Radiation Report

Single-Event-Effects Test Report of the TPS7H2201-SEP eFuse

ABSTRACT

The purpose of this study is to characterize the Single-Event-Effects (SEE) performance due to heavy-ion irradiation of the TPS7H2201-SEP. Heavy-ions with LET_{EFF} (Effective Linear Energy Transfer) of 48 MeV·cm^2/mg were used to irradiate 5 devices. A flux of ≈ 10^5 ions/(cm^2·s) and fluence of ≈ 10^7 ions/cm^2 per run were used for the characterization. The results demonstrated that the TPS7H2201-SEP is Single Event Latch-Up, Single-Event-Burnout/Single-Event-Gate-Rupture (EN = High)-free at T = 125°C and 25°C, respectively, using ^{109}Ag across the full electrical specifications. The device is Single-Event-Burnout/Single-Event-Gate-Rupture (EN = Low)-free up to V_{IN} = 7V. Not a single Transient was observed from V_{IN} of 1.5 to 7 V at LEF_{EFF} ≤ 48 MeV·cm^2/mg. Refer to the SET section for more details.

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1 Introduction

The TPS7H2201-SEP is a radiation-tolerant, 1.5-V to 7-V input, 6-A, single channel eFuse. The device provides reverse current protection, overvoltage protection, and a configurable rise time. The device contains a P-channel MOSFET which operates over the full input range and supports the maximum 6-A of continuous current. The switch is controlled through the active-high Enable (EN) input pin, which is capable of interfacing directly with low-voltage control signals.

The device is offered in a 32-pin plastic package (HTSSOP). Table 1-1 lists general device information and test conditions. For more detailed technical specifications, user's guides, and application notes, please go to the TPS7H2201-SEP product page.

Table 1-1. Overview Information

Description(1)	Device Information
TI part number	TPS7H2201-SEP
Orderable number	TPS7H2201MDAPTSEP
Device function	eFuse
Technology	250-nm linear BiCMOS 7 (LBC7)
Exposure facility	Radiation Effects Facility, Cyclotron Institute, Texas A&M University (15 MeV/nucleon)
Heavy ion fluence per run	≈ 1×10^7 ions/cm^2
Irradiation temperature	25°C (for SEB testing), 25°C (for SET testing), and 125°C (for SEL testing)

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2 Single-Event Effects

The primary concern of interest for the TPS7H2201-SEP is the robustness against the Destructive Single-Event Effects (DSEE) named as:

- Single-Event Latch-up (SEL)
- Single-Event Burn-out (SEB)
- Single-Event Gate Rupture (SEGR)

In mixed technologies, such as the Linear BiCMOS 7 process used on the TPS7H2201-SEP, the CMOS circuitry introduces a potential for SEL susceptibility. SEL can occur if excess current injection caused by the passage of an energetic ion is high enough to trigger the formation of a parasitic cross-coupled PNP and NPN bipolar structure (formed between the p-sub and n-well and n+ and p+ contacts) [1, 2]. The parasitic bipolar structure initiated by a single-event creates a high-conductance path (inducing a steady-state current that is typically orders-of-magnitude higher than the normal operating current). This current between power and ground persists or is *latched* until power is removed, the device is reset, or until the device is destroyed by the high-current state. The TPS7H2201-SEP was tested for SEL at the maximum recommended voltage of 7 V and maximum load current of 6 A. The device exhibits no-SEL with heavy-ions of LET_{EFF} = 48 MeV·cm^2/mg at Flux ≈ 10^5 ions/cm^2·s, fluences of ≈ 10^7 ions/cm^2, and a die temperature of 125°C, using ^{109}Ag.

DMOS are susceptible to SEB/SEGR while in the off state. However, the device was also evaluated on all possible cases (Enable and Disable). SEB is similar to the SEL and occurs when the parasitic BJT of the DMOSFET is turned on by the heavy ion strike. When a heavy ion with sufficient energy hits the p body, it creates an excess charge inducing a voltage drop. This voltage drop forward biases the emitter-base junction of the parasitic NPN (formed by the N+ source, the P base region, and the N-drift region). If this happens when the DMOSFET is under a high drain bias, a secondary breakdown of the parasitic npn BJT can occur, creating permanent damage of the DMOS.

When the heavy-ion hits the neck region of the DMOS (under the gate), it creates electron hole-pairs on the oxide and silicon. Drift separates the excess electrons and holes due to the positive bias field on the drain to source of the DMOS. Holes are driven upward to the dioxide while the electrons are transported toward the drain. The collected holes on the dioxide create an equal image of electrons on the opposite side of the gate dioxide. Since the charge injection and collection after an event is faster than the transport and recombination of the e-h pairs, a voltage transient can be developed across the gate oxide. If this build-up voltage is higher than the oxide breakdown, permanent damage can be induced on the oxide, creating a destructive gate rupture [3, 4]. The TPS7H2201-SEP was evaluated for SEB and SEGR at full load conditions (6 A), enabled/disabled modes and LET_{EFF} of 48 MeV·cm^2/mg using ^{109}Ag (at angle of incidence of 0°). A flux of ≈10^5 ions/cm^2·s, fluence of ≈10^7 ions/cm^2, and a die temperature of ≈ 25°C per run was used during the SEB/SEGR characterization. The device is SEB and SEGR-free up to 7 V when using ^{109}Ag (under enabled and disabled mode).

