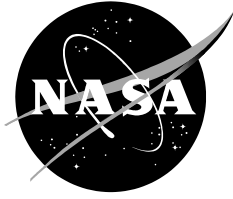


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Single-Event Effects Test Report Texas Instruments, OPA842 Low-Noise Operational Amplifier

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1. Introduction and Purpose

Testing was done to characterize the Texas Instruments Operational Amplifiers OPA842 single event effects (SEE) response. The primary SEE concerns for this device are single event latchup (SEL) and single event transients (SETs). Testing focused on determining susceptibility to SEL and characterizing the SET response. Testing occurred on November 11, 2022.

2. Device Description

The OPA842 is a wideband, low-distortion operational amplifier with differential inputs for wideband transimpedance and voltage amplifier applications. Three (3) parts were delidded and available for SEE testing. All specifications and descriptions are according to the datasheet. More information can be found in Table 1.

Table I. Part description

Part Number	OPA842
Manufacturer	Texas Instruments
Quantity Tested	3
Part Function	Wideband Operational Amplifier
Part Technology	CMOS
Package	SOIC

3. Test Setup

Table II. Pinout guide for OPA842

Pinout	Function
1	No connection
2	Inverting input
3	Noninverting input
4	$-V_s$
5	No connection
6	Output
7	$+V_s$
8	No connection

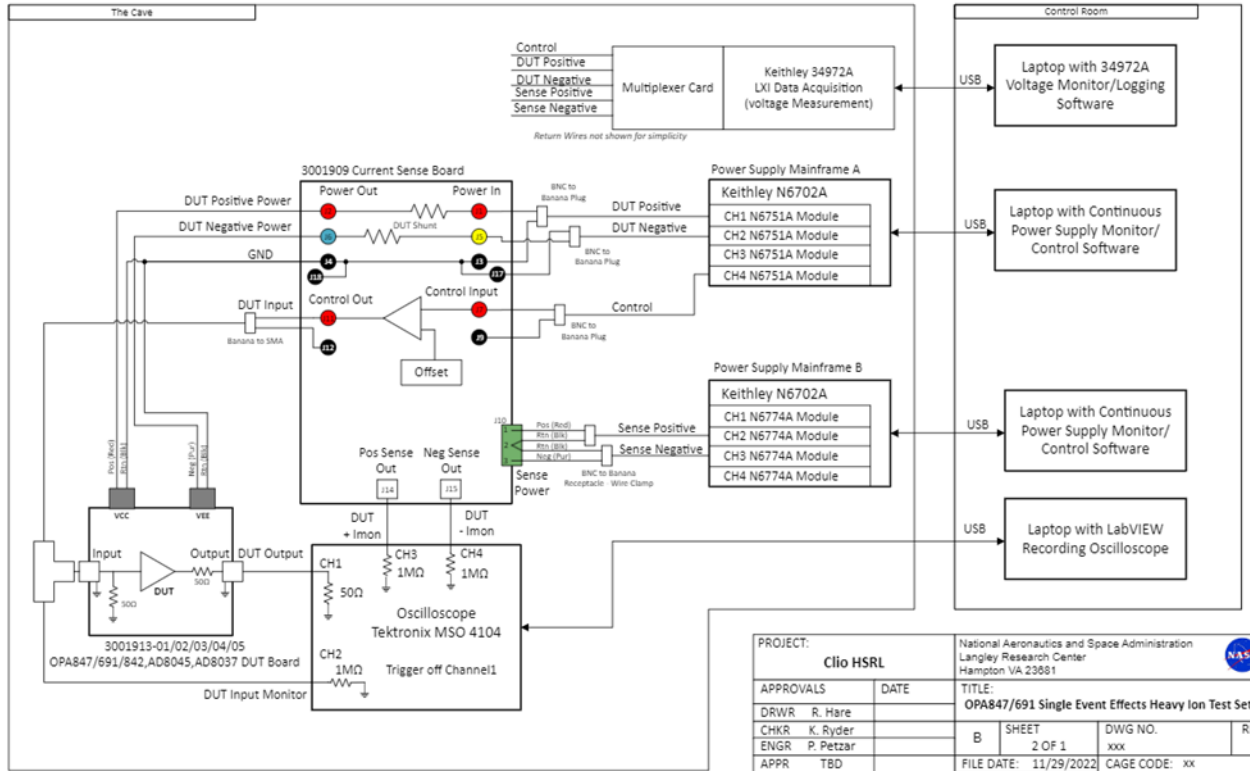


Figure 1. Test setup for the OPA842.

