Goes 8-12

GOES I, J, K, L & M
XRS, EPS and HEPAD
XRS PDR DATA PACKAGE

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to
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GOES I-M XRS

PRELIMINARY DESIGN REVIEW

0 OVERVIEW OF SYSTEM REQUIREMENTS XRS 1
0 OVERVIEW OF SYSTEM DESIGN XRS 2
0 SUMMARY OF PERTINENT GOES D-H DATA AND ANALYSIS XRS 3
0 REVIEW OF GOES I-M BREADBOARD TEST DATA XRS 4
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OVERVIEW OF SYSTEM REQUIREMENTS

0 General Functional Requirements
0 General Performance Requirements
0 System Block Diagram
0 Major Design Constraints
GOES 1 - M XRS

GENERAL FUNCTIONAL REQUIREMENTS

* Measure solar x-rays in the spectral range .5-3 and 1-8 angstrom.

* Detection of x-rays with dual ion chamber, one chamber for each spectral range.

* Minimize noise signals induced in the ion chambers by electrons, bremsstrahlung and solar UV by following means:

  Collimating telescope  
  Permanent magnetic field in the aperture  
  Suitable radiation shield for ion chamber  
  UV shield foil

* Signal processing by two separate electronic channels.

* Provide separate automatic range changing means for each signal processing channel.

* Provide command activated self-calibration of both channels and indicate mode commanded.
* **Calibrate ion chambers to an accuracy of ± 10%**.

* **Calibrate both electronic channels over total dynamic ranges with DC currents applied to the inputs. Obtain calibration over temperature range.**

* **Demonstrate accuracy of composite calibration to be ≤ ± 16%**

* **Verify composite calibration with Fe 55 source test.**
GOES I - M XRS

GENERAL PERFORMANCE REQUIREMENTS

* **X-RAY SPECTRAL BANDS**
  - 0.5-3 Ångström, short sun channel
  - 1-8 Ångström, long sun channel

* **X-RAY DETECTION**
  - Dual ion chamber to be used.
  - Detector and electronics operating design life to be 7 years and ground storage life to be 5 years.

* **X-RAY DYNAMIC RANGE**
  - Short sun: 10^-6 to 10^-1 erg/cm^2/sec.
  - Long sun: 10^-5 to 1 erg/cm^2/sec.
  - 5 decade dynamic range in each channel to be divided into 4 data ranges.

* **SENSOR THRESHOLD SENSITIVITY**
  - Definition: X-ray flux = standard deviation of data output.
  - Short sun: 10^-16 erg/cm^2/sec, design goal. Degradation to 10^-15 erg/cm^2/sec at maximum electron flux.
  - Long sun: 10^-15 erg/cm^2/sec
GOES I - M XRS

GENERAL PERFORMANCE REQUIREMENTS (CONT'D)

* **Data Processing**
  - Two separate electronics channels, one for each spectral band.
  - Resolution of data to be \( \leq 2\% \) at X-ray flux \( \geq 20X \) threshold flux.
  - Data sampling rate = 1/512 sec.
  - S/C digitizes to 8 bits.
  - 0-90% response to step input = 2 sec.

* **Automatic Ranging**
  - Sense data range limits.
  - Automatically initiate range change commands when limits are exceeded.
  - Divide total dynamic range into 4 ranges.
  - Provide sufficient hysteresis to prevent hunting.
  - Separate auto-range electronics for each channel.
GOES I - M XRS

GENERAL PERFORMANCE REQUIREMENTS (CONT'D)

* **Self Calibration** - Capable of determining electronics gain with accuracy of ± 2%, when gain corrected for temperature variations.

- Calibration signals to span total dynamic range of each channel.

- Provide 2 calibration points, 1/2 scale and 0-scale, for each range.

- Instrument derived clock controls calibration sequence and duration.

* **Operating Temperature** - +350°C to -200°C

* **Non-Operating Temperature** - +500°C to -200°C

* **Power Dissipation** - 2.5 W over bus voltage range 29.5V to 42.5V

* **Mass Properties** - 10,6 lbs

* **Commands** - See Table

* **Telemetry** - See Table
### GOES 1 - M XRS

**GENERAL PERFORMANCE REQUIREMENTS (CONT'D)**

#### Calibration Sequence

<table>
<thead>
<tr>
<th>Step</th>
<th>Range</th>
<th>Stimulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>50 ± 10% FS</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>No Signal</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>50 ± 10% FS</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>No Signal</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>50 ± 10% FS</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>50 ± 10% FS</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>No Signal</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>No Signal</td>
</tr>
</tbody>
</table>

#### Analog Data

**TM Outputs**
- Short Sun X-ray
- Long Sun X-ray

**Commands**
- XRS ON
- XRS OFF
- CAL ON
- CAL OFF

#### Bi-Level Data

**TM Outputs**
- CAL Data Mode
- Short Sun Range Bit 2
- Short Sun Range Bit 2'
- Long Sun Range Bit 2
- Long Sun Range Bit 2'

**Analog Monitors**

**TM Outputs**
- CAL Reference Voltage
- Preamplifier Temperature
- DPU Temperature

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XRS 1.2-4
NOTE: ELECTRICAL INTERFACE TO S/C REQUIRES AN 18 LEAD CABLE.
GOES I - M XRS

MAJOR DESIGN CONSTRAINTS

* DUAL ION CHAMBER - IS A SPEC. REQUIREMENT.

* FIELD OF VIEW - MINIMIZING RESPONSE TO DIRECT ENTRY ELECTRONS AND MAXIMIZING X-RAY RESPONSE DEFINES OPTIMUM FOV.

* CENTER OF GRAVITY - ACCURATE LOCATION OF XRS CG REQUIRED FOR FACC SUPPLIED POSITIONER AXIS DETERMINATION.
GOES I - M XRS

OVERVIEW OF SYSTEM DESIGN

0 Design Considerations
0 XRS Assembly
0 Collimator and Magnet Subassembly
0 Preamp Subassembly
0 DPU Subassembly
  0 Post Amplifier
  0 Auto-Range
  0 In-Flight Calibrator
  0 DC/DC Converter
GOES 1 - M

DESIGN CONSIDERATIONS

* Ion Chamber
  - Use of dual ion chamber is a requirement. Only dual ion chamber with combined flight history of 13 years on GOES D-F is manufactured by Reuter Stokes. Also successful acceptance testing and integration testing on GOES G & H. Use of identical part on current program is a design constraint.

* Preamplifier
  - Successful flight performance on GOES D-F and passed acceptance and S/C integration tests on GOES G & H. Use identical circuits on current program with modifications to in-flight and ground calibration schemes as well as frequency response and input stage bias considerations.

* Auto-Range
  - Successful flight performance on GOES D-F and passed acceptance and S/C integration tests on GOES G & H. Use identical circuit with minor modifications to interface circuits for range bit status outputs to TM.

* Magnet Yoke
  - Successful flight performance on GOES D-F and passed acceptance and S/C integration tests on GOES G & H. Makes most effective use of permanent magnets with minimum stray magnetic fields. Use identical design but with smaller field gap on current program.
XRS ASSEMBLY, FUNCTIONAL CHARACTERISTICS

* Real time measurement of solar X-rays.
* Dual ion chamber senses X-rays in two spectral bands, .5-3 and 1-8 Angstrom.
* Collimator defines ± 20 field of view and reduces response to unwanted background from electrons and bremsstrahlung.
* Use of a strong magnetic field sweeps out electrons below about 4 MeV.
* Preamplifiers convert the dc currents from the dual ion chamber into dc voltages. One preamp for each spectral band.
* Radiation shielding of ion chamber and preamp housing further reduces effects of bremsstrahlung.
* DPU processes preamplifier outputs by two separate electronic channels.
* Each channel provides filtering, post amplification and automatic range changing.
* In-flight calibration and power supply is common to both channels.
### XRS Assembly, Performance Characteristics

#### Nominal Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Short Sun (.5-3(\AA))</th>
<th>Long Sun (1-8(\AA))</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-Ray Flux (W/m(^2))</td>
<td>10^-9 to 10^-4</td>
<td>10^-8 to 10^-3</td>
</tr>
<tr>
<td>Ion Chamber Responsivity (A/W/m(^2))</td>
<td>1.7 x 10^-5</td>
<td>4.6 x 10^-6</td>
</tr>
<tr>
<td>Preamp Conversion Gain - MSR (V/A)</td>
<td>2.5 x 10^11</td>
<td>.93 x 10^11</td>
</tr>
<tr>
<td>Preamp BW in MSR (Hz)</td>
<td>-1</td>
<td>-1</td>
</tr>
<tr>
<td>Threshold Flux - Design Goal W/m(^2)</td>
<td>10^-9</td>
<td>10^-8</td>
</tr>
<tr>
<td>- Degraded, Max</td>
<td>10^-8</td>
<td>No Degradation</td>
</tr>
<tr>
<td>Preamp Out at Design Goal Threshold (MV)</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>Preamp Noise Output, RMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Spurious Ion Ch (1) (MV)</td>
<td>.5</td>
<td>.2</td>
</tr>
<tr>
<td>- Electronics (BW=1Hz) (MV)</td>
<td>.8</td>
<td>.8</td>
</tr>
<tr>
<td>- Background Radiation (MV)</td>
<td>.3</td>
<td>.08</td>
</tr>
<tr>
<td>(Max Electron Flux)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Total, RMS</td>
<td>1.0</td>
<td>.83</td>
</tr>
<tr>
<td>Post Amplifier Gain</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Auto-Ranging</td>
<td>4 Decade Ranges</td>
<td>4 Decade Ranges</td>
</tr>
<tr>
<td></td>
<td>Stimulation to 50(\pm) 10% and 0 in each range.</td>
<td></td>
</tr>
</tbody>
</table>

#### In-Flight Calibration

Requires telescope off-sun and low background environment.

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1) 5 x 10^-4 A\(pp\) R/S Test Limit with Keithley Electrometer, -100Hz BW. At 1Hz BW

2) Screening test data: Max .4 \(\mu\)V at 10Hz BW. Extrapolated to max 4 \(\mu\)V at 1Hz, 1Hz BW.

XRS 2.2:2-1
### XRS Assembly, Performance Characteristics (Cont'd)

<table>
<thead>
<tr>
<th>Power Dissipation</th>
<th>2.5W</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong></td>
<td>10.6 LB</td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td>Aluminum except entrance collimator is copper. Aluminum covered with 1/16&quot; beryllium sheet stock. Soft iron pole pieces, rare earth cobalt magnets. Aluminum</td>
</tr>
<tr>
<td><strong>Finish</strong></td>
<td>Aluminum is chromate conversion coated copper is electroless nickel plated Soft iron is electroless nickel plated No finish on beryllium or magnets</td>
</tr>
<tr>
<td><strong>Thermal Finish</strong></td>
<td>FACC to determine</td>
</tr>
</tbody>
</table>

---

XRS 2.2.2-2
ION CHAMBER NOMINAL RESPONSE VS. WAVELENGTH
### Ion Chamber Properties

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Chamber A Value</th>
<th>Chamber B Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal x-ray range (μ)</td>
<td>0.5 – 3</td>
<td>1 – 8</td>
</tr>
<tr>
<td>Window thickness - Be (mils) (nominal)</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Gas fill (Component/%)</td>
<td>Xe/99.6, He/0.3</td>
<td>Ar/99.6, He/0.4</td>
</tr>
<tr>
<td>Fill pressure (mm Hg at 25°C)</td>
<td>180</td>
<td>800</td>
</tr>
<tr>
<td>Window width, w (in/cm)</td>
<td>0.75/1.91</td>
<td>0.25/0.64</td>
</tr>
<tr>
<td>Window area, a(cm²)</td>
<td>5.80</td>
<td>1.90</td>
</tr>
<tr>
<td>Chamber depth (cm)</td>
<td>3.99</td>
<td>3.99</td>
</tr>
<tr>
<td>Effective gas density for x-ray absorption (mg/cm³(type))</td>
<td>1.266 (Xe)</td>
<td>1.712 (Ar)</td>
</tr>
<tr>
<td>Total gas thickness, t_g(mg/cm²)</td>
<td>5.051 (Xe)</td>
<td>6.831 (Ar)</td>
</tr>
<tr>
<td>1/e depth for Fe-55 x-rays, 1/μ (cm)</td>
<td>1.17</td>
<td>2.21</td>
</tr>
<tr>
<td>Energy to produce an electron-ion pair, W(eV/pair)</td>
<td>22.0 (Xe)</td>
<td>26.2 (Ar)</td>
</tr>
</tbody>
</table>
GOES I - M XRS

COLLIMATOR AND MAGNET

0 Functional Characteristics
0 Performance Characteristics
0 Cross Section of Collimator and Magnet Yoke, Conceptual Design
0 GOES D, E, F Magnet Yoke Assembly
0 Calculation of Shielding Effectiveness and Bremsstrahlung Response

XRS 2.3
COLLIMATOR AND MAGNET SUBASSEMBLY, FUNCTIONAL CHARACTERISTICS

- Reduces charge currents induced in the ion chamber by electrons and bremsstrahlung by following means:
  - Narrow field of view (±20°) reduces background from direct electron fluxes.
  - Out of aperture electrons are stopped by Al collimator housing and copper entrance collimator. Lo Z aluminum minimizes bremsstrahlung production.
  - In-aperture electrons to above 4 MeV are swept out of FOV of ion chamber by permanent magnetic field created by magnet and yoke.
  - Internal Al collimators minimize bremsstrahlung production. They are copper backed towards the front and lead backed towards the rear.
  - Horizontal and vertical SS baffles collimate electrons into the magnet gap.
  - Collimator housing has internal lead cladding near ion chamber to shield it from external bremsstrahlung.
  - Be-window does not permit UV and heat radiation from sun to reach ion chamber windows.
COLLIMATOR AND MAGNET SUBASSEMBLY PERFORMANCE CHARACTERISTICS

* Field of View of ± 20

* In-aperture electrons to above 4 MeV are swept out of FOV. (Electron flux above ~ 4 MeV of the order of 10^2 cm^-2 sec^-1)

* Design goal for reduction of bremsstrahlung emanating from external housing by two orders of magnitude with ion chamber heavily shielded with lead.

* When mounted to FACC supplied positioner sun tracking is better than 1/20 of arc N-S and E-W.