The TPS7H2201-SEP was characterized for SET at flux of ≈ 10^5 ions/cm^2·s, fluences of ≈ 10^7ions/cm^2, and room temperature. The device was characterized at input voltages ranging from 1.5 V (minimum recommended voltage) to 7 V (maximum recommended voltage), at I_{LOAD} of 6 A and under no-load conditions. The TPS7H2201-SP is SET-free at full V_{IN} range. For more details, see the *Single-Event Transients (SET) and Fast Trip Short Test* section.

3 Device and Test Board Information

The TPS7H2201-SEP is packaged in a 32-pin (HTSSOP) plastic package as shown in Figure 3-1.
A TPS7H2201EVM evaluation board was used to evaluate the performance and characteristics of the TPS7H2201-SEP under heavy-ions.

Figure 3-2 shows the top view of the evaluation board used for the radiation testing. Figure 3-3 shows the EVM board schematics for dual site testing. For more information about the evaluation board, see the *TPS7H2201-SEP Evaluation Module User's Guide*.

The package was delidded to reveal the die face for all heavy-ion testing.

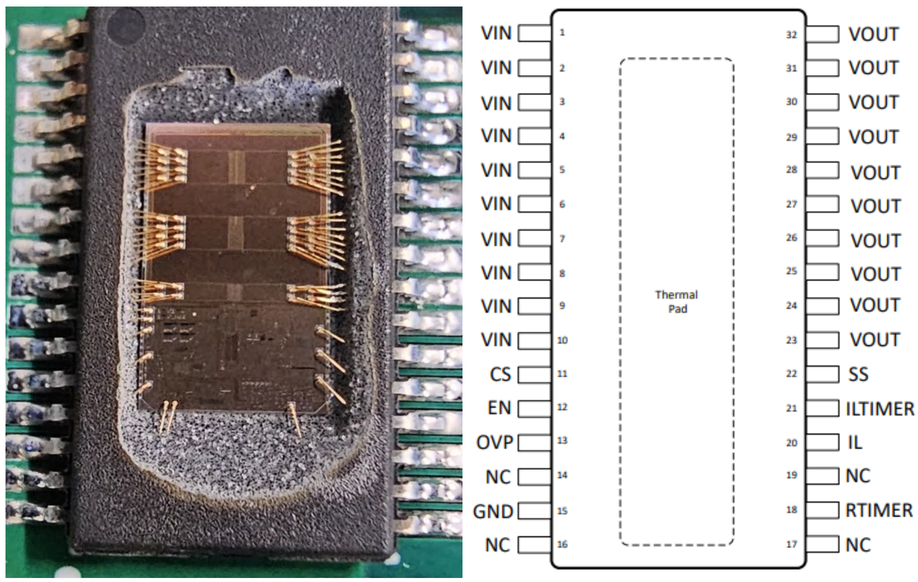

Figure 3-1. Photograph of Delidded TPS7H2201-SEP (Left) and Pin Out Diagram (Right)

