

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.



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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

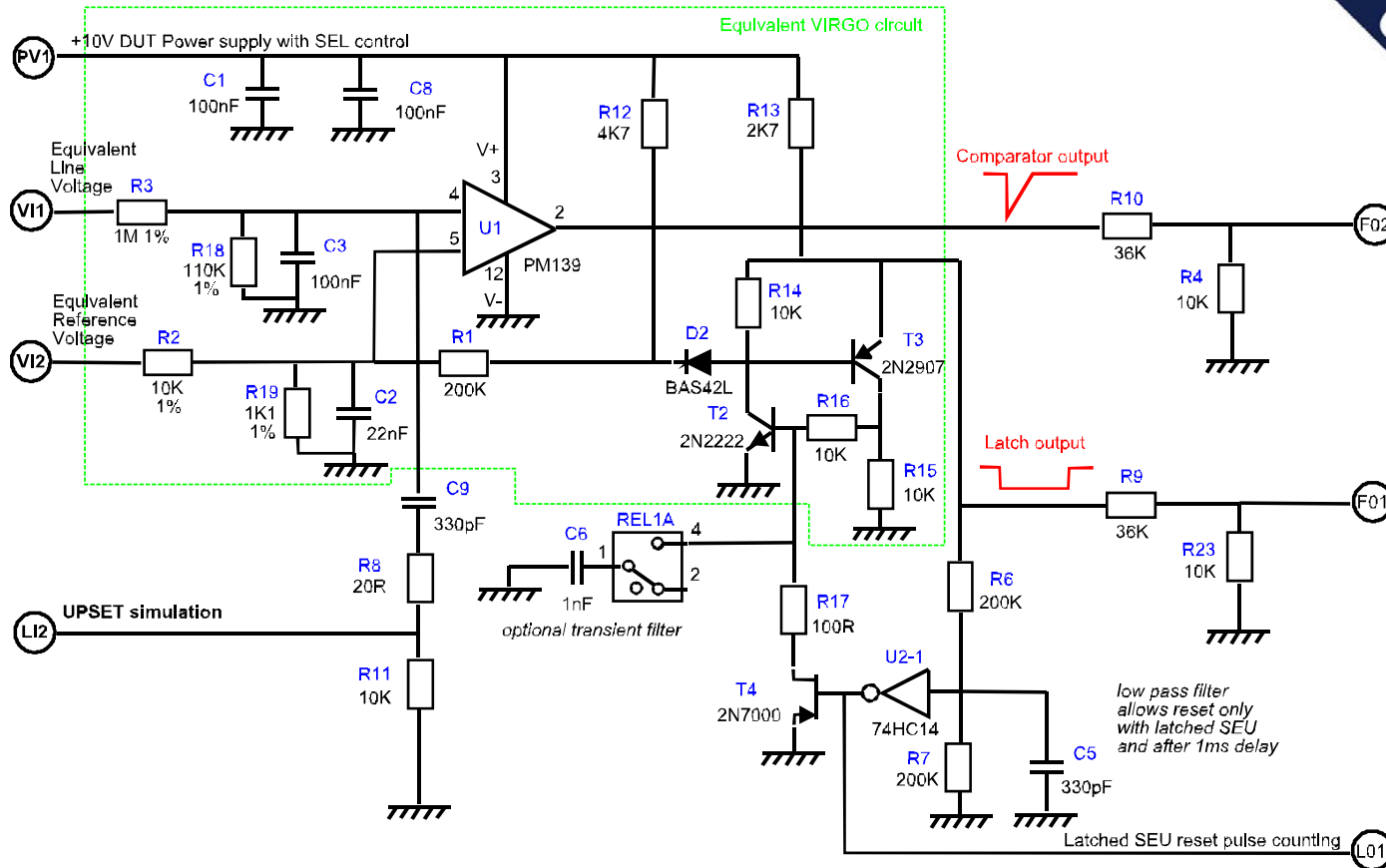
VIRGO PSU

LM/PM139 Quad Voltage Comparator



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LM/PM139 VIRGO Test Schematics/Set-up:



