Gas Chromatograph Mass Spectrometer (GCMS)

GCMS FS USER'S MANUAL

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1.0 Scope

1.1 Identification

This document is the Huygens Probe Gas Chromatograph Mass Spectrometer (GCMS) FS User's Manual. The document consists of the main document plus the following annex:

ANNEX 1 : GCMS Instrument Specific Test Procedures
(ACP Simulator Test and Rupture Valve Test)

1.2 Purpose

This document describes the operating characteristics of the GCMS instrument, with information specific to the Flight Spare model. It will be used as a reference manual during Cruise checkouts. A description of the telecommands used for FS checkout is provided, along with ATOL checkout program listings.

2.0 Applicable Documents

GCMS EID-B

GCMS Software Design Document

GCMS Software User's Manual

GCMS EGSE User's Manual

3.0 Science Overview

Refer to Section 1 of GCMS input to ESA-SP-1177 instrument summary.

4.0 Instrument Design Overview

Refer to Section 2 of GCMS input to ESA-SP-1177 instrument summary.

5.0 Instrument Operational Overview

5.1 Operating Principles

The GCMS contains a Flight Computer (FC) which controls all aspects of the instrument operation. Instrument software is stored in PROM, and is copied to SRAM for execution. The FC also contains EEPROM, which can be used store software patches and changes to sensor tuning parameters. There is a set of basic functions which are performed regardless of the DDB time or mission phase, and another set of functions which are performed based on information in the DDB or through telecommands.

At the hardware level, the interface between the flight computer and the analog electronics is primarily through a "microsequencer" which controls the timing of the mass selection and pulse count integration. Once every 5.008 milliseconds, values are written to digital to analog converters, pulse counter data is collected, and an analog to digital conversion made. The integration time of the pulse counters is set to 4.592 milliseconds. The most important data product is the pulse counts, which are used to determine the number of ions of a selected mass.

5.2 Basic Instrument Functions

After instrument power on, there is a delay of approximately one second before the Flight Computer Power-On Reset is released. After that, the FC performs various self tests and clears TC and TM buffers. The FC then places the instrument in a low power mode and begins the collection of housekeeping data. The program waits for receipt of 10 DDBs (20 seconds) before performing any device control operations. This delay allows time for the receipt of any telecommand which might be required to alter immediately the instrument operation, as well as to confirm the instrument mission phase in the DDB. At the end of the delay the FC examines the EEPROM and applies any memory patches which might have been uploaded. In all modes except Descent, the FC then performs a Pressure Test on the ion source, consisting of a thermistor test followed by a BA gauge test.

At the end of the turnon routine, one of the stored sequences is executed, depending on the mission mode and time in the DDB.

5.2.1 Operation in Ground Checkout

When the Mission Phase is Ground Checkout, the FC will enter a hold state after the completion of the pressure check. It will not proceed with any device turnons or sequence operations until it receives a “GO” telecommand. The test conductor will determine whether to issue the GO command based on

the contents of the experiment Status Word. The Status Word contains a “Waiting for GO” bit which indicates that the Pressure Test is complete and the instrument is in a hold mode. (See Section 7.1) If this bit is set AND the Pressure Test Fail bit is not set, then the GO command may be issued immediately. If the Pressure Test Fail bit is set, and no GCMS instrument representative is monitoring the test, the GCMS must be turned off. It is not critical that the turnoff be immediate, but it must occur before any additional telecommands are sent to the instrument, to avoid having a filament commanded on. If an instrument representative is present, the representative may give permission for the GO command to be sent even with the Pressure Test Fail bit set.

There are three components of the pressure test. The first is a reading of the pressure transducer in the ACP transfer line. This will detect only a very large leak, as the internal pressure must be about 0.3 bar before the test will fail. The second test is the monitoring of the difference in temperature between two thermistors, one located inside the sensor and one outside. This is a more sensitive test than the transducer. If either of these tests fail, the Pressure Fail bit remains set and the instrument waits for a GO command. If the tests pass or a GO command is received, the final pressure test is performed. This is a BA gauge reading, which involves turning on the BA filament and monitoring grid current. At the end of the BA test the instrument will enter "waiting for GO" mode. If any of the three pressure measurements have failed, the Pressure Test Fail bit will remain set. This means that two GO commands may be required if the ACP or thermistor pressure checks fail.

After a test in which the Pressure Test fails, the telemetry data from the test must be made available to the GCMS team as soon as possible. Until the data is analyzed by the experimenters, the GCMS must not be turned on when the Mission Phase indicates Descent. This would include both true descent simulations and ground tests in which the Mission Phase is incorrectly identified. It is preferred that the instrument not be powered on again until a GCMS representative has been contacted, but if subsequent tests are only Ground C/O or Cruise C/O, there is little risk of damage to the instrument.

The Ground C/O operating sequence was intended to be the same as the Descent sequence, but without operating the Rupture valves and with the Inlet heater only turned on for a short time. In the Flight Spare instrument, the final changes to the Descent valve sequence were not incorporated in the Ground C/O sequence, so there are additional differences. Since the Ground C/O flag is never used at Probe level after initial integration testing, this does not have an effect on operations. During bench testing, the Ground C/O flag is used but the Go telecommand is not sent so the stored sequence is not executed.

5.2.2 Operation in Flight Checkout

When the Mission Phase is Flight Checkout, if the Pressure Test succeeds the FC will automatically proceed with a measurement sequence. If the Pressure Test fails the FC will enter a hold state and will not proceed with any device turnons or sequence operations unless it receives a “GO” telecommand. The operation of the “Waiting for Go” bit is similar to that in Ground C/O, except that the bit will only remain set if the Pressure Test fails. If the test passes the instrument will automatically enter an operating sequence. For this reason it is not planned to include a GO telecommand in the nominal Flight C/O sequences; a Pressure Test failure in ground testing is handled as described in 5.2.1 above. A Pressure Test failure during cruise testing after launch may require modification of the telecommand sequence for the subsequent turnon.

In order to provide more information on the state of the instrument pressure during Flight C/O, the pressure check is done twice. During the second test, the BA gauge check is always done regardless of whether the ACP and thermistor have failed. The original rationale for this was that the second test was to be done when all valves were closed, reducing the risk of burning out the filament. The valves are now never closed, but it is still unlikely that the pressure during Flight would be high enough to damage the BA filament.

Since the valve operations are inhibited in the FS, the valves are always left open. The stored sequences still contain valve operations, however, so if the software patch which inhibits valve operations is overwritten by telecommand (or is not applied due to EEPROM failure) then valve operations will occur. The automatic valve operations must be kept in mind when Flight C/O contingency sequences are produced.

It was originally foreseen to leave some GCMS valves closed during Coast phase, so they would be properly configured for Entry. For this reason, after the Probe battery Depassivate sequence the GCMS is turned back on and a series of valve telecommands is sent. With the existing valve inhibit patch, this second turnon sequence has no effect. It was retained in case the decision is later made to return to the planned valve configuration for Entry. This would require changes to the present configuration sequence, to override the valve inhibit patch. To ensure that Deactivate mode will not result in the valves being reopened, ESOC has been instructed not to use Deactivate mode for the final GCMS sequence. (This is redundant, since typically the valve inhibit patch will be reinstalled at the end of the valve configuration sequence.)

5.2.3 Operation in Descent Mode

The Pressure Test is not done in descent mode, for several reasons. One is that it can require several minutes to perform, time which is better spent in warming up the ion sources. Another is that turning on the BA filament

unnecessarily introduces an additional possibility of producing an overcurrent condition. Since the Pressure Test is not done, a Descent simulation must not be the first test run after transportation, any environmental tests, or after an interval between tests of more than 24 hours. Stated differently, a non-Descent test must have been performed within the 24 hours before a Descent test. If the GCMS Pressure Test failed during this non-Descent test, the Descent test must not be performed without the approval of a GCMS representative.

In Descent mode, the Ion Pumps are turned on automatically before the stored sequence begins. The Ion Pump turnon includes checks of the instrument current monitor to determine whether the input current is low enough to safely turn on the pumps without tripping the Probe current limiter. If the current is not low enough after 90 seconds, the pump is turned on anyway. There are two Ion Pump Supplies, so the turnon can take as little as several seconds or as long as three minutes, depending on the input current reading.

5.3 Sequenced Operations

The GCMS performs sequences of control operations based on DDB time and mission phase. The following operations are stored as steps in control sequences in the GCMS:

Valve Enable/Disable
Valve Open/Close/Squirt
Heater Enable/Disable
Heater On/Off
Filament On/Off
BA filament On/Off
Ion Pump Supply On/Off
Ion Source Select
Mass Scan
Change to DAC voltages
Changes to computer memory areas

The GCMS contains seven stored sequences, one of which can be active at a given time. The active sequence is selected by the FC based on the Mission Phase in the DDB. The sequences are:

Ground Checkout Before T0
Ground Checkout After T0
Flight Checkout Before T0
Flight Checkout After T0
Descent Before T0
Descent After T0
Deactivate

Section 6 contains a complete description of the sequences. Events which have the same time stamp will be executed as quickly as possible, typically with 1 millisecond delay between operations.

5.3.1 Suspend Mode

If the mission phase becomes "Suspended", the instrument will hold in the sequence execution until the phase returns to an operating phase. Regardless of whether the DDB time keeps incrementing, the instrument time will remain fixed at the last valid time before mission phase became Suspended. Note that on the Probe time will continue to increment in pre-T0 Suspend, but not in post-T0 suspend. Note also that operation for extended periods in Suspend mode will result in telemetry data having all the same time stamp. Since the GCMS data analysis routines If time stops incrementing but the mission phase is not "Suspended", the GCMS FC will rely upon its internal clock and will proceed with the stored sequence. If there is a discontinuity in the DDB time such that the time "jumps" forward, the FC will process the intermediate steps at an accelerated rate until it reaches the new time. If time jumps backward more than one second, results may be unpredictable, as this mode has not been tested.

If the mission phase lasts for longer than the duration of the stored sequence (indicated by the last operation time in the list) then no sequence is active. Should a Suspend/Resume occur during this time, the instrument will start executing the sequence over again.

5.3.2 Deactivate Mode

When the mission phase becomes "Deactivate", the GCMS will power off all heaters, filaments, and ion pumps and will open all enabled valves. This was required before the valves were inhibited, but is now optional.

5.4 Functions Controlled by Telecommand

All of the functions listed in 5.3 above can also be controlled by telecommand during any mission phase. In addition, telecommands can be used to change D to A converter settings, modify memory locations, set the Status Word to a specified value, directly write to FC I/O addresses, and to reset the FC. Telecommands are discussed in detail in Section 7.0.

5.5 Operating Setup and Constraints

5.5.1 Connections

All connections to the GCMS must be made with all power off. The GCMS must be connected to Power (J01), CDMU or Simulator (J02 and J03), and Safe, Arm or Test plugs (J07). The pyro connectors (J05 and J06) are independent of other GCMS electrical operation and may be fitted with shorting plugs or other protection means as required by the test configuration. The ACP connector (J04) is to be connected to either the ACP or the ACP Simulator Test Box, or, if the ACP interface is not being tested, the connector cover can remain in place.

5.5.2 Constraints

Main Power should always be applied before Protected Power. There is no specific danger to the instrument if power is applied in the other order, but all testing has been performed with Main being applied first and removed last.

GCMS testing must always be performed with either the Rupture Valve Test Box or the Safe plug in place. The Arm plug will only be installed immediately before the final Probe assembly, when Protected Power will not be applied to the instrument until Descent.

A non-Descent test must have been performed within the 24 hours before a Descent test. If the GCMS Pressure Test failed during this non-Descent test, the Descent test must not be performed without the approval of a GCMS representative.

The GCMS FS contains live pyros, so proper pyro device handling must be used.

The GCMS should be powered on only after the sending of DDBs has begun. The Mission Phase must never indicate Descent unless it is intended to be a true Descent test.

5.6 Emergency Power Off

Bit 0 of the Status Word is used to indicate a condition exists within the instrument which is potentially damaging, such as a major flight computer failure. Since only one erroneous turnoff has been reported in the Probe level testing to date, it is acceptable for the turnoff to occur after a single reading of the Status Word.

Should the instrument be powered off because of the Emergency Power Off bit being set, it may be turned on again for subsequent testing but only in non-Descent modes. If the bit becomes set in the second test, no further testing shall be performed until the test data has been reviewed by a GCMS representative.

5.7 Valve Operations

The GCMS contains microvalves which control the flow of gas in the instrument. Two of the valves are Rupture valves, which must not be operated in the Close direction during testing. They are inhibited in two ways: 1. The Close logic is inhibited when Protected Power is Off, and 2. A Safe plug or Rupture Valve Test Box is used during testing.

Valve operations generally result in an audible click. This is normal operation. Valve opening and closing is monitored in the instrument telemetry by a reading of the state of a sense switch in each valve. The energy to drive the valves is stored on capacitors which are partially discharged by a valve operation. When the capacitor voltage is sampled soon after a valve operation, the voltage monitors will show the lowered voltage. This voltage is telemetered with approximately a one second resolution.

Consecutive valve operations such as "VAA open" "VAB open" must be separated by at least two seconds to allow the valve drive capacitor to recharge.

At the hardware level, the valves are controlled by writing a byte to output address 60A0 h. The bits of the control word are decoded as follows:

H1	H0	S3	S2	S1	S0	P	C
MSB							LSB

H1,H0 Select which of the two valve drive hybrids is addressed

S3...S0 Select which of the 16 valve drive outputs per hybrid to control. The Rupture Valves are always output 0.

P Selects the polarity of the output voltage. 0 = Negative, 1 = Positive. The Negative voltage Opens a valve, while the Positive voltage Closes a valve. A logic interlock prevents the Rupture Valves from being operated in the Closed direction unless the Protected Power is on.

C Turns the output switch On (1) or Off (0). Normal valve control is to turn the switch on for about 12 milliseconds to cause the valve to operate, then turn the switch off so the capacitor can recharge for another operation. This sequence is performed by the flight computer in response to a valve control command.

The data word is transmitted serially to the valve driver hybrids, and requires at least 160 microseconds to be clocked out.

In order for a valve control telecommand to be functional, the valve must first be enabled, either by telecommand (g_f_gv_venadis) or as part of the stored sequence. By default, all valves are disabled at instrument power on or after a reset.

Below are the control words for each of the FS valves:
Difference between FM and FS is
VD7

Valve Index (TCs)	Valve Name (ICCs)	Tabular gcmshkII MSB	Hyb	Ch.	Stop Open	Stop Opening	Stop Close	Stop Closing	
0	IV	VALVE31	2	0	81	80	83	82	
1	IVA	VALVE30	1	0	41	40	43	42	
2	VAA	VALVE28	1	1	45	44	47	46	
3	VAB	VALVE08	1	B	6D	6C	6F	6E	
4	VC1	VALVE02	1	E	79	78	7B	7A	
5	VC2	VALVE04	1	D	75	74	77	76	
6	VC3	VALVE16	1	7	5D	5C	5F	5E	
7	VD1	VALVE27	2	2	89	88	8B	8A	
8	VD2	VALVE21	2	5	95	94	97	96	
9	VD3	VALVE13	2	9	A5	A4	A7	A6	
10	VD4	VALVE11	2	A	A9	A8	AB	AA	
11	VX	VALVE01	2	F	BD	BC	BF	BE	Was VD5
12	VD6	VALVE03	2	E	B9	B8	BB	BA	
13	VE	VALVE18	1	6	59	58	5B	5A	
14	VG	VALVE00	1	F	7D	7C	7F	7E	
15	VG1	VALVE05	2	D	B5	B4	B7	B6	
16	VG2	VALVE07	2	C	B1	B0	B3	B2	
17	VG3	VALVE09	2	B	AD	AC	AF	AE	
18	VG4	VALVE24	1	3	1	0	3	2	Spare
19	VL1	VALVE26	1	2	49	48	4B	4A	
20	VL2	VALVE10	1	A	69	68	6B	6A	
21	VL3	VALVE22	1	4	51	50	53	52	
22	VL4	VALVE14	1	8	61	60	63	62	
23	VS1	VALVE23	2	4	91	90	93	92	
24	VS2	VALVE19	2	6	99	98	9B	9A	
25	VS3	VALVE17	2	7	9D	9C	9F	9E	
26	VS4	VALVE25	2	3	1	0	3	2	Spare
27	VS5	VALVE15	2	8	A1	A0	A3	A2	
28	VS6	VALVE29	2	1	85	84	87	86	
29	VS7	VALVE20	1	3	4D	4C	4F	4E	

30	VV	VALVE06	1	C	71	70	73	72
31	VZ	VALVE12	1	9	65	64	67	66

Note that:
1. Because of a problem with one FS hybrid drive channel, VD7 has different control words on the FS than the FM. On the FM the "stop opening" byte is 54 h.
2. The table of control bytes in the flight software (starting at address BA8E in the AMB) is equivalent to the "stop opening" column.
3. Because the VC3 drive is shorted to chassis in the FS, the control bytes for VC1, VC2, and VC3 were set to 0 by an EEPROM patch, effectively disabling the valves.
4. Valve operations have been disabled for all non-Descent modes, except for the IV and IVA Open operations which verify the Arm plug.

5.8 Heater Operations

The GCMS contains seven heaters. Some are cycled by the flight computer to achieve temperature regulation based on thermistor readings, while others are run open loop and turned on and off at specified times.

GC1 Heater - Temperature controlled - Protected Power
GC2 Heater - Temperature controlled - Protected Power
GC3 Heater - Temperature controlled - Protected Power
EC1 Heater - Sequence controlled - Protected Power
EC2 Heater - Descoped
ACP Heater - Sequence controlled - Protected Power

Inlet Heater - Sequence or TC controlled - Main Power
H2 Heater - On if Inlet heater is On and ACP heater is Off
Cal Heater - Descoped

For telecommand and hardware level control information, see Section 7.1.2.

For the heater control telecommand to function, the heaters must be enabled. By default, all heaters are disabled at instrument power on. To enable a heater, the g_f_gh_henadis telecommand is used.

The Inlet heater cannot be run normally if there is no cold gas passing through the instrument, because the tube will become too hot and perhaps cause a vacuum leak. This means that during a Descent test telecommands must be used to disable the heater. The heater nominally turns on at 20 seconds after T0, and remains on for the entire descent. The heater should be turned off within one minute of the time it turns on. Normally only one telecommand (on each channel) is necessary to disable the heater. In the event of a flight computer

reboot, however, the heater will become enabled and turned on again. For this reason the Inlet heater bit in the Status Word (Bit 8) must be monitored and the telecommands sent whenever the bit = 1.

The commands to be sent are: g_f_gh_henadis_a(0,0,0) and
g_f_gh_henadis_b(0,0,0)

If a command file must be sent instead of a command with parameters, the files should contain:

A channel	B channel
1F80	1FA0
C000	C000
0007	0007
0044	0044
0010	0010
0000	0000
7D87	D7FD

For the GC heaters, sending the Enable commands causes the heaters to turn on and off automatically to maintain the desired set temperatures. The nominal temperatures are 30 C for GC1 and GC2, and 40 C for GC3.

5.9 Filaments

The GCMS five ion source filaments. There is a sixth filament (BA) which is part of a pressure sensing system. For telecommand and hardware level control information, see Section 7.1.6.

5.10 Ion Pumps

The GCMS contains two Ion Pump Drive circuits, each of which drives three voltage multipliers to generate high voltage to a total of six Ion Pumps. The Drive circuits are controlled as described in Section 7.1.9. Ion Pump Supply 1 powers the ion pumps in IS1, IS3, and IS4; Ion Pump Supply 2 powers the ion pumps in IS2, IS5, and the switching lenses.

5.11 Secondary Electron Multipliers

The GCMS contains two Secondary Electron Multipliers (SEM) to detect ions exiting the quadrupole. The voltage levels generated are controlled by digital to analog converters. The multiplier strip current is monitored and telemetered in housekeeping.

In the Flight Spare instrument, the low gain SEM was too electrically noisy to be used. The voltage to this SEM is set at zero in the PROM software, and at a low level (approx. 500 V) in the Flight C/O 2 command sequence. The counter data associated with this SEM is not telemetered.

For both the FM and FS, the flight PROM contains a relatively high voltage for the multipliers, which is overridden by EEPROM patches to use a lower voltage. The settings and voltages are:

FS PROM		FS EEPROM		FM PROM		FM EEPROM	
DAC	Volts	DAC	Volts	DAC	Volts	DAC	Volts
230	2950	211	2700	217	2800	193	2500

5.12 Pulse Amplifiers and Counters

The GCMS FM contains two sets of pulse amplifiers and counters, one for each SEM. One is a high gain channel, the other a low gain which produces about 1/5000 the number of counts. The number of counts is also dependent on the pulse height detection threshold set for the counters. A maximum setting will reduce the counts, while minimum setting will create more counts due to noise pulses. See Section 7.1.8 for threshold setting telecommand description.

As discussed in 5.11 above, the counter data for the low gain channel is not telemetered in the FS.

5.13 Current Monitors and Overcurrent Interrupt

The GCMS contains internal current monitors on both the Main and Protected lines. The monitor values are telemetered in housekeeping packets. The Main power monitor also goes to a comparator which will generate an interrupt signal if the Main current reaches a preset level (just below Imax). This interrupt temporarily disables the Ion Pump Supplies and Inlet heater, and also sends a priority interrupt to the flight computer. The flight computer will turn off the Inlet heater and Ion Pumps. It then produces an Ack telemetry packet to indicate receipt of the interrupt.

The level at which the overcurrent interrupt occurs is adjusted by a D to A converter channel having 16 possible settings. The nominal setting is 4. If an interrupt occurs at this setting, the setting is increased by one. At each subsequent interrupt, the setting is raised again until it reaches the maximum of 16. Without a high Ion Pump current, the GCMS cannot draw enough current to cause an interrupt at even the lowest setting. The only overcurrent trips seen

during instrument testing occurred during conducted susceptibility tests, during which sufficient current was injected into the instrument Main power to cause an overcurrent trip.

The lowest possible setting of 0 on the DAC represents a trip level of about 1.44 Amps (calculated). The nominal setting of 4 should be a trip level of about 1.57 Amps. The Probe circuit breaker setting is nominally 1.85 Amps, and is "guaranteed" to be greater than 1.68 Amps (Imax).

The Descent post-T0 sequence contains Ion Pump and Inlet heater turnons about every five minutes, to allow recovery from an overcurrent turnoff.

6.0 Stored Operating Sequence Listings

Tables 6.1 through 6.6 contain listings of the instrument control sequences stored in PROM in the GCMS. They govern operation in the following mission phases:

Table 6.1 = Descent before T0
Table 6.2 = Descent after T0
Table 6.3 = Flight C/O before T0
Table 6.4 = Flight C/O after T0
Table 6.5 = Ground C/O before T0
Table 6.6 = Ground C/O after T0

The "DDB Time" column is the mission time at which the flight computer will begin executing the command. In cases where several steps have the same DDB Time, the flight computer will execute the commands in sequence as rapidly as possible (approximately 1 msec between steps). All steps are programmed with one second resolution. If there is a delay of more than 7 seconds between operations, a different timing function is used. The "Operation" column contains the key word descriptions of the operations to be performed. An interpreter is used to convert these times and key words to a data table in the proper format for use by the flight computer.

For the most part the sequence commands are self-explanatory. The ones that are somewhat obscure are:

valve VG1 squirt 4 -- Causes Valve VG1 to be opened for 4 * 25 msec = 100 msec and then closed again.

isource false round_robin 0 1 1 1 1 1 0 -- Enables ion sources, and allows for sampling of sources on a “round robin” basis in which the Direct and/or ACP sources are also sampled when the GC sources have signal. The “false” indicates that this is to enable the sources. A “true” would indicate that the command is to activate the sources. The alternative to “round robin” is “multiplex”, in which GC sources are given priority and can lock out the direct sources. The sources enabled are determined by the bit pattern, with the leftmost bit indicating no sources, the next five indicating ion source 1-5, and the last bit for selecting the Calibration source.

useq_ctrl alt_step direct 0 0 32 1 -- Causes the flight computer to interleave fractional scans of the Direct source, overriding any other sampling that is in process, regardless of whether the Direct source is enabled. The first

two zeros are artifacts of earlier software (indicating number of scans to integrate). The 32 means that every 32 * 10 = 320 scans the computer will produce one fractional sweep, consisting of eight scans. This means that once every 328 scans * .9365 sec = 307.17 seconds a fractional sweep will be done. This continues until disabled by a command such as:
useq_ctrl alt_step direct 0 0 0 0

No_op and No_op_L2 -- These are place holders in case the sequences need to be patched. The represent the two possible sequence command lengths.

acp_window 1 -- Causes the flight computer to respond to ACP sync pulses by opening and closing the appropriate valves. When the window is "closed" (acp_window 0) the software will issue Acknowleges to the sync signals but will not move valves.

cmp 1234 5678 -- Results in the flight software writing the data value "5678" hex to the RAM address "1234" hex.

It should be noted that there are many redundant commands in the sequences. Most valve commands, for instance, are redundant and do not actually result in a valve being moved.

Table 6.1 Descent pre-T0

```
  16#1#     0:00:00     valve VAA enable
  16#2#     0:00:00     valve VAB enable
  16#3#     0:00:00     valve VC1 enable
  16#4#     0:00:00     valve VC2 enable
  16#5#     0:00:00     valve VC3 enable
  16#6#     0:00:00     valve VD1 enable
  16#7#     0:00:00     valve VD2 enable
  16#8#     0:00:00     valve VD3 enable
  16#9#     0:00:00     valve VD4 enable
  16#A#     0:00:00     valve VX enable
  16#B#     0:00:00     valve VD6 enable
  16#C#     0:00:00     valve VE enable
  16#D#     0:00:00     valve VG enable
  16#E#     0:00:00     valve VG1 enable
  16#F#     0:00:00     valve VG2 enable
 16#10#     0:00:00     valve VG3 enable
 16#11#     0:00:00     valve VL1 enable
 16#12#     0:00:00     valve VL2 enable
 16#13#     0:00:00     valve VL3 enable
 16#14#     0:00:00     valve VL4 enable
 16#15#     0:00:00     valve VS1 enable
 16#16#     0:00:00     valve VS2 enable
 16#17#     0:00:00     valve VS3 enable
 16#18#     0:00:00     valve VS5 enable
 16#19#     0:00:00     valve VS6 enable
 16#1A#     0:00:00     valve VS7 enable
 16#1B#     0:00:00     valve VV enable
 16#1C#     0:00:00     valve VZ enable
 16#1D#     0:00:00     heater inlet disable
 16#1E#     0:00:00     heater mass_source_cal disable
 16#1F#     0:00:00     filament_ctrl filament1 enable
 16#20#     0:00:00     filament_ctrl filament2 enable
 16#21#     0:00:00     filament_ctrl filament3 enable
 16#22#     0:00:00     filament_ctrl filament4 enable
 16#23#     0:00:00     filament_ctrl filament5 enable
 16#24#     0:00:00     filament_ctrl filament6 disable
 16#25#     0:00:00     ipump one_two_and_three enable
 16#26#     0:00:00     ipump four_five_and_six enable
 16#27#     0:00:00     isource false round_robin 0 1 1 1 1 1 0
 16#28#     0:00:00     isource true round_robin 0 1 1 1 1 1 0
 16#29#     0:00:00     useq_ctrl alt_step direct 0 0 32 1
 16#2A#     0:00:00     valve VL1 close
 16#2B#     0:00:01     valve VD1 open
 16#2C#     0:00:02     valve VL2 close
 16#2D#     0:00:03     valve VD2 open
 16#2E#     0:00:04     valve VL4 close
 16#2F#     0:00:05     valve VV open
 16#30#     0:00:06     valve VX close
 16#31#     0:00:07     ipump four_five_and_six on
 16#32#     0:00:08     valve VC1 open
 16#33#     0:00:09     filament_ctrl filament1 on
 16#34#     0:00:10     valve VC2 open
 16#35#     0:00:11     filament_ctrl filament2 on
 16#36#     0:00:12     valve VC3 open
 16#37#     0:00:13     filament_ctrl filament3 on
 16#38#     0:00:14     valve VZ close
 16#39#     0:00:15     filament_ctrl filament4 on
 16#3A#     0:00:16     valve VS7 close
 16#3B#     0:00:17     filament_ctrl filament5 on
 16#3C#     0:00:18     valve VE close
 16#3D#     0:00:19     heater inlet disable
 16#3E#     0:00:20     valve VL3 close
 16#3F#     0:00:21     valve VD1 open
 16#40#     0:00:22     valve VD3 close
 16#41#     0:00:23     valve VD2 open
```

```
16#42#     0:00:24      valve VD4 close
16#43#     0:00:25      valve VV open
16#44#     0:00:26      valve VS6 close
16#45#     0:00:27      heater gc_oven_1 disable
16#46#     0:00:28      valve VS5 close
16#47#     0:00:29      heater gc_oven_2 disable
16#48#     0:00:30      valve VG1 close
16#49#     0:00:31      heater gc_oven_3 disable
16#4A#     0:00:32      valve VG2 close
16#4B#     0:00:33      ipump one_two_and_three on
16#4C#     0:00:34      valve VG3 close
16#4D#     0:00:35      No_op
16#4E#     0:00:36      valve VS1 close
16#4F#     0:00:37      No_op_L2
16#50#     0:00:38      valve VS2 close
16#51#     0:00:39      No_op
16#52#     0:00:40      valve VS3 close
16#53#     0:00:41      ipump four_five_and_six on
16#54#     0:00:42      valve VD6 open
16#55#     0:00:43      No_op_L2
16#56#     0:00:44      valve VG close
16#57#     0:00:45      No_op
16#58#     0:00:46      valve VAA close
16#59#     0:00:47      No_op_L2
16#5A#     0:00:48      valve VAB close
16#5B#     0:00:49      No_op
16#5C#     0:00:49      No_op_L2
16#5D#     0:00:50      valve VC1 open
16#5E#     0:00:51      valve VD1 open
16#5F#     0:00:52      valve VC2 open
16#60#     0:00:53      valve VD2 open
16#61#     0:00:54      valve VC3 open
16#62#     0:00:55      valve VV open
16#63#     0:00:56      valve VX close
16#64#     0:00:57      No_op
16#65#     0:00:58      valve VL4 close
16#66#     0:00:59      filament_ctrl filament1 on
16#67#     0:01:00      valve VL2 close
16#68#     0:01:01      filament_ctrl filament2 on
16#69#     0:01:02      valve VL1 close
16#6A#     0:01:03      filament_ctrl filament3 on
16#6B#     0:01:04      valve VZ close
16#6C#     0:01:05      filament_ctrl filament4 on
16#6D#     0:01:06      valve VS7 close
16#6E#     0:01:07      filament_ctrl filament5 on
16#6F#     0:01:08      valve VE close
16#70#     0:01:09      heater inlet disable
16#71#     0:01:10      valve VL3 close
16#72#     0:01:11      valve VD1 open
16#73#     0:01:12      valve VD3 close
16#74#     0:01:13      valve VD2 open
16#75#     0:01:14      valve VD4 close
16#76#     0:01:15      valve VV open
16#77#     0:01:16      valve VS6 close
16#78#     0:01:17      heater gc_oven_1 disable
16#79#     0:01:18      valve VS5 close
16#7A#     0:01:19      heater gc_oven_2 disable
16#7B#     0:01:20      valve VG1 close
16#7C#     0:01:21      heater gc_oven_3 disable
16#7D#     0:01:22      valve VG2 close
16#7E#     0:01:23      ipump one_two_and_three on
16#7F#     0:01:24      valve VG3 close
16#80#     0:01:25      No_op
16#81#     0:01:26      valve VS1 close
16#82#     0:01:27      No_op_L2
16#83#     0:01:28      valve VS2 close
```

```
16#84#     0:01:29      No_op
16#85#     0:01:30      valve VS3 close
16#86#     0:01:31      ipump four_five_and_six on
16#87#     0:01:32      valve VD6 open
16#88#     0:01:33      No_op_L2
16#89#     0:01:34      valve VG close
16#8A#     0:01:35      No_op
16#8B#     0:01:36      valve VAA close
16#8C#     0:01:37      No_op_L2
16#8D#     0:01:38      valve VAB close
16#8E#     0:01:39      No_op
16#8F#     0:01:40      No_op_L2
16#90#     TDIC      200
16#91#     0:05:00      valve VC1 open
16#92#     0:05:02      valve VD1 open
16#93#     0:05:04      valve VC2 open
16#94#     0:05:06      valve VD2 open
16#95#     0:05:08      valve VC3 open
16#96#     0:05:10      valve VV open
16#97#     0:05:12      valve VX close
16#98#     0:05:16      valve VL4 close
16#99#     0:05:20      valve VL2 close
16#9A#     0:05:24      valve VL1 close
16#9B#     0:05:28      valve VZ close
16#9C#     0:05:32      valve VS7 close
16#9D#     0:05:36      valve VE close
16#9E#     0:05:40      valve VL3 close
16#9F#     0:05:44      valve VD3 close
16#A0#     0:05:48      valve VD4 close
16#A1#     0:05:52      valve VS6 close
16#A2#     0:05:56      valve VS5 close
16#A3#     0:06:00      valve VG1 close
16#A4#     0:06:04      valve VG2 close
16#A5#     0:06:08      valve VG3 close
16#A6#     0:06:12      valve VS1 close
16#A7#     0:06:16      valve VS2 close
16#A8#     0:06:20      valve VS3 close
16#A9#     0:06:24      valve VD6 open
16#AA#     0:06:28      valve VG close
16#AB#     0:06:32      valve VAA close
16#AC#     0:06:36      valve VAB close
16#AD#     0:06:38      No_op
16#AE#     0:06:39      No_op_L2
16#AF#     TDIC      206
16#B0#     0:10:05      No_op
16#B1#     0:10:06      No_op_L2
16#B2#     TDIC      774
16#B3#     0:23:00 filament_ctrl filament1 off
16#B4#     0:23:01 filament_ctrl filament2 off
16#B5#     0:23:02 filament_ctrl filament3 off
16#B6#     0:23:03 filament_ctrl filament4 off
16#B7#     0:23:04 filament_ctrl filament5 off
16#B8#     0:23:05      ipump one_two_and_three off
16#B9#     0:23:06      ipump four_five_and_six off
16#BA#     0:23:07      isource false round_robin 1 0 0 0 0 0 0
16#BB#     0:23:08      isource true round_robin 1 0 0 0 0 0 0
16#BC#     0:23:10      useq_ctrl alt_step direct 0 0 0 0
16#BD#     TDIC       57
16#BE#     0:24:07      No_op
16#BF#     0:24:08      No_op_L2
```