XRS 2.3.2
NOTE POLARITY WHEN INSTALLING MAGNETS
1. FOR PARTS LIST SEE PC-4418

NOTES
x - NASA X-601-84-2 GOES 160°W, Solar Max
○ - FACC GOES I-M XRS Specification
□ - GOES G, H XRS Specification
△ - FACC Radiation Environment Specification
+ - GOES-5 El Channel Maximum
PHOTON ABSORPTION COEFFICIENTS FOR LEAD AND ALUMINUM

XRS 2.3.5-2
\[ \text{lead - Pb - } Z = 82 \]
\[ \text{iron - Fe - } Z = 26 \]
\[ \text{aluminum - Al - } Z = 13 \]
\[ \text{beryllium - Be - } Z = 4 \]

**Electron Energy (MeV)**

**FRACTIONAL STOPPING POWER FOR BREMSSTRAHLUNG (RADIATION)**
Bremsstrahlung Flux from the GOES 1600W, Solar Max Electron Spectrum - Stopping in Aluminum Electron and Bremsstrahlung Fluxes Isotropic

<table>
<thead>
<tr>
<th>Energy (MeV)</th>
<th>Bremsstrahlung Spectrum ( \frac{\Phi}{(cm^2 \cdot sec \cdot MeV)} )</th>
<th>ΔEγ ( \frac{d\Phi}{dE\gamma} )</th>
<th>Fraction of Bremsstrahlung from Electrons of Energy Range (MeV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(&lt; 0.3)</td>
</tr>
<tr>
<td>0.0625</td>
<td>0.025</td>
<td>2.51 x 10^6</td>
<td>0.358</td>
</tr>
<tr>
<td>0.0875</td>
<td>0.025</td>
<td>1.56 x 10^6</td>
<td>0.305</td>
</tr>
<tr>
<td>0.125</td>
<td>0.050</td>
<td>9.14 x 10^5</td>
<td>0.244</td>
</tr>
<tr>
<td>0.175</td>
<td>0.050</td>
<td>5.09 x 10^5</td>
<td>0.151</td>
</tr>
<tr>
<td>0.250</td>
<td>0.100</td>
<td>2.69 x 10^5</td>
<td>0.102</td>
</tr>
<tr>
<td>0.40</td>
<td>0.200</td>
<td>1.07 x 10^5</td>
<td>-</td>
</tr>
<tr>
<td>0.75</td>
<td>0.500</td>
<td>2.77 x 10^4</td>
<td>-</td>
</tr>
<tr>
<td>1.25</td>
<td>0.50</td>
<td>3.36 x 10^3</td>
<td>-</td>
</tr>
<tr>
<td>1.75</td>
<td>0.50</td>
<td>5.82 x 10^2</td>
<td>-</td>
</tr>
<tr>
<td>2.50</td>
<td>1.0</td>
<td>1.29 x 10^2</td>
<td>-</td>
</tr>
<tr>
<td>3.5</td>
<td>1.0</td>
<td>7.30 x 10^0</td>
<td>-</td>
</tr>
<tr>
<td>4.5</td>
<td>1.0</td>
<td>1.23 x 10^0</td>
<td>-</td>
</tr>
<tr>
<td>5.5</td>
<td>1.0</td>
<td>2.60 x 10^-2</td>
<td>-</td>
</tr>
</tbody>
</table>

XRS 2.3.5-4
## Ion Chamber Response to Bremsstrahlung

**GOES 1600W, Solar Max, Electron Spectrum into Aluminum Attenuated by 1.00g/cm² Al + 1.10 g/cm² Fe + 1.80 g/cm² Pb**

<table>
<thead>
<tr>
<th>Bremsstrahlung Energy (keV)</th>
<th>Attenuated Flux (photons/(cm² - sec))</th>
<th>Ion Chamber Current, ΔI (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Chamber A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Xe)</td>
</tr>
<tr>
<td>62.5</td>
<td>3.09 x 10⁰</td>
<td>5.08 x 10⁻¹⁷</td>
</tr>
<tr>
<td>87.5</td>
<td>1.53 x 10²</td>
<td>8.41 x 10⁻¹⁶</td>
</tr>
<tr>
<td>125</td>
<td>4.89 x 10³</td>
<td>1.09 x 10⁻¹⁶</td>
</tr>
<tr>
<td>175</td>
<td>1.23 x 10⁴</td>
<td>1.10 x 10⁻¹⁵</td>
</tr>
<tr>
<td>250</td>
<td>5.86 x 10⁵</td>
<td>2.37 x 10⁻¹⁵</td>
</tr>
<tr>
<td>400</td>
<td>1.18 x 10⁶</td>
<td>1.78 x 10⁻¹⁵</td>
</tr>
<tr>
<td>750</td>
<td>1.01 x 10⁷</td>
<td>7.16 x 10⁻¹⁶</td>
</tr>
<tr>
<td>1250</td>
<td>1.35 x 10⁸</td>
<td>6.26 x 10⁻¹⁷</td>
</tr>
<tr>
<td>1750</td>
<td>2.42 x 10⁹</td>
<td>9.69 x 10⁻¹⁸</td>
</tr>
<tr>
<td>2500</td>
<td>1.10 x 10¹⁰</td>
<td>3.56 x 10⁻¹⁸</td>
</tr>
<tr>
<td>3500</td>
<td>6.31 x 10¹¹</td>
<td>1.64 x 10⁻¹⁹</td>
</tr>
<tr>
<td>4500</td>
<td>1.07 x 10¹²</td>
<td>2.35 x 10⁻²⁰</td>
</tr>
<tr>
<td>5500</td>
<td>2.26 x 10¹³</td>
<td>9.62 x 10⁻²³</td>
</tr>
</tbody>
</table>

### Bremsstrahlung Background:
- X-Ray Threshold Flux Current (design goal) = 7.04 x 10⁻¹⁵A
- Background/Threshold = 7.04 x 10⁻¹⁵A / 4.7 x 10⁻¹⁴A = 0.391

<table>
<thead>
<tr>
<th>Electron Energy Range (MeV)</th>
<th>Chamber A Current (A)</th>
<th>Fraction</th>
<th>Chamber B Current (A)</th>
<th>Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0.3</td>
<td>7.09 x 10⁻¹⁶</td>
<td>0.101</td>
<td>1.71 x 10⁻¹⁶</td>
<td>0.059</td>
</tr>
<tr>
<td>0.3 - 1</td>
<td>4.55 x 10⁻¹⁵</td>
<td>0.646</td>
<td>1.89 x 10⁻¹⁵</td>
<td>0.654</td>
</tr>
<tr>
<td>1 - 2</td>
<td>1.57 x 10⁻¹⁵</td>
<td>0.223</td>
<td>7.28 x 10⁻¹⁶</td>
<td>0.252</td>
</tr>
<tr>
<td>≥ 2</td>
<td>2.06 x 10⁻¹⁶</td>
<td>0.029</td>
<td>1.01 x 10⁻¹⁶</td>
<td>0.035</td>
</tr>
</tbody>
</table>

XRS 2.3.5-5
### Summary of Electron Produced XRS Background

**Bremssstrahlung-Produced Background**

<table>
<thead>
<tr>
<th>Source</th>
<th>J(&gt;2MeV) (EL/(CM²·SEC))</th>
<th>Bkgnd/X-Ray Channel A</th>
<th>Threshold Channel B</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOES 1600 Solar Max</td>
<td>3.4 x 10⁴</td>
<td>= 0.39</td>
<td>= 0.062</td>
</tr>
<tr>
<td>FACC 1-M XRS Spec.</td>
<td>1.5 x 10⁵</td>
<td>1.4</td>
<td>0.22</td>
</tr>
<tr>
<td>GOES G,H XRS Spec.</td>
<td>1.5 x 10⁵</td>
<td>1.4</td>
<td>0.22</td>
</tr>
<tr>
<td>FACC Req. Env. Spec.</td>
<td>3.8 x 10⁴</td>
<td>0.44</td>
<td>0.069</td>
</tr>
<tr>
<td>GOES-5 E1 Max.</td>
<td>1.1 x 10⁶</td>
<td>13.</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Ion Chamber Background Currents Overestimated because:**

1. Have neglected 1/16 inch (1.80 g/cm²) lead shielding of sides, top and bottom of ion chamber.

2. Bremssstrahlung attenuation is calculated for the shortest absorber path in Al, Fe and Pb shielding.

3. Beryllium shielding is used on some external parts of housing.

**Neglected Background Currents are:**

1. Direct aperture entry electrons - assume magnetic shielding of ion chamber windows is for 4-6 MeV electrons.

2. In-aperture electron bremsstrahlung background - should be small but will be checked with the engineering model telescope.
ELECTRON AND BREMSSTRAHLUNG RESPONSE OF XRS

SUMMARY OF CALCULATION AND DATA FOR GOES-5 XRS

CALCULATED RESPONSE:

SOURCE OF BACKGROUND

DIRECT ELECTRON RESPONSE
(ELECTRONS > 2 MEV)

BREMSSTRAHLUNG RESPONSE
(MOSTLY ELECTRONS < 1 MEV)

TOTAL RESPONSE

METHOD OF CALCULATION

GOES D,E,F MAGNET DESIGN
REPORT - X-RAY SENSOR

GOES 1600W SPECTRAL SHAPE
AVERAGE OF LEAD/NO LEAD
SHIELDING CALCULATIONS

RESPONSES - A/(E1 COUNT)

<table>
<thead>
<tr>
<th></th>
<th>CHANNEL A (SHORT)</th>
<th>CHANNEL B (LONG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIRECT ELECTRON</td>
<td>1.02 x 10^-16</td>
<td>7.4 x 10^-17</td>
</tr>
<tr>
<td>RESPONSE (ELECTRONS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 2 MEV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BREMSSTRAHLUNG</td>
<td>8.6 x 10^-16</td>
<td>6.5 x 10^-17</td>
</tr>
<tr>
<td>RESPONSE (MOSTLY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELECTRONS &lt; 1 MEV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL RESPONSE</td>
<td>9.6 x 10^-16</td>
<td>1.39 x 10^-16</td>
</tr>
</tbody>
</table>

MEASURED RESPONSES FROM GOES-5

DATES OF DATA USED

XRS & EPS)

SOLAR X-RAY AND E1
FLUX CONDITIONS

LOW X-RAY: MODERATE
E1 (100 TO 600/READOUT)

LOW X-RAY: VERY HIGH
E1 (- 15000/READOUT)

MEASURED RESPONSES - A/(E1 COUNT)

<table>
<thead>
<tr>
<th></th>
<th>CHANNEL A (SHORT)</th>
<th>CHANNEL B (LONG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEB. &amp; AUG. 1985 DATA</td>
<td>7.8x10^-16</td>
<td>&lt;2.6x10^-16</td>
</tr>
<tr>
<td></td>
<td>0.81*</td>
<td>&lt;1.87*</td>
</tr>
<tr>
<td>8 OCT. 1985 DATA</td>
<td>1.02x10^-16</td>
<td>6.4x10^-16</td>
</tr>
<tr>
<td></td>
<td>1.00+</td>
<td>0.86+</td>
</tr>
</tbody>
</table>

* NORMALIZED TO THE TOTAL RESPONSE
+ NORMALIZED ONLY TO THE DIRECT ELECTRON RESPONSE

XRS 2.3.5-7
GOES I - M XRS

ION CHAMBER AND PREAMPLIFIER SUBASSEMBLY

0 Functional Characteristics
0 Performance Characteristics
0 Block Diagram
0 Cross Section of Ion Chamber Preamp Subassembly
0 Modifications from GOES D-H.
ION CHAMBER AND PREAMPLIFIER SUBASSEMBLY, FUNCTIONAL CHARACTERISTICS

* Dual ion chamber detects solar x-rays in the .5-3 and 1-8 Angstrom spectral band. Two charge current outputs, one for each band.

* Lead shielding surrounding ion chambers reduce background currents from bremsstrahlung.

* Preamplifiers convert continuous charge currents to dc voltages. One preamp per band.

* Dual MOS FET input stages have extremely low leakage currents.

* Two ranges of sensitivity (MSR and LSR) per preamp are selected by command from auto-range electronics.

* Range status is fed back to auto-range electronics.

* Preamp enclosed in electrical shield connected to signal ground.

* Test connectors allow ground calibration.

XRS 2.4.1
ION CHAMBER AND PREAMPLIFIER SUBASSEMBLY PERFORMANCE CHARACTERISTICS

* SEE PERFORMANCE CHARACTERISTICS OF XRS ASSEMBLY.

* NOMINAL DYNAMIC RANGE: SHORT SUN $1.7 \times 10^{-14}$ A TO $1.7 \times 10^{-9}$ A
  
  LONG SUN $4.6 \times 10^{-14}$ A TO $4.6 \times 10^{-9}$ A

* ANGULAR RESPONSE - SEE FOLLOWING GRAPHS.

* 5 DECADE DYNAMIC RANGE DIVIDED INTO 2 SENSITIVITY RANGES (MSR AND LSR). FACTOR OF 100 SENSITIVITY CHANGE.

* BANDWIDTH OF MORE SENSITIVE RANGE ≤ 1HZ TO KEEP ELECTRONIC NOISE TO A MINIMUM AT LOW SIGNAL LEVELS.

* VOLTAGE OUTPUT RANGE, BOTH SENSITIVITY RANGES: 0-5V, DC COUPLED TO PROCESSING ELECTRONICS IN DPU.

* MONITORS PREAMP TEMPERATURE.

XRS 2.4.2-1
A & B CHANNELS, E-W ANGULAR RESPONSE
B CHANNEL RELATIVE RESPONSE (NO COS θ FACTOR)

B CHANNEL, N-S ANGULAR RESPONSE
A CHANNEL RELATIVE RESPONSE (NO COS θ FACTOR)
GOES NEXT XRS PREAMPLIFIER BLOCK DIAGRAM
ONE CHANNEL SHOWN

XRS 2.4.3
ION CHAMBER AND PREAMPLIFIER SUBASSEMBLY, MODIFICATIONS FROM GOES D-H

* Change a.c. coupling of IFC signals to preamp input to d.c. coupling through Hi-Meg resistors.

* Change a.c. response (BP = 2Hz - 10Hz) of preamp to d.c. response with BW ≤ 1Hz.

