CRaTER
Long Form Functional Test Procedure

Dwg. No. 32-06003.01

Revision C
November 8, 2007

S/N: _____ Date: ____________
Table of Contents

PREFACE.........................................................................................................................4

1 INTRODUCTION.............................................................................................................5
  1.1 Activity Description .................................................................................................5
  1.2 Test Item Description ...............................................................................................5
  1.3 Support Item Description .........................................................................................5

2 REQUIREMENTS .............................................................................................................5
  2.1 Verification Plan .........................................................................................................5
  2.2 List of Required Items ...............................................................................................5

3 CONFIGURATION..........................................................................................................5
  3.1 General Constraints ..................................................................................................5
  3.2 Test Configurations ..................................................................................................5

4 PROCEDURES ..............................................................................................................6
  4.1 Identification of Test Environment ............................................................................6
  4.2 Identification of Equipment and Personnel ...............................................................6
  4.3 Accumulated Operating Time ...................................................................................7
  4.4 Short Form Functional Test ....................................................................................7
  4.5 Echo Command Function .......................................................................................7
  4.6 Bus Power Variations ..............................................................................................8
  4.7 Interrupt 1 Hz Tick ..................................................................................................10
  4.8 Interrupt 1553 Functions ........................................................................................10
  4.9 Test Mode ................................................................................................................11
  4.10 Detector Noise Thresholds .....................................................................................12
  4.11 Detector Zero Crossing ........................................................................................12
4.12 Internal Cal Signal Sweep .................................................................13
4.13 Coincidence Mask Test ......................................................................13
4.14 Cobalt-60 Radiation Test .....................................................................13
4.15 Dosimeter Tests ..................................................................................14
4.16 Clean Up and Shut Down ....................................................................14
4.17 Accumulated Operating Time ...............................................................14
4.18 Deviation from Baseline Performance .................................................15

APPENDIX A -- CRATERCHECK MAN PAGE ..............................................17

APPENDIX B -- SAMPLE COBALT-60 DATA .............................................18
Preface

The Long Form Test is not run often, for a variety of reasons, and some of its components yield data that must be evaluated by an observer familiar with the idiosyncrasies of particle detectors in general and the characteristics of this instrument in particular. Similarly, some data analysis involves EGSE procedures that are only sketchily described here. It is intended that only the Project Scientist, Project Engineer, or Project Test Engineer run the Long Form Test.

Rev. 01 is released for general comment.

Rev. 02 is an update based on the experience of the first full run on S/N 10.

Rev. 03 added Echo commands to mark test boundaries and incorporated new test software.

Rev. A had implemented packet checking of test mode plus minor procedural changes.

Rev. B added a range of internal cal signal data plus success criteria for assuring stable instrument operation over time (see Section 4.18). The Purge Flow test was deleted (tracking a hardware deletion!). An internal calibration sweep test was added. A criteria for the stability of the regulated power supplies over a range of input voltages was added.

Rev. C made power measurements at the GSE power supply rather than the now removed internal telemetry points.
1 Introduction

The flight hardware for the Cosmic Ray Telescope for the Effects of Radiation (CRaTER) instrument on the Lunar Reconnaissance Orbiter (LRO) is composed of a single assembly incorporating both radiation detector and all associated power, command, data processing, and telemetry electronics. Its external (functional) properties are controlled by the data (32-02001) and electrical (32-02002) ICDs.

1.1 Activity Description

This procedure will provide a demonstration that the hardware meets as many of its performance requirements as can be tested within a laboratory environment. In particular all functional modes, including redundant operations, will be exercised.

1.2 Test Item Description

See para. 1.2 of the Short Form Functional Test Procedure (32-06003.02).

1.3 Support Item Description

See para. 1.3 of the Short Form Functional Test Procedure (32-06003.02).

2 Requirements

2.1 Verification Plan

This Procedure supports the activities contained in the CRaTER EMI/EMC Test Procedure (MIT Dwg. 32-06006.01), CRaTER Vibration Test Procedure (MIT Dwg. 32-06004.03), and the CRaTER Thermal-Vacuum Test Procedure (MIT Dwg. 32-06005.01).

2.2 List of Required Items

See para. 2.2 of the Short Form Functional Test Procedure (32-06003.02).

3 Configuration

3.1 General Constraints

See para. 3.1 of the Short Form Functional Test Procedure (32-06003.02).

