XMM Optical Monitor

MULLARD SPACE SCIENCE LABORATORY
UNIVERSITY COLLEGE LONDON

Authors: Philip J. Smith, Matthew C. R. Whillock, Cheng Ho, Howard E. Huckle, Jeonghee Rho, Rudi Much, Kate G. Adamson, Jim Klarkowski

XMM-OM USER MANUAL (FM) - PART 2
Experiment Operations Procedures

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Table 1: Change Record

Issue	**Date**	**Changes**
0	30-Oct-98	Draft version
1	23-Dec-98	Added wait for Fred. Added ICU mode information at beginning and end of procedures. Added ICU mode change diagram. Corrected window table. Added missing mem window and sci window load tables. Added prime hvon sequence. Added idle before intermediate safe on time-tagged command. Changed timings. Changed the LUT update. Added stop integration commands. Added BPE binning commands. Added flood LED commands to flat-field. Changed frame_time units.
2	26-Mar-99	Blue2 is now the klingon. Change to idle mode at end of "post obs". Added slew. Turn off for perigee. Removed invalid command tests. Added filter wheel hk suspended warnings. Removed redundant powerup from commissioning. Added note on centroid table boundaries. Added substitution heaters on to nominal switch off. Added check HK DPU status word to choose guide stars. Filter to blocked and mode to intermediate safe at end of science data acquisition period. Added PHD. Go to idle after each engineering mode. Removed fixed time_frames from engineering modes. Added error recovery section. Added debug section. Added safing warning. Rewrote initial switch on, science exposure and commissioning sections. Added NCR warnings. Added reset section. Added time verification if Basic checks. Changed filter wheel to datum delay to 25 s. Changed HV timings. Added 100V step. Changed wrong acquisition modes in eng modes. Changed window coords in eng modes. Added move fw to blocked in PPP. Changed the order of things in the PPP. Added Dave at end of eng modes. Removed filter wheel to blocked at end of science data acq. period. Removed cathode to 2 V command. Moved centroid table load to mainenance procedures section.

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Issue	**Date**	**Changes**
3	24-Aug-99	Removed Clean Slate's time sync. Corrected code load in initial procedures. Added error recovery detail. Added a turn on tracking at the end of acc and track. Incorrect h510s changed to h150s in hvon procedures. Changed no windows in table wintablesimple. Added start window table task in cgs and flatfield. Moved "Initial Procedures" "Filter Wheel to Blocked" to later and removed "Filter Wheel to Datum". Moved watch for NCR 94 to later. Fixed the frame_time in "Mode 5". Added extra time verifications. Added default frame_time and threshold to "Acquisition". Added a "To Blocked" after "Clean Slate" and "Time Ver". Added A584 warning after "Time Ver". Put good boundaries in table. Added 3 more debug addresses to be read. Added a section on what to do when OM cannot be used. Changed fw to blocked at end of fw test. Added Appendix D. Added another time ver after clean slate. Added turn off secondaries in power-off procedure. Corrected threshold value. Added 5aee fix. Removed incorrect h510s. Added that clean slate and time verification should be run after a DPU code reload. Added missing fw move after rel steps 1000. End of science now finishes in idle. 70% ramp down does cathode as well.
4	29-Sep-99	Fixed frame time in flatfield. Added ECR 84 appendix. Added a loading new code section. Changed the commissioning HV ramp-up to be redundant. Added a 30 s wait after loading windows at start of cgs. Removed tracking=1 at end of flatfield. Replaced cgs and exp sections of flatfield with the standard ones. Fixed wrong window table in eng3. Added turn off tracking commands in flatfield. Added NCR 139 appendix. Changed exposure times in eng4 commissioning. Added eng4 timing table. Fixed mistake in OM not used section. Fixed window table prefs.

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1 Introduction and Overview

This is the Experiment Operations Procedures Manual for ^{XMM}OM . It specifies the telecommands to send and telemetry to watch for when performing routine and other ^{XMM}OM procedures.

This document describes the procedures for nominal science and engineering, configuration for orbit phases, maintenance, contingency and commissioning. For each step the database telecommands and params are given, if necessary, the time to wait before the next telecomand, telemetry to expect and for the benefit of ^{XMM}OM consortium software authors, the equivalent VxWorks commands.

The document is intented for use by the XMM MOC and SOC in the writing of their operational spacecraft procedures.

The "Initial Procedures" section describes what should be done during the first turn-on of the Optical Monitor. The "Nominal Procedures" section describes the procedures that should be followed during a normal orbit of switch-on, normal science and switch-off. The "Maintenance Procedures" describes the engineering procedures that will be used early in the mission and if a problem is found. Also included is a section on "Commissioning" to be followed after the initial switch-on and a section on "Error Recovery" describing what to do if the unexpected happens.

2 Reference Documents

- **XMM-OM/MSSL/ML/0010** ^{XMM}OM User Manual Part 3: Telecomand and Telemetry Specification
- **XMM-OM/MSSL/SP/0194** ^{XMM}OM (FM) Integrated Functional Test Procedure
- **XMM-OM/MSSL/ML/0011** ^{XMM}OM User Manual Part 4: ICU-DPU protocol definitions
- **XMM-SOC/TN-0010-SMD** ^{XMM}OM Operational Procedures Handbook
- **OM-MSSL-NCR 82** ^{XMM}OM NCR 82
- **OM-MSSL-ECR 84** ^{XMM}OM ECR 84
- **OM-MSSL-NCR 94** ^{XMM}OM NCR 94
- **OM-MSSL-NCR 106** ^{XMM}OM NCR 106
- **OM-MSSL-NCR 174** ^{XMM}OM NCR 139
- **OM-MSSL-NCR 174** ^{XMM}OM NCR 174
- **OM-MSSL-NCR 175** ^{XMM}OM NCR 175
- **OM-MSSL-NCR 176** ^{XMM}OM NCR 176
- (see http://xmmom.mssl.ucl.ac.uk/docs/xmm-om-ncrs/ncr.ps for an NCR summary)

3 Abbreviations

XMM	X-ray Multi Mirror Mission
OM	Optical Monitor
HK	Housekeeping
KAL	Keep Alive
IFT	Integrated Functional Test
ICU	Instrument Control Unit
DPU	Digital Processing Unit
HV	High Voltage
LUT	Lookup Table
tc	Telecommand
tm	Telemetry
MSSL	Mullard Space Science Lab (University College London)
ESA	European Space Agency
SOC	Science Operations Centre
MCP	Microchannel Plate(s)
FAQ	Field Acquisition
s/c	spacecraft
GS	guide star(s)
RBI	Remote Bus Interface
TMPSU	Telescope module power supply unit
fwhm	full width half max
LOS	Loss of Signal

4 Typographical and Other Conventions Used in this Document

4.1 Typographical

- Running text appears in this normal Roman font.
- *Italic font* will indicate a parameter that should not be taken literally.
- A `"typewriter" font` will be used to indicate MSSL EGSE VxWorks commands.
- A **"bold" font** will be used to indicate database entries.

5 Note: Alerts

Please note the following ...

The ground system should always monitor the telemetry stream for exception packets of (type, subtype):

- (3,2): Unsuccessful Command Acceptance
- (3,4): Unsuccessful Command Execution
- (4,2): Exception Report
- (4,3): Major Anomaly Report

as these indicate an error has occured (and should only be expected if an intentional bad command is sent as a test).

If the software fails (particularly the ICU software), after taking diagnostics (DMA read of ICU memory addresses fc0$_{hex}$ to fde$_{hex}$ and a21$_{hex}$ to a25$_{hex}$), the ICU should be reset as soon as possible so that it may safe the hardware (see Section 12).

5.1 Safing

In ICU Basic Mode, should the spacecraft issue a safing command, it will not conform to the standard format and the ICU will interpret the packet's CRC as the address to which it will jump leading to unpredictable results. Typically a reset or a watchdog kick (see Appendix C).

6 Initial Procedures

These procedures are intended to be used for the initial switch-on of the Optical Monitor.

6.1 Open Telescope Door

Opening the ^{XMM}OM telescope door is a spacecraft procedure. This should occur at least a week after launch and at least a day after the opening of the last X-ray telescope door.

Must then wait for at least 2 days for outgassing.

6.2 Initial Switch On Procedure (Full Switch On)

6.2.1 Turn on Power

Description	**tc**	**tm**	**params**	**VxWorks**
Spacecraft command: turn on KAL				
Perform the "Nominal Switch On Procedure" (see Section 9.1)				

The ICU is in "initial" mode.

Note that **the high voltages must not be switched on until at least 2 days after the opening of the door**.

6.2.2 Time Verification

Description	**tc**	**tm**	**params**	**VxWorks**
Perform Clock Resynchronisation (see Section 10.1)				
Send a tc (10, 5)				`tc_enable_time_verification`
Wait up to 2 s for a tm (10, 5)				
Check that the contents of the time management report packet are as expected				

6.2.3 Basic Mode Tests

Description	**tc**	**tm**	**params**	**VxWorks**
Send a valid tc packet	**h1**			`tc_test`
Check HK for good tc packet counter		**90000**	**h5385** should increment by 1	

6.2.4 Load Code

Description	**tc**	**tm**	**params**	**VxWorks**
Upload ICU operational mode software	multi **h4000** **h4001**		**h500**=***address***	`<load_icu`

6.2.5 Memory Dump of ICU's Loadable Code

Send dump memory packets to dump out the ICU's operational mode (loadable) code.

Description	**tc**	**tm**	**params**	**VxWorks**
Multiple dump memory requests instruction space	**multi** **h4101**		**h500**=***address*** **h510**=***length***	
Multiple dump memory requests operand space	**multi** **h4100**		**h500**=***address*** **h510**=***length***	

Compare the memory dump report tm packets with the memory load packets. This is important because of NCR 82/174 (see Appendix D). Reset (see Section 9.3) the ICU and reload full code if a difference is found (see Section 6.2.4).

6.2.6 Operational Mode

The ICU is in "initial" mode.

Description	**tc**	**tm**	**params**	**VxWorks**
Mode change to 1 ("full safe")	**h9001**			`tc_mode 1`
Wait up to 20 s				
Check HK		**90000**	**h5405="Operational"**	

The ICU is in "full safe" mode.

The DPU status is invalid.

6.2.7 Time Verification

Description	tc	tm	params	VxWorks
Perform Clock Resynchronisation (see Section 10.1)				
Send a tc (10, 5)				`tc_enable_time_verification`
Wait up to 2 s for a tm (10, 5)				
Check that the contents of the time management report packet are as expected				
Expect a tm (4,2) a584 from the DPU		**92226**	**h7725=A40E**$_{hex}$	

6.2.8 NCR 176 fix

Description	tc	tm	params	VxWorks
Fix the DPU status (see NCR 176)	**h7217**		**h630=5AEE**$_{hex}$, **h640=0**	`tc_load_mem 0x13, 0x5aee, 0`

The DPU status is valid.

6.2.9 Operational Mode Tests

Description	tc	tm	params	VxWorks
Check HK		**90000**	**h5405="Operational"**	
Check HK packet arrives approximately every 10 s		**90000**		
(Thermal control starts automatically)				
Prepare for heater switching: disable standard control algorithm	**h6670**			`tc_heater_stop`
Examine HK		**90000**	**h5240="offoffoffoff"**	
Measure S/C +28V voltage and current. Compare with Table 12				
Start heater contingency task	**h5660**			`tc_heater_config_start`
Switch on heater 1 (Main I/F)	**h7660**		**h380="onoffoffoff"**	`tc_heater_config 8`
Examine HK		**90000**	**h5240="onoffoffoff"**	
Measure S/C +28V voltage and current. Compare with Table 12				
Switch off heater 1	**h7660**		**h380="offoffoffoff"**	`tc_heater_config 0`
Examine HK		**90000**	**h5240="offoffoffoff"**	
Switch on heater 2 (forward tube)	**h7660**		**h380="offonoffoff"**	`tc_heater_config 4`
Examine HK		**90000**	**h5240="offonoffoff"**	
Measure S/C +28V voltage and current: Compare with Table 12				

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Description	tc	tm	params	VxWorks
Switch off heater 2	**h7660**		**h380="offoffoffoff"**	`tc_heater_config 0`
Examine HK		**90000**	**h5240="offoffoffoff"**	
Switch on heater 3 (metering rods)	**h7660**		**h380="offoffonoff"**	`tc_heater_config 2`
Examine HK		**90000**	**h5240="offoffonoff"**	
Measure S/C +28V voltage and current: Compare with Table 12				
Switchoff heater 3	**h7660**		**h380="offoffoffoff"**	`tc_heater_config 0`
Examine HK		**90000**	**h5240="offoffoffoff"**	
Switch on heater 4 (secondary mirror)	**h7660**		**h380="offoffoffon"**	`tc_heater_config 1`
Examine HK		**90000**	**h5240="offoffoffon"**	
Measure S/C +28V voltage and current: Compare with Table 12				
Switch off heater 4	**h7660**		**h380="offoffoffoff"**	`tc_heater_config 0`
Examine HK		**90000**	**h5240="offoffoffoff"**	
Disable heater switching: stop heater contingency task	**h6660**			`tc_heater_config_stop`
Enable standard control algorithm	**h5670**			`tc_heater_start`
Specify next move of the filter wheel to the datum position	**h7608**			`tc_fw_to_datum`
Command the filter wheel to move	**h5600**			`tc_fw_move`
Wait up to 25 s for a TMPSU event (housekeeping may be suspended for up to 15 s)		**92600**	**h7010="fw @ req pos"**	
Examine HK		**90000**	**h5150="seen", h5265=0**	
Command the filter wheel away from datum	**h7606**		**h290=1000**	`tc_fw_rel_steps 1000`
Command the filter wheel to move	**h5600**			`tc_fw_move`
Wait up to 20 s for a TMPSU event (housekeeping may be suspended for up to 10 s)		**92600**	**h7010="fw @ req pos"**	
Examine HK		**90000**	**h5150="seen", h5250="not seen"**	
Command the filter wheel to move to the coarse sensor position	**h7609**			`tc_fw_to_coarse`
Command the filter wheel to move	**h5600**			`tc_fw_move`
Wait up to 20 s for a TMPSU event (housekeeping may be suspended for up to 10 s)		**92600**	**h7010="fw @ req pos"**	
Command the filter wheel to move back to the datum position	**h7608**			`tc_fw_to_datum`
Command the filter wheel to move	**h5600**			`tc_fw_move`

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Description	tc	tm	params	VxWorks
Wait up to 25 s for a TMPSU event (housekeeping may be suspended for up to 15 s)		**92600**	**h7010="fw @ req pos"**	
Examine HK		**90000**	**h5150="seen" h5265=0**	

6.2.10 Filter Wheel to Blocked

Description	tc	tm	params	VxWorks
Specify next move of the filter wheel to absolute blocked position	**h7605**		**h290="1200"**	`tc_fw_abs_steps 1200`
Command the filter wheel to move	**h5600**			`tc_fw_move`
Wait up to 20 s for a TMPSU event (housekeeping may be suspended for up to 10 s)		**92600**	**h7010="fw @ req pos"**	

Table 12: Heater Switching Current Profile

Heater	+28 V Current
1 (Main Interface)	1440mA ± 100 mA
2 (Forward tube)	1740mA ± 100 mA
3 (Metering Rods)	1060mA ± 100 mA
4 (Secondary Mirror)	950mA ± 100 mA
Disable Heater Algorithm	810mA ± 100 mA

6.2.11 DPU

Check the heartbeat count is increasing at 1 every 10 s.

Description	tc	tm	params	VxWorks
Check the heartbeat count is increasing at 1 every 10 s		**90000**	**h5410**	

6.2.12 Load DPU Code

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Description	tc	tm	params	VxWorks
Reset DPU	**h7201**			`tc_reset_dsp`
Wait up to 12 s for alert		**92201**		Expect “Fred from the Dead”
Upload DPU memory load packets	**multi** **h4020** **h4023** **h4025** **h4027**		**h500=*address***	`<load_dpu`

6.2.13 Memory Dump of DPU's Loadable Code

Send dump memory packets to dump out the DPU's uploadable OS and science code. [1]

Description	tc	tm	params	VxWorks
Multiple Dump Bank 0 requests	**multi** **h4120**		**h500=*address*** **h510=*length***	
Multiple Dump Bank 3 requests	**multi** **h4123**		**h500=*address*** **h510=*length***	
Multiple Dump Bank 5 requests	**multi** **h4125**		**h500=*address*** **h510=*length***	
Multiple Dump Bank 7 requests	**multi** **h4127**		**h500=*address*** **h510=*length***	

Compare the memory dump report tm packets with the memory load packets.

6.2.14 Clean Slate

Description	tc	tm	params	VxWorks
Switch to the uploadable code	**h7202**			`tc_load_dpuos`
Wait up to 10 s for DA_DPUOS_READY		**92202**		Expect “Jim from the Rim”
Enable red dsp	**h7207**		**h522=“Red”** **h16=“Enabled”**	`tc_enbl_dsp red,1`
Wait 10 s				
Enable blue1 dsp	**h7207**		**h522=“Blue1”** **h16=“Enabled”**	`tc_enbl_dsp blue1,1`

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[1] With Release 8 of the ICU loadable flight code, use h7220 with **h660=*address*** and **h670=*number of 24-bit words*** here instead of h4120, h4123, h4125 & h4127 because of NCR 175 with Release 8 (see Appendix E).

(continued)

Description	tc	tm	params	VxWorks
Wait 10 s				
Enable blue2 dsp	**h7207**		**h522="Blue2" h16="Enabled"**	`tc_enbl_dsp blue2,1`
Wait 10 s				
Select blue2 as the klingon [2]	**h7206**		**h523="blue2"**	`tc_sel_klingon 2`
Initialize DPU	**h7248**			`tc_init_dpu`
Wait up to 25 s for DA_EOT_INIT_DPU event		**92210**		`tm_wait_for_alert DA_EOT_INIT_DPU` ("Dave from the Grave")
(Watch out for NCR 94 crash—see Section 11 and Appendix B)				
Turn on reference frame verbosity (DD_REF)	**h7244**		**h760=3 h16="enable"**	`tc_enbl_verbose 3, 1`

6.2.15 Time Verification

Description	tc	tm	params	VxWorks
Perform Clock Resynchronisation (see Section 10.1)				
Send a tc (10, 5)				`tc_enable_time_verification`
Wait up to 2 s for a tm (10, 5)				
Check that the contents of the time management report packet are as expected				
Check that the DPU time is correct. If not: repeat this time synchronization section				

6.2.16 Idle Mode

[2]The klingon in DPUOS is the processor that 1) finishes the memory access and 2) holds on to the bus until the arbiter informs him to give up. The default is white which is the one with the most complicated task. We have to change from the white to blue2 (note not blue1) so that the BUS IO interrupt will occur always at a know location. This is the result of DPU spontaneous reset at the busy spot, i.e. NCR125. The sel_klingon command needs to be sent because the White processor is the default at power up. By switching to Blue2 we are able to improve the accuracy of the DPU timing. The DPU timing is based on the number of millisecond bus cycles that have occurred. The Klingon holds onto the bus until the next millisecond interrupt occurs. When the interrupt is recognized the bus is passed to the next processor (order is White, Red, Blue1, Blue2, set by hardware) which would be White. This scheme minimizes the latency and jitter in the Whites bus cycle count. The White processor runs the "Traffic Cop" software that does all the timing for the exposure.

Description	**tc**	**tm**	**params**	**VxWorks**
Transition to ICU mode 2 (“idle mode”)	**h9002**			`tc_mode 2`

Begin commissioning (see Section 7).

7 Commissioning

7.1 Tests

7.1.1 Pulse Height Distribution

Perform Engineering Mode 6 exposure (see Section 10.12) with an exposure_time of 30 s and a threshold of 2 (LEDs off).

Check the histogram. It should show only noise. The object of this test is to check that there are no unwanted alerts and there is nothing out of limits.

7.1.2 HV

Note that **the high voltages must not be switched on until at least 2 days after the opening of the Optical Monitor door**.

Note also that the high voltages must not be switched on until XMM is above a safe orbital height for the MCPs.

The following HV ramp-up is for the Redundant Channel only.

Description	tc	tm	params	VxWorks
Check HK for temperatures in allowed range and if not, wait		**90000**	**h5135="−8 to +37 °C"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23" h160=100 h175="off"**	`tc_det_load_hv_ramp_params 3, 100, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 10 s for event		**92100**	**h7000="mcp23 ok"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23" h160=1500 h175="off"**	`tc_det_load_hv_ramp_params 3, 1500, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 90 s for event		**92100**	**h7000="mcp23 ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h150="mcp1" h160=500 h175="off"**	`tc_det_load_hv_ramp_params 2, 500, 25, 0`
Wait up to 40 s for event		**92100**	**h7000="mcp1 ok"**	
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Specify $V_{cathode}$ ramp parameters	**h7140**		**h150="cathode" h160=390 h175="off"**	`tc_det_load_hv_ramp_params 1, 390, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 30 s for event		**92100**	**h7000="cathode ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h150="mcp1" h160=550 h175="off"**	`tc_det_load_hv_ramp_params 2, 550, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`

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Description	tc	tm	params	VxWorks
Wait up to 10 s for event		**92100**	**h7000="mcp1 ok"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23"** **h160=1850 h175="off"**	`tc_det_load_hv_ramp_params 3, 1850, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 30 s for event		**92100**	**h7000="mcp23 ok"**	

7.1.3 Pulse Height Distribution with HV

Perform Engineering Mode 6 exposure (see Section 10.12) with an exposure_time of 30 s, a threshold of 2 and the flood LEDs set to 2.

Check the histogram. It should show a curve starting at 2 and peaking at about 100. Unwanted alerts or no peak or a peak more than 20 from 100 would be a failure.

Perform Engineering Mode 6 exposure (see Section 10.12) with an exposure_time of 30 s, a threshold of 12 and the flood LEDs set to 2.

Check the histogram. It should show the same curve starting at 12. Unwanted alerts or no peak or a peak more than 20 from 100 would be a failure.

7.2 Centroid Table Load

Description	tc	tm	params	VxWorks
Load centroid table boundaries	**h7100**		***Table 21***	`det_get_bounds` `< filename ;` `tc_det_load_bounds`
Wait up to 120 s for event		**92100**	**h7000=10h**	

7.2.1 Exposures

Change to "Science" mode:

Description	tc	tm	params	VxWorks
Change to ICU mode 3 ("science")	**h9003**			`tc_mode 3`

Perform "Choose Guide Stars", "Accumulate and Track" and flush (see 9.12) with the filter wheel in the blocked position, the flood LEDs off and the threshold set to 15. The science window should be 200 x 200 and the exposure_time 100 s.