4. Test Facility

Facility:	Lawrence Berkeley Nation Laboratory's 88" Cyclotron facility
Type of Radiation:	Heavy ions
Facility Configuration:	16 MeV/amu tune
Flux:	Varied between 1.06×10^5 and $1.10 \times 10^5 \text{ cm}^{-2} \cdot \text{s}^{-1}$
Fluence:	A total effective fluence of $1 \times 10^7 \text{ cm}^{-2}$ was achieved for each DUT to screen for destructive SEL.
Beams / LET:	Ag was used during testing at 45° . This provided an LET of $69.9 \text{ MeV} \cdot \text{cm}^2/\text{mg}$.

5. Test Conditions

Temperature:	40 °C, 65 °C, 67 °C, 92 °C
In-Air or Vacuum:	In-air
Supply Voltage:	$\pm 5.0 \text{ V}$
Input Voltage	+1.25 V

6. Test Methods

The operational amplifier was powered with a nominal supply voltage of ± 5 V and an input voltage of +1.25 V. The nominal supply current during testing was 60 mA and was monitored during testing for SEL. The amplifier's output voltage was monitored for SETs using an oscilloscope, which saved the waveforms of any observed SET. Elevated temperatures were used during SEL testing. If SEEs were observed, they were counted and recorded in the run log.

6.1. Single-Event Transients

SETs in the operational amplifier manifest as self-recovering changes in the output voltage. SETs can be either positive-going, negative-going, or have more complex features, and can be as large as the rail-to-rail voltage. The oscilloscope was used to observe and count all SETs with an amplitude above the nominal noise floor were observed. The counts were recorded in the run log and waveforms were captured by the oscilloscope.

6.2. Single-Event Latchup

SEL occurs when the supply current instantaneously increases to the compliance current set on the power supplies and is sustained until power is cycled. If SEL occurred the run was ended, and the operational amplifier was power cycled. SEL count was recorded in the run log.

7. Test Procedure

Testing was completed to an effective fluence of at least 1×10^7 cm⁻² at an LET of 69.9 MeV·cm²/mg to screen for SEL. SETs were observed and captured during these runs.

8. Data Requirements

The counts for SET and SEL were recorded by on-site personnel during testing and stored in the run log. Supply current was monitored and recorded by the power supplies and the oscilloscope captured any SETs. Relevant facility data (e.g., flux, fluence, LET, ion, air gap, angle, electrical setup) was recorded in real time and stored in the run log.

9. Equipment List

Table III. Equipment List

Manufacturer and P/N	Function	S/N or ECN
Agilent N6702A	Power supply	M161871
Agilent N6702A0	Power supply	M163374
Tektronix MSO5104	Oscilloscope	B010131

10. Run Log

Table IV. Run Log

Run #	Ion	Surface LET (MeV·cm ² /mg)	Temp (°C)	Air Gap (cm)	Angle (°)	Eff. LET (MeV·cm ² /mg)	Avg. Flux (cm ⁻² ·s ⁻¹)	Fluence (cm ⁻²)	Eff. Fluence (cm ⁻²)
28	Ag	39.17	40	5.715	45	69.9	1.1E+05	1.4E+07	1.0E+07
29	Ag	39.17	65	5.715	45	69.9	1.06E+05	1.4E+07	1.6E+06
30	Ag	39.17	67	5.715	45	69.9	1.10E+05	1.4E+07	1.0E+07

11. Results

11.1. Single-Event Latchup

SEL was not observed during testing at any of the test conditions, including elevated temperature and an LET of 69.9 MeV·cm²/mg up to an effective fluence of 1.0×10⁷ cm⁻².

11.2. Single-Event Transients

SETs were observed in the operational amplifier. All test conditions resulted in SET cross-sections of ~5.2e-5 cm². Amplitudes were less than rail-to-rail, with extremes of roughly V_{out}±1.75 V. Maximum duration of all SET was at or less than 0.1 μs. Figures 2 – 4 provide examples of SETs with peak positive amplitudes, negative amplitudes, and durations, respectively.