Table 6.2 Descent Post-T0

16#1#	0:00:00	valve IV enable
16#2#	0:00:00	valve IVA enable
16#3#	0:00:00	valve VAA enable
16#4#	0:00:00	valve VAB enable
16#5#	0:00:00	valve VC1 enable
16#6#	0:00:00	valve VC2 enable
16#7#	0:00:00	valve VC3 enable
16#8#	0:00:00	valve VD1 enable
16#9#	0:00:00	valve VD2 enable
16#A#	0:00:00	valve VD3 enable
16#B#	0:00:00	valve VD4 enable
16#C#	0:00:00	valve VX enable
16#D#	0:00:00	valve VD6 enable
16#E#	0:00:00	valve VE enable
16#F#	0:00:00	valve VG enable
16#10#	0:00:00	valve VG1 enable
16#11#	0:00:00	valve VG2 enable
16#12#	0:00:00	valve VG3 enable
16#13#	0:00:00	valve VL1 enable
16#14#	0:00:00	valve VL2 enable
16#15#	0:00:00	valve VL3 enable
16#16#	0:00:00	valve VL4 enable
16#17#	0:00:00	valve VS1 enable
16#18#	0:00:00	valve VS2 enable
16#19#	0:00:00	valve VS3 enable
16#1A#	0:00:00	valve VS5 enable
16#1B#	0:00:00	valve VS6 enable
16#1C#	0:00:00	valve VS7 enable
16#1D#	0:00:00	valve VV enable
16#1E#	0:00:00	valve VZ enable
16#1F#	0:00:00	heater inlet enable
16#20#	0:00:00	heater cell_1 enable
16#21#	0:00:00	heater cell_2 disable
16#22#	0:00:00	heater acp_line enable
16#23#	0:00:00	heater mass_source_cal disable
16#24#	0:00:00	heater gc_oven_1 disable
16#25#	0:00:00	heater gc_oven_2 disable
16#26#	0:00:00	heater gc_oven_3 disable
16#27#	0:00:00	filament_ctrl filament1 enable
16#28#	0:00:00	filament_ctrl filament2 enable
16#29#	0:00:00	filament_ctrl filament3 enable
16#2A#	0:00:00	filament_ctrl filament4 enable
16#2B#	0:00:00	filament_ctrl filament5 enable
16#2C#	0:00:00	filament_ctrl filament6 disable
16#2D#	0:00:00	ipump one_two_and_three enable
16#2E#	0:00:00	ipump four_five_and_six enable
16#2F#	0:00:00	isource false round_robin 0 1 1 1 1 1 0
16#30#	0:00:00	isource true round_robin 0 1 0 0 0 0 0
16#31#	0:00:00	useq_ctrl alt_step direct 0 0 32 1
16#32#	0:00:00	ipump one_two_and_three on
16#33#	0:00:00	No_op
16#34#	0:00:00	No_op_L2
16#35#	0:00:00	valve VL1 close
16#36#	0:00:01	valve VD1 open
16#37#	0:00:02	valve VL2 close
16#38#	0:00:03	valve VD2 open
16#39#	0:00:04	valve VL4 close
16#3A#	0:00:05	valve VV open
16#3B#	0:00:06	valve VX close
16#3C#	0:00:07	ipump four_five_and_six on
16#3D#	0:00:08	valve VC1 open
16#3E#	0:00:09	filament_ctrl filament1 on
16#3F#	0:00:10	valve VC2 open
16#40#	0:00:11	filament_ctrl filament2 on
16#41#	0:00:12	valve VC3 open

```
16#42#     0:00:13      filament_ctrl filament3 on
16#43#     0:00:14      valve VZ close
16#44#     0:00:15      filament_ctrl filament4 on
16#45#     0:00:16      valve VS7 close
16#46#     0:00:17      filament_ctrl filament5 on
16#47#     0:00:18      valve VE close
16#48#     0:00:19      heater acp_line off
16#49#     0:00:20      valve VL3 close
16#4A#     0:00:21      heater cell_1 off
16#4B#     0:00:22      valve VD3 close
16#4C#     0:00:23      heater inlet on
16#4D#     0:00:24      valve VD4 close
16#4E#     0:00:25      No_op
16#4F#     0:00:26      valve VS6 close
16#50#     0:00:27      No_op
16#51#     0:00:28      valve VS5 close
16#52#     0:00:29      No_op
16#53#     0:00:30      valve VG1 close
16#54#     0:00:31      No_op
16#55#     0:00:32      valve VG2 close
16#56#     0:00:33      No_op
16#57#     0:00:34      valve VG3 close
16#58#     0:00:35      No_op
16#59#     0:00:36      valve VS1 close
16#5A#     0:00:37      No_op
16#5B#     0:00:38      valve VS2 close
16#5C#     0:00:39      No_op
16#5D#     0:00:40      valve VS3 close
16#5E#     0:00:41      valve VD6 open
16#5F#     0:00:42      valve VG close
16#60#     0:00:43      No_op
16#61#     0:00:44      valve VAA close
16#62#     0:00:45      No_op
16#63#     0:00:46      valve VAB close
16#64#     0:00:50      No_op
16#65#     0:00:50      No_op_L2
16#66#     0:00:52      valve VZ open
16#67#     0:00:53      No_op
16#68#     0:00:54      valve VZ open
16#69#     0:00:55      valve VG1 close
16#6A#     0:00:56      valve VL1 open
16#6B#     0:00:57      heater inlet on
16#6C#     0:00:58      valve VL1 open
16#6D#     0:00:59      valve VG1 close
16#6E#     0:01:00      valve VD6 open
16#6F#     TDIC      240
16#70#     0:05:00 ipump four_five_and_six on
16#71#     TDIC       20
16#72#     0:05:20 ipump one_two_and_three on
16#73#     TDIC       10
16#74#     0:05:30 heater inlet on
16#75#     TDIC      270
16#76#     0:10:00 ipump one_two_and_three on
16#77#     TDIC       20
16#78#     0:10:20 ipump four_five_and_six on
16#79#     TDIC       10
16#7A#     0:10:30 heater inlet on
16#7B#     0:10:31      No_op
16#7C#     0:10:32      No_op_L2
16#7D#     TDIC      268
16#7E#     0:15:00 ipump four_five_and_six on
16#7F#     TDIC       20
16#80#     0:15:20 ipump one_two_and_three on
16#81#     TDIC       10
16#82#     0:15:30 heater inlet on
16#83#     0:15:30      valve VC1 open
```

```
16#84#     0:15:32      valve VD1 open
16#85#     0:15:34      valve VC2 open
16#86#     0:15:38      valve VD2 open
16#87#     0:15:42      valve VC3 open
16#88#     0:15:46      valve VV open
16#89#     0:15:52      valve VX close
16#8A#     0:15:54      No_op
16#8B#     0:15:56      valve VL4 close
16#8C#     0:15:58      No_op
16#8D#     0:16:00      valve VL2 close
16#8E#     0:16:04      valve VL1 open
16#8F#     0:16:06      No_op
16#90#     0:16:08      valve VZ open
16#91#     0:16:12      valve VS7 close
16#92#     0:16:14      No_op
16#93#     0:16:16      valve VE close
16#94#     0:16:18      No_op
16#95#     0:16:20      valve VL3 close
16#96#     0:16:22      No_op
16#97#     0:16:24      valve VD3 close
16#98#     0:16:26      No_op
16#99#     0:16:28      valve VD4 close
16#9A#     0:16:30      No_op
16#9B#     0:16:32      valve VS6 close
16#9C#     0:16:34      No_op
16#9D#     0:16:36      valve VS5 close
16#9E#     0:16:38      No_op
16#9F#     0:16:40      valve VG1 close
16#A0#     0:16:42      No_op
16#A1#     0:16:44      valve VG2 close
16#A2#     0:16:46      No_op
16#A3#     0:16:48      valve VG3 close
16#A4#     0:16:50      No_op
16#A5#     0:16:52      valve VS1 close
16#A6#     0:16:54      No_op
16#A7#     0:16:56      valve VS2 close
16#A8#     0:16:58      No_op
16#A9#     0:17:00      valve VS3 close
16#AA#     0:17:04      valve VD6 open
16#AB#     0:17:08      valve VG close
16#AC#     0:17:10      No_op
16#AD#     0:17:12      valve VAA close
16#AE#     0:17:14      No_op
16#AF#     0:17:16      valve VAB close
16#B0#     TDIC      164
16#B1#     0:20:00 ipump one_two_and_three on
16#B2#     TDIC       20
16#B3#     0:20:20 ipump four_five_and_six on
16#B4#     TDIC       10
16#B5#     0:20:30 heater inlet on
16#B6#     0:20:31      No_op
16#B7#     0:20:32      No_op_L2
16#B8#     TDIC      258
16#B9#     0:24:50      valve VL3 close
16#BA#     0:24:51      valve VV open
16#BB#     0:24:52      valve VL3 close
16#BC#     0:24:53      valve VE open
16#BD#     0:24:54      valve VG close
16#BE#     0:24:55      valve VV open
16#BF#     0:24:56      valve VG close
16#C0#     0:24:58      valve VE open
16#C1#     0:25:00      valve VS7 open
16#C2#     0:25:02      valve VL3 close
16#C3#     0:25:03      valve VS7 open
16#C4#     TDIC       42
16#C5#     0:25:45      valve VS7 close
```

```
 16#C6#     0:25:47      valve VS7 close
 16#C7#     0:25:49      valve VV close
 16#C8#     0:25:50      valve VG open
 16#C9#     0:25:51      valve VV close
 16#CA#     0:25:52      valve VG open
 16#CB#     TDIC       8
 16#CC#     0:26:00 ipump four_five_and_six on
 16#CD#     TDIC      20
 16#CE#     0:26:20 ipump one_two_and_three on
 16#CF#     TDIC      10
 16#D0#     0:26:30 heater inlet on
 16#D1#     TDIC      90
 16#D2#     0:28:00      valve VE close
 16#D3#     0:28:00      heater cell_1 on
 16#D4#     0:28:02      valve VE close
 16#D5#     0:28:03      No_op
 16#D6#     0:28:04      No_op_L2
 16#D7#     TDIC      30
 16#D8#     0:28:34      valve VD1 close
 16#D9#     0:28:36      valve VD4 close
 16#DA#     0:28:37      valve VD2 open
 16#DB#     0:28:38      valve VD3 close
 16#DC#     0:28:40      valve VG3 close
 16#DD#     0:28:42      valve VG2 close
 16#DE#     0:28:46      valve VX close
 16#DF#     0:28:48      valve VS5 close
 16#E0#     0:28:50      valve VS1 close
 16#E1#     0:28:52      valve VS2 close
 16#E2#     0:28:54      valve VS3 close
 16#E3#     0:28:56      valve VS6 close
 16#E4#     0:28:58      valve VD1 close
 16#E5#     0:29:00      valve VD4 close
 16#E6#     0:29:01      valve VD2 open
 16#E7#     0:29:02      valve VD3 close
 16#E8#     0:29:04      valve VG3 close
 16#E9#     0:29:06      valve VG2 close
 16#EA#     0:29:08      valve VL1 close
 16#EB#     0:29:10      valve VL1 close
 16#EC#     0:29:12      No_op
 16#ED#     0:29:13      No_op_L2
 16#EE#     0:29:14      valve IV close
 16#EF#     0:29:15      No_op
 16#F0#     0:29:16      No_op_L2
 16#F1#     0:29:17      No_op
 16#F2#     0:29:18      valve IV close
 16#F3#     0:29:19      valve IV open
 16#F4#     0:29:20      No_op
 16#F5#     0:29:21      No_op
 16#F6#     0:29:22      No_op_L2
 16#F7#     0:29:23      valve IV open
 16#F8#     0:29:24 valve VS5 close
 16#F9#     0:29:25 valve VD3 open
 16#FA#     0:29:26 valve VS1 close
 16#FB#     0:29:27 valve IV open
 16#FC#     0:29:28 valve VS2 close
 16#FD#     0:29:29 valve VD3 open
 16#FE#     0:29:30 valve VS3 close
 16#FF#     0:29:32 valve VS6 close
16#100#     0:29:34 valve VD3 close
16#101#     0:29:35 valve VD4 open
16#102#     0:29:36 valve VD3 close
16#103#     0:29:37 valve VD1 open
16#104#     0:29:39 valve VD4 open
16#105#     0:29:41 valve VD1 open
16#106#     TDIC      11
16#107#     0:29:52 valve VL4 close
```

```
16#108#     0:29:54 valve VL2 close
16#109#     0:29:56 valve VL3 close
16#10A#     0:29:58      valve VS7 close
16#10B#     0:30:00      valve VZ close
16#10C#     0:30:02      valve VZ close
16#10D#     0:30:04      valve VX open
16#10E#     0:30:06      valve VX open
16#10F#     0:30:10 ipump one_two_and_three on
16#110#     TDIC       10
16#111#     0:30:20 ipump four_five_and_six on
16#112#     TDIC       10
16#113#     0:30:30 heater inlet on
16#114#     0:30:31      No_op
16#115#     0:30:32      No_op_L2
16#116#     TDIC       46
16#117#     0:31:18      valve VG close
16#118#     0:31:20      valve VG close
16#119#     0:31:24      valve VE close
16#11A#     0:31:24      heater cell_1 on
16#11B#     0:31:26      valve VV close
16#11C#     0:31:28      heater cell_1 on
16#11D#     0:31:29      valve VL3 open
16#11E#     0:31:30      valve VG close
16#11F#     0:31:30      heater cell_1 on
16#120#     0:31:32      valve VL3 open
16#121#     TDIC       84
16#122#     0:32:56      valve VV close
16#123#     0:33:00      heater cell_1 on
16#124#     0:33:00      valve VE open
16#125#     0:33:01      valve VV close
16#126#     0:33:02      valve VE open
16#127#     TDIC       28
16#128#     0:33:30 heater cell_1 on
16#129#     TDIC       10
16#12A#     0:33:40      valve VC1 open
16#12B#     0:33:42      valve VD1 open
16#12C#     0:33:44      valve VC2 open
16#12D#     0:33:46      valve VD2 open
16#12E#     0:33:48      valve VC3 open
16#12F#     0:33:50      valve VD4 open
16#130#     0:33:57      valve IV open
16#131#     0:33:58      valve VS6 close
16#132#     0:34:01 heater cell_1 on
16#133#     TDIC        9
16#134#     0:34:10      valve VD3 close
16#135#     0:34:12      valve VL1 close
16#136#     0:34:14      valve VZ close
16#137#     0:34:16      valve VL2 close
16#138#     0:34:18      valve VS7 close
16#139#     0:34:20      valve VL4 close
16#13A#     0:34:22      valve VS1 close
16#13B#     0:34:24      valve VS2 close
16#13C#     0:34:26      valve VS3 close
16#13D#     0:34:30      valve VL3 close
16#13E#     0:34:31      valve VG open
16#13F#     0:34:31      heater cell_1 off
16#140#     0:34:32      valve VL3 close
16#141#     0:34:33      valve VG open
16#142#     0:34:33      heater cell_1 disable
16#143#     0:34:34      valve VE close
16#144#     0:34:36      valve VE close
16#145#     TDIC       19
16#146#     0:34:55      valve VAA open
16#147#     0:34:56      No_op
16#148#     0:34:57      valve VAA open
16#149#     0:34:58      No_op
```

```
16#14A#     0:34:59      No_op_L2
16#14B#     0:35:00      valve IVA close
16#14C#     0:35:01      No_op
16#14D#     0:35:02      No_op_L2
16#14E#     0:35:03      No_op
16#14F#     0:35:04      valve IVA close
16#150#     0:35:05      valve IVA open
16#151#     0:35:06      No_op
16#152#     0:35:07      No_op_L2
16#153#     0:35:08      No_op
16#154#     0:35:09      valve IVA open
16#155#     0:35:10      heater acp_line on
16#156#     0:35:11      valve VAB open
16#157#     0:35:13      heater acp_line on
16#158#     0:35:15      valve VAB open
16#159#     0:35:16      No_op
16#15A#     0:35:17      No_op_L2
16#15B#     0:35:18      valve IVA open
16#15C#     0:35:20      valve VL1 close
16#15D#     0:35:22      valve VE close
16#15E#     0:35:23      valve VG open
16#15F#     0:35:24      valve VL3 close
16#160#     0:35:25      valve VAA open
16#161#     0:35:26      valve VL4 close
16#162#     0:35:27      valve VAB open
16#163#     0:35:29      valve VC1 open
16#164#     0:35:31      valve VD6 open
16#165#     0:35:33      valve VC2 open
16#166#     0:35:35      valve VD1 open
16#167#     0:35:37      valve VC3 open
16#168#     0:35:39      valve VD2 open
16#169#     0:35:46      valve VG1 close
16#16A#     TDIC       12
16#16B#     0:35:58      valve VV close
16#16C#     0:36:00      valve VL2 open
16#16D#     0:36:00      heater inlet on
16#16E#     0:36:00      heater gc_oven_1 enable
16#16F#     0:36:00      heater gc_oven_2 enable
16#170#     0:36:00      heater gc_oven_3 enable
16#171#     0:36:02      valve VL2 open
16#172#     TDIC        8
16#173#     0:36:10 ipump four_five_and_six on
16#174#     TDIC       10
16#175#     0:36:20 ipump one_two_and_three on
16#176#     TDIC       10
16#177#     0:36:30 heater inlet on
16#178#     0:36:31      No_op
16#179#     0:36:32      No_op_L2
16#17A#     TDIC       86
16#17B#     0:37:58      valve VD4 open
16#17C#     0:38:00      valve VX open
16#17D#     0:38:01      valve VG2 close
16#17E#     0:38:02      valve VX open
16#17F#     0:38:03      valve VG3 close
16#180#     0:38:10      valve VD2 open
16#181#     0:38:11      valve VD1 close
16#182#     0:38:12      valve VD2 open
16#183#     0:38:14      valve VD4 open
16#184#     0:38:15      valve VD1 close
16#185#     0:38:16      valve VS5 open
16#186#     0:38:21      valve VS5 close
16#187#     0:38:23      valve VS5 close
16#188#     0:38:25      valve VD3 open
16#189#     0:38:30      valve VD3 close
16#18A#     0:38:31      valve VD1 open
16#18B#     0:38:32      valve VD3 close
```

```
16#18C#     0:38:33      valve VD1 open
16#18D#     0:38:40      valve VX open
16#18E#     0:38:41      valve VD3 close
16#18F#     0:38:42      valve VX open
16#190#     0:38:43      valve VS5 close
16#191#     0:38:44      valve VC1 open
16#192#     0:38:46      valve VC2 open
16#193#     0:38:48      valve VC3 open
16#194#     0:38:52 valve VD6 close
16#195#     0:38:54 valve VD6 close
16#196#     0:38:58 valve VG3 close
16#197#     0:39:00 valve VS3 open
16#198#     0:39:02 valve VS3 open
16#199#     TDIC       23
16#19A#     0:39:25 useq_ctrl alt_step direct 0 0 0 0
16#19B#     0:39:28      isource true round_robin 0 1 0 1 1 1 0
16#19C#     0:39:30 valve VS3 close
16#19D#     0:39:34 valve VS3 close
16#19E#     0:39:37 valve VD6 close
16#19F#     0:39:41 valve VS1 close
16#1A0#     0:39:41      heater gc_oven_1 enable
16#1A1#     0:39:41      heater gc_oven_2 enable
16#1A2#     0:39:41      heater gc_oven_3 enable
16#1A3#     0:39:44 valve VS2 close
16#1A4#     0:39:48 valve VS6 close
16#1A5#     0:39:49 valve VX open
16#1A6#     0:39:50 valve VD1 close
16#1A7#     0:39:52 valve VD1 close
16#1A8#     0:39:53 valve VD3 open
16#1A9#     0:39:54 valve VD2 close
16#1AA#     0:39:55      valve VD3 open
16#1AB#     0:39:55 isource true round_robin 0 1 0 1 1 1 0
16#1AC#     0:39:56      valve VD2 close
16#1AD#     0:39:57      valve VS3 open
16#1AE#     0:39:58 valve VD4 close
16#1AF#     0:39:59      No_op
16#1B0#     0:39:59      No_op_L2
16#1B1#     0:40:00      valve VG3 open
16#1B2#     0:40:00      useq_ctrl alt_step direct 0 0 32 1
16#1B3#     0:40:00      No_op
16#1B4#     0:40:00      No_op_L2
16#1B5#     0:40:01      valve VG3 close
16#1B6#     0:40:01      No_op
16#1B7#     0:40:02      valve VD4 open
16#1B8#     0:40:04      valve VG3 close
16#1B9#     0:40:06      valve VS3 close
16#1BA#     0:40:07      valve VD4 open
16#1BB#     0:40:08      valve VD3 close
16#1BC#     0:40:09      valve VD2 open
16#1BD#     0:40:10      valve VS3 close
16#1BE#     0:40:11      valve VD2 open
16#1BF#     0:40:12      valve VD3 close
16#1C0#     0:40:13      valve VD1 open
16#1C1#     0:40:14      valve VS3 close
16#1C2#     0:40:15      valve VD1 open
16#1C3#     TDIC       15
16#1C4#     0:40:30 ipump one_two_and_three on
16#1C5#     TDIC       10
16#1C6#     0:40:40 ipump four_five_and_six on
16#1C7#     TDIC       10
16#1C8#     0:40:50 heater inlet on
16#1C9#     TDIC      250
16#1CA#     0:45:00 ipump four_five_and_six on
16#1CB#     TDIC       20
16#1CC#     0:45:20 ipump one_two_and_three on
16#1CD#     TDIC       10
```

```
16#1CE#     0:45:30 heater inlet on
16#1CF#     TDIC      270
16#1D0#     0:50:00 ipump one_two_and_three on
16#1D1#     TDIC       20
16#1D2#     0:50:20 ipump four_five_and_six on
16#1D3#     TDIC       10
16#1D4#     0:50:30 heater inlet on
16#1D5#     0:50:31       No_op
16#1D6#     0:50:32       No_op_L2
16#1D7#     TDIC      116
16#1D8#     0:52:28       valve VG2 close
16#1D9#     0:52:30       valve VS2 open
16#1DA#     0:52:32       valve VS2 open
16#1DB#     TDIC       28
16#1DC#     0:53:00       valve VS2 close
16#1DD#     0:53:02 valve VS2 close
16#1DE#     0:53:03       isource true round_robin 0 1 0 1 1 1 0
16#1DF#     TDIC       10
16#1E0#     0:53:13       valve VS2 close
16#1E1#     0:53:18 No_op
16#1E2#     0:53:19       valve VS6 close
16#1E3#     0:53:20       valve VX open
16#1E4#     0:53:21       valve VD1 close
16#1E5#     0:53:23 valve VD1 close
16#1E6#     0:53:24 valve VD3 open
16#1E7#     0:53:25 valve VD2 close
16#1E8#     0:53:25 isource true round_robin 0 1 0 1 1 1 0
16#1E9#     0:53:26       valve VD3 open
16#1EA#     0:53:27       valve VD2 close
16#1EB#     0:53:28       valve VS2 open
16#1EC#     0:53:29 valve VD4 close
16#1ED#     0:53:29 useq_ctrl alt_step direct 0 0 0 0
16#1EE#     0:53:30       valve VG2 open
16#1EF#     0:53:31 valve VG2 close
16#1F0#     0:53:31       useq_ctrl alt_step direct 0 0 32 1
16#1F1#     0:53:32 valve VD4 open
16#1F2#     0:53:34       valve VG2 close
16#1F3#     0:53:36       valve VS2 close
16#1F4#     0:53:37       valve VD4 open
16#1F5#     0:53:38       valve VD3 close
16#1F6#     0:53:39       valve VD2 open
16#1F7#     0:53:40       valve VS2 close
16#1F8#     0:53:41       valve VD2 open
16#1F9#     0:53:42       valve VD3 close
16#1FA#     0:53:43       valve VD1 open
16#1FB#     0:53:44       valve VS1 close
16#1FC#     0:53:45 valve VD1 open
16#1FD#     TDIC       75
16#1FE#     0:55:00 ipump four_five_and_six on
16#1FF#     TDIC       20
16#200#     0:55:20 ipump one_two_and_three on
16#201#     TDIC       10
16#202#     0:55:30 heater inlet on
16#203#     TDIC      210
16#204#     0:59:00       heater acp_line on
16#205#     TDIC       60
16#206#     1:00:00 ipump one_two_and_three on
16#207#     TDIC       20
16#208#     1:00:20 ipump four_five_and_six on
16#209#     TDIC       10
16#20A#     1:00:30 heater inlet on
16#20B#     1:00:31       No_op
16#20C#     1:00:32       No_op_L2
16#20D#     TDIC      148
16#20E#     1:03:00       valve VAA open
16#20F#     TDIC       60
```

```
16#210#     1:04:00      valve VAA close
16#211#     1:04:02      valve VAA close
16#212#     1:04:04      valve VAB close
16#213#     1:04:06      valve VAB close
16#214#     TDIC       40
16#215#     1:04:46      isource true round_robin 0 0 1 0 0 0 0
16#216#     1:04:46 useq_ctrl alt_step direct 0 0 0 0
16#217#     TDIC       10
16#218#     1:04:56      valve VL4 open
16#219#     1:04:56      acp_window 1
16#21A#     1:04:58      No_op
16#21B#     TDIC       72
16#21C#     1:06:10      acp_window 0
16#21D#     1:06:10      valve VL4 close
16#21E#     1:06:10      isource true round_robin 0 1 1 1 1 1 0
16#21F#     1:06:12      valve VL4 close
16#220#     TDIC        8
16#221#     1:06:20 ipump four_five_and_six on
16#222#     TDIC       10
16#223#     1:06:30 ipump one_two_and_three on
16#224#     TDIC       10
16#225#     1:06:40 heater inlet on
16#226#     1:06:41      No_op
16#227#     1:06:42      No_op_L2
16#228#     TDIC       64
16#229#     1:07:46      isource true round_robin 0 0 1 0 0 0 0
16#22A#     1:07:50      cmp FC82 00E5
16#22B#     1:07:50      cmp FC85 00E5
16#22C#     1:07:56      valve VL4 open
16#22D#     1:07:56      acp_window 1
16#22E#     1:07:58      No_op
16#22F#     TDIC       29
16#230#     1:08:27 cmp FFA9 000E
16#231#     1:08:27 cmp FFAA 0000
16#232#     TDIC       13
16#233#     1:08:40 cmp FFA9 00EE
16#234#     1:08:40 cmp FFAA 00E0
16#235#     TDIC       25
16#236#     1:09:05      acp_window 0
16#237#     1:09:10      valve VL4 close
16#238#     1:09:10      isource true round_robin 0 1 1 1 1 1 0
16#239#     TDIC       50
16#23A#     1:10:00 ipump one_two_and_three on
16#23B#     TDIC       20
16#23C#     1:10:20 ipump four_five_and_six on
16#23D#     TDIC       10
16#23E#     1:10:30 heater inlet on
16#23F#     TDIC      145
16#240#     1:12:55 isource true round_robin 0 0 1 1 1 1 0
16#241#     1:12:56      valve VL4 open
16#242#     1:12:56      acp_window 1
16#243#     1:12:58      No_op
16#244#     TDIC       67
16#245#     1:14:05      acp_window 0
16#246#     1:14:05 isource true round_robin 0 1 1 1 1 1 0
16#247#     1:14:05      useq_ctrl alt_step direct 0 0 32 1
16#248#     1:14:10      valve VL4 close
16#249#     1:14:12      valve VL4 close
16#24A#     1:14:14      valve VAA close
16#24B#     1:14:16      valve VAA close
16#24C#     1:14:18      valve VAB close
16#24D#     1:14:20      valve VAB close
16#24E#     TDIC       40
16#24F#     1:15:00 ipump four_five_and_six on
16#250#     TDIC       20
16#251#     1:15:20 ipump one_two_and_three on
```

```
16#252#     TDIC       10
16#253#     1:15:30 heater inlet on
16#254#     1:15:31       No_op
16#255#     1:15:32       No_op_L2
16#256#     TDIC      268
16#257#     1:20:00 isource true round_robin 0 1 0 1 1 1 0
16#258#     1:20:00 ipump one_two_and_three on
16#259#     TDIC       20
16#25A#     1:20:20 ipump four_five_and_six on
16#25B#     TDIC       10
16#25C#     1:20:30 heater inlet on
16#25D#     TDIC      150
16#25E#     1:23:00       cmp FC82 01D3
16#25F#     1:23:00       cmp FC85 01D3
16#260#     TDIC      120
16#261#     1:25:00 ipump four_five_and_six on
16#262#     TDIC       20
16#263#     1:25:20 ipump one_two_and_three on
16#264#     1:25:25 heater inlet on
16#265#     1:25:28       valve VG1 close
16#266#     1:25:30       valve VS1 open
16#267#     1:25:32       valve VS1 open
16#268#     TDIC       28
16#269#     1:26:00       valve VS1 close
16#26A#     1:26:02       valve VS1 close
16#26B#     1:26:03       No_op
16#26C#     1:26:03       No_op_L2
16#26D#     TDIC        8
16#26E#     1:26:11       valve VS1 close
16#26F#     1:26:12       heater gc_oven_1 enable
16#270#     1:26:12       heater gc_oven_2 enable
16#271#     1:26:12       heater gc_oven_3 enable
16#272#     1:26:13       valve VS2 close
16#273#     1:26:15       valve VS3 close
16#274#     1:26:17       valve VS5 close
16#275#     1:26:19       valve VS6 close
16#276#     1:26:20       valve VX open
16#277#     1:26:21 valve VD1 close
16#278#     1:26:21 useq_ctrl alt_step direct 0 0 0 0
16#279#     1:26:21 isource true round_robin 0 1 0 1 1 1 0
16#27A#     1:26:23       valve VD1 close
16#27B#     1:26:24 valve VD3 open
16#27C#     1:26:25       valve VD2 close
16#27D#     1:26:26       valve VD3 open
16#27E#     1:26:27       valve VD2 close
16#27F#     1:26:28       valve VS1 open
16#280#     1:26:29       valve VD4 close
16#281#     1:26:30       valve VG1 open
16#282#     1:26:30 No_op
16#283#     1:26:30 No_op_L2
16#284#     1:26:31       valve VG1 close
16#285#     1:26:32       valve VD4 open
16#286#     1:26:34       valve VG1 close
16#287#     1:26:36       valve VS1 close
16#288#     1:26:37       valve VD4 open
16#289#     1:26:38       valve VD3 close
16#28A#     1:26:39       valve VD2 open
16#28B#     1:26:40       valve VS3 close
16#28C#     1:26:41       valve VD2 open
16#28D#     1:26:42       valve VD3 close
16#28E#     1:26:43       valve VD1 open
16#28F#     1:26:45       valve VD1 open
16#290#     TDIC      195
16#291#     1:30:00 ipump one_two_and_three on
16#292#     TDIC       20
16#293#     1:30:20 ipump four_five_and_six on
```

```
16#294#     TDIC       10
16#295#     1:30:30 heater inlet on
16#296#     TDIC      150
16#297#     1:33:00       heater acp_line on
16#298#     TDIC       10
16#299#     1:33:10       heater acp_line on
16#29A#     TDIC      110
16#29B#     1:35:00 ipump four_five_and_six on
16#29C#     TDIC       20
16#29D#     1:35:20 ipump one_two_and_three on
16#29E#     TDIC       10
16#29F#     1:35:30 heater inlet on
16#2A0#     1:35:31       No_op
16#2A1#     1:35:32       No_op_L2
16#2A2#     TDIC       88
16#2A3#     1:37:00       valve VAA open
16#2A4#     1:37:02       valve VAA open
16#2A5#     TDIC        8
16#2A6#     1:37:10 useq_ctrl alt_step direct 0 0 0 0
16#2A7#     TDIC       50
16#2A8#     1:38:00       valve VAA close
16#2A9#     1:38:02       valve VAA close
16#2AA#     1:38:04       valve VAB close
16#2AB#     1:38:06       valve VAB close
16#2AC#     TDIC       49
16#2AD#     1:38:55       isource true round_robin 0 0 1 0 0 0 0
16#2AE#     1:38:56       valve VL4 open
16#2AF#     1:38:56       acp_window 1
16#2B0#     1:38:58       No_op
16#2B1#     TDIC       67
16#2B2#     1:40:05       acp_window 0
16#2B3#     1:40:10       valve VL4 close
16#2B4#     1:40:10       isource true round_robin 0 1 1 1 1 1 0
16#2B5#     1:40:12       valve VL4 close
16#2B6#     TDIC        8
16#2B7#     1:40:20 ipump one_two_and_three on
16#2B8#     TDIC       20
16#2B9#     1:40:40 ipump four_five_and_six on
16#2BA#     TDIC       10
16#2BB#     1:40:50 heater inlet on
16#2BC#     TDIC       40
16#2BD#     1:41:30 No_op
16#2BE#     1:41:31 No_op_L2
16#2BF#     TDIC       24
16#2C0#     1:41:55       isource true round_robin 0 0 1 0 0 0 0
16#2C1#     1:41:56       valve VL4 open
16#2C2#     1:41:56       acp_window 1
16#2C3#     1:41:58       No_op
16#2C4#     TDIC       29
16#2C5#     1:42:27 cmp FFA9 000E
16#2C6#     1:42:27 cmp FFAA 0000
16#2C7#     1:42:34 cmp FFA9 00EE
16#2C8#     1:42:34 cmp FFAA 00E0
16#2C9#     TDIC       31
16#2CA#     1:43:05       acp_window 0
16#2CB#     1:43:10       valve VL4 close
16#2CC#     1:43:10       isource true round_robin 0 1 1 1 1 1 0
16#2CD#     1:43:12       valve VL4 close
16#2CE#     TDIC      108
16#2CF#     1:45:00 ipump four_five_and_six on
16#2D0#     TDIC       20
16#2D1#     1:45:20 ipump one_two_and_three on
16#2D2#     TDIC       10
16#2D3#     1:45:30 heater inlet on
16#2D4#     1:45:31       No_op
16#2D5#     1:45:32       No_op_L2
```

```
16#2D6#     TDIC       39
16#2D7#     1:46:11       valve VD1 open
16#2D8#     1:46:12       valve VS6 close
16#2D9#     1:46:13       valve VD2 open
16#2DA#     1:46:14       valve VD3 close
16#2DB#     1:46:15       valve VD4 open
16#2DC#     1:46:16       valve VS1 close
16#2DD#     1:46:17       valve VC1 open
16#2DE#     1:46:19       valve VC2 open
16#2DF#     1:46:20       valve VS3 close
16#2E0#     1:46:21       valve VC3 open
16#2E1#     1:46:22       valve VG1 close
16#2E2#     1:46:23       valve VL2 open
16#2E3#     1:46:24       valve VG2 close
16#2E4#     1:46:26       valve VG3 close
16#2E5#     1:46:28       valve VL1 close
16#2E6#     1:46:30       valve VZ close
16#2E7#     1:46:32       valve VS7 close
16#2E8#     1:46:36       valve VL3 close
16#2E9#     TDIC       19
16#2EA#     1:46:55       isource true round_robin 0 0 1 0 0 0 0
16#2EB#     1:46:56       valve VL4 open
16#2EC#     1:46:56       acp_window 1
16#2ED#     1:46:58       No_op
16#2EE#     TDIC       67
16#2EF#     1:48:05       acp_window 0
16#2F0#     1:48:05       isource true round_robin 0 1 1 1 1 1 0
16#2F1#     1:48:06 No_op
16#2F2#     1:48:06 No_op_L2
16#2F3#     1:48:07       valve VL4 close
16#2F4#     1:48:08       valve VAA open
16#2F5#     1:48:09       valve VS6 close
16#2F6#     1:48:10       valve VAA open
16#2F7#     1:48:11       valve VL4 close
16#2F8#     1:48:15       valve VAA close
16#2F9#     1:48:17       valve VAA close
16#2FA#     1:48:19       isource true round_robin 0 1 0 1 1 1 0
16#2FB#     1:48:20       valve VD3 close
16#2FC#     1:48:21       valve VX open
16#2FD#     1:48:21       heater acp_line off
16#2FE#     1:48:21 filament_ctrl filament2 off
16#2FF#     1:48:22       valve VS5 close
16#300#     1:48:24       valve VD2 close
16#301#     1:48:26       valve VD1 close
16#302#     1:48:28       valve VD4 close
16#303#     1:48:29       valve VD3 open
16#304#     1:48:30       valve VD3 close
16#305#     1:48:31       valve VS5 open
16#306#     1:48:32       valve VS5 close
16#307#     1:48:33       valve VD2 open
16#308#     1:48:35       valve VD3 open
16#309#     1:48:36       valve VD3 close
16#30A#     1:48:37       valve VD4 open
16#30B#     1:48:38       valve VD3 close
16#30C#     1:48:39       valve VD1 open
16#30D#     1:48:40       valve VS5 close
16#30E#     1:48:41       valve VD2 open
16#30F#     1:48:42       valve VS5 close
16#310#     1:48:43       valve VD2 open
16#311#     1:48:44       valve VD3 close
16#312#     1:48:46       valve VD1 open
16#313#     1:48:50 useq_ctrl alt_step direct 0 0 32 1
16#314#     TDIC       70
16#315#     1:50:00 ipump one_two_and_three on
16#316#     TDIC      320
16#317#     1:55:20 ipump four_five_and_six on
```

```
16#318#     TDIC       10
16#319#     1:55:30 heater inlet on
16#31A#     TDIC       30
16#31B#     1:56:00       isource true round_robin 0 1 0 1 1 1 0
16#31C#     TDIC      240
16#31D#     2:00:00 ipump one_two_and_three on
16#31E#     TDIC       20
16#31F#     2:00:20 ipump four_five_and_six on
16#320#     TDIC       10
16#321#     2:00:30 heater inlet on
16#322#     TDIC       47
16#323#     2:01:17       valve VL2 open
16#324#     2:01:18       valve VL1 close
16#325#     2:01:19       valve VD1 open
16#326#     2:01:20       valve VZ close
16#327#     2:01:21       valve VD2 open
16#328#     2:01:22       valve VS7 close
16#329#     2:01:23       valve VD4 open
16#32A#     2:01:24       valve VE close
16#32B#     2:01:25       valve VC1 open
16#32C#     2:01:26       valve VL3 close
16#32D#     2:01:27       valve VC2 open
16#32E#     2:01:28       valve VS1 close
16#32F#     2:01:29       valve VC3 open
16#330#     2:01:30       valve VS2 close
16#331#     2:01:31       valve VX open
16#332#     2:01:32       valve VS3 close
16#333#     2:01:34       valve VS5 close
16#334#     2:01:36       valve VL4 close
16#335#     2:01:38       valve VS6 close
16#336#     2:01:40       valve VG1 close
16#337#     2:01:42       valve VG2 close
16#338#     2:01:44       valve VG3 close
16#339#     2:01:46       valve VD3 close
16#33A#     2:01:50       valve VD3 close
16#33B#     2:01:51       valve VX open
16#33C#     2:01:52       valve VS5 close
16#33D#     2:01:54       valve VD2 close
16#33E#     2:01:56       valve VD1 close
16#33F#     2:01:58       valve VD4 close
16#340#     2:01:59       valve VD3 open
16#341#     2:02:00       valve VD3 close
16#342#     2:02:01       valve VS5 open
16#343#     2:02:02       valve VS5 close
16#344#     2:02:03       valve VD2 open
16#345#     2:02:05       valve VD3 open
16#346#     2:02:06       valve VD3 close
16#347#     2:02:07       valve VD4 open
16#348#     2:02:08       valve VD3 close
16#349#     2:02:09       valve VD1 open
16#34A#     2:02:10       valve VS5 close
16#34B#     2:02:11       valve VD2 open
16#34C#     2:02:12       valve VS5 close
16#34D#     2:02:13       valve VD2 open
16#34E#     2:02:14       valve VD3 close
16#34F#     2:02:16       valve VD1 open
16#350#     TDIC      164
16#351#     2:05:00 ipump four_five_and_six on
16#352#     TDIC       20
16#353#     2:05:20 ipump one_two_and_three on
16#354#     TDIC       10
16#355#     2:05:30 heater inlet on
16#356#     TDIC      270
16#357#     2:10:00 ipump one_two_and_three on
16#358#     TDIC       20
16#359#     2:10:20 ipump four_five_and_six on
```

```
16#35A#     TDIC       10
16#35B#     2:10:30 heater inlet on
16#35C#     TDIC      259
16#35D#     2:14:49       valve VD1 open
16#35E#     2:14:51       valve VD2 open
16#35F#     2:14:53       valve VD4 open
16#360#     TDIC        9
16#361#     2:15:02       valve VS3 close
16#362#     2:15:04       valve VS5 close
16#363#     2:15:06       valve VL4 close
16#364#     2:15:08       valve VS6 close
16#365#     TDIC        8
16#366#     2:15:16       valve VD3 close
16#367#     2:15:20       valve VD3 close
16#368#     2:15:21       valve VX open
16#369#     2:15:22       valve VS5 close
16#36A#     2:15:24       valve VD2 close
16#36B#     2:15:26       valve VD1 close
16#36C#     2:15:28       valve VD4 close
16#36D#     2:15:29       valve VD3 open
16#36E#     2:15:30       valve VD3 close
16#36F#     2:15:31       valve VS5 open
16#370#     2:15:32       valve VS5 close
16#371#     2:15:33       valve VD2 open
16#372#     2:15:35       valve VD3 open
16#373#     2:15:36       valve VD3 close
16#374#     2:15:37       valve VD4 open
16#375#     2:15:38       valve VD3 close
16#376#     2:15:39       valve VD1 open
16#377#     2:15:40       valve VS5 close
16#378#     2:15:41       valve VD2 open
16#379#     2:15:42       valve VS5 close
16#37A#     2:15:43       valve VD2 open
16#37B#     2:15:44       valve VD3 close
16#37C#     2:15:46       valve VD1 open
16#37D#     TDIC       14
16#37E#     2:16:00 ipump four_five_and_six on
16#37F#     TDIC       20
16#380#     2:16:20 ipump one_two_and_three on
16#381#     TDIC       10
16#382#     2:16:30 heater inlet on
16#383#     TDIC      210
16#384#     2:20:00 ipump one_two_and_three on
16#385#     TDIC       20
16#386#     2:20:20 ipump four_five_and_six on
16#387#     TDIC       10
16#388#     2:20:30 heater inlet on
16#389#     TDIC      270
16#38A#     2:25:00 ipump four_five_and_six on
16#38B#     TDIC       20
16#38C#     2:25:20 ipump one_two_and_three on
16#38D#     TDIC       10
16#38E#     2:25:30 heater inlet on
16#38F#     TDIC      169
16#390#     2:28:19       valve VD1 open
16#391#     2:28:21       valve VD2 open
16#392#     2:28:23       valve VD4 open
16#393#     2:28:25       valve VC1 open
16#394#     2:28:27       valve VC2 open
16#395#     2:28:29       valve VC3 open
16#396#     2:28:34       valve VS5 close
16#397#     2:28:38       valve VS6 close
16#398#     TDIC        8
16#399#     2:28:46       valve VD3 close
16#39A#     2:28:50       valve VD3 close
16#39B#     2:28:51       valve VX open
```

```
16#39C#     2:28:52      valve VS5 close
16#39D#     2:28:54      valve VD2 close
16#39E#     2:28:56      valve VD1 close
16#39F#     2:28:58      valve VD4 close
16#3A0#     2:28:59      valve VD3 open
16#3A1#     2:29:00      valve VD3 close
16#3A2#     2:29:01      valve VS5 open
16#3A3#     2:29:02      valve VS5 close
16#3A4#     2:29:03      valve VD2 open
16#3A5#     2:29:05      valve VD3 open
16#3A6#     2:29:06      valve VD3 close
16#3A7#     2:29:07      valve VD4 open
16#3A8#     2:29:08      valve VD3 close
16#3A9#     2:29:09      valve VD1 open
16#3AA#     2:29:10      valve VS5 close
16#3AB#     2:29:11      valve VD2 open
16#3AC#     2:29:12      valve VS5 close
16#3AD#     2:29:13      valve VD2 open
16#3AE#     2:29:14      valve VD3 close
16#3AF#     2:29:16      valve VD1 open
16#3B0#     TDIC       44
16#3B1#     2:30:00 ipump one_two_and_three on
16#3B2#     TDIC       20
16#3B3#     2:30:20 ipump four_five_and_six on
16#3B4#     TDIC       10
16#3B5#     2:30:30 heater inlet on
16#3B6#     TDIC      270
16#3B7#     2:35:00 ipump four_five_and_six on
16#3B8#     TDIC       20
16#3B9#     2:35:20 ipump one_two_and_three on
16#3BA#     TDIC       10
16#3BB#     2:35:30 heater inlet on
16#3BC#     TDIC      270
16#3BD#     2:40:00 ipump one_two_and_three on
16#3BE#     TDIC       20
16#3BF#     2:40:20 ipump four_five_and_six on
16#3C0#     TDIC       10
16#3C1#     2:40:30 heater inlet on
16#3C2#     TDIC       79
16#3C3#     2:41:49      valve VD1 open
16#3C4#     2:41:51      valve VD2 open
16#3C5#     2:41:53      valve VD4 open
16#3C6#     TDIC       11
16#3C7#     2:42:04      valve VS5 close
16#3C8#     2:42:08      valve VS6 close
16#3C9#     TDIC        8
16#3CA#     2:42:16      valve VD3 close
16#3CB#     2:42:20      valve VD3 close
16#3CC#     2:42:21      valve VX open
16#3CD#     2:42:22      valve VS5 close
16#3CE#     2:42:24      valve VD2 close
16#3CF#     2:42:26      valve VD1 close
16#3D0#     2:42:28      valve VD4 close
16#3D1#     2:42:29      valve VD3 open
16#3D2#     2:42:30      valve VD3 close
16#3D3#     2:42:31      valve VS5 open
16#3D4#     2:42:32      valve VS5 close
16#3D5#     2:42:33      valve VD2 open
16#3D6#     2:42:35      valve VD3 open
16#3D7#     2:42:36      valve VD3 close
16#3D8#     2:42:37      valve VD4 open
16#3D9#     2:42:38      valve VD3 close
16#3DA#     2:42:39      valve VD1 open
16#3DB#     2:42:40      valve VS5 close
16#3DC#     2:42:41      valve VD2 open
16#3DD#     2:42:42      valve VS5 close
```

```
16#3DE#     2:42:43      valve VD2 open
16#3DF#     2:42:44      valve VD3 close
16#3E0#     2:42:46      valve VD1 open
16#3E1#     TDIC      134
16#3E2#     2:45:00 ipump four_five_and_six on
16#3E3#     TDIC       20
16#3E4#     2:45:20 ipump one_two_and_three on
16#3E5#     TDIC       10
16#3E6#     2:45:30 heater inlet on
16#3E7#     TDIC      270
16#3E8#     2:50:00 ipump one_two_and_three on
16#3E9#     TDIC       20
16#3EA#     2:50:20 ipump four_five_and_six on
16#3EB#     TDIC       10
16#3EC#     2:50:30 heater inlet on
16#3ED#     TDIC      289
16#3EE#     2:55:19      valve VD1 open
16#3EF#     2:55:21      valve VD2 open
16#3F0#     2:55:23      valve VD4 open
16#3F1#     TDIC       11
16#3F2#     2:55:34      valve VS5 close
16#3F3#     2:55:38      valve VS6 close
16#3F4#     TDIC        8
16#3F5#     2:55:46      valve VD3 close
16#3F6#     2:55:50      valve VD3 close
16#3F7#     2:55:51      valve VX open
16#3F8#     2:55:52      valve VS5 close
16#3F9#     2:55:54      valve VD2 close
16#3FA#     2:55:56      valve VD1 close
16#3FB#     2:55:58      valve VD4 close
16#3FC#     2:55:59      valve VD3 open
16#3FD#     2:56:00      valve VD3 close
16#3FE#     2:56:01      valve VS5 open
16#3FF#     2:56:02      valve VS5 close
16#400#     2:56:03      valve VD2 open
16#401#     2:56:05      valve VD3 open
16#402#     2:56:06      valve VD3 close
16#403#     2:56:07      valve VD4 open
16#404#     2:56:08      valve VD3 close
16#405#     2:56:09      valve VD1 open
16#406#     2:56:10      valve VS5 close
16#407#     2:56:11      valve VD2 open
16#408#     2:56:12      valve VS5 close
16#409#     2:56:13      valve VD2 open
16#40A#     2:56:14      valve VD3 close
16#40B#     2:56:16      valve VD1 open
```