Table 21: Centroid Table Boundaries

Description	**Params**	**Initial Value**
Verification	**h10**	"enable"
X Centroid Table Boundary 0	**h20**	-1000
X Centroid Table Boundary 1	**h21**	-470
X Centroid Table Boundary 2	**h22**	-241
X Centroid Table Boundary 3	**h23**	-107
X Centroid Table Boundary 4	**h24**	-9
X Centroid Table Boundary 5	**h25**	89
X Centroid Table Boundary 6	**h26**	221
X Centroid Table Boundary 7	**h27**	449
X Centroid Table Boundary 8	**h28**	1000
Y Centroid Table Boundary 0	**h30**	-1000
Y Centroid Table Boundary 1	**h31**	-438
Y Centroid Table Boundary 2	**h32**	-213
Y Centroid Table Boundary 3	**h33**	-88
Y Centroid Table Boundary 4	**h34**	-1
Y Centroid Table Boundary 5	**h35**	86
Y Centroid Table Boundary 6	**h36**	207
Y Centroid Table Boundary 7	**h37**	426
Y Centroid Table Boundary 8	**h38**	1000

Examine the image. There should almost no counts and no unexpected alerts. The object of this test is to check the software (and therefore the hardware) and the detector when dark.

Turn on flood LEDs to level 4:

Description	**tc**	**tm**	**params**	**VxWorks**
Change to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Turn on flood LEDs to level 4	**h7134**		**h1040=4**	`tc_det_flood_led_current 4`
Change to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Change to ICU mode 3 ("science")	**h9003**			`tc_mode 3`

Perform "Choose Guide Stars", "Accumulate and Track" and flush (see 9.12) as above.

Examine the image. The window should be evenly illuminated so we should see somewhere between 10 000 and 20 000 count s^{-1} evenly distributed across the complete 2048 x 2048 image (a proportion of these in the specified window). No counts or a serious patterning would indicate a failure.

Perform an Engineering Mode 3 exposure (see Section 10.9) with an exposure_time of 300 s and a threshold of 15.

The boundaries should be within 20% of the boundaries loaded a little earlier.

Perform an Engineering Mode 4 exposure (see Section 10.10) with blocked filter, flood LEDs at 4 and an exposure_time of 4000 s.

Table 24: Eng 4 compress and download times

	16 chunks	**1 chunk**
compress time	4900 s	4900 s
downlink time 4 kbit s^{-1}	6200 s	6200 s
downlink time 8 kbit s^{-1}	3100 s	3100 s
effective time for compress & downlink 4 kbit s^{-1}	5300 s	11 100 s
effective time for compress & downlink 8 kbit s^{-1}	3400 s	8000 s

Examine the image. The image should be evenly illuminated so we should see somewhere between 10 000 and 20 000 count s^{-1} evenly distributed across the complete 2048 x 2048 image. No counts or a serious patterning would indicate a failure.

(Natural break point, if necessary.)

Perform an Engineering Mode 5 (centroiding check) exposure (see Section 10.11) with an exposure_time of 4000 s and a threshold of 15.

Examine the 8x8x8 image. It should show variations of not more than about 50% from the mean.

(Natural break point, if necessary.)

Point XMM at the OM boresight calibration field.

Perform “Acquisition”, “Choose Guide Stars”, “Accumulate and Track” and flush (see Section 9.12) with the V filter, a science window of 200 x 200 and an exposure_time of 100 s.

Examine image, guide stars etc. There should be no unexpected alerts. The fwhm of the stars should be less than 2.2 arcsec.

Perform an Engineering Mode 4 exposure (see Section 10.10) with V filter and an exposure_time of 600 s.

Examine the image. It should show stars and signs of drift.

(Natural break point, if necessary.)

7.3 Focus

Set up with appropriate science windows (see Rudi) on a test star and use the V filter. Perform “Acquisition”, “Choose Guide Stars”, “Accumulate and Track” and and flush (see 9.12).

Do the same with the magnifier instead of the V filter.

Check the image. If the PSF is far from nominal, the following focusing tests may need to be performed.

7.3.1 Focus with V Filter

If the focus is too bad, perform “Choose Guide Stars” and “Accumulate and Track” with the filter wheel in the V position and the focusing heaters at various settings. The science windows should be suitable for the field. This process could take many hours. It may take an hour between heater settings for the temperature to stabilize.

Anaylze images and adjust heaters for best focus.

7.3.2 Focus with Magnifier

Repeat the focus process above but with the magnifier instead of the V filter. This could take many hours.

Anaylze images and adjust heaters for best focus.

Perform engineering mode 4 with an exposure time of 600 s.

7.4 Boresight

The last images should be checked to assess the boresight alignment.

7.5 Filters

Choose a field with UV source(s). Perform a standard exposure without fast mode windows with some filters (1000 s per filter). Check the images. Look for non-smooth background or out-of-focus stars which would indicate a failure.

Perform a standard exposure (with fast mode windows) with each filter (1000 s per filter). Check the images.

7.6 Flatfield

Perform a standard flatfield (see Section 9.11). Examine the image. Large-scale variations should be no greater than 30%.

7.7 Wait for radiation test

Perform "Procedure for the Perparation for Perigee Passage" without the removal of the time-tagged command (see Section 9.15).

Wait until approximately hour 43 of the orbit (depending on radiation monitor results).

7.8 Radiation tests

Description	**tc**	**tm**	**params**	**VxWorks**
Transition to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Ramp up HV (see Section 9.16.5)				
Perform Engineering Mode 6 (see Section 10.12) 20 s exposure with filter in the blocked position, a threshold of 12 and flood LEDs at level 4				
Repeat eng 6 many times ...				

The countrate should not rise above 50 000 count s^{-1}. Countrates close to 200 000 count s^{-1} would be considered dangerous.

7.9 End of Tests

Description	tc	tm	params	VxWorks
Perform nominal switch off (see Section 9.2)				

The ICU is off.

8 Calibration and PV

See Rudi.

9 Nominal Procedures

These procedures are intended to be used in normal use during an XMM orbit.

9.1 Nominal Switch On

Description	tc	tm	params	VxWorks
Spacecraft procedure: Switch off substitution heater				
Spacecraft procedure: Switch on 28V.				
Wait up to 20 s for a bootstrap report		**92703**	"bootstrap report event packet"	
Check the HK: expect a HK packet every 10 s		**90000**		
In the HK packets, look for mode and heater status		**90000**	**h5395="Initial"** **h5240="OnOnOffOff"** **h5255="Disabled"**	
Upload "initial" mode patches using RBI write spacecraft commands				

The ICU will be in "initial" mode.

N.B. there is no need to do an RBI suspend for the "initial mode" patches. The suspend is just done by Dornier as a test.

9.2 Nominal Switch Off

N.B. High voltages must be ramped down slowly and safely before switching off main power, as described in this procedure.

The ICU will be in "idle", "science", "engineering" or "intermediate safe" mode.

Description	tc	tm	params	VxWorks
Specify $V_{cathode}$ ramp parameters	**h7140**		**h510="cathode", h160=0, h175="off"**	`tc_det_load_hv_ramp_params 1,0,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 120 s for event		**92100**	**h7000="cathode ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h510="mcp1", h160=0, h175="off"**	`tc_det_load_hv_ramp_params 2,0,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 120 s for event		**92100**	**h7000="mcp1 ok"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h510="mcp23, h160=0, h175="off"**	`tc_det_load_hv_ramp_params 3,0,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 120 s for event		**92100**	**h7000="mcp23 ok"**	
Turn off secondaries	**h6690**			`tc_secoff`
Spacecraft command: Send an RBI suspend	**D7200**			`suspend`
Spacecraft procedure: switch off +28 V				
Spacecraft procedure: switch on substitution heaters				

9.3 Transition to Safe Mode

Before this procedure, the ICU will be in "initial", "idle", "intermediate safe", "science", or "engineering" mode.

This is a initiated by a **tc h9001** either autonomously from the spacecraft or as a telecommand from the ground.

General case:

Description	**tc**	**tm**	**params**	**VxWorks**
Mode change to 1 ("full safe")	**h9001**			`tc_mode 1`
Wait up to 160 s				
Check HK		**90000**	**h5395="Safe"**	

When in "Initial mode":

Description	**tc**	**tm**	**params**	**VxWorks**
Mode change to 1 ("full safe")	**h9001**			`tc_mode 1`
Wait up to 2 s				
Check HK		**90000**	**h5395="Safe"**	

When in "Intermediate Safe" mode with the high voltages on:

Description	**tc**	**tm**	**params**	**VxWorks**
Mode change to 1 ("full safe")	**h9001**			`tc_mode 1`
Wait up to 20 s for mode change event packet		**92100**	**h7000="MCP1 ok"**	
Wait up to 100 s for mode change event packet		**92100**	**h7000="MCP2,3 ok"**	
Wait up to 40 s for 0, 1 or 2 filter wheel event packets		**92600**	**h7010="fw at req pos"**	
Check HK		**90000**	**h5395="Safe"**	

When in "Intermediate Safe" mode with the high voltages off:

Description	**tc**	**tm**	**params**	**VxWorks**
Mode change to 1 ("full safe")	**h9001**			`tc_mode 1`
Wait up to 40 s for 0, 1 or 2 filter wheel event packets		**92600**	**h7010="fw at req pos"**	
Check HK		**90000**	**h5395="Safe"**	

When in "idle", "science" or "engineering" modes with the high voltages on:

Description	**tc**	**tm**	**params**	**VxWorks**
Mode change to 1 ("full safe")	**h9001**			`tc_mode 1`
Wait up to 20 s for mode change event packet		**92100**	**h7000="cathode ok"**	
Wait up to 20 s for mode change event packet		**92100**	**h7000="MCP1 ok"**	
Wait up to 100 s for mode change event packet		**92100**	**h7000="MCP2,3 ok"**	
Wait up to 40 s for 0, 1 or 2 filter wheel event packets		**92600**	**h7010="fw at req pos"**	
Check HK		**90000**	**h5395="Safe"**	

When in "idle", "science" or "engineering" modes with the high voltages off:

Description	**tc**	**tm**	**params**	**VxWorks**
Mode change to 1 ("full safe")	**h9001**			`tc_mode 1`
Wait up to 20 s for filter wheel event packet		**92600**	**h7010="fw at req pos"**	
If filter wheel has not yet been to datum, wait up to 20 s for another filter wheel event packet		**92600**	**h7010="fw at req pos"**	
Check HK		**90000**	**h5395="Safe"**	

9.4 Example Observation

The example observation shown in Table 35 consists of an acquisition phase followed by 2 exposures. In turn, each exposure consists of a choose guide star phase followed by an accumulation and tracking phase. Science data is not available for downlinking until the end of the first exposure. The status of science data, filter wheel and detector during the course of the observation is summarized Table 35. This example can be generalized to a n-exposure sequence by repeating the "between exposures" and "Exposure 2" (with suitable changes in the uplinked configuration) phases as often as required.

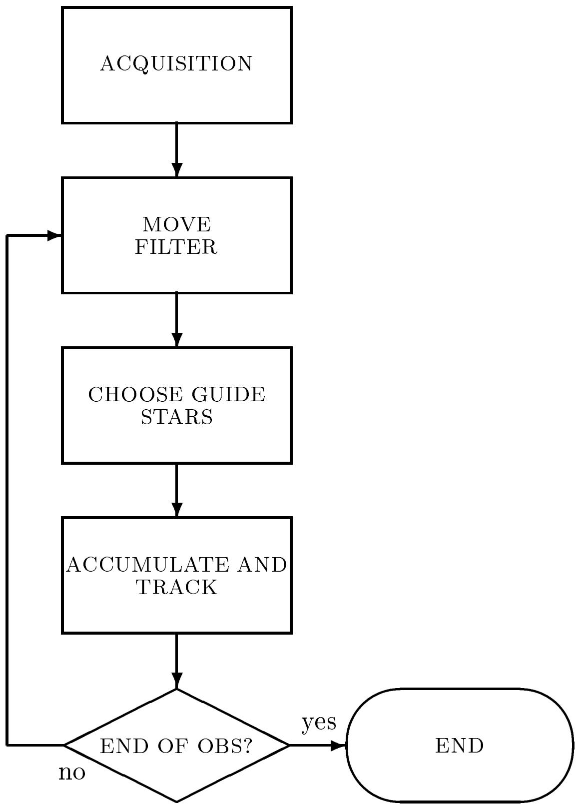
Table 35: Example Observation

<table>
<tr><th rowspan="2">Observation Phase</th><th rowspan="2">Associated Command Sequences</th><th colspan="2">Detector Status</th><th rowspan="2">Filter Wheel Position</th><th colspan="2">Science Data Status</th></tr>
<tr><th>Windows</th><th>Resolution</th><th>Priority</th><th>Regular</th></tr>
<tr><td>Acquisition</td><td>Acquisition</td><td rowspan="2">Four abutting windows covering the whole detector</td><td rowspan="2">Low</td><td>V Filter</td><td>–</td><td>–</td></tr>
<tr><td rowspan="2">Exposure 1</td><td>Choose Guide Stars</td><td rowspan="2">Observer Requested</td><td rowspan="2">Exposure 1 Downloading</td><td rowspan="2">–</td></tr>
<tr><td>Accumulate and Track</td><td>Observer requested + guiding</td><td>High</td></tr>
<tr><td>Between Exposures</td><td>–</td><td colspan="2">HV on
Data not sent to DPU</td><td>Last Observer Request</td><td>–</td><td rowspan="3">Exposure 1 Downloading</td></tr>
<tr><td>Exposure2</td><td>Choose Guide Stars</td><td>Four abutting windows covering the whole detector</td><td>Low</td><td rowspan="2">Observer Requested</td><td rowspan="2">Exposure2 Downloading</td></tr>
<tr><td></td><td>Accumulate and Track</td><td>Observer requested + guiding</td><td>High</td></tr>
<tr><td>Post Observation</td><td>Post Observation</td><td colspan="2">HV On
Data not sent to DPU</td><td>Blocked</td><td>–</td><td>Exposure2 Downloading</td></tr>
</table>

9.5 Overall Flow Diagram

The overall flow diagram is shown in Figure 1.

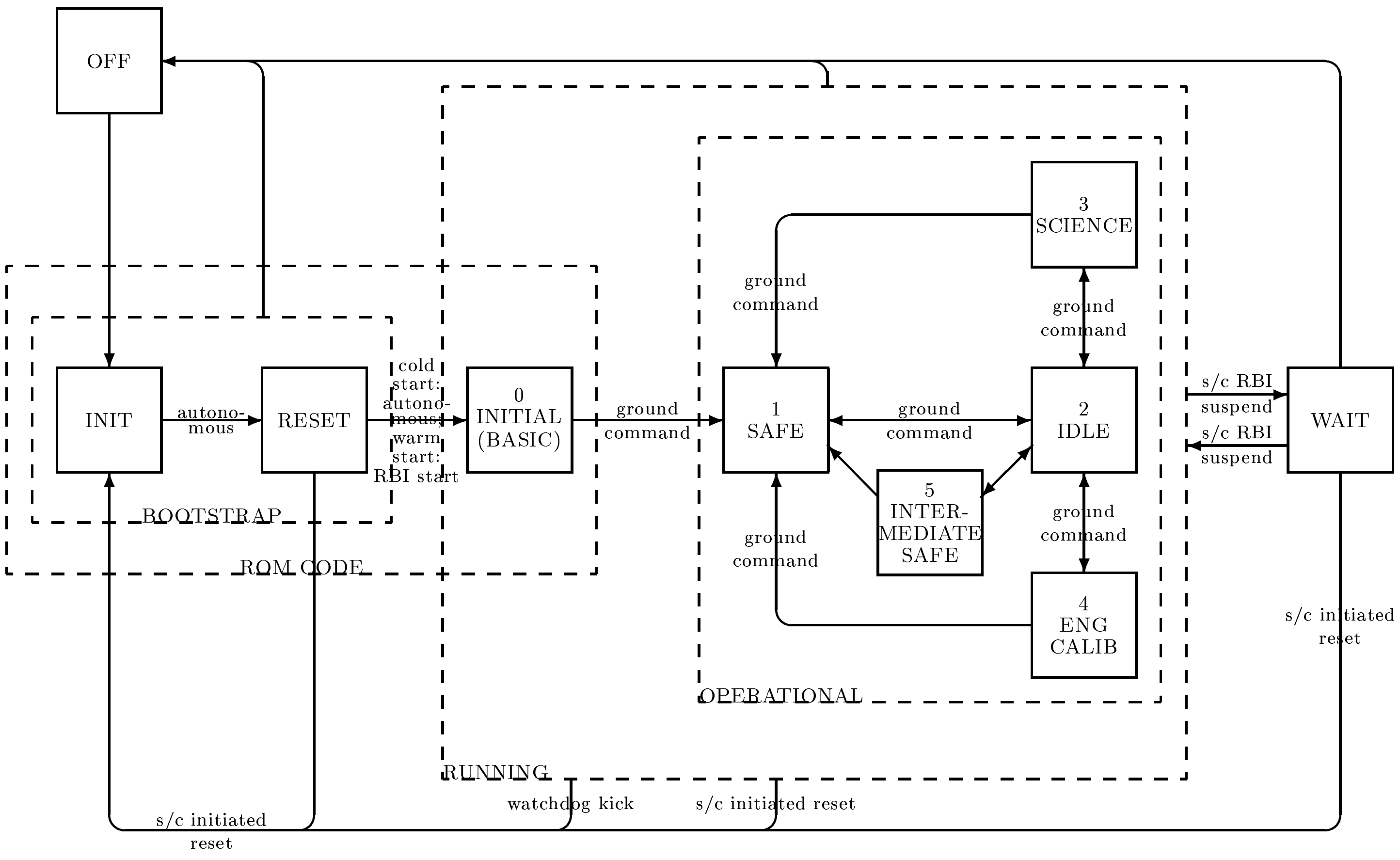
Figure 1: Overall Flow Diagram



9.6 OM FM Mode Transitions

The OM FM mode transitions are shown in Figure 2.

Figure 2: OM FM Mode Transitions



9.7 Acquisition

The threshold is normally 15. The frame time is normally 15.

The ICU is in "science" mode.

Description	**tc**	**tm**	**params**	**VxWorks**
Set acquisition mode	**h7130**		**"low res win"**	`tc_det_acq_mode 0`
Load window table parameters	**h7110**		***Table 37***	`det_reset_wind ;` `det_wind` *arg, arg, arg, arg ...*
Start load window table task	**h5110**			`tc_det_load_windows 4`
Wait up to 30 s for detector event		**92100**	**"win tab load"**	
Set filter wheel number for the V filter	**h7604**		**h280="V"**	`tc_fw_filter 1`
Move the filter wheel	**h5600**			`tc_fw_move`
Wait up to 20 s for TMPSU event (housekeeping may be suspended for up to 10 s)		**92600**	**h7010="FW @ req pos"**	
Set BPE binning 0	**h7257**		**h540="No binning"**	`tc_set_bpe 0`
Set the exposure id	**h7238**		**h530=*exposure_number***	`tc_set_exp_no` *exposure_id*
Ensure frame tags are enabled	**h7135**		**h16="enabled"**	`tc_det_enbl_frame_tag 1`
Set threshold	**h7131**		**h120=*threshold***	`tc_det_event_threshold` *threshold*
Load the reference stars	**h7240**		***Table 38***	`tc_prog_ref_stars` *file*
Set the DPU frame time (in units of 1/1024 s)	**h7236**		**h710=*frame_time***	`tc_set_frame_time` *frame_time*
Prepare the DPU for acquiring low resolution data	**h7249**			`tc_send_command IC_INIT_EXP`
Wait 3 s				
Start the detector integration	**h5130**			`tc_det_start_int`
Initiate acquire field	**h7250**			`tc_send_command IC_ACQUIRE_FLD` or `tc_acquire_field`
Wait for (*frame_time* + 1) s for the end of integration		**92211**		
Stop integration		**h6130**		`tc_det_stop_int`
Wait 60 s for DA_EOT_ACQUIRE_FLD		**92211**		`tm_wait_for_alert DA_EOT_ACQUIRE_FLD`
Receive priority science data (acquisition data)		**97402**		

The ICU is in "science" mode.

Table 37: Window Table 1024 x 1024

Description	**Params**	**Value**	
		Prime	**Redundant**
Verification	h10	"enable"	"enable"
Number of windows	h40	4	4
Window 1 Xlow	h50	52	64
Window 1 Ylow	h51	27	15
Window 1 Xsize	h52	128	128
Window 1 Ysize	h53	128	128
Window 2 Xlow	h54	52	64
Window 2 Ylow	h55	155	143
Window 2 Xsize	h56	128	128
Window 2 Ysize	h57	128	128
Window 3 Xlow	h58	180	192
Window 3 Ylow	h59	27	15
Window 3 Xsize	h60	128	128
Window 3 Ysize	h61	128	128
Window 4 Xlow	h62	180	192
Window 4 Ylow	h63	155	143
Window 4 Xsize	h64	128	128
Window 4 Ysize	h65	128	128

Table 38: Reference Stars

Description	PARAMS
Verification	**h10**
Number of reference stars	**h1160**
X co-ordinate of reference star 1	**h1095**
Y co-ordinate of reference star 1	**h1096**
X co-ordinate of reference star 2	**h1097**
Y co-ordinate of reference star 2	**h1098**
X co-ordinate of reference star 3	**h1099**
Y co-ordinate of reference star 3	**h1100**
X co-ordinate of reference star 4	**h1101**
Y co-ordinate of reference star 4	**h1102**
X co-ordinate of reference star 5	**h1103**
Y co-ordinate of reference star 5	**h1104**
X co-ordinate of reference star 6	**h1105**
Y co-ordinate of reference star 6	**h1106**
X co-ordinate of reference star 7	**h1107**
Y co-ordinate of reference star 7	**h1108**
X co-ordinate of reference star 8	**h1109**
Y co-ordinate of reference star 8	**h1110**
X co-ordinate of reference star 9	**h1111**
Y co-ordinate of reference star 9	**h1112**
X co-ordinate of reference star 10	**h1113**
Y co-ordinate of reference star 10	**h1114**
X co-ordinate of reference star 11	**h1115**
Y co-ordinate of reference star 11	**h1116**
X co-ordinate of reference star 12	**h1117**
Y co-ordinate of reference star 12	**h1118**
X co-ordinate of reference star 13	**h1119**
Y co-ordinate of reference star 13	**h1120**
X co-ordinate of reference star 14	**h1121**
Y co-ordinate of reference star 14	**h1122**
X co-ordinate of reference star 15	**h1123**
Y co-ordinate of reference star 15	**h1124**
X co-ordinate of reference star 16	**h1125**
Y co-ordinate of reference star 16	**h1126**
X co-ordinate of reference star 17	**h1127**
Y co-ordinate of reference star 17	**h1128**
X co-ordinate of reference star 18	**h1129**
Y co-ordinate of reference star 18	**h1130**
X co-ordinate of reference star 19	**h1131**
Y co-ordinate of reference star 19	**h1132**
X co-ordinate of reference star 20	**h1133**

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(continued)

Description	PARAMS
Y co-ordinate of reference star 20	**h1134**
X co-ordinate of reference star 21	**h1135**
Y co-ordinate of reference star 21	**h1136**
X co-ordinate of reference star 22	**h1137**
Y co-ordinate of reference star 22	**h1138**
X co-ordinate of reference star 23	**h1139**
Y co-ordinate of reference star 23	**h1140**
X co-ordinate of reference star 24	**h1141**
Y co-ordinate of reference star 24	**h1142**
X co-ordinate of reference star 25	**h1143**
Y co-ordinate of reference star 25	**h1144**
X co-ordinate of reference star 26	**h1145**
Y co-ordinate of reference star 26	**h1146**
X co-ordinate of reference star 27	**h1147**
Y co-ordinate of reference star 27	**h1148**
X co-ordinate of reference star 28	**h1149**
Y co-ordinate of reference star 28	**h1150**
X co-ordinate of reference star 29	**h1151**
Y co-ordinate of reference star 29	**h1152**
X co-ordinate of reference star 30	**h1153**
Y co-ordinate of reference star 30	**h1154**
X co-ordinate of reference star 31	**h1155**
Y co-ordinate of reference star 31	**h1156**
X co-ordinate of reference star 32	**h1157**
Y co-ordinate of reference star 32	**h1158**

9.8 Move Filter

The ICU is in "science" mode.