3.2 Test Configurations

Same as para. 3.2 of the Short Form Functional Test Procedure (32-06003.02) except that here two MIL-STD-1553 dual-coax cables connect the spacecraft simulator to the instrument 1553 connector.

Connector mating/demating procedures per MIT 99-03002 shall be observed. Any connections made directly to the unit under test shall be noted in the mate/demaite log. Although connector savers will normally be in use, there are times – such as during vibration testing – where these will have to be removed and later replaced.
4 Procedures

Space is provided for the recording of information of particular significance in the conduct this test. Where a value simply needs to be verified, as opposed to recorded, a simple check mark √ will suffice. In addition the Test Conductor may redline the procedure to more accurately document the actual flow of events, both routine and anomalous.

The complexities of running this test makes it difficult for the novice test conductor to achieve a satisfactory result. At the time of initial controlled release of this document, only Bob Goeke and Dorothy Gordon are qualified for this effort.

The pages of this section will be attached to the Test Report that is filed each time this activity is conducted. The telemetry data stream generated by the spacecraft simulator is also an integral part of the Test Report; that data is archived on crater.bu.edu.

4.1 Identification of Test Environment

Procedure requiring this test:

Location of Test Environment:

Date:

4.2 Identification of Equipment and Personnel

Flight Instrument, 32-10000  
S/N ____________

Spacecraft Simulator, 32-80201  
S/N ____________

Test Conductor:

QA Representative:

Other Individuals:
4.3 **Accumulated Operating Time**

Record the current reading of the cumulative operating time for this instrument by using a web browser to interrogate the spacecraft simulator at [http://csr-dyn-94.mit.edu](http://csr-dyn-94.mit.edu) (or whatever net address the simulator resides on for this test).

<table>
<thead>
<tr>
<th>EGSE S/N</th>
<th>Time in hours:minutes</th>
<th>Initial</th>
</tr>
</thead>
</table>

4.4 **Short Form Functional Test**

Perform the CRaTER Short Form Functional Test (32-06003.02) and attach the as-run copy to this report. Do not terminate the `sf_log` archive program at the end of the test (or, if you did, restart it now!).

<table>
<thead>
<tr>
<th>Pass</th>
<th>Fail</th>
<th>Time</th>
<th>Initial</th>
</tr>
</thead>
</table>

This simple test demonstrates most of the functionality of the instrument (as well as ensuring that the Instrument GSE is functioning properly). The remaining tests pick up specialized and redundant functions. We are using the echo command to place markers in the data stream so that we can go back and review individual tests.

4.5 **Echo Command Function**

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td></td>
<td>0x1234</td>
</tr>
</tbody>
</table>

Read, record, and verify the following

<table>
<thead>
<tr>
<th>Group</th>
<th>Measurement</th>
<th>Value</th>
<th>Expected</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>Echo</td>
<td>2 : 0x1234</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 4.6 Bus Power Variations

With the GSE power supply set at 31±0.5 VDC, read and record the following

<table>
<thead>
<tr>
<th>From GSE Power Supply</th>
<th>Measurement</th>
<th>Value</th>
<th>Expected</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td></td>
<td>31±0.5 volts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td></td>
<td>0.15-0.25 amps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculated Power</td>
<td></td>
<td>6-8 watts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjust the GSE power supply to 27±0.5 VDC, then read and record the following

<table>
<thead>
<tr>
<th>From house.tcl</th>
<th>Group</th>
<th>Measurement</th>
<th>Value</th>
<th>Expected</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus Voltages</td>
<td>+5 Digital</td>
<td></td>
<td>5.0±0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>+5 Analog</td>
<td></td>
<td>5.0±0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-5 Analog</td>
<td></td>
<td>5.0±0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Display</td>
<td>hh:mm:ss</td>
<td></td>
<td>Wall time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>From GSE Power Supply</th>
<th>Measurement</th>
<th>Value</th>
<th>Expected</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td></td>
<td>27±0.5 volts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td></td>
<td>0.15-0.25 amps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculated Power</td>
<td></td>
<td>6-8 watts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Adjust the GSE power supply to 35±0.5 VDC, then read and record the following. Note that for the regulated voltages, we are interested in the change from the previous condition being minimal.

