry. See Section 3.1.6.1
$Y085_c$	YPAUSE	/			Set/reset pause acquisition bit. See Section 3.1.2.3
$Y086_c$	YRANDOM	/			Fill science memory with pseudo-random sequence. See Section 3.1.6.3
$Y087_c$	YMCHREG	/			Set mechanism register to drive signal. See Section 3.1.4
$Y088_c$	YTA	/			Begin Mode II FOS Target Acquisition Calculations. See Section 3.1.5
Y101	YCMTRST	3/1:8		141.5	Carrousel motor status. A 0 is B and a 1 is A. See Section 3.1.4.4
Y102	YCALRPI	4/1:6		142.5	Calibration lamp supply RPI. A 0 is on and 1 is off. See Section 3.1.6.4
Y103	YWTCHDOG	3/1:3		141.5	Watchdog timer status. A 0 is OK and 1 is error. See Section 3.1.6.5
Y104	YINSENG	3/1:4		141.5	Instruction engineering bit status. A 0 is OK and 1 is error. See Section 3.1.6.5
Y105	YRESETST	3/1:1		141.5	Reset status. A 0 is reset and a 1 is not reset
Y106	YODSCRAM	3/1:5		141.5	Descramble PROM power status odd. A 0 is off and 1 is on
Y107	YEDSCRAM	3/1:6		141.5	Descramble PROM power status even. A 0 is off and 1 is on
Y117	YHVRPI	4/1:5		142.5	High voltage relay position. A 0 is HVON (on) and 1 is HVOF (off)
Y118	YHTRRPI	1/1:8		139.5	Heater control relay position. A 0 is HTON (on) and 1 is HTOF (off)
Y119	YQSRPI	4/1:3		142.5	Quiet supply relay position. A 0 is +QPS (on) and 1 is -QPS (off)
Y120	YLSRPI	4/1:4		142.5	Logic supply relay status. A 0 is +LPS (on) and 1 is -LPS (off)
Y121	Y1BUSRPI	4/1:7		142.5	Common bus relay #1 status. A 0 is B On/A Off1 and a 1 is A On/B Off1
Y122	Y2BUSRPI	4/1:8		142.5	Common bus relay #2 status. A 0 is B On/A Off2 and a 1 is A On/B Off2

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y123	YAPRFRPI	1/1:5		139.5	Aperture failsafe arm/safe status. A 0 is Arm and 1 is Safe. See Section 3.1.4.2
Y124	YENTFRPI	1/1:6		139.5	Entrance door failsafe arm/safe status. A 0 is Arm and 1 is Safe. See Section 3.1.4.1
Y125	Y1SDFPRT	1/1:1		139.5	SD CEA A K1-K6 status. A 0 is AB and 1 is AA
Y126	Y2SDFPRT	1/1:2		139.5	SD CEA A K7-K11 status. A 0 is AB and 1 is AA
Y127	Y3SDFPRT	1/1:3		139.5	SD CEA B K1-K6 status. A 0 is BB and 1 is BA
Y128	Y4SDFPRT	1/1:4		139.5	SD CEA B K7-K11 status. A 0 is BB and 1 is BA
Y130	YPOLFRPI	1/1:7		139.5	Polarizer failsafe arm/safe status. A 0 is Arm and 1 is Safe. See Section 3.1.4.3
Y131	YRIUS2	4/1:1-2		142.5	RIU standby status. Bit 1 is for RIU A and bit 2 for RIU B. A 0 means STBY1 and a 1 means STBY2
Y133	YCALSELR	3/1:7		141.5	Calibration lamp select RPI. A 0 is B and a 1 is A. See Section 3.1.6.4
Y134	YCLKMON	3/1:2		141.5	Microprocessor clock monitor. A 0 is 3 MHz and 1 is 1.5 MHz. See Section 3.1.6.5
Y301	Y1OBTMP	7/0		145.5	Optical bench temperature location 1.
Y302	Y2OBTMP	7/1		146.5	Optical bench temperature location 2.
Y303	Y3OBTMP	7/2		147.5	Optical bench temperature location 3.
Y304	Y4OBTMP	7/3		148.5	Optical bench temperature location 4.
Y305	YPCATMP	7/4		149.5	Photocathode A temperature.
Y306	YPAMATMP	7/5		150.5	Pre-Amp assembly A temperature.
Y307	YPMFATMP	7/6		151.5	Permanent magnet focus assembly A temperature.
Y308	Y1OATMP	7/7		152.5	Optics area temperature location 1.
Y309	Y2OATMP	7/8		153.5	Optics area temperature location 2.
Y310	YSIGPTMP	7/9		154.5	Signal processor temperature.
Y311	YCEATMP	7/10		155.5	Central electronics temperature.
Y312	YDOORTMP	7/11		156.5	Entrance door mechanism temperature.
Y313	YAPERTMP	7/12		157.5	Aperture mechanism temperature.
Y314	YPOLRTMP	7/13		158.5	Polarizer mechanism temperature.
Y315	YFGMATMP	7/14		159.5	Filter/Grating Wheel motor A temperature.
Y316	YHVTMP	7/15		160.5	High voltage supply temperature.
Y318	YCPSTMP	7/18		163.5	Central power supply temperature.
Y319	YHVVLT	0/0		131.5	High voltage supply voltage.
Y320	YCALVLT	6/0		137.5	Calibration lamp supply voltage.
Y321	YXDEFCUR	2/0		133.5	X-Deflection coil driver current.
Y322	YYDEFCUR	3/0		134.5	Y-Deflection coil driver current.
Y323	YTRMFCUR	4/0		135.5	Trim focus coil driver current.
Y324	YDSCRVLT	5/0		136.5	Discriminator reference voltage.
Y325	YHVCUR	1/0		132.5	High voltage supply current.
Y326	YARIUTMP	7/16		161.5	RIU-A temperature.
Y327	YBRIUTMP	7/17		162.5	RIU-B temperature.
Y328	YCLSCUR	0/1		138.5	Calibration lamp supply current.
Y329	YFGMBTMP	7/19		164.5	Filter/Grating Wheel motor B temperature.
Y330	YPCBTMP	7/20		165.5	Photocathode B temperature.
Y331	YPAMBTMP	7/21		166.5	Pre-Amp assembly B temperature.
Y332	Y8VQPSV	5/1		143.5	Plus 8 volt quiet power supply voltage.
Y333	YPMFBTMP	7/22		167.5	Permanent magnet focus assembly B temperature.

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y334	YXYDFTMP	7/23		168.5	X Y deflection focus DAC temperature.
Y337	Y5VLPSV	6/1		144.5	Plus 5 volt logic power supply voltage.
Y338	YINTPRES	2/1		140.5	Vacuum gauge reading.
Y500	YENGSYNC	8/0	902.0		MP serial engr data packet sync. Value is X'A5'
Y501	YFIRMVER	8/1	902.5		Firmware version number. Has Y.201
Y501$_c$	YARMAP	/			Arm Aperture command. See Section 3.1.4.2
Y502	YERRCHK HI	8/2	903.0		Firmware check character HI. See Section 1.5
Y502	YERRCHK LO	8/3	903.5		Firmware check character LO. See Section 1.5
Y503	YDOOR	8/8:7-8	906.0		Entrance door position. See Section 3.1.4.1
Y503	YDOOR	8/38:7-8	921.0		Entrance door position. See Section 3.1.4.1
Y503	YDOOR	8/68:7-8	936.0		Entrance door position. See Section 3.1.4.1
Y503	YDOOR	8/98:7-8	951.0		Entrance door position. See Section 3.1.4.1
Y503$_c$	YARMED	/			Arm Entrance Port command. See Section 3.1.4.1
Y504	YFGWASTR	8/8:5	906.0		FGWA encoder strobe bit.
Y504	YFGWASTR	8/38:5	921.0		FGWA encoder strobe bit.
Y504	YFGWASTR	8/68:5	936.0		FGWA encoder strobe bit.
Y504	YFGWASTR	8/98:5	951.0		FGWA encoder strobe bit.
Y505$_c$	YSAFAP	/			Safe Aperture command. See Section 3.1.4.2
Y506	YFGWAPOS	8/8:1-4	906.0		Filter/Grating Wheel Assembly position. See Section 3.1.4.4
Y506	YFGWAPOS	8/38:1-4	921.0		Filter/Grating Wheel Assembly position. See Section 3.1.4.4
Y506	YFGWAPOS	8/68:1-4	936.0		Filter/Grating Wheel Assembly position. See Section 3.1.4.4
Y506	YFGWAPOS	8/98:1-4	951.0		Filter/Grating Wheel Assembly position. See Section 3.1.4.4
Y507$_c$	YSAFED	/			Safe Entrance Port command. See Section 3.1.4.1
Y508	YFGWASP	8/8:6	906.0		FGWA spare.
Y508	YFGWASP	8/38:6	921.0		FGWA spare.
Y508	YFGWASP	8/68:6	936.0		FGWA spare.
Y508	YFGWASP	8/98:6	951.0		FGWA spare.
Y509	YXFLWID	8/15	909.5		Target acquisition X filter width.
Y510	YTARXCTR HI	8/16	910.0		Target Acq X-center HI. See Section 3.1.5
Y510	YTARXCTR LO	8/17	910.5		Target Acq X-center LO. See Section 3.1.5
Y510	YTARXCTR HI	8/76	940.0		Target Acq X-center HI. See Section 3.1.5
Y510	YTARXCTR LO	8/77	940.5		Target Acq X-center LO. See Section 3.1.5
Y511	YTARYCTR HI	8/18	911.0		Target Acq Y-center HI. See Section 3.1.5
Y511	YTARYCTR LO	8/19	911.5		Target Acq Y-center LO. See Section 3.1.5
Y511	YTARYCTR HI	8/78	941.0		Target Acq Y-center HI. See Section 3.1.5
Y511	YTARYCTR LO	8/79	941.5		Target Acq Y-center LO. See Section 3.1.5
Y511$_c$	YARMPL	/			Arm Polarizer command. See Section 3.1.4.3
Y514	YSAFING	8/26	915.0		Auto safe mode transition. Has Y.202-Y.204 (bits 1-5 unused). Bits 6-7 zeroed when sampled
Y515	YTAMODE	8/27	915.5		Target acquisition mode. See Section 3.1.5
Y515$_c$	YSAFPL	/			Safe Polarizer command. See Section 3.1.4.3

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y516	YARITHCK HI	8/28	916.0		Arithmetic self-check (speed) results HI. See Section 1.5
Y516	YARITHCK LO	8/29	916.5		Arithmetic self-check (speed) results LO. See Section 1.5
Y517	YSELFCHK HI	8/30	917.0		Processor self-check results HI. See Section 1.5
Y517	YSELFCHK LO	8/31	917.5		Processor self-check results LO. See Section 1.5
Y517[c]	YHVOFF	/			High Voltage Supply Off command.
Y518	YDREFDAC	8/32	918.0		Discriminator reference DAC.
Y519	YFOCUSRB	8/33	918.5		Focus trim coil DAC readback. See Section 3.1.3
Y519[c]	YHVON	/			High Voltage Supply On command.
Y520	YHVDACRB HI	8/34:7-8	919.0		High voltage DAC readback HI. See Section 3.1.3
Y520	YHVDACRB LO	8/35	919.5		High voltage DAC readback LO. See Section 3.1.3
Y521	YYDAC HI	8/36	920.0		Y DAC readback HI. See Section 3.1.3
Y521	YYDAC LO	8/37	920.5		Y DAC readback LO. See Section 3.1.3
Y521[c]	YQSOFF	/			Quiet Supply Off command.
Y522	YXPITCH HI	8/46	925.0		X deflection pitch between diodes HI. See Section 3.1.3
Y522	YXPITCH LO	8/47	925.5		X deflection pitch between diodes LO. See Section 3.1.3
Y523	YXBASE HI	8/48	926.0		X deflection base HI. See Section 3.1.3
Y523	YXBASE LO	8/49	926.5		X deflection base LO. See Section 3.1.3
Y523[c]	YQSON	/			Quiet Supply On command.
Y524	YXSTEPS	8/50	927.0		X deflection sub-steps. See Section 3.1.1.2
Y525[c]	YLSOFF	/			Logic Supply Off command.
Y526	YYPITCH HI	8/53	928.5		Y deflection pitch between diodes HI. See Section 3.1.3
Y526	YYPITCH LO	8/54	929.0		Y deflection pitch between diodes LO. See Section 3.1.3
Y527	YYBASE HI	8/55	929.5		Y deflection base HI. See Section 3.1.3
Y527	YYBASE LO	8/56	930.0		Y deflection base LO. See Section 3.1.3
Y527[c]	YHTON	/			Heater On command.
Y528	YYSTEPS	8/57	930.5		Y deflection sub-steps. See Section 3.1.1.4
Y529[c]	YSDFB4	/			SDF B4 port to side select command.
Y530	YOVRSCAN	8/60	932.0		X deflection overscan. See Section 3.1.1.3
Y531	Y1STCHNL	8/61	932.5		First channel to be processed. See Section 3.1.2.2
Y531[c]	YSDFB2	/			SDF B2 port to side select command.
Y532	YNUMCHNL	8/62	933.0		Number of channels to be processed. See Section 3.1.2.2
Y533[c]	YSDFB3	/			SDF B3 port to side select command.
Y535[c]	YSDFB1	/			SDF B1 port to side select command.
Y536	YFWSTAT1 HI	8/82	943.0		Firmware status group 1 HI. Typically ASCII (interpretation depends on use)

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y536	YFWSTAT1 LO	8/83	943.5		Firmware status group 1 LO. Typically ASCII (interpretation depends on use)
Y537	YFWSTAT2 HI	8/84	944.0		Firmware status group 2 HI. Typically ASCII (interpretation depends on use)
Y537	YFWSTAT2 LO	8/85	944.5		Firmware status group 2 LO. Typically ASCII (interpretation depends on use)
Y537c	YSDFA4	/			SDF A4 port to side select command.
Y538	YFWSTAT3 HI	8/86	945.0		Firmware status group 3 HI. Typically ASCII (interpretation depends on use)
Y538	YFWSTAT3 LO	8/87	945.5		Firmware status group 3 LO. Typically ASCII (interpretation depends on use)
Y539	YFWSTAT4 HI	8/88	946.0		Firmware status group 4 HI. Typically ASCII (interpretation depends on use)
Y539	YFWSTAT4 LO	8/89	946.5		Firmware status group 4 LO. Typically ASCII (interpretation depends on use)
Y539c	YSDFA2	/			SDF A2 port to side select command.
Y540	YFWSTAT5 HI	8/90	947.0		Firmware status group 5 HI. Typically ASCII (interpretation depends on use)
Y540	YFWSTAT5 LO	8/91	947.5		Firmware status group 5 LO. Typically ASCII (interpretation depends on use)
Y541	YFWSTAT6 HI	8/92	948.0		Firmware status group 6 HI. Typically ASCII (interpretation depends on use)
Y541	YFWSTAT6 LO	8/93	948.5		Firmware status group 6 LO. Typically ASCII (interpretation depends on use)
Y541c	YSDFA3	/			SDF A3 port to side select command.
Y542	YMCLEARS	8/94	949.0		Memory clears/data acquisition. See Section 3.1.1.8
Y543	YLASTCMD HI	8/96	950.0		Last command at SMC error HI. See Section 3.1
Y543	YLASTCMD LO	8/97	950.5		Last command at SMC error LO. See Section 3.1
Y543c	YSDFA1	/			SDF A1 port to side select command.
Y544	YNOISELM HI	8/106	955.0		Burst noise rejection limit HI. See Section 3.1.1.1
Y544	YNOISELM LO	8/107	955.5		Burst noise rejection limit LO. See Section 3.1.1.1
Y545	YRAMADDR HI	8/108	956.0		RAM address pointer HI. See Section 3.1.6.3
Y545	YRAMADDR LO	8/109	956.5		RAM address pointer LO. See Section 3.1.6.3
Y545c	YRESET	/			Reset Microprocessor command. See Section 3.1.6.5
Y546	YINTEG	8/110	957.0		Number of integrations/X-step. See Section 3.1.1.1
Y547	YINTMODE	8/112	958.0		Initialization mode. Has Y.213-Y.218
Y547c	YHTOFF	/			Heater Off command.
Y548	YREADCYC	8/113	958.5		Readouts/memory clear. See Section 3.1.1.7
Y549	YDATALIM	8/114	959.0		High byte of acquisition limit. See Section 3.1.2.3
Y549c	YRIEBW	/			Reset IEB/Watchdog command. See Section 3.1.6.5
Y550	YMDMPADR HI	8/115	959.5		Memory dump address HI. See Section 3.1.2.1
Y550	YMDMPADR LO	8/116	960.0		Memory dump address LO. See Section 3.1.2.1