Table 6.3 Flight C/O Pre-T0

```
  16#1#     0:00:02      valve IV disable
  16#2#     0:00:02      valve IVA disable
  16#3#     0:00:02      valve VAA enable
  16#4#     0:00:02      valve VAB enable
  16#5#     0:00:02      valve VC1 enable
  16#6#     0:00:02      valve VC2 enable
  16#7#     0:00:02      valve VC3 enable
  16#8#     0:00:02      valve VD1 enable
  16#9#     0:00:02      valve VD2 enable
  16#A#     0:00:02      valve VD3 enable
  16#B#     0:00:02      valve VD4 enable
  16#C#     0:00:02      valve VX enable
  16#D#     0:00:02      valve VD6 enable
  16#E#     0:00:02      valve VE enable
  16#F#     0:00:02      valve VG enable
 16#10#     0:00:02      valve VG1 enable
 16#11#     0:00:02      valve VG2 enable
 16#12#     0:00:02      valve VG3 enable
 16#13#     0:00:02      valve VL1 enable
 16#14#     0:00:02      valve VL2 enable
 16#15#     0:00:02      valve VL3 enable
 16#16#     0:00:02      valve VL4 enable
 16#17#     0:00:02      valve VS1 enable
 16#18#     0:00:02      valve VS2 enable
 16#19#     0:00:02      valve VS3 enable
 16#1A#     0:00:02      valve VS5 enable
 16#1B#     0:00:02      valve VS6 enable
 16#1C#     0:00:02      valve VS7 enable
 16#1D#     0:00:02      valve VV enable
 16#1E#     0:00:02      valve VZ enable
 16#1F#     0:00:02      heater inlet disable
 16#20#     0:00:02      heater cell_1 disable
 16#21#     0:00:02      heater cell_2 disable
 16#22#     0:00:02      heater acp_line disable
 16#23#     0:00:02      heater mass_source_cal disable
 16#24#     0:00:02      heater gc_oven_1 disable
 16#25#     0:00:02      heater gc_oven_2 disable
 16#26#     0:00:02      heater gc_oven_3 disable
 16#27#     0:00:02      filament_ctrl filament1 disable
 16#28#     0:00:02      filament_ctrl filament2 disable
 16#29#     0:00:02      filament_ctrl filament3 disable
 16#2A#     0:00:02      filament_ctrl filament4 disable
 16#2B#     0:00:02      filament_ctrl filament5 enable
 16#2C#     0:00:02      filament_ctrl filament6 disable
 16#2D#     0:00:02      ipump one_two_and_three enable
 16#2E#     0:00:02      ipump four_five_and_six enable
 16#2F#     0:00:02      isource false round_robin 0 1 1 1 1 1 0
 16#30#     0:00:02      isource true round_robin 0 0 0 0 0 1 0
 16#31#     0:00:02      No_op
 16#32#     0:00:02      No_op_L2
 16#33#     0:00:02 valve VX close
 16#34#     TDIC      538
 16#35#     0:09:00      filament_ctrl filament5 on
 16#36#     0:09:00      No_op
 16#37#     0:09:01      No_op_L2
 16#38#     0:09:02      No_op
 16#39#     0:09:03      No_op_L2
 16#3A#     TDIC       57
 16#3B#     0:10:00 ipump four_five_and_six on
 16#3C#     TDIC       20
 16#3D#     0:10:20 ipump one_two_and_three on
 16#3E#     TDIC       10
 16#3F#     0:10:30 heater inlet disable
 16#40#     TDIC       30
 16#41#     0:11:00 valve VC3 open
```

```
16#42#     0:11:04 valve VC3 open
16#43#     0:11:08 valve VG1 open
16#44#     0:11:12 valve VG1 open
16#45#     0:11:16 valve VG2 open
16#46#     0:11:20 valve VG2 open
16#47#     0:11:24 valve VG3 open
16#48#     0:11:28 valve VG3 open
16#49#     0:11:32 valve VS5 open
16#4A#     0:11:36 valve VS5 open
16#4B#     0:11:40 valve VD6 open
16#4C#     0:11:44 valve VD6 open
16#4D#     0:11:48 valve VS3 open
16#4E#     0:11:52 valve VS3 open
16#4F#     0:11:56 valve VS2 open
16#50#     0:12:00 valve VS2 open
16#51#     0:12:04 valve VS1 open
16#52#     0:12:08 valve VS1 open
16#53#     0:12:12 valve VD3 open
16#54#     0:12:16 valve VD3 open
16#55#     0:12:20 valve VD4 open
16#56#     0:12:24 valve VD4 open
16#57#     0:12:28 valve VS6 open
16#58#     0:12:32 valve VS6 open
16#59#     0:12:36 valve VD1 open
16#5A#     0:12:40 valve VD1 open
16#5B#     0:12:44 valve VS7 open
16#5C#     0:12:48 valve VS7 open
16#5D#     0:12:52 valve VE open
16#5E#     0:12:56 valve VE open
16#5F#     0:13:00 valve VV open
16#60#     0:13:04 valve VV open
16#61#     0:13:08 valve VG open
16#62#     0:13:12 valve VG open
16#63#     0:13:16 valve VL1 open
16#64#     0:13:20 valve VL1 open
16#65#     0:13:24 valve VAB open
16#66#     0:13:28 valve VAB open
16#67#     0:13:32 valve VAA open
16#68#     0:13:36 valve VAA open
16#69#     0:13:40 valve VX open
16#6A#     0:13:44 valve VX open
16#6B#     0:13:48 valve VC2 open
16#6C#     0:13:52 valve VC2 open
16#6D#     0:13:56 valve VC1 open
16#6E#     0:14:00 valve VC1 open
16#6F#     0:14:04 valve VL3 open
16#70#     0:14:08 valve VL3 open
16#71#     0:14:12 valve VZ open
16#72#     0:14:16 valve VZ open
16#73#     0:14:20 valve VL2 open
16#74#     0:14:24 valve VL2 open
16#75#     0:14:28 valve VL4 open
16#76#     0:14:32 valve VL4 open
16#77#     0:14:36 valve VD2 open
16#78#     0:14:40 valve VD2 open
16#79#     TDIC      500
16#7A#     0:23:00 filament_ctrl filament5 off
16#7B#     0:23:00 ipump four_five_and_six off
16#7C#     0:23:00 ipump one_two_and_three off
16#7D#     0:23:02       No_op
16#7E#     0:23:03       No_op_L2
```