<table>
<thead>
<tr>
<th>Group</th>
<th>Measurement</th>
<th>Value</th>
<th>Expected</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus Voltages</td>
<td>+5 Digital</td>
<td>Δ &lt; 12mv</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>+5 Analog</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-5 Analog</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Display</td>
<td>hh:mm:ss</td>
<td></td>
<td>Wall time</td>
<td></td>
</tr>
</tbody>
</table>

From GSE Power Supply

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
<th>Expected</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>27±0.5 volts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>0.15-0.25 amps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculated Power</td>
<td>6-8 watts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjust the GSE power supply to 31±0.5 VDC and proceed to the next section/

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>0x4602</td>
<td></td>
</tr>
</tbody>
</table>

Time Completed | Initial

<table>
<thead>
<tr>
<th>Time Completed</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.7 Interrupt 1 Hz Tick

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>0x4700</td>
<td></td>
</tr>
<tr>
<td>1 Hz Tick off</td>
<td>(none)</td>
<td></td>
</tr>
</tbody>
</table>

Observe that the /One Hertz/ message appears preceding the time display.

<table>
<thead>
<tr>
<th>/One Hertz/ message displayed?</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>0x4701</td>
<td></td>
</tr>
<tr>
<td>1 Hz Tick on</td>
<td>(none)</td>
<td></td>
</tr>
</tbody>
</table>

Observe that the /One Hertz/ message has disappeared.

<table>
<thead>
<tr>
<th>/One Hertz/ message absent?</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.8 Interrupt 1553 Functions

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>0x4800</td>
<td></td>
</tr>
<tr>
<td>1553 Side B</td>
<td>(none)</td>
<td></td>
</tr>
</tbody>
</table>

Verify that the time display continues to run properly on the B side bus of the 1553 interface.

<table>
<thead>
<tr>
<th>From house.tcl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
</tr>
<tr>
<td>Time Display</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>0x4801</td>
<td></td>
</tr>
<tr>
<td>1553 Side A</td>
<td>(none)</td>
<td></td>
</tr>
</tbody>
</table>

Verify that the time display is back running properly on the A side.

<table>
<thead>
<tr>
<th>From house.tcl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
</tr>
<tr>
<td>Time Display</td>
</tr>
</tbody>
</table>
4.9 **Test Mode**

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>0x4900</td>
</tr>
<tr>
<td>Echo</td>
<td>8</td>
</tr>
<tr>
<td>Data Test</td>
<td>(none)</td>
</tr>
</tbody>
</table>

The Test Mode starts a science telemetry pattern generator within the digital section of the instrument. (The preceding “echo 8” instructs the system to run the entire suite of tests.) Run **CData** to verify that the test mode flag is set to “1” and test data is filling the science packets. (The Data Test button on the display also changes state here.)

<table>
<thead>
<tr>
<th>Data Field</th>
<th>Expected</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Mode Flag</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Wait a minimum of 2 minutes before proceeding. (The only way to exit Test Mode is to Reset the Instrument.)

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reset</td>
<td>(none)</td>
</tr>
<tr>
<td>HV Bias</td>
<td>On</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>Measurement</th>
<th>Value</th>
<th>Expected</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias Voltage</td>
<td>Thin</td>
<td></td>
<td>75±10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thick</td>
<td></td>
<td>220±10</td>
<td></td>
</tr>
</tbody>
</table>

We check the results of the Data Test (plus do a number of other consistency checks on the normal data packets) by running the following on the running data archive file starting in the initial Short Form test.

```
rtlm-x <archive_file | craterCheck
```

The desired outcome is to have no errors – though you will see messages reporting the clock outage we commanded back in Section 4.7. See Appendix A -- craterCheck man page for the details.
4.10 Detector Noise Thresholds

We now enable a single detector channel at a time; the noise threshold is determined by walking the appropriate LLD up from 64 (or approximately 0 mv) until the number of reported Good Events is less than 20. When a measurement is completed, reset the LLD to 128. Record the threshold setting, not the feedback voltage.

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>Echo</td>
<td>0x4A00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>LLD Thin Threshold</th>
<th>LLD Thick Threshold</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Process D1 Only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>Process D2 Only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>Process D3 Only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td>Process D4 Only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D5</td>
<td>Process D5 Only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td>Process D6 Only</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.11 Detector Zero Crossing

Run the `lf_zero` script. This will use the low range internal cal signal to draw a line between two points and calculate the ADU count of that line when it crosses zero (input).