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y551	YWRDSLIN HI	8/4	904.0		Words per line HI. See Section 3.1.2.1
Y551	YWRDSLIN LO	8/5	904.5		Words per line LO. See Section 3.1.2.1
$Y551_C$	Y3MHZ	/			Select 3.0 MHz Clock command. See Section 3.1.6.5
Y552	YLINSFRM HI	8/6	905.0		Lines per frame HI. See Section 3.1.2.1
Y552	YLINSFRM LO	8/7	905.5		Lines per frame LO. See Section 3.1.2.1
Y553	YXDAC HI	8/13	908.5		X DAC readback HI. See Section 3.1.3
Y553	YXDAC LO	8/14	909.0		X DAC readback LO. See Section 3.1.3
Y553	YXDAC HI	8/43	923.5		X DAC readback HI. See Section 3.1.3
Y553	YXDAC LO	8/44	924.0		X DAC readback LO. See Section 3.1.3
Y553	YXDAC HI	8/73	938.5		X DAC readback HI. See Section 3.1.3
Y553	YXDAC LO	8/74	939.0		X DAC readback LO. See Section 3.1.3
Y553	YXDAC HI	8/103	953.5		X DAC readback HI. See Section 3.1.3
Y553	YXDAC LO	8/104	954.0		X DAC readback LO. See Section 3.1.3
$Y553_C$	Y1.5MZ	/			Select 1.5 MHz Clock command. See Section 3.1.6.5
Y555	YRANGE	8/52	928.0		Y range. See Section 3.1.1.4
$Y555_C$	YABACQ	/			Abort Data Acquisition command. See Section 3.1.2.3
Y556	YSPRBIT1	8/117:1	960.5		Spare bit. All bits in word zeroed when sampled
$Y557_C$	YENDAC	/			End Data Acquisition command. See Section 3.1.2.3
Y558	YXDACERR	8/117:4	960.5		X DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
Y559	YYDACERR	8/117:6	960.5		Y DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
$Y559_C$	YBEGAC	/			Begin Data Acquisition command. See Section 3.1.2.3
Y560	YFDACERR	8/117:2	960.5		Focus DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
Y561	YHVDACER	8/117:7	960.5		HV DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
$Y561_C$	YBLAPR	/			Blow Aperture command. See Section 3.1.4.2. Not in SLIB L98
Y562	YDRDACER	8/117:8	960.5		Discriminator reference DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.6.2
Y563	YDDACERR	8/117:3	960.5		Discriminator DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.6.1
$Y563_C$	YBLENT	/			Blow Entrance Port command. See Section 3.1.4.1. Not in SLIB L98
Y564	YACTMERR	8/118:1	961.0		Accumulator timer set error. A 0 is OK and a 1 is error
Y566	YMECHTOC	8/118:2-4	961.0		Mechanism time-out code. See Section 3.1.4
Y567	YBEGINDA	8/118:5	961.0		Begin data acquisition command flag. A 1 means begin. See Section 3.1.2.3
$Y567_C$	YBLPOL	/			Blow Polarizer command. See Section 3.1.4.3. Not in SLIB L98

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y568	YENDDA	8/118:6	961.0		End data acquisition command flag. A 1 means end. See Section 3.1.2.3
Y569	YABORTDA	8/118:7	961.0		Abort data acquisition command flag. A 1 means abort. See Section 3.1.2.3
$Y569_c$	YLSON	/			Logic Supply On command.
Y570	YRESETMP	8/118:8	961.0		Reset microprocessor command flag. A 1 means reset. See Section 3.1.6.5
Y571	YNDAIP	8/119:1	961.5		Data acquisition not in progress. A 1 means not in progress. See Section 3.1.1
$Y571_c$	YCMTRA	/			Select Motor A command. See Section 3.1.4.4
Y572	YRIP	8/119:2	961.5		Resting in peace.
Y573	YPIP	8/119:3	961.5		Pause in progress. A 1 means pause in progress. See Section 3.1.2.3
$Y573_c$	YCMTRB	/			Select Motor B command. See Section 3.1.4.4
Y574	YCPIP	8/119:4	961.5		CEA plot in progress. A 1 means plot in progress
Y575	YTAQIP	8/119:5	961.5		Target acquisition in progress. A 1 means acquisition in progress. See Section 2.1.4
$Y575_c$	YCALON	/			Spectral Cal. Lamp On command. See Section 3.1.6.4
Y576	YMSLICES	8/59	931.5		Number of memory slices. See Section 3.1.1.5
Y577	YPTRNS	8/111	957.5		Patterns per readout. See Section 3.1.1.6
$Y577_c$	YCALOF	/			Spectral Cal. Lamp Off command. See Section 3.1.6.4
Y578	YCDACERR	8/117:5	960.5		Calibration DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.6.4
Y579	YDPRMPWR	8/34:1-2	919.0		Descramble PROM power status. A 00 is off, 01 is even, 10 is odd, and 11 is both
$Y579_c$	YBUSA1	/			A-On, B-Off S1 command.
Y580	YFFCPWR	8/34:4	919.0		Flat field cal lamp power. A zero is off and a 1 is on. See Section 3.1.6.4
$Y580_c$	YBUSB1	/			B-On, A-Off S1 command.
Y581	YHVSPAR	8/34:3	919.0		Spare bit.
$Y581_c$	YBUSA2	/			A-On, B-Off S2 command.
Y582	YMMIP	8/119:6	961.5		Mechanism motion in progress. A 1 means motion in progress
$Y582_c$	YBUSB2	/			B-On, A-Off S2 command.
Y583	YAMCIP	8/119:7	961.5		Auto memory clear in progress. A 1 means clear to be done (interface with data monitoring background task)
$Y583_c$	YCALSA	/			Select Cal. Lamp A command. See Section 3.1.6.4
Y584	YSDIP	8/119:8	961.5		Science dump in progress. A 1 means dump in progress. See Section 3.1.2.3
Y585	YLIVEHI	8/63	933.5		Accumulator open time high byte. See Section 3.1.1.1
$Y585_c$	YCALSB	/			Select Cal. Lamp B command. See Section 3.1.6.4

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y586	YLIVELO	8/64	934.0		Accumulator open time low byte. See Section 3.1.1.1
Y587	YDEADHI	8/65	934.5		Accumulator close time high byte. See Section 3.1.1.1
Y588	YDEADLO	8/66	935.0		Accumulator close time low byte. See Section 3.1.1.1
Y600	YSTBUF	9/0			Number of FOS status buffer entries. Measured since last time the counter reset
Y600[c]	YIGON	/			Ion Gauge On.
Y601	YONOFF	9/1			FOS on/off indicator. Is 1 if FOS turned off via processor 27; is 2 if turned on via processor 26; 0 otherwise
Y601[c]	YIGOFF	/			Ion Gauge Off.
Y602	YFINST	9/2			Status of INIT processor. Is 1 if processor 30 executing; 2 if terminated on error; 4 if disabled by another processor; 0 otherwise
Y603	YFSDST	9/3			Science data storage status. Is 1 if procesor 31 executing; 2 if terminated on error; 4 if termination normal; 0 otherwise
Y604	YFPRST	9/4			Science data processing status. Is 1 if processor 32 executing; 2 if terminated on error, 4 if termination normal; 0 otherwise
Y605	YSPRØ	9/5			Spare 0.
Y606	YLINCT	9/6			Line number within a frame.
Y607	YFHKST	9/7			Housekeeping status. Is 1 if processor 30 executing; 2 if terminated on error; 4 if disabled by another processor; 0 otherwise
Y608	YFASST	9/8			Autonomous safe status. Is 1 if processor 25 executing; 2 if terminated abnormally; 4 if termination normal; 0 otherwise
Y609	YFTOST	9/9			Turn off status. Is 1 if processor 27 executing; 2 if terminated abnormally; 4 if termination normal; 0 otherwise
Y610	YFL81	9/10			Data items 1-8. FOS limit check flags B1
Y611	YFL169	9/11			Data items 9-16. FOS limit check flags B2
Y612	YFL241	9/12			Data items 17-24. FOS limit check flags B3
Y613	YFL322	9/13			Data items 25-32. FOS limit check flags B4
Y614	YSPR1	9/14			Spare 1.
Y615	YSPR2	9/15			Spare 2.
Y616	YKEEP	9/16			Counts main frame keep-alive failures. Counter of consecutive major frames in which YENGSYNC (in serial ED) fails keep-alive test
Y617	YFLGCT	9/17			Counts main frame limit check failures. Counter of consecutive major frames in which the same FOS limit check flag is set
Y618	YSFFLG	9/18			Autonomous safe flag. Is 1 if processor 25 has been invoked by processor 30; 2 if not requested after reinitialization of processor 30; 0 otherwise

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y619	YTOFLG	9/19			Turn off flag. Is 1 if processor 27 has been invoked by processor 30; 2 if not requested after reinitialization of processor 30; 0 otherwise
Y620	YFM2FL	9/20		881_2 898_3 888_4	Action indicator for YFM2PR module. See Section 3.2.1
Y621	YFRCTR	9/21		880_3	Count frames for part 1 of YFSDPR processor. See Section 3.2.1
Y622	YGIVUP	9/22		880_2 879_3 880_4	Mode 2 target acquisition error indicator. See Section 3.2.1
Y623	YGPCTR	9/23		881_4	Count frames for part 2 of YFSDPR processor. See Section 3.2.1
Y624	YTACMP	9/24		879_2 879_4 879_5	Mode 2 target acquisition completion indicator. See Section 3.2.1
Y625	YFM2ST	9/25		896_2	Mode 2 target acquisition processor status. A 1 means processor 28 is executing normally; 2 means terminated on an error; 4 means successful completion; 0 otherwise
Y625c	YSTBY1A	/			RIU Standby 1-A; self on.
Y626c	YSTBY1B	/			RIU Standby 1-B; self on.
Y627	YOVPRO	9/27			NSSC-1 overlight protection flag. A 1 means NSSC-1 overlight sum test is enabled
Y627c	YSTBY2A	/			RIU Standby 2-A; mate off.
Y628c	YSTBY2B	/			RIU Standby 2-B; mate off.
Y630	YFDWCT	9/30		880_5	Dwell counter for YFPKUP. See Section 3.2.1
Y636	YSCNUM	9/36		891_2 890_3	Count steps in raster scan. Ranges from 0 to YRSMVS
Y637	YTACNT	9/37		893_2	Count window limit changes for Processor 28. Ranges from 0 to YTALIM
Y638	YFSCTR	9/38			Number of tests by YFHKPG where fail-safe armed. Counter indicating number of tests since YFHKPG was initialized where one or more of the fail-safe RPIs was armed
Y639	YERCTR	9/39			Consecutive major frames with error check error. Counter indicating consecutive major frames in which an error check error is indicated
Y640	YFWCTR	9/40			Consecutive major frames with firmware version error. Counter indicating consecutive major frames in which a firmware version error is indicated
Y641	YMFCCT	9/41			Counter of major frame fail-safe RPI test. Major frame counter used for fail-safe RPI test. It is reset 0 after reaches YDSARM
Y642	YMFECT	9/42			Counter of major frame output for data log. Major frame counter tested for output of SHPs during data acquisition. It is reset 0 after reaching YMFSHP or when [YNDAIP = 1]

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y643	YSAFCR	9/43			Consecutive major frames gone safe autonomously. Number of consecutive major frames in which FOS indicated (via YSAFING) it has gone safe autonomously
Y644	YOVCTR	9/44			Counter of failed overlight sum tests. Number of consecutive major frames in which FOS overlight sum test has failed
Y645	YSCCTR	9/45			Counter of failed self-check tests. Number of consecutive major frames in which the FOS has failed the self-check test (in YSELFCHK)
Y646	YSPCTR	9/46			Counter of speed check errors. Counter indicating consecutive major frames in which a speed check error is indicated (YARITHCHK below NSSC-1 YBUSY value)
Y647	YSPR6	9/47			Spare 6.
Y648	YSPR7	9/48			Spare 7.
Y649	YSMCERRS	8/95	949.5		Serial magnitude command error report flags. Has Y.219-Y.226. Word zeroed when sampled
Y650	YTAMAX HI	8/20	912.0		Upper target/acq window HI. See Section 3.1.5
Y650	YTAMAX LO	8/21	912.5		Upper target/acq window LO. See Section 3.1.5
Y651	YTAMIN HI	8/80	942.0		Lower target/acq window HI. See Section 3.1.5
Y651	YTAMIN LO	8/81	942.5		Lower target/acq window LO. See Section 3.1.5
Y652	YREJECTS HI	8/51	927.5		Number of adder rejects HI. See Section 3.1.1.1
Y652	YREJECTS LO	8/58	931.0		Number of adder rejects LO. See Section 3.1.1.1
Y656	YAPERHOE	8/9	906.5		Aperture high-order encoder. See Section 3.1.4.2
Y656	YAPERHOE	8/39	921.5		Aperture high-order encoder. See Section 3.1.4.2
Y656	YAPERHOE	8/69	936.5		Aperture high-order encoder. See Section 3.1.4.2
Y656	YAPERHOE	8/99	951.5		Aperture high-order encoder. See Section 3.1.4.2
Y657	YAPERLOE	8/10	907.0		Aperture low-order encoder. See Section 3.1.4.2
Y657	YAPERLOE	8/40	922.0		Aperture low-order encoder. See Section 3.1.4.2
Y657	YAPERLOE	8/70	937.0		Aperture low-order encoder. See Section 3.1.4.2
Y657	YAPERLOE	8/100	952.0		Aperture low-order encoder. See Section 3.1.4.2
Y658	YPLZRHOE	8/11	907.5		Polarizer high-order encoder. See Section 3.1.4.3
Y658	YPLZRHOE	8/41	922.5		Polarizer high-order encoder. See Section 3.1.4.3
Y658	YPLZRHOE	8/71	937.5		Polarizer high-order encoder. See Section 3.1.4.3

Table 4.2-5 All FOS Commands and Telemetry by Number (cont)

No	Mnemonic	WD/SF	UDL	SHP	Significance
Y658	YPLZRHOE	8/101	952.5		Polarizer high-order encoder. See Section 3.1.4.3
Y659	YPLZRLOE	8/12	908.0		Polarizer low-order encoder. See Section 3.1.4.3
Y659	YPLZRLOE	8/42	923.0		Polarizer low-order encoder. See Section 3.1.4.3
Y659	YPLZRLOE	8/72	938.0		Polarizer low-order encoder. See Section 3.1.4.3
Y659	YPLZRLOE	8/102	953.0		Polarizer low-order encoder. See Section 3.1.4.3
Y700	YASPARE1	7/24		169.5	Analog spare 1.
Y701	YASPARE2	7/25		170.5	Analog spare 2.
Y702	YASPARE3	7/26		171.5	Analog spare 3.
Y703	YASPARE4	7/27		172.5	Analog spare 4.
Y704	YASPARE5	7/28		173.5	Analog spare 5.
Y705	YYFLWID	8/45	924.5		Target acquisition Y filter width.
Y706	YSPRBYT1	8/75	939.5		Spare byte 1. Typical value X'48' (subframe)
Y707	YSPRBYT1	8/105	954.5		Spare byte 2. Typical value X'69' (subframe)
Y708	YPPINV	9/29		888_2 887_3	Preplanned branch request status. See Section 3.2.1
Y709	YRSINV	9/28		889_2 888_3 892_6	Raster scan request status. See Section 3.2.1
Y710	YFWSCT	9/26			Count major frames with firmware status errors.
Y711	YAQMD	8/67	935.5		Acquisition mode. Has Y.205-Y.212
Y712	YACMSB	9/31			Accumulated science data (8 MSBs). From YACACC (summation of science data in current frame)
Y713	YACNMS	9/32			Accumulated science data (second 8 MSBs). From YACACC (summation of science data in current frame)
Y714	YACNLS	9/33			Accumulated science data (third 8 MSBs). From YACACC (summation of science data in current frame)
Y715	YACLSB	9/34			Accumulated science data (fourth 8 MSBs). From YACACC (summation of science data in current frame)
Y716	YSPDOK	9/35			Enable speed check test in Processor 30. A 1 means speed check test permitted; 2 means not permitted; 0 otherwise
Y800	YOVRLTMB B1	8/22	913.0		Overlight sum MS byte. Total of 32 bits (see Section 2.1.5)
Y800	YOVRLTMB B2	8/23	913.5		Overlight sum NMS byte. Total of 32 bits (see Section 2.1.5)
Y800	YOVRLTMB B3	8/24	914.0		Overlight sum NLS byte. Total of 32 bits (see Section 2.1.5)
Y801	YOVRLTLB	8/25	914.5		Overlight sum LS byte. Total of 32 bits (see Section 2.1.5)
Y926	YIONRPI	7/29:2		174.5	Vacuum gauge power RPI.

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic

Mnemonic	No	WD/SF	UDL	SHP	Significance
CLKDRFTR$_S$ B1	Y.915	/		831	Byte 1 of clock drift rate. See Section 3.2.1
CLKDRFTR$_S$ B2	Y.915	/		831.5	Byte 2 of clock drift rate.
CLKDRFTR$_S$ B3	Y.915	/		832	Byte 3 of clock drift rate.
CLKDRFTR$_S$ B4	Y.915	/		832.5	Byte 4 of clock drift rate.
CLKDRFTR$_S$ B5	Y.915	/		833	Byte 5 of clock drift rate.
CLKDRFTR$_S$ B6	Y.915	/		833.5	Byte 6 of clock drift rate.
CLKDRFTR$_S$ B7	Y.915	/		834	Byte 7 of clock drift rate.
CLKDRFTR$_S$ B8	Y.915	/		834.5	Byte 8 of clock drift rate.
CLKRATE$_S$ B1	Y.914	/		827	Byte 1 of clock rate. See Section 3.2.1
CLKRATE$_S$ B2	Y.914	/		827.5	Byte 2 of clock rate.
CLKRATE$_S$ B3	Y.914	/		828	Byte 3 of clock rate.
CLKRATE$_S$ B4	Y.914	/		828.5	Byte 4 of clock rate.
CLKRATE$_S$ B5	Y.914	/		829	Byte 5 of clock rate.
CLKRATE$_S$ B6	Y.914	/		829.5	Byte 6 of clock rate.
CLKRATE$_S$ B7	Y.914	/		830	Byte 7 of clock rate.
CLKRATE$_S$ B8	Y.914	/		830.5	Byte 8 of clock rate.
DCFOBSN$_S$	Y.902	/		1.5	Observation number in SHP. See Section 3.2.1
FOSOBNØ1$_S$	Y.909	/		803	First ASCII FOS Observation Number character in SHP.
FOSOBNØ2$_S$	Y.910	/		803.5	Second ASCII FOS Observation Number character in SHP.
FOSOBSØ1$_S$	Y.907	/		802	First ASCII FOS Observation Set Number character in SHP.
FOSOBSØ2$_S$	Y.908	/		802.5	Second ASCII FOS Observation Set Number character in SHP.
FOSPRGØ1$_S$	Y.903	/		800	First ASCII FOS Program Number character in SHP.
FOSPRGØ2$_S$	Y.904	/		800.5	Second ASCII FOS Program Number character in SHP.
FOSPRGØ3$_S$	Y.905	/		801	Third ASCII FOS Program Number character in SHP.
SOURCEID$_S$	Y.901	/		1	SI ID in SHP. Value of X'DC' for FOS
SPCLINCN$_S$ B1	Y.913	/		825	Byte 1 of spacecraft clock at UTCO. See Section 3.2.1
SPCLINCN$_S$ B2	Y.913	/		825.5	Byte 2 of spacecraft clock at UTCO.
SPCLINCN$_S$ B3	Y.913	/		826	Byte 3 of spacecraft clock at UTCO.
SPCLINCN$_S$ B4	Y.913	/		826.5	Byte 4 of spacecraft clock at UTCO.
TIMECODE$_S$	Y.916	/		-5	Words 8 and 9 of packet ancillary data. See Section 3.2.4
TIMECODE$_S$	Y.916	/	-5		Words 8 and 9 of packet ancillary data. See Section 3.2.4
UTCO1$_S$ B1	Y.912	/		823	Byte 5 of UTCO. See Section 3.2.1
UTCO1$_S$ B2	Y.912	/		823.5	Byte 6 of UTCO.
UTCO1$_S$ B3	Y.912	/		824	Byte 7 of UTCO.
UTCO1$_S$ B4	Y.912	/		824.5	Byte 8 of UTCO.
UTCO2$_S$ B1	Y.911	/		821	Byte 1 of UTCO. See Section 3.2.1
UTCO2$_S$ B2	Y.911	/		821.5	Byte 2 of UTCO.
UTCO2$_S$ B3	Y.911	/		822	Byte 3 of UTCO.
UTCO2$_S$ B4	Y.911	/		822.5	Byte 4 of UTCO.

