Compendium of Single-Event Effects Test Results for Candidate Electronics at NASA Johnson Space Center from 2023

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Abstract: We present single-event effect (SEE) test results and analysis produced by NASA JSC in 2023 for candidate electronic components and devices. Test environments include heavy ions or protons, depending on the intended use case regarding mission, environment, application, and lifetime.

Part Number	Manufacturer	LDC	Device Function	Technology / Process	Sample Size	Test Env.	Test Facility (Test Date)	Test Results (Configuration, Effects, Weibull Parameters, Remarks)
Integrated Circuits								
ADCS7476	Texas Instruments	-	ADC converter, 12 bit, 1 MSPS	Analog	10	HI	TAMU (Jun. 2023)	**ambient temperature:** No DSEE @ LET = 63.4 MeV-cm^2/mg (3E7 ions/cm^2 across 3 samples) NDSEE LET$_{th}$ < 19.7 MeV-cm^2/mg, self-recovering **elevated temperature (80 °C):** No DSEE @ LET = 46.8 MeV-cm^2/mg (3E7 ions/cm^2 across 3 samples) High-current events (x8) @ LET = 63.4 MeV-cm^2/mg (6.4E7 ions/cm^2 across 3 samples), nominal after power cycle
TLC2652AM	Texas Instruments	4CAB 1928B	Op-Amp	Analog	7	HI	TAMU (Aug. 2023)	V_{cc} = +/- 7.5V, V_{in} = 0.5V_{pp} @ 500 Hz, R_{load} = 10k Ω **ambient temperature:** No destructive nor non-recoverable SEE @ LET = 61.3 MeV-cm^2/mg (2.2E7 ions/cm^2 across 2 samples) SET LET$_{th}$ < 18.9 MeV-cm^2/mg, maximum Δt < 100 µs, typical ΔV ~100-200 mV, maximum ΔV ~ 700 mV **elevated temperature (~60 °C):** No destructive nor non-recoverable SEE @ LET = 61.3 MeV-cm^2/mg (5E7 ions/cm^2 across 3 samples) High-current state @ LET = 83.2 MeV-cm^2/mg (1.7E6 ions/cm^2 across 2 samples), nominal after power cycle
SN65HVD11-HT	Texas Instruments	01295-2040	3.3V Transceiver	Analog	4	HI	TAMU (Aug. 2023)	ambient temperature, V_{cc} = 3.3V, $Data_{in}$ = square wave [0, 3.3V] @ 38.4 kHz SET LET$_{th}$ < 18.9 MeV-cm^2/mg, maximum Δt ~ 20 µs, maximum ΔV = +/- V_{cc} No destructive nor non-recoverable SEE @ LET = 18.9 MeV-cm^2/mg (3.4E7 ions/cm^2 across 1 sample) Multiple high-current modes observed* @ LET = 44.8 MeV-cm^2/mg (8.1E7 ions/cm^2 across 2 samples), 61.3 MeV-cm^2/mg (4.2E7 ions/cm^2 across 3 samples)
TXB0108	Texas Instruments	-	Level shifters	Analog	10	HI	TAMU (Dec. 2023)	No DSEE @ LET = 79.6 MeV-cm^2/mg at 85 °C (8E7 ions/cm^2 across 3 samples) No NDSEE observed at @ LET = 32.5 MeV-cm^2/mg (4E8 ions/cm^2), NDSEE observed as data errors @ LET = 35 MeV-cm^2/mg (5E8 ions/cm^2)
COTS Storage & Memory								
2KK103-003 (Exos X16)	Seagate	DOM 11JUN2022	Hard drive	COTS	1	P	LLUMC (Jan. 2023)	Non-recoverable SEE @ 2.1E9 p+/cm^2
DC HC550	Western Digital	07JUN2022	Hard drive	COTS	2	P	LLUMC (Jan. 2023)	Non-recoverable SEE in 2 samples @: 7.0E8 p+/cm^2, 2.2E9 p+/cm^2