Table 6.4 Flight C/O Post-T0

```
  16#1#     0:00:02      valve IV disable
  16#2#     0:00:02      valve IVA disable
  16#3#     0:00:02      valve VAA enable
  16#4#     0:00:02      valve VAB enable
  16#5#     0:00:02      valve VC1 enable
  16#6#     0:00:02      valve VC2 enable
  16#7#     0:00:02      valve VC3 enable
  16#8#     0:00:02      valve VD1 enable
  16#9#     0:00:02      valve VD2 enable
  16#A#     0:00:02      valve VD3 enable
  16#B#     0:00:02      valve VD4 enable
  16#C#     0:00:02      valve VX enable
  16#D#     0:00:02      valve VD6 enable
  16#E#     0:00:02      valve VE enable
  16#F#     0:00:02      valve VG enable
 16#10#     0:00:02      valve VG1 enable
 16#11#     0:00:02      valve VG2 enable
 16#12#     0:00:02      valve VG3 enable
 16#13#     0:00:02      valve VL1 enable
 16#14#     0:00:02      valve VL2 enable
 16#15#     0:00:02      valve VL3 enable
 16#16#     0:00:02      valve VL4 enable
 16#17#     0:00:02      valve VS1 enable
 16#18#     0:00:02      valve VS2 enable
 16#19#     0:00:02      valve VS3 enable
 16#1A#     0:00:02      valve VS5 enable
 16#1B#     0:00:02      valve VS6 enable
 16#1C#     0:00:02      valve VS7 enable
 16#1D#     0:00:02      valve VV enable
 16#1E#     0:00:02      valve VZ enable
 16#1F#     0:00:02      heater inlet disable
 16#20#     0:00:02      heater cell_1 enable
 16#21#     0:00:02      heater cell_2 enable
 16#22#     0:00:02      heater acp_line enable
 16#23#     0:00:02      heater mass_source_cal disable
 16#24#     0:00:02      heater gc_oven_1 disable
 16#25#     0:00:02      heater gc_oven_2 disable
 16#26#     0:00:02      heater gc_oven_3 disable
 16#27#     0:00:02      filament_ctrl filament1 enable
 16#28#     0:00:02      filament_ctrl filament2 disable
 16#29#     0:00:02      filament_ctrl filament3 disable
 16#2A#     0:00:02      filament_ctrl filament4 disable
 16#2B#     0:00:02      filament_ctrl filament5 disable
 16#2C#     0:00:02      filament_ctrl filament6 disable
 16#2D#     0:00:02      ipump one_two_and_three enable
 16#2E#     0:00:02      ipump four_five_and_six enable
 16#2F#     0:00:02      isource false round_robin 0 1 1 1 1 1 0
 16#30#     0:00:02      isource true round_robin 0 1 0 0 0 0 0
 16#31#     0:00:02      useq_ctrl alt_step direct 0 0 32 1
 16#32#     0:00:02      No_op
 16#33#     0:00:02      No_op_L2
 16#34#     TDIC       9
 16#35#     0:00:11      filament_ctrl filament1 on
 16#36#     TDIC       9
 16#37#     0:00:20      heater acp_line off
 16#38#     0:00:20      heater cell_2 off
 16#39#     0:00:20      heater cell_1 off
 16#3A#     TDIC      30
 16#3B#     0:00:50      No_op
 16#3C#     0:00:50      No_op_L2
 16#3D#     TDIC      13
 16#3E#     0:01:03      No_op
 16#3F#     0:01:04      No_op_L2
```

```
16#40#     0:01:10 ipump four_five_and_six on
16#41#     TDIC       10
16#42#     0:01:20 ipump one_two_and_three on
16#43#     TDIC       10
16#44#     0:01:30 heater inlet disable
16#45#     TDIC      210
16#46#     0:05:00 ipump four_five_and_six on
16#47#     0:05:01 ipump one_two_and_three on
16#48#     TDIC      329
16#49#     0:10:30 heater inlet disable
16#4A#     0:10:31       No_op
16#4B#     0:10:32       No_op_L2
16#4C#     TDIC       88
16#4D#     0:12:00 valve VL3 open
16#4E#     0:12:05 valve VL3 open
16#4F#     0:12:10 valve VV open
16#50#     0:12:15 valve VV open
16#51#     0:12:20 valve VG open
16#52#     0:12:25 valve VG open
16#53#     0:12:30 valve VE open
16#54#     0:12:35 valve VE open
16#55#     0:12:40 valve VZ open
16#56#     0:12:45 valve VZ open
16#57#     0:12:50 valve VX open
16#58#     0:12:55 valve VX open
16#59#     0:13:00 valve VC3 open
16#5A#     0:13:05 valve VC3 open
16#5B#     0:13:10 valve VC2 open
16#5C#     0:13:15 valve VC2 open
16#5D#     0:13:20 valve VC1 open
16#5E#     0:13:25 valve VC1 open
16#5F#     0:13:30 valve VG1 open
16#60#     0:13:35 valve VG1 open
16#61#     0:13:40 valve VD6 open
16#62#     0:13:45 valve VD6 open
16#63#     0:13:50 valve VG2 open
16#64#     0:13:55 valve VG2 open
16#65#     0:14:00 valve VG3 open
16#66#     0:14:05 valve VG3 open
16#67#     0:14:10 valve VS5 open
16#68#     0:14:15 valve VS5 open
16#69#     0:14:20 valve VS3 open
16#6A#     0:14:25 valve VS3 open
16#6B#     0:14:30 valve VS2 open
16#6C#     0:14:35 valve VS2 open
16#6D#     0:14:40 valve VS1 open
16#6E#     0:14:45 valve VS1 open
16#6F#     0:14:50 valve VS6 open
16#70#     0:14:55 valve VS6 open
16#71#     0:15:00 valve VL4 open
16#72#     0:15:05 valve VL4 open
16#73#     0:15:10 valve VAB open
16#74#     0:15:15 valve VAB open
16#75#     0:15:20 valve VAA open
16#76#     0:15:25 valve VAA open
16#77#     0:15:30 valve VD2 open
16#78#     0:15:35 valve VD2 open
16#79#     0:15:40 valve VS7 open
16#7A#     0:15:45 valve VS7 open
16#7B#     0:15:50 valve VL2 open
16#7C#     0:15:55 valve VL2 open
16#7D#     0:16:00 valve VL1 open
16#7E#     0:16:05 valve VL1 open
16#7F#     0:16:10 valve VD1 open
16#80#     0:16:15 valve VD1 open
16#81#     0:16:20 valve VD3 open
```

```
16#82#     0:16:25 valve VD3 open
16#83#     0:16:30 valve VD4 open
16#84#     0:16:35 valve VD4 open
16#85#     TDIC       25
16#86#     0:17:00       filament_ctrl filament2 enable
16#87#     0:17:00       filament_ctrl filament3 enable
16#88#     0:17:00       filament_ctrl filament4 enable
16#89#     0:17:00       filament_ctrl filament5 enable
16#8A#     0:17:01 isource true round_robin 0 1 1 1 1 1 0
16#8B#     TDIC       60
16#8C#     0:18:01       filament_ctrl filament2 on
16#8D#     0:18:02       filament_ctrl filament3 on
16#8E#     0:18:03       filament_ctrl filament4 on
16#8F#     0:18:04       filament_ctrl filament5 on
16#90#     TDIC      116
16#91#     0:20:00 ipump one_two_and_three on
16#92#     TDIC       20
16#93#     0:20:20 ipump four_five_and_six on
16#94#     TDIC       10
16#95#     0:20:30 heater inlet disable
16#96#     0:20:31       No_op
16#97#     0:20:32       No_op_L2
16#98#     TDIC      448
16#99#     0:28:00       heater cell_1 on
16#9A#     0:28:03       No_op
16#9B#     0:28:04       No_op_L2
16#9C#     TDIC       57
16#9D#     0:29:01       heater cell_1 off
16#9E#     TDIC       17
16#9F#     0:29:18       valve IV enable
16#A0#     0:29:19       valve IV open
16#A1#     0:29:23       valve IV open
16#A2#     0:29:24 valve IV disable
16#A3#     TDIC      309
16#A4#     0:34:33       heater cell_1 disable
16#A5#     TDIC       31
16#A6#     0:35:04 valve IVA enable
16#A7#     0:35:05       valve IVA open
16#A8#     0:35:09 valve IVA open
16#A9#     0:35:10       valve IVA disable
16#AA#     0:35:10       heater acp_line on
16#AB#     0:35:12       heater cell_2 on
16#AC#     0:35:16       No_op
16#AD#     0:35:17       No_op_L2
16#AE#     TDIC       43
16#AF#     0:36:00       heater inlet disable
16#B0#     0:36:00       heater cell_2 off
16#B1#     0:36:00       heater gc_oven_1 enable
16#B2#     0:36:00       heater gc_oven_2 enable
16#B3#     0:36:00       heater gc_oven_3 enable
16#B4#     TDIC       31
16#B5#     0:36:31       No_op
16#B6#     0:36:32       No_op_L2
16#B7#     TDIC      238
16#B8#     0:40:30 ipump one_two_and_three on
16#B9#     TDIC       10
16#BA#     0:40:40 ipump four_five_and_six on
16#BB#     TDIC       10
16#BC#     0:40:50 heater inlet disable
16#BD#     TDIC      550
16#BE#     0:50:00 ipump one_two_and_three on
16#BF#     TDIC       20
16#C0#     0:50:20 ipump four_five_and_six on
16#C1#     TDIC       10
16#C2#     0:50:30 heater inlet disable
16#C3#     0:50:31       No_op
```

```
 16#C4#     0:50:32      No_op_L2
 16#C5#     TDIC      161
 16#C6#     0:53:13 No_op
 16#C7#     TDIC      467
 16#C8#     1:01:00 valve VD4 close
 16#C9#     1:01:02 valve VD3 close
 16#CA#     1:01:04 valve VD1 close
 16#CB#     1:01:06 valve VL1 close
 16#CC#     1:01:08 valve VL2 close
 16#CD#     1:01:10 valve VS7 close
 16#CE#     1:01:12 valve VD2 close
 16#CF#     1:01:14 valve VAA close
 16#D0#     1:01:16 valve VAB close
 16#D1#     1:01:18 valve VL4 close
 16#D2#     1:01:20 valve VS6 close
 16#D3#     1:01:22 valve VS1 close
 16#D4#     1:01:24 valve VS2 close
 16#D5#     1:01:26 valve VS3 close
 16#D6#     1:01:28 valve VS5 close
 16#D7#     1:01:30 valve VG3 close
 16#D8#     1:01:32 valve VG2 close
 16#D9#     1:01:34 valve VD6 close
 16#DA#     1:01:36 valve VG1 close
 16#DB#     1:01:38 valve VC1 close
 16#DC#     1:01:40 valve VC2 close
 16#DD#     1:01:42 valve VC3 close
 16#DE#     1:01:44 valve VX close
 16#DF#     1:01:46 valve VZ close
 16#E0#     1:01:48 valve VE close
 16#E1#     1:01:50 valve VG close
 16#E2#     1:01:52 valve VV close
 16#E3#     1:01:54 valve VL3 close
 16#E4#     TDIC      186
 16#E5#     1:05:00 valve VD4 close
 16#E6#     1:05:04 valve VD3 close
 16#E7#     1:05:08 valve VD1 close
 16#E8#     1:05:12 valve VL1 close
 16#E9#     1:05:16 valve VL2 close
 16#EA#     1:05:20 valve VS7 close
 16#EB#     1:05:24 valve VD2 close
 16#EC#     1:05:28 valve VAA close
 16#ED#     1:05:32 valve VAB close
 16#EE#     1:05:36 valve VL4 close
 16#EF#     1:05:40 valve VS6 close
 16#F0#     1:05:44 valve VS1 close
 16#F1#     1:05:48 valve VS2 close
 16#F2#     1:05:52 valve VS3 close
 16#F3#     1:05:56 valve VS5 close
 16#F4#     1:06:00 valve VG3 close
 16#F5#     1:06:04 valve VG2 close
 16#F6#     1:06:08 valve VD6 close
 16#F7#     1:06:12 valve VG1 close
 16#F8#     1:06:16 valve VC1 close
 16#F9#     1:06:20 valve VC2 close
 16#FA#     1:06:24 valve VC3 close
 16#FB#     1:06:28 valve VX close
 16#FC#     1:06:32 valve VZ close
 16#FD#     1:06:36 valve VE close
 16#FE#     1:06:40 valve VG close
 16#FF#     1:06:44 valve VV close
16#100#     1:06:48 valve VL3 close
16#101#     TDIC       99
16#102#     1:08:27 cmp FFA9 000E
16#103#     1:08:27 cmp FFAA 0000
16#104#     TDIC       13
16#105#     1:08:40 cmp FFA9 00EE
```

```
16#106#     1:08:40 cmp FFAA 00E0
16#107#     TDIC       80
16#108#     1:10:00       No_op
16#109#     TDIC      120
16#10A#     1:12:00       valve VS6 squirt 4
16#10B#     TDIC      120
16#10C#     1:14:00       No_op
16#10D#     TDIC       60
16#10E#     1:15:00       valve VG1 close
16#10F#     1:15:04       valve VG2 close
16#110#     1:15:08       valve VS6 close
16#111#     1:15:12       valve VG3 close
16#112#     1:15:16       valve VS5 close
16#113#     TDIC      284
16#114#     1:20:00 valve VL3 open
16#115#     1:20:02 valve VL4 open
16#116#     1:20:04 valve VC1 open
16#117#     1:20:06 valve VC2 open
16#118#     1:20:08 valve VC3 open
16#119#     TDIC       40
16#11A#     1:20:48 valve VL3 open
16#11B#     1:20:52 valve VL4 open
16#11C#     1:20:56 valve VC1 open
16#11D#     1:21:00 valve VC2 open
16#11E#     1:21:04 valve VC3 open
16#11F#     1:21:06 valve VE open
16#120#     1:21:08 valve VAB open
16#121#     1:21:10 valve VAA open
16#122#     1:21:12 valve VG1 open
16#123#     TDIC       40
16#124#     1:21:52 valve VE open
16#125#     1:21:56 valve VAB open
16#126#     1:22:00 valve VAA open
16#127#     1:22:04 valve VG1 open
16#128#     1:22:06 valve VV open
16#129#     1:22:08 valve VG2 open
16#12A#     TDIC       40
16#12B#     1:22:48 valve VV open
16#12C#     1:22:52 valve VG2 open
16#12D#     1:22:54 valve VG open
16#12E#     1:22:56 valve VG3 open
16#12F#     TDIC       40
16#130#     1:23:36 valve VG open
16#131#     1:23:40 valve VG3 open
16#132#     1:23:42 valve VS5 open
16#133#     1:23:44 valve VZ open
16#134#     TDIC       40
16#135#     1:24:24 valve VS5 open
16#136#     1:24:28 valve VZ open
16#137#     1:24:30 valve VD6 open
16#138#     TDIC       30
16#139#     1:25:00       No_op
16#13A#     1:25:01       No_op_L2
16#13B#     TDIC        9
16#13C#     1:25:10 valve VD6 open
16#13D#     1:25:12 valve VD4 open
16#13E#     1:25:14 valve VD3 open
16#13F#     1:25:16 valve VS1 open
16#140#     1:25:18 valve VS2 open
16#141#     1:25:20 valve VS3 open
16#142#     TDIC       40
16#143#     1:26:00 valve VD4 open
16#144#     1:26:04 valve VD3 open
16#145#     1:26:08 valve VS1 open
16#146#     1:26:12 valve VS2 open
16#147#     1:26:16 valve VS3 open
```

```
16#148#     1:26:18 valve VD1 open
16#149#     1:26:20 valve VD2 open
16#14A#     1:26:22 valve VL1 open
16#14B#     1:26:24 valve VL2 open
16#14C#     1:26:26 valve VS7 open
16#14D#     1:26:28 valve VX open
16#14E#     1:26:30 valve VS6 open
16#14F#     TDIC       40
16#150#     1:27:10 valve VD1 open
16#151#     1:27:14 valve VD2 open
16#152#     1:27:18 valve VL1 open
16#153#     1:27:22 valve VL2 open
16#154#     1:27:26 valve VS7 open
16#155#     1:27:30 valve VX open
16#156#     1:27:34 valve VS6 open
16#157#     TDIC      746
16#158#     1:40:00 valve VD4 close
16#159#     1:40:02 valve VD3 close
16#15A#     1:40:04 valve VD1 close
16#15B#     1:40:06 valve VL1 close
16#15C#     1:40:08 valve VL2 close
16#15D#     1:40:10 valve VS7 close
16#15E#     1:40:12 valve VD2 close
16#15F#     1:40:14 valve VAA close
16#160#     1:40:16 valve VAB close
16#161#     1:40:18 valve VL4 close
16#162#     1:40:20 valve VS6 close
16#163#     1:40:22 valve VS1 close
16#164#     1:40:24 valve VS2 close
16#165#     1:40:26 valve VS3 close
16#166#     1:40:28 valve VS5 close
16#167#     1:40:30 valve VG3 close
16#168#     1:40:32 valve VG2 close
16#169#     1:40:34 valve VD6 close
16#16A#     1:40:36 valve VG1 close
16#16B#     1:40:38 valve VC1 close
16#16C#     1:40:40 valve VC2 close
16#16D#     1:40:42 valve VC3 close
16#16E#     1:40:44 valve VX close
16#16F#     1:40:46 valve VZ close
16#170#     1:40:48 valve VE close
16#171#     1:40:50 valve VG close
16#172#     1:40:52 valve VV close
16#173#     1:40:54 valve VL3 close
16#174#     1:41:00       No_op
16#175#     1:41:01       No_op_L2
16#176#     TDIC      239
16#177#     1:45:00 valve VD4 close
16#178#     1:45:04 valve VD3 close
16#179#     1:45:08 valve VD1 close
16#17A#     1:45:12 valve VL1 close
16#17B#     1:45:16 valve VL2 close
16#17C#     1:45:20 valve VS7 close
16#17D#     1:45:24 valve VD2 close
16#17E#     1:45:28 valve VAA close
16#17F#     1:45:32 valve VAB close
16#180#     1:45:36 valve VL4 close
16#181#     1:45:40 valve VS6 close
16#182#     1:45:44 valve VS1 close
16#183#     1:45:48 valve VS2 close
16#184#     1:45:52 valve VS3 close
16#185#     1:45:56 valve VS5 close
16#186#     1:46:00 valve VG3 close
16#187#     1:46:04 valve VG2 close
16#188#     1:46:08 valve VD6 close
16#189#     1:46:12 valve VG1 close
```

```
16#18A#     1:46:16 valve VC1 close
16#18B#     1:46:20 valve VC2 close
16#18C#     1:46:24 valve VC3 close
16#18D#     1:46:28 valve VX close
16#18E#     1:46:32 valve VZ close
16#18F#     1:46:36 valve VE close
16#190#     1:46:40 valve VG close
16#191#     1:46:44 valve VV close
16#192#     1:46:48 valve VL3 close
16#193#     TDIC      192
16#194#     1:50:00 valve VD4 open
16#195#     1:50:00       No_op_L2
16#196#     1:50:02 valve VC1 open
16#197#     1:50:04 valve VD1 open
16#198#     1:50:06 valve VD2 open
16#199#     1:50:08 valve VC2 open
16#19A#     1:50:10 valve VL3 open
16#19B#     1:50:12 valve VAA open
16#19C#     1:50:14 valve VAB open
16#19D#     1:50:16 valve VZ open
16#19E#     1:50:18 valve VE open
16#19F#     1:50:20 valve VG open
16#1A0#     1:50:22 valve VV open
16#1A1#     1:50:24 valve VC3 open
16#1A2#     1:50:30 valve VG1 open
16#1A3#     1:50:31       No_op_L2
16#1A4#     TDIC       33
16#1A5#     1:51:04 valve VC1 open
16#1A6#     1:51:08 valve VD1 open
16#1A7#     1:51:12 valve VD2 open
16#1A8#     1:51:16 valve VC2 open
16#1A9#     1:51:20 valve VL3 open
16#1AA#     1:51:24 valve VAA open
16#1AB#     1:51:28 valve VAB open
16#1AC#     1:51:32 valve VZ open
16#1AD#     1:51:36 valve VE open
16#1AE#     1:51:40 valve VG open
16#1AF#     1:51:44 valve VV open
16#1B0#     1:51:48 valve VC3 open
16#1B1#     TDIC      542
16#1B2#     2:00:50 valve VG1 open
16#1B3#     2:00:50       No_op_L2
16#1B4#     2:00:54 valve VD4 open
16#1B5#     TDIC      854
16#1B6#     2:15:08 valve VL2 open
16#1B7#     2:15:10 valve VS7 open
16#1B8#     TDIC        8
16#1B9#     2:15:18 valve VL4 open
16#1BA#     2:15:20 valve VS6 open
16#1BB#     2:15:22 valve VS1 open
16#1BC#     2:15:24 valve VS2 open
16#1BD#     2:15:26 valve VS3 open
16#1BE#     2:15:28 valve VS5 open
16#1BF#     2:15:30 valve VG3 open
16#1C0#     2:15:32 valve VG2 open
16#1C1#     2:15:36 valve VL1 open
16#1C2#     2:15:38 valve VC1 open
16#1C3#     2:15:40 valve VC2 open
16#1C4#     2:15:42 valve VD3 open
16#1C5#     2:15:44 valve VX open
16#1C6#     TDIC       16
16#1C7#     2:16:00 valve VD4 open
16#1C8#     2:16:04 valve VD3 open
16#1C9#     2:16:08 valve VD1 open
16#1CA#     2:16:12 valve VL1 open
16#1CB#     2:16:16 valve VL2 open
```

```
16#1CC#     2:16:20 valve VS7 open
16#1CD#     2:16:24 valve VD2 open
16#1CE#     2:16:28 valve VAA open
16#1CF#     2:16:32 valve VAB open
16#1D0#     2:16:36 valve VL4 open
16#1D1#     2:16:40 valve VS6 open
16#1D2#     2:16:44 valve VS1 open
16#1D3#     2:16:48 valve VS2 open
16#1D4#     2:16:52 valve VS3 open
16#1D5#     2:16:56 valve VS5 open
16#1D6#     2:17:00 valve VG3 open
16#1D7#     2:17:04 valve VG2 open
16#1D8#     2:17:08 valve VD6 open
16#1D9#     2:17:12 valve VG1 open
16#1DA#     2:17:16 valve VC1 open
16#1DB#     2:17:20 valve VC2 open
16#1DC#     2:17:24 valve VC3 open
16#1DD#     2:17:28 valve VX open
16#1DE#     2:17:32 valve VZ open
16#1DF#     2:17:36 valve VE open
16#1E0#     2:17:40 valve VG open
16#1E1#     2:17:44 valve VV open
16#1E2#     2:17:48 valve VL3 open
```

Table 6.5 Ground C/O Pre-T0

```
 16#1#     0:00:00      valve VAA enable
 16#2#     0:00:00      valve VAB enable
 16#3#     0:00:00      valve VC1 enable
 16#4#     0:00:00      valve VC2 enable
 16#5#     0:00:00      valve VC3 enable
 16#6#     0:00:00      valve VD1 enable
 16#7#     0:00:00      valve VD2 enable
 16#8#     0:00:00      valve VD3 enable
 16#9#     0:00:00      valve VD4 enable
 16#A#     0:00:00      valve VX enable
 16#B#     0:00:00      valve VD6 enable
 16#C#     0:00:00      valve VE enable
 16#D#     0:00:00      valve VG enable
 16#E#     0:00:00      valve VG1 enable
 16#F#     0:00:00      valve VG2 enable
16#10#     0:00:00      valve VG3 enable
16#11#     0:00:00      valve VL1 enable
16#12#     0:00:00      valve VL2 enable
16#13#     0:00:00      valve VL3 enable
16#14#     0:00:00      valve VL4 enable
16#15#     0:00:00      valve VS1 enable
16#16#     0:00:00      valve VS2 enable
16#17#     0:00:00      valve VS3 enable
16#18#     0:00:00      valve VS5 enable
16#19#     0:00:00      valve VS6 enable
16#1A#     0:00:00      valve VS7 enable
16#1B#     0:00:00      valve VV enable
16#1C#     0:00:00      valve VZ enable
16#1D#     0:00:00      heater inlet disable
16#1E#     0:00:00      heater mass_source_cal disable
16#1F#     0:00:00      filament_ctrl filament1 enable
16#20#     0:00:00      filament_ctrl filament2 enable
16#21#     0:00:00      filament_ctrl filament3 enable
16#22#     0:00:00      filament_ctrl filament4 enable
16#23#     0:00:00      filament_ctrl filament5 enable
16#24#     0:00:00      filament_ctrl filament6 disable
16#25#     0:00:00      ipump one_two_and_three enable
16#26#     0:00:00      ipump four_five_and_six enable
16#27#     0:00:00      isource false round_robin 0 1 1 1 1 1 0
16#28#     0:00:00      isource true round_robin 0 1 1 1 1 1 0
16#29#     0:00:00      useq_ctrl alt_step direct 0 0 32 1
16#2A#     0:00:00      valve VC1 close
16#2B#     0:00:01      valve VD1 open
16#2C#     0:00:02      valve VC2 close
16#2D#     0:00:03      valve VD2 open
16#2E#     0:00:04      valve VC3 close
16#2F#     0:00:05      valve VV open
16#30#     0:00:06      valve VX close
16#31#     0:00:07      No_op
16#32#     0:00:07      No_op_L2
16#33#     0:00:08      valve VL4 close
16#34#     0:00:09      filament_ctrl filament1 on
16#35#     0:00:10      valve VL2 close
16#36#     0:00:11      filament_ctrl filament2 on
16#37#     0:00:12      valve VL1 close
16#38#     0:00:13      filament_ctrl filament3 on
16#39#     0:00:14      valve VZ close
16#3A#     0:00:15      filament_ctrl filament4 on
16#3B#     0:00:16      valve VS7 close
16#3C#     0:00:17      filament_ctrl filament5 on
16#3D#     0:00:18      valve VE close
16#3E#     0:00:19      heater inlet disable
16#3F#     0:00:20      valve VL3 close
```

```
16#40#      0:00:21      valve VD1 open
16#41#      0:00:22      valve VD3 close
16#42#      0:00:23      valve VD2 open
16#43#      0:00:24      valve VD4 close
16#44#      0:00:25      valve VV open
16#45#      0:00:26      valve VS6 close
16#46#      0:00:27      heater gc_oven_1 disable
16#47#      0:00:28      valve VS5 close
16#48#      0:00:29      heater gc_oven_2 disable
16#49#      0:00:30      valve VG1 close
16#4A#      0:00:31      heater gc_oven_3 disable
16#4B#      0:00:32      valve VG2 close
16#4C#      0:00:33      ipump one_two_and_three on
16#4D#      0:00:34      valve VG3 close
16#4E#      0:00:35      No_op
16#4F#      0:00:36      valve VS1 close
16#50#      0:00:37      No_op_L2
16#51#      0:00:38      valve VS2 close
16#52#      0:00:39      No_op
16#53#      0:00:40      valve VS3 close
16#54#      0:00:41      ipump four_five_and_six on
16#55#      0:00:42      valve VD6 open
16#56#      0:00:43      No_op_L2
16#57#      0:00:44      valve VG close
16#58#      0:00:45      No_op
16#59#      0:00:46      valve VAA close
16#5A#      0:00:47      No_op_L2
16#5B#      0:00:48      valve VAB close
16#5C#      0:00:49      No_op
16#5D#      0:00:49      No_op_L2
16#5E#      0:00:50      valve VC1 close
16#5F#      0:00:51      valve VD1 open
16#60#      0:00:52      valve VC2 close
16#61#      0:00:53      valve VD2 open
16#62#      0:00:54      valve VC3 close
16#63#      0:00:55      valve VV open
16#64#      0:00:56      valve VX close
16#65#      0:00:57      No_op
16#66#      0:00:58      valve VL4 close
16#67#      0:00:59      filament_ctrl filament1 on
16#68#      0:01:00      valve VL2 close
16#69#      0:01:01      filament_ctrl filament2 on
16#6A#      0:01:02      valve VL1 close
16#6B#      0:01:03      filament_ctrl filament3 on
16#6C#      0:01:04      valve VZ close
16#6D#      0:01:05      filament_ctrl filament4 on
16#6E#      0:01:06      valve VS7 close
16#6F#      0:01:07      filament_ctrl filament5 on
16#70#      0:01:08      valve VE close
16#71#      0:01:09      heater inlet disable
16#72#      0:01:10      valve VL3 close
16#73#      0:01:11      valve VD1 open
16#74#      0:01:12      valve VD3 close
16#75#      0:01:13      valve VD2 open
16#76#      0:01:14      valve VD4 close
16#77#      0:01:15      valve VV open
16#78#      0:01:16      valve VS6 close
16#79#      0:01:17      heater gc_oven_1 disable
16#7A#      0:01:18      valve VS5 close
16#7B#      0:01:19      heater gc_oven_2 disable
16#7C#      0:01:20      valve VG1 close
16#7D#      0:01:21      heater gc_oven_3 disable
16#7E#      0:01:22      valve VG2 close
16#7F#      0:01:23      ipump one_two_and_three on
16#80#      0:01:24      valve VG3 close
16#81#      0:01:25      No_op
```

```
16#82#     0:01:26      valve VS1 close
16#83#     0:01:27      No_op_L2
16#84#     0:01:28      valve VS2 close
16#85#     0:01:29      No_op
16#86#     0:01:30      valve VS3 close
16#87#     0:01:31      ipump four_five_and_six on
16#88#     0:01:32      valve VD6 open
16#89#     0:01:33      No_op_L2
16#8A#     0:01:34      valve VG close
16#8B#     0:01:35      No_op
16#8C#     0:01:36      valve VAA close
16#8D#     0:01:37      No_op_L2
16#8E#     0:01:38      valve VAB close
16#8F#     0:01:39      No_op
16#90#     0:01:40      No_op_L2
16#91#     TDIC      200
16#92#     0:05:00      valve VC1 close
16#93#     0:05:02      valve VD1 open
16#94#     0:05:04      valve VC2 close
16#95#     0:05:06      valve VD2 open
16#96#     0:05:08      valve VC3 close
16#97#     0:05:10      valve VV open
16#98#     0:05:12      valve VX close
16#99#     0:05:16      valve VL4 close
16#9A#     0:05:20      valve VL2 close
16#9B#     0:05:24      valve VL1 close
16#9C#     0:05:28      valve VZ close
16#9D#     0:05:32      valve VS7 close
16#9E#     0:05:36      valve VE close
16#9F#     0:05:40      valve VL3 close
16#A0#     0:05:44      valve VD3 close
16#A1#     0:05:48      valve VD4 close
16#A2#     0:05:52      valve VS6 close
16#A3#     0:05:56      valve VS5 close
16#A4#     0:06:00      valve VG1 close
16#A5#     0:06:04      valve VG2 close
16#A6#     0:06:08      valve VG3 close
16#A7#     0:06:12      valve VS1 close
16#A8#     0:06:16      valve VS2 close
16#A9#     0:06:20      valve VS3 close
16#AA#     0:06:24      valve VD6 open
16#AB#     0:06:28      valve VG close
16#AC#     0:06:32      valve VAA close
16#AD#     0:06:36      valve VAB close
16#AE#     0:06:38      No_op
16#AF#     0:06:39      No_op_L2
16#B0#     TDIC      206
16#B1#     0:10:05      No_op
16#B2#     0:10:06      No_op_L2
16#B3#     TDIC      774
16#B4#     0:23:00 filament_ctrl filament1 off
16#B5#     0:23:01 filament_ctrl filament2 off
16#B6#     0:23:02 filament_ctrl filament3 off
16#B7#     0:23:03 filament_ctrl filament4 off
16#B8#     0:23:04 filament_ctrl filament5 off
16#B9#     0:23:05      ipump one_two_and_three off
16#BA#     0:23:06      ipump four_five_and_six off
16#BB#     0:23:07      isource false round_robin 1 0 0 0 0 0 0
16#BC#     0:23:08      isource true round_robin 1 0 0 0 0 0 0
16#BD#     0:23:10      useq_ctrl alt_step direct 0 0 0 0
16#BE#     TDIC       57
16#BF#     0:24:07      No_op
16#C0#     0:24:08      No_op_L2
```