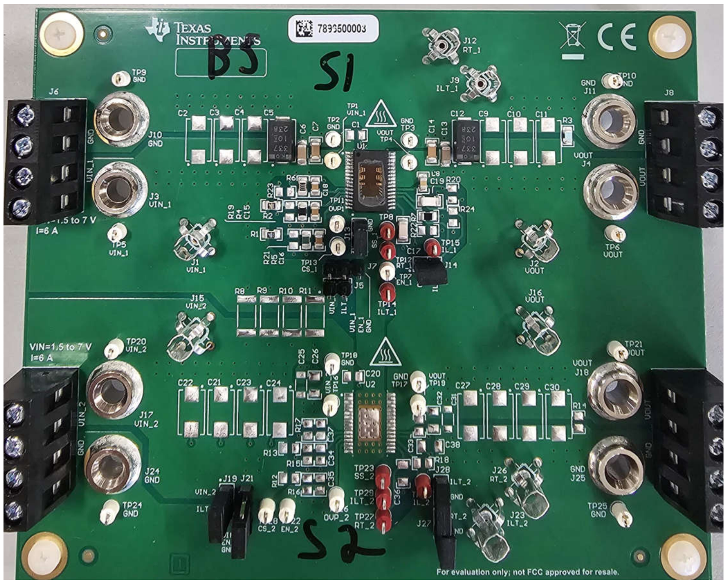

Figure 3-2. TPS7H2201-SEP Board Top View

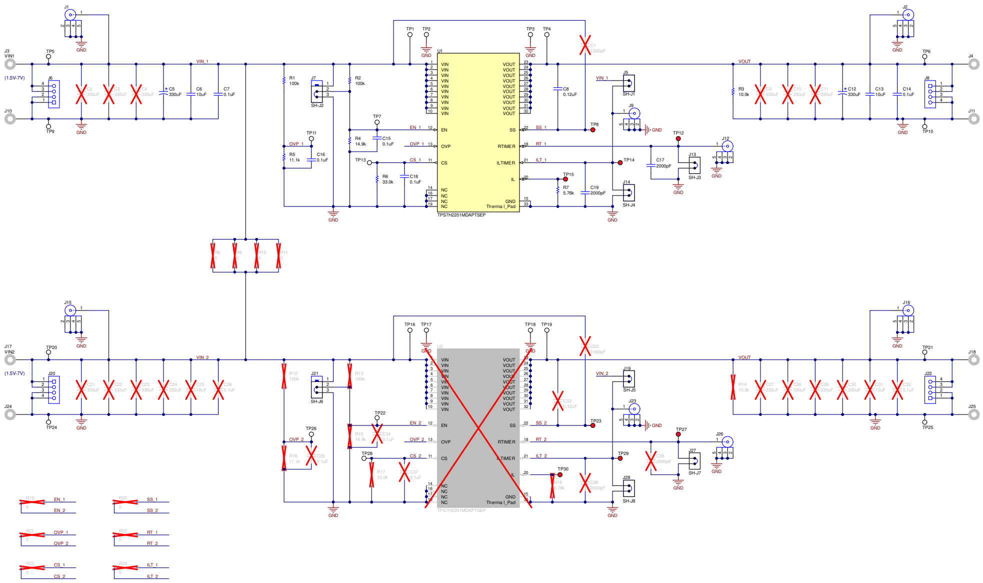

Figure 3-3. TPS7H2201-SP EVM Schematic

4 Irradiation Facility and Setup

The heavy-ion species used for the SEE studies on this product were provided and delivered by the TAMU Cyclotron Radiation Effects Facility using a superconducting cyclotron and an advanced Electron Cyclotron Resonance (ECR) ion source. At the fluxes used, ^{109}Ag had good flux stability and high irradiation uniformity over a 1-in diameter circular cross-sectional area for the in-air station. Uniformity is achieved by magnetic de-focusing. The flux of the beam is regulated over a broad range spanning several orders of magnitude. For the bulk of these studies, ion flux of ≈ 10^5 ions/cm^2·s were used to provide heavy-ion fluences of ≈ 10^7 ions/cm^2 per run.

Figure 4-1 shows the TPS7H2201-SEP test board used for the experiments at the TAMU facility. Although not visible in this photo, the beam port has a 1-mil Aramica window to allow in-air testing while maintaining the vacuum within the accelerator with only minor ion energy loss. An in-air gap of 40-mm between the device and the ion beam port window was maintained at these distances for all runs respective to the ion that was tested.

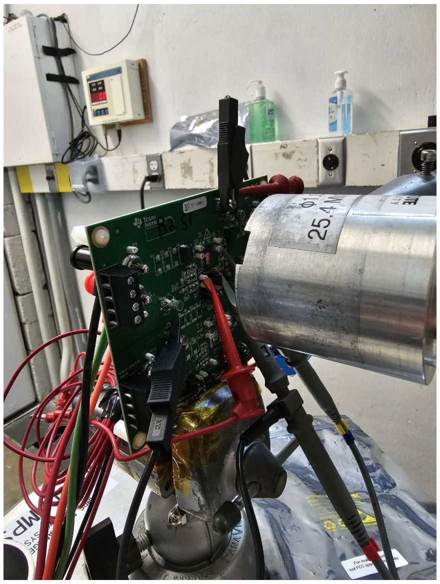

Figure 4-1. Photograph of the TPS7H2201-SEP Evaluation Board Mounted in Front of the Heavy-Ion Beam Exit Port at the Texas A&M Cyclotron

