ISL71590SEH, ISL73590SEH

Single-Event Effects (SEE)

AN1894
Rev 1.00
November 17, 2016

Introduction

The intense proton and heavy ion environment encountered in space applications can cause a variety of destructive and nondestructive single-event effects in electronic circuitry, including Single-Event Upset (SEU), Single-Event Transient (SET), Single-Event Functional Interrupt (SEFI), and Single-Event Burnout (SEB). SEE can lead to system-level performance issues including disruption, degradation, and destruction. For predictable and reliable space system operation, individual electronic components must be characterized to determine their SEE response. This report discusses the results of destructive SEE testing performed on the ISL71590SEH two-terminal temperature transducer. These results also apply to the ISL73590SEH.

Product Description

The ISL71590SEH is a radiation-hardened two-terminal temperature transducer. It has a high impedance current output that allows it to be insensitive to voltage drops across long lines. When provided a voltage between 4V and 33V on the input pin, the device acts as a constant current generator with a scale factor of 1µA/K. The ISL71590SEH can operate across the -55°C to +150°C temperature range without the need of additional circuitry, and produces results with ±1.7°C accuracy over that temperature range. The absolute maximum supply voltage is 40V while the maximum operational supply voltage for in-spec operation is 33V, and this value is also 33V for operation in the heavy ion environment ('in-beam'). The part features notable low dose rate total dose hardness, with a maximum accuracy error of -1.0°C after 50krad(Si) at low dose rate.

With power requirements as low as 1.5mW (5V at 25°C), the part is a good choice for payload and booster temperature sensing as any well-insulated twisted pair cable will allow for proper operation. It can be used in several applications including temperature compensation networks, laser diode temperature compensation, sensor bias and linearization functions, and Proportional-to-Absolute Temperature (PTAT) biasing. The high output impedance (>10MΩ) leaves plenty of room for variations in the power supply voltage. The part is electrically durable as it can withstand a forward voltage of 40V outside of the heavy ion environment (with a 33V maximum in-beam rating) and a reverse voltage of -40V. The case to lead breakdown voltage is >200V. The ISL71590SEH is available in a 2 Ld hermetically sealed flatpack. Key features of the part follow.

Features

- Minimal accuracy shift over low dose rate irradiation . . . . . -1.5°C maximum
- Linear output current 1.0µA/K
- Wide power supply range . . . . . 4V to 33V
- Low power consumption . . . . . 1.5mW at 5V supply
- Operating temperature range. . . . . -55°C to +125°C
- SEL/SEB threshold LET . . . . . 86.4MeV•cm^2/mg
- Total dose tolerance, high dose rate . . . . . 300krad(Si)
- Total dose tolerance, low dose rate . . . . . 50krad(Si)
- QML qualified per MIL-PRF-38535
- Produced in conformance with Standard Microcircuit Drawing (SMD) 5962-13215

Related Literature

- For a full list of related documents, visit our website
  - ISL71590SEH, ISL73590SEH product pages

SEE Test Objectives

The ISL71590SEH was tested to determine its susceptibility to destructive single-event effects including Single-Event Burnout (SEB) and Single-Event Latch-up (SEL). The part is an all-bipolar design, so Single-Event Gate Rupture (SEGR) is not a direct concern; however, the part does contain a poly–oxide–silicon capacitor and Single-Event Dielectric Rupture (SEDR) is a consideration. Nondestructive effects were not characterized as the part operates essentially in a DC environment.

SEE Test Facility

Testing was performed at the Texas A&M University (TAMU) Cyclotron Institute heavy ion facility. This facility is coupled to a K500 super-conducting cyclotron, which is capable of generating a wide range of test particles with the various energy, flux, and fluence levels needed for advanced radiation testing. Four units of the ISL71590SEH were subjected to heavy ion damage testing on June 20, 2013. The units were heated to +150°C case temperature in order to assure worst-case conditions and were irradiated with gold at zero degrees incidence for an effective surface LET of 86.3MeV•cm^2/mg.

Since the ISL71590SEH is two-terminal proportional to absolute temperature current source (with a nominal scale factor of 1µA/K), the variable used for SEE damage testing was the supply voltage using 2V increments. The normal supply voltage range for the ISL71590SEH is 4V to 33V. In order to determine destructive damage we monitored the supply current, recording the pre- and post-irradiation values. Each sample was irradiated to a fluence of $2x10^6$ions/cm^2 at a flux of $1x10^4$ions/cm^2*s at each voltage level.

The raw results appear in Table 1. Allowing ±1µA of measurement repeatability variation, only two tests (1 and 2 at 39V) appeared to damage the parts. All four parts passed at voltages of 37V and below; this value is 12% above the part's maximum rating.

Conclusion

SEE testing of the ISL71590SEH temperature sensor has demonstrated that the ISL71590SEH and the ISL73590SEH are not susceptible to destructive single-event effects at an LET of 86.3MeV • cm^2/mg up to an input voltage of 37V. This represents conditions that are 12% over the recommended maximum input voltage of 33V.

TABLE 1. RESULTS OF DESTRUCTIVE SEE TESTING OF THE ISL71590SEH

UNIT SN	V_{CC} (V)	I_{CC} PRE (µA)	I_{CC} POST (µA)	I_{CC} DELTA (µA)	RESULT
1	31	422	423	1	Pass
2		423	424	1	Pass
3		423	422	-1	Pass
4		420	421	1	Pass
1	33	423	423	0	Pass
2		424	424	0	Pass
3		421	422	1	Pass
4		422	422	0	Pass
1	35	424	423	-1	Pass
2		424	424	0	Pass
3		422	422	0	Pass
4		423	423	0	Pass
1	37	424	424	0	Pass
2		424	424	0	Pass
3		423	423	0	Pass
4		422	422	0	Pass
1	39	424	427	3	Fail
2		424	2000	1576	Fail
3		423	423	0	Pass
4		423	423	0	Pass

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(Rev.4.0-1 November 2017)

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