Description	**tc**	**tm**	**params**	**VxWorks**
Set filter number	**h7604**		**h280=*filter***	`tc_fw_filter` *filter*
Move the filter wheel	**h5600**			`tc_fw_move`
Wait up to 20 s for TMPSU event (housekeeping may be suspended for up to 10 s)		**92600**	**h7010="FW @ req pos"**	

The ICU is in "science" mode.

9.9 Choose Guide Stars

The ICU is in "science" mode.

Description	tc	tm	params	VxWorks
Set acquisition mode	**h7130**		**"low res win"**	`tc_det_acq_mode 0`
Load window table parameters	**h7110**		***Table 37***	`det_reset_wind ;` `det_wind` *arg, arg, arg, arg ...*
Start load window table task	**h5110**			`tc_det_load_windows 4`
Wait up to 30 s for detector event		**92100**	**"win tab load"**	
Set the exposure id	**h7238**		**h530=*exposure_number***	`tc_set_exp_no` *exposure_id*
Send IC_INIT_EXP	**h7249**			`tc_send_command IC_INIT_EXP`
Wait 3 s				
Ensure frame tags are enabled	**h7135**		**h16="enabled"**	`tc_det_enbl_frame_tag 1`
Set threshold	**h7131**		**h120=*threshold***	`tc_det_event_threshold` *threshold*
Set the DPU frame time (in units of 1/1024 s)	**h7236**		**h710=*frame_time***	`tc_set_frame_time` *frame_time*
Load the memory windows	**h7242**		***Table 41***	`tc_prog_mem_wind` ''*file*''
Load the science windows	**h7243**		***Table 42***	`tc_prog_sci_wind` ''*file*''
Set the exposure duration (in frames)	**h7237**		**h720=*number_of_frames***	`tc_set_exposure_time`
Set BPE binning 0	**h7257**		**h540="No binning"**	`tc_set_bpe 0`
Start the detector integration task	**h5130**			`tc_det_start_int`
Enable choose guide stars task	**h7251**			`tc_send_command IC_CHOOSE_GS`
Wait up to (*frame_time* + 40 + 40) s for DPU event report DA_EOT_CHOOSE_GS		**92212**		`tm_wait_for_alert DA_EOT_CHOOSE_GS`
Look for priority science data (window data)		**97401**		
Look for window table loaded event		**92100**	**h7000="win tab load"**	
Stop integration		**h6130**		`tc_det_stop_int`

The ICU is in "science" mode.

Table 42: Load Science Windows

Description	Params
Number of science windows (max 5)	**h1161**
Window 1 bottom left x coord	**h1050**
Window 1 bottom left y coord	**h1051**
coninued on next page	

(continued)

Description	PARAMS
Window 1 x size (centroided pixels)	**h1052**
Window 1 y size (centroided pixels)	**h1053**
Window 1 operation mode	**h1070**
Window 1 mode-dependent parameter	**h1071**
Window 1 mode-dependent parameter	**h1072**
Window 1 mode-dependent parameter	**h1073**
Window 1 mode-dependent parameter	**h1074**
Window 1 address in DPU RAM	
Window 1 memory window ID	
Window 2 bottom left x coord	**h1054**
Window 2 bottom left y coord	**h1055**
Window 2 x size (centroided pixels)	**h1056**
Window 2 y size (centroided pixels)	**h1057**
Window 2 operation mode	**h1075**
Window 2 mode-dependent parameter	**h1076**
Window 2 mode-dependent parameter	**h1077**
Window 2 mode-dependent parameter	**h1078**
Window 2 mode-dependent parameter	**h1079**
Window 2 address in DPU RAM	
Window 2 memory window ID	
Window 3 bottom left x coord	**h1058**
Window 3 bottom left y coord	**h1059**
Window 3 x size (centroided pixels)	**h1060**
Window 3 y size (centroided pixels)	**h1061**
Window 3 operation mode	**h1080**
Window 3 mode-dependent parameter	**h1081**
Window 3 mode-dependent parameter	**h1082**
Window 3 mode-dependent parameter	**h1083**
Window 3 mode-dependent parameter	**h1084**
Window 3 address in DPU RAM	
Window 3 memory window ID	
Window 4 bottom left x coord	**h1062**
Window 4 bottom left y coord	**h1063**
Window 4 x size (centroided pixels)	**h1064**
Window 4 y size (centroided pixels)	**h1065**
Window 4 operation mode	**h1085**
Window 4 mode-dependent parameter	**h1086**
Window 4 mode-dependent parameter	**h1087**
Window 4 mode-dependent parameter	**h1088**
Window 4 mode-dependent parameter	**h1089**
Window 4 address in DPU RAM	

coninued on next page

(continued)

Description	**PARAMS**
Window 4 memory window ID	
Window 5 bottom left x coord	**h1066**
Window 5 bottom left y coord	**h1067**
Window 5 x size (centroided pixels)	**h1068**
Window 5 y size (centroided pixels)	**h1069**
Window 5 operation mode	**h1090**
Window 5 mode-dependent parameter	**h1091**
Window 5 mode-dependent parameter	**h1092**
Window 5 mode-dependent parameter	**h1093**
Window 5 mode-dependent parameter	**h1094**
Window 5 address in DPU RAM	
Window 5 memory window ID	

Table 41: Load Memory Windows

Description	**Params**
Number of memory windows (max 5)	**h1159**
Window 1 bottom left x coord	**h1050**
Window 1 bottom left y coord	**h1051**
Window 1 x size (centroided pixels)	**h1052**
Window 1 y size (centroided pixels)	**h1053**
Window 1 address in DPU RAM	
Window 2 bottom left x coord	**h1054**
Window 2 bottom left y coord	**h1055**
Window 2 x size (centroided pixels)	**h1056**
Window 2 y size (centroided pixels)	**h1057**
Window 2 address in DPU RAM	
Window 3 bottom left x coord	**h1058**
Window 3 bottom left y coord	**h1059**
Window 3 x size (centroided pixels)	**h1060**
Window 3 y size (centroided pixels)	**h1061**
Window 3 address in DPU RAM	
Window 4 bottom left x coord	**h1062**
Window 4 bottom left y coord	**h1063**
Window 4 x size (centroided pixels)	**h1064**
Window 4 y size (centroided pixels)	**h1065**
Window 4 address in DPU RAM	
Window 5 bottom left x coord	**h1066**
Window 5 bottom left y coord	**h1067**
Window 5 x size (centroided pixels)	**h1068**
Window 5 y size (centroided pixels)	**h1069**
Window 5 address in DPU RAM	

9.10 Accumulate and Track

The ICU is in "science" mode.

Description	tc	tm	params	VxWorks
Set the acquisition mode to high resolution windowed	**h7130**		**h110="Hi Res Win"**	`tc_det_acq_mode 2`
Set BPE binning 0	**h7257**		**h540="No binning"**	`tc_set_bpe 0`
Enable frame tags	**h7135**		**h16="enabled"**	`tc_det_enbl_frame_tag 1`
Set threshold	**h7131**		**h120=15**	`tc_det_event_threshold 15`
Start the detector integration task	**h5130**			`tc_det_start_int`
Enable track guide stars task	**h7252**			`tc_send_command IC_TRACK_GS`
Wait up to (frame_time $\times$ (exposure_time + 1) + 10) s for DPU event report end of exposure		**92205**		`tm_wait_for_alert DA_COMPLETE_EXP`
Turn on tracking	**h7256**		**h1040="on"**	`tc_set_trk 1`

The ICU is in "science" mode.

9.11 Flatfielding

The LED current value of 4 may need to be changed after commissioning.

The ICU is in "science" mode. The filter wheel must be in the "blocked" position.

Description	tc	tm	params	VxWorks
Set the filter wheel to blocked	**h7604**		**h280="Blocked"**	`tc_fw_filter 0`
Move the filter wheel (housekeeping may be suspended for up to 10 s)	**h5600**			`tc_fw_move`
Wait up to 20 s for TMPSU event report		**92600**	**h7010="fw @ req pos"**	
Check HK		**90000**	**h5265=1200 ("blocked")**	
Set BPE binning	**h7257**		**h540="binning"**	`tc_set_bpe 1`
Change to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Turn on flood LEDs to level 4 (approx 20 000 count s^{-1})	**h7134**		**h1040=*current***	`tc_det_flood_led_current` *current*
Change to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Change to ICU mode 3 ("science")	**h9003**			`tc_mode 3`

Run the following standard exposure ("Choose Guide Stars followed by "Accumulate and Track") 4 times, the first time with the science windows in Table 48, the second time with the science windows in Table 49, the third time with the science windows in Table 50, and the fourth and last time with the science windows in Table 51.

Description	tc	tm	params	VxWorks
Turn off tracking	**h7256**		**h1040="off"**	`tc_set_trk 0`
Set acquisition mode	**h7130**		**"low res win"**	`tc_det_acq_mode 0`
Load window table parameters	**h7110**		***Table 37***	`det_reset_wind ;` `det_wind` *arg, arg, arg, arg ...*
Start load window table task	**h5110**			`tc_det_load_windows 4`
Wait up to 30 s for detector event		**92100**	**"win tab load"**	
Set the exposure id	**h7238**		**h530=*exposure_number***	`tc_set_exp_no` *exposure_id*
Send IC_INIT_EXP	**h7249**			`tc_send_command IC_INIT_EXP`
Wait 3 s				
Ensure frame tags are enabled	**h7135**		**h16="enabled"**	`tc_det_enbl_frame_tag 1`
Set threshold	**h7131**		**h120=*threshold***	`tc_det_event_threshold` *threshold*
Set the DPU frame time (in units of 1/1024 s)	**h7236**		**h710=*frame_time***	`tc_set_frame_time` *frame_time*
continued on next page				

(continued)

Description	tc	tm	params	VxWorks
Load the memory windows	**h7242**		*Table 41*	`tc_prog_mem_wind ''file''`
Load the science windows	**h7243**		*Table 42*	`tc_prog_sci_wind ''file''`
Set the exposure duration (in frames)	**h7237**		**h720=*number_of_frames***	`tc_set_exposure_time`
Set BPE binning 0	**h7257**		**h540="No binning"**	`tc_set_bpe 0`
Start the detector integration task	**h5130**			`tc_det_start_int`
Enable choose guide stars task	**h7251**			`tc_send_command IC_CHOOSE_GS`
Wait up to (*frame_time* + 40 + 40) s for DPU event report DA_EOT_CHOOSE_GS		**92212**		`tm_wait_for_alert DA_EOT_CHOOSE_GS`
Look for priority science data (window data)		**97401**		
Look for window table loaded event		**92100**	**h7000="win tab load"**	
Stop integration		**h6130**		`tc_det_stop_int`
Set the acquisition mode to high resolution windowed	**h7130**		**h110="Hi Res Win"**	`tc_det_acq_mode 2`
Set BPE binning 0	**h7257**		**h540="No binning"**	`tc_set_bpe 0`
Enable frame tags	**h7135**		**h16="enabled"**	`tc_det_enbl_frame_tag 1`
Set threshold	**h7131**		**h120=15**	`tc_det_event_threshold 15`
Start the detector integration task	**h5130**			`tc_det_start_int`
Enable track guide stars task	**h7252**			`tc_send_command IC_TRACK_GS`
Wait up to (frame_time × (exposure_time + 1) + 10) s for DPU event report end of exposure		**92205**		`tm_wait_for_alert DA_COMPLETE_EXP`
Turn on tracking	**h7256**		**h1040="on"**	`tc_set_trk 1`

Description	tc	tm	params	VxWorks
Set BPE binning 0	**h7257**		**h540="No binning"**	`tc_set_bpe 0`
Change to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Turn off flood LEDs	**h7134**		**h1040=0**	`tc_det_flood_led_current 0`
Change to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Change to ICU mode 3 ("science")	**h9003**			`tc_mode 3`

The ICU is in “science” mode.

Table 47: Flatfield Memory Windows

Description	**Params**
Number of memory windows	**h1159 = 1**
Window 1 bottom left x coord	**h1050 = 0**
Window 1 bottom left y coord	**h1051 = 0**
Window 1 x size (centroided pixels)	**h1052 = 1024**
Window 1 y size (centroided pixels)	**h1053 = 1024**
Window 1 address in DPU RAM	0

Table 48: Flatfield Science Windows 1

Description	**Params**
Number of science windows	**h1161 = 4**
Window 1 bottom left x coord	**h1050 = 0**
Window 1 bottom left y coord	**h1051 = 0**
Window 1 x size (centroided pixels)	**h1052 = 64**
Window 1 y size (centroided pixels)	**h1053 = 1024**
Window 1 operation mode	**h1070 = 0**
Window 1 mode-dependent parameter	**h1071 = 0**
Window 1 mode-dependent parameter	**h1072 = 0**
Window 1 mode-dependent parameter	**h1073 = 0**
Window 1 mode-dependent parameter	**h1074 = 0**
Window 1 address in DPU RAM	0
Window 1 memory window ID	0
Window 2 bottom left x coord	**h1054 = 64**
Window 2 bottom left y coord	**h1055 = 0**
Window 2 x size (centroided pixels)	h**1056 = 64**
Window 2 y size (centroided pixels)	**h1057 = 1024**
Window 2 operation mode	**h1075 = 0**
Window 2 mode-dependent parameter	**h1076 = 0**
Window 2 mode-dependent parameter	**h1077 = 0**
Window 2 mode-dependent parameter	**h1078 = 0**
Window 2 mode-dependent parameter	**h1079 = 0**
Window 2 address in DPU RAM	0
Window 2 memory window ID	0
Window 3 bottom left x coord	**h1058 = 128**
Window 3 bottom left y coord	**h1059 = 0**
Window 3 x size (centroided pixels)	**h1060 = 64**
Window 3 y size (centroided pixels)	**h1061 = 1024**
Window 3 operation mode	**h1080 = 0**

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(continued)

Description	Params
Window 3 mode-dependent parameter	**h1081 = 0**
Window 3 mode-dependent parameter	**h1082 = 0**
Window 3 mode-dependent parameter	**h1083 = 0**
Window 3 mode-dependent parameter	**h1084 = 0**
Window 3 address in DPU RAM	0
Window 3 memory window ID	0
Window 4 bottom left x coord	**h1062 = 192**
Window 4 bottom left y coord	**h1063 = 0**
Window 4 x size (centroided pixels)	**h1064 = 64**
Window 4 y size (centroided pixels)	**h1065 = 1024**
Window 4 operation mode	**h1085 = 0**
Window 4 mode-dependent parameter	**h1086 = 0**
Window 4 mode-dependent parameter	**h1087 = 0**
Window 4 mode-dependent parameter	**h1088 = 0**
Window 4 mode-dependent parameter	**h1089 = 0**
Window 4 address in DPU RAM	0
Window 4 memory window ID	0

Table 49: Flatfield Science Windows 2

Description	Params
Number of science windows	**h1161 = 4**
Window 1 bottom left x coord	**h1050 = 256**
Window 1 bottom left y coord	**h1051 = 0**
Window 1 x size (centroided pixels)	**h1052 = 64**
Window 1 y size (centroided pixels)	**h1053 = 1024**
Window 1 operation mode	**h1070 = 0**
Window 1 mode-dependent parameter	**h1071 = 0**
Window 1 mode-dependent parameter	**h1072 = 0**
Window 1 mode-dependent parameter	**h1073 = 0**
Window 1 mode-dependent parameter	**h1074 = 0**
Window 1 address in DPU RAM	0
Window 1 memory window ID	0
Window 2 bottom left x coord	**h1054 = 320**
Window 2 bottom left y coord	**h1055 = 0**
Window 2 x size (centroided pixels)	**h1056 = 64**
Window 2 y size (centroided pixels)	**h1057 = 1024**
Window 2 operation mode	**h1075 = 0**
Window 2 mode-dependent parameter	**h1076 = 0**
Window 2 mode-dependent parameter	**h1077 = 0**
Window 2 mode-dependent parameter	**h1078 = 0**

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(continued)

Description	Params
Window 2 mode-dependent parameter	**h1079 = 0**
Window 2 address in DPU RAM	0
Window 2 memory window ID	0
Window 3 bottom left x coord	**h1058 = 384**
Window 3 bottom left y coord	**h1059 = 0**
Window 3 x size (centroided pixels)	**h1060 = 64**
Window 3 y size (centroided pixels)	**h1061 = 1024**
Window 3 operation mode	**h1080 = 0**
Window 3 mode-dependent parameter	**h1081 = 0**
Window 3 mode-dependent parameter	**h1082 = 0**
Window 3 mode-dependent parameter	**h1083 = 0**
Window 3 mode-dependent parameter	**h1084 = 0**
Window 3 address in DPU RAM	0
Window 3 memory window ID	0
Window 4 bottom left x coord	**h1062 = 448**
Window 4 bottom left y coord	**h1063 = 0**
Window 4 x size (centroided pixels)	**h1064 = 64**
Window 4 y size (centroided pixels)	**h1065 = 1024**
Window 4 operation mode	**h1085 = 0**
Window 4 mode-dependent parameter	**h1086 = 0**
Window 4 mode-dependent parameter	**h1087 = 0**
Window 4 mode-dependent parameter	**h1088 = 0**
Window 4 mode-dependent parameter	**h1089 = 0**
Window 4 address in DPU RAM	0
Window 4 memory window ID	0

Table 50: Flatfield Science Windows 3

Description	Params
Number of science windows	**h1161 = 4**
Window 1 bottom left x coord	**h1050 = 512**
Window 1 bottom left y coord	**h1051 = 0**
Window 1 x size (centroided pixels)	**h1052 = 64**
Window 1 y size (centroided pixels)	**h1053 = 1024**
Window 1 operation mode	**h1070 = 0**
Window 1 mode-dependent parameter	**h1071 = 0**
Window 1 mode-dependent parameter	**h1072 = 0**
Window 1 mode-dependent parameter	**h1073 = 0**
Window 1 mode-dependent parameter	**h1074 = 0**
Window 1 address in DPU RAM	0
Window 1 memory window ID	0

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(continued)

Description	Params
Window 2 bottom left x coord	**h1054 = 576**
Window 2 bottom left y coord	**h1055 = 0**
Window 2 x size (centroided pixels)	**h1056 = 64**
Window 2 y size (centroided pixels)	**h1057 = 1024**
Window 2 operation mode	**h1075 = 0**
Window 2 mode-dependent parameter	**h1076 = 0**
Window 2 mode-dependent parameter	**h1077 = 0**
Window 2 mode-dependent parameter	**h1078 = 0**
Window 2 mode-dependent parameter	**h1079 = 0**
Window 2 address in DPU RAM	0
Window 2 memory window ID	0
Window 3 bottom left x coord	**h1058 = 640**
Window 3 bottom left y coord	**h1059 = 0**
Window 3 x size (centroided pixels)	**h1060 = 64**
Window 3 y size (centroided pixels)	**h1061 = 1024**
Window 3 operation mode	**h1080 = 0**
Window 3 mode-dependent parameter	**h1081 = 0**
Window 3 mode-dependent parameter	**h1082 = 0**
Window 3 mode-dependent parameter	**h1083 = 0**
Window 3 mode-dependent parameter	**h1084 = 0**
Window 3 address in DPU RAM	0
Window 3 memory window ID	0
Window 4 bottom left x coord	**h1062 = 704**
Window 4 bottom left y coord	**h1063 = 0**
Window 4 x size (centroided pixels)	**h1064 = 64**
Window 4 y size (centroided pixels)	**h1065 = 1024**
Window 4 operation mode	**h1085 = 0**
Window 4 mode-dependent parameter	**h1086 = 0**
Window 4 mode-dependent parameter	**h1087 = 0**
Window 4 mode-dependent parameter	**h1088 = 0**
Window 4 mode-dependent parameter	**h1089 = 0**
Window 4 address in DPU RAM	0
Window 4 memory window ID	0

Table 51: Flatfield Science Windows 4

Description	Params
Number of science windows	**h1161 = 4**
Window 1 bottom left x coord	**h1050 = 768**
Window 1 bottom left y coord	**h1051 = 0**
Window 1 x size (centroided pixels)	**h1052 = 64**

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(continued)

Description	Params
Window 1 y size (centroided pixels)	**h1053 = 1024**
Window 1 operation mode	**h1070 = 0**
Window 1 mode-dependent parameter	**h1071 = 0**
Window 1 mode-dependent parameter	**h1072 = 0**
Window 1 mode-dependent parameter	**h1073 = 0**
Window 1 mode-dependent parameter	**h1074 = 0**
Window 1 address in DPU RAM	0
Window 1 memory window ID	0
Window 2 bottom left x coord	**h1054 = 832**
Window 2 bottom left y coord	**h1055 = 0**
Window 2 x size (centroided pixels)	**h1056 = 64**
Window 2 y size (centroided pixels)	**h1057 = 1024**
Window 2 operation mode	**h1075 = 0**
Window 2 mode-dependent parameter	**h1076 = 0**
Window 2 mode-dependent parameter	**h1077 = 0**
Window 2 mode-dependent parameter	**h1078 = 0**
Window 2 mode-dependent parameter	**h1079 = 0**
Window 2 address in DPU RAM	0
Window 2 memory window ID	0
Window 3 bottom left x coord	**h1058 = 896**
Window 3 bottom left y coord	**h1059 = 0**
Window 3 x size (centroided pixels)	**h1060 = 64**
Window 3 y size (centroided pixels)	**h1061 = 1024**
Window 3 operation mode	**h1080 = 0**
Window 3 mode-dependent parameter	**h1081 = 0**
Window 3 mode-dependent parameter	**h1082 = 0**
Window 3 mode-dependent parameter	**h1083 = 0**
Window 3 mode-dependent parameter	**h1084 = 0**
Window 3 address in DPU RAM	0
Window 3 memory window ID	0
Window 4 bottom left x coord	**h1062 = 960**
Window 4 bottom left y coord	**h1063 = 0**
Window 4 x size (centroided pixels)	**h1064 = 64**
Window 4 y size (centroided pixels)	**h1065 = 1024**
Window 4 operation mode	**h1085 = 0**
Window 4 mode-dependent parameter	**h1086 = 0**
Window 4 mode-dependent parameter	**h1087 = 0**
Window 4 mode-dependent parameter	**h1088 = 0**
Window 4 mode-dependent parameter	**h1089 = 0**
Window 4 address in DPU RAM	0
Window 4 memory window ID	0

9.12 Procedure for the End of Science Data Acquisition Period

At the end of the science data acquisition period of an orbit, care has to be taken that the science data of the last exposure of the last observation are compressed and are made available for downlinking. This can be ensured by forcing the flush compression queue, as follows:

The ICU is in "Science" mode (mode 3).