5 Depth, Range, and LET_{EFF} Calculation

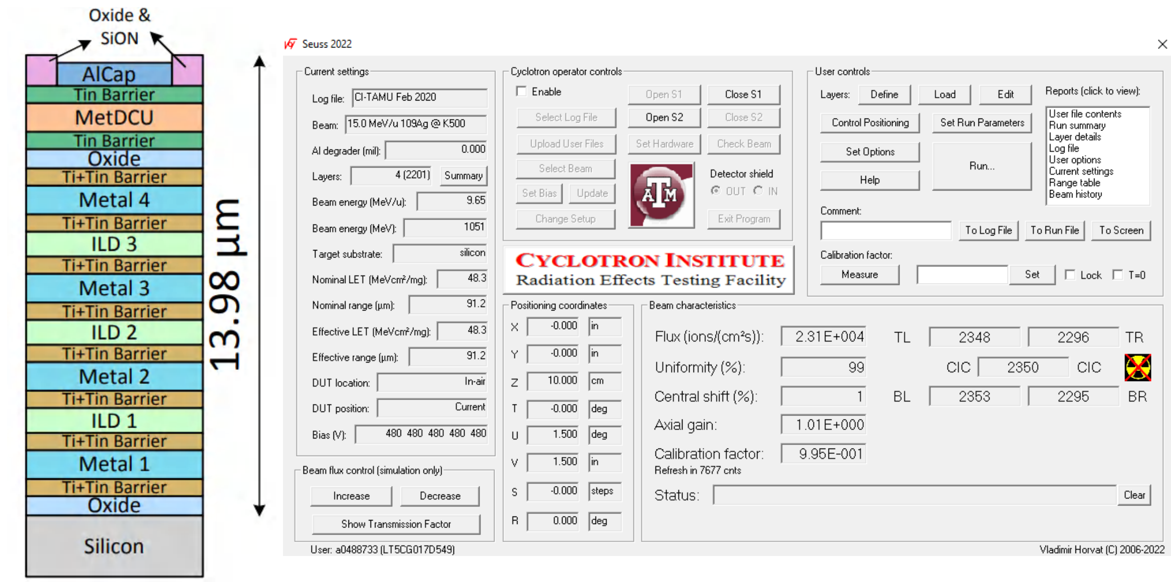

Figure 5-1. Generalized Cross-Section of the LBC7 Technology BEOL Stack on the TPS7H2201-SEP (Left) and SEUSS 2022 Application Used to Determine Key Ion Parameters (Right)

The TPS7H2201-SEP is fabricated in the TI Linear BiCMOS 7 (LBC7, 250-nm process with a Back-End-Of-Line (BEOL) stack consisting of four levels of standard thickness aluminum metal. The total stack height from the surface of the passivation to the silicon surface is 13.5 µm based on nominal layer thickness as shown in Figure 5-1. Accounting for energy loss through the 1-mil thick Aramica beam port window, the 40-mm air gap and the BEOL stack over the TPS7H2201-SEP, the effective LET (LET_{EFF}) at the surface of the silicon substrate, the depth, and the ion range was determined with the SEUSS 2020 Software (provided by the Texas A&M Cyclotron Institute and based on the latest SRIM-2013 (7) models). Table 5-1 lists the results. The stack was modeled as a homogeneous layer of silicon dioxide (valid since SiO_2 and aluminum density are similar).

Table 5-1. Praseodymium and Homium Ion LET_{EFF} Depth and Range in Silicon

Ion Type	Angle of Incidence (°)	$Range_{EFF}$ in Silicon (µm)	LET_{EFF} (MeV·cm²/mg)
^{109}Ag	0	91.2	48.3

6 Test Setup and Procedures

SEE testing was performed on a TPS7H2201-SEP device mounted on a TPS7H2201EVM. The device power was provided by using the J3 (VIN-1) and J10 (GND) inputs with the N6765A precision power supply in a 4-wire configuration mounted on a N6705 rack. A Chroma E-Load (Electronic Load) in the Constant-Resistance (CR) mode was used to load the device to 6 A for the SEE testing campaign.

For the SEL and SEB/SEGR, the device was powered up to the maximum recommended operating voltage of 7 V and loaded with the maximum load of 6 A. For the SEB/SEGR characterization, the device was tested under enabled and disabled modes. The device was disabled by using the TP 7, connecting EN to GND. The E-Load was connected even when the device was disabled to help differentiate if an SET momentarily activated the device under the heavy-ion irradiation. During the SEB/SEGR testing with the device enabled, not a single input current event was observed.

For the SET characterization, the TPS7H2201-SEP was evaluated at input voltages ranging from 1.5 V (minimum recommended voltage) to 7 V (maximum recommended voltage), at I_{LOAD} of 6 A and under no-load conditions. The SET events were monitored using two National Instruments™ (NI) PXIe-5172 scope card. The first 5172 scope was used to monitored and trigger from V_{OUT} using a window trigger around ±3% from the nominal output voltage. The second 5172 scope was used to monitor and trigger from the Soft-Start (SS) at 4 V, using a edge and positive trigger. Both scopes were mounted on a NI PXIe-1095 chassis. During SET testing, no V_{OUT} or SS transients or SS SETs were observed.