Table 6.6 Ground C/O Post-T0

```
  16#1#      0:00:00      valve IV disable
  16#2#      0:00:00      valve IVA disable
  16#3#      0:00:00      valve VAA enable
  16#4#      0:00:00      valve VAB enable
  16#5#      0:00:00      valve VC1 enable
  16#6#      0:00:00      valve VC2 enable
  16#7#      0:00:00      valve VC3 enable
  16#8#      0:00:00      valve VD1 enable
  16#9#      0:00:00      valve VD2 enable
  16#A#      0:00:00      valve VD3 enable
  16#B#      0:00:00      valve VD4 enable
  16#C#      0:00:00      valve VX enable
  16#D#      0:00:00      valve VD6 enable
  16#E#      0:00:00      valve VE enable
  16#F#      0:00:00      valve VG enable
 16#10#      0:00:00      valve VG1 enable
 16#11#      0:00:00      valve VG2 enable
 16#12#      0:00:00      valve VG3 enable
 16#13#      0:00:00      valve VL1 enable
 16#14#      0:00:00      valve VL2 enable
 16#15#      0:00:00      valve VL3 enable
 16#16#      0:00:00      valve VL4 enable
 16#17#      0:00:00      valve VS1 enable
 16#18#      0:00:00      valve VS2 enable
 16#19#      0:00:00      valve VS3 enable
 16#1A#      0:00:00      valve VS5 enable
 16#1B#      0:00:00      valve VS6 enable
 16#1C#      0:00:00      valve VS7 enable
 16#1D#      0:00:00      valve VV enable
 16#1E#      0:00:00      valve VZ enable
 16#1F#      0:00:00      heater inlet enable
 16#20#      0:00:00      heater cell_1 enable
 16#21#      0:00:00      heater cell_2 disable
 16#22#      0:00:00      heater acp_line enable
 16#23#      0:00:00      heater mass_source_cal disable
 16#24#      0:00:00      heater gc_oven_1 disable
 16#25#      0:00:00      heater gc_oven_2 disable
 16#26#      0:00:00      heater gc_oven_3 disable
 16#27#      0:00:00      filament_ctrl filament1 enable
 16#28#      0:00:00      filament_ctrl filament2 enable
 16#29#      0:00:00      filament_ctrl filament3 enable
 16#2A#      0:00:00      filament_ctrl filament4 enable
 16#2B#      0:00:00      filament_ctrl filament5 enable
 16#2C#      0:00:00      filament_ctrl filament6 disable
 16#2D#      0:00:00      ipump one_two_and_three enable
 16#2E#      0:00:00      ipump four_five_and_six enable
 16#2F#      0:00:00      isource false round_robin 0 1 1 1 1 1 0
 16#30#      0:00:00      isource true round_robin 0 1 0 0 0 0 0
 16#31#      0:00:00      useq_ctrl alt_step direct 0 0 32 1
 16#32#      0:00:00      ipump one_two_and_three on
 16#33#      0:00:00      No_op
 16#34#      0:00:00      No_op_L2
 16#35#      0:00:00      valve VC1 close
 16#36#      0:00:01      valve VD1 open
 16#37#      0:00:02      valve VC2 close
 16#38#      0:00:03      valve VD2 open
 16#39#      0:00:04      valve VC3 close
 16#3A#      0:00:05      valve VV open
 16#3B#      0:00:06      valve VX close
 16#3C#      0:00:07      ipump four_five_and_six on
 16#3D#      0:00:08      valve VL4 close
 16#3E#      0:00:09      filament_ctrl filament1 on
 16#3F#      0:00:10      valve VL2 close
```

```
16#40#     0:00:11      filament_ctrl filament2 on
16#41#     0:00:12      valve VL1 close
16#42#     0:00:13      filament_ctrl filament3 on
16#43#     0:00:14      valve VZ close
16#44#     0:00:15      filament_ctrl filament4 on
16#45#     0:00:16      valve VS7 close
16#46#     0:00:17      filament_ctrl filament5 on
16#47#     0:00:18      valve VE close
16#48#     0:00:19      heater acp_line off
16#49#     0:00:20      valve VL3 close
16#4A#     0:00:21      heater cell_1 off
16#4B#     0:00:22      valve VD3 close
16#4C#     0:00:23      heater inlet on
16#4D#     0:00:24      valve VD4 close
16#4E#     0:00:25      No_op
16#4F#     0:00:26      valve VS6 close
16#50#     0:00:27      No_op
16#51#     0:00:28      valve VS5 close
16#52#     0:00:29      No_op
16#53#     0:00:30      valve VG1 close
16#54#     0:00:31      heater acp_line on
16#55#     0:00:32      valve VG2 close
16#56#     0:00:33      No_op
16#57#     0:00:34      valve VG3 close
16#58#     0:00:35      No_op
16#59#     0:00:36      valve VS1 close
16#5A#     0:00:37      No_op
16#5B#     0:00:38      valve VS2 close
16#5C#     0:00:39      No_op
16#5D#     0:00:40      valve VS3 close
16#5E#     0:00:41      valve VD6 open
16#5F#     0:00:42      valve VG close
16#60#     0:00:43      No_op
16#61#     0:00:44      valve VAA close
16#62#     0:00:45      No_op
16#63#     0:00:46      valve VAB close
16#64#     0:00:50      No_op
16#65#     0:00:50      No_op_L2
16#66#     0:00:50      heater inlet off
16#67#     0:00:50      heater acp_line off
16#68#     0:00:52      valve VZ open
16#69#     0:00:53      No_op
16#6A#     0:00:54      valve VZ open
16#6B#     0:00:55      valve VG1 close
16#6C#     0:00:56      valve VL1 open
16#6D#     0:00:57      heater inlet disable
16#6E#     0:00:58      valve VL1 open
16#6F#     0:00:59      valve VG1 close
16#70#     0:01:00      valve VD6 open
16#71#     TDIC      240
16#72#     0:05:00 ipump four_five_and_six on
16#73#     TDIC       20
16#74#     0:05:20 ipump one_two_and_three on
16#75#     TDIC       10
16#76#     0:05:30 heater inlet disable
16#77#     TDIC      270
16#78#     0:10:00 ipump one_two_and_three on
16#79#     TDIC       20
16#7A#     0:10:20 ipump four_five_and_six on
16#7B#     TDIC       10
16#7C#     0:10:30 heater inlet disable
16#7D#     0:10:31      No_op
16#7E#     0:10:32      No_op_L2
16#7F#     TDIC      268
16#80#     0:15:00 ipump four_five_and_six on
16#81#     TDIC       20
```

```
16#82#     0:15:20 ipump one_two_and_three on
16#83#     TDIC       10
16#84#     0:15:30 heater inlet disable
16#85#     0:15:30       valve VC1 close
16#86#     0:15:32       valve VD1 open
16#87#     0:15:34       valve VC2 close
16#88#     0:15:38       valve VD2 open
16#89#     0:15:42       valve VC3 close
16#8A#     0:15:46       valve VV open
16#8B#     0:15:52       valve VX close
16#8C#     0:15:54       No_op
16#8D#     0:15:56       valve VL4 close
16#8E#     0:15:58       No_op
16#8F#     0:16:00       valve VL2 close
16#90#     0:16:04       valve VL1 open
16#91#     0:16:06       No_op
16#92#     0:16:08       valve VZ open
16#93#     0:16:12       valve VS7 close
16#94#     0:16:14       No_op
16#95#     0:16:16       valve VE close
16#96#     0:16:18       No_op
16#97#     0:16:20       valve VL3 close
16#98#     0:16:22       No_op
16#99#     0:16:24       valve VD3 close
16#9A#     0:16:26       No_op
16#9B#     0:16:28       valve VD4 close
16#9C#     0:16:30       No_op
16#9D#     0:16:32       valve VS6 close
16#9E#     0:16:34       No_op
16#9F#     0:16:36       valve VS5 close
16#A0#     0:16:38       No_op
16#A1#     0:16:40       valve VG1 close
16#A2#     0:16:42       No_op
16#A3#     0:16:44       valve VG2 close
16#A4#     0:16:46       No_op
16#A5#     0:16:48       valve VG3 close
16#A6#     0:16:50       No_op
16#A7#     0:16:52       valve VS1 close
16#A8#     0:16:54       No_op
16#A9#     0:16:56       valve VS2 close
16#AA#     0:16:58       No_op
16#AB#     0:17:00       valve VS3 close
16#AC#     0:17:04       valve VD6 open
16#AD#     0:17:08       valve VG close
16#AE#     0:17:10       No_op
16#AF#     0:17:12       valve VAA close
16#B0#     0:17:14       No_op
16#B1#     0:17:16       valve VAB close
16#B2#     TDIC      164
16#B3#     0:20:00 ipump one_two_and_three on
16#B4#     TDIC       20
16#B5#     0:20:20 ipump four_five_and_six on
16#B6#     TDIC       10
16#B7#     0:20:30 heater inlet disable
16#B8#     0:20:31       No_op
16#B9#     0:20:32       No_op_L2
16#BA#     TDIC      258
16#BB#     0:24:50       valve VL3 close
16#BC#     0:24:51       valve VV open
16#BD#     0:24:52       valve VL3 close
16#BE#     0:24:53       valve VE open
16#BF#     0:24:54       valve VG close
16#C0#     0:24:55       valve VV open
16#C1#     0:24:56       valve VG close
16#C2#     0:24:58       valve VE open
16#C3#     0:25:00       valve VS7 open
```

```
 16#C4#     0:25:02      valve VL3 close
 16#C5#     0:25:03      valve VS7 open
 16#C6#     TDIC       42
 16#C7#     0:25:45      valve VS7 close
 16#C8#     0:25:47      valve VS7 close
 16#C9#     0:25:49      valve VV close
 16#CA#     0:25:50      valve VG open
 16#CB#     0:25:51      valve VV close
 16#CC#     0:25:52      valve VG open
 16#CD#     TDIC        8
 16#CE#     0:26:00 ipump four_five_and_six on
 16#CF#     TDIC       20
 16#D0#     0:26:20 ipump one_two_and_three on
 16#D1#     TDIC       10
 16#D2#     0:26:30 heater inlet disable
 16#D3#     TDIC       90
 16#D4#     0:28:00      valve VE close
 16#D5#     0:28:00      heater cell_1 on
 16#D6#     0:28:02      valve VE close
 16#D7#     0:28:03      No_op
 16#D8#     0:28:04      No_op_L2
 16#D9#     TDIC       30
 16#DA#     0:28:34      valve VD1 close
 16#DB#     0:28:36      valve VD4 close
 16#DC#     0:28:37      valve VD2 open
 16#DD#     0:28:38      valve VD3 close
 16#DE#     0:28:40      valve VG3 close
 16#DF#     0:28:42      valve VG2 close
 16#E0#     0:28:46      valve VX close
 16#E1#     0:28:48      valve VS5 close
 16#E2#     0:28:50      valve VS1 close
 16#E3#     0:28:52      valve VS2 close
 16#E4#     0:28:54      valve VS3 close
 16#E5#     0:28:56      valve VS6 close
 16#E6#     0:28:58      valve VD1 close
 16#E7#     0:29:00      valve VD4 close
 16#E8#     0:29:01      valve VD2 open
 16#E9#     0:29:02      valve VD3 close
 16#EA#     0:29:04      valve VG3 close
 16#EB#     0:29:06      valve VG2 close
 16#EC#     0:29:10      valve VX close
 16#ED#     0:29:12      No_op
 16#EE#     0:29:13      No_op_L2
 16#EF#     0:29:14      valve IV enable
 16#F0#     0:29:15      No_op
 16#F1#     0:29:16      No_op_L2
 16#F2#     0:29:17      No_op
 16#F3#     0:29:19      valve IV open
 16#F4#     0:29:20      No_op
 16#F5#     0:29:21      No_op
 16#F6#     0:29:22      No_op_L2
 16#F7#     0:29:23      valve IV open
 16#F8#     0:29:24 valve VS5 close
 16#F9#     0:29:25 valve VD3 open
 16#FA#     0:29:26 valve VS1 close
 16#FB#     0:29:27 valve IV disable
 16#FC#     0:29:28 valve VS2 close
 16#FD#     0:29:29 valve VD3 open
 16#FE#     0:29:30 valve VS3 close
 16#FF#     0:29:32 valve VS6 close
16#100#     0:29:34 valve VD3 close
16#101#     0:29:35 valve VD4 open
16#102#     0:29:36 valve VD3 close
16#103#     0:29:37 valve VD1 open
16#104#     0:29:39 valve VD4 open
16#105#     0:29:41 valve VD1 open
```

```
16#106#     TDIC       11
16#107#     0:29:52 valve VL4 close
16#108#     0:29:54 valve VL2 close
16#109#     0:29:56 valve VL3 close
16#10A#     0:29:58       valve VS7 close
16#10B#     0:30:00       valve VZ close
16#10C#     0:30:02       valve VZ close
16#10D#     0:30:04       valve VL1 close
16#10E#     0:30:06       valve VL1 close
16#10F#     0:30:10 ipump one_two_and_three on
16#110#     TDIC       10
16#111#     0:30:20 ipump four_five_and_six on
16#112#     TDIC       10
16#113#     0:30:30 heater inlet disable
16#114#     0:30:31       No_op
16#115#     0:30:32       No_op_L2
16#116#     TDIC       46
16#117#     0:31:18       valve VG close
16#118#     0:31:20       valve VG close
16#119#     0:31:24       valve VE close
16#11A#     0:31:24       heater cell_1 on
16#11B#     0:31:26       valve VV close
16#11C#     0:31:28       heater cell_1 on
16#11D#     0:31:29       valve VL3 open
16#11E#     0:31:30       valve VG close
16#11F#     0:31:30       heater cell_1 on
16#120#     0:31:32       valve VL3 open
16#121#     TDIC       84
16#122#     0:32:56       valve VV close
16#123#     0:33:00       heater cell_1 on
16#124#     0:33:00       valve VE open
16#125#     0:33:01       valve VV close
16#126#     0:33:02       valve VE open
16#127#     TDIC       28
16#128#     0:33:30 heater cell_1 on
16#129#     TDIC       20
16#12A#     0:33:50       valve VC1 close
16#12B#     0:33:51       valve VD1 open
16#12C#     0:33:52       valve VC2 close
16#12D#     0:33:53       valve VD2 open
16#12E#     0:33:54       valve VC3 close
16#12F#     0:33:55       valve VD4 open
16#130#     0:33:56       valve VX close
16#131#     0:33:57       valve IV open
16#132#     0:33:58       valve VS6 close
16#133#     0:34:01 heater cell_1 on
16#134#     TDIC        9
16#135#     0:34:10       valve VD3 close
16#136#     0:34:12       valve VL1 close
16#137#     0:34:14       valve VZ close
16#138#     0:34:16       valve VL2 close
16#139#     0:34:18       valve VS7 close
16#13A#     0:34:20       valve VL4 close
16#13B#     0:34:22       valve VS1 close
16#13C#     0:34:24       valve VS2 close
16#13D#     0:34:26       valve VS3 close
16#13E#     0:34:30       valve VL3 close
16#13F#     0:34:31       valve VG open
16#140#     0:34:31       heater cell_1 off
16#141#     0:34:32       valve VL3 close
16#142#     0:34:33       valve VG open
16#143#     0:34:33       heater cell_1 disable
16#144#     0:34:34       valve VE close
16#145#     0:34:36       valve VE close
16#146#     TDIC       19
16#147#     0:34:55       valve VAA open
```

```
16#148#     0:34:56      No_op
16#149#     0:34:57      valve VAA open
16#14A#     0:34:58      No_op
16#14B#     0:34:59      No_op_L2
16#14C#     0:35:00      valve IVA enable
16#14D#     0:35:01      No_op
16#14E#     0:35:02      No_op_L2
16#14F#     0:35:03      No_op
16#150#     0:35:05      valve IVA open
16#151#     0:35:06      No_op
16#152#     0:35:07      No_op_L2
16#153#     0:35:08      No_op
16#154#     0:35:09      valve IVA open
16#155#     0:35:10      heater acp_line on
16#156#     0:35:11      valve VAB open
16#157#     0:35:13      heater acp_line on
16#158#     0:35:15      valve VAB open
16#159#     0:35:16      No_op
16#15A#     0:35:17      No_op_L2
16#15B#     0:35:18      valve IVA disable
16#15C#     0:35:20      valve VL1 close
16#15D#     0:35:26      valve VE close
16#15E#     0:35:27      valve VG open
16#15F#     0:35:28      valve VL3 close
16#160#     0:35:29      valve VAA open
16#161#     0:35:30      valve VL4 close
16#162#     0:35:31      valve VAB open
16#163#     0:35:32      valve VC1 close
16#164#     0:35:33      valve VD6 open
16#165#     0:35:34      valve VC2 close
16#166#     0:35:35      valve VD1 open
16#167#     0:35:36      valve VC3 close
16#168#     0:35:37      valve VD2 open
16#169#     TDIC        9
16#16A#     0:35:46      valve VG1 close
16#16B#     TDIC       12
16#16C#     0:35:58      valve VV close
16#16D#     0:36:00      valve VL2 open
16#16E#     0:36:00      heater inlet disable
16#16F#     0:36:00      heater gc_oven_1 enable
16#170#     0:36:00      heater gc_oven_2 enable
16#171#     0:36:00      heater gc_oven_3 enable
16#172#     0:36:02      valve VL2 open
16#173#     TDIC        8
16#174#     0:36:10 ipump four_five_and_six on
16#175#     TDIC       10
16#176#     0:36:20 ipump one_two_and_three on
16#177#     TDIC       10
16#178#     0:36:30 heater inlet disable
16#179#     0:36:31      No_op
16#17A#     0:36:32      No_op_L2
16#17B#     TDIC       86
16#17C#     0:37:58      valve VD4 open
16#17D#     0:38:00      valve VX open
16#17E#     0:38:01      valve VG2 close
16#17F#     0:38:02      valve VX open
16#180#     0:38:03      valve VG3 close
16#181#     0:38:10      valve VD2 open
16#182#     0:38:11      valve VX close
16#183#     0:38:12      valve VD2 open
16#184#     0:38:13      valve VX close
16#185#     0:38:14      valve VD4 open
16#186#     0:38:15      valve VD1 close
16#187#     0:38:16      valve VS5 open
16#188#     0:38:21      valve VS5 close
16#189#     0:38:23      valve VS5 close
```

```
16#18A#     0:38:25      valve VD3 open
16#18B#     0:38:30      valve VD3 close
16#18C#     0:38:31      valve VD1 open
16#18D#     0:38:32      valve VD3 close
16#18E#     0:38:33      valve VD1 open
16#18F#     0:38:40      valve VX open
16#190#     0:38:41      valve VD3 close
16#191#     0:38:42      valve VX open
16#192#     0:38:43      valve VS5 close
16#193#     0:38:44      valve VC1 open
16#194#     0:38:46      valve VC2 open
16#195#     0:38:48      valve VC3 open
16#196#     0:38:52 valve VD6 close
16#197#     0:38:54 valve VD6 close
16#198#     0:38:58 valve VG3 close
16#199#     0:39:00 valve VS3 open
16#19A#     0:39:02 valve VS3 open
16#19B#     TDIC       23
16#19C#     0:39:25 useq_ctrl alt_step direct 0 0 0 0
16#19D#     0:39:28      isource true round_robin 0 1 0 1 1 1 0
16#19E#     0:39:30 valve VS3 close
16#19F#     0:39:34 valve VS3 close
16#1A0#     0:39:37 valve VD6 close
16#1A1#     0:39:41 valve VS1 close
16#1A2#     0:39:41      heater gc_oven_1 enable
16#1A3#     0:39:41      heater gc_oven_2 enable
16#1A4#     0:39:41      heater gc_oven_3 enable
16#1A5#     0:39:44 valve VS2 close
16#1A6#     0:39:48 valve VS6 close
16#1A7#     0:39:49 valve VX open
16#1A8#     0:39:50 valve VD1 close
16#1A9#     0:39:52 valve VD1 close
16#1AA#     0:39:53 valve VD3 open
16#1AB#     0:39:54 valve VD2 close
16#1AC#     0:39:55      valve VD3 open
16#1AD#     0:39:55 isource true round_robin 0 1 0 1 1 1 0
16#1AE#     0:39:56      valve VD2 close
16#1AF#     0:39:57      valve VS3 open
16#1B0#     0:39:58 valve VD4 close
16#1B1#     0:40:00      valve VG3 squirt 4
16#1B2#     0:40:00      useq_ctrl alt_step direct 0 0 32 1
16#1B3#     0:40:04      valve VG3 close
16#1B4#     0:40:05 valve VD4 open
16#1B5#     0:40:06      valve VS3 close
16#1B6#     0:40:07      valve VD4 open
16#1B7#     0:40:08      valve VD3 close
16#1B8#     0:40:09      valve VD2 open
16#1B9#     0:40:10      valve VS3 close
16#1BA#     0:40:11      valve VD2 open
16#1BB#     0:40:12      valve VD3 close
16#1BC#     0:40:13      valve VD1 open
16#1BD#     0:40:14      valve VS3 close
16#1BE#     0:40:15      valve VD1 open
16#1BF#     TDIC       15
16#1C0#     0:40:30 ipump one_two_and_three on
16#1C1#     TDIC       10
16#1C2#     0:40:40 ipump four_five_and_six on
16#1C3#     TDIC       10
16#1C4#     0:40:50 heater inlet disable
16#1C5#     TDIC      250
16#1C6#     0:45:00 ipump four_five_and_six on
16#1C7#     TDIC       20
16#1C8#     0:45:20 ipump one_two_and_three on
16#1C9#     TDIC       10
16#1CA#     0:45:30 heater inlet disable
16#1CB#     TDIC      270
```

```
16#1CC#     0:50:00 ipump one_two_and_three on
16#1CD#     TDIC       20
16#1CE#     0:50:20 ipump four_five_and_six on
16#1CF#     TDIC       10
16#1D0#     0:50:30 heater inlet disable
16#1D1#     0:50:31       No_op
16#1D2#     0:50:32       No_op_L2
16#1D3#     TDIC      116
16#1D4#     0:52:28       valve VG2 close
16#1D5#     0:52:30       valve VS2 open
16#1D6#     0:52:32       valve VS2 open
16#1D7#     TDIC       28
16#1D8#     0:53:00       valve VS2 close
16#1D9#     0:53:02 valve VS2 close
16#1DA#     0:53:03       isource true round_robin 0 1 0 1 1 1 0
16#1DB#     TDIC       10
16#1DC#     0:53:13       valve VS2 close
16#1DD#     0:53:18 No_op
16#1DE#     0:53:19       valve VS6 close
16#1DF#     0:53:20       valve VX open
16#1E0#     0:53:21       valve VD1 close
16#1E1#     0:53:23 valve VD1 close
16#1E2#     0:53:24 valve VD3 open
16#1E3#     0:53:25 valve VD2 close
16#1E4#     0:53:25 isource true round_robin 0 1 0 1 1 1 0
16#1E5#     0:53:26       valve VD3 open
16#1E6#     0:53:27       valve VD2 close
16#1E7#     0:53:28       valve VS2 open
16#1E8#     0:53:29 valve VD4 close
16#1E9#     0:53:29 useq_ctrl alt_step direct 0 0 0 0
16#1EA#     0:53:30       valve VG2 open
16#1EB#     0:53:31 valve VG2 close
16#1EC#     0:53:31       useq_ctrl alt_step direct 0 0 32 1
16#1ED#     0:53:34       valve VG2 close
16#1EE#     0:53:35 valve VD4 open
16#1EF#     0:53:36       valve VS2 close
16#1F0#     0:53:37       valve VD4 open
16#1F1#     0:53:38       valve VD3 close
16#1F2#     0:53:39       valve VD2 open
16#1F3#     0:53:40       valve VS2 close
16#1F4#     0:53:41       valve VD2 open
16#1F5#     0:53:42       valve VD3 close
16#1F6#     0:53:43       valve VD1 open
16#1F7#     0:53:44       valve VS1 close
16#1F8#     0:53:45 valve VD1 open
16#1F9#     TDIC       75
16#1FA#     0:55:00 ipump four_five_and_six on
16#1FB#     TDIC       20
16#1FC#     0:55:20 ipump one_two_and_three on
16#1FD#     TDIC       10
16#1FE#     0:55:30 heater inlet disable
16#1FF#     TDIC      210
16#200#     0:59:00       heater acp_line on
16#201#     TDIC       60
16#202#     1:00:00 ipump one_two_and_three on
16#203#     TDIC       20
16#204#     1:00:20 ipump four_five_and_six on
16#205#     TDIC       10
16#206#     1:00:30 heater inlet disable
16#207#     1:00:31       No_op
16#208#     1:00:32       No_op_L2
16#209#     TDIC      148
16#20A#     1:03:00       valve VAA open
16#20B#     TDIC       60
16#20C#     1:04:00       valve VAA close
16#20D#     1:04:02       valve VAA close
```

```
16#20E#     1:04:04      valve VAB close
16#20F#     1:04:06      valve VAB close
16#210#     TDIC       40
16#211#     1:04:46      isource true round_robin 0 0 1 0 0 0 0
16#212#     1:04:46 useq_ctrl alt_step direct 0 0 0 0
16#213#     TDIC       10
16#214#     1:04:56      valve VL4 open
16#215#     1:04:58      No_op
16#216#     TDIC       72
16#217#     1:06:10      valve VL4 close
16#218#     1:06:10      isource true round_robin 0 1 1 1 1 1 0
16#219#     1:06:12      valve VL4 close
16#21A#     TDIC        8
16#21B#     1:06:20 ipump four_five_and_six on
16#21C#     TDIC       10
16#21D#     1:06:30 ipump one_two_and_three on
16#21E#     TDIC       10
16#21F#     1:06:40 heater inlet disable
16#220#     1:06:41      No_op
16#221#     1:06:42      No_op_L2
16#222#     TDIC       64
16#223#     1:07:46      isource true round_robin 0 0 1 0 0 0 0
16#224#     1:07:50      cmp FC82 0127
16#225#     1:07:50      cmp FC85 0127
16#226#     1:07:56      valve VL4 open
16#227#     1:07:58      No_op
16#228#     TDIC       29
16#229#     1:08:27 cmp FFA9 000E
16#22A#     1:08:27 cmp FFAA 0000
16#22B#     TDIC       13
16#22C#     1:08:40 cmp FFA9 00EE
16#22D#     1:08:40 cmp FFAA 00E0
16#22E#     TDIC       30
16#22F#     1:09:10      valve VL4 close
16#230#     1:09:10      isource true round_robin 0 1 1 1 1 1 0
16#231#     TDIC       50
16#232#     1:10:00 ipump one_two_and_three on
16#233#     TDIC       20
16#234#     1:10:20 ipump four_five_and_six on
16#235#     TDIC       10
16#236#     1:10:30 heater inlet disable
16#237#     TDIC      145
16#238#     1:12:55 isource true round_robin 0 0 1 1 1 1 0
16#239#     1:12:56      valve VL4 open
16#23A#     1:12:58      No_op
16#23B#     TDIC       67
16#23C#     1:14:05 isource true round_robin 0 1 1 1 1 1 0
16#23D#     1:14:05      useq_ctrl alt_step direct 0 0 32 1
16#23E#     1:14:10      valve VL4 close
16#23F#     1:14:12      valve VL4 close
16#240#     1:14:14      valve VAA close
16#241#     1:14:16      valve VAA close
16#242#     1:14:18      valve VAB close
16#243#     1:14:20      valve VAB close
16#244#     TDIC       40
16#245#     1:15:00 ipump four_five_and_six on
16#246#     TDIC       20
16#247#     1:15:20 ipump one_two_and_three on
16#248#     TDIC       10
16#249#     1:15:30 heater inlet disable
16#24A#     1:15:31      No_op
16#24B#     1:15:32      No_op_L2
16#24C#     TDIC      268
16#24D#     1:20:00 isource true round_robin 0 1 0 1 1 1 0
16#24E#     1:20:00 ipump one_two_and_three on
16#24F#     TDIC       20
```

```
16#250#     1:20:20 ipump four_five_and_six on
16#251#     TDIC       10
16#252#     1:20:30 heater inlet disable
16#253#     TDIC      150
16#254#     1:23:00       cmp FC82 01D3
16#255#     1:23:00       cmp FC85 01D3
16#256#     TDIC      120
16#257#     1:25:00 ipump four_five_and_six on
16#258#     TDIC       20
16#259#     1:25:20 ipump one_two_and_three on
16#25A#     1:25:25 heater inlet disable
16#25B#     1:25:28       valve VG1 close
16#25C#     1:25:30       valve VS1 open
16#25D#     1:25:32       valve VS1 open
16#25E#     TDIC       28
16#25F#     1:26:00       valve VS1 close
16#260#     1:26:02       valve VS1 close
16#261#     1:26:03       No_op
16#262#     1:26:03       No_op_L2
16#263#     TDIC        8
16#264#     1:26:11       valve VS1 close
16#265#     1:26:12       heater gc_oven_1 enable
16#266#     1:26:12       heater gc_oven_2 enable
16#267#     1:26:12       heater gc_oven_3 enable
16#268#     1:26:13       valve VS2 close
16#269#     1:26:15       valve VS3 close
16#26A#     1:26:17       valve VS5 close
16#26B#     1:26:19       valve VS6 close
16#26C#     1:26:20       valve VX open
16#26D#     1:26:21 valve VD1 close
16#26E#     1:26:21 useq_ctrl alt_step direct 0 0 0 0
16#26F#     1:26:21 isource true round_robin 0 1 0 1 1 1 0
16#270#     1:26:23       valve VD1 close
16#271#     1:26:24       valve VD3 open
16#272#     1:26:25       valve VD2 close
16#273#     1:26:26       valve VD3 open
16#274#     1:26:27       valve VD2 close
16#275#     1:26:28       valve VS1 open
16#276#     1:26:29       valve VD4 close
16#277#     1:26:30       valve VG1 open
16#278#     1:26:30       No_op
16#279#     1:26:30       No_op_L2
16#27A#     1:26:31       valve VG1 close
16#27B#     1:26:31       useq_ctrl alt_step direct 0 0 32 1
16#27C#     1:26:34       valve VG1 close
16#27D#     1:26:35       valve VD4 open
16#27E#     1:26:36       valve VS1 close
16#27F#     1:26:37       valve VD4 open
16#280#     1:26:38       valve VD3 close
16#281#     1:26:39       valve VD2 open
16#282#     1:26:40       valve VS3 close
16#283#     1:26:41       valve VD2 open
16#284#     1:26:42       valve VD3 close
16#285#     1:26:43       valve VD1 open
16#286#     1:26:45       valve VD1 open
16#287#     TDIC      195
16#288#     1:30:00       ipump one_two_and_three on
16#289#     TDIC       20
16#28A#     1:30:20       ipump four_five_and_six on
16#28B#     TDIC       10
16#28C#     1:30:30       heater inlet disable
16#28D#     TDIC      150
16#28E#     1:33:00       heater acp_line on
16#28F#     TDIC       10
16#290#     1:33:10       heater acp_line on
16#291#     TDIC      110
```

```
16#292#     1:35:00      ipump four_five_and_six on
16#293#     TDIC       20
16#294#     1:35:20      ipump one_two_and_three on
16#295#     TDIC       10
16#296#     1:35:30      heater inlet disable
16#297#     1:35:31      No_op
16#298#     1:35:32      No_op_L2
16#299#     TDIC       88
16#29A#     1:37:00      valve VAA open
16#29B#     1:37:02      valve VAA open
16#29C#     TDIC        8
16#29D#     1:37:10 useq_ctrl alt_step direct 0 0 0 0
16#29E#     TDIC       50
16#29F#     1:38:00 useq_ctrl alt_step direct 0 0 32 1
16#2A0#     1:38:00      valve VAA close
16#2A1#     1:38:02      valve VAA close
16#2A2#     1:38:04      valve VAB close
16#2A3#     1:38:06      valve VAB close
16#2A4#     TDIC       49
16#2A5#     1:38:55      isource true round_robin 0 0 1 0 0 0 0
16#2A6#     1:38:56      valve VL4 open
16#2A7#     1:38:58      No_op
16#2A8#     TDIC       72
16#2A9#     1:40:10      valve VL4 close
16#2AA#     1:40:10      isource true round_robin 0 1 1 1 1 1 0
16#2AB#     1:40:12      valve VL4 close
16#2AC#     TDIC        8
16#2AD#     1:40:20 ipump one_two_and_three on
16#2AE#     TDIC       20
16#2AF#     1:40:40 ipump four_five_and_six on
16#2B0#     TDIC       10
16#2B1#     1:40:50 heater inlet disable
16#2B2#     TDIC       40
16#2B3#     1:41:30 No_op
16#2B4#     1:41:31 No_op_L2
16#2B5#     TDIC       24
16#2B6#     1:41:55      isource true round_robin 0 0 1 0 0 0 0
16#2B7#     1:41:56      valve VL4 open
16#2B8#     1:41:58      No_op
16#2B9#     TDIC       29
16#2BA#     1:42:27 cmp FFA9 000E
16#2BB#     1:42:27 cmp FFAA 0000
16#2BC#     1:42:34 cmp FFA9 00EE
16#2BD#     1:42:34 cmp FFAA 00E0
16#2BE#     TDIC       36
16#2BF#     1:43:10      valve VL4 close
16#2C0#     1:43:10      isource true round_robin 0 1 1 1 1 1 0
16#2C1#     1:43:12      valve VL4 close
16#2C2#     TDIC      108
16#2C3#     1:45:00 ipump four_five_and_six on
16#2C4#     TDIC       20
16#2C5#     1:45:20 ipump one_two_and_three on
16#2C6#     TDIC       10
16#2C7#     1:45:30 heater inlet disable
16#2C8#     1:45:31      No_op
16#2C9#     1:45:32      No_op_L2
16#2CA#     TDIC       39
16#2CB#     1:46:11      valve VD1 open
16#2CC#     1:46:12      valve VS6 close
16#2CD#     1:46:13      valve VD2 open
16#2CE#     1:46:14      valve VD3 close
16#2CF#     1:46:15      valve VD4 open
16#2D0#     1:46:16      valve VS1 close
16#2D1#     1:46:17      valve VC1 open
16#2D2#     1:46:19      valve VC2 open
16#2D3#     1:46:20      valve VS3 close
```

```
16#2D4#     1:46:21      valve VC3 open
16#2D5#     1:46:22      valve VG1 close
16#2D6#     1:46:23      valve VL2 open
16#2D7#     1:46:24      valve VG2 close
16#2D8#     1:46:26      valve VG3 close
16#2D9#     1:46:28      valve VL1 close
16#2DA#     1:46:30      valve VZ close
16#2DB#     1:46:32      valve VS7 close
16#2DC#     1:46:36      valve VL3 close
16#2DD#     1:41:55      isource true round_robin 0 0 1 0 0 0 0
16#2DE#     TDIC      301
16#2DF#     1:46:56      valve VL4 open
16#2E0#     1:46:58      No_op
16#2E1#     TDIC       67
16#2E2#     1:48:05      isource true round_robin 0 1 1 1 1 1 0
16#2E3#     1:48:06 No_op
16#2E4#     1:48:06 No_op_L2
16#2E5#     1:48:07      valve VL4 close
16#2E6#     1:48:08      valve VAA open
16#2E7#     1:48:09      valve VS6 close
16#2E8#     1:48:10      valve VAA open
16#2E9#     1:48:11      valve VL4 close
16#2EA#     1:48:15      valve VAA close
16#2EB#     1:48:17      valve VAA close
16#2EC#     1:48:19      isource true round_robin 0 1 0 1 1 1 0
16#2ED#     1:48:19      valve VD2 close
16#2EE#     1:48:21      valve VD1 close
16#2EF#     1:48:21      heater acp_line off
16#2F0#     1:48:21 filament_ctrl filament2 off
16#2F1#     1:48:22      valve VS5 close
16#2F2#     1:48:24 valve VD4 close
16#2F3#     1:48:26      valve VD2 close
16#2F4#     1:48:27      valve VD3 open
16#2F5#     1:48:28      valve VD1 close
16#2F6#     1:48:30      valve VS5 squirt 8
16#2F7#     1:48:34      valve VS5 close
16#2F8#     1:48:35      valve VD4 open
16#2F9#     1:48:36      valve VD3 close
16#2FA#     1:48:37      valve VD4 open
16#2FB#     1:48:38      valve VD3 close
16#2FC#     1:48:39      valve VD2 open
16#2FD#     1:48:40      valve VS5 close
16#2FE#     1:48:41      valve VD1 open
16#2FF#     1:48:43      valve VD2 open
16#300#     1:48:44      valve VAB close
16#301#     1:48:45      valve VD1 open
16#302#     1:48:46      valve VAB close
16#303#     TDIC       74
16#304#     1:50:00 ipump one_two_and_three on
16#305#     TDIC       20
16#306#     1:50:20 ipump four_five_and_six on
16#307#     TDIC       10
16#308#     1:50:30 heater inlet disable
16#309#     TDIC      150
16#30A#     1:53:00      isource true round_robin 0 1 0 1 1 1 0
16#30B#     TDIC      120
16#30C#     1:55:00 ipump four_five_and_six on
16#30D#     TDIC       20
16#30E#     1:55:20 ipump one_two_and_three on
16#30F#     TDIC       10
16#310#     1:55:30 heater inlet disable
16#311#     1:55:31      No_op
16#312#     1:55:32      No_op_L2
16#313#     TDIC      268
16#314#     2:00:00 ipump one_two_and_three on
16#315#     TDIC       20
```

```
16#316#     2:00:20 ipump four_five_and_six on
16#317#     TDIC       10
16#318#     2:00:30 heater inlet disable
16#319#     TDIC       47
16#31A#     2:01:17       valve VL2 open
16#31B#     2:01:18       valve VL1 close
16#31C#     2:01:19       valve VD1 open
16#31D#     2:01:20       valve VZ close
16#31E#     2:01:21       valve VD2 open
16#31F#     2:01:22       valve VS7 close
16#320#     2:01:23       valve VD4 open
16#321#     2:01:24       valve VE close
16#322#     2:01:25       valve VC1 open
16#323#     2:01:26       valve VL3 close
16#324#     2:01:27       valve VC2 open
16#325#     2:01:28       valve VS1 close
16#326#     2:01:29       valve VC3 open
16#327#     2:01:30       valve VS2 close
16#328#     2:01:31       valve VX open
16#329#     2:01:32       valve VS3 close
16#32A#     2:01:34       valve VS5 close
16#32B#     2:01:36       valve VL4 close
16#32C#     2:01:38       valve VS6 close
16#32D#     2:01:40       valve VG1 close
16#32E#     2:01:42       valve VG2 close
16#32F#     2:01:44       valve VG3 close
16#330#     2:01:46       valve VD3 close
16#331#     2:01:48       valve VD2 close
16#332#     2:01:50       valve VD1 close
16#333#     2:01:51       No_op
16#334#     2:01:51       No_op_L2
16#335#     2:01:52       valve VS5 close
16#336#     2:01:53       valve VX open
16#337#     2:01:54       valve VD4 close
16#338#     2:01:55       valve VX open
16#339#     2:01:56       valve VD2 close
16#33A#     2:01:57       valve VD3 open
16#33B#     2:01:58       valve VD1 close
16#33C#     2:02:00       valve VS5 squirt 8
16#33D#     2:02:04       valve VS5 close
16#33E#     2:02:05       valve VD4 open
16#33F#     2:02:06       valve VD3 close
16#340#     2:02:07       valve VD4 open
16#341#     2:02:08       valve VD3 close
16#342#     2:02:09       valve VD2 open
16#343#     2:02:10       valve VS5 close
16#344#     2:02:11       valve VD1 open
16#345#     2:02:13       valve VD2 open
16#346#     2:02:15       valve VD1 open
```