* Increase bias of MOSFETs to at least 100 microamps (was 80) to reduce electronic noise.
DPU SUBASSEMBLY, FUNCTIONAL CHARACTERISTICS

* Signal conditioning and post amplification of preamp output. One electronic channel for each wavelength band.
* Automatic range changing keeps data output within voltage limits.
* Provides four decade ranges per channel.
* Indicates range selected by two bi-level status bits per channel.
* Generates the necessary in-flight calibration signals for both preamplifiers.
* Initiates and terminates a calibration sequence by ground command.
* One bi-level signal indicates the calibration and data mode.
* Provides an analog monitor of the calibration reference voltage.
* Monitors the subassembly temperature.
* DC/DC converter accepts spacecraft bus power and supplies all electronics with necessary D.C. voltages.
* Converter is turned on and off by ground command.
DPU SUBASSEMBLY, PENDING MODIFICATIONS

* PROVIDE ONE BI-LEVEL, POWER ON/OFF STATUS MONITOR.
* PROVIDE DESIRABLE HOUSEKEEPING MONITORS.
* MODIFY IFC CIRCUITS TIMING AND CONTROL DESIGN.
* MODIFY DC/DC CONVERTERS COMMAND INTERFACE.
DPU SUBASSEMBLY POSTAMPLIFIER

0 Performance Characteristics
0 Block Diagram
0 Engineering Schematic (not released).
POST AMPLIFIER, PERFORMANCE CHARACTERISTICS

(Each Channel)

* Attenuates Preamplifier signal x10 or x1 on command from Auto-Range.
* Final low pass filter with about 800 ms time constant.
* Post amplification of attenuated and filtered d.c. signal. Closed loop gain of 10.
* Analog output has 4 ranges of sensitivity to accommodate the 5 decade range of x-ray input.
* Output is referenced to incident x-ray flux via electronics calibration and ion chamber calibration.
* Output has .5V offset at zero x-ray flux.
DPU SUBASSEMBLY, AUTO-RANGE

0 Performance Characteristics
0 Block and Timing Diagram
0 Modifications from GOES D-H
AUTO-RANGE, PERFORMANCE CHARACTERISTICS
(EACH CHANNEL)

* Changes X-ray electronics sensitivity automatically when post amp output reaches its range limits.

* Provides 4 incremental ranges each covering approximately one decade of total dynamic range.

* Provides range status indication with two bi-level outputs, where

  Range 1 = "00"
  Range 2 = "01"
  Range 3 = "10"
  Range 4 = "11"

* Drives post amp to mid-range for approximately 3 ms when range change occurs.

* Hysteresis prevents hunting.

* Ranges are forced or inhibited, as necessary, in calibration mode.
AUTO-RANGE, PERFORMANCE CHARACTERISTICS (CONT)

HYSTERESIS

\[
\frac{\text{UTP}}{10} = \text{LTP} + H_L
\]

10 \text{ LTP} = \text{UTP} - H_u

\[H_u = 10 H_L\]

\[
\min H_L = 1.4 e_n \quad \text{where } e_n = \text{rms noise} = V_{\text{thr}}
\]

\[
\min H_L = 0.6V \quad V_{\text{thr}} = .04V
\]

Choose \[H_L = .09V\]

\[H_u = .9V\]

Required \[\text{UTP} = 4.3V\]

Then \[\text{LTP} = .43 - .09 = .34V\]

With Post Amp offset = .5V

\[\text{UTP} = 4.6V = 96\% \text{ F.S.}\]

\[\text{LTP} = .84V = 17\% \text{ F.S.}\]

Hysterisis unchanged.
**AUTO-RANGE, PERFORMANCE CHARACTERISTICS (CONT'D)**

**TRUTH TABLE AND NORMALIZED GAIN**

<table>
<thead>
<tr>
<th>RANGE</th>
<th>PREAMP GAIN STATUS</th>
<th>ATTENUATOR STATUS</th>
<th>RANGE STATUS</th>
<th>NORMALIZED GAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MSR</td>
<td>LSR</td>
<td>X10</td>
<td>X1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

XRS 2.5.5.1-3
GOES XRS BLOCK AND TIMING DIAGRAM, AUTO-RANGE
AUTO-RANGE, MODIFICATIONS FROM GOES D-H

* CHANGE "1" AND "0" LEVEL OF STATUS BITS TO 5V AND 0V RESPECTIVELY.
DPU SUBASSEMBLY, IN-FLIGHT CALIBRATOR

0 PERFORMANCE CHARACTERISTICS
0 BLOCK DIAGRAM
0 ENGINEERING SCHEMATIC
0 PENDING MODIFICATIONS
## IN-FLIGHT CALIBRATOR, PERFORMANCE CHARACTERISTICS

**CAL MODE - LOGIC AND SIGNAL OUTPUTS**

<table>
<thead>
<tr>
<th>REQUIREMENT</th>
<th>PERFORMANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STEP</strong></td>
<td><strong>RANGE</strong></td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>

XRS 2.5.6.1
IN-FLIGHT CALIBRATOR, PERFORMANCE CHARACTERISTICS (CONT'D)

* Calibration sequence and duration controlled by on-board oscillator.
* Duration per cal step = 12 sec.
* Cal sequence duration = 46 sec.
* Cal sequence is initiated and terminated by ground command. Not self terminating.
* Cal voltages derived from stable reference voltage.
* Analog of reference voltage is continuously available to TM.
* Bi-level output monitors CAL/DATA Mode.
IN-FLIGHT CALIBRATOR, PENDING MODIFICATIONS

* Use spacecraft derived timing signal instead of instrument timing oscillator to synchronize the calibration step output and cal flag with TM read rate.

* Configure the command interface circuit to accept successive pulse commands on single line to initiate and terminate cal sequence. Was two command lines.
DPU SUBASSEMBLY, DC/DC CONVERTER

- PERFORMANCE CHARACTERISTICS
- BLOCK DIAGRAM
- MODIFICATIONS FROM GOES D-H
DC/DC CONVERTER PERFORMANCE CHARACTERISTICS

* Accepts spacecraft provided bus and converts it to multiple DC output voltages, required by instrument.

* Output voltages are: +8V, -8V, +5V for electronics, -75V for ion chamber bias.

* Converter is enabled and disabled by ground command.

* Command interface accepts two pulse commands, one for XRS on and one for XRS off.
DC/DC CONVERTER PENDING MODIFICATIONS

* CHANGE FROM TWO LINE PULSE COMMAND TO SINGLE LINE LATCHING RELAY COMMAND.
GOES I-M XRS

SUMMARY OF PERTINENT GOES D-H DATA AND ANALYSIS

0 Ion Chamber Calibration XRS 3.1
0 Electronics Calibration and Test XRS 3.2
0 EM Magnet Test and Analysis XRS 3.3
0 Analyses XRS 3.4
0 Flight Data and Analysis XRS 3.5

XRS 3
GOES D, E, F CALIBRATION REPORT
X-RAY SENSOR

Calibration Report for the Engineering Model and Flight Unit X-Ray Ion Chambers

P. O. No. 779412-LY5
October 30, 1978

Prepared for
Hughes Aircraft Company
P. O. Box 92919
Los Angeles, CA 90009

by

PANAMETRICS, INC.
221 Crescent Street
Waltham, MA 02154
Outline of Geometry for Ion Chamber Calibration
GOES XRS
## Table 3.6

### Fe-55 Calibration Results for A Chambers

<table>
<thead>
<tr>
<th>Item</th>
<th>Value for A Chamber of Ion Chamber #</th>
<th>Average (A-m²/W)/#in average</th>
<th>Average for top &amp; middle 9/78 Cal Cal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Fe-55</td>
<td>1.892x10⁻⁵/5 1.919x10⁻⁵/7 1.942x10⁻⁵/6 1.998x10⁻⁵/7 1.971x10⁻⁵/6 1.973x10⁻⁵/6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative responses for Fe-55 source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#331-top</td>
<td>1.000 1.009 1.009 1.002 1.027 0.988 1.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#547-top</td>
<td>- 0.997 0.997 0.989 1.003 1.002 0.999 1.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4S-top</td>
<td>0.993 0.992 0.993 0.997 0.998 1.004 0.997</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#331-middle</td>
<td>1.011 0.997 0.995 1.013 0.989 1.026 1.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#547-middle</td>
<td>0.994 1.001 1.014 0.994 0.982 0.990 0.996 0.997</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4S-middle</td>
<td>- 0.987 0.987 0.989 1.002 0.991 0.991</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#331-top</td>
<td>1.002 - - - - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#331-middle</td>
<td>- 1.016 - - - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4S-top</td>
<td>- - 1.016 - - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviation, σ, in relative response, for a single measurement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.007 0.010 0.010 0.011 0.015 0.014 0.012</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Data from 6/78 Calibration for the Engineering Model ion chamber.
### Table 3.7

**Fe-55 Calibration Results for B Chambers**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value for B Chamber of Ion Chamber #</th>
<th>Average for top &amp; middle Cal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W2336*</td>
<td>W2336</td>
</tr>
<tr>
<td>Average Fe-55 Calibration (A·m²/W)/# in average</td>
<td>5.69x10⁻⁶/5</td>
<td>5.93x10⁻⁶/7</td>
</tr>
<tr>
<td>Relative responses for Fe-55 source</td>
<td>&lt;</td>
<td>&lt;</td>
</tr>
<tr>
<td>#331-top</td>
<td>0.986</td>
<td>0.987</td>
</tr>
<tr>
<td>#547-top</td>
<td></td>
<td>0.994</td>
</tr>
<tr>
<td>4S-top</td>
<td>0.971</td>
<td>0.943</td>
</tr>
<tr>
<td>#331-middle</td>
<td>1.069</td>
<td>1.028</td>
</tr>
<tr>
<td>#548-middle</td>
<td></td>
<td>1.044</td>
</tr>
<tr>
<td>4S-middle</td>
<td>0.971</td>
<td>0.965</td>
</tr>
<tr>
<td>#331-top</td>
<td>1.003</td>
<td></td>
</tr>
<tr>
<td>#331-middle</td>
<td></td>
<td>1.038</td>
</tr>
<tr>
<td>4S-top</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviation, σ, in relative response, for a single measurement</td>
<td>0.029</td>
<td>0.038</td>
</tr>
</tbody>
</table>

*Data from 6/78 Calibration for the Engineering Model ion chamber.*
### Table 3.8

**Summary of Ion Chamber Calibration Results**

<table>
<thead>
<tr>
<th>Ion Chamber #</th>
<th>Chamber A (0.5-3Å)</th>
<th>Chamber B (1-8Å)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normalization Factor, $B_m$</td>
<td>Corrected Response to flat spectrum, $\sigma_{cal}(0.5-3)(A \cdot m^2/W)$</td>
</tr>
<tr>
<td>W2336*</td>
<td>1.030</td>
<td>1.821 x 10^{-5}</td>
</tr>
<tr>
<td>W2337</td>
<td>1.044</td>
<td>1.843 x 10^{-5}</td>
</tr>
<tr>
<td>W2338</td>
<td>1.068</td>
<td>1.903 x 10^{-5}</td>
</tr>
<tr>
<td>W2339</td>
<td>1.059</td>
<td>1.868 x 10^{-5}</td>
</tr>
<tr>
<td>W2340</td>
<td>1.056</td>
<td>1.879 x 10^{-5}</td>
</tr>
</tbody>
</table>

Average = 1.051

*W2336 is the Engineering Model ion chamber. Results listed are for the 9/78 calibration.*

### Table 3.9

**Estimated Uncertainties in Ion Chamber Calibrations**

<table>
<thead>
<tr>
<th>Uncertainty Source</th>
<th>All uncertainties in %; 3σ uncertainties listed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chamber A</td>
</tr>
<tr>
<td>NBS Calibration</td>
<td>1.8</td>
</tr>
<tr>
<td>Fe-55 half life effect</td>
<td>1.4</td>
</tr>
<tr>
<td>Transfer of Fe-55 calibration</td>
<td>6.7</td>
</tr>
<tr>
<td>Fe-55 source contribution</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>6.7</td>
</tr>
<tr>
<td>Shadow correction uncertainty</td>
<td>0.5</td>
</tr>
<tr>
<td>1/μ correction uncertainty</td>
<td>3.0</td>
</tr>
<tr>
<td>Measurement $3σ(1/\sqrt{6})$</td>
<td>1.5</td>
</tr>
<tr>
<td>Electrometer calibration</td>
<td>4.0</td>
</tr>
<tr>
<td>Total 3σ uncertainty</td>
<td>8.5%</td>
</tr>
<tr>
<td>Total 1σ uncertainty</td>
<td>2.8%</td>
</tr>
</tbody>
</table>
Table 4.1

Results of Initial Leak Tests on Ion Chambers

<table>
<thead>
<tr>
<th>Date</th>
<th>Normalized Response for Chambers ( A/B^* )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W2336† W2337 W2338 W2339 W2340</td>
</tr>
<tr>
<td>Engine Model Chamber</td>
<td>6/28-30/78 0.99/0.96</td>
</tr>
<tr>
<td></td>
<td>2 weeks vacuum, 7/12/78 0.99/0.97</td>
</tr>
<tr>
<td></td>
<td>1 week vacuum, 7/20/78 1.00/0.98</td>
</tr>
<tr>
<td></td>
<td>EM tests, 9/19/78 1.05/1.08</td>
</tr>
<tr>
<td>Flight unit chambers</td>
<td>8/25-28/78 1.07/1.02 1.06/1.10 1.02/1.05 1.04/0.99</td>
</tr>
<tr>
<td></td>
<td>3 weeks vacuum, 9/19-21/78 1.07/1.05 1.07/1.10 1.06/1.03 1.05/1.02</td>
</tr>
</tbody>
</table>

* A chamber normalization = \( 4.0 \times 10^{-12} \text{A/mCi} \), B chamber normalization = \( 8.0 \times 10^{-13} \text{A/mCi} \).
† Engineering Model ion chamber.

Table 4.1

Results of Initial Leak Tests on Ion Chambers

Response ratio to 1/16/84 date for Fe-55 sources

<table>
<thead>
<tr>
<th>Date</th>
<th>W2336†</th>
<th>B-1652</th>
<th>B-1653</th>
<th>B-1654</th>
<th>B-1655</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/6-13/84</td>
<td>1.00/1.01</td>
<td>1.01/0.99</td>
<td>1.00/0.99</td>
<td>1.00/1.00</td>
<td>1.01/1.01</td>
</tr>
<tr>
<td>9/19/78</td>
<td>0.96/1.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/20/78</td>
<td>0.92/0.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/78</td>
<td>0.91/0.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6/30/78</td>
<td>0.91/0.93</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Engineering model ion chamber. Most of the pre-1984 data are for Fe-55 source #331.
1. REMOVE BURRS, BREAK EDGES WHEN APPLICABLE.

2. a. WINDOW
   CHAMBER A: 1.216 x .780 x .220 Berillium
   CHAMBER B: 1.216 x .780 x .220 Berillium

2. b. ANode SPACING TO CHAMBER
   CHAMBER A: .275
   CHAMBER B: .125

2. c. FILL GAS
   CHAMBER A: XENON & HELIUM
   CHAMBER B: ARGON & HELIUM

3. MARK WITH CUSTOMER'S PART NUMBER, SERIAL NUMBER, AND REOKE STELO.

4. EXHAUST TUBE MASTERY PLATINUM, PROVIDED IT DOES NOT INFLICT OUTSIDE THE BODY OF THE CHAMBER (1.310 X 1.240 DIMENSIONS).