All equipment was controlled and monitored using a custom-developed LabVIEW™ program (PXI-RadTest) running on a HP-Z4™ desktop computer. The computer communicates with the PXI chassis via an MXI-Express cable and a NI PXIe-8381 remote control module. Figure 6-1 shows a block diagram of the setup used for SEE testing of the TPS7H2201-SEP. Table 6-1 shows the connections, limits, and compliance values used during the testing. A die temperature of 125°C was used for SEL. During the SEL testing the device was heated to 125°C by using a Closed-Loop PID controlled heat gun (MISTRAL 6 System (120V, 2400W)). For the SEB/SEGR testing, the device was tested at room temperature ≈ 25°C. For SET testing, the device was tested at room temperature (no cooling or heating was applied to the DUT). The die temperature was monitored prior to radiation using a FLIR thermal camera.

Table 6-1. Equipment Set and Parameters Used for SEE Testing the TPS7H2201-SEP

Pin Name	Equipment Used	Capability	Compliance	Range of Values Used
VIN	Agilent N6766A PS (Channel #1)	50 A	10 A	1.5 to 7 V
EN	E36311A	—	0.1 A	1.5 to 5 V
Oscilloscope Card on SS	NI-PXIe 5172	100 MS/s	—	5 MS/s
Oscilloscope Card on V_{OUT}	NI-PXIe 5172	100 MS/s	—	5 MS/s

All boards used for SEE testing were fully checked for functionality. Dry runs were also performed to make sure that the test system was stable under all bias and load conditions prior to being taken to the TAMU facility. During the heavy-ion testing, the LabVIEW control program powered up the TPS7H2201-SEP device and set the external sourcing and monitoring functions of the external equipment. After functionality and stability had been confirmed, the beam shutter was opened to expose the device to the heavy-ion beam. The shutter remained open until the target fluence was achieved (determined by external detectors and counters). During irradiation, the NI scope cards continuously monitored the signals. When the output voltage exceeds the pre-defined ±3% window trigger, or when the PG signal changed from high to low (using a negative edge trigger), a data capture was initiated. In addition to monitoring the voltage levels of the two scopes, VIN current and the 5-V (beam on and off) signal from TAMU were monitored at all times. No sudden increases in current were observed (outside of normal fluctuations) on any of the test runs and indicated that no SEL events occurred during any of the tests.

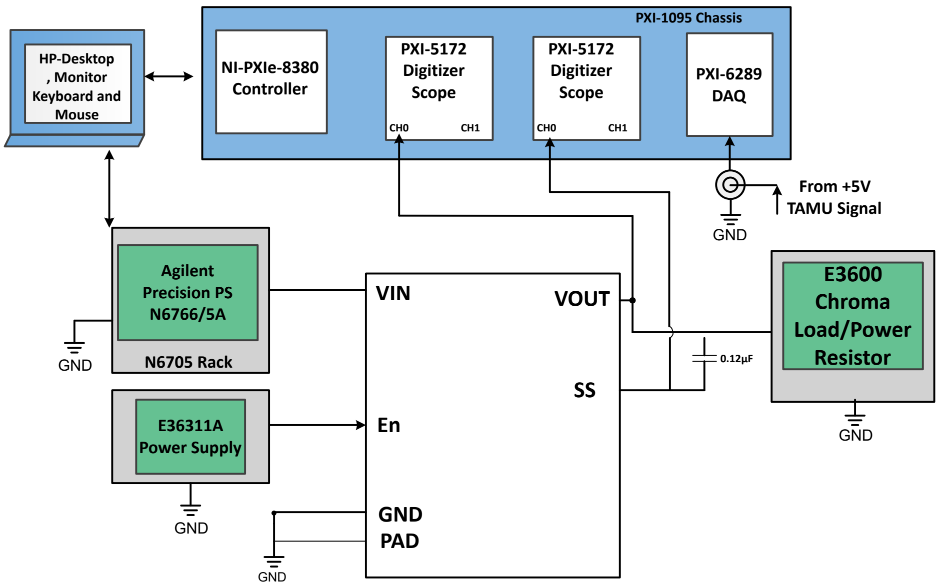

Figure 6-1. Block Diagram of SEE Test Setup With the TPS7H2201-SEP

7 Destructive Single-Event Effects (DSEE)

7.1 Single-Event Latch-Up (SEL) Results

During SEL characterization, the device was heated using forced hot air, maintaining the DUT temperature at 125°C. The die temperature was monitored prior to radiation using a FLIR IR-camera.

The species used for the SEL testing was Silver (^{109}Ag) ion with an angle-of-incedence of 0° for an LET_{EFF} = 48 MeV·cm^2/mg (for more details, see *Depth, Range, and LET EFF Calculation*). The kinetic energy in the vacuum is 1.634 GeV (15-MeV/amu line). Flux of approximately 10^5 ions/cm^2·s and a fluence of approximately 10^7 ions/cm^2 were used for the three runs. Run duration to achieve this fluence was approximately 2 minutes (per 1 × 10^7 ions·cm^2). The three devices were powered up and exposed to the heavy-ions using the maximum recommended voltage of 7 V and maximum load of 6 A. No SEL events were observed during all three runs, indicating that the TPS7H2201-SEP is SEL-free. Table 7-1 shows the SEL test conditions and results. Figure 7-1 shows a typical plot of current versus time for an SEL testing.