Table 6.7 Deactivate Mode

```
 16#1#     0:00:00     valve VAA enable
 16#2#     0:00:00     valve VAB enable
 16#3#     0:00:00     valve VC1 enable
 16#4#     0:00:00     valve VC2 enable
 16#5#     0:00:00     valve VC3 enable
 16#6#     0:00:00     valve VD1 enable
 16#7#     0:00:00     valve VD2 enable
 16#8#     0:00:00     valve VD3 enable
 16#9#     0:00:00     valve VD4 enable
 16#A#     0:00:00     valve VX enable
 16#B#     0:00:00     valve VD6 enable
 16#C#     0:00:00     valve VE enable
 16#D#     0:00:00     valve VG enable
 16#E#     0:00:00     valve VG1 enable
 16#F#     0:00:00     valve VG2 enable
16#10#     0:00:00     valve VG3 enable
16#11#     0:00:00     valve VL1 enable
16#12#     0:00:00     valve VL2 enable
16#13#     0:00:00     valve VL3 enable
16#14#     0:00:00     valve VL4 enable
16#15#     0:00:00     valve VS1 enable
16#16#     0:00:00     valve VS2 enable
16#17#     0:00:00     valve VS3 enable
16#18#     0:00:00     valve VS5 enable
16#19#     0:00:00     valve VS6 enable
16#1A#     0:00:00     valve VS7 enable
16#1B#     0:00:00     valve VV enable
16#1C#     0:00:00     valve VZ enable
16#1D#     0:00:00     valve IV disable
16#1E#     0:00:00     valve IVA disable
16#1F#     0:00:00     heater inlet off
16#20#     0:00:00     valve VS5 open
16#21#     0:00:01     filament_ctrl filament6 off
16#22#     0:00:02     valve VD3 open
16#23#     0:00:03     heater mass_source_cal off
16#24#     0:00:04     valve VD1 open
16#25#     0:00:05     isource true multiplex 0 0 0 0 0 0 0
16#26#     0:00:06     valve VD2 open
16#27#     0:00:07     heater acp_line OFF
16#28#     0:00:08     valve VD4 open
16#29#     0:00:09     heater cell_2 OFF
16#2A#     0:00:10     valve VG1 open
16#2B#     0:00:11     heater cell_1 OFF
16#2C#     0:00:12     valve VG2 open
16#2D#     0:00:13     heater gc_oven_1 disable
16#2E#     0:00:14     valve VG3 open
16#2F#     0:00:15     heater gc_oven_2 disable
16#30#     0:00:16     valve VS6 open
16#31#     0:00:17     heater gc_oven_3 disable
16#32#     0:00:18     valve VL4 open
16#33#     0:00:19     filament_ctrl filament1 off
16#34#     0:00:20     valve VS3 open
16#35#     0:00:21     filament_ctrl filament2 off
16#36#     0:00:22     valve VS2 open
16#37#     0:00:23     filament_ctrl filament3 off
16#38#     0:00:24     valve VS1 open
16#39#     0:00:25     filament_ctrl filament4 off
16#3A#     0:00:26     valve VL3 open
16#3B#     0:00:27     filament_ctrl filament5 off
16#3C#     0:00:28     valve VE open
16#3D#     0:00:29     heater acp_line disable
16#3E#     0:00:30     valve VS7 open
16#3F#     0:00:31     heater cell_2 disable
```

```
16#40#      0:00:32      valve VL2 open
16#41#      0:00:33      heater cell_1 disable
16#42#      0:00:34      valve VL1 open
16#43#      0:00:35      filament_ctrl filament1 disable
16#44#      0:00:36      valve VAA open
16#45#      0:00:37      filament_ctrl filament2 disable
16#46#      0:00:38      valve VAB open
16#47#      0:00:39      filament_ctrl filament3 disable
16#48#      0:00:40      valve VZ open
16#49#      0:00:41      filament_ctrl filament4 disable
16#4A#      0:00:42      valve VX open
16#4B#      0:00:43      filament_ctrl filament5 disable
16#4C#      0:00:44      valve VV open
16#4D#      0:00:45      filament_ctrl filament6 disable
16#4E#      0:00:46      valve VG open
16#4F#      0:00:47      heater inlet disable
16#50#      0:00:48      valve VC1 open
16#51#      0:00:49      heater mass_source_cal disable
16#52#      0:00:50      valve VC2 open
16#53#      0:00:51      ipump four_five_and_six off
16#54#      0:00:52      valve VC3 open
16#55#      0:00:53      ipump one_two_and_three off
16#56#      0:00:54      valve VD6 open
```

7.0 Telecommands

Receipt of valid telecommands is acknowledged in telemetry by Ack_a and Ack_b subpackets, and in the Status Word. Receipt of telecommands which do not have a valid CRC are indicated by "Not Acknowledge" Nack_a and Nack_b subpackets. Invalid telecommands are not executed. The Ack packets are sent on both channels, but the Status Word bit is only set on the active TC channel, as determined by the Processor Valid signal. The Ack packets include a readback of a command Serial Number which can be input to each telecommand sent to identify a specific command in a sequence.

7.1 List of Telecommands in Probe Database

The following sections describe each telecommand which will be used in ATOL-based Probe level testing, along with its nominal effect on instrument operation and its file name in the telecommand database. The descriptions are oriented toward the use of the telecommands from ATOL. The term "Stem" refers to the basic command name as it is used in GCMS EID-B Annex 2, which provides additional details on command construction. "Database filename" refers to the name of the Experiment TC Database file which describes the command for ATOL. "ATOL usage" shows what parameters must be used with the command. The command must be preceeded by “tc cdms” (old usage) or “tc A”, “tc B” (new usage, for channel A or B respectively). The "Verification in telemetry" indicates whether it is possible to verify that the command was actually executed properly, rather than just received, as reception of all commands is acknowledged in telemetry.

These commands are the ones configured in the Probe database. Other commands have been created for specific tests with the IWS and with CRID files. These are discussed in section 7.4.

Following each description is the text of the Telecommand Database file which is used by ATOL (in the MTP and IWS) to create the telecommands.

7.1.1 Heater Enable/Disable

Stem: gh_henadis

Database filename: g_f_gh_henadis_a.dat
g_f_gh_henadis_b.dat

ATOL Usage: g_f_gh_henadis_a(s,m,n)
g_f_gh_henadis_b(s,m,n)

s = Serial number (0 to 127)
m = Heater number, valid values integers 0 to 7
n = Operation, valid values integer 0 or 1

Heater Number m versus Heater Name:

0	Inlet (and H2)
1	EC1
2	EC2 (descoped)
3	EC3
4	Cal (descoped)
5	GC1
6	GC2
7	GC3

Operation n values

0	Disable
1	Enable

Effect of command: Enable allows heater to be turned on and off by a sequence or by the Heater On/Off telecommand. Disable causes the heater to be turned off and all further commands to the heater are ignored.

Verification in telemetry: DCON enable status word indicates.

```
TC_CMD_MNEMO    :       G_F_GH_HENADIS_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0010#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       HEATER_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       OPERATION
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GH_HENADIS_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0010#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       HEATER_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       OPERATION
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
-------------------------
```

7.1.2 Heater On/Off

Stem: gh_honoff

Database filenames: g_f_gh_honoff_a.dat
g_f_gh_honoff_b.dat

ATOL Usage: g_f_gh_honoff_a(s,m,n)
g_f_gh_honoff_b(s,m,n)

s = Serial number (0 to 127)
m = Heater number, valid values integers 0 to 7
n = Operation, valid values integer 0 or 1

Heater Number m versus Heater Name, Watts, and I/O Port Bit No.:
(Watts are approximate at 28 V and are indicated as being from the Main (M) or Protected (P) power lines.)

m	Name	Watts	Bit No. at Addr. 60E0h
0	Inlet	M 6	7
	H2	M 2	
1	EC1	P 9.2	6
2	EC2	P 9.2	5 (descoped)
3	ACP	P 6.2	4
4	Cal	M 6.5	3 (descoped)
5	GC1	P 10	2
6	GC2	P 5	1
7	GC3	P 5	0

Operation n values

0	Off
1	On

Effect of command: "On" causes the FC to turn on the heater, and "Off" causes the FC to turn off the heater. If the heater is not Enabled, the command has no effect. If the Protected power is not applied, the commands will still be processed and the heaters turned on and off. There is a hardware interlock which prevents EC1 And EC2 from being turned on at the same time. If they are both commanded on, only EC1 will actually be turned on, but when EC1 is then turned off, EC2 will turn back on.

Verification in telemetry: Direct verification in the Status Word of the Inlet heater in Bit 8. HKII contains a readout of the status of all heater on/off bits.

Additional verification is through the effect on the instrument input current and by the temperature rise of the thermistor associated with each heater.

```
TC_CMD_MNEMO    :       G_F_GH_HONOFF_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0011#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       HEATER_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       OPERATION
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GH_HONOFF_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0011#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       HEATER_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       OPERATION
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
-------------------------
```

7.1.3 Valve Enable/Disable

Stem: gv_venadis

Database filename: g_f_gv_venadis_a.dat
g_f_gv_venadis_b.dat

ATOL Usage: g_f_gv_venadis_a(s,m,n)
g_f_gv_venadis_b(s,m,n)

s = Serial number (0 to 127)
m = Valve number, valid values integers 1 to 32
n = Operation, valid values integer 0 or 1

Operation n values

0	Disable
1	Enable

Effect of command: Enable allows valve to be opened and closed by a sequence or by the Valve On/Off telecommand. Disable causes all further commands to the valve to be ignored.

Verification in telemetry: HKII contains 32 bits indicating the enable/disable status of all valves.

Correlation of Valve Numbers to Valve Names and position in telemetry:

Valve Index (TCs)	Valve Name (ICCs)	Tabular gcmshkII MSB
0	IV	VALVE31
1	IVA	VALVE30
28	VS6	VALVE29
2	VAA	VALVE28
7	VD1	VALVE27
19	VL1	VALVE26
26	VS4	VALVE25
18	VG4	VALVE24
23	VS1	VALVE23
21	VL3	VALVE22
8	VD2	VALVE21
29	VS7	VALVE20
24	VS2	VALVE19
13	VE	VALVE18
25	VS3	VALVE17
6	VC3	VALVE16
27	VS5	VALVE15
22	VL4	VALVE14
9	VD3	VALVE13
31	VZ	VALVE12
10	VD4	VALVE11
20	VL2	VALVE10
17	VG3	VALVE09
3	VAB	VALVE08
16	VG2	VALVE07
30	VV	VALVE06
15	VG1	VALVE05
5	VC2	VALVE04
12	VD6	VALVE03
4	VC1	VALVE02
11	VX	VALVE01
14	VG	VALVE00

```
TC_CMD_MNEMO    :       G_F_GV_VENADIS_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#000E#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       VALVE_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       OPERATION
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GV_VENADIS_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#000E#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       VALVE_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       OPERATION
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
-------------------------
```

7.1.4 Valve Open/Close

Stem: gv_vopclos

Database filename: g_f_gv_vopclos_a.dat
g_f_gv_vopclos_b.dat

ATOL Usage: g_f_gv_vopclos_a(s,m,n)
g_f_gv_vopclos_b(s,m,n)

s = Serial number (0 to 127)
m = Valve number, valid values integers 1 to 29
n = Operation, valid values integer 0 or 1

Operation n values

0	Close
1	Open

Effect of command: Close causes valve to be closed. Open causes valve to be opened.

Verification in telemetry: Each valve has a position monitor which is sampled and telemetered in the science housekeeping telemetry.

```
TC_CMD_MNEMO    :       G_F_GV_VENADIS_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#000E#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       VALVE_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       OPERATION
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GV_VENADIS_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#000E#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       VALVE_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       OPERATION
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
-------------------------
```

7.1.5 Valve Squirt

Stem: gv_squirt

Database filename: g_f_gv_squirt_a.dat
g_f_gv_squirt_b.dat

ATOL Usage: g_f_gv_squirt_a(s,m)
g_f_gv_squirt_b(s,m)

s = Serial number (0 to 127)
m = Valve number, valid values integers 1 to 29

Effect of command: Causes valve to be opened for approximately 3 milliseconds, then closed. Any valve can be squirted, but this is not a normal operation for the Rupture valves, IVA (0) and IVB (1)

Verification in telemetry: No direct verification. A drop in valve drive capacitor voltage may be noted.

```
TC_CMD_MNEMO    :       G_F_GV_SQUIRT_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0013#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       VALVE_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       OPERATION
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GV_SQUIRT_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0013#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       VALVE_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       OPERATION
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
-------------------------
```

7.1.6 Filament Enable/Disable

Stem: gf_fenadis

Database filenames: g_f_gf_fenadis_a.dat
g_f_gf_fenadis_b.dat

ATOL Usage: g_f_gf_fenadis_a(s,m,n)
g_f_gf_fenadis_b(s,m,n)

s = Serial number (0 to 127)
m = Filament number, valid values integers 0 to 5
n = Operation, valid values integer 0 or 1

Filament Number m versus Filament Name, and I/O Port Bit No.:

m	Name	Bit No. at Addr. 60E0h
0	Fil 1	15
1	Fil 2	14
2	Fil 3	13
3	Fil 4	12
4	Fil 5	11
5	BA Fil	10

Operation n values

0	Disable
1	Enable

Effect of command: Enable allows control of the filament on/off by the sequence or by telecommand. Disable prevents further operations on the filament. Note that disable does not turn off the filament, as it does with heaters.

Verification in telemetry: HKII contains a readout of the enable/disable status of the filaments.

```
TC_CMD_MNEMO    :       G_F_GF_FENADIS_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0012#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       IP_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OFF_OP
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ENA_DIS_OP
BIT_NO          :       88
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OR_ENA
BIT_NO          :       89
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GF_FENADIS_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0012#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       IP_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OFF_OP
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ENA_DIS_OP
BIT_NO          :       88
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OR_ENA
BIT_NO          :       89
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
-------------------------
```

7.1.7 Filament On/Off

Stem: gf_fonoff

Database filenames: g_f_gf_fonoff_a.dat
g_f_gf_fonoff_b.dat

ATOL Usage: g_f_gf_fonoff_a(s,m,n)
g_f_gf_fonoff_b(s,m,n)

s = Serial number (0 to 127)
m = Filament number, valid values integers 0 to 5
n = Operation, valid values integer 0 or 1

Filament Number m versus Filament Name, and I/O Port Bit No.:

m	Name	Bit No. at Addr. 60E0h
0	Fil 1	15
1	Fil 2	14
2	Fil 3	13
3	Fil 4	12
4	Fil 5	11
5	BA Fil	10

Operation n values

0	Off
1	On

Effect of command: "On" causes the FC to turn on the filament, and "Off" causes the FC to turn off the filament.

Verification in telemetry: Direct verification in the Status Word of the BA Filament in Bit 11 and Filament 1 in Bit 10. Verification of the other filaments is through their effect on the instrument input current and by the housekeeping monitor of their emission current. HKII also contains a readout of the on/off status of all filaments.

```
TC_CMD_MNEMO    :       G_F_GF_FONOFF_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0012#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       IP_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OFF_OP
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ENA_DIS_OP
BIT_NO          :       88
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ON_OR_ENA
BIT_NO          :       89
LENGTH          :       1
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       TRUE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GF_FONOFF_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0012#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       IP_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OFF_OP
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ENA_DIS_OP
BIT_NO          :       88
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ON_OR_ENA
BIT_NO          :       89
LENGTH          :       1
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       TRUE
-------------------------
```

7.1.8 DAC Parameter Change

Stem: gd_dacparm

Database filenames:g_f_gd_dacparm_a.dat
g_f_gd_dacparm_b.dat

ATOL Usage: g_f_gd_dacparm_a(s,m,n)
g_f_gd_dacparm_b(s,m,n)

s = Serial number (0 to 127)
m = DAC channel ID, valid range 1 to 30
n = Value to be sent to channel, valid range 0 to 255

For 8-bit DAC channels, value n sets the output voltage between 0 volts (0) and 9.96 volts (255) in 39 mV steps. For 4-bit channels, n represents two 4-bit values, each setting the output voltage betwee 0 volts (0) and 9.37 volts (15) in 625 mV steps. The 4-bit channels are 7,8,15,16,23,24.

DAC Channel ID versus functional description. The designation [ISS] means that the values will change under flight computer control as the ion sources are switched. Any new values updated to these DACs will be overwritten by the appropriate ISS voltage at the next mass sweep.

1 = QR_A1_CTRL = (8 bits) [ISS QLU 1] : Ion source lens control
2 = QR_A2_CTRL = (8 bits) [ISS QLU 2] : Ion source lens control
3 = QR_B1_CTRL = (8 bits) [ISS QLU 3] : Ion source lens control
4 = QR_B2_CTRL = (8 bits) [ISS QLU 4] : Ion source lens control
5 = QR_A3_CTRL = (8 bits) [ISS QLL 1] : Ion source lens control
6 = QR_A4_CTRL = (8 bits) [ISS QLL 2] : Ion source lens control
7 = Fil 2 CTRL (High 4 bits) + Fil 1 CTRL (Low 4 bits) : Ionization Voltage
8 = Fil 4 CTRL (High 4 bits) + Fil 3 CTRL (Low 4 bits) : Ionization Voltage
9 = QR_B3_CTRL = (8 bits) [ISS QLL 2] : Ion source lens control
10 = QR_B4_CTRL = (8 bits) [ISS QLL 2] : Ion source lens control
11 = EP1_CTRL = (8 bits) [ISS QLL 2] : Ion source lens control
12 = EP1_CTRL = (8 bits) [ISS QLL 2] : Ion source lens control
13 = EP1_CTRL = (8 bits) [ISS QLL 2] : Ion source lens control
14 = EP1_CTRL = (8 bits) [ISS QLL 2] : Ion source lens control
15 = BA Emis. Control (High 4 bits) + Fil 5 Ionization Energy (Low 4 bits)
16 = Counter 2 threshold (High 4 bits) + Counter 1 threshold (Low 4 bits)
17 = EM1_CTRL = (8 bits) Voltage to Electron Multiplier 1
18 = EM2_CTRL = (8 bits) Voltage to Electron Multiplier 2
19 = Lens_1_CTRL = SL2A : Ion source lens control
20 = Lens_2_CTRL = BS LENS : Ion source lens control

21 = Lens_3_CTRL = SL2B : Ion source lens control
22 = Lens_4_CTRL = SL1A : Ion source lens control
23 = PRES2_ADJ (High 4 bits) + PRES1_ADJ (Low 4 bits) : Pressure transducer offset adjust
24 = Thermistor Offset Adjust (High 4 bits) + ILIM_ADJ (Low 4 bits)

```
TC_CMD_MNEMO    :       G_F_GD_DACPARM_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       6
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#001A#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       LENGTH
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DAC_NO
BIT_NO          :       105
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       VALUE
BIT_NO          :       97
LENGTH          :       8
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
---------------------
```

```
TC_CMD_MNEMO    :       G_F_GD_DACPARM_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       6
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#001A#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       LENGTH
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DAC_NO
BIT_NO          :       105
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       VALUE
BIT_NO          :       97
LENGTH          :       8
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
---------------------
```

7.1.9 Ion Pump Enable/Disable

Stem: gp_ipenadis

Database filenames: g_f_gp_ipenadis_a.dat
g_f_gp_ipenadis_b.dat

ATOL Usage: g_f_gp_ipenadis_a(s,m,n)
g_f_gp_ipenadis_b(s,m,n)

s = Serial number (0 to 127)
m = Ion Pump Supply (IPS), valid values integer 0 or 1
n = Operation, valid values integer 0 or 1

Ion Pump Supply m versus Ion Pumps, and I/O Port Bit No.:

m	Name	Bit No. at Addr. 60E0h
0	IPS 1	9
1	IPS 2	8

Operation n values

0	Disable
1	Enable

Effect of command: Enable allows on/off control of the ion pumps by sequence or telecommand. Disable inhibits control of the ion pump supplies. If the input current as measured by the internal GCMS Main current monitor is higher than 1.21 Amps, the ion pump turnon command will not be executed.