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
UTCO$_s$ B1	Y.917	/		821	Byte 1 of UTCO. Same as UTCO2$_s$ B1
UTCO$_s$ B2	Y.917	/		821.5	Byte 2 of UTCO. Same as UTCO2$_s$ B2
UTCO$_s$ B3	Y.917	/		822	Byte 3 of UTCO. Same as UTCO2$_s$ B3
UTCO$_s$ B4	Y.917	/		822.5	Byte 4 of UTCO. Same as UTCO2$_s$ B4
UTCO$_s$ B5	Y.917	/		823	Byte 5 of UTCO. Same as UTCO1$_s$ B1
UTCO$_s$ B6	Y.917	/		823.5	Byte 6 of UTCO. Same as UTCO1$_s$ B2
UTCO$_s$ B7	Y.917	/		824	Byte 7 of UTCO. Same as UTCO1$_s$ B3
UTCO$_s$ B8	Y.917	/		824.5	Byte 8 of UTCO. Same as UTCO1$_s$ B4
Y1.5MZ	Y553$_c$	/			Select 1.5 MHz Clock command. See Section 3.1.6.5
Y1BUSRPI	Y121	4/1:7		142.5	Common bus relay #1 status. A 0 is B On/A Off1 and a 1 is A On/B Off1
Y1OATMP	Y308	7/7		152.5	Optics area temperature location 1.
Y1OBTMP	Y301	7/0		145.5	Optical bench temperature location 1.
Y1SDFPRT	Y125	1/1:1		139.5	SD CEA A K1-K6 status. A 0 is AB and 1 is AA
Y1STCHNL	Y531	8/61	932.5		First channel to be processed. See Section 3.1.2.2
Y1STCHNL	Y042$_c$	/			Set first channel to be processed. See Section 3.1.2.2
Y2BUSRPI	Y122	4/1:8		142.5	Common bus relay #2 status. A 0 is B On/A Off2 and a 1 is A On/B Off2
Y2OATMP	Y309	7/8		153.5	Optics area temperature location 2.
Y2OBTMP	Y302	7/1		146.5	Optical bench temperature location 2.
Y2SDFPRT	Y126	1/1:2		139.5	SD CEA A K7-K11 status. A 0 is AB and 1 is AA
Y3MHZ	Y551$_c$	/			Select 3.0 MHz Clock command. See Section 3.1.6.5
Y3OBTMP	Y303	7/2		147.5	Optical bench temperature location 3.
Y3SDFPRT	Y127	1/1:3		139.5	SD CEA B K1-K6 status. A 0 is BB and 1 is BA
Y4OBTMP	Y304	7/3		148.5	Optical bench temperature location 4.
Y4SDFPRT	Y128	1/1:4		139.5	SD CEA B K7-K11 status. A 0 is BB and 1 is BA
Y5VLPSV	Y337	6/1		144.5	Plus 5 volt logic power supply voltage.
Y8VQPSV	Y332	5/1		143.5	Plus 8 volt quiet power supply voltage.
YABACQ	Y555$_c$	/			Abort Data Acquisition command. See Section 3.1.2.3
YABORTDA	Y569	8/118:7	961.0		Abort data acquisition command flag. A 1 means abort. See Section 3.1.2.3
YACAI21 HI	Y.031	/		886$_5$	Bits 1-2 of 36-bit accumulated science data for current dwell. See Section 3.2.1
YACAI21 LO	Y.031	/		887$_5$	Bits 3-18 of 36-bit accumulated science data for current dwell. See Section 3.2.1
YACAI22 HI	Y.031	/		888$_5$	Bits 19-20 of 36-bit accumulated science data for current dwell. See Section 3.2.1
YACAI22 LO	Y.031	/		889$_5$	Bits 21-36 of 36-bit accumulated science data for current dwell. See Section 3.2.1
YACLSB	Y715	9/34			Accumulated science data (fourth 8 MSBs). From YACACC (summation of science data in current frame)
YACMSB	Y712	9/31			Accumulated science data (8 MSBs). From YACACC (summation of science data in current frame)

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YACNLS	Y714	9/33			Accumulated science data (third 8 MSBs). From YACACC (summation of science data in current frame)
YACNMS	Y713	9/32			Accumulated science data (second 8 MSBs). From YACACC (summation of science data in current frame)
YACQLIM	$Y016_c$	/			Set data acquisition limit. See Section 3.1.2.3
YACQMODE	$Y049_c$	/			Set data acquisition mode. See Section 3.1.6.1
YACSI21 HI	Y.029	/		882_5	Bits 1-2 of 36-bit accumulated science data for successful dwell. See Section 3.2.1
YACSI21 LO	Y.029	/		883_5	Bits 3-18 of 36-bit accumulated science data for successful dwell. See Section 3.2.1
YACSI22 HI	Y.029	/		884_5	Bits 19-20 of 36-bit accumulated science data for successful dwell. See Section 3.2.1
YACSI22 LO	Y.029	/		885_5	Bits 21-36 of 36-bit accumulated science data for successful dwell. See Section 3.2.1
YACTMERR	Y564	8/118:1	961.0		Accumulator timer set error. A 0 is OK and a 1 is error
YAMCIP	Y583	8/119:7	961.5		Auto memory clear in progress. A 1 means clear to be done (interface with data monitoring background task)
YAPER	$Y035_c$	/			Set entrance aperture to position. See Section 3.1.4.2
YAPERHOE	Y656	8/9	906.5		Aperture high-order encoder. See Section 3.1.4.2
YAPERHOE	Y656	8/39	921.5		Aperture high-order encoder. See Section 3.1.4.2
YAPERHOE	Y656	8/69	936.5		Aperture high-order encoder. See Section 3.1.4.2
YAPERHOE	Y656	8/99	951.5		Aperture high-order encoder. See Section 3.1.4.2
YAPERLOE	Y657	8/10	907.0		Aperture low-order encoder. See Section 3.1.4.2
YAPERLOE	Y657	8/40	922.0		Aperture low-order encoder. See Section 3.1.4.2
YAPERLOE	Y657	8/70	937.0		Aperture low-order encoder. See Section 3.1.4.2
YAPERLOE	Y657	8/100	952.0		Aperture low-order encoder. See Section 3.1.4.2
$YAPERPO1_s$ HI	Y.106	8/9	906.5		Same as first YAPERHOE.
$YAPERPO1_s$ LO	Y.106	8/10	907.0		Same as first YAPERLOE.
$YAPERTMP^s$	Y313	7/12		157.5	Aperture mechanism temperature.
YAPRFRPI	Y123	1/1:5		139.5	Aperture failsafe arm/safe status. A 0 is Arm and 1 is Safe. See Section 3.1.4.2
YAQMD	Y711	8/67	935.5		Acquisition mode. Has Y.205-Y.212
YARITHCK HI	Y516	8/28	916.0		Arithmetic self-check (speed) results HI. See Section 1.5

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YARITHCK LO	Y516	8/29	916.5		Arithmetic self-check (speed) results LO. See Section 1.5
YARIUTMP	Y326	7/16		161.5	RIU-A temperature.
YARMAP	$Y501_c$	/			Arm Aperture command. See Section 3.1.4.2
YARMED	$Y503_c$	/			Arm Entrance Port command. See Section 3.1.4.1
YARMPL	$Y511_c$	/			Arm Polarizer command. See Section 3.1.4.3
YASPARE1	Y700	7/24		169.5	Analog spare 1.
YASPARE2	Y701	7/25		170.5	Analog spare 2.
YASPARE3	Y702	7/26		171.5	Analog spare 3.
YASPARE4	Y703	7/27		172.5	Analog spare 4.
YASPARE5	Y704	7/28		173.5	Analog spare 5.
YBASKP	Y.019	/		891_3 887_4 889_6	Y-BASE for current data. See Section 3.2.1
YBEGAC	$Y559_c$	/			Begin Data Acquisition command. See Section 3.1.2.3
YBEGINDA	Y567	8/118:5	961.0		Begin data acquisition command flag. A 1 means begin. See Section 3.1.2.3
YBLAPR	$Y561_c$	/			Blow Aperture command. See Section 3.1.4.2. Not in SLIB L98
YBLENT	$Y563_c$	/			Blow Entrance Port command. See Section 3.1.4.1. Not in SLIB L98
YBLPOL	$Y567_c$	/			Blow Polarizer command. See Section 3.1.4.3. Not in SLIB L98
YBRIUTMP	Y327	7/17		162.5	RIU-B temperature.
YBSM	Y.022	/		894_3	Channel number of peak. See Section 3.2.1
YBUSA1	$Y579_c$	/			A-On, B-Off S1 command.
YBUSA2	$Y581_c$	/			A-On, B-Off S2 command.
YBUSB1	$Y580_c$	/			B-On, A-Off S1 command.
YBUSB2	$Y582_c$	/			B-On, A-Off S2 command.
YCALOF	$Y577_c$	/			Spectral Cal. Lamp Off command. See Section 3.1.6.4
YCALON	$Y575_c$	/			Spectral Cal. Lamp On command. See Section 3.1.6.4
YCALRPI	Y102	4/1:6		142.5	Calibration lamp supply RPI. A 0 is on and 1 is off. See Section 3.1.6.4
YCALSA	$Y583_c$	/			Select Cal. Lamp A command. See Section 3.1.6.4
YCALSB	$Y585_c$	/			Select Cal. Lamp B command. See Section 3.1.6.4
YCALSELR	Y133	3/1:7		141.5	Calibration lamp select RPI. A 0 is B and a 1 is A. See Section 3.1.6.4
YCALVLT	Y320	6/0		137.5	Calibration lamp supply voltage.
YCDACERR	Y578	8/117:5	960.5		Calibration DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.6.4
YCEATMP	Y311	7/10		155.5	Central electronics temperature.
YCHNLEN	$Y012_c$	/			Enable/inhibit channel(s). See Section 3.1.6.2

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YCHNLS	Y050$_c$	/			Set number of channels to be processed. See Section 3.1.2.2
YCLEARS	Y053$_c$	/			Set number of memory clears/acquisition. See Section 3.1.1.8
YCLKMON	Y134	3/1:2		141.5	Microprocessor clock monitor. A 0 is 3 MHz and 1 is 1.5 MHz. See Section 3.1.6.5
YCLSCUR	Y328	0/1		138.5	Calibration lamp supply current.
YCMTRA	Y571$_c$	/			Select Motor A command. See Section 3.1.4.4
YCMTRB	Y573$_c$	/			Select Motor B command. See Section 3.1.4.4
YCMTRST	Y101	3/1:8		141.5	Carrousel motor status. A 0 is B and a 1 is A. See Section 3.1.4.4
YCPIP	Y574	8/119:4	961.5		CEA plot in progress. A 1 means plot in progress
YCPSTMP	Y318	7/18		163.5	Central power supply temperature.
YDATA	Y001$_c$	/			Data for type four commands.
YDATALIM	Y549	8/114	959.0		High byte of acquisition limit. See Section 3.1.2.3
YDDACERR	Y563	8/117:3	960.5		Discriminator DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.6.1
YDDCHK	Y083$_c$	/			Sample all discriminator DACs. See Section 3.1.6.1
YDEADHI	Y587	8/65	934.5		Accumulator close time high byte. See Section 3.1.1.1
YDEADLO	Y588	8/66	935.0		Accumulator close time low byte. See Section 3.1.1.1
YDEAD$_s$ HI	Y.109	8/65	934.5		Same as YDEADHI.
YDEAD$_s$ LO	Y.109	8/66	935.0		Same as YDEADLO.
YDEADTYM	Y010$_c$	/			Set accumulator closed (dead) time. See Section 3.1.1.1
YDISC	Y031$_c$	/			Set discriminator DAC table value. See Section 3.1.6.2
YDISCADR	Y006$_c$	/			Load discriminator at address or set all values. See Section 3.1.6.2
YDOOR	Y503	8/8:7-8	906.0		Entrance door position. See Section 3.1.4.1
YDOOR	Y503	8/38:7-8	921.0		Entrance door position. See Section 3.1.4.1
YDOOR	Y503	8/68:7-8	936.0		Entrance door position. See Section 3.1.4.1
YDOOR	Y503	8/98:7-8	951.0		Entrance door position. See Section 3.1.4.1
YDOORTMP	Y312	7/11		156.5	Entrance door mechanism temperature.
YDPRMPWR	Y579	8/34:1-2	919.0		Descramble PROM power status. A 00 is off, 01 is even, 10 is odd, and 11 is both
YDRDACER	Y562	8/117:8	960.5		Discriminator reference DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.6.2
YDREFDAC	Y518	8/32	918.0		Discriminator reference DAC.
YDSCRVLT	Y324	5/0		136.5	Discriminator reference voltage.
YDWELS	Y.040	/		881_5 880_6	Total number of dwells in this ST dwell-scan. See Section 3.2.1
YEDGE	Y.027	/		889_4	Result of edge test. See Section 3.2.1
YEDSCRAM	Y107	3/1:6		141.5	Descramble PROM power status even. A 0 is off and 1 is on

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YEFILL	$Y084_c$	/			Sample all serial digital telemetry. See Section 3.1.6.1
YENDAC	$Y557_c$	/			End Data Acquisition command. See Section 3.1.2.3
YENDDA	Y568	8/118:6	961.0		End data acquisition command flag. A 1 means end. See Section 3.1.2.3
YENGSYNC	Y500	8/0	902.0		MP serial engr data packet sync. Value is X'A5'
YENTFRPI	Y124	1/1:6		139.5	Entrance door failsafe arm/safe status. A 0 is Arm and 1 is Safe. See Section 3.1.4.1
YENTRNC	$Y034_c$	/			Set entrance port open or closed. See Section 3.1.4.1
YERCTR	Y639	9/39			Consecutive major frames with error check error. Counter indicating consecutive major frames in which an error check error is indicated
YERRCHK HI	Y502	8/2	903.0		Firmware check character HI. See Section 1.5
YERRCHK LO	Y502	8/3	903.5		Firmware check character LO. See Section 1.5
YFASST	Y608	9/8			Autonomous safe status. Is 1 if processor 25 executing; 2 if terminated abnormally; 4 if termination normal; 0 otherwise
YFDACERR	Y560	8/117:2	960.5		Focus DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
YFDWCT	Y630	9/30		880_5	Dwell counter for YFPKUP. See Section 3.2.1
YFFCAL	$Y038_c$	/			Set LED flat-field lamp on or off. See Section 3.1.6.4
YFFCPWR	Y580	8/34:4	919.0		Flat field cal lamp power. A zero is off and a 1 is on. See Section 3.1.6.4
YFGMATMP	Y315	7/14		159.5	Filter/Grating Wheel motor A temperature.
YFGMBTMP	Y329	7/19		164.5	Filter/Grating Wheel motor B temperature.
$YFGWAP01_s$	Y.105	8/8:1-4	906.0		Same as first YFGWAPOS.
$YFGWAPOS^s$	Y506	8/8:1-4	906.0		Filter/Grating Wheel Assembly position. See Section 3.1.4.4
YFGWAPOS	Y506	8/38:1-4	921.0		Filter/Grating Wheel Assembly position. See Section 3.1.4.4
YFGWAPOS	Y506	8/68:1-4	936.0		Filter/Grating Wheel Assembly position. See Section 3.1.4.4
YFGWAPOS	Y506	8/98:1-4	951.0		Filter/Grating Wheel Assembly position. See Section 3.1.4.4
YFGWASP	Y508	8/8:6	906.0		FGWA spare.
YFGWASP	Y508	8/38:6	921.0		FGWA spare.
YFGWASP	Y508	8/68:6	936.0		FGWA spare.
YFGWASP	Y508	8/98:6	951.0		FGWA spare.
YFGWASTR	Y504	8/8:5	906.0		FGWA encoder strobe bit.
YFGWASTR	Y504	8/38:5	921.0		FGWA encoder strobe bit.
YFGWASTR	Y504	8/68:5	936.0		FGWA encoder strobe bit.
YFGWASTR	Y504	8/98:5	951.0		FGWA encoder strobe bit.
YFHKST	Y607	9/7			Housekeeping status. Is 1 if processor 30 executing; 2 if terminated on error; 4 if disabled by another processor; 0 otherwise