Description	tc	tm	params	VxWorks
Flush the compression queue	**h7255**			`tc_send_command IC_FLUSH_CMPRS`
Wait up to 1000 s for alert DA_EOT_FLUSH_CMPRS and data to come out		**92217**		`tm_wait_for_alert DA_EOT_FLUSH_CMPRS`
Change to ICU mode 2 ("idle")	**h9002**			`tc_mode 2`

The ICU is in "idle" mode.

9.13 Procedure for Slew

The ICU is in "idle" mode.

Description	tc	tm	params	VxWorks
Perform "Flatfielding" (see Section 9.11)				

The ICU is in "idle" mode.

If slews are very long we may want to consider doing high-resolution flatfields (see Section 9.14).

9.14 OM not used because of bright sources

If there isn't much time, using the blocked filter, perform "Flatfielding" (see Section 9.11). Approximately once per week, perform "Engineering Mode 5: Centroiding Confirmation Data" procedure (see Section 10.11) for longer than 4 ks. If there is time, perform many Engineering Mode 4 exposures (see Section 10.10) with the blocked filter and with the flood LEDs set to 4 for as long as possible.

9.15 Procedure for the Preparation for Perigee Passage

The remaining science data in the compressed data buffer should have already have been downloaded (see Section 9.12).

Time tagged "goto safe mode" commands are needed to ensure HV ramp down in case unexpected LOS occurs. This command will be scheduled at the instrument activiation period of an orbit and will be removed as part of the preparation for perigee passage procedure.

The ICU is in "idle" mode after performing the "End of Science Data Acquisition Period" procedure (see Section 9.12).

9.15.1 HV to 70% Prime only

Note: this is for prime only

Description	tc	tm	params	VxWorks
Specify $V_{cathode}$ ramp parameters	**h7140**		**h510="cathode", h160=0, h175="off"**	`tc_det_load_hv_ramp_params 1,0,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 120 s for event		**92100**	**h7000="cathode ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h510="mcp1", h160=364, h175="off"**	`tc_det_load_hv_ramp_params 2,364,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 60 s for event		**92100**	**h7000="mcp1 ok"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h510="mcp23, h160=1190, h175="off"**	`tc_det_load_hv_ramp_params 3,1190,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 60 s for event		**92100**	**h7000="mcp23 ok"**	
Change to ICU mode 5 ("intermediate safe") (housekeeping may be suspended for up to 10 s)	**h9005**			`tc_mode 5`
Wait up to 20 s for a $V_{cathode}$ event packet		**92100**	**h7000="Vcathode reached"**	
Wait up to 20 s for filter wheel event packet		**92600**	**h7010="fw at req pos"**	

9.15.2 HV to 70% Redundant only

Note: this is for redundant only

Description	tc	tm	params	VxWorks
Specify $V_{cathode}$ ramp parameters	**h7140**		**h510="cathode", h160=0, h175="off"**	`tc_det_load_hv_ramp_params 1,0,25,0`

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Description	**tc**	**tm**	**params**	**VxWorks**
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 120 s for event		**92100**	**h7000="cathode ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h510="mcp1", h160=385, h175="off"**	`tc_det_load_hv_ramp_params 2,385,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 60 s for event		**92100**	**h7000="mcp1 ok"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h510="mcp23, h160=1295, h175="off"**	`tc_det_load_hv_ramp_params 3,1295,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 60 s for event		**92100**	**h7000="mcp23 ok"**	
Change to ICU mode 5 ("intermediate safe") (housekeeping may be suspended for up to 10 s)	**h9005**			`tc_mode 5`
Wait up to 20 s for a $V_{cathode}$ event packet		**92100**	**h7000="Vcathode reached"**	
Wait up to 20 s for filter wheel event packet		**92600**	**h7010="fw at req pos"**	

9.15.3 Remove Tagged Safe command

Description	**tc**	**tm**	**params**	**VxWorks**
Spacecraft procedure: remove the MOC's time tagged "goto safe" command				

The ICU is in intermediate safe mode.

9.16 Post Perigee Procedure

The ICU is in "Intermediate Safe" mode.

9.16.1 Idle Mode

Description	**tc**	**tm**	**params**	**VxWorks**
Transition to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`

9.16.2 Memory Dump of ICU's Loadable Code

Send dump memory packets to dump out the ICU's operational mode (loadable) code.

Description	**tc**	**tm**	**params**	**VxWorks**
Multiple dump memory requests instruction space	**multi h4101**		**h500=*address*** **h510=*length***	
Multiple dump memory requests operand space	**multi h4100**		**h500=*address*** **h510=*length***	

Compare the memory dump report tm packets with the memory load packets. This is important because of NCR 82/174 (See Appendix D). Reset (see Section 9.3) the ICU and reload full code if a difference is found (see Section 6.2.4).

9.16.3 Memory Dump of DPU's Loadable Code

Send dump memory packets to dump out the DPU's uploadable OS and science code.

Description	**tc**	**tm**	**params**	**VxWorks**
Multiple Dump Bank 0 requests	**multi h4120**		**h500=*address*** **h510=*length***	
Multiple Dump Bank 3 requests	**multi h4123**		**h500=*address*** **h510=*length***	
Multiple Dump Bank 5 requests	**multi h4125**		**h500=*address*** **h510=*length***	
Multiple Dump Bank 7 requests	**multi h4127**		**h500=*address*** **h510=*length***	

Compare the memory dump report tm packets with the memory load packets. If a difference is found, reload full code (see Section 6.2.12) and perform "Clean Slate" (see Section 6.2.14) and "Time Verification" (see Section 6.2.15).

9.16.4 Time Verification

Perform Clock Resynchronisation (see Section 10.1).

Description	tc	tm	params	VxWorks
Send a tc (10, 5)				`tc_enable_time_verification`
Wait up to 2 s for a tm (10, 5)				
Check that the contents of the time management report packet and heartbeats are as expected				

9.16.5 HV

These HV ramp-ups are from 70% mcp voltage, 0 V cathode.

The following HV ramp-up is for the Prime Channel only.

Description	tc	tm	params	VxWorks
Check HK for temperatures in allowed range and if not, wait		**90000**	**h5135="−8 to +37 °C"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23" h160=1700 h175="off"**	`tc_det_load_hv_ramp_params 3, 1700, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 30 s for event		**92100**	**h7000="mcp23 ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h150="mcp1" h160=520 h175="off"**	`tc_det_load_hv_ramp_params 2, 520, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 10 s for event		**92100**	**h7000="mcp1 ok"**	
Specify $V_{cathode}$ ramp parameters	**h7140**		**h150="cathode" h160=396 h175="off"**	`tc_det_load_hv_ramp_params 1, 396, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 25 s for event		**92100**	**h7000="cathode ok"**	

The following HV ramp-up is for the Redundant Channel only.

Note: this should only be used if the prime channel fails.

Description	tc	tm	params	VxWorks
Check HK for temperatures in allowed range and if not, wait		**90000**	**h5135="−8 to +37 °C"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23" h160=1850 h175="off"**	`tc_det_load_hv_ramp_params 3, 1850, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 30 s for event		**92100**	**h7000="mcp23 ok"**	

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Description	tc	tm	params	VxWorks
Specify V_{mcp1} ramp parameters	**h7140**		**h150="mcp1" h160=550 h175="off"**	`tc_det_load_hv_ramp_params 2, 550, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 10 s for event		**92100**	**h7000="mcp1 ok"**	
Specify $V_{cathode}$ ramp parameters	**h7140**		**h150="cathode" h160=390 h175="off"**	`tc_det_load_hv_ramp_params 1, 390, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 25 s for event		**92100**	**h7000="cathode ok"**	

The ICU is in "idle" mode.

9.17 Post perigee engineering mode tests

The ICU is in "idle" mode.

9.17.1 Pulse Height Distribution

Description	tc	tm	params	VxWorks
Perform Engineering Mode 6 (see Section 10.12) 20 s exposure with filter in the blocked position, a threshold of 12 and flood LEDs at level 4				

9.17.2 LUT Update

This procedure calculates and loads the centroiding boundary lookup table.

Description	tc	tm	params	VxWorks
Perform "Engineering Mode 3: Channel Boundary Data" procedure (see Section 10.9)				
Perform "Engineering Mode 5: Centroiding Confirmation Data" procedure (see Section 10.11) for 4 ks				
Check the output on the ground				

9.17.3 Time Verification

Perform Clock Resynchronisation (see Section 10.1).

Description	tc	tm	params	VxWorks
Send a tc (10, 5)				`tc_enable_time_verification`
Wait up to 2 s for a tm (10, 5)				
Check that the contents of the time management report packet are as expected				

9.17.4 Dave

Description	tc	tm	params	VxWorks
Initialize DPU	**h7248**			`tc_init_dpu`
Wait up to 25 s for DA_EOT_INIT_DPU event		**92210**		`tm_wait_for_alert DA_EOT_INIT_DPU` ("Dave from the Grave")

The ICU is in "idle" mode.

9.17.5 Science Mode

The ICU is in "idle" mode.

Description	tc	tm	params	VxWorks
Change to ICU mode 3 ("science")	**h9003**			`tc_mode 3`

The ICU is in "science mode".

9.18 Procedure for the Preparation for Eclipse

Before transition into eclipse, Optical Monitor has to be switched off by invoking the "Nominal Switch Off Procedure" (see Section 9.2). The remaining data in the compressed data queue buffer have been already sent down ("flushed"—see Section 9.12).

The ICU is in "idle" mode after performing the "End of Science Data Acquisition Period" procedure (see Section 9.12).

Description	**tc**	**tm**	**params**	**VxWorks**
Perform "Nominal Switch Off Procedure" (see Section 9.2)				

The ICU is off.

9.19 Procedure for Activation After Eclipse

Wait until after the perigee LOS.

The ICU is off.

9.19.1 Switch On

Description	**tc**	**tm**	**params**	**VxWorks**
Perform the "Nominal Switch On" procedure (see Section 9.1)				

The ICU is in "initial" mode.

9.19.2 Time Verification

Description	**tc**	**tm**	**params**	**VxWorks**
Perform Clock Resynchronisation (see Section 10.1)				
Send a tc (10, 5)				`tc_enable_time_verification`
Wait up to 2 s for a tm (10, 5)				
Check that the contents of the time management report packet are as expected				

9.19.3 Memory Dump of ICU's Loadable Code

Send dump memory packets to dump out the ICU's operational mode (loadable) code.

Description	**tc**	**tm**	**params**	**VxWorks**
Multiple dump memory requests instruction space	**multi h4101**		**h500=*address*** **h510=*length***	
Multiple dump memory requests operand space	**multi h4100**		**h500=*address*** **h510=*length***	

Compare the memory dump report tm packets with the memory load packets. This is important because of NCR 82/174 (See Appendix D). If a difference is found, reset (see Section 9.3) the ICU and reload full code (see Section 6.2.4).

9.19.4 Operational Mode

The ICU is in "initial" mode.

Description	**tc**	**tm**	**params**	**VxWorks**
Mode change to 1 ("full safe")	**h9001**			`tc_mode 1`
Wait up to 20 s				
Check HK		**90000**	**h5405="Operational"**	

The ICU is in "full safe" mode.

The DPU status is invalid.

9.19.5 Time Verification

Description	**tc**	**tm**	**params**	**VxWorks**
Perform Clock Resynchronisation (see Section 10.1)				
Send a tc (10, 5)				`tc_enable_time_verification`
Wait up to 2 s for a tm (10, 5)				
Check that the contents of the time management report packet are as expected				
Expect a tm (4,2) a584 from the DPU		**92226**	**h7725=A40E**$_{hex}$	

9.19.6 NCR 176 fix

Description	**tc**	**tm**	**params**	**VxWorks**
Fix the DPU status (see NCR 176)	**h7217**		**h630=5AEE**$_{hex}$, **h640=0**	`tc_load_mem 0x13, 0x5aee, 0`

The DPU status is valid.

9.19.7 Memory Dump of DPU's Loadable Code

Send dump memory packets to dump out the DPU's uploadable OS and science code.

Description	tc	tm	params	VxWorks
Multiple Dump Bank 0 requests	**multi h4120**		**h500=*address* h510=*length***	
Multiple Dump Bank 3 requests	**multi h4123**		**h500=*address* h510=*length***	
Multiple Dump Bank 5 requests	**multi h4125**		**h500=*address* h510=*length***	
Multiple Dump Bank 7 requests	**multi h4127**		**h500=*address* h510=*length***	

Compare the memory dump report tm packets with the memory load packets. If a difference is found, reload full code (see Section 6.2.12) and perform "Clean Slate" (see Section 6.2.14) and "Time Verification" (see Section 6.2.15).

6.2.12).

9.19.8 Clean Slate

Description	tc	tm	params	VxWorks
Switch to the uploadable code	**h7202**			`tc_load_dpuos`
Wait up to 10 s for DA_DPUOS_READY		**92202**		Expect "Jim from the Rim"
Enable red dsp	**h7207**		**h522="Red" h16="Enabled"**	`tc_enbl_dsp red,1`
Wait 10 s				
Enable blue1 dsp	**h7207**		**h522="Blue1" h16="Enabled"**	`tc_enbl_dsp blue1,1`
Wait 10 s				
Enable blue2 dsp	**h7207**		**h522="Blue2" h16="Enabled"**	`tc_enbl_dsp blue2,1`
Wait 10 s				
Select blue2 as the klingon [3]	**h7206**		**h523="blue2"**	`tc_sel_klingon 2`
Initialize DPU	**h7248**			`tc_init_dpu`
Wait up to 25 s for DA_EOT_INIT_DPU event		**92210**		`tm_wait_for_alert DA_EOT_INIT_DPU` ("Dave from the Grave")
continued on next page				

[3] The klingon in DPUOS is the processor that 1) finishes the memory access and 2) holds on to the bus until the arbiter informs him to give up. The default is white which is the one with the most complicated task. We have to change from the white to blue2 (note not blue1) so that the BUS IO interrupt will occur always at a know location. This is the result of DPU spontaneous reset at the busy spot, i.e. NCR125. The sel_klingon command needs to be sent because the White processor is the default at power up. By switching to Blue2 we are able to improve the accuracy of the DPU timing. The DPU timing is based on the number of millisecond bus cycles that have occurred. The Klingon holds onto the bus until the next millisecond interrupt occurs. When the interrupt is recognized the bus is passed to the next processor (order is White, Red, Blue1, Blue2, set by hardware) which would be White. This scheme minimizes the latency and jitter in the Whites bus cycle count. The White processor runs the "Traffic Cop" software that does all the timing for the exposure.

(continued)

Description	tc	tm	params	VxWorks
(Watch out for NCR 94 crash—see Section 11 and Appendix B)				
Turn on reference frame verbosity (DD_REF)	**h7244**		**h760=3 h16="enable"**	`tc_enbl_verbose 3, 1`

9.19.9 Time Verification

Perform Clock Resynchronisation (see Section 10.1).

Description	tc	tm	params	VxWorks
Send a tc (10, 5)				`tc_enable_time_verification`
Wait up to 2 s for a tm (10, 5)				
Check that the contents of the time management report packet and heartbeats are as expected				

9.19.10 Filter Wheel to Datum

Description	tc	tm	params	VxWorks
Specify next move of the filter wheel to the datum position	**h7608**			`tc_fw_to_datum`
Command the filter wheel to move	**h5600**			`tc_fw_move`
Wait up to 25 s for a TMPSU event (housekeeping may be suspended for up to 15 s)		**92600**	**h7010="fw @ req pos"**	
Change to ICU mode 2 ("idle")	**h9002**			`tc_mode 2`

9.19.11 Filter Wheel to Blocked

Description	tc	tm	params	VxWorks
Set the filter wheel to blocked	**h7604**		**h280="Blocked"**	`tc_fw_filter 0`
Command the filter wheel to move	**h5600**			`tc_fw_move`
Wait up to 20 s for a TMPSU event (housekeeping may be suspended for up to 15 s)		**92600**	**h7010="fw @ req pos"**	

9.19.12 Science Aux Data Enable

Description	tc	tm	params	VxWorks
Enable science aux data	**h2003**			`tc_enable_sid 0xff`

9.19.13 HV

These HV ramp-ups are from 0 V.

The following HV ramp-up is for the Prime Channel only.

Description	tc	tm	params	VxWorks
Check HK for temperatures in allowed range and if not, wait		**90000**	**h5135="−8 to +37 °C"**	
Transition to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23" h160=100 h175="off"**	`tc_det_load_hv_ramp_params 3, 100, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 20 s for event		**92100**	**h7000="mcp23 ok"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23" h160=1400 h175="off"**	`tc_det_load_hv_ramp_params 3, 1400, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 90 s for event		**92100**	**h7000="mcp23 ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h150="mcp1" h160=550 h175="off"**	`tc_det_load_hv_ramp_params 2, 550, 25, 0`
Wait up to 40 s for event		**92100**	**h7000="mcp1 ok"**	
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Specify $V_{cathode}$ ramp parameters	**h7140**		**h150="cathode" h160=396 h175="off"**	`tc_det_load_hv_ramp_params 1, 396, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 25 s for event		**92100**	**h7000="cathode ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h150="mcp1" h160=520 h175="off"**	`tc_det_load_hv_ramp_params 2, 520, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 20 s for event		**92100**	**h7000="mcp1 ok"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23" h160=1700 h175="off"**	`tc_det_load_hv_ramp_params 3, 1700, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 30 s for event		**92100**	**h7000="mcp23 ok"**	

The following HV ramp-up is for the Redundant Channel only.

Note: this should only be used if the prime channel fails.

Description	tc	tm	params	VxWorks
Check HK for temperatures in allowed range and if not, wait		**90000**	**h5135="−8 to +37 °C"**	
Transition to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23" h160=100 h175="off"**	`tc_det_load_hv_ramp_params 3, 100, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 10 s for event		**92100**	**h7000="mcp23 ok"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23" h160=1500 h175="off"**	`tc_det_load_hv_ramp_params 3, 1500, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 90 s for event		**92100**	**h7000="mcp23 ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h150="mcp1" h160=500 h175="off"**	`tc_det_load_hv_ramp_params 2, 500, 25, 0`
Wait up to 40 s for event		**92100**	**h7000="mcp1 ok"**	
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Specify $V_{cathode}$ ramp parameters	**h7140**		**h150="cathode" h160=390 h175="off"**	`tc_det_load_hv_ramp_params 1, 390, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 30 s for event		**92100**	**h7000="cathode ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h150="mcp1" h160=550 h175="off"**	`tc_det_load_hv_ramp_params 2, 550, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 10 s for event		**92100**	**h7000="mcp1 ok"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h150="mcp23" h160=1850 h175="off"**	`tc_det_load_hv_ramp_params 3, 1850, 25, 0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 30 s for event		**92100**	**h7000="mcp23 ok"**	

9.19.14 Engineering tests

Description	tc	tm	params	VxWorks
Perform "Post Perigee Engineering mode tests" (see Section 9.17)				

The ICU is in "science" mode.

9.20 Pre-apogee Gap Procedure

Normal operation.

9.21 Procedure for Activation After the Apogee Gap

Normal operation.

10 Maintenance Procedures

10.1 Clock Resynchronisation

Description	**tc**	**tm**	**params**	**VxWorks**
Check HK for time sync flag		**90000**	**h5330="inactive"**	
Check time invalid flag in HK		**90000**	**h5335="invalid"**	
Enable time synchronization				`tc_enable_time_synch`
Check HK for time sync flag		**90000**	**h5330="active"**	
Check RBI config register in HK		**90000**	**h5345=1**	
Spacecraft procedure: send bcp3				`bcp3`
Check HK for time sync still enabled		**90000**	**h5330="active"**	
Check RBI config register in HK		**90000**	**h5345=0**	
Add time code				`tc_add_time_code` *time*
Check HK for time sync disabled		**90000**	**h5330="inactive"**	
Check HK for time code as expected		**90000**		
Check HK for time invalid flag		**90000**	**h5335="valid"**	

10.2 Procedure to Change Heater Configuration

The procedure for changing the heater configuration can be used for the heater control test or for contingency. For the heater checkout one would cycle through on/off of all heaters individually. (See XMM-OM/MSSL/ML/0010: User Manual Part 3: Telecommand and Telemetry Specification, Section 2.2.4.4.3, pages 27–28).

The ICU is in mode 1–5 (any of the operational modes).

Description	**tc**	**tm**	**params**	**VxWorks**
Load up heater configuration	One of **h7671** to **h7678**		(see XMM-OM/MSSL/ML/0010: User Manual Part 3: Telecommand and Telemetry Specification, Section 2.2.4.4.3.2)	`tc_heater_function` *`fid, param1, param2, param3`*
Start heater control again	**h5670**			`tc_heater_start`

10.3 Dichroic Reconfiguration

10.3.1 Selecting the Prime Chain

Note: this is only to be performed if the prime channel fails. It should not be performed as a "test".

The ICU is in any operational mode.

Description	tc	tm	params	VxWorks
Change to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Request dichroic move to the prime position	**h7650**		**h370=**−1 **h375=0**	`tc_dm_direction -1,0`
Move dichroic	**h5650**			`tc_dm_move`
Wait for TMPSU event		**92600**	**h7010="dich @ req pos"**	
Examine HK		**90000**	**h5275=**−31	
Return to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`

The ICU is in "idle" mode.

10.3.2 Selecting the Redundant Chain

The ICU is in any operational mode.

Description	tc	tm	params	VxWorks
Change to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Request dichroic move to the redundant position	**h7650**		**h370=1 h375=0**	`tc_dm_direction 1,0`
Move dichroic	**h5650**			`tc_dm_move`
Wait for TMPSU event		**92600**	**h7010="dich @ req pos"**	
Examine HK		**90000**	**h5275=32**	
Return to ICU mode 2 ("idle mode")	**h9002**			`tc_mode 2`

The ICU is in "idle" mode.

10.3.3 Check the Chain

Run through most of the commissioning tests (see Section 7).

