Summary of Radiation Effects Data Search for Selected THEMIS Active Components*

v1p0

ICI RADIATION DYNAMICS

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September 12, 2003

* In partial fulfillment of UC Berkeley PO NO 1-0000818421

Device List

- List of the devices included in radiation effects data search for THEMIS P3&P4

GENERIC P/N	MIL P/N	SMD P/N	Mfr.	DESCRIPTION
A1020	-	-	Actel	IC, FPGA Actel
A1020	-	-	Actel	IC, FPGA Actel
A1020	-	-	Actel	IC, FPGA Actel
54--245A	54LVTH245A	-	MAXWELL	Data Buffer/Translator
54--162244	54LVTH162244	-	MAXWELL	Addr-Cntl Buffer/Translater
AHA3520	AHA3520A-040PQC	-	AHA	Data Compression, CMOS
AHA3850	AHA3850A-080PTC	-	AHA	Data Compression, CMOS
AD524	AD524SD/883B	5962-8853901EA	AD	PREAMP, Precision Monolithic Instrumentation Amplifier
AD549	AD549SH/883B	-	AD	OPAMP, Ultralow Input Bias Current Operational Amplifier
AD5544	AD5544ARS	-	-	DAC, Precision QUAD 16-Bit DAC
AD625	AD625SD/883B	5962-8771901EA	AD	PREAMP, Programmable Gain Instrumentation Amplifier
AD7664	AD7664AST	-	AD	A/D, 16-Bit, 570 kSPS CMOS Successive Approximation ADC with No Missing Codes
AD822	AD822ARM-R2	-		OPAMP, Single Supply, Dual Precision, Rail to Rail Low Power FET-Input Op Amp
AD8005A	AD8005ART	-	AD	AMP, Ultralow Power, 170 MHz and Slew Rate of 280 V/µs
AU5517D	-	-	PHILLIPS	

Device List cont.

GENERIC P/N	MIL P/N	SMD P/N	Mfr.	DESCRIPTION
CA3080A	CA3080AT->AM ok, AS(discontinued)	-	Intersil	CMOS, OTA, Operational Transconductance Amplifier, Reduced Input Offset Voltage, 2MHz
CA3280A	CA3280AS	-	Intersil	CMOS, OTA, Operational Transconductance Amplifier, Reduced Input Offset Voltage, 2MHz
CMP04	-	-	AD	COMPARATOR, Quad Low Power, Precision Comparator
DG613	DG613AK/883	5962-93255503MEA	VISHAY	Analog Switch, High-Speed, Low-Glitch D/CMOS Analog Switch
EL2001	EL2001CN	-	Elentec	OPAMP, Low Power, 180MHz Buffer Amplifier
HA-5170	HA7-5170-8	-	Intersil	Op Amp, 8MHz, Precision, JFET Input, Unity Gain
LF411ACH	-	-	NSC	OPAMP, Low Offset, Low Drift JFET Input Operational Amplifier
~~LM117~~	~~JM38510/11703BXA~~	-	~~NSC~~	~~Regulator, 3-Terminal Adjustable~~
~~LM137~~	~~JM38510/11803BXA, LM137H/883~~	-	~~NSC~~	~~Negative Regulator, 3-Terminal Adjustable~~
LM13700	LM13700M	-		AMP, Dual Operational Transconductance Amplifier with Linearizing Diodes and Buffers
LM3485	-	-	NSC	PFET Switching Regulator (Buck) Controller, Hysteretic, MOSFET
LM5030	N/A	N/A	NSC	N/A
LMV762	LMV762MMX	-	NSC	COMPARATOR, Low Voltage, Precision Comparator with Push-Pull Output
LM193	LM193AJ-QMLV	5962-9452602VPA	NSC	Dual Comparator, Low Power Low Offset Voltage
LT1217	LT1217CS8	-	Linear Tech	OPAMP,
LT1352	LT1352IS8	-	Linear Tech	OPAMP, Dual and Quad 250mA, 3MHz, 200V/ms Operational Amplifiers, SO-8pack, also SO-14 pack available (1353IS)
LT1671	LT1671CMS8	-	Linear Tech	COMPARATOR,
LT1353	LT1353IS	-	Linear Tech	OPAMP, Dual and Quad 250mA, 3MHz, 200V/ms Operational Amplifiers, SO-14pack, also SO-8 pack available
LTC1604	LTC1604AIG	-	Linear Tech	ADC, A/D 16 bit converter

Device List cont.