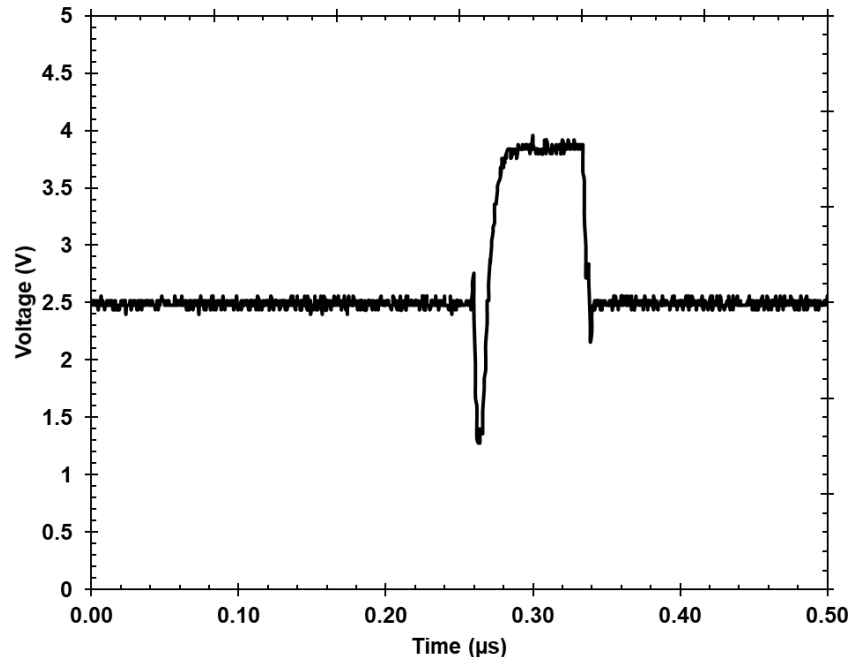


Figure 2. Example of a bipolar SET with the maximum observed positive amplitude.

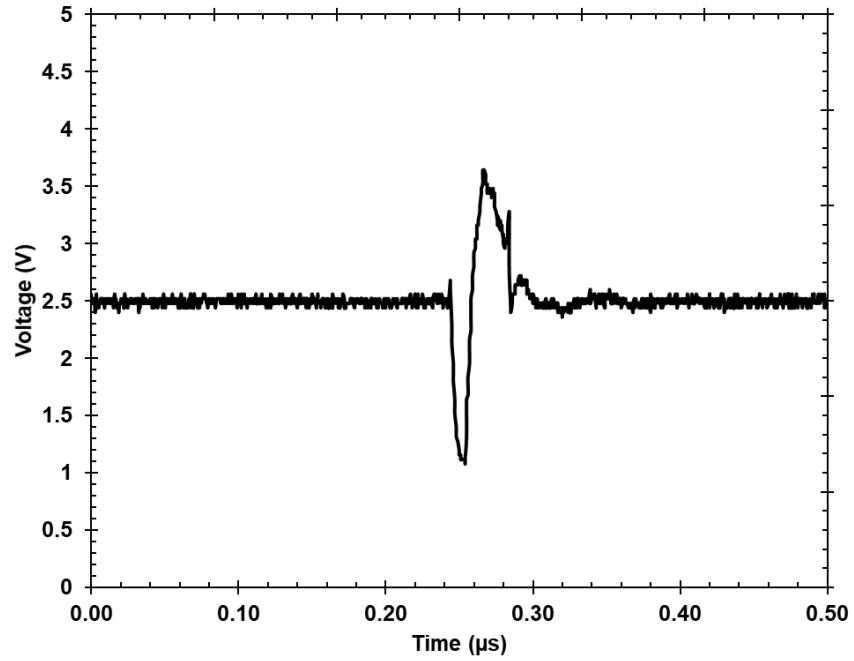


Figure 3. Example of a bipolar SET with the maximum observed negative amplitude.

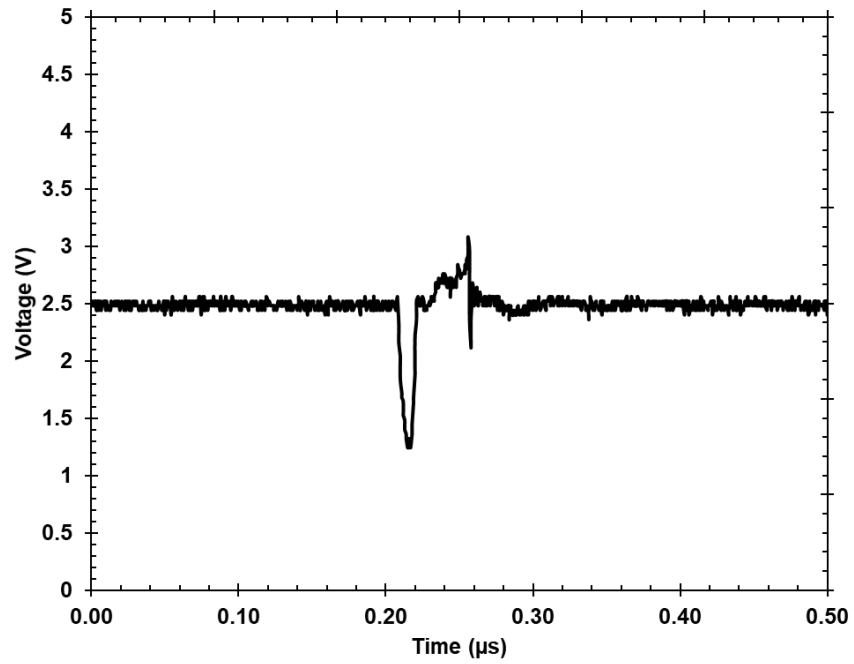


Figure 4. Example of a bipolar SET with the maximum observed duration.