10.4 Centroid Table Load

Description	tc	tm	params	VxWorks

Load centroid table boundaries	**h7100**		*Table 21*	`det_get_bounds`
				`<` *filename* `;`
				`tc_det_load_bounds`

Wait up to 120 s for event		**92100**	**h7000=10h**	

10.5 Reset

Description	tc	tm	params	VxWorks
Spacecraft command: RBI reset cold	**D????**			`<reset`
Wait up to 10 s for boot event, boot exception or boot anomaly packet				
Upload "initial" mode patches using RBI write spacecraft commands				

10.6 Engineering Mode 0: Raw Data of Both DSPs

The ICU is in "idle" mode (2). All DSPs are up.

Description	tc	tm	params	VxWorks
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Set frame time	**h7236**		**h710=*frame_time***	`tc_set_frame_time` *`frame_time`*
Set exposure id	**h7238**		**h530=*exposure_id***	`tc_set_exp_no` *`exposure_id`*
Send IC_INIT_EXP	**h7249**			`tc_send_command IC_INIT_EXP`
Wait 3 s				
Load window table	**h7110**		***Table 91***	`det_reset_wind ; det_wind x0, y0, xsize, ysize`
Load windows	**h5110**			`tc_det_load_windows 1`
Wait up to 60 s for event		**92100**	**h7000="win tab load"**	
Enable or diable frame tags	**h7135**		**h16="enabled" or "disabled"**	`tc_det_enbl_frame_tag` *`enable / disable`*
Set threshold	**h7131**		**h120=*threshold***	`tc_det_event_threshold` *`threshold`*
Set acquisition mode	**h7130**		**h110="hi res full"**	`tc_det_acq_mode 3`
Start sending events from mic	**h5130**			`tc_det_start_int`
Choose engineering mode 0	**h7254**		**h880="Raw + 2 blue"**	`tc_enbl_eng 1, 0`
Wait up to (*frame_time* + 1) s for end of exposure and complete exposure		**92205** **92209**		`tm_wait_for_alert DA_ENDOF_EXP ; tm_wait_for_alert DA_COMPLETE_EXP`
Wait as long as necessary for enough data (approx. 0–2 hr)				
Reset DPU	**h7201**			`tc_reset_dsp`
Wait up to 12 s for alert		**92201**		Expect "Fred from the Dead"
Run Clean Slate (see Section 6.2.14)				
Change to ICU mode 2 ("idle")	**h9002**			`tc_mode 2`

Table 91: Window Table

Description	Params
Verification	**h10**
Number of windows	**h40**
Window 1 Xlow	**h50**
Window 1 Ylow	**h51**
Window 1 Xsize	**h52**
Window 1 Ysize	**h53**
Window 2 Xlow	**h54**
Window 2 Ylow	**h55**
Window 2 Xsize	**h56**
Window 2 Ysize	**h57**
.	.
.	.
.	.
Window 14 Xlow	**h102**
Window 14 Ylow	**h103**
Window 14 Xsize	**h104**
Window 14 Ysize	**h105**
Window 15 Xlow	**h106**
Window 15 Ylow	**h107**
Window 15 Xsize	**h108**
Window 15 Ysize	**h109**

10.7 Engineering Mode 1: Raw Data of Blue DSP1

The ICU is in "idle" mode (2). All DSPs are up.

Description	tc	tm	params	VxWorks
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Initialize DPU	**h7248**			`tc_init_dpu`
Wait up to 25 s for DA_EOT_INIT_DPU event		**92210**		`tm_wait_for_alert DA_EOT_INIT_DPU` ("Dave from the Grave")
Set frame time	**h7236**		**h710=*frame_time***	`tc_set_frame_time` *`frame_time`*
Set exposure id	**h7238**		**h530=*exposure_id***	`tc_set_exp_no` *`exposure_id`*
Send IC_INIT_EXP	**h7249**			`tc_send_command IC_INIT_EXP`
Wait 3 s				
Load window table	**h7110**		***Table 91***	`det_reset_wind ; det_wind x0, y0, xsize, ysize`
Load windows	**h5110**			`tc_det_load_windows 1`
Wait up to 60 s for event		**92100**	**h7000="win tab load"**	
Ensure frame tags are enabled	**h7135**		**h16="enabled"**	`tc_det_enbl_frame_tag 1`
Set threshold	**h7131**		**h120=*threshold***	`tc_det_event_threshold` *`threshold`*
Set acquisition mode	**h7130**		**h110="hi res full"**	`tc_det_acq_mode 3`
Start sending events from mic	**h5130**			`tc_det_start_int`
Choose engineering mode 1	**h7254**		**h880="Raw + blue 1"**	`tc_enbl_eng 1, 1`
Wait up to (*frame_time* + 1) s for end of exposure and complete exposure		**92205** **92209**		`tm_wait_for_alert DA_ENDOF_EXP ; tm_wait_for_alert DA_COMPLETE_EXP`
Wait as long as necessary for enough data (approx. 0–2 hr)				
Reset DPU	**h7201**			`tc_reset_dsp`
Wait up to 12 s for alert		**92201**		Expect "Fred from the Dead"
Run Clean Slate (see Section 6.2.14)				
Change to ICU mode 2 ("idle")	**h9002**			`tc_mode 2`

10.8 Engineering Mode 2: Raw Data of Blue DSP2

The ICU is in "idle" mode (2). All DSPs are up.

Description	**tc**	**tm**	**params**	**VxWorks**
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Initialize DPU	**h7248**			`tc_init_dpu`
Wait up to 25 s for DA_EOT_INIT_DPU event		**92210**		`tm_wait_for_alert DA_EOT_INIT_DPU` ("Dave from the Grave")
Set frame time	**h7236**		**h710=*frame_time***	`tc_set_frame_time` *`frame_time`*
Set exposure id	**h7238**		**h530=*exposure_id***	`tc_set_exp_no` *`exposure_id`*
Send IC_INIT_EXP	**h7249**			`tc_send_command IC_INIT_EXP`
Wait 3 s				
Load window table	**h7110**		***Table 91***	`det_reset_wind ; det_wind x0, y0, xsize, ysize`
Load windows	**h5110**			`tc_det_load_windows 1`
Wait up to 60 s for event		**92100**	**h7000="win tab load"**	
Ensure frame tags are enabled	**h7135**		**h16="enabled"**	`tc_det_enbl_frame_tag 1`
Set threshold	**h7131**		**h120=*threshold***	`tc_det_event_threshold` *`threshold`*
Set acquisition mode	**h7130**		**h110="hi res full"**	`tc_det_acq_mode 3`
Start sending events from mic	**h5130**			`tc_det_start_int`
Choose engineering mode 2	**h7254**		**h880="Raw + blue 2"**	`tc_enbl_eng 1, 2`
Wait up to (*frame_time* + 1) s for end of exposure and complete exposure		**92205** **92209**		`tm_wait_for_alert DA_ENDOF_EXP ; tm_wait_for_alert DA_COMPLETE_EXP`
Wait as long as necessary for enough data (approx. 0–2 hr)				
Reset DPU	**h7201**			`tc_reset_dsp`
Wait up to 12 s for alert		**92201**		Expect "Fred from the Dead"
Run Clean Slate (see Section 6.2.14)				
Change to ICU mode 2 ("idle")	**h9002**			`tc_mode 2`

10.9 Engineering Mode 3: Channel Boundary Data

This loads the Centroiding Lookup Table.

The ICU is in "idle" mode (2).

Description	tc	tm	params	VxWorks
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Initialize DPU	**h7248**			`tc_init_dpu`
Move the filter wheel to blocked	**h7604**		**h280="Blocked"**	`tc_fw_filter 0`
Move the filter wheel (housekeeping may be suspended for up to 10 s)	**h5600**			`tc_fw_move`
Wait up to 20 s for TMPSU event report		**92600**	**h7010="fw @ req pos"**	
Turn on flood LEDs to level 4	**h7134**		**h1040=4**	`tc_det_flood_led_current 4`
Wait up to 25 s for DA_EOT_INIT_DPU event		**92210**		`tm_wait_for_alert DA_EOT_INIT_DPU` ("Dave from the Grave")
Set frame time to 300 s	**h7236**		**h710=*frame_time***	`tc_set_frame_time _time`
Set exposure id	**h7238**		**h530=*exposure_id***	`tc_set_exp_no` *exposure_id*
Send IC_INIT_EXP	**h7249**			`tc_send_command IC_INIT_EXP`
Wait 3 s				
(Enable M,N image dump, if wanted)	**h7244**		**h760="eng data" h16="enable"**	tc_enbl_verbose 4,1
Load window table	**h7110**		***Table 95***	`det_reset_wind ; det_wind x0, y0, xsize, ysize`
Load windows	**h5110**			`tc_det_load_windows 1`
Wait up to 60 s for event		**92100**	**h7000="win tab load"**	
Ensure frame tags are disabled	**h7135**		**h16="disabled"**	`tc_det_enbl_frame_tag 0`
Set threshold	**h7131**		**h120=*threshold***	`tc_det_event_threshold` *threshold*
Set acquisition mode	**h7130**		**h110="eng x m/n"**	`tc_det_acq_mode 4`
Start sending events from mic	**h5130**			`tc_det_start_int`
Choose engineering mode 3	**h7254**		**h880="Centroiding"**	`tc_enbl_eng 1, 3`
Wait up to 301 s for end of exposure		**92205**		`tm_wait_for_alert DA_ENDOF_EXP`
Wait up to 79 s for complete exposure		**92209**		`tm_wait_for_alert DA_COMPLETE_EXP` and end of data tm packets
Wait up to 0 s for telemetry to finish		Multi- **97322** **92207**		

continued on next page

(continued)

Description	tc	tm	params	VxWorks
Turn off flood LEDs	**h7134**		**h1040=0**	`tc_det_flood_led_current 0`
Change to ICU mode 2 (“idle”)	**h9002**			`tc_mode 2`

Table 95: Window Table 256 x 256 Eng mode 3

Description	Params	Value	
		Prime	**Redundant**
Verification	h10	“enable”	“enable”
Number of windows	h40	1	1
Window 1 Xlow	h50	52+32	64+32
Window 1 Ylow	h51	27+32	15+32
Window 1 Xsize	h52	256+64	256+64
Window 1 Ysize	h53	256+64	256+64

10.10 Engineering Mode 4: Full Frame, High Resolution

The ICU is in "idle" mode (2).

Description	**tc**	**tm**	**params**	**VxWorks**
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Initialize DPU	**h7248**			`tc_init_dpu`
Wait up to 25 s for DA_EOT_INIT_DPU event		**92210**		`tm_wait_for_alert DA_EOT_INIT_DPU` ("Dave from the Grave")
Set frame time in units of 1/1024 s	**h7236**		**h710=*frame_time***	`tc_set_frame_time` *frame_time*
Set exposure id	**h7238**		**h530=*exposure_id***	`tc_set_exp_no` *exposure_id*
Send IC_INIT_EXP	**h7249**			`tc_send_command IC_INIT_EXP`
Wait 3 s				
Load window table	**h7110**		***Table 97***	`det_reset_wind ; det_wind x0, y0, xsize, ysize`
Load windows	**h5110**			`tc_det_load_windows 1`
Wait up to 60 s for event		**92100**	**h7000="win tab load"**	
Ensure frame tags are disabled	**h7135**		**h16="disabled"**	`tc_det_enbl_frame_tag 0`
Set threshold	**h7131**		**h120=*threshold***	`tc_det_event_threshold` *threshold*
Set acquisition mode	**h7130**		**h110="hi res full"**	`tc_det_acq_mode 3`
Start sending events from mic	**h5130**			`tc_det_start_int`
Choose engineering mode 4	**h7254**		**h880="Full Hi Res"**	`tc_enbl_eng 1, 4`
Wait up to *frame_time + 1* s for end of exposure		**92205**		`tm_wait_for_alert DA_ENDOF_EXP`
Wait up to 4800 s for complete exposure		**92209**		`tm_wait_for_alert DA_COMPLETE_EXP`
Wait up to 1000 s for eng data telemetry to finish		Multi-**97322** **92207**		
Change to ICU mode 2 ("idle")	**h9002**			`tc_mode 2`

Table 97: Window Table 256 x 256

Description	**Params**	**Value**	
		Prime	**Redundant**
Verification	h10	"enable"	"enable"
Number of windows	h40	1	1
Window 1 Xlow	h50	52	64
Window 1 Ylow	h51	27	15
Window 1 Xsize	h52	256	256
Window 1 Ysize	h53	256	256

10.11 Engineering Mode 5: Centroiding Confirmation Data

The ICU is in "idle" mode (2).

Description	tc	tm	params	VxWorks
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Initialize DPU	**h7248**			`tc_init_dpu`
Wait up to 25 s for DA_EOT_INIT_DPU event		**92210**		`tm_wait_for_alert DA_EOT_INIT_DPU` ("Dave from the Grave")
Move the filter wheel to blocked	**h7604**		**h280="Blocked"**	`tc_fw_filter 0`
Move the filter wheel (housekeeping may be suspended for up to 10 s)	**h5600**			`tc_fw_move`
Wait up to 20 s for TMPSU event report		**92600**	**h7010="fw @ req pos"**	
Turn on flood LEDs to level 4	**h7134**		**h1040=4**	`tc_det_flood_led_current 4`
Set the DPU frame time to (4000 × 1024) in units of 1/1024 s	**h7236**		**h710=*frame_time***	`tc_set_frame_time` *frame_time*
Set exposure id	**h7238**		**h530=*exposure_id***	`tc_set_exp_no` *exposure_id*
Send IC_INIT_EXP	**h7249**			`tc_send_command IC_INIT_EXP`
Wait 3 s				
Load window table	**h7110**		***Table 97***	`det_reset_wind ; det_wind x0, y0, xsize, ysize`
Load windows	**h5110**			`tc_det_load_windows 1`
Wait up to 60 s for event		**92100**	**h7000="win tab load"**	
Ensure frame tags are disabled	**h7135**		**h16="disabled"**	`tc_det_enbl_frame_tag 0`
Set threshold	**h7131**		**h120=*threshold***	`tc_det_event_threshold` *threshold*
Set acquisition mode	**h7130**		**h110="hi res full"**	`tc_det_acq_mode 3`
Start sending events from mic	**h5130**			`tc_det_start_int`
Choose engineering mode 5	**h7254**		**h880="Centr Conf"**	`tc_enbl_eng 1, 5`
Wait up to *frame_time*+1 s for end of exposure		**92205**		`tm_wait_for_alert DA_ENDOF_EXP`
Wait up to 150 s for complete exposure		**92209**		`tm_wait_for_alert DA_COMPLETE_EXP`
Wait up to 20 s for eng data telemetry to finish		Multi- **97322** **92207**		
Turn off flood LEDs	**h7134**		**h1040=0**	`tc_det_flood_led_current 0`
Change to ICU mode 2 ("idle")	**h9002**			`tc_mode 2`

10.12 Engineering Mode 6: Intensifier Characteristics

The ICU is in "idle" mode (2).

Description	tc	tm	params	VxWorks
Change to ICU mode 4 ("engineering mode")	**h9004**			`tc_mode 4`
Initialize DPU	**h7248**			`tc_init_dpu`
Wait up to 25 s for DA_EOT_INIT_DPU event		**92210**		`tm_wait_for_alert DA_EOT_INIT_DPU` ("Dave from the Grave")
Move the filter wheel to blocked	**h7604**		**h280="Blocked"**	`tc_fw_filter 0`
Move the filter wheel (housekeeping may be suspended for up to 10 s)	**h5600**			`tc_fw_move`
Wait up to 20 s for TMPSU event report		**92600**	**h7010="fw @ req pos"**	
Turn on flood LEDs to level 4	**h7134**		**h1040=4**	`tc_det_flood_led_current 4`
Set the DPU frame time (in units of 1/1024 s)	**h7236**		**h710=*frame_time***	`tc_set_frame_time` *`frame_time`*
Set exposure id	**h7238**		**h530=*exposure_id***	`tc_set_exp_no` *`exposure_id`*
Send IC_INIT_EXP	**h7249**			`tc_send_command IC_INIT_EXP`
Wait 3 s				
Load window table	**h7110**		***Table 97***	`det_reset_wind ; det_wind x0, y0, xsize, ysize`
Load windows	**h5110**			`tc_det_load_windows 1`
Wait up to 60 s for event		**92100**	**h7000="win tab load"**	
Ensure frame tags are disabled	**h7135**		**h16="disabled"**	`tc_det_enbl_frame_tag 0`
Set threshold to 12	**h7131**		**h120=*threshold***	`tc_det_event_threshold` *`threshold`*
Set acquisition mode	**h7130**		**h110="eng evt ht"**	`tc_det_acq_mode 6`
Start sending events from mic	**h5130**			`tc_det_start_int`
Choose engineering mode 6	**h7254**		**h880="Intensifier"**	`tc_enbl_eng 1, 6`
Wait up to 21 s for end of exposure		**92205**		`tm_wait_for_alert DA_ENDOF_EXP`
Wait up to 20 s for complete exposure		**92209**		`tm_wait_for_alert DA_COMPLETE_EXP`
Wait up to 20 s for telemetry to finish		Multi-**97322** **92207**		
Turn off flood LEDs	**h7134**		**h1040=0**	`tc_det_flood_led_current 0`
Change to ICU mode 2 ("idle")	**h9002**			`tc_mode 2`

10.13 Loading new code

10.13.1 Reset the ICU

See Section 9.3.

10.13.2 Load ICU code

See Section 6.2.4.

11 Error recovery

If an error occurs in the running of the ICU of DPU code, the following procedures should be followed to help understand the problem and make the instrument safe.

If the OM needs to be reset, the "initial" mode patches should be uploaded after the reset command is sent (see Section 10.5).

11.1 Unsuccessful Command Acceptance (3,2)

If the error recovery procedure for an ICU alert is not covered here or fails, the ICU's general debug procedure (see section 12.1 should be followed. If the error is still occuring after reset, the OM should be powered off (see section 9.2).

TPN	Code	Reason	Pref1	Pref2
TM 91200	0	Illegal APID	**H6000** (the apid)	
TM 91201	1	Incorrect checksum	**H6005** (expected crc)	**H6010** (found crc)
TM 91202	2	Bad pkt type	**H6015** (pkt type)	**H6020** (pkt subtype)
TM 91203	3	Bad subtype	**H6015** (ditto)	**H6020** (ditto)
TM 91204	4	Bad param value		
TM 91205	5	Invalid length	**H6030** (bad length)	
TM 91208	8	Illegal TID	**H6035** (Bad TID)	
TM 91209	9	Illegal FID	**H6040** (Associated TID)	**H6045** (Bad FID)
TM 91210	10	Illegal Mode	**H6050** (Bad mode)	
TM 91211	11	Illegal MID	**H6055** (Bad MID)	
TM 91212	12	Illegal Start addr	**H6060** (Bad addr)	
TM 91213	13	Non existent mem	**H6065** (Bad MID)	
TM 91219	19	Illegal SID	**H6070** (Bad SID)	
TM 91292	192	Invalid for mode		

Check the telecommand. Check that the ICU and DPU are in the appropriate mode for that command.

11.2 Unsuccessful Command Execution (3,3)

Check the telecommand. Check that the ICU and DPU are in the appropriate mode for that command.

11.2.1 Busy (3,4)

Check the time since the last similar command.

11.3 Major Anomaly Reports (4,3)

None.

11.4 ICU Exceptions (4,2)

11.4.1 92703 Exception: Bootstrap report

If ICB_dead is not set and there have been no ICB errors:

1. filter wheel not safed
2. macs bus dead

If the filter wheel error counter is > 0 then there has been an error whilst moving the filter wheel during safing.

Recovery:

1. boot again
2. turn on without high voltages, mode 2, play with filter wheel

see "loss of filter wheel position" (see Section 11.4.4).

11.4.2 92101 h8010=10_{hex} centroid table load failed

Did the macsbus error count in the housekeeping increase (h5350 in 90000)? If not it is possibly just software: retry.

Otherwise is was probably a real macsbus error: investigate macsbus errors by enabling SID 44 IF THERE AREN'T TOO MANY and running the command again, reloading the table (note macsbus errors received).

If it is not the macsbus: it could be detector electronics. Try to dump memory.

11.4.3 91101 h8010=11_{hex} window table load failed

Same as above.

11.4.4 92601 h8060=60_{hex} loss of filter wheel position

1. If macsbus error, investigate, retry
2. If not macsbus, it could be software: filter wheel to datum, try again
3. Could be LED brightness: h7601 h310=9 by default. Increase by 1, run again

4. Could be coarse sensor: can we find coarse? h7600 h300=4 + 1 by default. Increase coarse brightness by 1
5. Go to coarse h7609, h5600
6. Repeat with hight LED currents
7. Standard reset
8. Try again

11.4.5 92601 Loss of Dichroic Position (4,2)

TM 92601 SID = 0x61 exception code **H8060 = "DC Pos Loss" (0x61)** This is bizzare: we should be there anyway.

11.4.6 92301 SSI errors

92301 sid=31_{hex} exception_code=$30,31_{hex}$ h8030=$30,31_{hex}$ h8035=$1,2,7,8,9,11,b,c,89_{hex}$

exception_code=30_{hex}	1	length inconsistent
	2	wordcount big
	7	overflow at end of block
	8	overflow
	9	put length too long
	11_{hex}	wordcount too big
	b	output buffer full
	c	interrupt input queue full
	89_{hex}	overflow detected during put

exception_code=31_{hex} Invalid DPU block type

11.4.7 ADA Exceptions

92101 h8010=12_{hex}
92401 h8040=41_{hex}
92501 h8050=50_{hex}
92501 h8050=51_{hex}
92601 h8060=62_{hex}
92301 h8030=32_{hex}
92702 h8020=2
92907 h8070=$d1_{hex}$
92907 h8070=$d2_{hex}$
92907 h8070=$d0_{hex}$

92800 h8080=c0_{hex}
92800 h8080=c1_{hex}
92800 h8080=32_{hex}

Perform a standard ICU debug and reset (see Section 12).

11.4.8 Unsuccessful command execution (3,4)

- 91400 Task Stopped by command too early: the user did it
- 91401 Command too soon filter wheel memory dump busy: try later
- 91402 Parameters not loaded: check required parameters were loaded (e.g., HV)
- 91403 hv ramp failure:
  1. Ramp to 0 V using the force flag
  2. Command voltage to an intermediate value then to the full value
- 91404 Filter wheel not yet "datum"ed: turn filter wheel to datum

11.4.9 91204 Illegal parameter value (3,2)

1. Check telecommand for bad parameters
2. Try the command again
3. Send 3 test commands

If none of this helps, then it is a serious problem with the software

11.4.10 91201 (3,2) Incorrect Checksum BASIC MODE

Telecommands with no checksum give a (3,2): the operator forgot to load the basic mode patch.

11.4.11 Unexpected ICU reset (4,1) (4,2)

(4,1) **TM 92703** for a bootstrap report
(4,2) **TM 92704** for a baaaad bootstrap report Dump operational mode code from the ICU's memory and check.