GENERIC P/N	MIL P/N	SMD P/N	Mfr.	DESCRIPTION
LTC1609	LTC1609AISW	-	Linear Tech	ADC, 16-Bit, 200ksps, Serial Sampling ADC
LT1787	LT1787HV	-	Linear Tech	AMP, Precision, High Side Current Sense Amplifiers
LT1766	-	-	Linear Tech	Step-Down Switching Regulator, High Voltage 1.5A, 200 kHz
LTC1604	LTC1604AIG	-		A/D, High Speed, 16-Bit, 333kspsSampling A/D Converterwith Shutdown
LTC1877	-	-	Linear Tech	Step-Down Regulator, High Efficiency Monolithic Synchronous
MAX907	MAX907ESA	-	MAXIM	COMPARATOR, Dual/Quad/Single, High-Speed, Ultra-Low-Power, Single-Supply TTL Comparators
MAX991	-	-	MAXIM	COMPARATOR, High-Speed, Micropower, Low-Voltage, SOT23, Rail-to-Rail I/O Comparators
MIC4425	MIC4425AJPQ	5962-8850306PA	Micrel, AustinSemi, I	DRIVER, DUAL HIGH-POWER MOSFET
8256804S	MMSD08256804S-C-1S	-	3D+	SDRAM, 2GB SDRAM STACK, SPACE GRADE
OM9808	OMR9808SF	-	IR	Voltage Regulator (5V-3.3V)
OP220	OP220AJ/883C	-	AD	OPAMP, Dual Micropower Operational Amplifier
OP482	OP482GP	5962-9458101MCA	AD	OPAMP, Quad Low Power, High Speed JFET Operational Amplifier
OP484	OP484FS	-	AD	OPAMP, Precision Rail-to-Rail Input & Output Operational Amplifier
OP490	OP490AY	5962-8967001CA	AD	OPAMP, Low-Voltage Micropower Quad Operational Amplifier
UC1526A	UC1526AJ/883B	5962-8951102EA	TI	Regulating Pulse Width Modulator
2N3439	2N3439 JANTXV	-		NPN LOW POWER SILICON TRANSISTOR, Qualified per MIL-PRF-19500/368
2N5416	2N5416 JANTXV	-		PNP LOW POWER SILICON TRANSISTOR, Qualified per MIL-PRF-19500/485
MMBT3904	MMBT3904LT1	-	MOT	NPN, UHF/VHF TRANSISTOR
MMBT3906	MMBT3906LT1	-	MOT	PNP,
MMBTH81	MMBTH81LT1	-	MOT	PNP
SD210DE	SD210DE-2	-	VISHAY	N-Channel Lateral DMOS FET

Radiation Data Found

MIL P/N	HI SEU	P SEU	SEL	Total Dose (Krads(Si))	Destructive	Comments and Reference
A1020	LETth = 25, 1E-6 Upset/Bit-Day	Immune	Immune	300	No	HI LETth Data from R. Koga et al, 94 SEE Symposium. All other data from Actel's website http://www.actel.com/documents/RADHARDds.pdf
A1020	LETth = 25, 1E-6 Upset/Bit-Day	Immune	Immune	300	No	HI LETth Data from R. Koga et al, 94 SEE Symposium. All other data from Actel's website http://www.actel.com/documents/RADHARDds.pdf
A1020	LETth = 25, 1E-6 Upset/Bit-Day	Immune	Immune	300	No	HI LETth Data from R. Koga et al, 94 SEE Symposium. All other data from Actel's website http://www.actel.com/documents/RADHARDds.pdf
54LVTH245A	?	?	?	>100	No	Total Dose data from MAXWELL, http://www.maxwell.com/pdf/me/product_datasheets/logic/54LVTH162244_Rev1.pdf
54LVTH162244	?	?	?	>100	No	Total Dose data from MAXWELL, http://www.maxwell.com/pdf/me/product_datasheets/logic/54LVTH162244_Rev1.pdf
AHA3850A-080PTC	?	?	?	?	?	Can't find radiation data. May exhibit Proton and Heavy Ion SEE (SEU, SEL)
AD524SD/883B	LETth = 11.5, 1E-3 cm2/device	?	>80	≤100	No	Heavy Ion SEU and SEL Data from K. Label, 1995 IEEE NSREC Data Workshop pg. 29. Total Dose Data from DSCC http://www.dscc.dla.mil/Downloads/MilSpec/Smd/88539.pdf
AD549SH/883B	?	?	?	<5	?	Total Dose Data from GSFC Project Component Engineering Monthly Report - April 2003: http://nepp.nasa.gov/index_nasa.cfm/957/. Device may exhibit Single Event Effects
AD5544ARS	?	?	?	?	?	Can't find radiation data
AD625SD/883B	?	?	?	20	No	Co-60 source Total Dose Data from http://radhome.gsfc.nasa.gov/radhome/papers/G1002_AD625.pdf. No parametric degredation up to 20 krads(Si)
AD7664AST	?	?	LETth ~7; ~1.2E-3cm^2/device	20	Yes	This device will require extensive mitigation techniques in order to prevent DESTRUCTIVE effects caused by SEL. SEL data from http://radhome.gsfc.nasa.gov/radhome/papers/T120202_AD7664.pdf.
AD822ARM-R2	?	?	?	20	No	Co-60 source Total Dose Data from http://radhome.gsfc.nasa.gov/radhome/papers/G0902_AD822.pdf. No parametric degredation up to 20 krads(Si)
AD8005ART						Can't find radiation data