NOTES:
GOES 1-M XRS

D-H, ELECTRONICS CALIBRATION TESTS

* PREAMPLIFIER CALIBRATION XRS 3.2.1
* AUTO-RANGE BREADBOARD TESTS XRS 3.2.2
Note: Input and Output connections inside shield box are coax cables.

GOES-XRS Test Set-up for Preamplifier D.C. CAL

XRS 3.2.1-1
GOES I-M XRS

SUMMARY OF D-H PREAMP DC CALIBRATION

* Measurements made at +25, +40, +55, 0 and -25°C

* Average delta of output offset from +25 to +40°C = 2.5 mV
  from +25 to -25°C = 2.7 mV

* Average tempco from +25 to 55°C: Ch A: -0.24%/°C  Ch B: -0.18%/°C

* Average tempco from +25 to -25°C: Ch A: -0.15%/°C  Ch B: -0.13%/°C
### GOES I–M XRS

**D–H PREAMP DC CALIBRATION**

<table>
<thead>
<tr>
<th>GOES</th>
<th>CH A OUTPUT, RANGE MSR (V)</th>
<th>CH B OUTPUT, RANGE MSR (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PREAMP IN (A)</td>
<td>+25C</td>
</tr>
<tr>
<td>0</td>
<td>.000</td>
<td>-.002</td>
</tr>
<tr>
<td>2x10^{-12}</td>
<td>.445</td>
<td>.430</td>
</tr>
<tr>
<td>5x10^{-14}</td>
<td>1.102</td>
<td>1.066</td>
</tr>
<tr>
<td>1x10^{-11}</td>
<td>2.140</td>
<td>2.085</td>
</tr>
<tr>
<td>2x10^{-11}</td>
<td>4.120</td>
<td>4.020</td>
</tr>
<tr>
<td>0</td>
<td>.001</td>
<td>-.002</td>
</tr>
<tr>
<td>2x10^{-12}</td>
<td>.485</td>
<td>.466</td>
</tr>
<tr>
<td>5x10^{-14}</td>
<td>1.194</td>
<td>1.153</td>
</tr>
<tr>
<td>1x10^{-11}</td>
<td>2.310</td>
<td>2.238</td>
</tr>
<tr>
<td>2x10^{-11}</td>
<td>4.400</td>
<td>4.268</td>
</tr>
<tr>
<td>0</td>
<td>.001</td>
<td>+.001</td>
</tr>
<tr>
<td>2x10^{-12}</td>
<td>.525</td>
<td>.505</td>
</tr>
<tr>
<td>5x10^{-14}</td>
<td>1.285</td>
<td>1.238</td>
</tr>
<tr>
<td>1x10^{-11}</td>
<td>2.439</td>
<td>2.358</td>
</tr>
<tr>
<td>0</td>
<td>.0006</td>
<td>+.010</td>
</tr>
<tr>
<td>2x10^{-12}</td>
<td>.518</td>
<td>.512</td>
</tr>
<tr>
<td>5x10^{-14}</td>
<td>1.295</td>
<td>1.277</td>
</tr>
<tr>
<td>1x10^{-11}</td>
<td>2.478</td>
<td>2.423</td>
</tr>
<tr>
<td>0</td>
<td>.001</td>
<td>.002</td>
</tr>
<tr>
<td>2x10^{-12}</td>
<td>.504</td>
<td>.490</td>
</tr>
<tr>
<td>5x10^{-14}</td>
<td>1.256</td>
<td>1.219</td>
</tr>
<tr>
<td>1x10^{-11}</td>
<td>2.454</td>
<td>2.383</td>
</tr>
</tbody>
</table>

XRS 3.2.1-3
GOES 1-M

SUMMARY OF D, E & F AUTO-RANGE BB TEST DATA

* Circuit performance measured -50, -25, 0, +50, +75 and +100°C.

* Stability of the upper trip point is ± .05% and the hysteresis is stable to ± .5%.

* Stability of the lower trip point is ± .3% and the hysteresis is stable to ± 1%.

* In data mode, verified proper ranging sequence for range signal inputs of 5.1V and .8V, respectively.

* In cal mode the range signal required to trip the upper and lower threshold detectors is stable within ± 8% for the forced as well as the inhibited condition.

* Verified proper range bit status (2 bits) with respect to actual range commands.

* Verified pulse width of MSR and LSR commands to be approximately 6 ms.
### D.E.F AUTO-RANGE BB TEMPERATURE TEST

#### Discriminator Trip Voltages and Hysteresis

<table>
<thead>
<tr>
<th>TEMP, OC</th>
<th>+25</th>
<th>0</th>
<th>-25</th>
<th>-50</th>
<th>+50</th>
<th>+75</th>
<th>+100</th>
<th>MIN</th>
<th>MAX</th>
<th>△</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYSSTERIS</td>
<td>.228</td>
<td>.229</td>
<td>.228</td>
<td>.228</td>
<td>.229</td>
<td>.230</td>
<td>.225</td>
<td>.225</td>
<td>.230</td>
<td>.005</td>
</tr>
<tr>
<td>LTP = 1</td>
<td>.904</td>
<td>.905</td>
<td>.902</td>
<td>.903</td>
<td>.905</td>
<td>.906</td>
<td>.908</td>
<td>.902</td>
<td>.908</td>
<td>.006</td>
</tr>
<tr>
<td>LTP = 0</td>
<td>1.018</td>
<td>1.020</td>
<td>1.018</td>
<td>1.018</td>
<td>1.021</td>
<td>1.022</td>
<td>1.023</td>
<td>1.018</td>
<td>1.023</td>
<td>.005</td>
</tr>
<tr>
<td>UTP, FORCE</td>
<td>-.848</td>
<td>-.815</td>
<td>-.804</td>
<td>-.773</td>
<td>-.877</td>
<td>-.905</td>
<td>-.930</td>
<td>-.773</td>
<td>-.930</td>
<td>.157</td>
</tr>
<tr>
<td>LTP, FORCE</td>
<td>+1.452</td>
<td>+1.444</td>
<td>+1.435</td>
<td>+1.423</td>
<td>+1.452</td>
<td>+1.446</td>
<td>+1.436</td>
<td>+1.423</td>
<td>+1.452</td>
<td>.029</td>
</tr>
<tr>
<td>LTP, INH.</td>
<td>-.969</td>
<td>-.950</td>
<td>-.945</td>
<td>-.930</td>
<td>-.979</td>
<td>-.989</td>
<td>-1.002</td>
<td>-.930</td>
<td>+1.002</td>
<td>.072</td>
</tr>
</tbody>
</table>

XRS 3.2.2-3
GOES I-M

SUMMARY OF D, E, F EM MAGNET TEST AND ANALYSIS

* Magnetic Field Properties measured along telescope axis 3.78 KG-cm (see Table 2.1, XRS 3.3-1)

* Calculated displacement and bending angles for electrons of .5 to 10 MeV (see Table 3.1, XRS 3.3-4)

* Measured ion chamber responses to beta sources (see Table 3.7, XRS 3.3-4)

* Electron shielding effectiveness (see Table 3.8, XRS 3.3-5)

XRS 3.3
GOES D, E, F MAGNET DESIGN REPORT
X-RAY SENSOR

The Design and Electron Shielding Effectiveness Measurement
for the Engineering Model X-Ray Telescope and Magnet Assembly

P.O. #08-779412-LY5
November 6, 1978

Prepared for
Hughes Aircraft Company
P.O. Box 92919
Los Angeles, CA 90009

by
PANAMETRICS, INC.
221 Crescent Street
Waltham, MA 02154
Fig. 3.2. Design of Aluminum Collimator Housing Used for Tests of Electron Shielding Effectiveness of Final Magnet Design.
<table>
<thead>
<tr>
<th>Distance along telescope axis from magnet pole axis (in/cm)</th>
<th>Panametrics EM Magnet Assembly (fields in G)</th>
<th>Keithley EM Magnet Assembly (fields in G)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centerline Value</td>
<td>Average over $\pm$1/4 inch*</td>
</tr>
<tr>
<td>-3.0/-7.62</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>-2.5/-6.35</td>
<td>26</td>
<td>17</td>
</tr>
<tr>
<td>-2.0/-5.08</td>
<td>58</td>
<td>37</td>
</tr>
<tr>
<td>-1.5/-3.81</td>
<td>135</td>
<td>84</td>
</tr>
<tr>
<td>-1.0/-2.54</td>
<td>312</td>
<td>310</td>
</tr>
<tr>
<td>-0.5/-1.27</td>
<td>628</td>
<td>656</td>
</tr>
<tr>
<td>0.0/0.00</td>
<td>826</td>
<td>888</td>
</tr>
<tr>
<td>+0.5/+1.27</td>
<td>628</td>
<td>656</td>
</tr>
<tr>
<td>+1.0/+2.54</td>
<td>312</td>
<td>310</td>
</tr>
<tr>
<td>+1.5/+3.81</td>
<td>135</td>
<td>84</td>
</tr>
</tbody>
</table>

Shielding effectiveness for -1.75 to +1.75 inches (kG-cm) 3.78 3.79 3.36 3.33

*Average is over $\pm$1 inch for $\pm$1.5, -2.0, -2.5, and -3.0 inches.
<table>
<thead>
<tr>
<th>Electron Energy (MeV)</th>
<th>In baffles</th>
<th>From baffles to ion chamber</th>
<th>In baffles</th>
<th>From baffles to ion chamber</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0.05/2.4</td>
<td>*</td>
<td>0.22/8.1</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>0.03/1.5</td>
<td>4.80/53</td>
<td>0.14/4.9</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>0.02/1.1</td>
<td>2.95/36</td>
<td>0.10/3.6</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>0.02/0.9</td>
<td>2.21/28</td>
<td>0.08/2.9</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>0.02/0.7</td>
<td>1.79/23</td>
<td>0.07/2.4</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>0.01/0.6</td>
<td>1.51/19</td>
<td>0.06/2.0</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>0.01/0.5</td>
<td>1.15/15</td>
<td>0.04/1.6</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>0.01/0.4</td>
<td>0.93/12</td>
<td>0.04/1.3</td>
<td></td>
</tr>
<tr>
<td>10.0</td>
<td>0.00/0.2</td>
<td>0.48/6</td>
<td>0.02/0.7</td>
<td></td>
</tr>
</tbody>
</table>

*For this energy the electrons bend 90° before reaching the ion chamber.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Chamber A Measured Current (A)</th>
<th>Chamber A Measured/Calculated</th>
<th>Chamber B Measured Current (A)</th>
<th>Chamber B Measured/Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>No magnets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panametrics EM</td>
<td>[Sr-Y-90] 7.03x10^-10</td>
<td>0.62</td>
<td>3.17x10^-10</td>
<td>1.03</td>
</tr>
<tr>
<td>Panametrics EM</td>
<td>[Ru-Rh-106] 1.99x10^-10</td>
<td>0.46</td>
<td>8.07x10^-11</td>
<td>0.69</td>
</tr>
<tr>
<td>Keithley EM</td>
<td>[Sr-Y-90] 7.51x10^-10</td>
<td>0.66</td>
<td>3.46x10^-10</td>
<td>1.12</td>
</tr>
<tr>
<td>Keithley EM</td>
<td>[Ru-Rh-106] 2.14x10^-10</td>
<td>0.50</td>
<td>8.68x10^-11</td>
<td>0.74</td>
</tr>
<tr>
<td>Magnets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panametrics EM</td>
<td>[Sr-Y-90] 7.27x10^-11</td>
<td>12.2</td>
<td>4.05x10^-11</td>
<td>0.70</td>
</tr>
<tr>
<td>Panametrics EM</td>
<td>[Ru-Rh-106] 2.96x10^-11</td>
<td>0.89</td>
<td>1.67x10^-11</td>
<td>0.20</td>
</tr>
<tr>
<td>Keithley EM</td>
<td>[Sr-Y-90] 6.97x10^-11</td>
<td>3.92</td>
<td>5.20x10^-11</td>
<td>0.44</td>
</tr>
<tr>
<td>Keithley EM</td>
<td>[Ru-Rh-106] 3.02x10^-11</td>
<td>0.54</td>
<td>2.31x10^-11</td>
<td>0.21</td>
</tr>
</tbody>
</table>
Table 3.8
Comparison of Panametrics EM and Keithley EM
Electron Shielding Effectiveness

<table>
<thead>
<tr>
<th>Condition</th>
<th>Panametrics EM Response Ratio (Mags/no mags)</th>
<th>Keithley EM Response Ratio (Mags/no mags)</th>
<th>(Panametrics Ratio) / (Keithley Ratio)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sr-Y-90</td>
<td>0.013</td>
<td>0.093</td>
<td>1.11</td>
</tr>
<tr>
<td>Ru-Rh-106</td>
<td>0.149</td>
<td>0.141</td>
<td>1.06</td>
</tr>
<tr>
<td>Chamber B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sr-Y-90</td>
<td>0.128</td>
<td>0.150</td>
<td>0.85</td>
</tr>
<tr>
<td>Ru-Rh-106</td>
<td>0.207</td>
<td>0.266</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Average = 0.95
GOES 1-M XRS

GOES D-H ANALYSIS

* PARTS APPLICATION DERATING AND STRESS ANALYSIS
* RELIABILITY ANALYSIS
* RADIATION DEGRADATION ANALYSIS

XRS 3.4.1
XRS 3.4.2
XRS 3.4.3

XRS 3.4
GOES XRS

PARTS APPLICATION DERATING AND STRESS ANALYSIS

Prepared for

HUGHES AIRCRAFT COMPANY
P.O. Box 92919
Los Angeles, California 90009

In accordance with P.O. No. 08-871102-LBF

SCDRL Line Item No. 27

by

PANAMETRICS, INC.
221 Crescent Street
Waltham, MA 02254

Prepared by J.L. Humenick, Jr.
Approved by J. F. Miller

Date 4-29-83
Date 4-24-83
Date 5/3/83
Table 2.1

GOES XRS SUBSYSTEM - ITEMS

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preamplifier Input Board</td>
</tr>
<tr>
<td>2</td>
<td>Preamplifier Sideboard &quot;A&quot;</td>
</tr>
<tr>
<td>3</td>
<td>Preamplifier Sideboard &quot;B&quot;</td>
</tr>
<tr>
<td>4</td>
<td>Post, Null and WB Amplifiers</td>
</tr>
<tr>
<td>5</td>
<td>Autot Range Logic</td>
</tr>
<tr>
<td>6</td>
<td>Timing Logic</td>
</tr>
<tr>
<td>7</td>
<td>In-Flight Calibrator (IFC)</td>
</tr>
<tr>
<td>8</td>
<td>DC/DC Converter, Mother Board</td>
</tr>
<tr>
<td>9</td>
<td>DC/DC Converter, Daughter Board</td>
</tr>
<tr>
<td>10</td>
<td>XRS Telescope Assembly</td>
</tr>
<tr>
<td>11</td>
<td>DPU Assembly</td>
</tr>
</tbody>
</table>
Table 2.2

Assumptions - General

1) The case temperature of all components is equal to the maximum specified ambient operating temperature (+35°C).