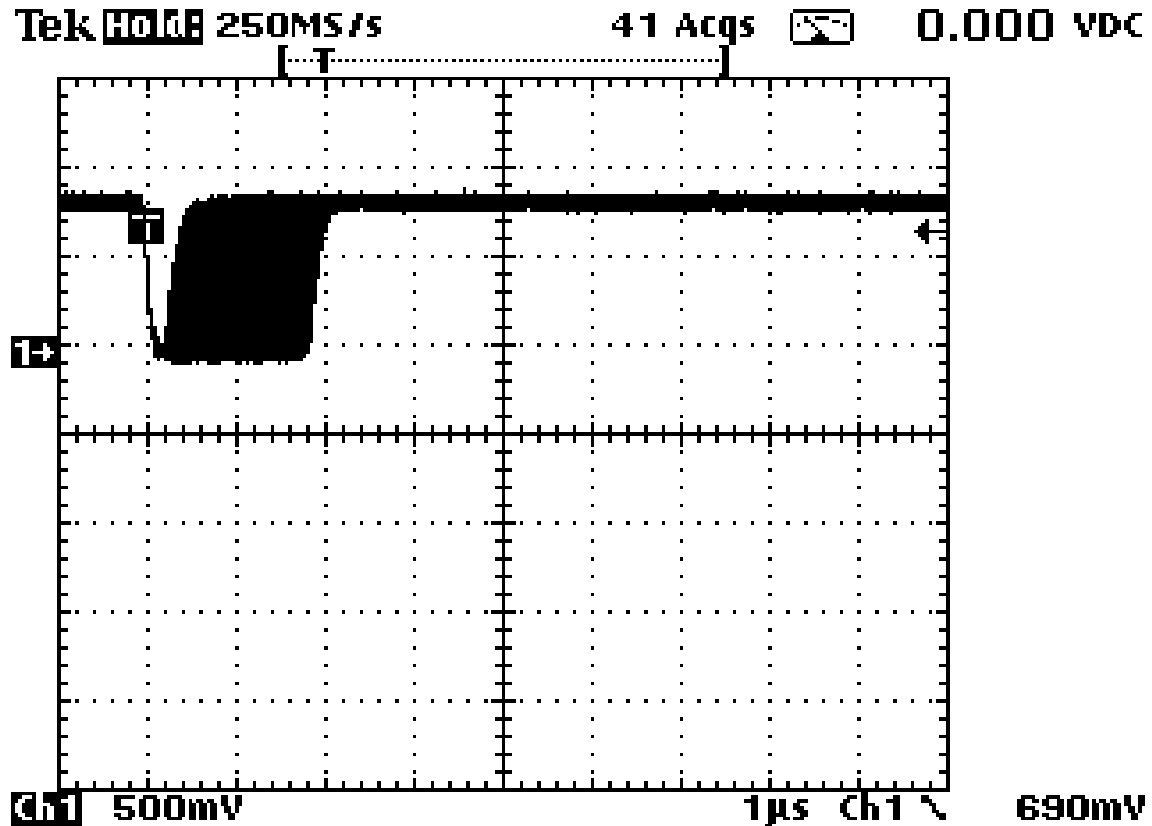
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LM/PM139 VIRGO/Comparator SET Results:



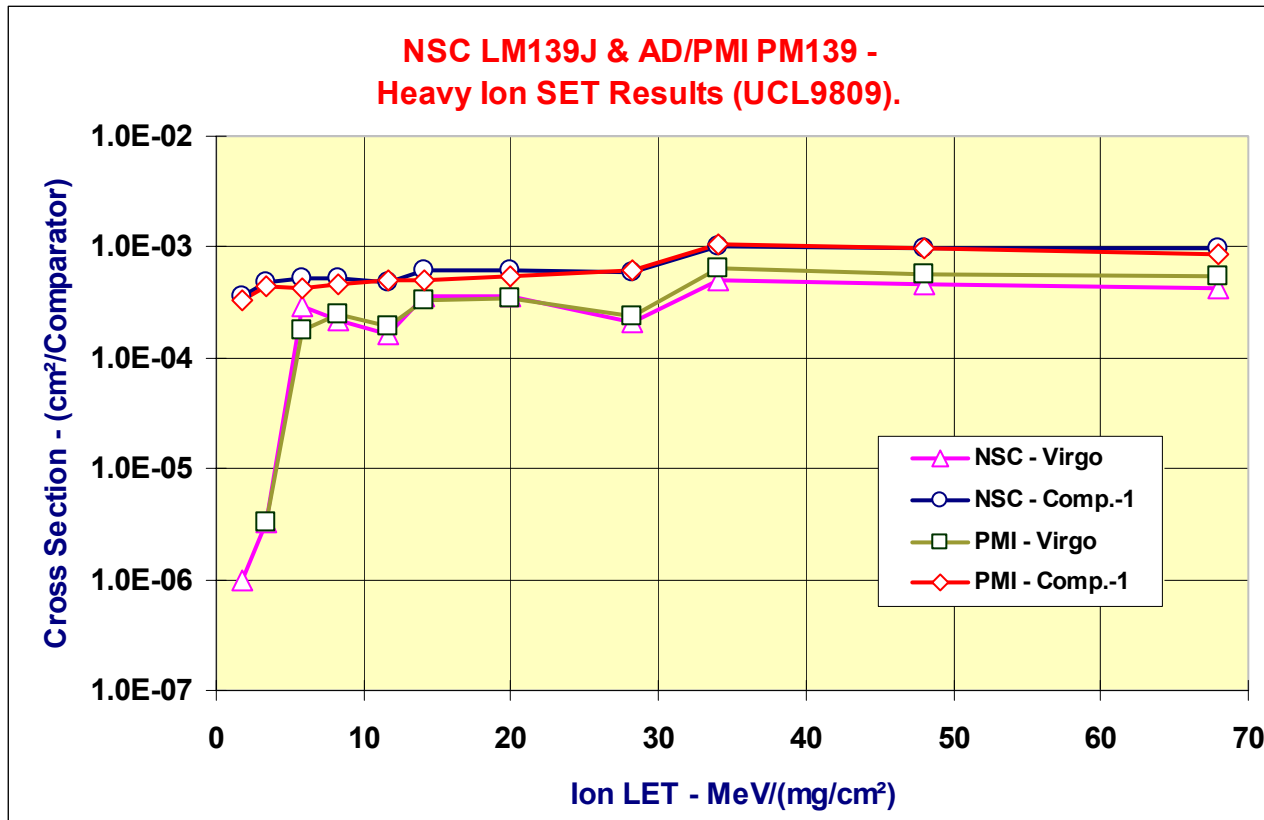
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LM/PM139 VIRGO/Comparator SET Results:



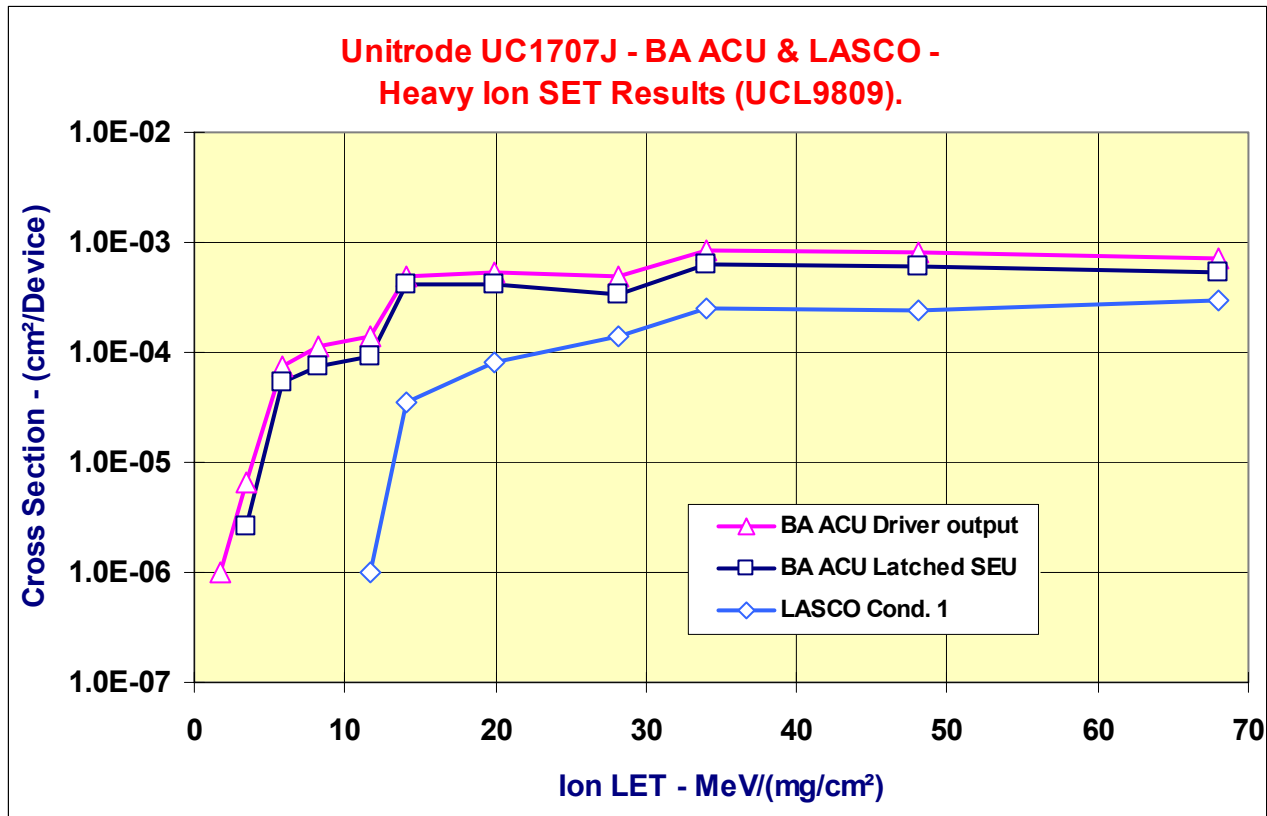
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UC1707J BA ACU/LASCO SET Results:



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SOHO - CREME96 SEU Predictions: mission rates (~5 years)



VIRGO PM139 design -

Predicted

5 events/comparator

Observed

5 events/comparator

LASCO UC1707 design -

Predicted

0.1 event/device

Observed

0 verified events

BA ACU UC1707 design -

Predicted

5 events/device

Observed

3 events/device



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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)**



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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.*



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