11.4.12 Watchdog Kick RBI Status = xxxF

Perform a standard ICU debug and reset (see Section 12.1).

11.4.13 The Telemetry Stops

1. Check the OBDH
2. Send 3 test commands
3. Perform a standard ICU debug and reset (see Section 12.1).

11.5 DPU-related exceptions generated by the ICU (4,2)

11.5.1 92802 h8090=a500$_{hex}$ Loss of DPU heartbeat exception

1. <`tasks`: check the task is still running (see Section 12.1.2)
2. Check for heartbeats increasing in housekeeping 90000 h5410 increasing

If increasing, the fault is with the ICU so perform a standard ICU debug and reset (see Section 12.1). If not increasing: the fault is probably with the DPU:

1. Send a harmless DPU test command
2. If DPU responds: ICU task crashed
3. If DPU doesn't respond: reset the DPU
4. If still not working, perform a standard ICU debug and reset (see Section 12.1).

11.5.2 92803 h8095=a510$_{hex}$ unexpected DPU reset

Perform a standard DPU debug (see section 12.2) then perform a "Clean Slate" (see Section 6.2.14).

11.6 HK Values out of Range

11.6.1 Condition parameters

- The value in the TM_COND_MODE field for parameters X9010 and X9020 need to be swapped, ie, the mode for X9010 needs to read "H5400 = 1" and for X9202 it should read "H5400 = 0".
- New condition parameters for the secondary rail currents.

PREF	PARA NAME	DESCRIPTION	TM COND MODE
X9060	PRI CAMON	Camera ctl started & primary channel	H5230 = 1 AND H5400 = 1
X9070	PRI CAMOFF	Camera ctl stopped & primary channel & secondaries on	H5230 = 0 AND H5400 = 1 AND H5255 = 1
X9080	RED CAMON	Camera ctl started & redundant channel	H5230 = 1 AND H5400 = 0
X9090	RED CAMOFF	Camera ctl stopped & redundant channel & secondaries on	H5230 = 0 AND H5400 = 0 AND H5255 = 1

- New condition parameters for the low voltage monitors.

PREF	PARA NAME	DESCRIPTION	TM COND MODE
X9100	SECON	Secondaries on	H5255 = 1
X9110	SECOFF	Secondaries off	H5255 = 0

- New condition parameters for the high voltage.

PREF	PARA NAME	DESCRIPTION	TM COND MODE
X9120	PRI HV ON	HV enabled & prime channel	H5145 = 1 AND H5400 = 1
X9130	RED HV ON	HV enabled & redundant channel	H5145 = 1 AND H5400 = 0

11.6.2 Warnings and alarms

- Warnings and alarms for the secondary rail currents (in mA).

PREF	NAME	COND	Warn Low	Warn High	Alarm Low	Alarm High
H5280	Current +25 SV	X9060	18.00	23.00	16.00	25.00
H5280	Current +25 SV	X9070	18.00	22.00	16.00	24.00
H5280	Current +25 SV	X9080	19.00	24.00	17.00	26.00
H5280	Current +25 SV	X9090	17.00	22.00	15.00	24.00
H5285	Current +15 SV	X9060	44.00	54.00	39.00	59.00
H5285	Current +15 SV	X9070	44.00	54.00	39.00	59.00
H5285	Current +15 SV	X9080	42.00	52.00	37.00	56.00
H5285	Current +15 SV	X9090	41.00	50.00	36.00	55.00
H5290	Current +11 SV	X9060	149.00	183.00	133.00	199.00
H5290	Current +11 SV	X9070	90.00	96.00	87.00	99.00
H5290	Current +11 SV	X9080	153.00	188.00	136.00	205.00
H5290	Current +11 SV	X9090	87.00	107.00	77.00	116.00
H5295	Current +5.3 SV	X9060	797.00	975.00	709.00	1064.00
H5295	Current +5.3 SV	X9070	442.00	541.00	393.00	590.00
H5295	Current +5.3 SV	X9080	821.00	1005.00	730.00	1096.00
H5295	Current +5.3 SV	X9090	440.00	539.00	391.00	588.00
H5300	Current -5.3 SV	X9060	432.00	528.00	384.00	576.00
H5300	Current -5.3 SV	X9070	414.00	506.00	368.00	552.00
H5300	Current -5.3 SV	X9080	407.00	498.00	362.00	543.00
H5300	Current -5.3 SV	X9090	405.00	495.00	360.00	540.00
H5305	Current -15 SV	X9060	49.00	60.00	43.00	65.00
H5305	Current -15 SV	X9070	49.00	60.00	43.00	65.00
H5305	Current -15 SV	X9080	47.00	58.00	41.00	63.00
H5305	Current -15 SV	X9090	47.00	58.00	41.00	63.00
H5310	Current +28 UV	X9060	5.00	6.00	4.00	7.00
H5310	Current +28 UV	X9070	5.00	6.00	4.00	7.00
H5310	Current +28 UV	X9080	5.00	6.00	4.00	7.00
H5310	Current +28 UV	X9090	5.00	6.00	4.00	7.00
H5315	Current +5 UV	X9060	100.00	123.00	90.00	134.00
H5315	Current +5 UV	X9070	96.00	117.00	86.00	128.00
H5315	Current +5 UV	X9080	108.00	132.00	96.00	144.00
H5315	Current +5 UV	X9090	108.00	132.00	96.00	144.00

Note: see NCR 139 (see http://xmmom.mssl.ucl.ac.uk/docs/xmm-om-ncrs/ncr.ps) for difficulties with the -5.3 V rail of the primary chain and Appendix F.

- Warnings and alarms for the low voltage monitors (in V).

PREF	NAME	COND	Warn Low	Warn High	Alarm Low	Alarm High
H5170	LVM +5V	X9100	4.75	5.75	4.00	6.50
H5175	LVM +15V	X9100	13.50	16.50	12.00	18.00
H5180	LVM -15V	X9100	-14.00	-17.00	-12.00	-18.50
H5185	LVM 1.23V Ref	X9100	1.50	1.75	1.00	2.00

- Warnings and alarms for the thermistors (in °C).

PREF	NAME	COND	Warn Low	Warn High	Alarm Low	Alarm High
H5105	BPE thermistor	X9100	-10.00	40.00	-20.00	50.00
H5135	CCD Thermistor	X9100	-4.00	37.00	-8.00	42.00
H5140	Ref A Thermistor	X9100	18.00	21.00	17.00	22.00
H5110	Ref B Thermistor	X9100	18.00	21.00	17.00	22.00
H5120	Main Thermistor	X9100	18.00	21.00	17.00	22.00
H5115	Ref C Thermistor	X9100	NC	NC	NC	NC
H5125	Fwd 1 Thermistor	X9100	17.00	22.00	16.00	23.00
H5130	Fwd 2 Thermistor	X9100	17.00	22.00	16.00	23.00

Note: Ref A, Ref B and Main thermistors are averaged together to control the heater settings. The actual values for the warnings and alarms will have to be reviewed. NC = No Connection.

- Spacecraft thermistors.

  ?? TO BE COMPLETED ??

- Warnings and alarms for the high voltages.

  The warnings and alarms for these parameters (PREFs H5155, H5160 and H5165) pose some problems for entry in the database because they can be set to variable levels.

  Note that mcp23 is first commanded to 100 V and may give an alarm if the low alarm is set to just below its final value.

  If there is an unexpected alert from any HV commanding, the HV should be commanded back down (see Section 12.1.1).

  The "HV enabled bit" is h5145 where "0" is off and "1" is on (alias 9010). This can be used to see if the HV limits are to be checked. If this bit isn't enabled, the voltages should be 0.

  For the prime channel (where nom is the expected operating voltage):

PREF	NAME	Nom	COND	Warn Low	Warn High	Alarm Low	Alarm High
H5155	HVM Vmcp1	550	X9120	542.00	558.00	536.00	566.00
H5155	HVM Vmcp1	520	X9120	512.00	529.00	504.00	536.00
H5160	HVM Vmcp23	1400	X9120	1384.00	1423.00	1354.00	1451.00
H5160	HVM Vmcp23	1700	X9120	1676.00	1716.00	1647.00	1745.00
H5165	HVM Vcath	2	X9120	N/A	4.00	N/A	5.00
H5165	HVM Vcath	396	X9120	394.00	398.00	390.00	402.00

For the redundant channel (where nom is the expected operating voltage):

PREF	NAME	Nom	COND	Warn Low	Warn High	Alarm Low	Alarm High
H5155	HVM Vmcp1	500	X9130	494.00	504.00	487.00	512.00
H5155	HVM Vmcp1	550	X9130	546.00	556.00	538.00	563.00
H5160	HVM Vmcp23	1500	X9130	1481.00	1521.00	1452.00	1550.00
H5160	HVM Vmcp23	1850	X9130	1833.00	1872.00	1803.00	1901.00
H5165	HVM Vcath	2	X9130	N/A	4.00	N/A	5.00
H5165	HVM Vcath	390	X9130	388.00	392.00	384.00	396.00

Note: the low warn and alarm are designated N/A as it is not possible to resolve such values.

11.6.3 Recovery actions

- Secondary currents.

Low alarm	If enabled, turn off high voltages in the correct order Turn off secondaries (tc **H6690**)
Low warn	Monitor closely
High warn	Monitor closely
High alarm	If enabled, turn off high voltages in the correct order Turn off secondaries (tc **H6690**)

- Low voltage currents.

Low alarm	If enabled, turn off high voltages in the correct order Turn off secondaries (tc **H6690**)
Low warn	Monitor closely
High warn	Monitor closely
High alarm	If enabled, turn off high voltages in the correct order Turn off secondaries (tc **H6690**)

- Thermistors.

  – BPE and CCD thermistors.

Low alarm	Monitor closely
Low warn	Monitor closely
High warn	Monitor closely
High alarm	Stop detector integration (tc **H6130**) If enabled, turn off high voltage in the correct order Stop heater switching (tc **H6670**) Start contingency heater control (tc **H5660**) Uplink heater configuration (tc **H7660**, **H380** = **"ONONOFFOFF"**) Turn off secondaries (tc **H6690**)

  – Ref A, Ref B, Main thermistors.

  Average value 19.5 ± 0.5 °C.

  Low warning: 18 °C. High warning: 21 °C. Contact MSSL.

  Low alarm: −10 °C. High warning: 35 °C. Power down OM.

  – Forward 1, Forward 2 thermistors.

  Average value 19.5 ± 1.5 °C.

  Low warning: 17 °C. High warning: 23 °C. Contact MSSL.

  Low alarm: −10 °C. High warning: 35 °C. Power down OM.

- High voltages.

Low alarm	When ramping, hold and observe
Low warn	Monitor closely
High warn	Monitor closely
High alarm	Command instrument to full safe mode (tc **H9001**)

- In the event of any alarm perform the recovery procedure and consult the PI institute as to the next course of action.

11.7 Data Corruption

Check the OM telemetry rate. Perform the ICU and DPU debug procedures (see Section 12), abort the current exposure and continue with the next. See Section 20.

11.8 Sudden DPU death

Perform the DPU debug procedure (see Section 12.2). Perform "Clean Slate" (see Section 6.2.14).

11.9 DPU Status Exposure Number Crazy

Check the OM telemetry rate. Perform the ICU and DPU debug procedures (see Section 12), abort the current exposure and continue with the next.

11.10 Non-Periodic Housekeeping: DPU Exception Reports (4,2): Error Handling for DPU in Response to DPU Exception Alerts

Unless otherwise stated, these errors are non-critical and should not need a reset. Leave the system running and see what happens. At the end of the exposure check the data.

11.10.1 92222 DA_CLK_SYNCH_ERROR 0XA580

After the DPU is rebooted and DPUOS reloaded, ICU should issue an IC_SYNCH_CLK command. This first synchronization command should not generate any error. After this initial CLK synchronization, further issuance of IC_SYNCH_CLK will generate a DA_CLK_SYNCH_ERROR within 10 s. This is normal.

If a DA_CLK_SYNCH_ERROR occurs not as a response to IC_CLK_SYNCH. If the alert indicates a loss of time tick, the DPU code may need some fine tuning.

Normal response: Do nothing. The DPU operation should not be affected. Note the exposure ID, occurrence and subsequent DPU behaviour. Contact DPU software maintainer for a post facto DPU diagnostics. If the alert indicates a gain of time tick on the DPU by a small number, e.g., 1 or 2, contact the DPU hardware/software maintainer immediately.

11.10.2 92223 DA_PROG_RAM_ERROR 0XA581

Do nothing. This alert indicates that DPU code scrubbing has been performed by the red DSP.

11.10.3 92224 DA_BOTTOM_WHITEDSP 0XA582

This alert should be followed by a spontaneous DPU reset indicated by an unsheduled DA_DPU_BOOT_READY. Perform DPUPM procedure (see Section 12.2) and resume OM operation.

11.10.4 92225 DA_CID_TOO_LARGE 0XA583

Check the validity of the most recent uploaded ICU to DPU command. That one has not taken on the DPU, reset the DPU and resume OM operation.

11.10.5 92226 DA_BAD_CMD 0XA584

Check the vaildity of the most recent uploaded ICU to DPU command. That one has not taken on the DPU, reset the DPU and resume OM operation.

11.10.6 92227 DA_DPU_ABORTING 0XA585

This is a placeholder. This indicates that the DPU is in a limbo state. If this is the result of a ground uploaded DPU command that is not part of the standard procedure, reset DPU completely and proceed. If this occurs in the normal course of OM operation, perform a DPUPMM process then resume OM operation.

11.10.7 92228 DA_BAD_BLOCK 0XA586

This alert indicates that DPU has received a bad block from the SSI interface. If the DPU does not generate any further alert, continue with OM operation. Expect the DPU operation to generate erratic results for the current exposure.

11.10.8 92229 DA_ZERO_LENGTH_DQ 0XA587

This alert indicates that DPU is attempting to send out a data et of length 0. If the DPU does not generate any further alert, continue with OM operation. Expect the DPU operation to generate erratic results for the current exposure.

11.10.9 92241 DA_PROG_RAM_MERROR 0XA588

This alert indicates the detection of an unrecoverable program error in the DPU. It should be preceded by a DA_RED_E_ALERT with an error condition $\geq$ 0x0100. Reset the DPU and perform a DPUPMM. Reload the DPU codes and follow the standard post-code-load procedures. At a later stage, utility might be developed to upload only the culprit block.

11.10.10 92230 DA_SCI_RCVR_ERROR 0XA590

Not used.

11.10.11 92231 DA_SCI_HBEAT_ERROR 0XA591

This alert could occur under rare occasion at the initial startup of the DPU. If this alert occurs only once or twice, expecially during startup, do nothing and proceed with DPU operation. If this is a alert repeats more than 5 times in 10 seconds indicating the same processor (0=blue1, 2=blue2, 1/3=red), the culprit processor is not operating properly. Reset the DPU and perform the DPUPMM. Resume OM operation afterwards.

11.10.12 92232 DA_RED_E_ALERT 0xA592

This alerts carries a 16 bit error word. See ICU-DPU protocol document (XMM-OM/MSSL/ML/0011) for definition. If single bit error is indicated, do nothing. If multi-bit error is indicated, continue DPU operation until the exposure complete and the A588 alerts appears, then reset DPU and perform DPUPMM. If the DPU spontaneous reset before the A588 appears, reset DPU and perform DPUPMM.

h7735 format xy where x is the number of multi-bit errors and y is the number of single bit errors since the last reboot. (These are bytes 2 and 3 of the packet source data.)

h7560 is the alert code which in this case is 0xa592.

11.10.13 92233 DA_RED_S_ALERT 0xA593

This alert is not being used. This alert could occur during start up if the DPU was reset from a strange state. Under such circumstance, do nothing.

h7560 is the alert code which in this case is 0xa593.

11.10.14 92232 DA_BLUE1_E_ALERT 0xA594

This alert is not being used unless the bluedsp bad address (BADD) compilation flag is turned on and code loaded with this debugging procedure. Be aware of the code configuration. If BADD is set, consult the DPU code maintainer. If the BADD is not set in the blue codes, this alert could occur during start up if the DPU was reset from a strange state. Under such circumstance, do nothing.

h7560 is the alert code which in this case is 0xa594.

11.10.15 92233 DA_BLUE1_S_ALERT 0xA595

This alert is not being used unless the bluedsp bad address (BADD) compilation flag is turned on and code loaded with this debugging procedure. Be aware of the code configuration. If BADD is set, consult the DPU code maintainer. If the BADD is not set in the blue codes, this alert could occur during start up if the DPU was reset from a strange state. Under such circumstance, do nothing.

h7560 is the alert code which in this case is 0xa595.

11.10.16 92232 DA_BLUE2_E_ALERT 0xA596

This alert is not being used unless the bluedsp bad address (BADD) compilation flag is turned on and code loaded with this debugging procedure. Be aware of the code configuration. If BADD is set, consult the DPU code maintainer. If the BADD is not set in the blue codes, this alert could occur during start up if the DPU was reset from a strange state. Under such circumstance, do nothing.

h7560 is the alert code which in this case is 0xa596.

11.10.17 92233 DA_BLUE2_S_ALERT 0xA597

This alert is not being used unless the bluedsp bad address (BADD) compilation flag is turned on and code loaded with this debugging procedure. Be aware of the code configuration. If BADD is set, consult the DPU code maintainer. If the BADD is not set in the blue codes, this alert could occur during start up if the DPU was reset from a strange state. Under such circumstance, do nothing.

h7560 is the alert code which in this case is 0xa597.

Special Note for alerts A594 – A597:

It has been observed that a transient pair of alerts of DA_BLUE1_S_ALERT were generated by the DPU without other severe detrimental effects such as crashing or major change in operation configuration. It is believed that this is an artifect of the particular message passing method between the different DSPs in the DPU. The handling procedure of a transient pair of error alerts from A594 through A597 is as follows.

1. When a pair is observed, mark the occurrence for post facto checkup and continue normal operation.
2. Post facto checkup: The pair should be separated by one DPU bus_cycle_count. Examine the status/error word to make sure that the first word is a simple change (e.g., bit-flip) from the normal value and the second occurrence carries the normal value. The normal values for A594/A596 and A595/A597 are 0 and 0x300 respectively. If all of these conditions are met, then this is a classical transient pair. Mark the occurrence for long-term monitoring.
3. Long term monitor: If this transient alert pair occurs at a relatively high regularity, this could indicate that the memory has become susceptible for corruption. In this case, a simple change in the DPU code will relocate the memory without loss of DPU functionality.

11.10.18 92238 DA_GADE_RPI 0XA5A0

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

?? Alert code (a5a0 in this case) - byte 2 of the source data ?? h7570=a5a0

11.10.19 92239 DA_GADE_RPIA_L 0XA5A1

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.20 92240 DA_GADE_RPIA_H 0XA5A2

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.21 92238 DA_GADE_WPI 0XA5A3

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.22 92239 DA_GADE_WPIA_L 0XA5A4

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.23 92240 DA_GADE_WPIA_H 0XA5A5

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.24 92238 DA_GADE_RBI 0XA5A6

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.25 92239 DA_GADE_RBIA_L 0XA5A7

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.26 92240 DA_GADE_RBIA_H 0XA5A8

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.27 92238 DA_GADE_WBI 0XA5A9

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.28 92239 DA_GADE_WBIA_L 0XA5AA

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.29 92240 DA_GADE_WBIA_H 0XA5AB

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.30 92238 DA_GADE_RSI 0XA5AC

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.31 92239 DA_GADE_RSIA_L 0XA5AD

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.32 92240 DA_GADE_RSIA_H 0XA5AE

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.33 92238 DA_GADE_WSI 0XA5AF

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.34 92239 DA_GADE_WSIA_L 0XA5B0

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.35 92240 DA_GADE_WSIA_H 0XA5B1

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low). Note the occurence and do nothing.

11.10.36 92242 DA_GADE_RANGE_ERROR 0XA5B2

This is a global memory access error trap. An illegal global memory access has been requested, typically as a result of erratic DPU operation due to pathological field condition (photon counts too low or star image quality too bad). Note the occurence and do nothing.

11.10.37 92245 DA_ZERO_CNT_CALBGD 0XA5FF

Do nothing. This alert is usually associated with very low count rate into the DPU. Double check the OM operation. If the filter is narrow and the FOV is small, this is not unexpected. Check the health indicators of the MIC detector (high voltage and current reading) and the BPE.

11.10.38 92243 DA_NO_GOOD_GS 0XA5D7

The DPU cannot find any good guide stars to track on. The DPU is likely to continue the exposure with the tracking function turned on. In this case, do nothing. Mark the exposure as such as an advisory for the observer.

11.10.39 92244 DA_RSTR_BAD_TASK_ID 0XA5FC

This alert is generated when the task id was changed during the operation of the su_restore_stars. Review the operation procedure. If this change in DPU task ID is issued from the operation procedure, modify the procedure. Presumably a established procedure should not generate this condition. Under such circumstance, perform a DPU reset and DPUPMM, then proceed with OM operation.

11.11 Undocumented DPU alerts

Summary of undocumented DPU alerts blocked out by compliation flag or normal parameter setting.

The following alerts are present in the DPU codes that are currently blocked off by compilation flag or no used under normal condition. The presence of these alerts are very context dependent. The interpretation and handling of these alerts should be done in conjunction with the code developer/maintainer.