Table 7-1. Summary of TPS7H2201-SEP SEL Test Condition and Results

For all runs, the device was loaded with a ≈ 6 amps load.

Run Number	Unit Number	Ion	LET_{EFF} (MeV·cm^2/mg)	Flux (ions·cm^2/s)	Fluence (ions·cm^2)	V_{IN} (V)
1	1	^{109}Ag	48	1.02 × 10^5	1.00 × 10^7	7
2	2	^{109}Ag	48	8.60 × 10^4	1.00 × 10^7	7
3	3	^{109}Ag	48	1.08 × 10^5	1.00 × 10^7	7

Using the MFTF method described in SLVK047 and combining (or summing) the fluences of the eight runs at 125°C (3.00 × 10^7 ions·cm2), the upper-bound cross-section (using a 95% confidence level) is calculated as:

$$\sigma_{SEL} \leq 1.22\ x\ 10^{-7} \frac{cm^2}{device} for\ LET_{EFF} = 48\ MeV \cdot \frac{cm^2}{mg} and\ T = 125°C \quad (1)$$

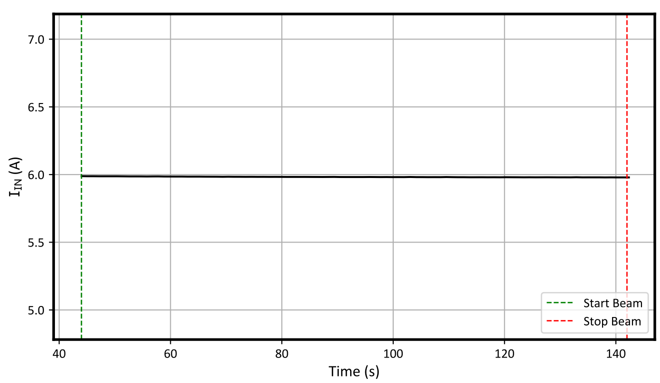

Figure 7-1. Current vs Time for Run # 1 of the TPS7H2201-SEP at T = 125°C

7.2 Single-Event Burnout (SEB) and Single-Event Gate Rupture (SEGR) Results

During the SEB/SEGR characterization, the device was tested at room temperature ≈ 25°C. The die temperature was verified using a FLIR IR-camera.

The species used for the SEB testing was Silver (^{109}Ag) ion with an angle-of-incedence of 0° for an LET_{EFF} = 48 MeV·cm^2/mg (for more details, see *Depth, Range, and LET EFF Calculation*). The kinetic energy in the vacuum is 1.634 GeV (15-MeV/amu line). Flux of approximately 10^5 ions/cm^2·s and a fluence of approximately 10^7 ions/cm^2 were used for the three runs. Run duration to achieve this fluence was approximately two minutes (per 1 × 10^7 ions·cm^2). The TPS7H2201-SEP was tested under enabled and disabled modes. The device was disabled by forcing 0 V on the EN pin with a E36311A power supply. The E-Load was connected, even when the device was disabled, to help differentiate if an SET momentarily activated the device under the heavy-ion irradiation. During SEB/SEGR testing using the ^{109}Ag ion with the device *disabled/enabled* no V_{OUT} transient or input current event was observed. This indicates that the TPS7H2201-SEP is SEB/SEGR free, up to LET_{EFF} = 48 MeV·cm^2/mg.Table 7-2 lists the SEB test conditions and results. .Figure 7-2 shows a plot of the current vs time for run # 4 (enabled) and Figure 7-3 for run #5 (disabled).

Table 7-2. Summary of TPS7H2201-SEP SEB/SEGR Test Condition and Results

For all runs the device was enabled and loaded with ≈ 6 amps. *During all runs not a single device was damaged.*

Run Number	Unit Number	Ion	LET_{EFF} (MeV·cm^2/mg)	Flux (ions·cm^2/s)	Fluence (ions·cm^2)	V_{IN} (V)	EN
4	1	^{109}Ag	48	4.78 × 10^4	1.00 × 10^7	7	Yes
5	1	^{109}Ag	48	3.75 × 10^4	1.00 × 10^7	7	No
6	2	^{109}Ag	48	1.20 × 10^5	1.00 × 10^7	7	Yes
7	2	^{109}Ag	48	1.20 × 10^5	1.00 × 10^7	7	No
8	3	^{109}Ag	48	1.20 × 10^5	1.00 × 10^7	7	Yes
9	3	^{109}Ag	48	1.20 × 10^5	9.96 × 10^6	7	No

