Observation and Analysis of Single Event Effects On-board the SOHO Satellite.

by

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Abstract

SOHO has experienced a large number of SEUs since its launch in December 1995. Self switch-off power supply events will be detailed as well as SEUs in the Solid State Recorder and in the GOLF instrument. Relevant ground verification testing will be presented and upset predictions will be compared with observations.
Spacecraft Radiation Anomalies III – SOHO.

SOlar and Heliospheric Observatory

# Scientific International Satellite
# Dedicated to the study of the Sun
# Launched in December 1995
# Orbit at the Lagrangian point L1
# 1.5 million-Km from the earth
# Large number of SEEs –

1) Self switch-off power supply events
2) DRAM SEUs in the Solid State Recorder
3) SRAM SEUs in the GOLF instrument
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Power Supply ‘self switch-off events’ - I.

### Service Module: 7 events
- 04/12-1995 Attitude Control Unit PS – Reset
- 19/11-1997 Attitude Control Unit PS – Switch-off
- 03/03-1998 Data Handling PS – Switch to redundant
- 28/11-1999 Attitude Control Unit PS – Reset
- 07/01-2000 Sun Pointing Detector – Spurious signal
- 28/11-2000 Attitude Control Unit PS – Reset
- 14/01-2001 Attitude Control Unit PS – Reset

### Battery Discharge Regulator: 3 events
- 12/01-1997 BDR1.2 PS – Switch-off
- 01/04-1997 BDR1.1 PS – Switch-off
- 12/01-1998 BDR2.1 PS – Switch-off
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Power Supply ‘self switch-off events’ - II.

# Payload Module: VIRGO 7 events

09/09-1996 VIRGO crashed – self switch-off event
07/05-1997 VIRGO latch-up – self switch-off event (2nd)
20/05-1997 VIRGO latch-up – self switch-off event (3rd)
26/05-1998 VIRGO power fail – self switch-off event (4th)
12/07-1999 VIRGO I drop to 370 mA – latch-up (1st SEL)
11/02-2000 VIRGO latch-up in DAS – latch-up (2nd SEL)
30/03-2001 VIRGO latch-up in DAS – latch-up (2nd SEL)

# Payload Module: LASCO 5 events

19/03-1996 LASCO voltage anomaly – requiring reboot
10/06-1996 LASCO voltage anomaly – requiring reboot
19/12-1996 LASCO voltage anomaly – requiring reboot
26/04-1998 LASCO hung-up – requiring reboot
28/03-2000 LASCO PROM off – requiring reboot
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Possible SEU/Latch Scenarios:

# BA ACU PSU
LM/PM139 Quad Voltage Comparator
UC1707J Dual Channel Power Driver
UC1842J Current Mode PWM Controller

# CDMU PCCS
LM/PM139 Quad Voltage Comparator
UC1707J Dual Channel Power Driver

# LASCO PSU
LM/PM139 Quad Voltage Comparator
UC1707J Dual Channel Power Driver

# VIRGO PSU
LM/PM139 Quad Voltage Comparator
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LM/PM139 VIRGO Test Schematics/Set-up:

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LM/PM139 VIRGO/Comparator SET Results:

![Graph showing radiation anomaly results.](image-url)
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LM/PM139 VIRGO/Comparator SET Results:

NSC LM139J & AD/PMI PM139 - Heavy Ion SET Results (UCL9809).

Cross Section - (cm²/Comparator)

Ion LET - MeV/(mg/cm²)
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UC1707J BA ACU/LASCO SET Results:

Unitrode UC1707J - BA ACU & LASCO -
Heavy Ion SET Results (UCL9809).
SOHO - CREME96 SEU Predictions: mission rates (~5 years)

<table>
<thead>
<tr>
<th>Design</th>
<th>Predicted</th>
<th>Observed</th>
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</thead>
<tbody>
<tr>
<td>VIRGO PM139 design</td>
<td>5 events/comparator</td>
<td>5 events/comparator</td>
</tr>
<tr>
<td>LASCO UC1707 design</td>
<td>0.1 event/device</td>
<td>0 verified events</td>
</tr>
<tr>
<td>BA ACU UC1707 design</td>
<td>5 events/device</td>
<td>3 events/device</td>
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SOHO - Conclusions/ESA

# Satellite SEU data reported – and made available to the radiation community

# SEU ground testing/predictions recognize these events

# Using current solar flares need to be addressed SEU predictions

# XMM/Integral/Rosetta – designs re-checked/assessed for transient SEU (testing on going)
Spacecraft Malfunction Attributed to Transients*

NASA Missions.

# TOPAX/Poseidon in 1992
Operational Amplifier OP-15

# Microwave Anisotropy Probe (MAP) in 2001 and one later
Voltage Comparator LM139

# TDRS
Problems Attributed to Transients

# CASSINI
Problems Attributed to Transients

# TERRA
Problems Attributed to Transients

*2005 IEEE NSREC Short Course – Steve Buchner, NASA GSFC & Dale McMorrow, NRL.