Table 100: Undocumented Alerts

		Comp. or control variable	**default**
cwhite.c:	0xA5F1	DEBUG_LOAD_CODE==1	0
cwhite.c:	0xA5F2	FEC_UPLINK_TEST==1	0
cwhite.c:	0xA5F0	DEBUG_LOAD_CODE==1	0
su_calbgd.c:	0xA5F0	keep_a_log & 0x8000	0x0001
su_calbgd.c:	0xA5F1	keep_a_log & 0x8000	0x0001
su_calbgd.c:	0xA5F2	keep_a_log & 0x8000	0x0001
su_calbgd.c:	0xA5FE	keep_a_log & 0x8000	0x0001
su_caldrft.c:	0xA5E0	keep_a_log & 0x0200	0x0001
su_caldrft.c:	0xA532	DEBUG_CALDRFT==1	0
su_caldrft.c:	0xA537	DEBUG_CALDRFT==2	0
su_compress.c:	0xA5F1	DPU_DEBUG==10	0
su_compress.c:	0xA5F0	DPU_DEBUG==9	0
su_compress.c:	0xA5E1	DPU_DEBUG==9	0
su_compress.c:	0xA5E2	DPU_DEBUG==9	0
su_compress.c:	0xA5F3	DPU_DEBUG==9	0
su_compress.c:	0xA5E6	DPU_DEBUG==1 or 19	0
su_compress.c:	0xA5E3	DPU_DEBUG==1 or 19	0
su_compress.c:	0xA5Ea	DPU_DEBUG==1 or 19	0

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(continued)

		Comp. or control variable	default
su_compress.c:	0xA5C4	DPU_DEBUG==3	0
su_compress.c:	0xA5C1	DPU_DEBUG==13	0
su_compress.c:	0xA5Cb	DPU_DEBUG==3	0
su_compress.c:	0xA5C0	DPU_DEBUG==3	0
su_compress.c:	0xA5C2	DPU_DEBUG==13	0
su_compress.c:	0xA5F0	DPU_DEBUG==1	0
su_compress.c:	0xA5E4	DPU_DEBUG==11	0
su_compress.c:	0xA5E5	DPU_DEBUG==11	0
su_compress.c:	0xA5E5	DPU_DEBUG==1	0
su_compress.c:	0xA5E5	DPU_DEBUG==2	0
su_compress.c:	0xA5E9	DPU_DEBUG==1	0
su_deliverdata.c:	0xA5E2	keep_a_log & 0x2000	0x0001
su_deliverdata.c:	0xA5E3	keep_a_log & 0x2000	0x0001
su_deliverdata.c:	0xA5d8	keep_a_log & 0x2000	0x0001
su_deliverdata.c:	0xA5d9	keep_a_log & 0x2000	0x0001
su_dowindow.c:	0xA5c9	keep_a_log & 0x1000	0x0001
su_dowindow.c:	0xA5F0	DEBUG_DOWINDOW==1	0
su_dowindow.c:	0xA5F5	DEBUG_DOWINDOW==1	0
su_engineering.c:	0xA5E0		
su_engineering.c:	0xA5E1		
su_engineering.c:	0xA5E3		
su_getref.c:	0xA5D1		
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C2	STRESS_TEST==1	0
su_initialize.c:	0xA5C3	STRESS_TEST==1	0
su_initialize.c:	0xA5C4	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C2	STRESS_TEST==1	0
su_initialize.c:	0xA5C3	STRESS_TEST==1	0
su_initialize.c:	0xA5C4	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C2	STRESS_TEST==1	0
su_initialize.c:	0xA5C3	STRESS_TEST==1	0
su_initialize.c:	0xA5C4	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0

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(continued)

		Comp. or control variable	**default**
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5C1	STRESS_TEST==1	0
su_initialize.c:	0xA5Ce	STRESS_TEST==1	0
su_initialize.c:	0xA5F9	STRESS_TEST==1	0
su_initialize.c:	0xA5c9	CHECK_ACCUM_WSIA==1	0
su_initialize.c:	0xA5cA	CHECK_ACCUM_WSIA==1	0
su_initialize.c:	0xA5c0	TEST_RAM!=0	0
su_initialize.c:	0xA5c1	TEST_RAM!=0	0
su_initialize.c:	0xA5c2	TEST_RAM!=0	0
su_initialize.c:	0xA5c3	TEST_RAM!=0	0
su_initialize.c:	0xA5cc	TEST_RAM!=0	0
su_initialize.c:	0xA5cd	TEST_RAM!=0	0
su_initialize.c:	0xA5f0	STRESS_DATA_Q	undefined
su_initialize.c:	0xA5CC		
su_locategs.c:	0xA5B1	DEBUG_LOCATEGS==1	0
whitedsp.c:	0xA5D2	DEBUG_RED_SAA==1	0
whitedsp.c:	0xA5D3	DEBUG_RED_SAA==1	0
whitedsp.c:	0xA5D4	DEBUG_RED_SAA==1	0
whitedsp.c:	0xA5D5	DEBUG_RED_SAA==1	0
whitedsp.c:	0xA5D6	DEBUG_RED_SAA==1	0
whitedsp.c:	0xA5D9	DO_FROG==1	0

The appearance of these alerts are very much dependent on the context DPU software and its debugging configuration. Consult the DPU software maintainer/developer for advice.

Instruction to DPU software developer/maintainer:

When turning on any compilation flag, be mindful of these extraneous alerts that have been turned on or any others that might have been implemented as a diagnostics tool. Inform the instrument operator/simulator not familiar with the internal working of the DPU to expect such extraneous alerts.

12 General Debug Procedure

12.1 ICU

12.1.1 HV

Safe the high voltages, if possible.

Description	tc	tm	params	VxWorks
Specify $V_{cathode}$ ramp parameters	**h7140**		**h510="cathode", h160=0, h175="off"**	`tc_det_load_hv_ramp_params 1,0,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 120 s for event		**92100**	**h7000="cathode ok"**	
Specify V_{mcp1} ramp parameters	**h7140**		**h510="mcp1", h160=0, h175="off"**	`tc_det_load_hv_ramp_params 2,0,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 120 s for event		**92100**	**h7000="mcp1 ok"**	
Specify V_{mcp23} ramp parameters	**h7140**		**h510="mcp23, h160=0, h175="off"**	`tc_det_load_hv_ramp_params 3,0,25,0`
Perform ramp	**h5140**			`tc_det_start_hv_ramp`
Wait up to 120 s for event		**92100**	**h7000="mcp23 ok"**	

If there are errors from this HV ramp-down or there is not time to perform it, continue with the following debug and reset.

12.1.2 Debug

Do a low-level RBI DMA read of the ICU's memory (operand space).

These DMA reads of the ICU's memory can be done with the ICU even in a "crashed" state. The ICU's code does not need to be running correctly. It can be done at any time as long as the ICU is powered on.

Description	tc	tm	params	VxWorks
Spacecraft command: read the words in the OM ICU memory at addresses $fc0_{hex}$ to fdf_{hex}				`<debug`
Spacecraft command: read the words in the OM ICU memory at addresses $a08_{hex}$ to $a0a_{hex}$				
Spacecraft command: read the words in the OM ICU memory at addresses $a20_{hex}$ to $a25_{hex}$				
Wait approx. 60 s				

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Description	tc	tm	params	VxWorks
Spacecraft command: read the words in the OM ICU memory at addresses fc0$_{hex}$ to fdf$_{hex}$				`<debug`

12.1.3 Reset

Reset the ICU see Section 9.3) and follow the "Post Perigee Procedure" (see Section 9.16).

If this fails do an RBI reset of the ICU.

12.2 DPU

This is the DPUPMM procedure. In all cases of unscheduled DPU reset (Fred) and some severe exceptions alerts described above, it is necessary to capture the DPU state for post mortem failure analysis. The following is a sequence of DPU memory data extraction for this purpose.

12.2.1 Dump Prog Area

Description	tc	tm	params	VxWorks
Reset DPU	**h7201**			`tc_reset_dsp`
Wait up to 10 s for alert		**92201**		Expect "Fred from the Dead"
Dump Bank 0 request	**h4120**		**h500=e00000**$_{hex}$ **h510=b000**$_{hex}$	`tc_dump_mem(0x20, 0xe00000, 0xb000)`
Dump Bank 3 request	**h4123**		**h500=e30000**$_{hex}$ **h510=1000**$_{hex}$	`tc_dump_mem(0x23, 0xe30000, 0x1000)`
Dump Bank 5 request	**h4125**		**h500=e50000**$_{hex}$ **h510=3400**$_{hex}$	`tc_dump_mem(0x25, 0xe50000, 0x3400)`
Dump Bank 7 request	**h4127**		**h500=e70000**$_{hex}$ **h510=3400**$_{hex}$	`tc_dump_mem(0x27, 0xe70000, 0x3400)`
Dump Bank 7 LUT request	**h4127**		**h500=e7ff00**$_{hex}$ **h510=100**$_{hex}$	`tc_dump_mem(0x27, 0xe7ff00, 0x100)`

12.2.2 Dump Proc area

Description	tc	tm	params	VxWorks
Dump Proc request	**h4114**		**h500=0 h510=8000**$_{hex}$	`tc_dump_mem(0x14, 0x0, 0x8000`

13 Appendix A: VxWorks Scripts

Here are the VxWorks scripts used for software testing in the UK and USA.

13.1 acquire

```
##############################################################################
#
# RCS $Id: acquire,v 1.5 1999/03/21 17:37:26 pjs1 Exp $
# RCS $Log: acquire,v $
# RCS Revision 1.5  1999/03/21 17:37:26  pjs1
# RCS Don't set exp_no and don't copy ref_stars.cfg file.
# RCS
# RCS Revision 1.4  1999/03/18 20:46:28  pjs1
# RCS Set threshold to 15.  Increased end delay.
# RCS
# RCS Revision 1.3  1999/03/15 15:26:41  pjs1
# RCS Decreased Jon delay (for simulator use only).
# RCS
# RCS Revision 1.2  1999/03/04 04:44:03  pjs1
# RCS Added load_tables.
# RCS
# RCS Revision 1.1  1999/03/04 02:28:45  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
##############################################################################


#################################################################
#
#   Set up some numbers first
#
#################################################################

date
frame_time = 15
bpe_bin = 0
filter = 1
#exp_no = 0xd40001
#copy "/home/xmmom/sim_data/ref_stars.cfg","ref_stars.cfg"

############################################

```

```
tc_det_acq_mode 0

# load det acq 0 configuration
< load_table_24
# Jon delay
taskDelay(10*60)

tc_fw_filter 1
tc_fw_move
taskDelay(20*60)

tc_set_bpe bpe_bin
tc_set_exp_no exp_no

tc_det_enbl_frame_tag 1
tc_det_event_threshold 15

# load reference stars
< load_table_25

# ref frame exp
tc_set_frame_time frame_time*1024

tc_send_command IC_INIT_EXP
taskDelay(3*60)

# change to science mode
#tc_mode 3
# start the detector integration
tc_det_start_int

tc_send_command IC_ACQUIRE_FLD
taskDelay(frame_time*60)
tc_det_stop_int
# should check this
taskDelay(60*60)
```

13.2 cgs

```
###########################################################################
#
# RCS $Id: cgs,v 1.4 1999/04/13 16:21:16 pjs1 Exp $
# RCS $Log: cgs,v $
# RCS Revision 1.4  1999/04/13 16:21:16  pjs1
# RCS Removed Jon delay.
# RCS
# RCS Revision 1.3  1999/03/18 20:46:50  pjs1
# RCS Added enable frame tags and threshold.
# RCS
# RCS Revision 1.2  1999/03/04 04:44:03  pjs1
# RCS Added load_tables.
# RCS
# RCS Revision 1.1  1999/03/04 02:28:46  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
###########################################################################

date
tc_fw_filter filter
tc_fw_move
taskDelay(20*60)
tc_det_acq_mode 0

# load acq 0 mode
< load_table_24
# Jon delay
taskDelay(20*60)

tc_set_exp_no exp_no
tc_send_command IC_INIT_EXP
taskDelay(3*60)

tc_det_enbl_frame_tag 1
tc_det_event_threshold 15

############
tc_set_frame_time frame_time*1024
# tc_prog_mem_wind "mmw.cfg"
< load_table_28
# tc_prog_sci_wind "scw.cfg"
< load_table_29
```

```
tc_set_exposure_time exposure_time
tc_set_bpe bpe_bin
tc_det_start_int
tc_send_command IC_CHOOSE_GS
taskDelay((frame_time+40+40)*60)
tc_det_stop_int
# Jon delay
#taskDelay(60*60)
```

13.3 exp

```
#############################################################################
#
# RCS $Id: exp,v 1.3 1999/04/13 16:21:31 pjs1 Exp $
# RCS $Log: exp,v $
# RCS Revision 1.3  1999/04/13 16:21:31  pjs1
# RCS Added tracking on.
# RCS
# RCS Revision 1.2  1999/03/18 20:47:05  pjs1
# RCS Changed threshold.
# RCS
# RCS Revision 1.1  1999/03/04 02:28:47  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
#############################################################################

date
tc_det_acq_mode 2
tc_set_bpe bpe_bin
#
# Put BPE into the right mode, really shouldn't be here
#
tc_det_enbl_frame_tag 1
tc_det_event_threshold 15
#
tc_det_start_int
# taskDelay 2*60
tc_send_command IC_TRACK_GS
taskDelay((frame_time*(exposure_time+1)+10)*60)
tc_set_trk 1
```

13.4 eng3

```
##############################################################################
#
# RCS $Id: eng3,v 1.8 1999/04/13 16:14:52 pjs1 Exp $
# RCS $Log: eng3,v $
# RCS Revision 1.8  1999/04/13 16:14:52  pjs1
# RCS Changed detector windows.
# RCS
# RCS Revision 1.7  1999/03/21 17:38:48  pjs1
# RCS Changed archive name.  Changed exposure id.  Changed window size.  Added missing delay at end.
# RCS
# RCS Revision 1.6  1999/03/20 20:39:55  pjs1
# RCS Added open packet_archive. Moved LEDs. Changed exposure id.  Removed enable_verbose. Changed thre
# RCS
# RCS Revision 1.5  1999/03/17 21:19:54  pjs1
# RCS Added date, increased frame_time, added leds, added blocked, turned off frame
# RCS tags, increased delay, added Dave.
# RCS
# RCS Revision 1.4  1999/03/16 19:45:24  pjs1
# RCS Changed exposure ID, window coords, delays.
# RCS
# RCS Revision 1.3  1999/03/16 08:43:29  pjs1
# RCS Changed exposure id, acquisition mode, delay.
# RCS
# RCS Revision 1.2  1999/03/15 15:25:42  pjs1
# RCS Increased delay at end.
# RCS
# RCS Revision 1.1  1999/03/15 15:24:53  pjs1
# RCS New engineering mode scripts.
# RCS
#
##############################################################################
date
open_packet_archive("/data/xmmom/archive/d40003")
frame_time=300
tc_mode 4

tc_init_dpu
taskDelay(60*25)
# expect Dave from the Grave

tc_fw_filter 0
tc_fw_move
taskDelay(20*60)
```

```
tc_det_flood_led_current 4
tc_set_frame_time frame_time*1024
tc_set_exp_no 0xd40003
tc_send_command IC_INIT_EXP
# tm_wait_for_alert DA_EOT_INIT_EXP
taskDelay(3*60)

det_reset_wind
# full size
#det_wind 64, 15, 256, 256
#inner part
det_wind 64+32, 15+32, 256-64, 256-64
tc_det_load_windows 1
taskDelay(60*60)

#turn on eng7 if necessary - probably not for post perigee procedure
#tc_enbl_verbose 4,1
tc_det_enbl_frame_tag 0
tc_det_event_threshold 15

tc_det_acq_mode 4

# start sending events from mic
tc_det_start_int

tc_enbl_eng 1, 3

# wait for DA_ENDOF_EXP DA_COMPLETE_EXP all data
taskDelay(frame_time*60)
# the following delay is for 4,1
#taskDelay(500*60)
taskDelay(380*60)

close_packet_archive
tc_det_flood_led_current 0

tc_mode 2
```

13.5 eng4

```
###########################################################################
#
# RCS $Id: eng4,v 1.7 1999/07/08 10:54:46 pjs1 Exp $
# RCS $Log: eng4,v $
# RCS Revision 1.7  1999/07/08 10:54:46  pjs1
# RCS Changed delay.
# RCS
# RCS Revision 1.6  1999/03/21 17:39:12  pjs1
# RCS Changed archive name and exposure id.
# RCS
# RCS Revision 1.5  1999/03/20 20:43:47  pjs1
# RCS Changed frame_time. Added open_packet_archive. Added Dave.
# RCS
# RCS Revision 1.4  1999/03/17 21:20:45  pjs1
# RCS Added date, fixed delay, turned off frame tags.
# RCS
# RCS Revision 1.3  1999/03/16 19:50:37  pjs1
# RCS Changed threshold.
# RCS
# RCS Revision 1.2  1999/03/16 08:43:48  pjs1
# RCS Added mode change to idle.
# RCS
# RCS Revision 1.1  1999/03/15 16:47:26  pjs1
# RCS Engineering mode 4.
# RCS
#
###########################################################################
date
open_packet_archive("/data/xmmom/archive/d40004")
frame_time=300
tc_mode 4

tc_init_dpu
taskDelay(60*25)
# expect Dave from the Grave

tc_set_frame_time frame_time*1024
tc_set_exp_no 0xd40004
tc_send_command IC_INIT_EXP
# tm_wait_for_alert DA_EOT_INIT_EXP
taskDelay(3*60)

det_reset_wind
```

```
det_wind 64, 15, 256, 256
tc_det_load_windows 1
taskDelay(60*60)

# Jon delay
taskDelay(20*60)

tc_det_enbl_frame_tag 0
tc_det_event_threshold 15
tc_det_acq_mode 3

# start sending events from mic
tc_det_start_int

tc_enbl_eng 1, 4

# wait for DA_ENDOF_EXP
taskDelay(frame_time*60)
#tm_wait_for_alert DA_COMPLETE_EXP
taskDelay(4800*60)
taskDelay(4800*60)
taskDelay(4800*60)
taskDelay(1000*60)

tc_mode 2
close_packet_archive
```

13.6 eng5

```
################################################################################
#
# RCS $Id: eng5,v 1.6 1999/04/13 16:14:05 pjs1 Exp $
# RCS $Log: eng5,v $
# RCS Revision 1.6  1999/04/13 16:14:05  pjs1
# RCS Changed delays and exposure time.
# RCS
# RCS Revision 1.5  1999/03/21 17:39:31  pjs1
# RCS Changed archive name and exposure id.
# RCS
# RCS Revision 1.4  1999/03/20 20:44:52  pjs1
# RCS Lengthened frame_time. Added open_packet_archive. Moved LEDs. Changed threshold. Added Dave.
# RCS
# RCS Revision 1.3  1999/03/17 21:21:59  pjs1
# RCS Added date, increased frame_time, added blocked, disabled tags, added LEDs, added Dave.
# RCS
# RCS Revision 1.2  1999/03/16 19:45:24  pjs1
# RCS Changed exposure ID, window coords, delays.
# RCS
# RCS Revision 1.1  1999/03/15 15:24:53  pjs1
# RCS New engineering mode scripts.
# RCS
#
################################################################################
date
open_packet_archive("/data/xmmom/archive/d40005")
# was 600
frame_time=4000
tc_mode 4

tc_init_dpu
taskDelay(60*25)
# expect Dave from the Grave

tc_fw_filter 0
tc_fw_move
taskDelay(20*60)
tc_det_flood_led_current 4
tc_set_frame_time frame_time*1024
tc_set_exp_no 0xd40005
tc_send_command IC_INIT_EXP
# tm_wait_for_alert DA_EOT_INIT_EXP
taskDelay(3*60)
```

```

det_reset_wind
det_wind 64, 15, 256, 256
tc_det_load_windows 1
taskDelay(60*60)

tc_det_enbl_frame_tag 0
tc_det_event_threshold 15
tc_det_acq_mode 3

# start sending events from mic
tc_det_start_int

tc_enbl_eng 1, 5

# wait for DA_ENDOF_EXP
taskDelay(frame_time*60)
taskDelay(130*60)
#tm_wait_for_alert DA_COMPLETE_EXP
taskDelay(20*60)
# wait for data
taskDelay(20*60)

close_packet_archive

tc_det_flood_led_current 0

tc_mode 2
```

13.7 eng6

```
###############################################################################
#
# RCS $Id: eng6,v 1.6 1999/04/13 16:15:44 pjs1 Exp $
# RCS $Log: eng6,v $
# RCS Revision 1.6  1999/04/13 16:15:44  pjs1
# RCS Changed delay.
# RCS
# RCS Revision 1.5  1999/03/21 17:39:31  pjs1
# RCS Changed archive name and exposure id.
# RCS
# RCS Revision 1.4  1999/03/20 20:46:11  pjs1
# RCS Added open_packet_archive. Added Dave.
# RCS
# RCS Revision 1.3  1999/03/17 21:22:34  pjs1
# RCS Added date, added blocked, added LEDs, disabled frame tags, added Dave.
# RCS
# RCS Revision 1.2  1999/03/16 19:45:25  pjs1
# RCS Changed exposure ID, window coords, delays.
# RCS
# RCS Revision 1.1  1999/03/15 15:24:54  pjs1
# RCS New engineering mode scripts.
# RCS
#
###############################################################################
date
open_packet_archive("/data/xmmom/archive/d40006")
frame_time=20
tc_mode 4

tc_init_dpu
taskDelay(60*25)
# expect Dave from the Grave

tc_fw_filter 0
tc_fw_move
taskDelay(20*60)
tc_det_flood_led_current 4

tc_set_frame_time frame_time*1024
tc_set_exp_no 0xd40006
tc_send_command IC_INIT_EXP
# tm_wait_for_alert DA_EOT_INIT_EXP
taskDelay(3*60)
```

```

det_reset_wind
det_wind 64, 15, 256, 256
tc_det_load_windows 1
taskDelay(60*60)

tc_det_enbl_frame_tag 0
tc_det_event_threshold 12
tc_det_acq_mode 6

# start sending events from mic
tc_det_start_int

tc_enbl_eng 1, 6

# wait (exposure time) for DA_ENDOF_EXP
taskDelay(frame_time*60)
#tm_wait_for_alert DA_COMPLETE_EXP
taskDelay(20*60)
# wait for end of data
taskDelay(20*60)

close_packet_archive

tc_det_flood_led_current 0

tc_mode 2
```

13.8 flatfield

```
###############################################################################
#
# RCS $Id: flatfield,v 1.5 1999/09/27 19:43:57 pjs1 Exp $
# RCS $Log: flatfield,v $
# RCS Revision 1.5  1999/09/27 19:43:57  pjs1
# RCS Added turn off tracking before each cgs.
# RCS Removed turn on tracking at end (done by exp now).
# RCS
# RCS Revision 1.4  1999/07/08 10:55:21  pjs1
# RCS Added move filter wheel to blocked.
# RCS
# RCS Revision 1.3  1999/03/20 20:57:38  pjs1
# RCS Added open_packet_archive. Changed exposure IDs. Altered LED. Put all exposures back in.
# RCS
# RCS Revision 1.2  1999/03/17 21:27:30  pjs1
# RCS Added date.
# RCS
# RCS Revision 1.1  1999/03/04 02:28:59  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
###############################################################################

date
open_packet_archive("/data/xmmom/archive/d40018")
#####################
# Common parameters for all 4 FF
#
frame_time = 25
exposure_time = 20
bpe_bin = 1
track = 0
filter = 0
led = 4
copy "/home/xmmom/sim_data/e40018/mmw.cfg","mmw.cfg"
#####################
tc_fw_filter 0
tc_fw_move
taskDelay(20*60)
tc_set_bpe bpe_bin
tc_mode 2
tc_mode 4
tc_det_flood_led_current led
```

```
tc_mode 2
tc_mode 3
######################
# Specific parameters for FF
#
exp_no = 0xd40008
copy "/home/xmmom/sim_data/e40018/scw.cfg","scw.cfg"
######################
# could be <cgs_wo_fw_move to save some time
#
tc_set_trk track
<cgs
<exp
######################
# Specific parameters for FF
exp_no = 0xd40009
copy "/home/xmmom/sim_data/e40019/scw.cfg","scw.cfg"
######################
# could be <cgs_wo_fw_move to save some time
#
tc_set_trk track
<cgs
<exp
######################
# Specific parameters for FF
exp_no = 0xd4000a
copy "/home/xmmom/sim_data/e4001a/scw.cfg","scw.cfg"
######################
# could be <cgs_wo_fw_move to save some time
#
tc_set_trk track
<cgs
<exp
######################
# Specific parameters for FF
exp_no = 0xd4000b
copy "/home/xmmom/sim_data/e4001b/scw.cfg","scw.cfg"
######################
# could be <cgs_wo_fw_move to save some time
#
tc_set_trk track
<cgs
<exp
######################
tc_set_bpe 0
tc_mode 2
```

```
tc_mode 4
tc_det_flood_led_current 0
tc_mode 2
tc_mode 3

##########################################################################
##########################################################################
# vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv
# remember to flush and close_packet_archive #############################
# ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
##########################################################################
##########################################################################
```