Using the MFTF method described in SLVK047 and combining (or summing) the fluences of the runs with the same categories as described on the columns the SEB/SEGR upper-bound cross-section (using a 95% confidence level) is calculated as:

$$\sigma_{SEB} \leq 6.19\,x\,10^{-8} \frac{cm^2}{device} for\ LET_{EFF} = 48\ MeV \cdot \frac{cm^2}{mg} and\ T = 25°C \quad (2)$$

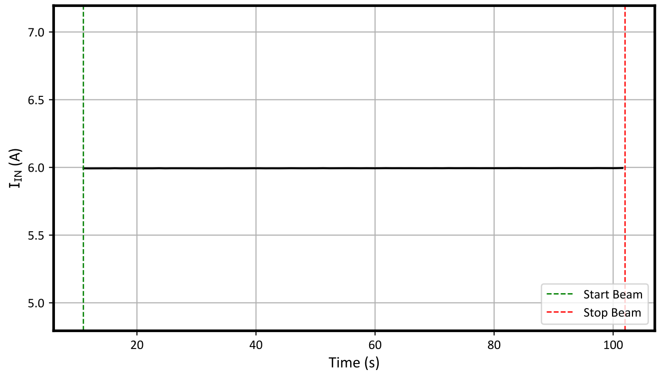

Figure 7-2. Current vs Time for Run # 4 (Enabled) for the TPS7H2201-SEP at T = 25°C

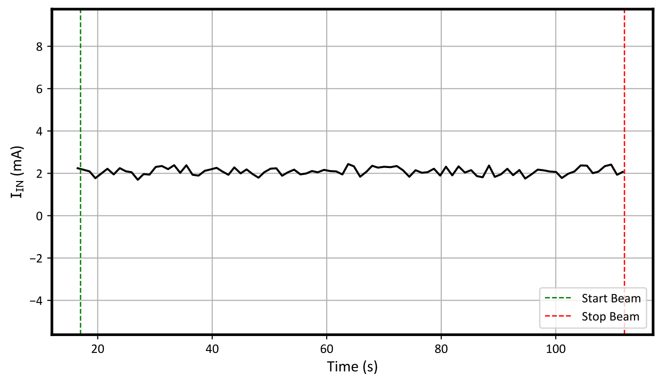

Figure 7-3. Current vs Time for Run # 5 (Disabled) for the TPS7H2201-SEP at T = 25°C

8 Single-Event Transients (SET)

8.1 Single Event Transients

SETs are defined as heavy-ion-induced transients upsets on the V_{OUT} and the Soft-Start (SS) flag of the TPS7H2211-SP. SET testing was performed at room temperature (no external temperature control applied). The species used for the SET testing was Silver (^{109}Ag) ion with an angle-of-incidence of 0° for an LET_{EFF} = 48 MeV·cm^2/mg respectively, for more details, refer to *Depth, Range, and LET_{EFF} Calculation*. Flux of approximately 10^5 ions/cm^2·s and a fluence of approximately 10^7 ions/cm^2 were used for the 12 SET runs.

V_{OUT} SETs were characterized using a window trigger of ±3% around the nominal output voltage (≈ 1.5 V to 7 V). The devices were characterized with input voltages ranging from V_{IN} = 1.5 V (minimum) to V_{IN} = 7 V (maximum). The output load was set to 0 or 6 Amps for each run by using a Chroma Load on Constant-Resistance (CR) mode. To capture the SET's two NI-PXI-5172 continuously monitoring the V_{OUT} and the SS were used, respectively. Each scope was operated independently. The output voltage was monitored by using the TP6 and the TP10 test points on the EVM, while the SS was monitored using the TP8 test point.

The scope triggering from V_{OUT} was programmed to record 20 k samples with a sample rate of 5-M samples per second (S/s) in case of a event (trigger). The scope triggering from SS was programmed with 30 ks and 5 MS/s. Both scopes were programmed to record 20% of the data before (pre) the trigger happen.

Not a single upset on V_{OUT} or SS was observed. Table 8-1 lisrs the SET test condition and results for all of the data.