Verification in telemetry: HKII contains a monitor of the IP enable status.

```
TC_CMD_MNEMO    :       G_F_GP_IPENADIS_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0014#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       IP_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OFF_OP
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ENA_DIS_OP
BIT_NO          :       88
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OR_ENA
BIT_NO          :       89
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GP_IPENADIS_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0014#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       IP_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OFF_OP
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ENA_DIS_OP
BIT_NO          :       88
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OR_ENA
BIT_NO          :       89
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
-------------------------
```

7.1.10 Ion Pump On/Off

Stem: gp_iponoff

Database filenames: g_f_gp_iponoff_a.dat
g_f_gp_iponoff_b.dat

ATOL Usage: g_f_gp_iponoff_a(s,m,n)
g_f_gp_iponoff_b(s,m,n)

s = Serial number (0 to 127)
m = Ion Pump Supply (IPS), valid values integer 0 or 1
n = Operation, valid values integer 0 or 1

Ion Pump Supply m versus Ion Pumps, and I/O Port Bit No.:

m	Name	Bit No. at Addr. 60E0h
0	IPS 1	9
1	IPS 2	8

Operation n values

0	Off
1	On

Effect of command: Each Ion Pump Supply controls three Ion Pumps. Ion Pump Supply 1 powers the ion pumps in IS1, IS3, and IS4; Ion Pump Supply 2 powers the ion pumps in IS2, IS5, and the switching lenses.

Verification in telemetry: Direct verification in the Status Word of the Ion Pump Supply 1 in Bit 9. HKII contains a readout of the on/off status of the Ion Pump Supplies.

```
TC_CMD_MNEMO    :       G_F_GP_IPONOFF_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0014#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       IP_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OFF_OP
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ENA_DIS_OP
BIT_NO          :       88
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ON_OR_ENA
BIT_NO          :       89
LENGTH          :       1
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       TRUE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GP_IPONOFF_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0014#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       IP_ID
BIT_NO          :       81
LENGTH          :       5
DEFAULT_VAL     :       16#1F#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ON_OFF_OP
BIT_NO          :       87
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       ENA_DIS_OP
BIT_NO          :       88
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ON_OR_ENA
BIT_NO          :       89
LENGTH          :       1
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       TRUE
-------------------------
```

7.1.11 Write raw data to I/O location

Stem: gx_rawio

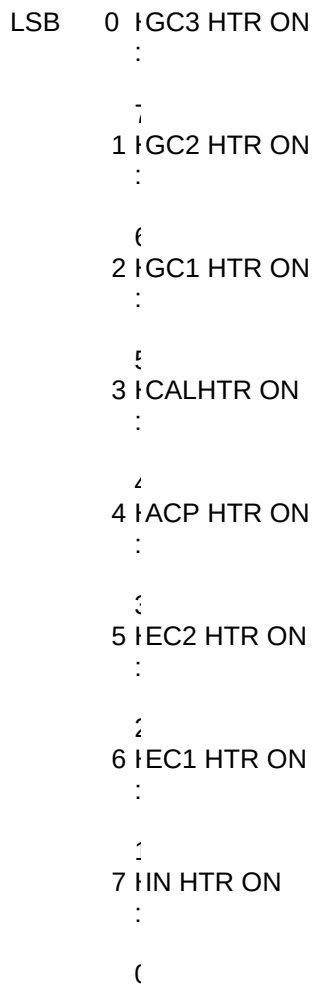
Database filenames: g_f_gx_rawio_a.dat
g_f_gx_rawio_b.dat

ATOL Usage: g_f_gp_iponoff_a(s,m,n)
g_f_gp_iponoff_b(s,m,n)

s = Serial number (0 to 127)
m = Output address to write to (16 bits)
n = Data to write (16 bits)

Effect of command: Allows control of hardware by writing directly to output port addresses. Some of the more useful addresses are:

#60E0 = Digital Control output



8 IPS-2 ON

9 IPS-1 ON

10 FIL6 ON

11 FIL5 ON

12 FIL4 ON

13 FIL3 ON

14 FIL2 ON

MSB 15 FIL1 ON

#6043 Write Status Word A

#6063 Write Status Word B

#60A0 Valve Control Byte (LSB)

Verification in telemetry: Direct verification in the Status Word of Status Word commands, Inlet Heater, IPS1, Filament 1, and BA filament.

```
TC_CMD_MNEMO    :       G_F_GX_RAWIO_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#001D#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       PORT
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DATA
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
---------------------
```

```
TC_CMD_MNEMO    :       G_F_GX_RAWIO_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#001D#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       PORT
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DATA
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
----------------------
```

7.1.12 Set Status Word

Stem: based on gx_rawio

Database filenames: g_f_gx_setswa_a.dat (Sets A channel)
g_f_gx_setswa_b.dat
g_f_gx_setswb_a.dat (Sets B channel)
g_f_gx_setswb_b.dat

ATOL Usage: g_f_gx_setswa_a(s,#00nn) (Sets A channel)
g_f_gx_setswa_b(s,#00nn)
g_f_gx_setswb_a(s,#00nn) (Sets B channel)
g_f_gx_setswb_b(s,#00nn)

s = Serial number (0 to 127)
#00nn = hexadecimal value between #0000 and #00FF

Effect of command: Writes low byte of data to low byte of Status Word on A or B channel as indicated. Primary purpose is to simulate an instrument turn-off request by setting bit 0 high. The high byte of the Status Word is set by hardware and is not controlled by this command. The command produces a direct write to I/O address 6043 h (A) or 6063 h (B), using the gx_rawio format.

Verification in telemetry: Next read of Status Word will contain the data byte as the least significant byte.

```
TC_CMD_MNEMO    :       G_F_GX_SETSWA_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#001D#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       PORT
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#6043#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DATA
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
---------------------
```

```
TC_CMD_MNEMO    :       G_F_GX_SETSWA_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#001D#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       PORT
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#6043#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DATA
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
----------------------
```

```
TC_CMD_MNEMO    :       G_F_GX_SETSWB_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#001D#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       PORT
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#6063#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DATA
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
---------------------
```

```
TC_CMD_MNEMO    :       G_F_GX_SETSWB_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#001D#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       PORT
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#6063#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DATA
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       FALSE
----------------------
```

7.1.13 No-Operation Command

Stem: gx_noop

Database filenames:g_f_gx_noop_a.dat
g_f_gx_noop_b.dat

ATOL Usage: g_f_gx_noop_a(s)
g_f_gx_noop_b(s)

s = Serial number (0 to 127)

Effect of command: Command has no effect on instrument operation, other than generation of a TC Acknowledge packet and setting of the TC receive bit in the Status Word.

Verification in telemetry: None

```
TC_CMD_MNEMO    :       G_F_GX_NOOP_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0000#
DEFAULT_CONST   :       TRUE
---------------------
TC_CMD_MNEMO    :       G_F_GX_NOOP_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0000#
DEFAULT_CONST   :       TRUE
---------------------
```

7.1.14 Flight Computer Warm Boot

Stem: gx_wboot

Database filenames: g_f_gx_wboot_a.dat
g_f_gx_wboot_b.dat

ATOL Usage: g_f_gx_wboot_a(s)
g_f_gx_wboot_b(s)

s = Serial number (0 to 127)

Effect of command: Causes the flight computer to set its trigger-go (watchdog) counter to a small number, resulting in a flight computer reset.

Verification in telemetry: The telemetry stream will be interrupted for several seconds while the processor reboots, then the TM sequence counter will be reset.

```
TC_CMD_MNEMO    :       G_F_GX_WBOOT_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0008#
DEFAULT_CONST   :       TRUE
---------------------
TC_CMD_MNEMO    :       G_F_GX_WBOOT_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0008#
DEFAULT_CONST   :       TRUE
---------------------
```

7.1.15 EEPROM memory dump

Stem: qe_eepromdump

Database filenames: g_f_qe_eepromdump_a.dat
g_f_qe_eepromdump_b.dat

ATOL Usage: g_f_qe_eepromdump_a(s,m,n)
g_f_qe_eepromdump_b(s,m,n)

s = Serial number (0 to 127)
m = Starting Memory Address for dump (16 bits)
n = Number of words to dump, integer value from 1 to 128

Effect of command: Causes a memory dump packet to be created which contains the data in the EEPROM from location m to location m + n.

Verification in telemetry: Produces a memory dump packet.

```
TC_CMD_MNEMO    :       G_F_QE_EEPROMDUMP_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#55#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0002#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       START_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0000#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       FALSE
----------------------
```

```
TC_CMD_MNEMO    :       G_F_QE_EEPROMDUMP_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#55#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0002#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       START_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0000#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       FALSE
----------------------
```

7.1.16 RAM memory dump

Stem: qe_ramdump

Database filenames:g_f_qe_ramdump_a.dat
g_f_qe_ramdump_b.dat

ATOL Usage: g_f_qe_ramdump_a(s,m,n)
g_f_qe_ramdump_b(s,m,n)

s = Serial number (0 to 127)
m = Starting Memory Address for dump (16 bits)
n = Number of words to dump, integer value from 1 to 128

Effect of command: Causes a memory dump packet to be created which contains the data in RAM from location m to location m + n.

Verification in telemetry: Produces a memory dump packet.

```
TC_CMD_MNEMO    :       G_F_QE_RAMDUMP_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#55#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       START_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0000#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       FALSE
----------------------
```

```
TC_CMD_MNEMO    :       G_F_QE_RAMDUMP_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#55#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       START_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0000#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       FALSE
----------------------
```

7.1.17 IO Mapped RAM memory dump

Stem: qe_ioramdump

Database filenames: g_f_qe_ioramdump_a.dat
g_f_qe_ioramdump_b.dat

ATOL Usage: g_f_qe_ioramdump_a(s,m,n)
g_f_qe_ioramdump_b(s,m,n)

s = Serial number (0 to 127)
m = Starting Memory Address for dump (16 bits)
n = Number of words to dump, integer value from 1 to 128

Effect of command: Causes a memory dump packet to be created which contains the data in IO mapped RAM from location m to location m + n.

Verification in telemetry: Produces a memory dump packet.

```
TC_CMD_MNEMO    :       G_F_QE_IORAMDUMP_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#55#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0003#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       START_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0000#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       FALSE
---------------------
```

```
TC_CMD_MNEMO    :       G_F_QE_IORAMDUMP_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       5
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#55#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0003#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       START_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0000#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       FALSE
----------------------
```

7.1.18 GO command

Stem: gx_go

Database filenames: g_f_gx_go _a.dat
g_f_gx_go _b.dat

ATOL Usage: g_f_gx_go _a(s)
g_f_gx_go _b(s)

s = Serial number (0 to 127)

Effect of command: Causes the instrument to leave Hold mode following the Pressure Test in Ground C/O mode. Also causes the instrument to leave Hold mode in the event of a Pressure Test failure in Cruise C/O.

Verification in telemetry: Status Word indicates Run mode and Science Data begins.

```
TC_CMD_MNEMO    :       G_F_GX_GO_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0030#
DEFAULT_CONST   :       TRUE
---------------------
TC_CMD_MNEMO    :       G_F_GX_GO_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0030#
DEFAULT_CONST   :       TRUE
---------------------
```

7.1.19 ACP Window Open

Stem: cx_acpopen

Database filenames: g_f_cx_acpopen_a.dat
g_f_cx_acpopen_b.dat

ATOL Usage: g_f_cx_acpopen_a(s)
g_f_cx_acpopen_b(s)

s = Serial number (0 to 127)

Effect of command: Causes the GCMS to respond to an ACP interrupt by performing the appropriate valve operations. Otherwise the GCMS will only send an acknowledge data packet.

Verification in telemetry: HKII General Status Bit 3 = 1 when window is open.

```
TC_CMD_MNEMO    :       G_F_GX_ACPOPEN_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0006#
DEFAULT_CONST   :       TRUE
---------------------
TC_CMD_MNEMO    :       G_F_GX_ACPOPEN_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0006#
DEFAULT_CONST   :       TRUE
---------------------
```

7.1.20 ACP Window Close

Stem: cx_acpclose

Database filenames: g_f_cx_acpclose_a.dat
g_f_cx_acpclose_b.dat

ATOL Usage: g_f_cx_acpclose_a(s)
g_f_cx_acpclose_b(s)

s = Serial number (0 to 127)

Effect of command: Causes the GCMS not to respond to an ACP interrupt by performing valve operations. The GCMS will only send an acknowledge data packet.

Verification in telemetry: HKII General Status Bit 3 = 0 when window is closed.

```
TC_CMD_MNEMO    :       G_F_GX_ACPCLOSE_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0007#
DEFAULT_CONST   :       TRUE
---------------------
TC_CMD_MNEMO    :       G_F_GX_ACPCLOSE_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0007#
DEFAULT_CONST   :       TRUE
---------------------
```

7.1.21 Initialize EEPROM

Stem: te_initeeprom

Database filenames: g_f_te_initeeprom_a.dat
g_f_te_initeeprom_b.dat

ATOL Usage: g_f_te_initeeprom_a(0)
g_f_te_initeeprom_b(0)

s = Serial number (0 to 127)

Effect of command: Used in conjunction with the cmpclr command to initialize and erase the EEPROM. This command is issued first, followed by the g_f_cx_cmpclr command.

Verification in telemetry: The Status Word and HK Startup will indicate that the EEPROM patches were not applied.

```
TC_CMD_MNEMO    :       G_F_TE_INITEEPROM_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       4
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#11#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0900#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       LENGTH
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
---------------------

TC_CMD_MNEMO    :       G_F_TE_INITEEPROM_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       4
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#11#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0900#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       LENGTH
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
---------------------
```

7.1.22 Clear EEPROM Memory Patches

Stem: cx_cmpclr

Database filenames: g_f_cx_cmpclr_a.dat
g_f_cx_cmpclr_b.dat

ATOL Usage: g_f_cx_cmpclr_a(s)
g_f_cx_cmpclr_b(s)

s = Serial number (0 to 127)

Effect of command: Clears the computer memory patch area of EEPROM.

Verification in telemetry: At next boot the Status Word will indicate that EEPROM patches were not applied.

```
TC_CMD_MNEMO    :       G_F_CX_CMPCLR_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#33#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0111#
DEFAULT_CONST   :       TRUE
---------------------
TC_CMD_MNEMO    :       G_F_CX_CMPCLR_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#33#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0111#
DEFAULT_CONST   :       TRUE
---------------------
```

7.1.23 Inhibit EEPROM Memory Patch Application

Stem: cx_eeinh

Database filenames: g_f_cx_eeinh_a.dat
g_f_cx_eeinh_b.dat

ATOL Usage: g_f_cx_eeinh_a(s)
g_f_cx_eeinh_b(s)

s = Serial number (0 to 127)

Effect of command: If received by the instrument within 20 seconds of turnon, the flight computer will not apply any memory patches in the EEPROM.

Verification in telemetry: Status Word indicates that EEPROM patches were not applied. HK Startup packet also contains this indication.

```
TC_CMD_MNEMO    :       G_F_CX_EEINH_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#33#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0113#
DEFAULT_CONST   :       TRUE
---------------------
TC_CMD_MNEMO    :       G_F_CX_EEINH_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       3
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#33#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0113#
DEFAULT_CONST   :       TRUE
---------------------
```

7.1.24 Refresh EEPROM

Stem: te_refreeprom

Database filenames: g_f_te_refreeprom_a.dat
g_f_te_refreeprom_b.dat

ATOL Usage: g_f_te_refreeprom_a(s)
g_f_te_refreeprom_b(s)

s = Serial number (0 to 127)

Effect of command: Causes flight computer to read all locations in EEPROM and re-write the data back to the same location. This may be used to ensure memory locations do not lose their contents. This command locks out other flight computer processes, resulting in a temporary loss of telemetry data and a restart of telemetry sequence count.

Verification in telemetry: A disruption in telemetry data will be seen, probably with a restart of packet sequence numbers.

```
TC_CMD_MNEMO    :       G_F_TE_REFREEPROM_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       4
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#11#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0901#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       LENGTH
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
---------------------

TC_CMD_MNEMO    :       G_F_TE_REFREEPROM_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       4
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#11#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0901#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       LENGTH
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
---------------------
```

7.1.25 Load Memory - One Word

Stem: based on cx_memload

Database filenames: g_f_cx_memload_1_a.dat
g_f_cx_memload_1_b.dat

ATOL Usage: g_f_cx_memload_1_a(s,m,n)
g_f_cx_memload_1_b(s,m,n)

s = Serial number (0 to 127)
m = Memory address for load (0 to FFFFh)
n = Value of word to place at memory location (0 to FFFFh)

Effect of command: This is a specific instance of the more general memory load capability; this command loads a single word to a single memory location.

Verification in telemetry: The memory location may be dumped after being modified.

```
TC_CMD_MNEMO    :       G_F_CX_MEMLOAD_1_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       6
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#33#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0210#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ST_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#FFF0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DATA_1
BIT_NO          :       113
LENGTH          :       16
DEFAULT_VAL     :       16#FFFF#
DEFAULT_CONST   :       FALSE
---------------------
```

```
TC_CMD_MNEMO    :       G_F_CX_MEMLOAD_1_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       6
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#33#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0210#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ST_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#FFF0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DATA_1
BIT_NO          :       113
LENGTH          :       16
DEFAULT_VAL     :       16#FFFF#
DEFAULT_CONST   :       FALSE
---------------------
```

7.1.26 Set Active Ion Sources

Stem: based on gu_isspref

Database filenames: g_f_gu_iss_actina_a.dat
g_f_gu_iss_actina_b.dat

ATOL Usage: g_f_gu_iss_actina_a(s,n,@b)
g_f_gu_iss_actina_b(s,n,@b)

s = Serial number (0 to 127)
n = Sampling mode (0 or 1)
b = Ion Source Select pattern (0 to 127)

n	Meaning
0	Multiplex sampling = GC priority = Direct/ACP locked out if any GC has signal
1	Round Robin sampling = Direct/ACP sources are included in sampling cycle along with GC sources

b = 7 bit select pattern: bit 0 = Calibration Source
bit 1 = Ion Source 5 -- GC3
bit 2 = Ion Source 4 -- GC2
bit 3 = Ion Source 3 -- GC1
bit 4 = Ion Source 2 -- ACP
bit 5 = Ion Source 1 -- Direct
bit 6 = None -- No source selected

Effect of command: Selects which ion sources are to be sampled. Example: g_f_gu_iss_actina_a(0,1,@0101110) means that the Direct, GC1, GC2, and GC3 sources are selected in a round robin sampling. Ion sources must first be enabled by g_f_gu_iss_enadis.

Verification in telemetry: No direct verification in telemetry.

```
TC_CMD_MNEMO    :       G_F_GU_ISS_ACTINA_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0018#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       MODE
BIT_NO          :       81
LENGTH          :       2
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       CMD_ACT
BIT_NO          :       84
LENGTH          :       1
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       MSC_ID
BIT_NO          :       92
LENGTH          :       5
DEFAULT_VAL     :       16#1D#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ISS_PAT
BIT_NO          :       97
LENGTH          :       7
DEFAULT_VAL     :       16#3F#
DEFAULT_CONST   :       FALSE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GU_ISS_ACTINA_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0018#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       MODE
BIT_NO          :       81
LENGTH          :       2
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       CMD_ACT
BIT_NO          :       84
LENGTH          :       1
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       MSC_ID
BIT_NO          :       92
LENGTH          :       5
DEFAULT_VAL     :       16#1D#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ISS_PAT
BIT_NO          :       97
LENGTH          :       7
DEFAULT_VAL     :       16#3F#
DEFAULT_CONST   :       FALSE
-------------------------
```

7.1.27 Enable Ion Sources

Stem: based on gu_isspref

Database filenames: g_f_gu_iss_enadis_a.dat
g_f_gu_iss_enadis_b.dat

ATOL Usage: g_f_gu_iss_enadis_a(s,@b)
g_f_gu_iss_enadis_b(s,@b)

s = Serial number (0 to 127)
b = 7 bit select pattern: bit 0 = Calibration Source
bit 1 = Ion Source 5 -- GC3
bit 2 = Ion Source 4 -- GC2
bit 3 = Ion Source 3 -- GC1
bit 4 = Ion Source 2 -- ACP
bit 5 = Ion Source 1 -- Direct
bit 6 = None -- No source selected

Effect of command: Enables ion sources to be selected for sampling. Example: g_f_gu_iss_actina_a(0,0101110) means that the Direct, GC1, GC2, and GC3 sources are enabled for sampling.

Verification in telemetry: No direct verification in telemetry.

```
TC_CMD_MNEMO    :       G_F_GU_ISS_ENADIS_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0018#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       MODE_MUX
BIT_NO          :       81
LENGTH          :       2
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       CMD_ENA
BIT_NO          :       84
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       MSC_ID
BIT_NO          :       92
LENGTH          :       5
DEFAULT_VAL     :       16#1D#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ISS_PAT
BIT_NO          :       97
LENGTH          :       7
DEFAULT_VAL     :       16#3F#
DEFAULT_CONST   :       FALSE
-------------------------
```

```
TC_CMD_MNEMO    :       G_F_GU_ISS_ENADIS_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       16
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0018#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       MODE_MUX
BIT_NO          :       81
LENGTH          :       2
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       CMD_ENA
BIT_NO          :       84
LENGTH          :       1
DEFAULT_VAL     :       16#0#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       MSC_ID
BIT_NO          :       92
LENGTH          :       5
DEFAULT_VAL     :       16#1D#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ISS_PAT
BIT_NO          :       97
LENGTH          :       7
DEFAULT_VAL     :       16#3F#
DEFAULT_CONST   :       FALSE
-------------------------
```

7.1.28 Set Mass Step Increment

Stem: gu_stepinc

Database filenames: g_f_gu_stepinc_a.dat
g_f_gu_stepinc_b.dat

ATOL Usage: g_f_gu_stepinc_a(s,m,n)
g_f_gu_stepinc_b(s,m,n)

s = Serial number (0 to 127)
m = Ion Source (0 to 6)
n = Step increment (1 or 8)

m	Name
0	No Source
1	Ion Source 1 (Direct)
2	Ion Source 2 (ACP)
3	Ion Source 3 (GC1)
4	Ion Source 4 (GC2)
5	Ion Source 5 (GC3)
6	Calibration Source

Effect of command: Sets the mass step to either fractional 1/8 mass (n = 1) or full mass (n = 8) for the ion source represented by m.

Verification in telemetry: Sweep data for each source contains full or fractional sweep status.

```
TC_CMD_MNEMO    :       G_F_GU_STEPINC_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       6
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0018#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ION_SOURCE
BIT_NO          :       81
LENGTH          :       3
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       STEP_RES
BIT_NO          :       85
LENGTH          :       4
DEFAULT_VAL     :       16#8#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       MSC_NO
BIT_NO          :       92
LENGTH          :       5
DEFAULT_VAL     :       16#2#
DEFAULT_CONST   :       TRUE
---------------------
```

```
TC_CMD_MNEMO    :       G_F_GU_STEPINC_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       6
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0018#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ION_SOURCE
BIT_NO          :       81
LENGTH          :       3
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       STEP_RES
BIT_NO          :       85
LENGTH          :       4
DEFAULT_VAL     :       16#8#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       MSC_NO
BIT_NO          :       92
LENGTH          :       5
DEFAULT_VAL     :       16#2#
DEFAULT_CONST   :       TRUE
---------------------
```

7.1.29 Set Mass Sweep Limits

Stem: gu_swplim

Database filenames: g_f_gu_swplim_a.dat
g_f_gu_swplim_b.dat

ATOL Usage: g_f_gu_swplim_a(s,i,m,n)
g_f_gu_swplim_b(s,i,m,n)

s = Serial number (0 to 127)
i = Ion Source (0-7)
m = Start mass number (2 to 141)
n = End mass number (2 to 141)

i	Name
0	No Source
1	Ion Source 1 (Direct)
2	Ion Source 2 (ACP)
3	Ion Source 3 (GC1)
4	Ion Source 4 (GC2)
5	Ion Source 5 (GC3)
6	Calibration Source

Effect of command: Causes the mass sweep for ion source i to sweep only from mass m to mass n.

Verification in telemetry: The mass sweep limits are shown in sweep subpackets.

```
TC_CMD_MNEMO    :       G_F_GU_SWPLIM_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0018#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ION_SOURCE
BIT_NO          :       81
LENGTH          :       3
DEFAULT_VAL     :       1
DEFAULT_CONST   :       FALSE
PAR_NAME        :       SWP_IND
BIT_NO          :       92
LENGTH          :       5
DEFAULT_VAL     :       16#5#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       LOW_MASS
BIT_NO          :       97
LENGTH          :       11
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       HIGH_MASS
BIT_NO          :       113
LENGTH          :       11
DEFAULT_VAL     :       143
DEFAULT_CONST   :       FALSE
---------------------
```

```
TC_CMD_MNEMO    :       G_F_GU_SWPLIM_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0018#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ION_SOURCE
BIT_NO          :       81
LENGTH          :       3
DEFAULT_VAL     :       1
DEFAULT_CONST   :       FALSE
PAR_NAME        :       SWP_IND
BIT_NO          :       92
LENGTH          :       5
DEFAULT_VAL     :       16#5#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       LOW_MASS
BIT_NO          :       97
LENGTH          :       11
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       HIGH_MASS
BIT_NO          :       113
LENGTH          :       11
DEFAULT_VAL     :       143
DEFAULT_CONST   :       FALSE
----------------------
```

7.1.30 Set Alternating Sweep Mode

Stem: gu_asparm

Database filenames: g_f_gu_asparm_a.dat
g_f_gu_asparm_b.dat

ATOL Usage: g_f_gu_asparm_a(s,i,m,n)
g_f_gu_asparm_b(s,i,m,n)

s = Serial number (0 to 127)
i = Ion Source (Not used; always set to 1)
m = Number of unity sweeps / 10 (UR)
n = Number of fractional sweeps to perform (usually one) (FR)

```
TC_CMD_MNEMO    :       G_F_GU_ASPARM_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0018#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ION_SOURCE
BIT_NO          :       81
LENGTH          :       3
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       MSC
BIT_NO          :       92
LENGTH          :       5
DEFAULT_VAL     :       16#1A#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       UR
BIT_NO          :       121
LENGTH          :       8
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       FR
BIT_NO          :       113
LENGTH          :       8
DEFAULT_VAL     :       16#A#
DEFAULT_CONST   :       FALSE
---------------------
```

```
TC_CMD_MNEMO    :       G_F_GU_ASPARM_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#44#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0018#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ION_SOURCE
BIT_NO          :       81
LENGTH          :       3
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       MSC
BIT_NO          :       92
LENGTH          :       5
DEFAULT_VAL     :       16#1A#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       UR
BIT_NO          :       121
LENGTH          :       8
DEFAULT_VAL     :       16#1#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       FR
BIT_NO          :       113
LENGTH          :       8
DEFAULT_VAL     :       16#A#
DEFAULT_CONST   :       FALSE
---------------------
```

7.2 Use of Serial Numbers in Telecommands

The serial number use has been modified from the QM. Serial numbers are now used as markers to indicate to the analysis software points at which data is to be sampled and processed. Generally speaking, serial numbers of zero indicate setup steps, while non-zero numbers are points of interest for data analysis. Serial number 127 is used to indicate that all subsequent serial numbers are to be incremented by 128. This acts to extend the range of serial numbers available.

7.3 Files in GCMS Instrument Telecommand Database

The following files have been submitted to DASA for inclusion in the telecommand database for use with ATOL programs. For reference, their equivalent DOS filenames are also given.

TC Database Filename	DOS Filename
g_f_cx_acpclose_a.dat	FMACPCA.DAT
g_f_cx_acpclose_b.dat	FMACPCB.DAT
g_f_cx_acpopen_a.dat	FMACPOA.DAT
g_f_cx_acpopen_b.dat	FMACPOB.DAT
g_f_cx_cmpclr_a.dat	FMCMPA.DAT
g_f_cx_cmpclr_b.dat	FMCMPB.DAT
g_f_cx_eeinh_a.dat	FMEEINHA.DAT
g_f_cx_eeinh_b.dat	FMEEINHB.DAT
g_f_cx_memload_1_a.dat	FMMEML1A.DAT
g_f_cx_memload_1_b.dat	FMMEML1B.DAT
g_f_gd_dacparm_a.dat	FMDACPAA.DAT
g_f_gd_dacparm_b.dat	FMDACPAB.DAT
g_f_gf_fenadis_a.dat	FMFENADA.DAT
g_f_gf_fenadis_b.dat	FMFENADB.DAT
g_f_gf_fonoff_a.dat	FMFONOFA.DAT
g_f_gf_fonoff_b.dat	FMFONOFB.DAT
g_f_gh_henadis_a.dat	FMHENADA.DAT
g_f_gh_henadis_b.dat	FMHENADB.DAT
g_f_gh_honoff_a.dat	FMHONOFA.DAT
g_f_gh_honoff_b.dat	FMHONOFB.DAT
g_f_gp_ipenadis_a.dat	FMIPENAA.DAT
g_f_gp_ipenadis_b.dat	FMIPENAB.DAT
g_f_gp_iponoff_a.dat	FMIPONOA.DAT
g_f_gp_iponoff_b.dat	FMIPONOB.DAT
g_f_gu_iss_actina_a.dat	FMISACTA.DAT
g_f_gu_iss_actina_b.dat	FMISACTB.DAT
g_f_gu_iss_enadis_a.dat	FMISENAA.DAT
g_f_gu_iss_enadis_b.dat	FMISENAB.DAT
g_f_gu_stepinc_a.dat	FMSTINCA.DAT
g_f_gu_stepinc_b.dat	FMSTINCB.DAT
g_f_gu_swplim_a.dat	FMSWPLMA.DAT
g_f_gu_swplim_b.dat	FMSWPLMB.DAT
g_f_gv_squirt_a.dat	FMSQUIRA.DAT
g_f_gv_squirt_b.dat	FMSQUIRB.DAT
g_f_gv_venadis_a.dat	FMVENADA.DAT

g_f_gv_venadis_b.dat	FMVENADB.DAT
g_f_gv_vopclos_a.dat	FMVOPCLA.DAT
g_f_gv_vopclos_b.dat	FMVOPCLB.DAT
g_f_go_tc _a.dat	FM_GO_A.DAT
g_f_go_tc _b.dat	FM_GO_B.DAT
g_f_gx_noop_a.dat	FMNOOPA.DAT
g_f_gx_noop_b.dat	FMNOOPB.DAT
g_f_gx_rawio_a.dat	FMRAWIOA.DAT
g_f_gx_rawio_b.dat	FMRAWIOB.DAT
g_f_gx_setswa_a.dat	FMSSWAA.DAT
g_f_gx_setswa_b.dat	FMSSWAB.DAT
g_f_gx_setswb_a.dat	FMSSWBA.DAT
g_f_gx_setswb_b.dat	FMSSWBB.DAT
g_f_gx_wboot_a.dat	FMWBOOTA.DAT
g_f_gx_wboot_b.dat	FMWBOOTB.DAT
g_f_qe_eepromdump_a.dat	FMEEPROA.DAT
g_f_qe_eepromdump_b.dat	FMEEPROB.DAT
g_f_qe_ioramdump_a.dat	FMIODMPA.DAT
g_f_qe_ioramdump_b.dat	FMIODMPB.DAT
g_f_qe_ramdump_a.dat	FMRAMDUA.DAT
g_f_qe_ramdump_b.dat	FMRAMDUB.DAT
g_f_te_initeeprom_a.dat	FMINTEEA DAT
g_f_te_initeeprom_b.dat	FMINTEEB DAT
g_f_te_refreeprom_a.dat	FMREFREA.DAT
g_f_te_refreeprom_b.dat	FMREFREB.DAT
g_f_gu_asparm_a.dat	FMASPARA.DAT
g_f_gu_asparm_b.dat	FMASPARB.DAT

7.3 GCMS Telecommands not configured

Because ATOL cannot produce telecommands of variable length, it is often convenient to produce specific command files for RAM or EEPROM memory loads. Commands to load one or two words to RAM are configured in the Probe database. EEPROM load commands were not included in the database since it was assumed that these would be one-time commands sent from hexadecimal files (*.bin files). As of FS delivery, the IWS ATOL interpreter could not perform the sending of telecommands from *.bin files. For bench testing, these files were sent directly from the UMPIFS. Since it is not possible to include a command file from the UMPIFS in a CRID sequence, test-specific telecommand files were created.