2) The power or current rating of components is derated for +35°C ambient, where applicable (some components are rated up to 70°C ambient). For integrated circuits, transistors and diodes the specified $\theta_{JA}$ was used.

3) Actual junction temperatures are calculated for +35°C ambient using worst case device power dissipation and $\theta_{JA}$.

4) Command and control signal pulses from the spacecraft or from subsystem circuits are treated as d.c. levels of the max "1" or "0" state of that signal pulse, whichever results in a worst case analysis of a particular parameter.

5) For Set At Test (SAT) components the typical value according to schematic is used, except if the range of possible SAT values may require parts of different ratings (capacitors, for example).

Table 2.3

Additional Assumptions - Preamplifier Input Board (Item 1)

1) Quiescent operating conditions - derated parameters not appreciably affected by signal levels due to low duty cycle ($\approx 10\%$) and low output loading.

2) Relays (RY201, 301) are energized once per minute - actual duty cycle is much less.

Table 2.4

Additional Assumptions - Preamplifier Sideboards "A" & "B" (Item 2 and 3)

1) Quiescent operating conditions - derated parameters not appreciably affected by signal levels due to low duty cycle ($\approx 10\%$) and low output loading.
Table 2.5

Additional Assumptions - Post, Null and WB Amplifiers (Item 4)

1) Maximum input and output signal range conditions for Post and Null amplifiers and associated components.
2) Quiescent operating conditions for WB amplifier - derated parameters not appreciably affected by signal levels due to low duty cycle (≈10%) and low output loading.
3) FET switches considered ON or OFF in accordance with internally generated timing signals.

Table 2.6

Additional Assumptions - Auto Range Logic (Item 5)

1) Analog inputs of threshold discriminators are considered at max high or low d.c. level, whichever results in worst case analysis.
2) Quiescent operating conditions for all C-MOS IC's - max. input frequency is < 2 Hz and therefore does not contribute to power consumption.

Table 2.7

Additional Assumptions - Timing Logic (Item 6)

1) Quiescent operating conditions for all IC's (C-MOS) except as noted in 2) below - maximum input frequency is < 2 Hz and therefore does not contribute to power consumption.
2) 3.4 kHz input frequency for IC 1, IC 2 and IC 10 - this is specified clock frequency from spacecraft.
3) Input tr and tf < 100 ns at f = 1 kHz for IC 3, 9 and 11 - dynamic power depends on tr, tf and f. Actual f = 1.7 kHz for 1/6 of IC 3 and < 1 kHz for remaining IC's.
Table 2.8

Additional Assumptions - In-Flight Calibrator (Item 7)

1) Worst case, continuous "On" conditions for all IC's, transistors and diodes - actual conditions are max 13% duty cycle pulses or ramp signals.

Table 2.9

Additional Assumptions - DC/DC Converter, Mother Board (Item 8)

1) Worst case steady state bus voltage is 30 V including ripple.

2) The 0 to 40 V bus transient is used to calculate the voltage stress ratio of all components directly or indirectly affected by that transient. The actual power stress is not affected by the 100 us transient, since thermal time constants of components are much larger. The X-Ray ON/OFF relay circuit is not affected by the transient since the relay supply voltage is derived from LP filter.

3) The pass transistors (Q1101, 1106) in the constant current regulator and zener diode (D1114) are heat sunk to the DPU chassis. The junction temperatures of the transistors are calculated using $\theta_{J-C}$, assuming a case temperature of $+35^\circ$C. The junction temperature of the zener is calculated using $\theta_{J-A}$ (no data for $\theta_{J-C}$ available) resulting in an overestimate of junction temperature.

Table 2.10

Additional Assumptions - DC/DC Converter, Daughter Board (Item 9)

1) Supply and input voltages, as well as output currents, are within limits per test procedure PANA-RTF-13.

2) No transients are present - voltage and current preregulated on mother board.
### Table 3.1

**Deviations From MAC Derating Policy For Subcontractors No. 303**

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Reference Designation</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>C203, C208</td>
<td>Voltage stress ratio &lt; .25</td>
</tr>
<tr>
<td>3</td>
<td>C303, C308</td>
<td>Voltage stress ratio &lt; .25</td>
</tr>
<tr>
<td>4</td>
<td>C614, C615, C616 C714, C715, C716</td>
<td>Voltage stress ratio &lt; .25 and Series Resistance &lt; 3 ohms/V</td>
</tr>
<tr>
<td>4</td>
<td>C406, C506 C691, C701</td>
<td>Voltage stress ratio &lt; .25</td>
</tr>
<tr>
<td>5</td>
<td>C812, C814</td>
<td>Voltage stress ratio &lt; .25 and Series Resistance &lt; 3 ohms/V</td>
</tr>
<tr>
<td>6</td>
<td>C1, C2</td>
<td>Voltage stress ratio &lt; .25</td>
</tr>
<tr>
<td>7</td>
<td>C1008, C1010</td>
<td>Voltage stress ratio &lt; .25 and Series Resistance &lt; 3 ohms/V</td>
</tr>
<tr>
<td>7</td>
<td>C1009</td>
<td>Voltage stress ratio &lt; .25</td>
</tr>
<tr>
<td>8</td>
<td>C1102</td>
<td>Voltage stress ratio &lt; .25</td>
</tr>
<tr>
<td>8</td>
<td>C1109</td>
<td>Voltage stress ratio &lt; .25 and Series Resistance &lt; 3 ohms/V</td>
</tr>
<tr>
<td>8</td>
<td>C1110, C1111</td>
<td>Series Resistance &lt; 3 ohms/V</td>
</tr>
<tr>
<td>8</td>
<td>Q1108, Q1109</td>
<td>Voltage stress ratio &gt; .71</td>
</tr>
<tr>
<td>9</td>
<td>C1114, C115, C117</td>
<td>Voltage stress ratio &lt; .25 and Series Resistance &lt; 3 ohms/V</td>
</tr>
</tbody>
</table>
# Parts Stress Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Schematic</th>
<th>Parts List</th>
<th>Assembly</th>
</tr>
</thead>
</table>

**Program**: GOES G+H XRS  
**Date**: 3/23/83  
**Sheet**: 1 of 2

<table>
<thead>
<tr>
<th>Part or Drawing Number</th>
<th>Reference Designation</th>
<th>Critical Stress Parameter</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
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### PARTS STRESS ANALYSIS

**Item** Preamp. Sideboard A

**Schematic** D-4337 Rev. C, D-4510 Rev -

**Parts List** Pl-4524 Rev C

**Assembly** C-4524 Rev A

**Program** GOES C+H XRS

**Date** 3/30/83

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**Temperature (°C)**

**Rated**

**Act. op.**
## Parts Stress Analysis

**Item**: Preamp Sideboard A  
**Schematic**: D-4337 Rev C  
**Parts List**: PL-4524 Rev C  
**Assembly**: C-4524 Rev A  
**Program**: GOES C+H XRS  
**Date**: 3/30/24  
**Sheet**: 2 of 2

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### Parts Stress Analysis

**Program:** GOES G+H XRS  
**Date:** 3/29/83  
**Sheet:** 1 of 2

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Goes G & H XRS

RELIABILITY REPORT

Prepared for

HUGHES AIRCRAFT COMPANY
P.O. Box 92919
Los Angeles, California 90009

In accordance with P.O. No. 08-871102-LBP

SCDRL Item 26 - Reliability Analysis
SCDRL Item 28 - Failure Mode Effects and Criticality Analysis
SCDRL Item 29 - Single Point Failure Analysis

by

PANAMETRICS, INC.
221 Crescent Street
Waltham, MA 02254

Prepared by

Date 5/5/83

Approved by

Date 5/15/83

Date 5/5/83
FIG. 2.1
GOES XRS
RELIABILITY BLOCK DIAGRAM

XRS 3.4.2-2
### FREAMP-B SIDE BOARD

**XRS 2 LONG SUN**

**INPUT DATA**

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**Figure 2.2 Data Input Printout**
## PREAMP-3 SIDE BOARD
### XRS 2 LONG SUN
#### ANALYSIS REPORT

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Sub Unit Failure Rate: 0.018947 / 0.039715 / 10^6 Hours

Sub Unit Failure Rate: 0.001162 / 0.002435 / 7 Years

Sub Unit Reliability Factor: P = .998839 / .997568

Figure 2.3 Reliability Analysis Printout
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<td>( \lambda_p = \lambda_b \left( \sigma_x \pi A \pi Q \pi \sigma_R \pi \sigma S2 \pi \sigma C \right) ) where ( \lambda_b ) is a table look-up.</td>
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<td>( \lambda_p = \lambda_b \left( \sigma_x \pi x \pi \Omega \pi \sigma R \pi \pi \sigma S2 \pi \sigma C \right) ) where ( \lambda_b = \frac{AE^xY}{\left( \frac{273 + T + (\Delta T)S}{T} \right)^m} )</td>
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<td>( \lambda_p = \lambda_b \left( \sigma_x \pi S \pi Q \pi \sigma G \right) )</td>
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<tr>
<td>5</td>
<td>( \lambda_p = \sigma x \pi \Omega \left( C_1 + T_2 + C_2 \right) \pi \Omega ) where ( C_1 = 0.0056 ), ( T_1 = 763 ), ( C_2 = 0.0026 )</td>
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<tr>
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<td>( \lambda_p = \sigma x \pi \Omega \left( C_1 + T + C_2 \right) \pi \Omega ) where ( C_1 = 0.0128 ), ( C_2 = 0.0018 ), ( T = ) Number of Transistors</td>
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<tr>
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<td>( \lambda_p = \lambda_b \left( \sigma_x \pi G \pi \sigma C \pi \sigma G \right) ) where ( \lambda_b = \lambda_x \pi \pi \right) )</td>
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</tr>
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<td>10</td>
<td>( \lambda_p = \lambda_b \left( \sigma_x \pi Q \right) ) where ( \lambda_b = \frac{AE^x}{x} )</td>
</tr>
</tbody>
</table>

Note: Formulae 7 and 9 were not used.
### Table 2.2

**Computer Input Parameter Assignments**

<table>
<thead>
<tr>
<th>Formula</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
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<td>$\pi_A$</td>
<td>$\pi_Q$</td>
<td>$\pi_R$</td>
<td>$\pi_S2$</td>
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<td>$\pi_E$</td>
<td>$\pi_A$</td>
<td>$\pi_Q$</td>
<td>$\pi_R$</td>
<td>$\pi_S2$</td>
<td>$\pi_C$</td>
<td>A</td>
<td>$N_T$</td>
<td>T</td>
<td>$\Delta T$</td>
<td>S</td>
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<td>P</td>
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<td>$\pi_{SR}$</td>
<td>$\pi_Q$</td>
<td>$\pi_{CV}$</td>
<td>$\pi_T$</td>
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<td>$\pi_Q$</td>
<td>$\pi_{T2}$</td>
<td>$\pi_E$</td>
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<td>$\pi_Q$</td>
<td>$\pi_T$</td>
<td>$\pi_E$</td>
<td>$\pi_P$</td>
<td>$\pi_G$</td>
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<td>$\pi_L$</td>
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<td>$\pi_{CYC}$</td>
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<td>$\pi_A$</td>
<td>$\pi_T$</td>
<td>$N_T$</td>
<td>$G$</td>
<td>$S$</td>
<td>$N_S$</td>
<td>H</td>
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</table>

XRS 3.4.2-6
**Table 2.3**

**Summary of XRS Subsystem Sub Unit Failure Rates and Reliabilities**

<table>
<thead>
<tr>
<th>Sub Unit</th>
<th>Description</th>
<th>Failure Rate</th>
<th>Reliabilities</th>
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<tr>
<td></td>
<td></td>
<td>PAN</td>
<td>HAC</td>
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<tr>
<td>XRS-1</td>
<td>SS Ion Chamber and Electrometer</td>
<td>.018950</td>
<td>.039776</td>
</tr>
<tr>
<td>XRS-2</td>
<td>LS Ion Chamber and Electrometer</td>
<td>.018947</td>
<td>.039715</td>
</tr>
<tr>
<td>XRS-3</td>
<td>Filters and Connector Pins (common)</td>
<td>.014143</td>
<td>.014143</td>
</tr>
<tr>
<td>XRS-5</td>
<td>SS Null and Buffer Amplifier</td>
<td>.040837</td>
<td>.062965</td>
</tr>
<tr>
<td>XRS-6</td>
<td>SS Post Amp., Atten. + Analog Gates</td>
<td>.012457</td>
<td>.024891</td>
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<tr>
<td>XRS-7</td>
<td>SS WB Amplifier</td>
<td>.008056</td>
<td>.016054</td>
</tr>
<tr>
<td>XRS-8</td>
<td>LS Null and Buffer Amplifier</td>
<td>.040837</td>
<td>.062965</td>
</tr>
<tr>
<td>XRS-9</td>
<td>LS Post Amp., Atten. + Analog Gates</td>
<td>.012457</td>
<td>.024891</td>
</tr>
<tr>
<td>XRS-10</td>
<td>LS WB Amplifier</td>
<td>.008056</td>
<td>.016054</td>
</tr>
<tr>
<td>XRS-11</td>
<td>SS Auto Range Comp., Dig. Logic + Dr.</td>
<td>.051571</td>
<td>.098942</td>
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<tr>
<td>XRS-12</td>
<td>LS Auto Range Comp., Dig. Logic + Dr.</td>
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<td>XRS-13</td>
<td>Auto Range Connector Pins (common)</td>
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<td>.026518</td>
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<td>XRS-14</td>
<td>Timing, Digital Logic + Drivers</td>
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<td>.136179</td>
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<td>XRS-15</td>
<td>In-Flight Calibrator (IFC)</td>
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<td>.175254</td>
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<tr>
<td>XRS-16</td>
<td>DC/DC Converter</td>
<td>.281671</td>
<td>.370272</td>
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</table>