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YFILTER	Y037 c	/			Set FGWA to position. See Section 3.1.4.4
YFINST	Y602 c	9/2			Status of INIT processor. Is 1 if processor 30 executing; 2 if terminated on error; 4 if disabled by another processor; 0 otherwise
YFIRMVER	Y501	8/1	902.5		Firmware version number. Has Y.201
YFL169	Y611	9/11			Data items 9-16. FOS limit check flags B2
YFL241	Y612	9/12			Data items 17-24. FOS limit check flags B3
YFL322	Y613	9/13			Data items 25-32. FOS limit check flags B4
YFL81	Y610	9/10			Data items 1-8. FOS limit check flags B1
YFLGCT	Y617	9/17			Counts main frame limit check failures. Counter of consecutive major frames in which the same FOS limit check flag is set
YFM2FL	Y620	9/20		881_2 898_3 888_4	Action indicator for YFM2PR module. See Section 3.2.1
YFM2ST	Y625	9/25		896_2	Mode 2 target acquisition processor status. A 1 means processor 28 is executing normally; 2 means terminated on an error; 4 means successful completion; 0 otherwise
YFNMAX	Y.042	/		880_6	Upper count for star field window. See Section 3.2.1
YFNMIN	Y.043	/		881_6	Lower count limit for star field window. See Section 3.2.1
YFOCUS	Y033 c	/			Set focus trim DAC. See Section 3.1.3
YFOCUSRB	Y519 c	8/33	918.5		Focus trim coil DAC readback. See Section 3.1.3
YFOUND	Y.039	/		881_3	Total number of peaks found in the aperture map.
YFPRST	Y604	9/4			Science data processing status. Is 1 if processor 32 executing; 2 if terminated on error, 4 if termination normal; 0 otherwise
YFPUTT HI	Y.030	/		890_5	Saved dwell time HI. See Section 3.2.1
YFPUTT LO	Y.030	/		891_5	Saved dwell time LO. See Section 3.2.1
YFRCTR	Y621	9/21		880_3	Count frames for part 1 of YFSDPR processor. See Section 3.2.1
YFSCTR	Y638	9/38			Number of tests by YFHKPG where fail-safe armed. Counter indicating number of tests since YFHKPG was initialized where one or more of the fail-safe RPIs was armed
YFSDST	Y603	9/3			Science data storage status. Is 1 if procesor 31 executing; 2 if terminated on error; 4 if termination normal; 0 otherwise
YFTOST	Y609	9/9			Turn off status. Is 1 if processor 27 executing; 2 if terminated abnormally; 4 if termination normal; 0 otherwise
YFWCTR	Y640	9/40			Consecutive major frames with firmware version error. Counter indicating consecutive major frames in which a firmware version error is indicated

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YFWSCT	Y710	9/26			Count major frames with firmware status errors.
YFWSTAT1 HI	Y536	8/82	943.0		Firmware status group 1 HI. Typically ASCII (interpretation depends on use)
YFWSTAT1 LO	Y536	8/83	943.5		Firmware status group 1 LO. Typically ASCII (interpretation depends on use)
YFWSTAT2 HI	Y537	8/84	944.0		Firmware status group 2 HI. Typically ASCII (interpretation depends on use)
YFWSTAT2 LO	Y537	8/85	944.5		Firmware status group 2 LO. Typically ASCII (interpretation depends on use)
YFWSTAT3 HI	Y538	8/86	945.0		Firmware status group 3 HI. Typically ASCII (interpretation depends on use)
YFWSTAT3 LO	Y538	8/87	945.5		Firmware status group 3 LO. Typically ASCII (interpretation depends on use)
YFWSTAT4 HI	Y539	8/88	946.0		Firmware status group 4 HI. Typically ASCII (interpretation depends on use)
YFWSTAT4 LO	Y539	8/89	946.5		Firmware status group 4 LO. Typically ASCII (interpretation depends on use)
YFWSTAT5 HI	Y540	8/90	947.0		Firmware status group 5 HI. Typically ASCII (interpretation depends on use)
YFWSTAT5 LO	Y540	8/91	947.5		Firmware status group 5 LO. Typically ASCII (interpretation depends on use)
YFWSTAT6 HI	Y541	8/92	948.0		Firmware status group 6 HI. Typically ASCII (interpretation depends on use)
YFWSTAT6 LO	Y541	8/93	948.5		Firmware status group 6 LO. Typically ASCII (interpretation depends on use)
YGIVUP	Y622	9/22		880_2 879_3 880_4	Mode 2 target acquisition error indicator. See Section 3.2.1
YGPCTR	Y623	9/23		881_4	Count frames for part 2 of YFSDPR processor. See Section 3.2.1
YHTOFF	Y547$_C$	/			Heater Off command.
YHTON	Y527^C	/			Heater On command.
YHTRRPI	Y118^C	1/1:8		139.5	Heater control relay position. A 0 is HTON (on) and 1 is HTOF (off)
YHVCLR	Y325	1/0		132.5	High voltage supply current.
YHVDAC	Y030$_C$	/			Set high voltage power supply DAC. See Section 3.1.3
YHVDACER	Y561	8/117:7	960.5		HV DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
YHVDACRB HI	Y520	8/34:7-8	919.0		High voltage DAC readback HI. See Section 3.1.3
YHVDACRB LO	Y520	8/35	919.5		High voltage DAC readback LO. See Section 3.1.3
YHVOFF	Y517$_C$	/			High Voltage Supply Off command.
YHVON	Y519^C	/			High Voltage Supply On command.
YHVRPI	Y117^C	4/1:5		142.5	High voltage relay position. A 0 is HVON (on) and 1 is HVOF (off)
YHVSPAR	Y581	8/34:3	919.0		Spare bit.
YHVTMP	Y316	7/15		160.5	High voltage supply temperature.

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YHVVLT	Y319	0/0		131.5	High voltage supply voltage.
YHWHM	Y.045	/		884$_6$	Width for merging peaks. See Section 3.2.1
YIGOFF	Y601$_c$	/			Ion Gauge Off.
YIGON	Y600$_c$	/			Ion Gauge On.
YINIT	Y041$_c$	/			Set initialization mode. See Section 3.1.6.1
YINSENG	Y104	3/1:4		141.5	Instruction engineering bit status. A 0 is OK and 1 is error. See Section 3.1.6.5
YINTEG	Y546	8/110	957.0		Number of integrations/X-step. See Section 3.1.1.1
YINTMODE	Y547	8/112	958.0		Initialization mode. Has Y.213-Y.218
YINTPRES	Y338	2/1		140.5	Vacuum gauge reading.
YINTS	Y043$_c$	/			Set number of sub-integrations per X-step. See Section 3.1.1.1
YIONRPI	Y926	7/29:2		174.5	Vacuum gauge power RPI.
YKEEP	Y616	9/16			Counts main frame keep-alive failures. Counter of consecutive major frames in which YENGSYNC (in serial ED) fails keep-alive test
YKEY	Y071$_c$	/			Provide FORTH KEY capability. See Section 3.1.6.5
YKPALVED	Y058$_c$	/			Enable/disable autonomous going safe. See Section 3.1.6.5
YLASTCMD HI	Y543	8/96	950.0		Last command at SMC error HI. See Section 3.1
YLASTCMD LO	Y543	8/97	950.5		Last command at SMC error LO. See Section 3.1
YLINCT	Y606	9/6			Line number within a frame.
YLINSFRH$_s$	Y.103	8/6	905.0		Same as YLINSFRM HI.
YLINSFRL$_s$	Y.104	8/7	905.5		Same as YLINSFRM LO.
YLINSFRM HI	Y552	8/6	905.0		Lines per frame HI. See Section 3.1.2.1
YLINSFRM LO	Y552	8/7	905.5		Lines per frame LO. See Section 3.1.2.1
YLIVEHI	Y585	8/63	933.5		Accumulator open time high byte. See Section 3.1.1.1
YLIVELO	Y586	8/64	934.0		Accumulator open time low byte. See Section 3.1.1.1
YLIVE$_s$ HI	Y.108	8/63	933.5		Same as YLIVEHI.
YLIVE$_s$ LO	Y.108	8/64	934.0		Same as YLIVELO.
YLIVETYM	Y008$_c$	/			Set accumulator open (live) time. See Section 3.1.1.1
YLSOFF	Y525$_c$	/			Logic Supply Off command.
YLSON	Y569$_c$	/			Logic Supply On command.
YLSRPI	Y120	4/1:4		142.5	Logic supply relay status. A 0 is +LPS (on) and 1 is -LPS (off)
YMCHREG	Y087$_c$	/			Set mechanism register to drive signal. See Section 3.1.4
YMCHSTEP	Y056$_c$	/			Step mechanism. See Section 3.1.4
YMCLEARS	Y542	8/94	949.0		Memory clears/data acquisition. See Section 3.1.1.8
YMDMPADH$_s$	Y.110	8/115	959.5		Same as YMDMPADR HI.
YMDMPADL$_s$	Y.111	8/116	960.0		Same as YMDMPADR LO.
YMDMPADR HI	Y550	8/115	959.5		Memory dump address HI. See Section 3.1.2.1
YMDMPADR LO	Y550	8/116	960.0		Memory dump address LO. See Section 3.1.2.1

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YMECHCAL	$Y022_C$	/			Set feedback code for mechanism. See Section 3.1.4
YMECHTOC	Y566	8/118:2-4	961.0		Mechanism time-out code. See Section 3.1.4
YMEMCHK	$Y055_C$	/			Fill science memory with test pattern. See Section 3.1.6.3
YMFCCT	Y641	9/41			Counter of major frame fail-safe RPI test. Major frame counter used for fail-safe RPI test. It is reset 0 after reaches YDSARM
YMFECT	Y642	9/42			Counter of major frame output for data log. Major frame counter tested for output of SHPs during data acquisition. It is reset 0 after reaching YMFSHP or when [YNDAIP = 1]
YMMIP	Y582	8/119:6	961.5		Mechanism motion in progress. A 1 means motion in progress
YMSLICES	Y576	8/59	931.5		Number of memory slices. See Section 3.1.1.5
YNBCTR	Y.020	/		892_3	Brightness rank. See Section 3.2.1
YNBRT	Y.046	/		885_6	Peak number to choose. See Section 3.2.1
YNDAIP	Y571	8/119:1	961.5		Data acquisition not in progress. A 1 means not in progress. See Section 3.1.1
YNMAX	Y.023	/		895_3	Number of counts in peak (scaled program value). See Section 3.2.1
YNMEAN	Y.024	/		896_3 891_4	Computed mean sky background (scaled program value).
YNOISELM HI	Y544	8/106	955.0		Burst noise rejection limit HI. See Section 3.1.1.1
YNOISELM LO	Y544	8/107	955.5		Burst noise rejection limit LO. See Section 3.1.1.1
YNPEAK	Y.044	/		883_6	Peak mapping indicator. See Section 3.2.1
YNTARG	Y.028	/		890_4	Counts in target channels (scaled program value). See Section 3.2.1
YNUMCHNL	Y532	8/62	933.0		Number of channels to be processed. See Section 3.1.2.2
YOBSJ	Y.021	/		893_3	Peak matrix number. See Section 3.2.1
YODSCRAM	Y106	3/1:5		141.5	Descramble PROM power status odd. A 0 is off and 1 is on
YOFFST	Y.049	/		890_6	Y offset for target acquisition centering. See Section 3.2.1
YONOFF	Y601	9/1			FOS on/off indicator. Is 1 if FOS turned off via processor 27; is 2 if turned on via processor 26; 0 otherwise
YOUT-CLR	$Y045_C$	/			Set readouts/memory clear. See Section 3.1.1.7
YOVCTR	Y644	9/44			Counter of failed overlight sum tests. Number of consecutive major frames in which FOS overlight sum test has failed
YOVPRO	Y627	9/27			NSSC-1 overlight protection flag. A 1 means NSSC-1 overlight sum test is enabled
YOVRLTLB	Y801	8/25	914.5		Overlight sum LS byte. Total of 32 bits (see Section 2.1.5)

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YOVRLTMB B1	Y800	8/22	913.0		Overlight sum MS byte. Total of 32 bits (see Section 2.1.5)
YOVRLTMB B2	Y800	8/23	913.5		Overlight sum NMS byte. Total of 32 bits (see Section 2.1.5)
YOVRLTMB B3	Y800	8/24	914.0		Overlight sum NLS byte. Total of 32 bits (see Section 2.1.5)
YOVRSCAN	Y530	8/60	932.0		X deflection overscan. See Section 3.1.1.3
YOVRSCAN	$Y051_c$	/			Set number of diodes overscan. See Section 3.1.1.3
YPAMATMP	Y306	7/5		150.5	Pre-Amp assembly A temperature.
YPAMBTMP	Y331	7/21		166.5	Pre-Amp assembly B temperature.
YPAUSE	$Y085_c$	/			Set/reset pause acquisition bit. See Section 3.1.2.3
YPCATMP	Y305	7/4		149.5	Photocathode A temperature.
YPCBTMP	Y330	7/20		165.5	Photocathode B temperature.
YPIP	Y573	8/119:3	961.5		Pause in progress. A 1 means pause in progress. See Section 3.1.2.3
YPKCT1	Y.012	/		882_4	Objects found in field. See Section 3.2.1
$YPLRZPO1_s$ HI	Y.107	8/11	907.5		Same as first YPLZRHOE.
$YPLRZPO1_s$ LO	Y.107	8/12	908.0		Same as first YPLZRLOE.
YPLZR	$Y036_c$	/			Set polarizer mechanism to position. See Section 3.1.4.3
YPLZRHOE	Y658	8/11	907.5		Polarizer high-order encoder. See Section 3.1.4.3
YPLZRHOE	Y658	8/41	922.5		Polarizer high-order encoder. See Section 3.1.4.3
YPLZRHOE	Y658	8/71	937.5		Polarizer high-order encoder. See Section 3.1.4.3
YPLZRHOE	Y658	8/101	952.5		Polarizer high-order encoder. See Section 3.1.4.3
YPLZRLOE	Y659	8/12	908.0		Polarizer low-order encoder. See Section 3.1.4.3
YPLZRLOE	Y659	8/42	923.0		Polarizer low-order encoder. See Section 3.1.4.3
YPLZRLOE	Y659	8/72	938.0		Polarizer low-order encoder. See Section 3.1.4.3
YPLZRLOE	Y659	8/102	953.0		Polarizer low-order encoder. See Section 3.1.4.3
YPMFATMP	Y307	7/6		151.5	Permanent magnet focus assembly A temperature.
YPMFBTMP	Y333	7/22		167.5	Permanent magnet focus assembly B temperature.
YPOLFRPI	Y130	1/1:7		139.5	Polarizer failsafe arm/safe status. A 0 is Arm and 1 is Safe. See Section 3.1.4.3
YPOLRTMP	Y314	7/13		158.5	Polarizer mechanism temperature.
YPPB	Y.033	/		887_2 886_3 886_6	Flag for pre-planned branch availability. See Section 3.2.1
YPPINV	Y708	9/29		888_2 887_3	Preplanned branch request status. See Section 3.2.1
YPTRNOUT	$Y054_c$	/			Set number of patterns/readout. See Section 3.1.1.6

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YPTRNS	Y577	8/111	957.5		Patterns per readout. See Section 3.1.1.6
YQSOFF	Y521$_c$	/			Quiet Supply Off command.
YQSON	Y523$_c$	/			Quiet Supply On command.
YQSRPI	Y119	4/1:3		142.5	Quiet supply relay position. A 0 is +QPS (on) and 1 is -QPS (off)
YRAM-MAP	Y052$_c$	/			Map physical to logical RAM page. See Section 3.1.6.5
YRAMADDR	Y000$_c$	/			Load RAM storage address. See Section 3.1.6.3
YRAMADDR HI	Y545	8/108	956.0		RAM address pointer HI. See Section 3.1.6.3
YRAMADDR LO	Y545	8/109	956.5		RAM address pointer LO. See Section 3.1.6.3
YRANDOM	Y086$_c$	/			Fill science memory with pseudo-random sequence. See Section 3.1.6.3
YRANGE	Y555	8/52	928.0		Y range. See Section 3.1.1.4
YREADCYC	Y548	8/113	958.5		Readouts/memory clear. See Section 3.1.1.7
YREFDAC	Y032$_c$	/			Set common discriminator reference DAC. See Section 3.1.6.2
YREJECTS HI	Y652	8/51	927.5		Number of adder rejects HI. See Section 3.1.1.1
YREJECTS LO	Y652	8/58	931.0		Number of adder rejects LO. See Section 3.1.1.1
YREJLIM	Y014$_c$	/			Set noise rejection limit. See Section 3.1.1.1
YRESET	Y545$_c$	/			Reset Microprocessor command. See Section 3.1.6.5
YRESETMP	Y570	8/118:8	961.0		Reset microprocessor command flag. A 1 means reset. See Section 3.1.6.5
YRESETST	Y105	3/1:1		141.5	Reset status. A 0 is reset and a 1 is not reset
YRIEBW	Y549$_c$	/			Reset IEB/Watchdog command. See Section 3.1.6.5
YRIP	Y572	8/119:2	961.5		Resting in peace.
YRIUS2	Y131	4/1:1-2		142.5	RIU standby status. Bit 1 is for RIU A and bit 2 for RIU B. A 0 means STBY1 and a 1 means STBY2
YRSINV	Y709	9/28		889_2 888_3 892_6	Raster scan request status. See Section 3.2.1
YRSMVS	Y.034	/		890_2 889_3 893_6	Maximum moves during a raster scan.
YSAFAP	Y505$_c$	/			Safe Aperture command. See Section 3.1.4.2
YSAFCR	Y643	9/43			Consecutive major frames gone safe autonomously. Number of consecutive major frames in which FOS indicated (via YSAFING) it has gone safe autonomously
YSAFED	Y507$_c$	/			Safe Entrance Port command. See Section 3.1.4.1
YSAFING	Y514	8/26	915.0		Auto safe mode transition. Has Y.202-Y.204 (bits 1-5 unused). Bits 6-7 zeroed when sampled
YSAFPL	Y515$_c$	/			Safe Polarizer command. See Section 3.1.4.3

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YSCCTR	Y645	9/45			Counter of failed self-check tests. Number of consecutive major frames in which the FOS has failed the self-check test (in YSELFCHK)
YSCIACT	$Y070_c$	/			Control science data dump. See Section 3.1.2.3
YSCIADDR	$Y059_c$	/			Set first RAM address for science data. See Section 3.1.6.5
YSCIDMP	$Y002_c$	/			Set dump parameters. See Section 3.1.2.1
YSCNUM	Y636	9/36		891_2 890_3	Count steps in raster scan. Ranges from 0 to YRSMVS
YSDERASE	$Y057_c$	/			Clear science memory locations. See Section 3.1.6.3
YSDFA1	$Y543_c$	/			SDF A1 port to side select command.
YSDFA2	$Y539_c$	/			SDF A2 port to side select command.
YSDFA3	$Y541_c$	/			SDF A3 port to side select command.
YSDFA4	$Y537_c$	/			SDF A4 port to side select command.
YSDFB1	$Y535_c$	/			SDF B1 port to side select command.
YSDFB2	$Y531_c$	/			SDF B2 port to side select command.
YSDFB3	$Y533_c$	/			SDF B3 port to side select command.
YSDFB4	$Y529_c$	/			SDF B4 port to side select command.
YSDIP	Y584	8/119:8	961.5		Science dump in progress. A 1 means dump in progress. See Section 3.1.2.3
YSDPRC	Y.041	/		879_6	Science data processing flag. See Section 3.2.1
YSELFCHK HI	Y517	8/30	917.0		Processor self-check results HI. See Section 1.5
YSELFCHK LO	Y517	8/31	917.5		Processor self-check results LO. See Section 1.5
YSFFLG	Y618	9/18			Autonomous safe flag. Is 1 if processor 25 has been invoked by processor 30; 2 if not requested after reinitialization of processor 30; 0 otherwise
YSIGPTMP	Y310	7/9		154.5	Signal processor temperature.
YSLICES	$Y068_c$	/			Set number of memory slices. See Section 3.1.1.5
YSMCERRS	Y649	8/95	949.5		Serial magnitude command error report flags. Has Y.219-Y.226. Word zeroed when sampled
YSMOTSV	Y.052	/		882_6	Multiple of sky variance. See Section 3.2.1
YSPCTR	Y646	9/46			Counter of speed check errors. Counter indicating consecutive major frames in which a speed check error is indicated (YARITHCHK below NSSC-1 YBUSY value)
YSPDOK	Y716	9/35			Enable speed check test in Processor 30. A 1 means speed check test permitted; 2 means not permitted; 0 otherwise
YSPRØ	Y605	9/5			Spare 0.
YSPR1	Y614	9/14			Spare 1.
YSPR2	Y615	9/15			Spare 2.
YSPR6	Y647	9/47			Spare 6.