7.3.1 Load EEPROM - One Word

Stem: based on cx_eepload

Database filenames: g_f_cx_eepload_1_a.dat
g_f_cx_eepload_1_b.dat

ATOL Usage: g_f_cx_eepload_1_a(s,m,n)
g_f_cx_eepload_1_b(s,m,n)

s = Serial number (0 to 127)
m = Memory address for load (0 to FFFFh)
n = Value of word to place at memory location (0 to FFFFh)

Effect of command: This is a specific instance of the more general memory load capability; this command loads a single word to a single EEPROM location.

Verification in telemetry: The memory location may be dumped after being modified.

```
TC_CMD_MNEMO    :       G_F_CX_EEPLOAD_1_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       6
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#33#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0110#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ST_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#FFF0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DATA_1
BIT_NO          :       113
LENGTH          :       16
DEFAULT_VAL     :       16#FFFF#
DEFAULT_CONST   :       FALSE
---------------------
```

```
TC_CMD_MNEMO    :       G_F_CX_EEPLOAD_1_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       6
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#33#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0110#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ST_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#FFF0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0001#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DATA_1
BIT_NO          :       113
LENGTH          :       16
DEFAULT_VAL     :       16#FFFF#
DEFAULT_CONST   :       FALSE
---------------------
```

7.3.2 Load EEPROM - Two Words

Stem: based on cx_eepload

Database filenames: g_f_cx_eepload_2_a.dat
g_f_cx_eepload_2_b.dat

ATOL Usage: g_f_cx_eepload_2_a(s,m,n1,n2)
g_f_cx_eepload_2_b(s,m,n1,n2)

s = Serial number (0 to 127)
m = Memory address for load (0 to FFFFh)
n1 = Value of word to place at memory location (0 to FFFFh)
n2 = Value of word to place at memory location + 1

Effect of command: This is a specific instance of the more general memory load capability; this command loads a two words to consecutive EEPROM locations.

Verification in telemetry: The memory location may be dumped after being modified.

```
TC_CMD_MNEMO    :       G_F_CX_EEPLOAD_2_A
TC_APPL_ID      :       16#780#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#33#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0110#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ST_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#FFF0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0002#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DATA_1
BIT_NO          :       113
LENGTH          :       16
DEFAULT_VAL     :       16#FFFF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DATA_2
BIT_NO          :       129
LENGTH          :       16
DEFAULT_VAL     :       16#FFFF#
DEFAULT_CONST   :       FALSE
--------------------
```

```
TC_CMD_MNEMO    :       G_F_CX_EEPLOAD_2_B
TC_APPL_ID      :       16#7A0#
TC_ID           :       0
NO_OF_PARS      :       7
PAR_NAME        :       OP_CODE
BIT_NO          :       49
LENGTH          :       8
DEFAULT_VAL     :       16#33#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       SER_NO
BIT_NO          :       57
LENGTH          :       8
DEFAULT_VAL     :       16#FF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DEST_MOD
BIT_NO          :       65
LENGTH          :       16
DEFAULT_VAL     :       16#0110#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       ST_ADDR
BIT_NO          :       81
LENGTH          :       16
DEFAULT_VAL     :       16#FFF0#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       LENGTH
BIT_NO          :       97
LENGTH          :       16
DEFAULT_VAL     :       16#0002#
DEFAULT_CONST   :       TRUE
PAR_NAME        :       DATA_1
BIT_NO          :       113
LENGTH          :       16
DEFAULT_VAL     :       16#FFFF#
DEFAULT_CONST   :       FALSE
PAR_NAME        :       DATA_2
BIT_NO          :       129
LENGTH          :       16
DEFAULT_VAL     :       16#FFFF#
DEFAULT_CONST   :       FALSE
---------------------
```

8.0 Telemetry

The GCMS sends Science telemetry alternately to CDMU A and B. The nominal GCMS telemetry polling rate is 15 packets / 16 seconds on each channel. If the GCMS is polled at a higher rate, it will produce extra Idle housekeeping packets to fill some of the polling slots.

The purpose and use of the various types of telemetry data are discussed below. The detailed descriptions of subpacket encoding can be found in Annex 2 to the GCMS EID-B.

8.1 Status Word

The GCMS 16-bit Serial Status Word consists of a high byte which is a direct monitor of hardware bits, and a low byte which is set by a write from the flight computer. The high byte is continuously updating, and reflects the instrument status at the time the Status Word Sample goes low. The flight computer updates the low byte initially at powerup; after that, the flight computer will wait until the previous Status Word has been read out before writing the next. The bits are defined in the table below.

The Status Word has been modified significantly from the EM version, in order to provide more information.

If the flight computer does not update the low byte after a word has been read out, these bits will be left all 1's for the next reading. That is, the serial in line of the shift register is tied high, so if the flight computer fails the default will be to request a power off.

GCMS Status Word Bit Definitions

MSB	Hardwired Bits 8-15	Meaning of "0"	Meaning of "1"
15	FC RESET\ Mon.	Reset active, FC stopped	Reset released
14	Proc. Valid Signal Mon.	CDMU Valid Input line = 0	CDMU Valid Input line = 1
13	CPU Power Up Monitor	CPU Error	CPU Normal Powerup
12	Start-up ROM Ena. Mon.	Running from PROM	Running from RAM
11	BA Filament Monitor	BA Filament Off	BA Filament On
10	Filament 1 Monitor	Filament 1 Off	Filament 1 On
9	IPS 1 Monitor	IPS 1 Off	IPS 1 On
8	Inlet Heater Monitor	Inlet Heater Off	Inlet Heater On

7 - 0	Software Set Bits 0-7	Varies by Mode	
		See Below	

Bit 0 is the "Turn-off Request" bit which is set to "1" when there is a major problem with the instrument and power must be removed. (Note that the flight computer does not presently set this bit; it will be set if the flight computer is not updating the Status Word, or the Status Word has become corrupted.) In order to verify that the turn-off is performed correctly, the bit can be set by telecommand.

Bit 1 is the ESW bit which indicates whether Bits 2-7 are indicating instrument software status or sequence execution step numbers. If Bit 1 is equal to 0, then Bits 2 through 7 show the least significant bits of the sequence step number. This allows verification that an instrument stored sequence is executing.

If Bit 1 is equal to 1, bits 2 and 3 indicate the software operating mode:

0 0 = Boot mode, in which FC built in tests and memory checks are performed.

0 1 = Initialization mode, in which any EEPROM memory patches are applied and the Pressure Test is performed.

1 0 = Run mode before T0, in which the instrument has begun executing the stored sequence.

1 1 = Run mode after T0.

Once the instrument has entered Run mode, the Status Words will alternate with Bit 1 being 0 and 1. This acts as an "alive" toggle as well as indicating the contents of the rest of the Status Word.

8.1.1 Boot Mode

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PROM Fail	RAM Fail	IORAM Fail	CPU BIT Fail	Mode 0	Mode 0	ESW 1	Turnoff 0

Any test failure results in the appropriate bit being set = 1.

If there are no test failures a single Boot Mode Status Word will be output. If there are failures there will be as many as three Boot Mode Status Words.

8.1.2 Initialization Mode

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PressureTest Fail	Waiting for Go	CMPs Applied	EEPROM Fail	Mode = 0	Mode = 1	ESW = 1	Turnoff = 0

The Initialization Mode lasts for the duration of the Pressure Test. In Ground C/O or Cruise C/O it can last for as long as 3 min 30 sec. The Pressure Test bit is not valid until the Waiting for Go bit is set, which indicates that the Pressure Test has been completed.

A value of 0 in the Pressure Test bit indicates that the internal pressure check passed. This bit is not valid until the Waiting for Go bit is also set to 1. When the Waiting for Go bit is = 1 and the Pressure Test Fail bit = 0, the test operator should issue the GO telecommand. When the Waiting for Go bit is = 1 and the Pressure Test bit = 1, the operator should inquire with the GCMS representative as to whether the GO command should be sent. If there is no GCMS representative available, the GO command must not be sent and the GCMS must be turned off.

If there are memory patches in the EEPROM that are applied to the flight software, the CMP Applied bit will be set = 1.

If the EEPROM fails its checksum, the EEPROM Fail bit will be set = 1.

8.1.3 Run Mode

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TC Recvd	Proc. Valid Int	CDMU Online	ASG	Mode = 1	Mode = 0 <T0 = 1 > T0	ESW = 1	Turnoff = 0

Run mode lasts for the duration of the test after Initialization. The configuration shown above alternates with the Sequence Step indication.

A value of 1 in the TC Recvd bit indicates that a valid telecommand was received on the associated CDMU channel since the last Status Word read.

The Proc. Valid Int. bit indicates which CDMU the GCMS flight software considers valid (1 = A, 0 = B).

The CDMU Online bit indicates that the DDB and telemetry interface is functioning properly on the associated channel. (1= Online, 0 = Not Online)

The ASG (All Systems Go) bit is a general software health indication (1 = OK, 0 = Not OK).

8.1.4 Sequence Step indication

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Five least significant bits of Sequence Index						ESW = 0	Turnoff = 0

8.2 Packet Telemetry Overview

The GCMS telemetry is based on subpackets which do not necessarily correspond to the size of the Huygens standard packet. Some are larger, and thus require several TM packets for transmission, while others are smaller, allowing several subpackets per TM packet. It is in general not possible to assign a particular GCMS telemetry value to a fixed position in the TM packet. The exception to this is the HKII type packets, which will be discussed later.

The general format of the TM packets from the GCMS is:

The first three words are the required Packet Header as defined by the Huygens project.

Word 1 = Packet ID = 0F80 h on A channel, 0FA0 h on B channel
Word 2 = Sequence Control = Count of TM packets sent + C000 h
Word 3 = Packet Length = 0077 h

Word 4 = SW status byte + "Link" byte = Pointer to start of first subpacket

Word 5 - 61 = Subpacket data

Word 62 = HK I data

Word 63 = CRC = Packet error control

The Link pointer is used to allow the telemetry decoding software to locate the start of the first complete subpacket within the TM packet. This is required in case packets are lost. From that point the positions of further subpackets are calculated from knowledge of subpacket sizes.

The TM packet as received by the IWS can be viewed using the tabular display "gcms_bin_a" and “gcms_bin_b”.

8.3 GCMS Science Data

The Science data consists primarily of ion count data. For each mass period, 16 bits of counts are read from each of two counter channels (High and Low Gain). If the count value is greater than 127, the counts are square rooted and the most significant bit set to 1. If both SEMs were used, the Low Gain data would be transmitted when the High Gain data exceeded a specified count rate. On the FS, only High Gain counter data is transmitted. Data for complete mass scans from a given Ion Source is sent alternately to the two CDMU channels.

The Science data is sent in Science Subpackets as described in Annex 2 to EID-B. These are decoded by the IWS and can be viewed by selecting the following tabular displays:

gcms_sweep_a	Counter data from TM channel A
gcms_sweep_b	Counter data from TM channel B

8.4 GCMS Housekeeping Data

The GCMS contains an Analog to Digital converter for monitoring various voltages which represent the instrument operating status. There are 91 channels of A to D data, with one channel selected for measurement during each mass integration period. The A to D converter is capable of 12 bits of precision, but only the 10 most significant bits are read by the flight computer, and only the eight most significant bits are telemetered. Most of the signals vary slowly and only need to be telemetered every 45 seconds or so. Others, identified as mid-speed (MS) or high-speed (HS) are telemetered more often. A signal table with classification and indication of which subpacket contains the data follows the packet descriptions.

8.4.1 Housekeeping Type I Data (HK I)

The HK I data consists of one word, Word 62 in a standard TM packet. The word is an indication of the execution status of the internal sequence:

Where:

Status Bit 15 : 1 = All Systems Go
Status Bit 14 : 1 = CDMU A Valid
Status Bit 13 : 1 = TDIC Running (Instrument sequence active)

Active ICC is:
000 = Descent after T0
001 = Descent before T0
010 = Ground Checkout after T0
011 = Flight Checkout after T0
100 = Deactivate
101 = Flight Checkout before T0
110 = Ground Checkout before T0

and the Sequence Step Number is the number of the next operation which is scheduled to be performed, as shown previously in Tables 6.1 and 6.2.
This means that in the standard TM packets the word just before the CRC can be used as a monitor of the progress of the instrument through the sequence.

8.4.2 HK II data

In order to ensure that required housekeeping data would be telemetered at regular intervals without being delayed by a large science subpacket which might span several TM packets, the HK II data is handled differently from the other subpacket data. It is allocated a complete TM packet, and is telemetered once every 40 TM packets. Whenever the TM Sequence Count is an even multiple of 40, the packet will be HK II data. The HK II packet does not require a Link pointer and does not contain HK I data, and thus differs from the "standard" GCMS TM packet. HK II data is selected on the IWS by choosing tabular displays:

gcms_hkII_a	HK II data from TM Channel A
gcms_hkII_scaled_a	Data converted to engineering units
gcms_hkII_b	HK II data from TM Channel B
gcms_hkII_scaled_b	Data converted to engineering units

8.4.3 Idle Data

The Idle Data packet is so named because it is sent out whenever the TM output buffer is empty and there is no science data available to be sent. Since the GCMS EM generates very little science data, the majority of the data sent is Idle Data subpackets. These subpackets contain data for each of the A to D converter channels, and thus provide a large amount of housekeeping data for the EM. Idle data is displayed by selecting one of the following tabulars:

gcms_idle_a	Idle Data from TM Channel A
gcms_idle_scaled_a	Idle Data from TM Channel A with some of the voltages converted to engineering units
gcms_idle_b	Idle Data from TM Channel B
gcms_idle_scaled_b	Idle Data from TM Channel B with some of the voltages converted to engineering units
gcms_idle_eng_a	Standard display of engineering units

8.4.4 HK Startup Data

This is a single packet sent after the flight computer has booted and tested the subsystems. It contains software version information and the results of built-in tests. It is displayed by the gcms_hks tabular.

8.4.5 Acknowledge and Not-Acknowledge Subpackets

The Acknowledge (Ack) subpackets are used for several purposes. They are sent whenever a telecommand is received on the active TC channel, and also whenever one of the flight computer external interrupts is received. The type of Acknowledge is indicated in the subpacket and is one of the following:

Type	
0	ACP Interrupt (generated by sync signal)
1	Over Current Interrupt (generated by Main current monitor)
2	Over Pressure Interrupt
3	Telecommand
4	Telecommand

If the type is an External Interrupt (EI) (0, 1, 2) then the subpacket contains only the time that the interrupt was received. If the type is a TC (3 or 4) the subpacket also echoes back the TC Sequence Count which was in the TC header.

Not-Acknowledge (Nack) subpackets are used to indicate that an invalid telecommand was received. The subpacket contains the time the telecommand was received.

In order to prevent noise on an interrupt line or a series of bad DDBs from causing the entire instrument data rate to be used for Acknowledges, a limit has been set for the number of EI Acks and TC Nacks during Cruise and Descent:

		Limits	
Name	Ground	Flight	Descent
EI Ack Limit	65,535	100	100
TC Nack Limit	65,535	100	20

Acks and Nacks are viewed with the following tabular displays:

gcms_ack_a	Acks received on TM Channel A
gcms_ack_b	Acks received on TM Channel B
gcms_nack_a	Nacks received on TM Channel A
gcms_nack_b	Nacks received on TM Channel B

8.4.6 Memory Dump Data

The contents of the flight computer SRAM and EEPROM can be read out and telemetered by telecommand. Memory Dump subpackets are produced in response to the gcms_qe_ramdump or gcms_qe_eepromdump telecommands. The length of the dumped subpacket will depend on the number of words requested in the telecommand, up to a maximum of 128 words. The IWS tabular displays for this data, gcms_dump_a and gcms_dump_b, always display the maximum number of words. If the length of the subpacket is less, the remaining words are set to zero. The tabular also displays the number of memory words sent, so the end point of the data can be easily determined.

9.0 Test Sequences

9.1 ATOL Programs for GCMS FS Integration and Test

9.1.1 gcms_fm_tholdscan.atol

Test purpose: The GCMS instrument uses two channel type secondary electron multipliers. The gain (amplitude of the output pulse) is influenced by many factors. To verify that the gain of the multipliers is constant with input variations there is a threshold detector that is controlled by a 4 bit D/A. This threshold D/A is stepped through its range, and the number of counts produced at each step is plotted. This plot is then compared to lab calibration data. This plot also shows the system noise margin for the counting system.

9.1.2 gcms_fm_lens_scan.atol

Test purpose: The GCMS has 12 lenses/electrodes which deflect the ions from the five ion sources into the Quadrupole Mass Analyzer. There are also three focus lenses that control the ion beam shape. The voltage on each of these electrodes is selected by an 8 bit D/A controlling a 300 volt op-amp. The selected lens voltage is different for each of the five ion sources.

To determine the correct voltage for each lens, for each ion source, seven different voltages are applied to each lens for 10 seconds. The number of ion counts is plotted for each voltage, to depict the shape of the tuning peak.

Scanning 15 lenses for five ion sources over seven voltages would require 525 commands. In practice, some of the lenses do not influence the ion beam for some of the ion sources. However, there are several additional setup commands and serial number commands required by the analysis software.

9.1.3 gcms_fm_calibrate.atol

Test purpose: This test causes the instrument to dwell for extended periods in a 1/8 mass scan mode on various mass ranges. This allows for integration of counts to help verify that the mass tuning is correct, i.e. that the center of the mass peak is at the proper mass number.

This test also creates a high power condition on the Main Power, in order to verify that the Probe current limiter trip point has not degraded.

9.1.4 gcms_fm_maxpower.atol

Test purpose: Creates maximum power condition for one minute on the Main Power and then on the Protected Power. Used during GCMS integration.

```
;  File name: gcms_fm_maxpower.atol
;  Created by Larry Frost, 29 October 1996
; Creates maximum power draw condition for approx. 1 minute on
;  Main, 1 minute on Protected
;  Intended to be run at T0 + 30 minutes in Ground C/O mode
;   during integration only.
;   Assumes EMs and RF are already on
;
integer N
DISPLAY "GCMS MAX POWER WITH HEATERS"
; First make sure all heaters are off
REPEAT N=0,7
            tc cdms g_f_gh_henadis_a(0,N,0)
            WAIT 0.2
ENDREPEAT
; Raise nominal GC temps to ensure turnon
; Call for higher than normal GC temps (70 C for all) = E5h
tc cdms g_f_cx_memload_1_a(0,#FC80,#00E5)
wait 0.2
tc cdms g_f_cx_memload_1_a(0,#FC81,#00E5)
wait 0.2
tc cdms g_f_cx_memload_1_a(0,#FC82,#00E5)
wait 0.2
tc cdms g_f_cx_memload_1_a(0,#FC83,#00E5)
wait 0.2
tc cdms g_f_cx_memload_1_a(0,#FC84,#00E5)
wait 0.2
tc cdms g_f_cx_memload_1_a(0,#FC85,#00E5)
wait 0.2
;
; Make sure Ion Pumps are on
display "Turning on Ion Pumps"
tc cdms g_f_gp_ipenadis_a(0,0,1)
wait 0.2
tc cdms g_f_gp_ipenadis_a(0,1,1)
wait 0.2
tc cdms g_f_gp_iponoff_a(0,0,1)
wait 5.0
```

```
tc cdms g_f_gp_iponoff_a(0,1,1)
wait 0.2
;
; Turn on all Ion Source filaments
; (should be on already)
; Plus BA filament at half emission
tc cdms g_f_gd_dacparm_a(0,15,#8E)
wait 0.2
display " Turning on Filaments"
REPEAT N=0,5
        tc cdms g_f_gf_fenadis_a(0,N,1)
        WAIT 0.2
ENDREPEAT

REPEAT N=0,5
        tc cdms g_f_GF_FONOFF_A(0,N,1)
        WAIT 1.0
ENDREPEAT
wait 5.0
; Dwell on highest power mass (19)
;
; Don't do fractionals
tc cdms g_f_gu_asparm_a(0,1,0,0)
wait 0.2
tc cdms g_f_gu_iss_actina_a(0,1,@0100000)
wait 1.0
tc cdms g_f_gu_swplim_a(0,1,19,19)
wait 10.0
;
;  Turn on Main power heaters (except Cal)
;  i.e., Inlet is on and ACP is off so H2 is on
; Ensure ACP heater is off
tc cdms g_f_gh_henadis_a(0,3,0)
        WAIT 1.0
; Turn on Inlet
tc cdms g_f_gh_henadis_a(0,0,1)
        WAIT 1.0
tc cdms g_f_gh_honoff_a(0,0,1)
        WAIT 5.0
tc cdms g_f_gx_noop_a(1)
wait 0.2
repeat N = 1,6
    display "Main at Max. Value-- Seconds Remaining = ", (7-N)*10
    wait 10.0
endrepeat
tc cdms g_f_gx_noop_a(2)
wait 0.2
; Turn off Inlet and BA
tc cdms g_f_gh_honoff_a(0,0,0)
wait 1.0
tc cdms g_f_gh_henadis_a(0,0,0)
wait 1.0
tc cdms g_f_gf_fonoff_a(0,5,0)
wait 1.0
tc cdms g_f_gf_fenadis_a(0,5,0)
wait 1.0
; Turn on ACP
tc cdms g_f_gh_henadis_a(0,3,1)
        WAIT 0.2
```

```
tc cdms g_f_gh_honoff_a(0,3,1)
        WAIT 1.0
; Turn on EC1
tc cdms g_f_gh_henadis_a(0,1,1)
        WAIT 0.2
tc cdms g_f_gh_honoff_a(0,1,1)
        WAIT 1.0
; Turn on GC1
tc cdms g_f_gh_henadis_a(0,5,1)
        WAIT 0.2
tc cdms g_f_gh_honoff_a(0,5,1)
        WAIT 1.0
; Turn on GC2
tc cdms g_f_gh_henadis_a(0,6,1)
        WAIT 0.2
tc cdms g_f_gh_honoff_a(0,6,1)
        WAIT 1.0
; Turn on GC3
tc cdms g_f_gh_henadis_a(0,7,1)
        WAIT 0.2
tc cdms g_f_gh_honoff_a(0,7,1)
        WAIT 1.0
tc cdms g_f_gx_noop_a(3)
wait 1.0
repeat N = 1,6
    display " Prot at Max.-- secs to off = ", (7-N)*10
    wait 10.0
endrepeat
;Put mass scan back to normal
tc cdms g_f_gu_swplim_a(0,1,2,141)
        WAIT 0.2
;  Disable heaters
REPEAT N=0,7
            tc cdms g_f_gh_henadis_a(0,N,0)
            WAIT 0.2
ENDREPEAT

; Put GCs back to nominal temps
tc cdms g_f_cx_memload_1_a(0,#FC80,#0238)
wait 0.2
tc cdms g_f_cx_memload_1_a(0,#FC81,#0238)
wait 0.2
tc cdms g_f_cx_memload_1_a(0,#FC82,#01D3)
wait 0.2
tc cdms g_f_cx_memload_1_a(0,#FC83,#0238)
wait 0.2
tc cdms g_f_cx_memload_1_a(0,#FC84,#0238)
wait 0.2
tc cdms g_f_cx_memload_1_a(0,#FC85,#01D3)
wait 0.2
DISPLAY "End of GCMS Max Power Sequence"
```

9.1.5 gcms_qm_initialize_ac.atol

```
;  File name: gcms_qm_initialize_ac.atol
;  Created by Larry Frost, 26 November 1995
;  GCMS QM Initialize sequence.  Places instrument in
```

```
;  lower power "safe" state.  RF continues, but all filaments/heaters
off.
;  Status of Ion Pumps is not changed
;  Disables all heaters and Rupture valves.  Filaments remain enabled.
;  Approx. 20 seconds, 18 commands channel A
;  Sequence ID is 42h
integer ser_no = 1
tc cdms gcms_fm_gx_noop_a(#42)
wait 2.0

INTEGER N=1
INTEGER I=1
display "Starting Initialize Sequence"

DISPLAY "TURNING all filaments OFF"

REPEAT N=0,6
        tc cdms gcms_fm_GF_FONOFF_A(ser_no,N,0)
        let ser_no = (ser_no + 1) MASK #7F
        wait 1.0
       ENDREPEAT

DISPLAY "Disabling Heaters"
REPEAT N=0,7
        tc cdms gcms_fm_gh_henadis_a(ser_no,N,0)
        let ser_no = (ser_no + 1) MASK #7F
        wait 1.0
      ENDREPEAT
DISPLAY "Disabling Rupture Valves"
      tc cdms gcms_fm_gv_venadis_a(ser_no,0,0)
      let ser_no = (ser_no + 1) MASK #7F
            wait 0.2
      tc cdms gcms_fm_gv_venadis_a(ser_no,1,0)
      let ser_no = (ser_no + 1) MASK #7F
            wait 1.0

display "End of Initialize Sequence"
stop
```

9.1.4 9.1.5 gcms_qm_eeprom_inhibit_ac.atol

```
; File name: gcms_qm_eeprom_inhibit_ac.atol
; Created by Larry Frost, 26 November 1995
; Sequence to test GCMS EEPROM inhibit function.
; May be performed at any time during ground or flight C/O
; Approx. duration 16 seconds, 4 commands channel A
;  Atol sequence ID is 44h
;
integer ser_no = 1
tc cdms gcms_fm_gx_noop_a(#44)
wait 5.0
display "GCMS rebooting"
tc cdms gcms_fm_gx_wboot_a(ser_no)
let ser_no = (ser_no + 1) MASK #7F
wait 5.0
display "Sending eeprom inhibit"
tc cdms gcms_fm_cx_eeinh_a(ser_no)
let ser_no = (ser_no + 1) MASK #7F
wait 5.0
tc cdms gcms_fm_cx_eeinh_a(ser_no)
let ser_no = (ser_no + 1) MASK #7F
wait 0.2
stop
```

9.1.6 gcms_qm_sim_fail_ac.atol

```
;  File name: gcms_qm_sim_fail_ac.atol
;  Created by Larry Frost, 26 November 1995
;  Sequence to test MTP capability to turn off
;  GCMS if Fail bit is set
;  Approx. 24 seconds (nominally terminated at approx. 3 seconds by
;  automatic turnoff by MTP)
;  5 commands channel A
;  ATOL Sequence ID 45h
;
;
integer ser_no = 1
tc cdms gcms_fm_gx_noop_a(#45)
wait 2.0
display "Setting SW A&B to xx43 h"
tc cdms gcms_fm_gx_setswa_a(ser_no,#0043)
let ser_no = (ser_no + 1) MASK #7F
wait 1.0
tc cdms gcms_fm_gx_setswb_a(ser_no,#0043)
let ser_no = (ser_no + 1) MASK #7F
wait 20.0
tc cdms gcms_fm_gx_setswa_a(ser_no,#0043)
let ser_no = (ser_no + 1) MASK #7F
wait 1.0
tc cdms gcms_fm_gx_setswb_a(ser_no,#0043)
Display "End of Status Word simulated fail seq."
stop
```

9.2 Go/NoGo Test

The Go/NoGo test is intended to determine quickly whether a major instrument functional failure has occurred, such as between axes of a vibration test. It must be performed with DDBs indicating Ground C/O. The Status Word will be the only data examined to make this determination. The Go/NoGo test should have a duration of at least 5 minutes to allow time for the Pressure Test to complete and for the Ion Pumps to be turned on. Assuming no GO telecommand is sent, the Status Words should indicate:

1111 0000 01x0 0110 if CDMU A channel is Valid

9.3 Short Experiment Functional Test

The nearest equivalent of a Short Experiment Functional Test (SEFT) used for the GCMS FM is an ATOL sequence called “func_test_long_6.atol” which has been used between vibration axes and pre- and post-shipment. It turns on all switchable subsystems in turn to make sure they have not been

damaged. The initial part of the test requires about 25 minutes and is used when time is limited. The complete test requires about 2 hour and ten minutes.

9.4 Long Experiment Functional Test

The Long Experiment Functional Test (LEFT) is intended to test both the nominal checkout or descent sequence and additional functions. The planned test consists of a checkout or descent sequence of nominal duration, during which the instrument specific ATOL sequences are run.

At all times when there is access to the GCMS Arm Connector, the Rupture Valve Test Box should be installed to allow verification of Rupture Valve drive circuitry.

9.5 Instrument Specific Tests

9.5.1 ACP Interface Test

This test verifies that both of the redundant ACP sync signal receivers are functioning. It requires access to the GCMS ACP connector so that a test box can be attached. The test will need to be performed after integration, and after vibration and EMC testing. The procedure for the test is contained in Annex 1 to this document.

9.5.2 Rupture Valve Test

This test verifies that the instrument attempts to operate the Rupture Valves at the proper times in the proper mission phase. It also verifies that the instrument does not operate the valves at improper times. The valves should only be operated automatically when the DDBs indicated Descent mode and the Protected power is on. This test can be used to command the instrument to operate the valves in any mode. The procedure for the test is described in Annex 1 to this document.