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>Echo</td>
<td>0x4B00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
<th>D6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
<th>D6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
<th>D6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.12 Internal Cal Signal Sweep

This test is run purely to gather data which would be used by the science team to cross-calibrate instrument performance in case of on-orbit anomalies. The internal calibration source is run in both low and high amplitude modes, stepping 8 (command) LSBs and collecting a few thousand events at each step.

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>0x4C00</td>
<td></td>
</tr>
</tbody>
</table>

Run the `lf_ecal` script.

<table>
<thead>
<tr>
<th>Time Completed</th>
<th>Success?</th>
</tr>
</thead>
</table>

4.13 Coincidence Mask Test

This is a test which, for all combinations of detector processing enable, verifies that one and only one coincidence mask bit allows good events to be recorded. Since the test involves $2^6$ processing combinations and the same number of coincidence mask bits, it takes at least $3 \times 2^{12}$ seconds (3.4 hours) to complete. (We do not attempt to test all combinations of the coincidence mask, even for a single processing case; that would take $10^{12}$ years.)

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>0x4D00</td>
<td></td>
</tr>
</tbody>
</table>

Run the `lf_mask` script.

<table>
<thead>
<tr>
<th>Time Completed</th>
<th>Cases Run</th>
<th>Success?</th>
</tr>
</thead>
</table>

4.14 Cobalt-60 Radiation Test

This test works best with a 5 microcurie source held just in front of the telescope aperture (effectively about 1 cm from the closest thick detector). A stronger source held at a greater distance would do as well. With some of our older sources one must take into account the 5.3 year half-life in establishing the effective strength.

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>0x4E00</td>
<td></td>
</tr>
</tbody>
</table>
Run the “lf_cobalt 60” script (it will take 60 minutes worth of data) and compare the plots to the reference data in Appendix B. (The example is from a 13 hour run!)

<table>
<thead>
<tr>
<th>Time Completed</th>
<th>Max Counts D1,3,5</th>
<th>Max Counts D2,4,6</th>
<th>Success?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 4.15 Dosimeter Tests

The dosimeter does not respond to commonly available radiation sources. There is no test available once the instrument is buttoned up.

### 4.16 Clean Up and Shut Down

We intentionally use the “clear” command here to exercise that function; the “reset” command used elsewhere is a more general instruction which affects most of the internal logic states.

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>(none)</td>
<td></td>
</tr>
</tbody>
</table>

Read, record, and verify the following

<table>
<thead>
<tr>
<th>Group</th>
<th>Measurement</th>
<th>Value</th>
<th>Expected</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias Voltage</td>
<td>Thin</td>
<td>3±1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thick</td>
<td>3±1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Turn off GSE 28VDC power supply and Spacecraft Simulator if no further testing is to be performed immediately.

Close the archive data file by closing the window opened by `sf_log`.

<table>
<thead>
<tr>
<th>Time Completed</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 4.17 Accumulated Operating Time

Record the current reading of the cumulative operating time for this instrument by using a web browser to interrogate the spacecraft simulator at [http://csr-dyn-94.mit.edu](http://csr-dyn-94.mit.edu) (or whatever net address the simulator resides on for this test).

<table>
<thead>
<tr>
<th>EGSE S/N</th>
<th>Time in hours:minutes</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 4.18 Deviation from Baseline Performance

Where applicable, test limits have been defined in this procedure and the accompanying Short Form Functional. These limits are intended to encompass all operating conditions. Additionally, we want to assure that the operation of instrument remains stable. To that end we calculate here – when appropriate – the deviation of various parameters from their baseline values. (The nominal, ambient temperature and pressure baseline is available from the CRaTER database under the 32-06001 heading.)