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YSPR7	Y648	9/48			Spare 7.
YSPRBIT1	Y556	8/117:1	960.5	-	Spare bit. All bits in word zeroed when sampled
YSPRBYT1	Y706	8/75	939.5		Spare byte 1. Typical value X'48' (subframe)
YSPRBYT1	Y707	8/105	954.5		Spare byte 2. Typical value X'69' (subframe)
YSTAT	Y.047	/		887_6	Scaling of statistical fluctuation. See Section 3.2.1
YSTBUF	Y600	9/0			Number of FOS status buffer entries. Measured since last time the counter reset
YSTBY1A	$Y625_c$	/			RIU Standby 1-A; self on.
YSTBY1B	$Y626_c$	/			RIU Standby 1-B; self on.
YSTBY2A	$Y627_c$	/			RIU Standby 2-A; mate off.
YSTBY2B	$Y628_c$	/			RIU Standby 2-B; mate off.
YSTOPDMP	$Y044_c$	/			Stop science dump. See Section 3.1.2.3
YSTRWRD	$Y018_c$	/			Store next commands as data. See Section 3.1.6.3
YSYNC	$Y023_c$	/			Set delay for starting synchronous acquisition. See Section 3.1.6.1
YTA	$Y088_c$	/			Begin Mode II FOS Target Acquisition Calculations. See Section 3.1.5
YTACMP	Y624	9/24		879_2 879_4 879_5	Mode 2 target acquisition completion indicator. See Section 3.2.1
YTACNT	Y637	9/37		893_2	Count window limit changes for Processor 28. Ranges from 0 to YTALIM
YTAINV	Y.032	/		898_1 897_4 894_6	Maneuver direction inversion flag. See Section 3.2.1
YTALIM	Y.035	/		892_2	Number (+ 1) of window limit changes allowed by YFMOD2.
YTAMAX HI	Y650	8/20	912.0		Upper target/acq window HI. See Section 3.1.5
YTAMAX LO	Y650	8/21	912.5		Upper target/acq window LO. See Section 3.1.5
YTAMIN HI	Y651	8/80	942.0		Lower target/acq window HI. See Section 3.1.5
YTAMIN LO	Y651	8/81	942.5		Lower target/acq window LO. See Section 3.1.5
YTAMOD	$Y046_c$	/			Set target acquisition mode. See Section 3.1.5
YTAMODE	Y515	8/27	915.5		Target acquisition mode. See Section 3.1.5
YTAQIP	Y575	8/119:5	961.5		Target acquisition in progress. A 1 means acquisition in progress. See Section 2.1.4
YTARACQ	$Y004_c$	/			Set target acquisition parameters. See Section 3.1.5
YTARXCTR HI	Y510	8/16	910.0		Target Acq X-center HI. See Section 3.1.5
YTARXCTR HI	Y510	8/76	940.0		Target Acq X-center HI. See Section 3.1.5
YTARXCTR LO	Y510	8/17	910.5		Target Acq X-center LO. See Section 3.1.5
YTARXCTR LO	Y510	8/77	940.5		Target Acq X-center LO. See Section 3.1.5
YTARYCTR HI	Y511	8/18	911.0		Target Acq Y-center HI. See Section 3.1.5
YTARYCTR HI	Y511	8/78	941.0		Target Acq Y-center HI. See Section 3.1.5
YTARYCTR LO	Y511	8/19	911.5		Target Acq Y-center LO. See Section 3.1.5
YTARYCTR LO	Y511	8/79	941.5		Target Acq Y-center LO. See Section 3.1.5
YTOFLG	Y619	9/19			Turn off flag. Is 1 if processor 27 has been invoked by processor 30; 2 if not requested after reinitialization of processor 30; 0 otherwise

Table 4.2-6 All FOS Commands and Telemetry by Mnémonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YTOLER	Y.048	/		888_6	Tolerance for edge centering. See Section 3.2.1
YTRMFCUR	Y323	4/0		135.5	Trim focus coil driver current.
YUPDWN	Y.051	/		881_6	Direction of Peakup/Peakdown search. See Section 3.2.1
YVARI1	Y.025	/		897_3 892_4	Sky variance (scaled program value). See Section 3.2.1
YWRDSLIH$_s$	Y.101	8/4	904.0		Same as YWRDSLIN HI.
YWRDSLIL$_s$	Y.102	8/5	904.5		Same as YWRDSLIN LO.
YWRDSLIN HI	Y551	8/4	904.0		Words per line HI. See Section 3.1.2.1
YWRDSLIN LO	Y551	8/5	904.5		Words per line LO. See Section 3.1.2.1
YWTCHDOG	Y103	3/1:3		141.5	Watchdog timer status. A 0 is OK and 1 is error. See Section 3.1.6.5
YX-BASE	Y026$_c$	/			Base value for X deflection computations. See Section 3.1.3
YX-DEFL	Y024$_c$	/			Set X-deflection amplifier DAC. See Section 3.1.3
YX-PITCH	Y028$_c$	/			Scaled X-deflection DAC value for one diode width in X. See Section 3.1.3
YX-STEP	Y039$_c$	/			Select number of X deflection steps. See Section 3.1.1.2
YXBASE HI	Y523	8/48	926.0		X deflection base HI. See Section 3.1.3
YXBASE LO	Y523	8/49	926.5		X deflection base LO. See Section 3.1.3
YXDAC HI	Y553	8/13	908.5		X DAC readback HI. See Section 3.1.3
YXDAC HI	Y553	8/43	923.5		X DAC readback HI. See Section 3.1.3
YXDAC HI	Y553	8/73	938.5		X DAC readback HI. See Section 3.1.3
YXDAC HI	Y553	8/103	953.5		X DAC readback HI. See Section 3.1.3
YXDAC LO	Y553	8/14	909.0		X DAC readback LO. See Section 3.1.3
YXDAC LO	Y553	8/44	924.0		X DAC readback LO. See Section 3.1.3
YXDAC LO	Y553	8/74	939.0		X DAC readback LO. See Section 3.1.3
YXDAC LO	Y553	8/104	954.0		X DAC readback LO. See Section 3.1.3
YXDACERR	Y558	8/117:4	960.5		X DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
YXDEFCUR	Y321	2/0		133.5	X-Deflection coil driver current.
YXFILW	Y040$_c$	/			Specify X filter width. See Section 3.1.5
YXFLWID	Y509	8/15	909.5		Target acquisition X filter width.
YXOFST	Y.050	/		891_6	X offset for target acquisition centering. See Section 3.2.1
YXPITCH HI	Y522	8/46	925.0		X deflection pitch between diodes HI. See Section 3.1.3
YXPITCH LO	Y522	8/47	925.5		X deflection pitch between diodes LO. See Section 3.1.3
YXSTEPS	Y524	8/50	927.0		X deflection sub-steps. See Section 3.1.1.2
YXYDFTMP	Y334	7/23		168.5	X Y deflection focus DAC temperature.
YY-BASE	Y027$_c$	/			Base value for Y deflection computations. See Section 3.1.3
YY-DEFL	Y025$_c$	/			Set Y-deflection amplifier DAC. See Section 3.1.3

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YY-PITCH	$Y029_C$	/			Scaled Y-deflection DAC value for one diode width in Y. See Section 3.1.3
YY-RNGE	$Y066_C$	/			Set range for Y deflection. See Section 3.1.1.4
YY-STEP	$Y047_C$	/			Set number of Y deflection steps. See Section 3.1.1.4
$YYAPMC_S$	Y.410	/	234		Aperture Mechanism Control Block (18 words). See Section 3.2.2
$YYASCIIH_S$	Y.403	/	838		ASCII header (64 words). See Section 3.2.2
YYAUTPO	Y.210	8/67:6	935.5		Automatic polarizer sequence instrument mode. See Section 2.1.6
YYBASE HI	Y527	8/55	929.5		Y deflection base HI. See Section 3.1.3
YYBASE LO	Y527	8/56	930.0		Y deflection base LO. See Section 3.1.3
YYCHPK1	Y.013	/		882_3 883_4	First channel where peak found. See Section 3.2.1
YYCHPK2	Y.014	/		883_3 884_4	Second channel where peak found. See Section 3.2.1
YYCHPK3	Y.015	/		884_3 885_4	Third channel where peak found. See Section 3.2.1
YYCHPK4	Y.016	/		885_3 886_4	Fourth channel where peak found. See Section 3.2.1
YYDAC HI	Y521	8/36	920.0		Y DAC readback HI. See Section 3.1.3
YYDAC LO	Y521	8/37	920.5		Y DAC readback LO. See Section 3.1.3
YYDACERR	Y559	8/117:6	960.5		Y DAC readback error flag. A 0 is OK and a 1 is error. See Section 3.1.3
YYDBBUF	Y.232	8/27:5	915.5		Double buffer FOS memory. See Section 3.1.5
YYDBLSN	Y.209	8/67:5	935.5		Double/-Single precision adder instrument mode. See Section 2.1.5
YYDCMIP	Y.223	8/95:5	949.5		Data command illegal path. See Section 3.1
YYDCMOF	Y.222	8/95:4	949.5		Data command overflow.
$YYDDTBL_S$	Y.401	/	322		Discriminator DAC/Disabled Diode Table (512 words). See Section 3.2.2
YYDEFCUR	Y322	3/0		134.5	Y-Deflection coil driver current.
YYEPMC	Y.409	/	226		Entrance Port Mechanism Control Block (8 words). See Section 3.2.2
$YYFGMC_S$	Y.412	/	306		FGWA Mechanism Control Block (16 words). See Section 3.2.2
YYFILTER	Y.228	8/27:1	915.5		Filter data before finding peak. See Section 3.1.5
YYFILW	$Y048_C$	/			Specify Y filter width. See Section 3.1.5
YYFIX	Y.229	8/27:2	915.5		Fix the target acquisition data. See Section 3.1.5
YYFLWID	Y705	8/45	924.5		Target acquisition Y filter width.
YYFVCTR1 HI	Y.010	/		883_2 893_4	First element for coordinate transformation HI. See Section 3.2.1
YYFVCTR1 LO	Y.010	/		884_2 894_4	First element for coordinate transformation LO. See Section 3.2.1
YYFVTCR2 HI	Y.011	/		885_2 895_4	Second element for coordinate transformation HI. See Section 3.2.1

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YYFVTCR2 LO	Y.011	/		886_2 896_4	Second element for coordinate transformation LO. See Section 3.2.1
YYILT3CC	Y.219	8/95:1	949.5		Illegal Type-3 command code. See Section 3.1
YYILT4CC	Y.220	8/95:2	949.5		Illegal Type-4 command code. See Section 3.1
YYILT4MO	Y.221	8/95:3	949.5		Illegal Type-4 command modifier. See Section 3.1
$YYINDFHY_S$	Y.217	8/112:5	958.0		Do deflection hysteresis pattern at beginning of data acquisition. See Section 2.1.1
YYINHSLT	Y.214	8/112:2	958.0		Inhibit slice table fill. See Section 2.1.1
YYINHXDF	Y.216	8/112:4	958.0		Inhibit X-deflection table fill. See Section 2.1.1
YYINHYDF	Y.215	8/112:3	958.0		Inhibit Y-deflection table fill. See Section 2.1.1
YYINXFFL	Y.231	8/27:4	915.5		Inhibit filter filling for X. See Section 3.1.5
YYINYFFL	Y.230	8/27:3	915.5		Inhibit filter filling for Y. See Section 3.1.5
YYMAF	Y.405	/	962.5		Major frame number (8 bits). See Section 3.2.2
YYMIF	Y.404	/	962		Minor frame number (8 bits). See Section 3.2.2
YYMYE	Y.235	8/27:8	915.5		Do Y direction edge finding. See Section 3.1.5
YYNEDM2	Y.037	/		895_2	Most recent high-order word of FOS engineering telemetry word YTARYCTR. See Section 3.2.1
YYNEDM4	Y.036	/		894_2	Most recent high-order word of FOS engineering telemetry word YTARXCTR. See Section 3.2.1
YYNMEMCL	Y.407	/	964		Memory clear number (16 bits). See Section 3.2.2
YYNMINOR	Y.007	/		882_2	Minor frame number. See Section 3.2.1
$YYNREAD_S$	Y.406	/	963		Readout number (16 bits). See Section 3.2.2
$YYPATH_S$	Y.201	8/1:8	902.5		Path identification. A 0 is "A" (amber or red) and 1 is "B" (blue). See Section 3.2.3
YYPITCH HI	Y526	8/53	928.5		Y deflection pitch between diodes HI. See Section 3.1.3
YYPITCH LO	Y526	8/54	929.0		Y deflection pitch between diodes LO. See Section 3.1.3
$YYPLMC_S$	Y.411	/	252		Polarizer Mechanism Control Block (54 words). See Section 3.2.2
YYPYE	Y.234	8/27:7	915.5		Find the Y direction upper edge. See Section 3.1.5
YYRAMMAP	Y.402	/	834		RAM map (4 words). See Section 3.2.2
$YYREJRE_S$	Y.207	8/67:3	935.5		Reject/-Retry instrument mode. See Section 2.1.3
YYRSMNI	Y.213	8/112:1	958.0		Resume (no initialization). See Section 2.1.1
YYSAFED	Y.204	8/26:8	915.0		Auto safing enabled/disabled. See Section 3.1.6.5
YYSAFLKA	Y.202	8/26:6	915.0		Auto safe due to loss of keep-alive SMC. See Section 3.1.6.5

Table 4.2-6 All FOS Commands and Telemetry by Mnemonic (cont)

Mnemonic	No	WD/SF	UDL	SHP	Significance
YYSAFTSL	Y.203	8/26:7	915.0		Auto safe due to loss of telemetry sync. See Section 3.1.6.5
YYSDCIP	Y.226	8/95:8	949.5		Science dump command illegal path. See Section 3.1
YYSHUID	Y.001	/		878	Identifier for FOS-Unique SHP data. See Section 3.2.1
YYSPR	Y.211	8/67:7	935.5		Spare bit.
YYSPR	Y.212	8/67:8	935.5		Spare bit.
YYSPR	Y.218	8/112:6-8	958.0		Spare bits.
YYSPR	Y.227	8/34:5-6	919.0		Spare bits.
YYSPR	Y.233	8/27:6	915.5		Spare bit.
YYSPR	Y.301	7/29:1		174.5	Spare bit.
YYSPR	Y.302	7/29:3-8		174.5	Spare bits.
YYSPR	Y.400	/	1		Spare (225 words). See Section 3.2.2
YYSPR	Y.408	/	965		Spare word.
YYSPR	Y.906	/		801.5	Spare in SHP. Value of X'00'
YYSPR8 B1	Y.648	9/49			Spare.
YYSPR8 B2	Y.648	9/50			Spare.
YYSPR8 B3	Y.648	9/51			Spare.
YYSPR8 B4	Y.648	9/52			Spare.
YYSPR8 B5	Y.648	9/53			Spare.
YYSPR8 B6	Y.648	9/54			Spare.
YYSPR8 B7	Y.648	9/55			Spare.
YYSPR8 B8	Y.648	9/56			Spare.
YYSPR8 B9	Y.648	9/57			Spare.
YYSPR8 B1Ø	Y.648	9/58			Spare.
YYSPR8 B11	Y.648	9/59			Spare.
YYSSCIP	Y.224	8/95:6	949.5		Synchronous start command illegal path. See Section 3.1
YYSTEPS	Y528	8/57	930.5		Y deflection sub-steps. See Section 3.1.1.4
YYSYNCS	Y.205	8/67:1	935.5		Synchronous start instrument mode. See Section 2.1.1
YYTAMOD	Y.038	/		897_2	Sampled value of FOS engineering telemetry word YTAMODE. See Section 3.2.1
$YYTARGA_S$	Y.208	8/67:4	935.5		Target acquisition instrument mode. See Section 2.1.4
YYTAWCIP	Y.225	8/95:7	949.5		Target acquisition window command illegal path. See Section 3.1
YYTIMTG	Y.206	8/67:2	935.5		Time-Tag instrument mode. See Section 2.1.2

4.3 LMSC'S ORGANIZATION OF FOS TELEMETRY

Section 4.2 provided the data for the engineering telemetry as presented by the FOS instrument. This section treats the data as it is actually sent on the downlink. To understand the downlink material, it is first necessary to establish the general features of the engineering telemetry (see the LMSC information in SLIB 1340 for more details).