Radiation Data Found cont.

MIL P/N	HI SEU	P SEU	SEL	Total Dose (Krads(Si))	Destructive	Comments and Reference
AU5517D						Can't find radiation data
CA3080AT->AM ok, AS(discontinued)						Can't find radiation data
CA3280AS						Can't find radiation data
CMP04						Can't find radiation data
DG613AK/883						Can't find radiation data
EL2001CN						Can't find radiation data
HA7-5170-8						Can't find radiation data
LF411ACH						Can't find radiation data
~~JM38510/11703BXA~~						Can't find radiation data
~~JM38510/11903BXA, LM137H/883~~						Can't find radiation data
LM13700M						Can't find radiation data
LM3485						Can't find radiation data
N/A						Can't find radiation data
LMV762MMX						Can't find radiation data
LT1217CS8						Can't find radiation data
LT1352IS8						Can't find radiation data
LT1671CMS8						Can't find radiation data
LT1353IS						Can't find radiation data
LTC1604AIG			LETth > 65		No	SEL Data from 2002 IEEE NSREC Data Workshop, page 88.
LTC1609AISW						Can't find radiation data
LT1787HV						Can't find radiation data
LT1766						Can't find radiation data
LTC1604AIG						Can't find radiation data
LTC1877						Can't find radiation data

Known Radiation Data cont.

MIL P/N	HI SEU	P SEU	SEL	Total Dose (Krads(Si))	Destructive	Comments and Reference
MAX907ESA						Can't find radiation data
MAX991						Can't find radiation data
MIC4425AJPQ	LETth > 60	N/A	LETth > 60	?	?	Data from M. O'Bryan et al., 2000 IEEE NSREC Data Workshop for **MIC4423** (same process family), page 109. SEU and SEL are application specific
MMSD08256804S-C-1S						Can't find radiation data
OMR9808SF						Can't find radiation data
OP220AJ/883C					?	Can't find radiation data
OP482GP					?	Can't find radiation data
OP484FS	LETth ~5.6, = 3.4E-4 cm^2/Op-Amp	?	Immune	100	Yes (SEDR)	All data from ICI internal data (BSS proprietary document). Total Dose data from DSCC website, http://www.dscc.dla.mil/Downloads/MilSpec/Smd/00517.pdf
OP490AY	?	?	?	~15	No	Total Dose data from http://radhome.gsfc.nasa.gov/radhome/papers/tid/PPM-92-185.pdf
UC1526AJ/883B	?	?	?	?	No	PWMs with the soft start feature have a specifice kind of SEE on the soft-start mechanism where the outage on the output can last for many PWM clock cycles and possibly be detrimental to power supply operation.
2N3439JANTXV	N/A	N/A	N/A	N/A	No	Not known to exhibit measurable SEE
2N5416JANTXV	N/A	N/A	N/A	N/A	No	Not known to exhibit measurable SEE
MMBT3904LT1	N/A	N/A	N/A	N/A	No	Not known to exhibit measurable SEE
MMBT3906LT1	N/A	N/A	N/A	N/A	No	Not known to exhibit measurable SEE
MMBTH81LT1	N/A	N/A	N/A	N/A	No	Not known to exhibit measurable SEE
SD210DE-2	N/A	N/A	N/A	?	?	Destructive effects in power MOSFETs requires particular attention to a number of factors including the application VDS and VGS (off), as well as VDS, VGS, and LET failure threshold derived from the manufacturer specifications.

AD7664 Device

- AD7664 is an A/D, 16-Bit, 570 kSPS CMOS
- NASA data shows that the AD7664 have an SEL LET threshold of ~7 MeV/(mg/cm^2) with an SEL cross section of 1.2E-3 cm^2/device, and can withstand ~20 krads(Si) of total dose accumulation.
- This device may require SEL mitigation.
- Proton measurement is recommended.