**Notes:**
1) Sum of individual part failure rates (failures per 10^6 Hours)
2) Probability of Sub Unit success for 7 year mission
3) Sub Unit XRS-4 is the telescope thermistor for which no reliability is calculated.
Table 2.4
Summary of XRS Subsystem Success Path Reliabilities

<table>
<thead>
<tr>
<th>Operating Mode</th>
<th>Success Path</th>
<th>Sub Units</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATA</td>
<td>SS X-Ray</td>
<td>1 2 3 5 6</td>
<td>.969647 .953665</td>
</tr>
<tr>
<td>DATA</td>
<td>SS WB</td>
<td>1 2 3 5 6</td>
<td>.969168 .952726</td>
</tr>
<tr>
<td>DATA</td>
<td>SS Background</td>
<td>1 2 3 5 6</td>
<td>.978431 .970569</td>
</tr>
<tr>
<td>DATA</td>
<td>SS Range Stat</td>
<td>1 2 3 5 6</td>
<td>.974797 .961992</td>
</tr>
<tr>
<td>DATA</td>
<td>LS X-Ray</td>
<td>1 2 3 5 6</td>
<td>.969647 .953668</td>
</tr>
<tr>
<td>DATA</td>
<td>LS WB</td>
<td>1 2 3 5 6</td>
<td>.969168 .952730</td>
</tr>
<tr>
<td>DATA</td>
<td>LS Background</td>
<td>1 2 3 5 6</td>
<td>.978431 .970573</td>
</tr>
<tr>
<td>DATA</td>
<td>LS Range Stat</td>
<td>1 2 3 5 6</td>
<td>.974797 .961992</td>
</tr>
<tr>
<td>DATA</td>
<td>All Paths</td>
<td>1 2 3 5 6</td>
<td>.961363 .938660</td>
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<tr>
<td>CAL</td>
<td>SS X-Ray</td>
<td>1 2 3 5 6</td>
<td>.964353 .943471</td>
</tr>
<tr>
<td>CAL</td>
<td>SS Range Stat</td>
<td>1 2 3 5 6</td>
<td>.969475 .951709</td>
</tr>
<tr>
<td>CAL</td>
<td>LS X-Ray</td>
<td>1 2 3 5 6</td>
<td>.964353 .943475</td>
</tr>
<tr>
<td>CAL</td>
<td>LS Range Stat</td>
<td>1 2 3 5 6</td>
<td>.969475 .951709</td>
</tr>
<tr>
<td>CAL</td>
<td>All Circuits</td>
<td>1 2 3 5 6</td>
<td>.957059 .930457</td>
</tr>
<tr>
<td>ALL</td>
<td>All Data + Cal</td>
<td>1 2 3 5 6</td>
<td>.956114 .928627</td>
</tr>
</tbody>
</table>

Notes: 1) X denotes the Sub Unit (XRS-1 through -16) in a particular success path
2) Probability of path success for 7 year mission
### Table 3.1

<table>
<thead>
<tr>
<th>Sub Unit Identification</th>
<th>Primary Elements</th>
<th>Failure Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telescope -1</td>
<td>Short Sun Ion Chamber and Electrometer</td>
<td>Loss of Short Sun X-Ray, WB and Background Data</td>
</tr>
<tr>
<td>-2</td>
<td>Long Sun Ion Chamber and Electrometer</td>
<td>Loss of Long Sun X-Ray, WB and Background Data</td>
</tr>
<tr>
<td>-3</td>
<td>Telescope RF Filters and Connector Pins common to both Channels</td>
<td>Loss of Short and Long Sun X-Ray, WB and Background Data</td>
</tr>
<tr>
<td>-4</td>
<td>Telescope Thermistor</td>
<td>Loss of Telescope Temperature Monitor</td>
</tr>
<tr>
<td>DPU</td>
<td>-5 Short Sun Null and Buffer Amplifiers</td>
<td>Loss of Short Sun Background, X-Ray and WB Data</td>
</tr>
<tr>
<td>-6</td>
<td>Short Sun Post Amp., Attenuator and Analog Gates</td>
<td>Loss of Short Sun X-Ray and WB Data</td>
</tr>
<tr>
<td>-7</td>
<td>Short Sun WB Amp</td>
<td>Loss of Long Sun WB Data</td>
</tr>
<tr>
<td>-8</td>
<td>Long Sun Null and Buffer Amplifiers</td>
<td>Loss of Long Sun Background, X-Ray and WB Data</td>
</tr>
<tr>
<td>-9</td>
<td>Long Sun Post Amp., Attenuator and Analog Gates</td>
<td>Loss of Long Sun X-Ray and WB Data</td>
</tr>
<tr>
<td>-10</td>
<td>Long Sun WB Amp</td>
<td>Loss of Long Sun WB Data</td>
</tr>
<tr>
<td>-11</td>
<td>Short Sun Auto Range Comparators, Digital Logic and Drivers</td>
<td>Loss of Short Sun X-Ray and WB Data. Loss of Short Sun Range status monitor</td>
</tr>
<tr>
<td>-12</td>
<td>Long Sun Auto Range Comparators, Digital Logic and Drivers</td>
<td>Loss of Long Sun X-Ray and WB Data. Loss of Long Sun Range status monitor</td>
</tr>
<tr>
<td>Sub Unit Identification</td>
<td>Primary Elements</td>
<td>Failure Effects</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>-14</td>
<td>Timing Digital Logic and Drivers</td>
<td>Loss of Short and Long Sun X-Ray and Range Status Monitors. Loss of In-Flight Calibration Capability of both channels (Short and Long Sun). CAL Status and Ref. Voltage not affected</td>
</tr>
<tr>
<td>-15</td>
<td>In-Flight Calibration</td>
<td>Loss of In-Flight Calibration Capability of both channels (Short and Long Sun), Ref. Voltage and CAL status monitors. Short and Long Sun X-Ray, WB and Background Data not affected in Data Mode.</td>
</tr>
<tr>
<td>-16</td>
<td>DC/DC Converter</td>
<td>Loss of all data and Monitor Outputs</td>
</tr>
<tr>
<td>-17</td>
<td>DPU Thermistor</td>
<td>Loss of DPU Temperature Monitor</td>
</tr>
</tbody>
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RADIATION REPORT
FOR
GOES D, E & F XRS SUBSYSTEM

P. O. No. 08-779412-LBG

July, 1980

Prepared for
Hughes Aircraft Company
P. O. Box 92919
Los Angeles, CA 90009

This report has been reviewed and found to meet the requirements of HAC Purchase Order No. 08-871102-LBP, SCDRL Line Item No. 19, "Radiation Assessment."

Reviewed by
Date
Red
3/29/83
3/27/83
Figure 2.1 Diagram of Telescope P.C. Board Shielding in X and Y Axis by Box Walls and other Structural Materials
Figure 2.2 Diagram of Telescope P.C. Board Shielding in Z Axis by Box Walls and Ground Plane

Note: Glass Epoxy, $\rho = 2.1 \text{ g/cm}^3$
Figure 2.3 Diagram of DPU P.C. Board Shielding in X and Y Axis by Box Walls and Structural Material
Figure 2.4 Diagram of DPU P.C. Board Shielding in Z Axis by Box Walls and Structural Material
<table>
<thead>
<tr>
<th>Printed Circuit Board</th>
<th>Min. Shielding (mil Al)</th>
<th>Avg. Shielding (mil Al)</th>
<th>Total Shielding (mil Al)</th>
<th>Internal Dose (RAD's x 10^4)</th>
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</thead>
<tbody>
<tr>
<td>Telescope -</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preamp Input</td>
<td>54</td>
<td>76</td>
<td>119</td>
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</tr>
<tr>
<td>Preamp Side A</td>
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<td>750</td>
<td>793</td>
<td>negligible</td>
</tr>
<tr>
<td>Preamp Side B</td>
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<td>750</td>
<td>793</td>
<td>negligible</td>
</tr>
<tr>
<td>DPU -</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Auto-Range</td>
<td>29</td>
<td>78</td>
<td>121</td>
<td>1.8</td>
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<tr>
<td>Post-Null-WB</td>
<td>29</td>
<td>78</td>
<td>121</td>
<td>1.8</td>
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<td>IFC</td>
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<td>78</td>
<td>121</td>
<td>1.8</td>
</tr>
<tr>
<td>Timing</td>
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<td>78</td>
<td>121</td>
<td>1.8</td>
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<td>DC/DC Conv. Daughter</td>
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<td>148</td>
<td>.7</td>
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<tr>
<td>DC/DC Conv. Mother</td>
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<td>105</td>
<td>148</td>
<td>.7</td>
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</table>

Notes: (1) From Figure 2.1 for Telescope, Figure 2.3 for DPU
(2) $\sqrt{2} \times$ min. Shielding for Telescope p.c. boards
$\sqrt{2} \times$ min. Shielding + 37 mil Al for DPU p.c. boards in X and Y axis (see Appendix for detailed calculation of added shielding).
(3) Sum of avg. Shielding + external shielding + typical part can shielding
(4) 1/6 of reading from GOES Dose Depth Curve of Metsat-0422.
**TABLE 2.2**

Telescope & DPU P.C. Board Shielding and Radiation Dose for -X Direction

<table>
<thead>
<tr>
<th>Printed Circuit Board</th>
<th>Min. Shielding (mil Al)</th>
<th>Avg. Shielding (mil Al)</th>
<th>Total Shielding (mil Al)</th>
<th>Internal Dose (RAD's x 10⁴)</th>
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<tbody>
<tr>
<td>Telescope -</td>
<td></td>
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</tr>
<tr>
<td>Preamp Input</td>
<td>54</td>
<td>76</td>
<td>119</td>
<td>2.0</td>
</tr>
<tr>
<td>Preamp Side A</td>
<td>531</td>
<td>750</td>
<td>793</td>
<td>negligible</td>
</tr>
<tr>
<td>Preamp Side B</td>
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<td>750</td>
<td>793</td>
<td>negligible</td>
</tr>
<tr>
<td>DPU -</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Auto-Range</td>
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<td>78</td>
<td>121</td>
<td>1.8</td>
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<td>Post-Null-WB</td>
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<td>1.8</td>
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<td>121</td>
<td>1.8</td>
</tr>
<tr>
<td>Timing</td>
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<td>1.8</td>
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<tr>
<td>DC/DC Conv. Daughter</td>
<td>49</td>
<td>105</td>
<td>148</td>
<td>.7</td>
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<tr>
<td>DC/DC Conv. Mother</td>
<td>49</td>
<td>105</td>
<td>148</td>
<td>.7</td>
</tr>
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</table>

Notes:
1. From Figure 2.1 for Telescope, Figure 2.3 for DPU
2. $\sqrt{2} \times$ min. Shielding for Telescope p.c. boards
   $\sqrt{2} \times$ min. Shielding + 37 mil Al for DPU p.c. boards in X and Y axis (see Appendix for detailed calculation of added shielding).
3. Sum of avg. Shielding + external shielding + typical part can shielding
4. 1/6 of reading from GOES Dose Depth Curve of Metsat-0422.
<table>
<thead>
<tr>
<th>Printed Circuit Board</th>
<th>Min. Shielding (1) (mil Al)</th>
<th>Avg. Shielding (2) (mil Al)</th>
<th>Total Shielding (3) (mil Al)</th>
<th>Internal Dose (4) (RAD's $\times 10^4$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telescope -</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Preamp Input</td>
<td>248</td>
<td>350</td>
<td>393</td>
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<tr>
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<td>160</td>
<td>226</td>
<td>269</td>
<td>0.04</td>
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<tr>
<td>Preamp Side B</td>
<td>160</td>
<td>226</td>
<td>269</td>
<td>0.04</td>
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<tr>
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<td></td>
</tr>
<tr>
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<td>65</td>
<td>108</td>
<td>3.2</td>
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<tr>
<td>Post-Null-WB</td>
<td>20</td>
<td>65</td>
<td>108</td>
<td>3.2</td>
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<td>20</td>
<td>65</td>
<td>108</td>
<td>3.2</td>
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<td>Timing</td>
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<td>108</td>
<td>3.2</td>
</tr>
<tr>
<td>DC/DC Conv. Daughter</td>
<td>20</td>
<td>65</td>
<td>108</td>
<td>3.2</td>
</tr>
<tr>
<td>DC/DC Conv. Mother</td>
<td>20</td>
<td>65</td>
<td>108</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Notes:
(1) From Figure 2.1 for Telescope, Figure 2.3 for DPU
(2) $\sqrt{2} \times$ min. Shielding for Telescope p.c. boards
$\sqrt{2} \times$ min. Shielding + 37 mil Al for DPU p.c. boards in X and Y axis (see Appendix for detailed calculation of added shielding).
(3) Sum of avg. Shielding + external shielding + typical part can shielding
(4) 1/6 of reading from GOES Dose Depth Curve of Metsat-0422.
<table>
<thead>
<tr>
<th>Printed Circuit Board</th>
<th>Min. Shielding (1) (mil Al)</th>
<th>Avg. Shielding (2) (mil Al)</th>
<th>Total Shielding (3) (mil Al)</th>
<th>Internal Dose (4) (RAD's x 10^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Telescope</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preamp Input</td>
<td>54</td>
<td>76</td>
<td>119</td>
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<tr>
<td>Preamp Side A</td>
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<td>76</td>
<td>119</td>
<td>2.0</td>
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<tr>
<td>Preamp Side B</td>
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<td>76</td>
<td>119</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>DPU</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto-Range</td>
<td>60</td>
<td>122</td>
<td>165</td>
<td>.38</td>
</tr>
<tr>
<td>Post-Null-WB</td>
<td>60</td>
<td>122</td>
<td>165</td>
<td>.38</td>
</tr>
<tr>
<td>IFC</td>
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<td>122</td>
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<td>.38</td>
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<tr>
<td>Timing</td>
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<td>.38</td>
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<td>80</td>
<td>150</td>
<td>193</td>
<td>.16</td>
</tr>
<tr>
<td>DC/DC Conv. Mother</td>
<td>80</td>
<td>150</td>
<td>193</td>
<td>.16</td>
</tr>
</tbody>
</table>

Notes:
1. From Figure 2.1 for Telescope, Figure 2.3 for DPU
2. $\sqrt{2} \times$ min. Shielding for Telescope p.c. boards
   $\sqrt{2} \times$ min. Shielding + 37 mil Al for DPU p.c. boards in X and Y axis (see Appendix for detailed calculation of added shielding).
3. Sum of avg. Shielding + external shielding + typical part can shielding
4. 1/6 of reading from GOES Dose Depth Curve of Metsat-0422.
| Printed Circuit Board | Telescope 1 - Preamp Input A | Telescope 1 - Preamp Side B | Telescope 2 - DC/DC Conv. Daughter | Telescope 2 - DC/DC Conv. Mother | DPU - Auto-Range | DPU - Post-Null-WB | Timing | FPC | \( \sqrt{2} \times \) min. shielding