Although there are several different basic telemetry formats available on the ST, the engineering telemetry format reflected in this section is:

Format AN: 4 KBPS Programmable Format.

According to SLIB 1340, "The purpose of this format is to provide telemetry data during normal day-to-day operations." The fact that it is "Programmable" means (again from SLIB 1340) "The structure or data content can be changed in flight by ground commands. Such changes will require careful planning, coordination, and ST program approval."

The following definitions apply to engineering telemetry:

1. A major frame is the period in which all data in the format is sampled at least once (barring a few exceptions that do not apply to FOS). The major frame for Format AN requires 120 minor frames.

2. A minor frame is the period from the start of one telemetry sync word to the next. The minor frame length for Format AN is 250 eight-bit words.

3. A subframe is a group or list of measurements that are sampled sequentially, one per minor frame, until each measurement in the group has been sampled once. The list is then repeated. Each subframe is assigned to a specific minor frame location, and as a result the measurements in the subframe will appear in that word location, one after another, in a fixed sequence. If the subframe length is 2, for example, this means that every other minor frame will contain another sample of the data (and it will be sampled 60 times in the Format AN major frame).

Since Format AN has 250 eight-bit words (or 2000 bits) per minor frame, and since its rate is 4 KBPS, this means that it takes [$2000/(4 * 10^3)$ =] 0.5 second to send a minor frame, and [120 * 0.5 =] 60 seconds to send a major frame.

Of the 250 eight-bit words in the Format AN minor frame, the complete SI C&DH is allocated 64. Of these 64, ten are allocated to each of the 5 SIs and the remaining to the SI C&DH itself. The 10 FOS words, with the SI word numbers (0-9) used in Section 4.2, the C&DH (0-63) telemetry word number, the corresponding minor frame word number (1-250), the subframe length, and the assignments are given in the following table:

SI #	C&DH	Minor Frame	Subframe Length	Assignment
0	18	80	2	Y319, Y328
1	19	83	2	Y325, bilevels
2	21	85	2	Y321, Y338
3	22	100	2	Y322, bilevels
4	24	102	2	Y323, bilevels
5	25	103	2	Y324, Y332
6	27	111	2	Y320, Y337
7	28	112	24	Y301-Y316 etc (temperatures)
8	30	126	120	Serial Digital Telemetry
9	47	192	60	NSSC-1 Processors

Table 4.3-1 shows the LMSC telemetry information (using the same data as in Section 4.2) arranged by the LMSC abbreviated measurement number (the same sequence as in SLIB 1340). The information differs from Section 4.2 in that subframe numbers begin with one, not zero, and the minor frame word numbers reflect the assignment in the Format AN telemetry.

It should be realized that the "official" source of information on telemetry data eventually must be the ST project data base rather than the material on the following pages.

Table 4.3-1 FOS Engineering Telemetry

Full No	Location	Significance	Mnemonic
Y11X101B	100/2:8	Carrousel motor status	YCMTRST
Y08X102B	102/2:6	Calibration lamp supply RPI	YCALRPI
Y02X103B	100/2:3	Watchdog timer status	YWTCHDOG
Y02X104B	100/2:4	Instruction engineering bit status	YINSENG
Y02X105B	100/2:1	Reset status	YRESETST
Y04X106B	100/2:5	Descramble PROM power status odd	YODSCRAM
Y04X107B	100/2:6	Descramble PROM power status even	YEDSCRAM
Y03X117B	102/2:5	High voltage relay position	YHVRPI
Y03X118B	83/2:8	Heater control relay position	YHTRRPI
Y03X119B	102/2:3	Quiet supply relay position	YQSRPI
Y03X120B	102/2:4	Logic supply relay status	YLSRPI
Y03X121B	102/2:7	Common bus relay #1 status	Y1BUSRPI
Y03X122B	102/2:8	Common bus relay #2 status	Y2BUSRPI
Y03X123B	83/2:5	Aperture failsafe arm/safe status	YAPRFRPI
Y03X124B	83/2:6	Entrance door failsafe arm/safe status	YENTFRPI
Y02X125B	83/2:1	SD CEA A K1-K6 status	Y1SDFPRT
Y02X126B	83/2:2	SD CEA A K7-K11 status	Y2SDFPRT
Y02X127B	83/2:3	SD CEA B K1-K6 status	Y3SDFPRT
Y02X128B	83/2:4	SD CEA B K7-K11 status	Y4SDFPRT
Y03X130B	83/2:7	Polarizer failsafe arm/safe status	YPOLFRPI
Y09X131D	102/2:1-2	RIU standby status	YRIUS2
Y08X133B	100/2:7	Calibration lamp select RPI	YCALSELR
Y02X134B	100/2:2	Microprocessor clock monitor	YCLKMON
Y11T301A	112/1	Optical bench temperature location 1	Y1OBTMP
Y11T302A	112/2	Optical bench temperature location 2	Y2OBTMP
Y11T303A	112/3	Optical bench temperature location 3	Y3OBTMP
Y11T304A	112/4	Optical bench temperature location 4	Y4OBTMP
Y11T305A	112/5	Photocathode A temperature	YPCATMP
Y11T306A	112/6	Pre-Amp assembly A temperature	YPAMATMP
Y11T307A	112/7	Permanent magnet focus assembly A temperature	YPMFATMP
Y11T308A	112/8	Optics area temperature location 1	Y1OATMP
Y11T309A	112/9	Optics area temperature location 2	Y2OATMP
Y04T310A	112/10	Signal processor temperature	YSIGPTMP
Y02T311A	112/11	Central electronics temperature	YCEATMP
Y01T312A	112/12	Entrance door mechanism temperature	YDOORTMP
Y01T313A	112/13	Aperture mechanism temperature	YAPERTMP
Y01T314A	112/14	Polarizer mechanism temperature	YPOLRTMP
Y01T315A	112/15	Filter/Grating Wheel motor A temperature	YFGMATMP
Y05T316A	112/16	High voltage supply temperature	YHVTMP
Y03T318A	112/19	Central power supply temperature	YCPSTMP
Y05V319A	80/1	High voltage supply voltage	YHVVLT
Y08V320A	111/1	Calibration lamp supply voltage	YCALVLT
Y03C321A	85/1	X-Deflection coil driver current	YXDEFCUR
Y03C322A	100/1	Y-Deflection coil driver current	YYDEFCUR
Y03C323A	102/1	Trim focus coil driver current	YTRMFCUR
Y03V324A	103/1	Discriminator reference voltage	YDSCRVLT
Y05C325A	83/1	High voltage supply current	YHVCUR
Y09T326A	112/17	RIU-A temperature	YARIUTMP

Table 4.3-1 FOS Engineering Telemetry (cont)

Full No	Location	Significance	Mnemonic
Y10T327A	112/18	RIU-B temperature	YBRIUTMP
Y08C328A	80/2	Calibration lamp supply current	YCLSCUR
Y01T329A	112/20	Filter/Grating Wheel motor B temperature	YFGMBTMP
Y11T330A	112/21	Photocathode B temperature	YPCBTMP
Y11T331A	112/22	Pre-Amp assembly B temperature	YPAMBTMP
Y03V332A	103/2	Plus 8 volt quiet power supply voltage	Y8VQPSV
Y11T333A	112/23	Permanent magnet focus assembly B temperature	YPMFBTMP
Y03T334A	112/24	X Y deflection focus DAC temperature	YXYDFTMP
Y03V337A	111/2	Plus 5 volt logic power supply voltage	Y5VLPSV
Y11P338A	85/2	Vacuum gauge reading	YINTPRES
Y02J500A	126/1	MP serial engr data packet sync	YENGSYNC
Y02J501A	126/2	Firmware version number	YFIRMVER
Y02J502Aa	126/3	Firmware check character HI	YERRCHK HI
Y02J502Ab	126/4	Firmware check character LO	YERRCHK LO
Y02X503D	126/9:7-8	Entrance door position	YDOOR
Y02X503D	126/39:7-8	Entrance door position	YDOOR
Y02X503D	126/69:7-8	Entrance door position	YDOOR
Y02X503D	126/99:7-8	Entrance door position	YDOOR
Y02X504B	126/9:5	FGWA encoder strobe bit	YFGWASTR
Y02X504B	126/39:5	FGWA encoder strobe bit	YFGWASTR
Y02X504B	126/69:5	FGWA encoder strobe bit	YFGWASTR
Y02X504B	126/99:5	FGWA encoder strobe bit	YFGWASTR
Y02H506A	126/9:1-4	Filter/Grating Wheel Assembly position	YFGWAPOS
Y02H506A	126/39:1-4	Filter/Grating Wheel Assembly position	YFGWAPOS
Y02H506A	126/69:1-4	Filter/Grating Wheel Assembly position	YFGWAPOS
Y02H506A	126/99:1-4	Filter/Grating Wheel Assembly position	YFGWAPOS
Y02Z508B	126/9:6	FGWA spare	YFGWASP
Y02Z508B	126/39:6	FGWA spare	YFGWASP
Y02Z508B	126/69:6	FGWA spare	YFGWASP
Y02Z508B	126/99:6	FGWA spare	YFGWASP
Y02J509A	126/16	Target acquisition X filter width	YXFLWID
Y02H510Aa	126/17	Target Acq X-center HI	YTARXCTR HI
Y02H510Ab	126/18	Target Acq X-center LO	YTARXCTR LO
Y02H510Aa	126/77	Target Acq X-center HI	YTARXCTR HI
Y02H510Ab	126/78	Target Acq X-center LO	YTARXCTR LO
Y02H511Aa	126/19	Target Acq Y-center HI	YTARYCTR HI
Y02H511Ab	126/20	Target Acq Y-center LO	YTARYCTR LO
Y02H511Aa	126/79	Target Acq Y-center HI	YTARYCTR HI
Y02H511Ab	126/80	Target Acq Y-center LO	YTARYCTR LO
Y02J514A	126/27	Auto safe mode transition	YSAFING
Y02J515A	126/28	Target acquisition mode	YTAMODE
Y02J516Aa	126/29	Arithmetic self-check (speed) results HI	YARITHCK HI
Y02J516Ab	126/30	Arithmetic self-check (speed) results LO	YARITHCK LO
Y02J517Aa	126/31	Processor self-check results HI	YSELFCHK HI
Y02J517Ab	126/32	Processor self-check results LO	YSELFCHK LO
Y02J518A	126/33	Discriminator reference DAC	YDREFDAC
Y02J519A	126/34	Focus trim coil DAC readback	YFOCUSRB
Y02V520Aa	126/35:7-8	High voltage DAC readback HI	YHVDACRB HI

Table 4.3-1 FOS Engineering Telemetry (cont)

Full No	Location	Significance	Mnemonic
Y02V520Ab	126/36	High voltage DAC readback LO	YHVDACRB LO
Y02J521Aa	126/37	Y DAC readback HI	YYDAC HI
Y02J521Ab	126/38	Y DAC readback LO	YYDAC LO
Y02H522Aa	126/47	X deflection pitch between diodes HI	YXPITCH HI
Y02H522Ab	126/48	X deflection pitch between diodes LO	YXPITCH LO
Y02H523Aa	126/49	X deflection base HI	YXBASE HI
Y02H523Ab	126/50	X deflection base LO	YXBASE LO
Y02J524A	126/51	X deflection sub-steps	YXSTEPS
Y02H526Aa	126/54	Y deflection pitch between diodes HI	YYPITCH HI
Y02H526Ab	126/55	Y deflection pitch between diodes LO	YYPITCH LO
Y02H527Aa	126/56	Y deflection base HI	YYBASE HI
Y02H527Ab	126/57	Y deflection base LO	YYBASE LO
Y02J528A	126/58	Y deflection sub-steps	YYSTEPS
Y02H530A	126/61	X deflection overscan	YOVRSCAN
Y02J531A	126/62	First channel to be processed	Y1STCHNL
Y02J532A	126/63	Number of channels to be processed	YNUMCHNL
Y02J536Aa	126/83	Firmware status group 1 HI	YFWSTAT1 HI
Y02J536Ab	126/84	Firmware status group 1 LO	YFWSTAT1 LO
Y02J537Aa	126/85	Firmware status group 2 HI	YFWSTAT2 HI
Y02J537Ab	126/86	Firmware status group 2 LO	YFWSTAT2 LO
Y02J538Aa	126/87	Firmware status group 3 HI	YFWSTAT3 HI
Y02J538Ab	126/88	Firmware status group 3 LO	YFWSTAT3 LO
Y02J539Aa	126/89	Firmware status group 4 HI	YFWSTAT4 HI
Y02J539Ab	126/90	Firmware status group 4 LO	YFWSTAT4 LO
Y02J540Aa	126/91	Firmware status group 5 HI	YFWSTAT5 HI
Y02J540Ab	126/92	Firmware status group 5 LO	YFWSTAT5 LO
Y02J541Aa	126/93	Firmware status group 6 HI	YFWSTAT6 HI
Y02J541Ab	126/94	Firmware status group 6 LO	YFWSTAT6 LO
Y02J542A	126/95	Memory clears/data acquisition	YMCLEARS
Y02J543Aa	126/97	Last command at SMC error HI	YLASTCMD HI
Y02J543Ab	126/98	Last command at SMC error LO	YLASTCMD LO
Y02J544Aa	126/107	Burst noise rejection limit HI	YNOISELM HI
Y02J544Ab	126/108	Burst noise rejection limit LO	YNOISELM LO
Y02J545Aa	126/109	RAM address pointer HI	YRAMADDR HI
Y02J545Ab	126/110	RAM address pointer LO	YRAMADDR LO
Y02J546A	126/111	Number of integrations/X-step	YINTEG
Y02J547A	126/113	Initialization mode	YINTMODE
Y02J548A	126/114	Readouts/memory clear	YREADCYC
Y02J549A	126/115	High byte of acquisition limit	YDATALIM
Y02J550Aa	126/116	Memory dump address HI	YMDMPADR HI
Y02J550Ab	126/117	Memory dump address LO	YMDMPADR LO
Y02J551Aa	126/5	Words per line HI	YWRDSLIN HI
Y02J551Ab	126/6	Words per line LO	YWRDSLIN LO
Y02J552Aa	126/7	Lines per frame HI	YLINSFRM HI
Y02J552Ab	126/8	Lines per frame LO	YLINSFRM LO
Y02J553Aa	126/14	X DAC readback HI	YXDAC HI
Y02J553Ab	126/15	X DAC readback LO	YXDAC LO
Y02J553Aa	126/44	X DAC readback HI	YXDAC HI
Y02J553Ab	126/45	X DAC readback LO	YXDAC LO

Table 4.3-1 FOS Engineering Telemetry (cont)

Full No	Location	Significance	Mnemonic
Y02J553Aa	126/74	X DAC readback HI	YXDAC HI
Y02J553Ab	126/75	X DAC readback LO	YXDAC LO
Y02J553Aa	126/104	X DAC readback HI	YXDAC HI
Y02J553Ab	126/105	X DAC readback LO	YXDAC LO
Y02J555A	126/53	Y range	YRANGE
Y02Z556B	126/118:1	Spare bit	YSPRBIT1
Y02X558B	126/118:4	X DAC readback error flag	YXDACERR
Y02X559B	126/118:6	Y DAC readback error flag	YYDACERR
Y02X560B	126/118:2	Focus DAC readback error flag	YFDACERR
Y02X561B	126/118:7	HV DAC readback error flag	YHVDACER
Y02X562B	126/118:8	Discriminator reference DAC readback error flag	YDRDACER
Y02X563B	126/118:3	Discriminator DAC readback error flag	YDDACERR
Y02X564B	126/119:1	Accumulator timer set error	YACTMERR
Y02X566D	126/119:2-4	Mechanism time-out code	YMECHTOC
Y02X567B	126/119:5	Begin data acquisition command flag	YBEGINDA
Y02X568B	126/119:6	End data acquisition command flag	YENDDA
Y02X569B	126/119:7	Abort data acquisition command flag	YABORTDA
Y02X570B	126/119:8	Reset microprocessor command flag	YRESETMP
Y02X571B	126/120:1	Data acquisition not in progress	YNDAIP
Y02X572B	126/120:2	Resting in peace	YRIP
Y02X573B	126/120:3	Pause in progress	YPIP
Y02X574B	126/120:4	CEA plot in progress	YCPIP
Y02X575B	126/120:5	Target acquisition in progress	YTAQIP
Y02J576A	126/60	Number of memory slices	YMSLICES
Y02J577A	126/112	Patterns per readout	YPTRNS
Y02X578B	126/118:5	Calibration DAC readback error flag	YCDACERR
Y02X579D	126/35:1-2	Descramble PROM power status	YDPRMPWR
Y02X580B	126/35:4	Flat field cal lamp power	YFFCPWR
Y02Z581B	126/35:3	Spare bit	YHVSPAR
Y02X582B	126/120:6	Mechanism motion in progress	YMMIP
Y02X583B	126/120:7	Auto memory clear in progress	YAMCIP
Y02X584B	126/120:8	Science dump in progress	YSDIP
Y02W585A	126/64	Accumulator open time high byte	YLIVEHI
Y02W586A	126/65	Accumulator open time low byte	YLIVELO
Y02W587A	126/66	Accumulator close time high byte	YDEADHI
Y02W588A	126/67	Accumulator close time low byte	YDEADLO
Y11Q600A	192/1	Number of FOS status buffer entries	YSTBUF
Y11X601D	192/2	FOS on/off indicator	YONOFF
Y11J602D	192/3	Status of INIT processor	YFINST
Y11J603D	192/4	Science data storage status	YFSDST
Y11J604D	192/5	Science data processing status	YFPRST
Y11Z605A	192/6	Spare 0	YSPRØ
Y11J606A	192/7	Line number within a frame	YLINCT
Y11J607D	192/8	Housekeeping status	YFHKST
Y11J608A	192/9	Autonomous safe status	YFASST
Y11J609D	192/10	Turn off status	YFTOST
Y11J610A	192/11	Data items 1-8	YFL81
Y11J611A	192/12	Data items 9-16	YFL169