13.9 tc_clean_slate

```
###############################################################################
#
# RCS $Id: tc_clean_slate,v 1.3 1999/09/27 19:41:29 pjs1 Exp $
# RCS $Log: tc_clean_slate,v $
# RCS Revision 1.3  1999/09/27 19:41:29  pjs1
# RCS Added wait for "synchronize the clock".
# RCS
# RCS Revision 1.2  1999/03/17 21:13:23  pjs1
# RCS Added date and removed debug patch.
# RCS
# RCS Revision 1.1  1999/03/04 02:29:02  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
###############################################################################

date
#
#  Reset the ICU to the operational mode
#

rate 8

open_packet_archive "/data/xmmom/archive/d80ini"

set_dump_tm 0

#####################################################
#
# This script brings up the DPU in a clean slate
#
#####################################################

# clear all GSE semaphores

tm_clear_sem

#
#  First reset the DPU
#
tc_reset_dsp 0
taskDelay (60*12)

```

```
#
# Next reload the DPUOS
#
tc_load_dpuos
taskDelay (60*10)

# Turn on all color processors
tc_enbl_dsp red,1
taskDelay (60*10)

tc_enbl_dsp blue1,1
taskDelay (60*10)

tc_enbl_dsp blue2,1
taskDelay (60*10)

# Select blue2 as the klingon
tc_sel_klingon 1

# synchronize the clock bewteen ICU and DPU
tc_synch_clk_auto

#wait for it to happen
taskDelay(60*2)

#################################################################
#
# Initialize DPU
#
#################################################################
tc_init_dpu
taskDelay(60*25)
# expect Dave from the Grave

# DA_TRK enabled by code - not selectable
#tc_report_tracking 1
# DP_TRH enabled already
#tc_enbl_verbose 0,1
# turn on DD_REF verbosity
tc_enbl_verbose 3,1

# remove this later. special patch to debug Linux/Sim
#tc_load_local_ram 0x5c60,0x30

close_packet_archive
```

13.10 dpu_post_mortem

```
##########################################################################
#
# RCS $Id: dpu_post_mortem,v 1.4 1999/03/20 20:15:55 pjs1 Exp $
# RCS $Log: dpu_post_mortem,v $
# RCS Revision 1.4  1999/03/20 20:15:55  pjs1
# RCS Removed unnecessary close_packet_archive.
# RCS
# RCS Revision 1.3  1999/03/17 21:27:20  pjs1
# RCS Added date.
# RCS
# RCS Revision 1.2  1999/03/04 05:24:04  pjs1
# RCS Added taskDelay after reset.
# RCS
# RCS Revision 1.1  1999/03/04 02:28:47  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
##########################################################################
#
#
date

open_packet_archive "/data/xmmom/archive/dpupmm"

speed = 3

tc_reset_dsp
taskDelay(10*60)
#### SU
base = 0xE00000
length = 0xB000
tc_dump_prog_ram base, length
#### Blue
base = 0xE30000
length = 0x1000
tc_dump_prog_ram base, length
#### Red
base = 0xE50000
length = 0x3400
tc_dump_prog_ram base, length
#### White DPUOS
base = 0xE70000
length = 0x3400
```

```
tc_dump_prog_ram base, length
#### LUT
base = 0xE7FF00
length =  0x0100
tc_dump_prog_ram base, length
#### PROC
tc_dump_ram 0x0000, 0x8000
###
taskDelay(60*180*speed)
close_packet_archive
```

13.11 load_icu

```
##############################################################################
#
# RCS $Id: load_icu,v 1.2 1999/07/08 10:56:36 pjs1 Exp $
# RCS $Log: load_icu,v $
# RCS Revision 1.2  1999/07/08 10:56:36  pjs1
# RCS Commented out set_dump_tc and set_dump_tm.
# RCS
# RCS Revision 1.1  1999/03/04 02:29:00  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
##############################################################################
rate 100
set_dump_tc 0
set_dump_tm 0
packet_load < /home/pjs1/icu/fm/oper/icu.hex
#set_dump_tc 1
#set_dump_tm 1
rate 8
```

13.12 load_dpu

```
##############################################################################
#
# RCS $Id: load_dpu,v 1.3 1999/07/08 10:57:03 pjs1 Exp $
# RCS $Log: load_dpu,v $
# RCS Revision 1.3  1999/07/08 10:57:03  pjs1
# RCS Commented out set_dump_tc and set_dump_tm.
# RCS
# RCS Revision 1.2  1999/03/20 20:58:12  pjs1
# RCS Removed unnecessary delay. Removed set_dump_tm.
# RCS
# RCS Revision 1.1  1999/03/04 02:28:59  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
##############################################################################
rate 100
set_dump_tc 0
set_dump_tm 0
tc_reset_dsp
taskDelay(60*10)
tc_packet_load 0 < /home/xmmom/dpu/development/eeprom/p0.cmd.0
tc_packet_load 5 < /home/xmmom/dpu/development/eeprom/p5.cmd.0
tc_packet_load 7 < /home/xmmom/dpu/development/eeprom/p7.cmd.0
tc_packet_load 3 < /home/xmmom/dpu/development/eeprom/blue_p3.cmd.0
#set_dump_tc 0
#set_dump_tm 0
#taskDelay(60*12)
tc_load_dpuos
taskDelay(60*6)
rate 8
```

13.13 load_table_24

```
##############################################################################
#
# RCS $Id: load_table_24,v 1.1 1999/03/04 04:44:04 pjs1 Exp $
# RCS $Log: load_table_24,v $
# RCS Revision 1.1  1999/03/04 04:44:04  pjs1
# RCS Added load_tables.
# RCS
#
##############################################################################
det_reset_wind
det_wind 64,15,128,128
det_wind 64,143,128,128
det_wind 192,15,128,128
det_wind 192,143,128,128
tc_det_load_windows 4
taskDelay(30*60)
```

13.14 load_table_25

```
##############################################################################
#
# RCS $Id: load_table_25,v 1.1 1999/03/04 04:44:04 pjs1 Exp $
# RCS $Log: load_table_25,v $
# RCS Revision 1.1  1999/03/04 04:44:04  pjs1
# RCS Added load_tables.
# RCS
#
##############################################################################
tc_prog_ref_stars "ref_stars.cfg"
```

13.15 load_table_28

```
##############################################################################
#
# RCS $Id: load_table_25,v 1.1 1999/03/04 04:44:04 pjs1 Exp $
# RCS $Log: load_table_25,v $
# RCS Revision 1.1  1999/03/04 04:44:04  pjs1
# RCS Added load_tables.
# RCS
#
##############################################################################
tc_prog_ref_stars "ref_stars.cfg"
```

13.16 load_table_29

```
################################################################################
#
# RCS $Id: load_table_29,v 1.1 1999/03/04 04:44:05 pjs1 Exp $
# RCS $Log: load_table_29,v $
# RCS Revision 1.1  1999/03/04 04:44:05  pjs1
# RCS Added load_tables.
# RCS
#
################################################################################
tc_prog_sci_wind "scw.cfg"
```

13.17 bounds

```
##############################################################################
#
# RCS $Id: bounds,v 1.4 1999/03/21 17:37:55 pjs1 Exp $
# RCS $Log: bounds,v $
# RCS Revision 1.4  1999/03/21 17:37:55  pjs1
# RCS Open archive.  Lengthened delay.
# RCS
# RCS Revision 1.3  1999/03/15 16:00:16  pjs1
# RCS Turned on verification.
# RCS
# RCS Revision 1.2  1999/03/15 15:27:30  pjs1
# RCS Altered delays.
# RCS
# RCS Revision 1.1  1999/03/04 02:28:45  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
##############################################################################
date
open_packet_archive("/data/xmmom/archive/bounds")
det_equal_bounds
tc_det_load_bounds 1
taskDelay(100*60)
# Jon delay
taskDelay(20*60)
close_packet_archive
```

13.18 todatum

```
############################################################################
#
# RCS $Id: todatum,v 1.1 1999/03/17 21:12:41 pjs1 Exp $
# RCS $Log: todatum,v $
# RCS Revision 1.1  1999/03/17 21:12:41  pjs1
# RCS To datum script.
# RCS
# RCS
#
############################################################################
date
tc_fw_to_datum
tc_fw_move
taskDelay(25*60)
```

13.19 hvonr

```
################################################################################
#
# RCS $Id: hvonr,v 1.2 1999/03/21 17:40:02 pjs1 Exp $
# RCS $Log: hvonr,v $
# RCS Revision 1.2  1999/03/21 17:40:02  pjs1
# RCS Removed cathode to 2 V ramp.
# RCS
# RCS Revision 1.1  1999/03/17 21:08:17  pjs1
# RCS HV procedures.
# RCS
#
################################################################################

date
tc_det_load_hv_ramp_params 3,100,25,0
tc_det_start_hv_ramp
taskDelay(10 * 60)

tc_det_load_hv_ramp_params 3,1500,25,0
tc_det_start_hv_ramp
taskDelay(90 * 60)

tc_det_load_hv_ramp_params 2,500,25,0
tc_det_start_hv_ramp
taskDelay(40 * 60)

# don't need
#tc_det_load_hv_ramp_params 1,2,25,0
#tc_det_start_hv_ramp
#taskDelay(8 * 60)

tc_det_load_hv_ramp_params 1,390,25,0
tc_det_start_hv_ramp
taskDelay(30 * 60)

tc_det_load_hv_ramp_params 2,550,25,0
tc_det_start_hv_ramp
taskDelay(10 * 60)

tc_det_load_hv_ramp_params 3,1850,25,0
tc_det_start_hv_ramp
taskDelay(30 * 60)
```

13.20 hvoff

```
##############################################################################
#
# RCS $Id: hvoff,v 1.1 1999/03/17 21:08:16 pjs1 Exp $
# RCS $Log: hvoff,v $
# RCS Revision 1.1  1999/03/17 21:08:16  pjs1
# RCS HV procedures.
# RCS
#
##############################################################################

date
tc_det_load_hv_ramp_params 1,0,25,0
tc_det_start_hv_ramp
taskDelay(30*60)

tc_det_load_hv_ramp_params 2,0,25,0
tc_det_start_hv_ramp
taskDelay(40*60)

tc_det_load_hv_ramp_params 3,0,25,0
tc_det_start_hv_ramp
taskDelay(100*60)
```

13.21 flush

```
################################################################################
#
# RCS $Id: flush,v 1.2 1999/03/10 22:13:19 mcrw Exp $
# RCS $Log: flush,v $
# RCS Revision 1.2  1999/03/10 22:13:19  mcrw
# RCS Added date.
# RCS
# RCS Revision 1.1  1999/03/04 02:28:59  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
################################################################################
date
tc_send_command IC_FLUSH_CMPRS
```

13.22 reset

```
###############################################################################
#
# RCS $Id: reset,v 1.2 1999/03/17 21:27:31 pjs1 Exp $
# RCS $Log: reset,v $
# RCS Revision 1.2  1999/03/17 21:27:31  pjs1
# RCS Added date.
# RCS
# RCS Revision 1.1  1999/03/04 02:29:02  pjs1
# RCS The scripts after the Feb 1999 USA integration.
# RCS
#
###############################################################################
date
reset
packet_msg 0
taskDelay(20*60)
packet_msg 1
```

14 Appendix B: NCR 94

```
From ho@lanl.gov Mon Feb  8 04:32:54 1999
Date: Sun, 7 Feb 1999 21:31:04 -0700 (MST)
From: Cheng Ho <ho@lanl.gov>
Subject: NCR94 resolution report

Everyone, especially Howard and Jim, please review the following document.
We should submit this to ESA for approval and then we close NCR94.
----------------------------------------------------------
| Cheng Ho, Ph.D.                                        |
| Los Alamos National Lab. MS D436, Los Alamos, NM 87545 |
| Phone: (505)667-3904/667-6438, Fax: (505) 665-4414     |
| E-mail: ho@lanl.gov                                    |
----------------------------------------------------------

XMM-OM NCR94 Resolution Report
==============================

Problem statement
-----------------

The symptom we see is that the DPU will crash when we try to boot the red
or blue if the uploaded codes for red/blue contains an FEC Error. Current
suspiscion is that the error reporting mechanism between the color DSPs'
ROM code and the white DSP's DPUOS (Jim) codes. It is almost certain that
the problem resides on the ROM codes for the red and blue.

Possible resolutions
--------------------

1. The problematic codes resides on the space-qualified ROMs. The DPU
project does not have the resource to replace them.

2. The occurence of this error requires that the uploaded codes contain
an FEC error, which should be rare.

3. The problem is easily recognizable as rebooting the DPU will almost be
the first thing we do after we load the DPU codes. The validity of the
codes can be immediately checked. Codes can be immediately reloaded if
necessary.

These considerations lead to the following resolution approach: Develop
and implement a DPU code upload validation and recovery procedure, which
```

```
is described as follows.

XMM-OM DPU Code Upload and Validation Procedures
------------------------------------------------

1. The DPU codes are uploaded using the standard memory patch procedures.

2. Immediately after the DPU codes are loaded, load DPUOS and initialize
DPU. After initialization, the DPU red scrubbing will be activated and it
will protect against single bit error and report multiple bit error in the
program storage.

3. If the DPU resets during the post-code-load DPU initialization, then it
is likely that the uploaded codes contain FEC error(s). Immediately
perform a DPU code reload and reinitialization.

4. If the code load and initialization fail for two consecutive times,
perform the standard DPU post-mortem procedure to dump the DPU program
area for further diagnostics.

5. Whenever possible, leave the DPU in the DPUOS initialized state where
the red scrubbing is continuously exercised. This will help maintain the
integrity of the DPU codes stored in the program RAM.
```

15 Appendix C: NCR 106

In ICU Basic Mode, should the spacecraft issue a safing command, it will not conform to the standard format and the ICU will interpret the packet's CRC as the address to which it will jump leading to unpredictable results. Typically a reset or a watchdog kick.

The full text of the NCR follows:

"Mode transition telecommand (MFN 9001, GOTO SAFE) currently takes two parameters to specify safing level and start address of code to execute. The spacecraft CDMU will not supply these parameters, as it is based on an earlier version of the command."

16 Appendix D: NCR 82 and NCR 174

An hardware problem means that the ICU may corrupt its memory during power down/power up. Even though "Keep Alive" is on, some addresses may get corrupted. The memory must be checked after a power down.

17 Appendix E: NCR 175

17.1 Problem

Memory dump (6,2) MID=0x20 to 0x27 produces bad data.

17.2 Reason

The dump memory telecommand generates the wrong DPU command: it generates a IC_DUMP_RAM instead of a IC_DUMP_PROG_RAM which causes (6,2) memory dumps of program RAM to be wrong.

17.3 Fix

Change one constant on line 261 of dpu_mem_manager.adb from IC_DUMP_RAM to IC_DUMP_PROG_RAM.

18 Appendix F: NCR 139

Fluctuations of the -5.3 V current monitor (prime) have been seen whilst operating the FM OM-1 system. The fluctuation is caused by noise pick-up on the -5.3 current amplifier (TMPSU).

The nominal -5.3 V current level is biased very close to the upper extreme of the house keeping ADC's dynamic range. Amplifier noise can cause the ADC to saturate, causing wraparound of the ADC data (254, 255 – 0, 1 etc.). The -5.3 V current line therefore operates within both the upper and lower ranges.

The problem is not considered to be serious, as the -5.3 V monitor can still be used as a status register i.e. the electronics are working and within acceptable limits (accounting for the wrap around effect).

19 Appendix G: NCR 176

The DPU status is invalid until the appropriate memory patch is loaded.

20 Appendix H: ECR 84

```
From ho@lanl.gov  Thu Jul 22 08:10:22 1999
Date: Thu, 22 Jul 1999 01:09:47 -0600 (MDT)
From: Cheng Ho <ho@lanl.gov>
To: fgiannin@estec.esa.nl
Subject: Re: ECR 84, Data Buffer overflow

> OM to provide via Users Manual (UM section 11) a procedure to identify and
> recover from DPU buffer being full.
> Due date: 31 August 1999
>

Kate, please see if this makes any sense to you.

DPU data buffer usage monitoring and overflow detection/recovery
Cheng Ho, 1999 Jul 22

1. Overview

This document describes the methodology of determining the XMMOMDPU
compressed data queue buffer usage. Section 2 describes the anatomy of
data downlink from the DPU. Section 3 discusses the method of using
current (1999 July DPU software configuration) to monitor the DPU data
buffer usage. Section 4 discusses options of enhancing the ease for this
monitoring. Section 5 discusses 'recovery' procedure.

2. Anatomy of DPU data downlink

      DA_ENDOF_EXP  a514 0008 0000 5000 0000 0032 00d8 0511 0013 7d0a
- End of exposure d80511
   DA_SENT_CMPRS_Q  a527 0010 00d8 0511 a302 0000 0008 3401 0000 0130
                         0070 0000 0000 016e 00d8 0512 0016 bd71
- During d80512, data set a302-0000 is compressed
- and submitted to the compress queue
- the data resides in 700000 length 16e
       DA_DATA_END  a516 0004 00d8 0512 0016 be2b
- one data set is downlinked (d80511-a302-0000)
   DA_SENT_CMPRS_Q  a527 0010 00d8 0511 a301 0000 0008 35a6 0000 0514
                         0070 016e 0000 066f 00d8 0512 0016 c51b
- During d80512, data set a301-0000 is compressed
- and submitted to the compress queue
- the data resides in 70016e length 66f
       DA_DATA_END  a516 0004 00d8 0512 0016 c88b
- one data set is downlinked (d80511-a301-0000)
```

```
   DA_SENT_CMPRS_Q  a527 0010 00d8 0511 a303 0000 0000 8000 0003 9280
                        0070 07dd 0001 702c 00d8 0512 001b 63e4
- During d80512, data set a303-0000 is compressed
- and submitted to the compress queue
- the data resides in 7007dd length 1702c
       DA_DATA_END  a516 0004 00d8 0512 001d f690
- one data set is downlinked (d80511-a303-0000)
   DA_SENT_CMPRS_Q  a527 0010 00d8 0511 a303 0001 0004 1280 0002 a400
                        0071 7809 0000 e07d 00d8 0512 001e e0f2
- During d80512, data set a303-0001 is compressed
- and submitted to the compress queue
- the data resides in 717809 length e07d
   DA_SENT_CMPRS_Q  a527 0010 00d8 0511 a304 0001 0060 0000 0000 4295
                        0072 5886 0000 33a3 00d8 0512 001f 3b6a
- During d80512, data set a304-0001 is compressed
- and submitted to the compress queue
- the data resides in 725886 length 33ac
*  DA_SENT_CMPRS_Q  a527 0010 00d8 0511 a304 0002 0064 0000 0000 4295
                        0072 8c29 0000 338d 00d8 0512 001f 967b
- During d80512, data set a304-0002 is compressed
- and submitted to the compress queue
- the data resides in 728c29 length 338d
**     DA_DATA_END  a516 0004 00d8 0512 0020 727b
- one data set is downlinked (d80511-a303-0001)
       DA_DATA_END  a516 0004 00d8 0512 0020 d3e5
- one data set is downlinked (d80511-a304-0001)
       DA_DATA_END  a516 0004 00d8 0512 0021 31fb
- one data set is downlinked (d80511-a304-0002)
      DA_ENDOF_EXP  a514 0008 0000 5000 0000 0032 00d8 0512 0026 0748
- end of exposure d80512
```

Notes:

2.a. The DPU alerts ENDOF_EXP and SENT_CMPRS_Q are promptly downlinked as major milestones. DATA_END alerts are part of the auxlliary data stream but not the normal downlink. Recommendation: Make DATA_END part of the normal downlink.

2.b. For each SENT_CMPRS_Q, there should be one and only one corresponding DATA_END. They follow the same first-in-first-out sequence.

3. Reading the buffer usage

The queue usage can be read by following the CMPRS_Q sequence and the corresponding DATA_END.

Example 1. AT DPU time 1f967b when the SENT_CMPRS_Q alert appears (marked with *), the data queue buffer is used up to 73bfb6 (=728c29+338d). The last reported downlink data completion is for the data set d80511-a303-0000 whose compressed data occupied space up to 717809. Thus the occupied space is 717809 to 73bfb6.

Example 2. At DPU time 20727b when the DATA_END alert appears (marked with *), the reported data queue usage is up to 73bfb6 (=728c29+338d). There is possibly more data being written to the buffer if there is continuing compression. But we have no information of that. The area that has been downlinked is up to where d80511-a303-0001's compressed data has occupied, 725886 (=717809+e07d). Thus, there is un-downlinked data between 725886 and 73bfb6.

4. Options

4.a. As described above, it is possible to determine roughly the DPU compressed buffer usage. First of all, we recommend making DATA_END to be downlinked by default instead transmitted only as the Aux data stream (HEH, please confirm status). It is obvious that making the determination requires one to keep detailed track of how many SENT_CMPRS_Q and DATA_END has occurred since the last DPU reset. This entails additional work for the ground software.

4.b. It is possible for the DPU code to include the last address associated with the DA_DATA_END. This require a change in the ICU-DPU in terface protocol. But this will allow one to quickly determine the status by simply keep track of the most recent SENT_CMPRS_Q and DATA_END. One drawback is that the information will be confusing if the RAM dump has been requested and intermingled with the regular operation.

4.c. A proposal was made recently to dump out the full DPU data queue management table. Dumping this table once every exposure or on demand will allow the ground to get FULL picture of the DPU dtaa store usage. It also involves the introduction of a new data type and possibly new command.

5. Recovery

If data overwrite is suspected, then we should use the following procedures to identify the corrupted data sets. Those data sets should be considered suspect.

5.a. Construct the SENT_CMPRS_Q and DATA_END correspondence table in a similar fashion as shown above.

5.b. Determined the DPU buffer usage for each occurrence of SENT_CMPRS_Q and DATA_END.

5.c. If at any moment, the free space is smaller than (twice) the size of a typical compressed data set, then the data set that is being downlinked should be consider suspect. Marked as such to alert the user for possible irretrievable data corruption.

21 Production Notes

This document was typeset by P. J. Smith on a AMD K6-2 350 MHz PC running RedHat Linux 5.2 using LaTeX2ϵ (specifically the tetex-0.9.6 rpm).