LM193 Device

- The LM193 is Dual Comparator, Low Power, Low offset Voltage
- Published Data from Bogorad et al, 99NSREC Poster Paper PD-1 Preprint shows:
  - Heavy Ion SEU: LET_{th} = 8 MeV/(mg/cm^2), ó = 8.4E-3 cm^2/device
  - SEL: LET_{th} > 84 MeV/(mg/cm^2)
- Published data from JPL C.C. Yui et al, http://parts.jpl.nasa.gov/docs/REDW22.pdf shows:
  - Some limited low dose rate data out to 10 krad(Si) with no expected issues for THEMIS.

UC1526A Device

- UC1526A is a Regulating Pulse Width Modulator with Soft-Start feature
- Can't find radiation data on this device
- Our experience and published data on unitrode PWMs with the soft start feature capability have a specific kind of SEE on the soft-start mechanism where the outage on the output can last for many PWM clock cycles and possibly be detrimental to power supply operation.
  - Much longer duration; Could sag P/S output voltage out of tolerance
  - Duration depends on capacitance of SS pin and output voltage sag depends on nominal current loads
- We recommend that increased attention be paid to PWMs in all program circuit designs. Particular attention must be paid to the PWMs with soft-start capability to determine whether they have this extra circuitry that significantly increases their soft start SEU sensitivity.

A1020 Device

- A1020 is Radiation Hardened Actel FPGA
- Heavy Ion SEU Data from R. Koga et al, 94 SEE Symposium shows ~25 MeV/(cm^2/mg) with an upset of 1.0E-6 Upsets/(bit-day).
- Manufacturer data shows 300 krads(Si), SEL Immunity, and a tested single event upset (SEU) of 1.0E -6 Upsets/(bit-day)

OP484 Device

- The OP484 is an Precision Rail-to-Rail Input & Output Operational Amplifier
- Our In-house data shows
  - Heavy Ion SEU: LET_{th} ~5.6 MeV/(mg/cm_2), X-sec = 3.4E-4 cm^2/Op-Amp
  - Because of the low LET threshold this device is likely to exhibit transients from energetic protons depending on the application.
  - SEL Immune
  - The device exhibits Single Event Gate Rupture (SEDR): lower LET_{th} = 63 MeV/(mg/cm^2), Upper LET_{th} = 95 63 MeV/(mg/cm^2), X-sec =1.06E-6 cm^2/device
- Total Dose data from SMD#, 100 krads(Si)

SD210DE-2 Device

- The Vishay SD210E is an N-channel Lateral DMOS FET
- Can’t find data for this device
  - Destructive effects (SEGR/SEDR) in MOSFETs requires particular attention to a number of factors including the application VDS and VGS (off), as well as VDS, VGS, and LET failure threshold derived from SEE measurements.

MIC4425 Device

- The MIC4425 is a DUAL HIGH-POWER MOSFET DRIVER
- Published data for similar process (MIC4423), M. O'Bryan et al., 2000 IEEE NSREC Data Workshop, page 109 shows:
  - SEU and SEL LETth > 60 MeV/(cm^2/mg)
- Total Dose data not available

AD549 Device

- The AD549 OPAMP is an Ultralow Input Bias Current Operational Amplifier
- Limited data available on this device but
  - GSFC Project Component Engineering Monthly Report - April 2003 claims that the track record for the AD549 Op-Amp is not positive, the parts typically start failing at or below 5 krads(Si).
- The AD549 would require additional shielding if used or recommended alternative would be the Rad-Hard RH1056A from Linear Technology

Comparator Devices with No Rad Data

- Voltage Comparators
  - Comparator devices with No radiation data may exhibit Single Event Effects in the form of single event transients (SETs)
  - An SET event caused by Heavy Ion/Energetic Proton in a voltage comparator is a transient pulse at the device output.
  - The SET can have a rail-to-rail output change of state with duration up to a few microseconds.
  - In general the SET sensitivity of comparators is a function of the input differential voltage.
  - It has been observed that the lower the comparator differential input voltage, the higher the device sensitivity.

Op-Amp Devices with No Rad Data

- Operational Amplifiers (Op-Amps)
  - The Op-Amps with no radiation data may exhibit single event effects in the form of Single Event Dielectric Rupture (SEDR) and Single Event Transients (SET)
  - A SET in an operational amplifier produces an output transient glitch. A large variety of waveforms have been observed.
  - The output pulses can have many shapes including positive-going unipolar, negative-going unipolar, bipolar, and relatively short or even long duration.
  - The worst-case glitch can have an amplitude of the power supply rail and of duration of tens of microseconds.
  - Careful analysis of the potential destructive impact of a SET should be performed.