Table 4.3-1 FOS Engineering Telemetry (cont)

Full No	Location	Significance	Mnemonic
Y11J612A	192/13	Data items 17-24	YFL241
Y11J613A	192/14	Data items 25-32	YFL322
Y11Z614A	192/15	Spare 1	YSPR1
Y11Z615A	192/16	Spare 2	YSPR2
Y11Q616A	192/17	Counts main frame keep-alive failures	YKEEP
Y11Q617A	192/18	Counts main frame limit check failures	YFLGCT
Y11J618D	192/19	Autonomous safe flag	YSFFLG
Y11J619D	192/20	Turn off flag	YTOFLG
Y11J620A	192/21	Action indicator for YFM2PR module	YFM2FL
Y11Q621A	192/22	Count frames for part 1 of YFSDPR processor	YFRCTR
Y11J622A	192/23	Mode 2 target acquisition error indicator	YGIVUP
Y11Q623A	192/24	Count frames for part 2 of YFSDPR processor	YGPCTR
Y11J624D	192/25	Mode 2 target acquisition completion indicator	YTACMP
Y11J625D	192/26	Mode 2 target acquisition processor status	YFM2ST
Y11J627A	192/28	NSSC-1 overlight protection flag	YOVPRO
Y11Q630A	192/31	Dwell counter for YFPKUP	YFDWCT
Y11Q636A	192/37	Count steps in raster scan	YSCNUM
Y11Q637A	192/38	Count window limit changes for Processor 28	YTACNT
Y11Q638A	192/39	Number of tests by YFHKPG where fail-safe armed	YFSCTR
Y11J639A	192/40	Consecutive major frames with error check error	YERCTR
Y11J640A	192/41	Consecutive major frames with firmware version error	YFWCTR
Y11Q641A	192/42	Counter of major frame fail-safe RPI test	YMFCCT
Y11Q642A	192/43	Counter of major frame output for data log	YMFECT
Y11Q643A	192/44	Consecutive major frames gone safe autonomously	YSAFCR
Y11Q644A	192/45	Counter of failed overlight sum tests	YOVCTR
Y11Q645A	192/46	Counter of failed self-check tests	YSCCTR
Y11Q646A	192/47	Counter of speed check errors	YSPCTR
Y11Z647A	192/48	Spare 6	YSPR6
Y11Z648A	192/49	Spare 7	YSPR7
Y11J649A	126/96	Serial magnitude command error report flags	YSMCERRS
Y11Q650Aa	126/21	Upper target/acq window HI	YTAMAX HI
Y11Q650Ab	126/22	Upper target/acq window LO	YTAMAX LO
Y11Q651Aa	126/81	Lower target/acq window HI	YTAMIN HI
Y11Q651Ab	126/82	Lower target/acq window LO	YTAMIN LO
Y11Q652Aa	126/52	Number of adder rejects HI	YREJECTS HI
Y11Q652Ab	126/59	Number of adder rejects LO	YREJECTS LO
Y02H656A	126/10	Aperture high-order encoder	YAPERHOE
Y02H656A	126/40	Aperture high-order encoder	YAPERHOE
Y02H656A	126/70	Aperture high-order encoder	YAPERHOE
Y02H656A	126/100	Aperture high-order encoder	YAPERHOE
Y02H657A	126/11	Aperture low-order encoder	YAPERLOE
Y02H657A	126/41	Aperture low-order encoder	YAPERLOE
Y02H657A	126/71	Aperture low-order encoder	YAPERLOE
Y02H657A	126/101	Aperture low-order encoder	YAPERLOE
Y02H658A	126/12	Polarizer high-order encoder	YPLZRHOE

Table 4.3-1 FOS Engineering Telemetry (cont)

Full No	Location	Significance	Mnemonic
Y02H658A	126/42	Polarizer high-order encoder	YPLZRHOE
Y02H658A	126/72	Polarizer high-order encoder	YPLZRHOE
Y02H658A	126/102	Polarizer high-order encoder	YPLZRHOE
Y02H659A	126/13	Polarizer low-order encoder	YPLZRLOE
Y02H659A	126/43	Polarizer low-order encoder	YPLZRLOE
Y02H659A	126/73	Polarizer low-order encoder	YPLZRLOE
Y02H659A	126/103	Polarizer low-order encoder	YPLZRLOE
Y11Z700A	112/25	Analog spare 1	YASPARE1
Y11Z701A	112/26	Analog spare 2	YASPARE2
Y11Z702A	112/27	Analog spare 3	YASPARE3
Y11Z703A	112/28	Analog spare 4	YASPARE4
Y11Z704A	112/29	Analog spare 5	YASPARE5
Y02J705A	126/46	Target acquisition Y filter width	YYFLWID
Y11Z706A	126/76	Spare byte 1	YSPRBYT1
Y11Z707A	126/106	Spare byte 2	YSPRBYT1
Y11J708A	192/30	Preplanned branch request status	YPPINV
Y11J709A	192/29	Raster scan request status	YRSINV
Y11Q710A	192/27	Count major frames with firmware status errors	YFWSCT
Y02J711A	126/68	Acquisition mode	YAQMD
Y11J712A	192/32	Accumulated science data (8 MSBs)	YACMSB
Y11J713A	192/33	Accumulated science data (second 8 MSBs)	YACNMS
Y11J714A	192/34	Accumulated science data (third 8 MSBs)	YACNLS
Y11J715A	192/35	Accumulated science data (fourth 8 MSBs)	YACLSB
Y11J716A	192/36	Enable speed check test in Processor 30	YSPDOK
Y02Q800Aa	126/23	Overlight sum MS byte	YOVRLTMB B1
Y02Q800Ab	126/24	Overlight sum NMS byte	YOVRLTMB B2
Y02Q800Ac	126/25	Overlight sum NLS byte	YOVRLTMB B3
Y02Q801A	126/26	Overlight sum LS byte	YOVRLTLB
Y11X926B	112/30:2	Vacuum gauge power RPI	YIONRPI

5.0 FOS CALIBRATION ALGORITHMS

The FOS Calibration Algorithms are divided into a set used in all FOS Ground Software modes (Sections 5.1-5.3) and those used in the Spectroscopy, Time-Resolved, Spectropolarimetry, Rapid-Readout, Time-Tagged, and LED Flat Field Map Reductions Ground Software Modes (Sections 5.4-5.9 respectively). Only those in Sections 5.1-5.3 are used in the Target Acquisition Ground Software Mode (see SLIB 799 Section 10.2.2.2.1). The following sections are arranged in the same sequence as SLIB 799.

5.1 FOS SCIENCE DATA FILES

See SLIB 799 Section 10.1.3.2.

5.2 STANDARD CASE REDUCTIONS, CONVERT RAW COUNTS TO COUNT RATES

See SLIB 799 Section 10.2.2.1.1.1.

5.3 STANDARD CASE REDUCTIONS, REQUIRED OUTPUTS

See SLIB 799 Section 10.2.2.1.1.3.

5.4 SPECTROSCOPY MODE REDUCTIONS

See SLIB 799 Section 10.2.2.1.2.

5.5 TIME-RESOLVED MODE REDUCTIONS

See SLIB 799 Section 10.2.2.1.3.

5.6 SPECTROPOLARIMETRY MODE REDUCTIONS

See SLIB 799 Section 10.2.2.1.4.

5.7 RAPID-READOUT MODE REDUCTIONS

See SLIB 799 Section 10.2.2.1.5.

5.8 TIME-TAGGED MODE REDUCTIONS

See SLIB 799 Section 10.2.2.1.6.

5.9 LED FLAT FIELD MAP REDUCTIONS

See SLIB 799 Section 10.2.2.2.2.

6.0 FOS DATA QUALITY/UTILITY ALGORITHMS

The FOS Data Quality/Utility Algorithms are used in the Spectrographic Ground Software Modes (all except Target Acquisition and LED Flat Field Map Reductions). The following sections are arranged in the same sequence as SLIB 799 Section 10.3.2.

6.1 SYNCHRONOUS STACKING OF DATA

See SLIB 799 Section 10.3.2.1.

6.2 ESTIMATION OF LINE INTENSITIES AND EQUIVALENT WIDTHS

See SLIB 799 Section 10.3.2.2.

6.3 DISPLAY OF HISTOGRAMS OF SELECTED POINTS OF THE SPECTRA

See SLIB 799 Section 10.3.2.3 (use standard SOGS image utility).

6.4 DETERMINATION OF LINE CENTERS

See SLIB 799 Section 10.3.2.4.

6.5 WAVELENGTH CALIBRATION ROUTINE

See SLIB 799 Section 10.3.2.5.

7.0 FOS TARGET ACQUISITION ALGORITHMS

The FOS Target Acquisition Algorithms are used solely in the Target Acquisition Ground Software Mode. The following sections are arranged in the same sequence as in SLIB 799 Section 10.4.2.

7.1 PICTURE CONSTRUCTION INPUT SCANS

See SLIB 799 Section 10.4.2.1.1.

7.2 PICTURE CONSTRUCTION UNRESTORED PICTURES

See SLIB 799 Section 10.4.2.1.2.

7.3 PICTURE CONSTRUCTION RESTORED PICTURES

See SLIB 799 Section 10.4.2.1.3.

7.4 PICTURE CONSTRUCTION GENERALIZED PICTURE CONSTRUCTION

See SLIB 799 Section 10.4.2.1.4.

7.5 CENTROIDING OBSERVER INTERACTIVE

See SLIB 799 Section 10.4.2.2.1.

7.6 CENTROIDING GROTH ALGORITHM

See SLIB 799 Section 10.4.2.2.2.

7.7 IMAGE CORRELATION

See SLIB 799 Section 10.4.2.3.

7.8 CROSS-CORRELATION OF COMPLEX IMAGE

See SLIB 799 Section 10.4.2.3.1.

8.0 REFERENCES

This section has three divisions: the first gives a summary of the significant sources used for earlier sections of this document; the second gives sources for other topics not covered in this document; and the third provides information on some SOGS Library documents (SLIB IDs) having information on FOS.

8.1 MAJOR NOTEBOOK SOURCES

FOS data in Section 1 was taken from SLIB L64, SLIB L66, SLIB L69, SLIB L72, SLIB L90, SLIB T23, SLIB T30, SLIB 118, SLIB 706, SLIB 739, SLIB 763, SLIB 767, SLIB 810, SLIB 814, SLIB 1006b, SLIB 1106, and SLIB 1351. SOGS Notebook plans are based on SOGS-300-82-273 (dated 30 July 1982).

Data in Section 2 was taken from SLIB L02, SLIB L64, SLIB L72, SLIB T25, SLIB T30, SLIB T34, SLIB 598, SLIB 706, SLIB 767, SLIB 810, SLIB 814, and SLIB 1006b.

Data in Section 3 was taken from SLIB L37, SLIB L55, SLIB L64, SLIB L65, SLIB L66, SLIB L72, SLIB L74, SLIB L83, SLIB L85, SLIB L88, SLIB L90, SLIB L95, SLIB L96, SLIB L97, SLIB L98, SLIB L99, SLIB T23, SLIB T25, SLIB T30, SLIB T39, SLIB T40, SLIB T43, SLIB 204, SLIB 259, SLIB 598, SLIB 683, SLIB 706, SLIB 739, SLIB 753, SLIB 763, SLIB 767, SLIB 810, SLIB 814, SLIB 936, SLIB 1106, SLIB 1219, SLIB 1334, SLIB 1340, and SLIB 1351.

Data in Section 4 was taken from SLIB L66, SLIB L72, SLIB L98, SLIB T30, SLIB T40, SLIB T43, SLIB 598, SLIB 683, SLIB 739, SLIB 753, SLIB 763, SLIB 767, SLIB 814, SLIB 936, and SLIB 1340.

Data in Sections 5-7 was taken from SLIB 799 and SLIB 814.

8.2 OTHER TOPICS

The following lists some of the FOS-related subjects omitted from this Notebook. The SLIB references are suggested as a starting point for future study of the topics indicated:

Topic	SLIB References
Algorithm Discussion	SLIB 411
Analysis Software	SLIB 411
Commands	SLIB L98, SLIB 683
FOS Astronomer Viewpoint	SLIB L90
FOS Hardware Requirements	SLIB 706
FOS Instrument Description and User Handbook (SE-01)	SLIB 1219
FOS Microprocessor Memory	SLIB 739
FOS Overview	SLIB 810
FOS Tape Analysis	SLIB 1106
Mission Operations Requirements	SLIB 1187
NSSC-1 FOS Processor Design	SLIB 763
Operational Considerations for FOS	SLIB 411
Operations Concept Analysis	SLIB 732
Prototype Software	SLIB 411
Scenarios using FOS	SLIB 731
SHP Contents	SLIB 936
SI C&DH Performance Specification	SLIB 530
SI Overview	SLIB 110, SLIB 595
SI-to-SI C&DH ICD, FOS Appendix	SLIB 753

8.3 SLIB REFERENCES

Given on the following pages are identifications of the SLIB documents cited in this document, as well as a selection of other TRW SOGS Library FOS-unique documents. They are in the following formats:

Table 8.3-1 is a list in order by SLIB number;

Table 8.3-2 is the same list, but arranged by descending date (most recent document first); and

Table 8.3-3 is the same list, but arranged in alphabetical order by title.

The cutoff date for the TRW SOGS Library material in this issue was the logged accessions for the week ending 21 February 1986.

Table 8.3-1 FOS References by SLIB Number

L02	820316	FOS Data Reduction Requirements, from U.Washington.
L04	820308	FOS Constraints and Restrictions, from UCSD.
L19	820406	Preliminary FOS Requirements for SOGS, from UCSD.
L20	820322	FOS Requirements for SOGS Support, from UCLA (Ford).
L25	820528	List of FOS Algorithms for SOGS, from UCSD.
L26	8104xx	Reducing Scanner Data (program documentation), from UCLA (Grandi).
L27	820412	Polarimetry Calibration Requirements for FOS, from U.Arizona.
L37	821101	DCF Observation Number, from Doxsey (ST ScI).
L55	830623	FOS Mechanism Information, from UCSD (Strein).
L64	830928	Review of TRW ST SI Notebook, from UCSD (Randall).
L65	831206	SI C&DH Questions, November 22, 1983, from IBM (Campbell).
L66	831206	SOGS Concerns with FOS Test Tape and Other Matters, from UCSD (Baity).
L69	831115	Naming of the Space Telescope, from MSFC.
L72	840117	Preliminary Answers to TRW Questions Raised by FOS Data Tape, from UCSD (Hier).
L74	840116	Coordinated Definition of .SHP Uplink Data Format, from GSFC.
L83	850403	Preparation for Meeting at UCSD on 19 April 1985, from UCSD (Baity).
L85	850609	Science Data from Application Processor 32 via NSSC-1, from UCSD (Baity).
L88	850904	FOS Discussion Topics for PODPS Meeting at GSFC 5-6 September 1985, from UCSD (Baity).
L90	8510xx	Faint Object Spectrograph Instrument Handbook, from ST ScI.
L95	851112	NSSC-1 Flight Software Baseline 3.7 Impact on SOGS, from IBM.
L96	860109	Interface Revision Notice 22 to ST-ICD-08, from IBM.
L97	860206	Change Pages for DM-03D [SLIB 1351] for Baseline 3.7, from IBM.
L98	851220	SDM-1001A, HST Command List, from LMSC.
L99	850917	SOGS Action Item #326 from FOS PODPS Meeting 5-6 Sept. 1985 at GSFC, from ST ScI (Hartig).
T14	820429	Minutes of SOGS-FOS-DOTL-STSOP Telecon of 29 April '82 on FOS Algorithms (AI T81 and T82), from SOGS.
T23	830623	Notes from GSFC/ST ScI Meetings 14-16 June 1983, from SOGS.
T25	830623	Results of FOS Question Discussion at GSFC on 16 June 1983, from SOGS.
T30	840126	Answers to Questions on FOS Data, from SOGS.
T34	840222	SI "Mode" Data, from SOGS.
T39	850423	Notes from IBM NSSC-1 Version 3.6 Review Meeting on 22 April 1985, from SOGS.
T40	850424	Notes from FOS PODPS Status/Update Meeting of 19 April 1985, from SOGS.
T43	860125	Compilation of YURINTAB Data for New Issue of SOGS Notebooks, from SOGS.
028	8003xx	DM-04, Ground Test Software for FOS (S/W Mgt Plan and Requirements), from UCSD.
046	8003xx	DM-03, SI Ground Test Software Requirements Document for FOS, from UCSD.
101	79xxxx	Testing of ST 512-channel Digicon, from SPIE.