Table 8-1. Summary of TPS7H2201-SEP SET Test Condition and Results

Run Number	Unit Number	Ion	LET_{EFF} (MeV.cm^2/mg)	Flux (ions·cm^2/s)	Fluence (ions·cm^2)	V_{IN} (V)	Enabled	$VOUT_{SET \geq \|3\%\|}$	SS_{SET} at 25 °C	Load Type (Chroma)	Load Value
10	4	^{109}Ag	48	1.15 × 10^5	1.00 × 10^7	7	Yes	0	0	CR	3.5
11	4	^{109}Ag	48	9.17 × 10^4	1.00 × 10^7	7	Yes	0	0	N/A	0
12	4	^{109}Ag	48	9.89 × 10^4	1.00 × 10^7	5	Yes	0	0	CR	3.5
13	4	^{109}Ag	48	9.97 × 10^4	1.00 × 10^7	5	Yes	0	0	N/A	0
14	4	^{109}Ag	48	8.66 × 10^4	1.00 × 10^7	1.5	Yes	0	0	CR	3.5
15	4	^{109}Ag	48	7.96 × 10^4	1.00 × 10^7	1.5	Yes	0	0	N/A	0
16	5	^{109}Ag	48	8.60 × 10^4	1.01 × 10^7	7	Yes	0	0	CR	3.5
17	5	^{109}Ag	48	8.94 × 10^4	1.00 × 10^7	7	Yes	0	0	N/A	0
18	5	^{109}Ag	48	9.18 × 10^4	1.00 × 10^7	5	Yes	0	0	CR	3.5
19	5	^{109}Ag	48	9.28 × 10^4	1.00 × 10^7	5	Yes	0	0	N/A	0
20	5	^{109}Ag	48	8.84 × 10^4	1.00 × 10^7	1.5	Yes	0	0	CR	3.5
21	5	^{109}Ag	48	9.14 × 10^4	1.00 × 10^7	1.5	Yes	0	0	N/A	0

The upper-bound cross-section (using a 95% confidence level) is calculated by combining all runs above as:

$\sigma_{SET} \leq 3.12 \times 10^{-8}$ cm^2/device for LET_{EFF} = 48 MeV·cm^2/mg and T = 25°C. Since no VOUT or SS SETs were observed, this cross section is valid for both cases.

9 Event Rate Calculations

Event rates were calculated for LEO (ISS) and GEO environments by combining CREME96 orbital integral flux estimations and simplified SEE cross-sections according to methods described in SLVK046. This report assumes a minimum shielding configuration of 100 mils (2.54 mm) of aluminum, and *worst-week* solar activity (this is similar to a 99% upper bound for the environment). Using the 95% upper-bounds for the SEL, SET and the SEB/SEGR, the event rate calculation for the SEL, SET, and the SEB/SEGR is listed in Table 9-1 and Table 9-2, respectively.

Table 9-1. SEL Event Rate Calculations for Worst-Week LEO and GEO Orbits

The SEL Event Rate is for reference only as not a Single Unit during any Run showed a Latch-up event.

Orbit Type	Onset LET_{EFF} (MeV-cm²/mg)	CREME96 Integral FLUX (/day/cm2)	σSAT (cm²)	Event Rate (/day)	Event Rate (FIT)	MTBE (Years)
LEO (ISS)	48	4.50×10^{-4}	1.23×10^{-7}	5.54×10^{-11}	2.31×10^{-3}	4.95×10^{7}
GEO		1.48×10^{-3}		1.82×10^{-10}	7.56×10^{-3}	1.51×10^{7}

Table 9-2. SEB/SEGR Event Rate Calculations for Worst-Week LEO and GEO Orbits

The SEB Event Rate is for reference only as not a Single Unit during any Run showed a Burnout event.

Orbit Type	Onset LET_{EFF} (MeV-cm²/mg)	CREME96 Integral FLUX (/day/cm2)	σSAT (cm²)	Event Rate (/day)	Event Rate (FIT)	MTBE (Years)
LEO (ISS)	48	4.50×10^{-4}	6.19×10^{-8}	2.79×10^{-11}	1.16×10^{-3}	9.83×10^{7}
GEO		1.48×10^{-3}		9.14×10^{-11}	3.81×10^{-3}	3.00×10^{7}

Table 9-3. VOUT and SS SET Event Rate Calculations for Worst-Week LEO and GEO Orbits

Orbit Type	Onset LET_{EFF} (MeV-cm²/mg)	CREME96 Integral FLUX (/day/cm2)	σSAT (cm²)	Event Rate (/day)	Event Rate (FIT)	MTBE (Years)
LEO (ISS)	48	4.50×10^{-4}	3.12×10^{-8}	1.40×10^{-11}	5.85×10^{-4}	1.95×10^{8}
GEO		1.48×10^{-3}		4.60×10^{-11}	1.92×10^{-3}	5.95×10^{7}

10 Summary

The purpose of this study was to characterize the effect of heavy-ion irradiation on the Single-Event-Effect (SEE) performance of the TPS7H2201-SEP eFuse. Heavy-ions with LET_{EFF} = 48 MeV·cm^2/mg were used for the SEE test campaign. Flux of 10^5ions/cm^2·s and fluences ranging from 9.97 × 10^6 to 1 × 10^7 ions/cm^2 per run were used for the characterization. The SEE results demonstrated that the TPS7H2201-SEP is SEL and SEB/SEGR free up to LET_{EFF} = 48 MeV·cm^2/mg up to 7 V when using ^{109}Ag heavy-ions. The device is SET-free up to LET_{EFF} = 48 MeV·cm^2/mg, which shows the robustness of the device to SET over the whole electrical and radiation range. CREME96-based worst-week event-rate calculations for LEO (ISS) and GEO orbits are shown for reference.

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