<table>
<thead>
<tr>
<th>Test Ref</th>
<th>Parameter</th>
<th>#/LSB</th>
<th>Baseline</th>
<th>This Test</th>
<th>Delta</th>
<th>Limit</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFF 4.4</td>
<td>+5 Digital</td>
<td>2mv</td>
<td></td>
<td></td>
<td></td>
<td>10mv</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+5 Analog</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-5 Analog</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bulkhead</td>
<td>0.1C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>∆Telescope</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.0C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>∆Analog</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>∆Digital</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>∆DC-DC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFF 4.5</td>
<td>Power</td>
<td>30mw</td>
<td></td>
<td></td>
<td></td>
<td>0.2w</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bias V, Thin</td>
<td>0.1v</td>
<td></td>
<td></td>
<td></td>
<td>0.5v</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bias V, Thick</td>
<td>0.1v</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D1 bias I</td>
<td>0.5µa, 12%/C</td>
<td></td>
<td></td>
<td></td>
<td>greater of 25% or 2.5µa</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D3 bias I</td>
<td>0.5µa, 12%/C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D5 bias I</td>
<td>0.5µa, 12%/C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D2 bias I</td>
<td>5µa, 12%/C</td>
<td></td>
<td></td>
<td></td>
<td>Greater of 25% or 25µa</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D4 bias I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D6 bias I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NB: Temperature data is entered here as differences between the monitored value and the temperature of the bulkhead, instrument reference. The bulk temperature of the instrument depends upon the environment; to a first order the internal deltas should not.
The Primary Science data is recorded here in ADU. For reference, the thick detectors have a scale of approximately 20KeV/LSB; the thin detectors approximately 60KeV/LSB.

<table>
<thead>
<tr>
<th>Test Ref</th>
<th>Parameter</th>
<th>Baseline</th>
<th>This Test</th>
<th>Delta</th>
<th>Limit</th>
<th>OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFF 4.7</td>
<td>D1 Cal Amp</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D2 Cal Amp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D3 Cal Amp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D4 Cal Amp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D5 Cal Amp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D6 Cal Amp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D1 Noise</td>
<td></td>
<td></td>
<td></td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D2 Noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D3 Noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D4 Noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D5 Noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D6 Noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LFF 4.11</td>
<td>D1 Zero Cross</td>
<td></td>
<td></td>
<td></td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D2 Zero Cross</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D3 Zero Cross</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D4 Zero Cross</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D5 Zero Cross</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D6 Zero Cross</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix A -- craterCheck man page

NAME
  craterCheck -- Search for errors in CRaTER packets in test mode

USAGE
  craterCheck        # For use on SUN Solaris machines
  craterCheck.mac    # For use on Mac OS X machines
  craterCheck.exe    # For use on Windows machines
  craterCheck.c      # Source code

FLAGS
  (none)
  Uses only STDIN and STDOUT

DESCRIPTION
  This program verifies the data integrity of the CraterInstrument, as well as the operation of the SRAM and 1553 bus subsystems. Although useful for looking at packets emitted by the instrument in normal mode, running the instrument in "text" mode provides a more thorough diagnostic. First set up a data archiving process. Then the commands

  echo 8
test

sent to the instrument will start a cycle of internal diagnostics which should be allowed to continue for at least 2 minutes.

  rtlm-x <archive_data | craterCheck

will process the data.

DATA OUTPUT DESCRIPTION
  PS - Primary Science
  SS - Secondary Science
  HK - Housekeeping
  SSCnt - Source Sequence Count

  ApIDErr - Encountered an illegal Application Process ID (not equal to 120, 121 or 122)

  HdrBitCorr - Corruption encountered at the beginning of the packet header (check includes Version Number, Type and Secondary Header Flag)

  PLen - indicates that the packet length field does not match the expected value.

  SSCnt - (Source Sequence Counter) errors are listed for each ApID. This error count is non-zero if the detected SSCnt is non-consecutive. Special cases were added to handle potential GSE problems: Drop1 indicates one dropped packet. Repeat1 indicates a duplicate packet.

  Testmode data integrity checking is continued if the Drop1 or Repeat1 error is found. The program resynchs when a more serious PS SSCnt error is encountered.

  Data Errors apply only to the PS Telemetry when the system is in TestMode. They indicate a test-mode pattern mismatch in the data portion of the packet. Data Errors are tabulated on a per packet basis and accumulated for all Testmode packets. If more than four errors are found in one packet, the MultErrs count is incremented and the system "resynchs".

BUGS
  The program will only work if provided the output of an rtlm -x process, with or without a 64-byte file header. The program is very intolerant of variations in input format and has only been used with an rtlm feed.

SEE ALSO
  rtlm-x.c, verify
Appendix B -- Sample Cobalt-60 data

![Graph 1](image1)

![Graph 2](image2)