Table 8.3-1 FOS References by SLIB Number (cont)

103	80xxxx	State of Art ST Digicon Performance Data, from SPIE.
104	79xxxx	ST Digicon, from SPIE.
110	79xxxx	ST Scientific Instruments, from SPIE.
118	79xxxx	FOS for the ST, from SPIE.
204	810807	SI & C&DH Command and Data Lists, from IBM.
213	790330	SI Operations and Data Mgt Requirements for FOS, from UCSD.
214	800522	DM-04C, Preliminary Ground Test Software Design (PDL) Document, from UCSD.
215	790718	DM-04, Preliminary Ground Test Software Requirements for UCSD FOS, from UCSD.
216	800320	DM-05C, Software Design Document for FOS for ST, from UCSD.
218	800714	Systems Description of Faint Object Spectrograph, Rev. A, from Martin.
220	800722	DRM Inputs for FOS, from UCSD.
224	770708	UC/MMC FOS Proposal for the ST, from UCSD.
259	8005xx	FOS Critical Design Review, from Martin.
262	790525	Prime Equipment Detail Spec, Pt. 2, Performance Design, and Verification Requirements for FOS, from Martin.
326	811221	FOS Ground Test Software Data Base, from .
343	811216	FOS Operations (Meeting Handout), from UCLA (H. Ford).
356	8202xx	FOS Bimonthly Review, from UCSD.
397	820303	FOS SI Data Base (printout), from UCSD.
411	820305	ST FOS Requirements Notebook, from SOGS.
439	800401	DM-01, SI Command and Data Lists for FOS, from Martin.
453	82xxxx	Performance of Spectropolarimeter for ST FOS, from Allen & Angel.
529	820504	OSS Scenario FOS, from CTA.
530	820325	Performance Spec for the SI C&DH Subsystem of the ST, from GSFC.
560	820524	A Brief Description of the FOS Eng'g TM, from ORI.
561	820524	Format and Content of FOS Science Data Output, from ORI.
563	7901xx	Operations and Data Management Plan for FOS, from UCSD.
595	8207xx	The ST, from Scientific American.
598	8206xx	FOS Data Requirements for SOGS, from UCSD.
630	790411	FOS System Performance Summary, from Martin.
633	8009xx	FOS 512-Channel Digicon Detector Performance Data, Paper #290-28, from UCSD.
634	7909xx	DM-05, Preliminary FOS NSSC-1 SW Requirements Document for FOS, Section B, from UCSD.
656b	820715	FOS Science Data Modes and Formats, from UCSD.
683	820804	FOS Serial Magnitude Command Definitions, from UCSD.
706	810825	FOS Prime Equipment Detail Spec, Pt. 2: Performance, Design, and Verification Requirements, from UCSD.
731	820830	SOGS Simulation Requirements Based on Operational Scenarios, from CTA.
732	820830	ST SOGS Operations Concept Analysis, from CTA.
733	820823	FOS Quality Utility Algorithms, from UCLA.
739	8208xx	SI/NSSC-1 Memory to SATS Interface Requirements Document (Preliminary), from GSFC.
753	820920	FOS Unique Appendix to SI/SI C&DH ICD, Rev. C, from UCSD.

Table 8.3-1 FOS References by SLIB Number (cont)

763	8208xx	DM-05, Flight Software for FOS, Section C, Pt. II, SW Design (PDL) Document Rev. E, from UCSD.
767	820807	Notes on FOS Briefing by G. Schmidt (SOGNOR-12), from SOGS.
769	820715	FOS Science Data Modes and Formats, from UCSD.
799	821029	SE-06-1 SOGS Design Manual Requirements Section (as updated, including PDCR-051 impact), from SOGS.
810	8208xx	The ST Observatory (10 papers), from ScI.
814	821104	UCSD Comments on FOS SOGS Notebook, from UCSD.
865	821231	ND-1004, FOS SOGS Notebook, from SOGS.
936	830307	Standard Header Packet Definition Document, Rev. A, from LMSC.
1006b	830506	SO-07, Final Science Operations Concept, Part 2, from SCI.
1106	831012	Analysis of Parts of FOS 20-22 March 1983 SI Data Tape, from SOGS.
1187	8401xx	SMO-1000, ST Mission Operations Functional Requirements, Rev. C, from MSFC (LMSC).
1204	840128	ND-1004A, Faint Object Spectrograph SOGS Notebook, from SOGS.
1219	840415	SE-01C, Instrument Description and User Handbook for the FOS, from UCSD.
1252	840728	ND-1004B, Faint Object Spectrograph SOGS Notebook, from SOGS.
1304	850322	Internal FOS Pt-Cr-Ne Calibration Lamp Performance in the Far UV, from ST ScI.
1327	8506xx	The Laboratory Absolute Photometic Calibration of the FOS, from ST ScI.
1334	8510xx	Mode 2 [FOS] Target Acquisition: Binary Search Parameters (CAL/FOS-023), from ST ScI.
1340	850925	SDM-1002A, ST Instrumentation Program and Component List, from LMSC.
1343	8508xx	Scattered Light from Bright Emission Lines (CAL/FOS-020), from ST ScI.
1351	851101	DM-03D Rev. E, SI C&DH Flight S/W User/Operator Manual (CCR 1389), from IBM.

Table 8.3-2 FOS References by Descending Date

L97	860206	Change Pages for DM-03D [SLIB 1351] for Baseline 3.7, from IBM.
T43	860125	Compilation of YURINTAB Data for New Issue of SOGS Notebooks, from SOGS.
L96	860109	Interface Revision Notice 22 to ST-ICD-08, from IBM.
L98	851220	SDM-1001A, HST Command List, from LMSC.
L95	851112	NSSC-1 Flight Software Baseline 3.7 Impact on SOGS, from IBM.
1351	851101	DM-03D Rev. E, SI C&DH Flight S/W User/Operator Manual (CCR 1389), from IBM.
L90	8510xx	Faint Object Spectrograph Instrument Handbook, from ST ScI.
1334	8510xx	Mode 2 [FOS] Target Acquisition: Binary Search Parameters (CAL/FOS-023), from ST ScI.
1340	850925	SDM-1002A, ST Instrumentation Program and Component List, from LMSC.
L99	850917	SOGS Action Item #326 from FOS PODPS Meeting 5-6 Sept. 1985 at GSFC, from ST ScI (Hartig).
L88	850904	FOS Discussion Topics for PODPS Meeting at GSFC 5-6 September 1985, from UCSD (Baity).

Table 8.3-2 FOS References by Descending Date (cont)

1343	8508xx	Scattered Light from Bright Emission Lines (CAL/FOS-020), from ST ScI.
1327	8506xx	The Laboratory Absolute Photometic Calibration of the FOS, from ST ScI.
L85	850609	Science Data from Application Processor 32 via NSSC-1, from UCSD (Baity).
T40	850424	Notes from FOS PODPS Status/Update Meeting of 19 April 1985, from SOGS.
T39	850423	Notes from IBM NSSC-1 Version 3.6 Review Meeting on 22 April 1985, from SOGS.
L83	850403	Preparation for Meeting at UCSD on 19 April 1985, from UCSD (Baity).
1304	850322	Internal FOS Pt-Cr-Ne Calibration Lamp Performance in the Far UV, from ST ScI.
1252	840728	ND-1004B, Faint Object Spectrograph SOGS Notebook, from SOGS.
1219	840415	SE-01C, Instrument Description and User Handbook for the FOS, from UCSD.
T34	840222	SI "Mode" Data, from SOGS.
1187	8401xx	SMO-1000, ST Mission Operations Functional Requirements, Rev. C, from MSFC (LMSC).
1204	840128	ND-1004A, Faint Object Spectrograph SOGS Notebook, from SOGS.
T30	840126	Answers to Questions on FOS Data, from SOGS.
L72	840117	Preliminary Answers to TRW Questions Raised by FOS Data Tape, from UCSD (Hier).
L74	840116	Coordinated Definition of SHP Uplink Data Format, from GSFC.
L65	831206	SI C&DH Questions, November 22, 1983, from IBM (Campbell).
L66	831206	SOGS Concerns with FOS Test Tape and Other Matters, from UCSD (Baity).
L69	831115	Naming of the Space Telescope, from MSFC.
1106	831012	Analysis of Parts of FOS 20-22 March 1983 SI Data Tape, from SOGS.
L64	830928	Review of TRW ST SI Notebook, from UCSD (Randall).
L55	830623	FOS Mechanism Information, from UCSD (Strein).
T23	830623	Notes from GSFC/ST ScI Meetings 14-16 June 1983, from SOGS.
T25	830623	Results of FOS Question Discussion at GSFC on 16 June 1983, from SOGS.
1006b	830506	SO-07, Final Science Operations Concept, Part 2, from SCI.
936	830307	Standard Header Packet Definition Document, Rev. A, from LMSC.
453	82xxxx	Performance of Spectropolarimeter for ST FOS, from Allen & Angel.
865	821231	ND-1004, FOS SOGS Notebook, from SOGS.
814	821104	UCSD Comments on FOS SOGS Notebook, from UCSD.
L37	821101	DCF Observation Number, from Doxsey (ST ScI).
799	821029	SE-06-1 SOGS Design Manual Requirements Section (as updated, including PDCR-051 impact), from SOGS.
753	820920	FOS Unique Appendix to SI/SI C&DH ICD, Rev. C, from UCSD.
763	8208xx	DM-05, Flight Software for FOS, Section C, Pt. II, SW Design (PDL) Document Rev. E, from UCSD.

Table 8.3-2 FOS References by Descending Date (cont)

739	8208xx	SI/NSSC-1 Memory to SATS Interface Requirements Document (Preliminary), from GSFC.
810	8208xx	The ST Observatory (10 papers), from ScI.
731	820830	SOGS Simulation Requirements Based on Operational Scenarios, from CTA.
732	820830	ST SOGS Operations Concept Analysis, from CTA.
733	820823	FOS Quality Utility Algorithms, from UCLA.
767	820807	Notes on FOS Briefing by G. Schmidt (SOGNOR-12), from SOGS.
683	820804	FOS Serial Magnitude Command Definitions, from UCSD.
595	8207xx	The ST, from Scientific American.
656b	820715	FOS Science Data Modes and Formats, from UCSD.
769	820715	FOS Science Data Modes and Formats, from UCSD.
598	8206xx	FOS Data Requirements for SOGS, from UCSD.
L25	820528	List of FOS Algorithms for SOGS, from UCSD.
560	820524	A Brief Description of the FOS Eng'g TM, from ORI.
561	820524	Format and Content of FOS Science Data Output, from ORI.
529	820504	OSS Scenario FOS, from CTA.
T14	820429	Minutes of SOGS-FOS-DOTL-STSOP Telecon of 29 April '82 on FOS Algorithms (AI T81 and T82), from SOGS.
L27	820412	Polarimetry Calibration Requirements for FOS, from U.Arizona.
L19	820406	Preliminary FOS Requirements for SOGS, from UCSD.
530	820325	Performance Spec for the SI C&DH Subsystem of the ST, from GSFC.
L20	820322	FOS Requirements for SOGS Support, from UCLA (Ford).
L02	820316	FOS Data Reduction Requirements, from U.Washington.
L04	820308	FOS Constraints and Restrictions, from UCSD.
411	820305	ST FOS Requirements Notebook, from SOGS.
397	820303	FOS SI Data Base (printout), from UCSD.
356	8202xx	FOS Bimonthly Review, from UCSD.
326	811221	FOS Ground Test Software Data Base, from .
343	811216	FOS Operations (Meeting Handout), from UCLA (H. Ford).
706	810825	FOS Prime Equipment Detail Spec, Pt. 2: Performance, Design, and Verification Requirements, from UCSD.
204	810807	SI & C&DH Command and Data Lists, from IBM.
L26	8104xx	Reducing Scanner Data (program documentation), from UCLA (Grandi).
103	80xxxx	State of Art ST Digicon Performance Data, from SPIE.
633	8009xx	FOS 512-Channel Digicon Detector Performance Data, Paper #290-28, from UCSD.
220	800722	DRM Inputs for FOS, from UCSD.
218	800714	Systems Description of Faint Object Spectrograph, Rev. A, from Martin.
259	8005xx	FOS Critical Design Review, from Martin.
214	800522	DM-04C, Preliminary Ground Test Software Design (PDL) Document, from UCSD.
439	800401	DM-01, SI Command and Data Lists for FOS, from Martin.
046	8003xx	DM-03, SI Ground Test Software Requirements Document for FOS, from UCSD.
028	8003xx	DM-04, Ground Test Software for FOS (S/W Mgt Plan and Requirements), from UCSD.
216	800320	DM-05C, Software Design Document for FOS for ST, from UCSD.

Table 8.3-2 FOS References by Descending Date (cont)

118	79xxxx	FOS for the ST, from SPIE.
104	79xxxx	ST Digicon, from SPIE.
110	79xxxx	ST Scientific Instruments, from SPIE.
101	79xxxx	Testing of ST 512-channel Digicon, from SPIE.
634	7909xx	DM-05, Preliminary FOS NSSC-1 SW Requirements Document for FOS, Section B, from UCSD.
215	790718	DM-04, Preliminary Ground Test Software Requirements for UCSD FOS, from UCSD.
262	790525	Prime Equipment Detail Spec, Pt. 2, Performance Design, and Verification Requirements for FOS, from Martin.
630	790411	FOS System Performance Summary, from Martin.
213	790330	SI Operations and Data Mgt Requirements for FOS, from UCSD.
563	7901xx	Operations and Data Management Plan for FOS, from UCSD.
224	770708	UC/MMC FOS Proposal for the ST, from UCSD.

Table 8.3-3 FOS References by Title

560	820524	A Brief Description of the FOS Eng'g TM, from ORI.
1106	831012	Analysis of Parts of FOS 20-22 March 1983 SI Data Tape, from SOGS.
T30	840126	Answers to Questions on FOS Data, from SOGS.
L97	860206	Change Pages for DM-03D [SLIB 1351] for Baseline 3.7, from IBM.
T43	860125	Compilation of YURINTAB Data for New Issue of SOGS Notebooks, from SOGS.
L74	840116	Coordinated Definition of SHP Uplink Data Format, from GSFC.
L37	821101	DCF Observation Number, from Doxsey (ST ScI).
439	800401	DM-01, SI Command and Data Lists for FOS, from Martin.
046	8003xx	DM-03, SI Ground Test Software Requirements Document for FOS, from UCSD.
1351	851101	DM-03D Rev. E, SI C&DH Flight S/W User/Operator Manual (CCR 1389), from IBM.
028	8003xx	DM-04, Ground Test Software for FOS (S/W Mgt Plan and Requirements), from UCSD.
215	790718	DM-04, Preliminary Ground Test Software Requirements for UCSD FOS, from UCSD.
214	800522	DM-04C, Preliminary Ground Test Software Design (PDL) Document, from UCSD.
763	8208xx	DM-05, Flight Software for FOS, Section C, Pt. II, SW Design (PDL) Document Rev. E, from UCSD.
634	7909xx	DM-05, Preliminary FOS NSSC-1 SW Requirements Document for FOS, Section B, from UCSD.
216	800320	DM-05C, Software Design Document for FOS for ST, from UCSD.
220	800722	DRM Inputs for FOS, from UCSD.
L90	8510xx	Faint Object Spectrograph Instrument Handbook, from ST ScI.
561	820524	Format and Content of FOS Science Data Output, from ORI.
633	8009xx	FOS 512-Channel Digicon Detector Performance Data, Paper #290-28, from UCSD.
356	8202xx	FOS Bimonthly Review, from UCSD.
L04	820308	FOS Constraints and Restrictions, from UCSD.
259	8005xx	FOS Critical Design Review, from Martin.

Table 8.3-3 FOS References by Title (cont)

L02	820316	FOS Data Reduction Requirements, from U.Washington.
598	8206xx	FOS Data Requirements for SOGS, from UCSD.
L88	850904	FOS Discussion Topics for PODPS Meeting at GSFC 5-6 September 1985, from UCSD (Baity).
118	79xxxx	FOS for the ST, from SPIE.
326	811221	FOS Ground Test Software Data Base, from .
L55	830623	FOS Mechanism Information, from UCSD (Strein).
343	811216	FOS Operations (Meeting Handout), from UCLA (H. Ford).
706	810825	FOS Prime Equipment Detail Spec, Pt. 2: Performance, Design, and Verification Requirements, from UCSD.
733	820823	FOS Quality Utility Algorithms, from UCLA.
L20	820322	FOS Requirements for SOGS Support, from UCLA (Ford).
769	820715	FOS Science Data Modes and Formats, from UCSD.
656b	820715	FOS Science Data Modes and Formats, from UCSD.
683	820804	FOS Serial Magnitude Command Definitions, from UCSD.
397	820303	FOS SI Data Base (printout), from UCSD.
630	790411	FOS System Performance Summary, from Martin.
753	820920	FOS Unique Appendix to SI/SI C&DH ICD, Rev. C, from UCSD.
L96	860109	Interface Revision Notice 22 to ST-ICD-08, from IBM.
1304	850322	Internal FOS Pt-Cr-Ne Calibration Lamp Performance in the Far UV, from ST ScI.
L25	820528	List of FOS Algorithms for SOGS, from UCSD.
T14	820429	Minutes of SOGS-FOS-DOTL-STSOP Telecon of 29 April '82 on FOS Algorithms (AI T81 and T82), from SOGS.
1334	8510xx	Mode 2 [FOS] Target Acquisition: Binary Search Parameters (CAL/FOS-023), from ST ScI.
L69	831115	Naming of the Space Telescope, from MSFC.
865	821231	ND-1004, FOS SOGS Notebook, from SOGS.
1204	840128	ND-1004A, Faint Object Spectrograph SOGS Notebook, from SOGS.
1252	840728	ND-1004B, Faint Object Spectrograph SOGS Notebook, from SOGS.
T40	850424	Notes from FOS PODPS Status/Update Meeting of 19 April 1985, from SOGS.
T23	830623	Notes from GSFC/ST ScI Meetings 14-16 June 1983, from SOGS.
T39	850423	Notes from IBM NSSC-1 Version 3.6 Review Meeting on 22 April 1985, from SOGS.
767	820807	Notes on FOS Briefing by G. Schmidt (SOGNOR-12), from SOGS.
L95	851112	NSSC-1 Flight Software Baseline 3.7 Impact on SOGS, from IBM.
563	7901xx	Operations and Data Management Plan for FOS, from UCSD.
529	820504	OSS Scenario FOS, from CTA.
453	82xxxx	Performance of Spectropolarimeter for ST FOS, from Allen & Angel.
530	820325	Performance Spec for the SI C&DH Subsystem of the ST, from GSFC.
L27	820412	Polarimetry Calibration Requirements for FOS, from U.Arizona.
L72	840117	Preliminary Answers to TRW Questions Raised by FOS Data Tape, from UCSD (Hier).
L19	820406	Preliminary FOS Requirements for SOGS, from UCSD.
L83	850403	Preparation for Meeting at UCSD on 19 April 1985, from UCSD (Baity).

Table 8.3-3 FOS References by Title (cont)

262	790525	Prime Equipment Detail Spec, Pt. 2, Performance Design, and Verification Requirements for FOS, from Martin.
L26	8104xx	Reducing Scanner Data (program documentation), from UCLA (Grandi).
T25	830623	Results of FOS Question Discussion at GSFC on 16 June 1983, from SOGS.
L64	830928	Review of TRW ST SI Notebook, from UCSD (Randall).
1343	8508xx	Scattered Light from Bright Emission Lines (CAL/FOS-020), from ST ScI.
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