WD 181KRYZ GOLD 18TB	Western Digital	15SEP2021	Hard drive	COTS	1	P	LLUMC (Jan. 2023)	Non-recoverable SEE @ 2.3E8 p+/cm^2
ME25600 32GB	Nemix	-	RAM	COTS	2	P	LLUMC (Jan. 2023)	Non-recoverable SEE in 2 samples @: 2.0E8 p+/cm^2, 3.6E8 p+/cm^2
SDCQNRZ-2T00-1006	Western Digital	-	SSD	COTS	4	P	LLUMC (May. 2023)	Non-recoverable SEE in 3 samples @: 3.1E8 p+/cm^2, 4.8E8 p+/cm^2, 6.8E8 p+/cm^2 No non-recoverable SEE in 1 sample to 9.3E8 p+/cm^2
MZVL22T0HBLB-00BH7	Samsung	2022.06	SSD	COTS	4	P	LLUMC (May. 2023)	Non-recoverable SEE in 3 samples in 2.4E8 p+/cm^2 No non-recoverable SEE in 1 sample in 2.4E8 p+/cm^2
KXG8AZNV2T04	Kioxia	21JUN2022	SSD	COTS	4	P	LLUMC (May. 2023)	Non-recoverable SEE in 2 samples @: 2.18E8 p+/cm^2, 1.21E9 p+/cm^2 SEFI (x6) in 1.2E9 p+/cm^2
M426R4GA3BB0-CQK	Samsung	-	RAM	COTS	4	P	LLUMC (May. 2023)	Non-recoverable SEE in 1 sample in < 4.2E8 p+/cm^2 SEFI (x6) in 4.2E8 p+/cm^2
HMCG88MEBAA	Hynix	-	RAM	COTS	4	P	LLUMC (May. 2023)	SEFI (x5) in 3.1E8 p+/cm^2
Ironwolf 12TB 2PH103-500	Seagate	08DEC2022	HDD	COTS	2	P	LLUMC (Aug. 2023)	Non-recoverable SEE in 2 samples in > 4.6E9 p+/cm^2 SEFI (x2) in 5.9E9 p+/cm^2
10 TB WD101EFBX	Western Digital	03APR2023	HDD	COTS	1	P	LLUMC (Aug. 2023)	No non-recoverable SEE in 1E10 p+/cm^2 SEFI (x2) in 4.4E9 p+/cm^2
K4AAG085WA BCWE DDR4 DRAM	Samsung	-	RAM	COTS	2	P	LLUMC (Aug. 2023)	No non-recoverable SEE in 1E10 p+/cm^2 each SEFI (x4) in 6.6E8 p+/cm^2
K4AAG085WA DRAM	Samsung	-	RAM	COTS	Multiple	P	LLUMC (Aug. 2023)	No non-recoverable SEE in 1E10 p+/cm^2 each SEFI (x2) in 3.0E9 p+/cm^2
MX25U6432FM2I02	MXIC	-	Flash	COTS	1	P	LLUMC (Aug. 2023)	No non-recoverable SEE in 1E10 p+/cm^2 each SEFI (x3) in 5.2E9 p+/cm^2
Processors								
i7	Intel	-	CPU	COTS	2	P	LLUMC (May. 2023)	Non-recoverable SEE (dark screen) in 2 samples @: 1.5E9 p+/cm^2, 5.6E7 p+/cm^2
Xeon D-1622	Intel	-	CPU	COTS	1	P	LLUMC (Jan. 2023)	Non-recoverable SEE @ 7.4E9 p+/cm^2 SEFI (x4) in 2.2E9 p+/cm^2
Ryzen V1500B	AMD	-	CPU	COTS	1	P	LLUMC (Jan. 2023)	No SEE in 1E10 p+/cm^2
Xeon D-1527	Intel	-	CPU	COTS	1	P	LLUMC (Jan. 2023)	No Non-recoverable SEE in 1E10 p+/cm^2 SEFI (x4) in 1.3E9 p+/cm^2
Ryzen R1600	AMD	-	CPU	COTS	1	P	LLUMC (Aug. 2023)	No Non-recoverable SEE in 1E10 p+/cm^2 SEFI (x3) in 1E10 p+/cm^2
Miscellaneous								
BP-975	Canon	-	commercial lithium-ion battery pack	COTS	10	HI	NSRL (Jul. 2023)	**Bragg peak scanning at the CCA level with threshold LET of 37 MeV-cm^2/mg (18 steps, > 1E6 ions/cm^2/step):** No DSEE nor non-recoverable SEE observed Observed NDSEE (SET, SEFI as dropouts) with onset at 14.0 < LET$_{surface}$ < 17.2 MeV-cm^2/mg, recoverable with power-cycle. SET: Δt < 500ms, -ΔV < 4V
HP Server	Hewlett Packard	SN MXQ331080B MXQ331080C	Server	COTS	2	P	MGH (Sep. 2023)	Non-recoverable SEE in 2 samples @: 3.8E8 p+/cm^2, 1.7E8 p+/cm^2