<table>
<thead>
<tr>
<th>Min. Shielding (1)</th>
<th>Avg. Shielding (2)</th>
<th>Total Shielding (3)</th>
<th>Internal Dose (4)</th>
<th>Internal Dose (4)</th>
<th>Internal Dose (4)</th>
<th>Internal Dose (4)</th>
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<th>Internal Dose (4)</th>
<th>Internal Dose (4)</th>
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<tbody>
<tr>
<td>(mil Al)</td>
<td>(mil Al)</td>
<td>(mil Al)</td>
<td>(RAD's x 10^4)</td>
<td>(RAD's x 10^4)</td>
<td>(RAD's x 10^4)</td>
<td>(RAD's x 10^4)</td>
<td>(RAD's x 10^4)</td>
<td>(RAD's x 10^4)</td>
<td>(RAD's x 10^4)</td>
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<td>2.0</td>
<td>2.0</td>
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<td>negligible</td>
<td>negligible</td>
<td>negligible</td>
</tr>
<tr>
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<td></td>
<td></td>
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<td>371</td>
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<td>54</td>
<td>54</td>
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<td>232</td>
<td>184</td>
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<td></td>
</tr>
</tbody>
</table>

Notes:

1. From Figure 2.2 for Telescope, Figure 2.4 for DPU
2. \( \frac{\sqrt{2}}{2} \times \text{min. shielding for Telescope P.C. boards} + 37 \text{ mil Al for DPU P.C. boards in X and Y axis (see Appendix D for detailed calculation of added shielding).} \)
3. Avg. Shielding + external shielding + typical part can shielding
4. 1/6 of reading from GOES Dose Depth Curve of Metsat-0422.
### TABLE 2.6

**Telescope & DPU P.C. Board Shielding and Radiation Dose for -Z Direction**

<table>
<thead>
<tr>
<th>Printed Circuit Board</th>
<th>Min. Shielding $^{(1)}$ (mil Al)</th>
<th>Avg. Shielding $^{(2)}$ (mil Al)</th>
<th>Total Shielding $^{(3)}$ (mil Al)</th>
<th>Internal Dose $^{(4)}$ (RAD's x 10$^4$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Telescope -</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preamp Input</td>
<td>54</td>
<td>76</td>
<td>119</td>
<td>2.0</td>
</tr>
<tr>
<td>Preamp Side A</td>
<td>54</td>
<td>76</td>
<td>119</td>
<td>2.0</td>
</tr>
<tr>
<td>Preamp Side B</td>
<td>54</td>
<td>76</td>
<td>119</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>DPU -</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto-Range</td>
<td>68</td>
<td>96</td>
<td>139</td>
<td>.9</td>
</tr>
<tr>
<td>Post-Null-WB</td>
<td>116</td>
<td>164</td>
<td>207</td>
<td>.12</td>
</tr>
<tr>
<td>IFC</td>
<td>116</td>
<td>164</td>
<td>207</td>
<td>.12</td>
</tr>
<tr>
<td>Timing</td>
<td>164</td>
<td>232</td>
<td>275</td>
<td>.04</td>
</tr>
<tr>
<td>DC/DC Conv. Daughter</td>
<td>232</td>
<td>328</td>
<td>371</td>
<td>negligible</td>
</tr>
<tr>
<td>DC/DC Conv. Mother</td>
<td>280</td>
<td>395</td>
<td>438</td>
<td>negligible</td>
</tr>
</tbody>
</table>

**Notes:**

1. From Figure 2.2 for Telescope, Figure 2.4 for DPU
2. $\sqrt{2} \times$ min. Shielding for Telescope p.c. boards
   $\sqrt{2} \times$ min. Shielding + 37 mil Al for DPU p.c. boards in X and Y axis (see Appendix for detailed calculation of added shielding).
3. Sum of avg. Shielding + external shielding + typical part can shielding
4. 1/6 of reading from GOES Dose Depth Curve of Metsat-0422.
### TABLE 2.7

Telescope & DPU P.C. Board Summary of Dose Levels for each Direction and Total Dose

<table>
<thead>
<tr>
<th>Printed Circuit Board</th>
<th>Dose for each Direction - RAD's x 10^4</th>
<th>Total Dose (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+ X</td>
<td>- X</td>
</tr>
<tr>
<td>Telescope -</td>
<td></td>
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</tr>
<tr>
<td>Preamp Input</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Preamp Side A</td>
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</tr>
<tr>
<td>Preamp Side B</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>DPU -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto-Range</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Post-Null-WB</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>IFC</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Timing</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>DC/DC Conv. Daughter</td>
<td>.7</td>
<td>.7</td>
</tr>
<tr>
<td>DC/DC Conv. Mother</td>
<td>.7</td>
<td>.7</td>
</tr>
</tbody>
</table>

Note: (1) Sum of dose for each direction
<table>
<thead>
<tr>
<th>Module</th>
<th>Ref. Desc.</th>
<th>908XXX</th>
<th>(Xsitors only) IC</th>
<th>Parameter</th>
<th>Starting Value</th>
<th>Radiated Value</th>
<th>Required Value</th>
<th>Problem</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q202.302</td>
<td>MEU 455-0.12</td>
<td></td>
<td>MOS FET's</td>
<td>ΔVgs/Th, V</td>
<td>0</td>
<td>0</td>
<td>0.1</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
|         |           |       | I_D = 100 µA | ΔIgs/I₀ | 0 | 0 | 0.01 | No | 10^{-2} R  
|         |           |       | Vgs (umho) | 700 | 700 | 200 | No | Table 2.8 |  
| Q201.301 | 2N420     |       | Used as diode base in emitter | ΔIₕro (A) | 0 | 3.5x10^{-14} | 1x10^{-14} | No | 5x10^{-4} R²  
|         |           |       | | | | | | | Table 2.8 |  

XRS 3.4.3-13
<table>
<thead>
<tr>
<th>Module</th>
<th>Ref. Dcs.</th>
<th>908XXX</th>
<th>(Xsistors only)</th>
<th>IC</th>
<th>Parameter</th>
<th>Starting Value</th>
<th>Radiated Value</th>
<th>Required Value</th>
<th>Problem</th>
<th>Remarks</th>
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<tr>
<td>IC 20430</td>
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<td>LM1532A</td>
<td>ΔV_{IL} (mV)</td>
<td>0</td>
<td>1</td>
<td>≤ 0.5</td>
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<td></td>
<td>No</td>
<td></td>
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<tr>
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<td></td>
<td></td>
<td>I_{RB} (mA)</td>
<td>0.2</td>
<td>0.26</td>
<td>≤ 20</td>
<td></td>
<td></td>
<td>No</td>
<td>2×10^4</td>
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<tr>
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<td></td>
<td></td>
<td>I_{E} (mA)</td>
<td>2</td>
<td>3.1</td>
<td>≤ 16</td>
<td></td>
<td></td>
<td>N/A</td>
<td>Table 2.8</td>
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<tr>
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<td>N_{E} (V)</td>
<td>50</td>
<td>45</td>
<td>≥ 20</td>
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<tr>
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<td>.04 mA</td>
<td>K_{FE}</td>
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<td>25</td>
<td>≥ 1</td>
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<td></td>
<td>No</td>
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<tr>
<td>308.307</td>
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<td></td>
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<td>Q204.205</td>
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<td>Launch Date</td>
<td>Turn On Date</td>
<td>Operational Status As of April, '86</td>
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<tr>
<td>GOES F/6</td>
<td>May, 1983</td>
<td>13 May, 1983</td>
<td>S/C operational. XRS operational for ~ 2.8 yrs.</td>
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</tbody>
</table>
GOES E/5 XRS IN-FLIGHT CALIBRATION DATA HISTORY

RATIOS OF (HIGH CAL-Low CAL)/BASE RANGE, AND (LOW CAL)/BASE

BASE = +25 C VALUES FROM THERMAL VACUUM TESTS = VALUES IN CALIBRATION REPORT

<table>
<thead>
<tr>
<th>X-RAY CHANNEL</th>
<th>RANGE</th>
<th>4JUN81</th>
<th>5JUN81</th>
<th>5SEP81</th>
<th>16OCT82</th>
<th>20AUG85</th>
<th>8OCT85</th>
<th>(HIGH CAL-Low CAL)/Base Range for 4JUN81</th>
<th>5JUN81</th>
<th>5SEP81</th>
<th>16OCT82</th>
<th>20AUG85</th>
<th>8OCT85</th>
<th>(LOW CAL)/Base for 4JUN81</th>
<th>5JUN81</th>
<th>5SEP81</th>
<th>16OCT82</th>
<th>20AUG85</th>
<th>8OCT85</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (SHORT)</td>
<td>3</td>
<td>1.007</td>
<td>1.015</td>
<td>1.011</td>
<td>1.006</td>
<td>1.007</td>
<td>1.004</td>
<td>0.987</td>
<td>0.967</td>
<td>0.984</td>
<td>0.974</td>
<td>0.972</td>
<td>0.964</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A (SHORT)</td>
<td>2</td>
<td>1.007</td>
<td>1.011</td>
<td>1.011</td>
<td>1.005</td>
<td>1.006</td>
<td>1.003</td>
<td>0.986</td>
<td>0.966</td>
<td>0.986</td>
<td>0.976</td>
<td>0.972</td>
<td>0.966</td>
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<td></td>
</tr>
<tr>
<td>A (SHORT)</td>
<td>1</td>
<td>0.987</td>
<td>0.994</td>
<td>1.011</td>
<td>0.995</td>
<td>0.990</td>
<td>0.985</td>
<td>0.986</td>
<td>0.982</td>
<td>(1.012)</td>
<td>0.972</td>
<td>0.986</td>
<td>0.984</td>
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<td></td>
<td></td>
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<tr>
<td>A (SHORT)</td>
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<td>0.978</td>
<td>0.990</td>
<td>1.007</td>
<td>0.990</td>
<td>1.018</td>
<td>0.988</td>
<td>1.010</td>
<td>1.004</td>
<td>(1.211)</td>
<td>0.984</td>
<td>0.984</td>
<td>(1.014)</td>
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<tr>
<td>B (LONG)</td>
<td>3</td>
<td>1.006</td>
<td>1.010</td>
<td>1.008</td>
<td>1.004</td>
<td>1.004</td>
<td>1.000</td>
<td>0.986</td>
<td>0.971</td>
<td>0.982</td>
<td>0.968</td>
<td>0.968</td>
<td>0.996</td>
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<td></td>
</tr>
<tr>
<td>B (LONG)</td>
<td>2</td>
<td>1.005</td>
<td>1.007</td>
<td>1.007</td>
<td>1.001</td>
<td>1.001</td>
<td>0.996</td>
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<td>0.988</td>
<td>0.974</td>
<td>0.968</td>
<td>0.971</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>B (LONG)</td>
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<td>0.951</td>
<td>0.955</td>
<td>1.015</td>
<td>1.000</td>
<td>0.997</td>
<td>0.989</td>
<td>0.974</td>
<td>0.994</td>
<td>(1.250)</td>
<td>0.998</td>
<td>0.968</td>
<td>0.968</td>
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<td></td>
<td></td>
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<td>B (LONG)</td>
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<td>1.018</td>
<td>0.998</td>
<td>0.997</td>
<td>0.990</td>
<td>0.994</td>
<td>(1.159)</td>
<td>(3.683)</td>
<td>(1.230)</td>
<td>1.004</td>
<td>0.984</td>
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</tr>
</tbody>
</table>

NOTE: (Low CAL)/Base numbers in parenthesis are affected by the solar X-ray pulse tail in the two lowest ranges.

After 4 years, 4 months of orbital operation the gains are all within 1.5% of the base value. The offset (Low CAL) values are all within 3.6% of the base values.
## GOES F/6 XRS IN-FLIGHT CALIBRATION DATA HISTORY

### Ratios of \((\text{High Cal} - \text{Low Cal})/\text{Base Range}\), and \((\text{Low Cal})/\text{Base}\)

**Base** = \(+25\ C\) values from Thermal Vacuum Tests  
= Values in Calibration Report (Performance Test Data)

<table>
<thead>
<tr>
<th>X-Ray Channel</th>
<th>Range</th>
<th>((\text{High Cal} - \text{Low Cal})/\text{Base Range For}) For</th>
<th>((\text{Low Cal})/\text{Base For})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>18MAY83</td>
<td>19AUG85</td>
</tr>
<tr>
<td>A (Short)</td>
<td>3</td>
<td>1.015</td>
<td>1.009</td>
</tr>
<tr>
<td>A (Short)</td>
<td>2</td>
<td>1.014</td>
<td>1.007</td>
</tr>
<tr>
<td>A (Short)</td>
<td>1</td>
<td>1.018</td>
<td>0.988</td>
</tr>
<tr>
<td>A (Short)</td>
<td>0</td>
<td>1.037</td>
<td>0.985</td>
</tr>
<tr>
<td>B (Long)</td>
<td>3</td>
<td>1.013</td>
<td>1.009</td>
</tr>
<tr>
<td>B (Long)</td>
<td>2</td>
<td>1.014</td>
<td>1.007</td>
</tr>
<tr>
<td>B (Long)</td>
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<td>1.029</td>
<td>1.015</td>
</tr>
<tr>
<td>B (Long)</td>
<td>0</td>
<td>1.036</td>
<td>1.009</td>
</tr>
</tbody>
</table>

**Note:** \((\text{Low Cal})/\text{Base}\) numbers in parenthesis are affected by the solar X-ray pulse tail in the two lowest ranges.

After 2 years, 3 months of orbital operation the gains are all within 1.5% of the base values. The offset \((\text{Low Cal})\) values are all within 3.1% of the base values.

XRS 3.5-3
### GOES XRS Range Data Summary - as of May 1986

#### A Channel (1/2 - 3 Å, Short) - Flux Ratios

<table>
<thead>
<tr>
<th>Range</th>
<th>( \frac{G-4}{G-2} )</th>
<th>( \frac{G-5}{G-4} )</th>
<th>( \frac{G-6}{G-5} )</th>
<th>( \frac{G-3}{G-2} )</th>
<th>( \frac{G-5}{G-2} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>R4</td>
<td>0.85</td>
<td></td>
<td>0.87</td>
<td>1.13</td>
<td>0.94</td>
</tr>
<tr>
<td>R3</td>
<td>0.88</td>
<td>1.14</td>
<td>0.85</td>
<td></td>
<td>0.98</td>
</tr>
<tr>
<td>R2</td>
<td>-1.00</td>
<td>1.04</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>-0.98</td>
<td>1.04</td>
<td>0.88</td>
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</tr>
</tbody>
</table>

#### B Channel (1-8 Å, Long) - Flux Ratios

<table>
<thead>
<tr>
<th>Range</th>
<th>( \frac{G-4}{G-2} )</th>
<th>( \frac{G-5}{G-4} )</th>
<th>( \frac{G-6}{G-5} )</th>
<th>( \frac{G-3}{G-2} )</th>
<th>( \frac{G-5}{G-2} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>R4</td>
<td>1.07</td>
<td></td>
<td>1.16</td>
<td>1.10</td>
<td>1.01</td>
</tr>
<tr>
<td>R3</td>
<td>1.07</td>
<td>1.00</td>
<td>1.15</td>
<td></td>
<td>1.02</td>
</tr>
<tr>
<td>R2</td>
<td>1.12</td>
<td>1.02</td>
<td>1.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>1.09</td>
<td></td>
<td>1.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Flux ratios at range switches - A channel

<table>
<thead>
<tr>
<th>Range Ratio</th>
<th>SMS-1</th>
<th>SMS-2</th>
<th>G-2</th>
<th>G-3</th>
<th>G-4</th>
<th>G-5</th>
<th>G-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>R4/R3</td>
<td>1.06</td>
<td>0.90</td>
<td>0.99</td>
<td>0.87</td>
<td>0.99</td>
<td>1.03</td>
<td>1.04</td>
</tr>
<tr>
<td>R3/R2</td>
<td>(-1)</td>
<td>1.0</td>
<td>0.95</td>
<td>0.86</td>
<td>0.95</td>
<td>1.09</td>
<td>1.06</td>
</tr>
<tr>
<td>R2/R1</td>
<td>(-1)</td>
<td>0.89</td>
<td>1.00</td>
<td>0.80</td>
<td>1.00</td>
<td>0.95</td>
<td>0.96</td>
</tr>
</tbody>
</table>

#### Flux ratios at range switches - B channel

<table>
<thead>
<tr>
<th>Range Ratio</th>
<th>SMS-1</th>
<th>SMS-2</th>
<th>G-2</th>
<th>G-3</th>
<th>G-4</th>
<th>G-5</th>
<th>G-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>R4/R3</td>
<td>1.08</td>
<td>0.95</td>
<td>0.99</td>
<td>1.07</td>
<td>1.01</td>
<td>1.03</td>
<td>1.04</td>
</tr>
<tr>
<td>R3/R3</td>
<td>0.90</td>
<td>0.93</td>
<td>0.98</td>
<td>1.21</td>
<td>0.92</td>
<td>0.95</td>
<td>0.94</td>
</tr>
<tr>
<td>R2/R1</td>
<td>(-1)</td>
<td>0.94</td>
<td>0.97</td>
<td>1.02</td>
<td>1.01</td>
<td>1.01</td>
<td>1.01</td>
</tr>
</tbody>
</table>
GOES 1-M XRS

MECHANICAL DESIGN AND ANALYSIS

MECHANICAL DESIGN AND ANALYSIS IS ADDRESSED IN THE FOLLOWING SECTIONS:

XRS Assembly

Collimator & Magnet Subassembly

Preamp Subassembly

DPU Subassembly

XRS 2.2.4

XRS 2.3.3

XRS 2.4.4

XRS 2.5.2

XRS 5.1
GOES I-M XRS

THERMAL DESIGN AND ANALYSIS

O EXTERNAL THERMAL CONTROL

O Heating Blanket controls XRS temperature. FACC supplied.

O Unit external thermal coating TBS by FACC during spacecraft thermal analysis.

O INTERNAL THERMAL ANALYSIS

O Maximum component temperature needed for derating and reliability analyses.

O Power dissipating components have heat energy conducted away by copper PC board traces.

O Low thermal conductivity of fiber glass/epoxy PC boards (FR4) results in most heat loss by thermal (blackbody) radiation.

O Calculate worst case component temperature rise from PC trace temperature drops and from PC board radiative temperature rises.

O Center PC boards will have the highest component temperatures.

O Preliminary estimates show component temperatures will generally be within 5 deg C of unit base temperature.
GOES 1-M XRS

DEVELOPMENT AND QUALIFICATION/ACCEPTANCE TEST PLANS

* COLLIMATOR SUBASSEMBLY INTEGRATION TEST SEQUENCE
* MAGNET YOKE SUBASSEMBLY INTEGRATION TEST SEQUENCE
* PREAMPLIFIER SUBASSEMBLY INTEGRATION TEST SEQUENCE
* EM TELESCOPE SUBASSEMBLY INTEGRATION TEST SEQUENCE
* P/F MODEL TELESCOPE SUBASSEMBLY INTEGRATION TEST SEQUENCE
* DPU SUBASSEMBLY INTEGRATION TEST SEQUENCE
* XRS ASSEMBLY INTEGRATION TEST SEQUENCE
* EM ACCEPTANCE TEST SEQUENCE
* PROTOFLIGHT/FLIGHT MODEL QUALIFICATION/ACCEPTANCE TEST SEQUENCE
GOES I-M XRS

MACHINED PARTS → INSPECT PER APPLICABLE PART DRAWINGS → ASSEMBLE COLLIMATOR AND Be WINDOW PER APPLICABLE DRAWINGS

BERYLLIUM WINDOW → TRANSMISSION TEST PER PANA-RTP-27 →

COLLIMATOR SUBASSEMBLY INTEGRATION TEST SEQUENCE

XRS 6-1
GOES I-M XRS

PREAMPLIFIER SUBASSEMBLY INTEGRATION TEST SEQUENCE
GOES I–M XRS

ENGINEERING MODEL
TELESCOPE SUBASSEMBLY INTEGRATION SEQUENCE

INSPECT → REWORKED OR NEW MACHINED PARTS → MODIFY DESIGN

COLLIMATOR SUBASSEMBLY → ASSEMBLE TELESCOPE PER APPLICABLE DRAWINGS

MAGNET YOKE SUBASSEMBLY → EFFECTIVENESS OF SHIELDING AND FOV TESTS PER TBS

PREAMPLIFIER SUBASSEMBLY → ACCEPTABLE?

CONTINUE TEST SEQUENCE → YES

NO
GOES I-M XRS

DPU SUBASSEMBLY INTEGRATION TEST SEQUENCE
GOES I-M XRS

TELESCOPE SUBASSEMBLY

DPU SUBASSEMBLY

SPACECRAFT SIMULATOR

VALIDATE PER TBS

INTEGRATE

ELECTRONICS CALIBRATION & VERIFICATION WITH Fe-55 SOURCE

PERFORMANCE TEST PER TBS

DISASSEMBLE, AND CONFORMAL COAT DPU PC BOARDS & FINAL ASSEMBLY

PRELIMINARY THERMAL TEST PER TBS

XRS ASSEMBLY INTEGRATION TEST SEQUENCE

XRS 6-7
GOES I–M XRS

BASELINE PERFORMANCE TEST → LIMITED EMC TESTS → PERFORMANCE TEST

THERMAL TEST → PERFORMANCE TEST → RANDOM VIBRATION TEST

ENGINEERING MODEL ACCEPTANCE TEST SEQUENCE
PROTOFLIGHT/FLIGHT MODEL QUALIFICATION/ACCEPTANCE TEST SEQUENCE

GOES 1–M XRS

BASELINE PERFORMANCE TEST → EMC TESTS → PERFORMANCE TEST

THERMAL VACUUM TEST * → PERFORMANCE TEST → RANDOM VIBRATION TEST

* INCLUDES REFERENCE PT @ +25° C

FINAL PERFORMANCE TEST
EMI - CONDUCTED EMISSION TEST SPECIFICATIONS

**Power Lines**

- \( \leq 3\% \text{ P-P, of DC} \)
- Steady-state input 1 Hz to 100 MHz
  \( (\leq 2.5 \text{ mA P-P}) \)

**Command Lines**

- \( \leq 8.3 \text{ mA, P-P} \)
- 1 Hz to 150 KHz
- \( \leq 0.15 \text{ mA, P-P} \)
- 150 KHz to 100 MHz

**Digital Telemetry Lines**

- \( \leq 20 \text{ mV, P-P} \)
- 1 Hz to 150 KHz
- \( \leq 10 \text{ mV, P-P} \)
- 150 KHz to 100 MHz

**Analog Telemetry Lines**

- \( \leq 10 \text{ mV, P-P} \)
- 1 Hz to 150 KHz
- \( \leq 5 \text{ mV, P-P} \)
- 150 KHz to 100 MHz

XRS 6-10
GOES I, J, K, L & M XRS

EMI - CONDUCTED SUSCEPTIBILITY TEST SPECIFICATIONS

GOES I, J, K, L & M

Power Lines

See Graphs

Command Lines

≤ 0.5 V, P-P
1 Hz to 150 KHz

≤ 0.25 V, P-P
150 KHz to 100 MHz

Digital Telemetry Lines

≤ 160 uA, P-P
1 Hz to 150 KHz

≤ 80 uA, P-P
150 KHz to 100 MHz

Analog Telemetry Lines

≤ 5 uA, P-P
1 Hz to 150 KHz

≤ 2.5 uA, P-P
150 KHz to 100 MHz

XRS 6-11
GOES I-M XRS

Power line steady state conducted susceptibility test specifications

Ripple Voltage (V_{P-P})

FREQUENCY (Hz)
GOES I, J, K, L & M XRS

ELECTROSTATIC SENSITIVITY (ARC DISCHARGE) SPECIFICATIONS

GOES I, J, K, L & M

RADIATED
(SUSCEPTIBILITY)

10 kV, 1 PPS*
30 SECONDS MINIMUM
30 CM FROM EACH EXPOSED FACE

Conducted
(Survivability)

10 kV, 1 PPS*
30 SECONDS MINIMUM
DIRECT DISCHARGE TO SHORT
PROJECTING LUG ATTACHED
TO FACE OR CORNER

XRS 6-13
GOES I, J, K, L & M XRS

VIBRATION TEST SPECIFICATIONS

RANDOM
PROTOFLIGHT LEVELS
PERPENDICULAR TO
MOUNTING PLANE

GOES I, J, K, L & M

14.8 G'S RMS
60 SEC
(SEE GRAPH)

PARALLEL TO
MOUNTING PLANE

10.5 G'S RMS
60 SEC PER AXIS
(SEE GRAPH)

RANDOM
ACCEPTANCE LEVELS
POWER SPECTRAL DENSITY

0.50 X PROTOFLIGHT
LEVELS

OVERALL G'S RMS

0.707 X PROTOFLIGHT
LEVELS

DURATION

SAME AS PROTOFLIGHT

NOTE

UNIT OPERATING
INPUT CURRENT TO BE
MONITORED

XRS 6-14
RANDOM VIBRATION TEST SPECIFICATION FOR PREVIOUS AND CURRENT GOES

(Parallel to mounting plane)

\[ H \cdot \Sigma \]

POWER SPECTRAL DENSITY (\( g^2/Hz \))

FREQUENCY (Hz)

Qual A, B, C

Qual L, J, K, M, I: 10.5 g RMS

Qual L, E, F, U, H

5.7 g RMS

XRS 6-16
GOES I-M XRS

THERMAL VACUUM TEST SPECIFICATIONS 1)

PT AT AMBIENT TEMPERATURE
COOL, NON-OPERATING, TO -200°C
TURN ON AT -200°C, PT AT -200°C, TURN OFF AT -200°C
HEAT, NON-OPERATING, TO +500°C
COOL, NON-OPERATING, TO +350°C (+25°C)
TURN ON AT +350°C (+25°C), PT AT 350°C (+25°C)
COOL, OPERATING, TO -200°C
PT AT -200°C (PROTOFLIGHT ONLY)
HEAT, OPERATING, TO +350°C (+25°C)
PT AT +350°C (+25°C) (PROTOFLIGHT ONLY)
COOL, OPERATING, TO -200°C
PT AT -200°C (PROTOFLIGHT ONLY)
HEAT, OPERATING, TO +350°C (+25°C)
PT AT +350°C (+25°C) (PROTOFLIGHT ONLY)
COOL, OPERATING, TO -200°C
PT AT -200°C
HEAT, OPERATING, TO +350°C (+25°C)
PT AT +350°C (+25°C)
COOL, OPERATING, TO AMBIENT TEMPERATURE
PT AT AMBIENT TEMPERATURE, TURN OFF

NOTE 1) NUMBERS IN PARENTHESIS ARE ACCEPTANCE TEMPERATURE LEVELS. WHERE NO NUMBERS IN PARENTHESIS ARE SHOWN THE QUALIFICATION AND ACCEPTANCE TEMPERATURE LEVELS ARE THE SAME.
GOES I-M XRS

SUMMARY OF INTEGRATION TESTS, FM PROTOFLIGHT AND FLIGHT MODEL

* All PC Bds and Subassemblies are tested in accordance with their respective test procedures. Procedures are under configuration control.

* Ion Chamber is tested and calibrated. Test includes long term leak test.

* UV foil shield (Be) thickness is measured.

* Magnet field strength is measured and magnet yoke subassembly field is mapped.

* Preamplifier conversion gain, offset and BW are set and noise measured. Tested over range -250C to 550C.

* Telescope subassembly, effectiveness of shielding and FOV:
  - EM serves to determine by analysis and test the final shielding material, thickness and location on telescope.
  - Verified on protoflight and flight models.

* In-flight calibration levels are set.

* Interface lines are tested under worst case drive and load conditions.

* Performance test at ambient conditions is conducted.

* Preliminary thermal test is conducted over qualification temperature range (-20 to +350C) with performance tests at ambient and temperature extremes.

XRS 6-19
SUMMARY OF INTEGRATION TESTS, EM PROTOFLIGHT AND FLIGHT MODEL (CONT'D)

* Electronics calibration is performed over dynamic range.
* Fe-55 sources are used to verify end to end calibration, threshold sensitivity, resolution and response time.
GOES I-M XRS

SUMMARY OF PERFORMANCE TEST

* Proper operation at low, nominal and high bus voltage is verified.
* Bus voltage and current levels are measured.
* Proper operation of all command lines is verified.
* Electronic calibration is verified.
* Analog telemetry output level of reference voltage is verified.
* Temperature monitor output levels are measured.
* Proper operation of automatic ranging and bi-level status output levels over dynamic range are verified.
* Proper operation of in-flight logic and output levels are verified.
* Data output noise levels are measured.
* Aliveness and proper response of ion chambers is verified with Fe-55 sources.