ISL78843ASRH, ISL78845ASRH

Single Event Effects (SEE) Test Report

TR005
Rev.1.00
Feb 6, 2018

Table of Contents

Introduction

This document describes the SEE tests performed on ISL78843ASRH and ISL78845ASRH in order to characterize its Single Event Burnout (SEB), Single Event Latch-Up (SEL), and Single Event Transient (SET) sensitivity. The test facility used for this purpose was the Cyclotron at Texas A&M Radiation Effects Test laboratory.

Product Description

The ISL7884xASRH are high performance, radiation hardened drop-in replacements for the popular 28C4x and 18C4x PWM controllers suitable for a wide range of power conversion applications including boost, flyback, and isolated output configurations. Its fast signal propagation and output switching characteristics make this an ideal product for existing and new designs. Features include up to 13.2V operation, low operating current, 300µA typical start-up current, adjustable switching frequency, and high peak current drive capability with 50ns rise and fall times. The differences in the part numbers of the metal mask variants are listed in Table 1.

TABLE 1. METAL MASK VARIANT DIFFERENCES BETWEEN PARTS

PART NUMBER	RISING UVLO	MAX. DUTY CYCLE (%)
ISL78840ASRH	7.0	100
ISL78841ASRH	7.0	50
ISL78843ASRH	8.4V	100
ISL78845ASRH	8.4V	50

- Name: ISL78843ASRH and ISL78845ASRH
- Function: Single-ended current mode PWM controllers
- Supply voltage: Minimum = 9V, typical = 12V, maximum = 13.2V
- Supply voltage absolute maximum: 14.7V
- Package: Hermetic 8 Ld dual-in-line flatpack

Related Literature

For a full list of related documents, visit our website

- ISL78840ASRH, ISL78841ASRH, ISL78843ASRH, ISL78845ASRH product pages

Irradiation Facility

- Name: TAMU
- Location: College Station, TX
- Date: August 28, 2009
- Characteristics of the tests performed: (15Mev Beam)
- LET43: 109Ag
- LET86: 109Ag at angle 60°

For the details on test conditions and fluence and cross sections refer to relevant tables and plots in this report.

Test Objectives

The aim is to characterize the SEE performance of the device at the LET levels mentioned in “Irradiation Facility”. This could be a missed pulse or wide pulse event, occurring at a fluence of $1x10^6$ particles/cm^2 and does not contribute to an output voltage transient of greater than +2% or less than -2%. For details on the SEE events and type detected during the testing, refer to relevant tables and plots in this report.

Flux Calculation

The cross-sections were calculated as follows: x(LET) = N/F

where:

x is the SET cross-section (cm^2), expressed as a function of the Heavy Ion LET

LET is the Linear Energy Transfer in MeV•cm^2/mg

N is the total Number of SET/SEU

F = Fluence (particles/cm^2) (corrected according to the incident angle, if any).

1/F is the assumed cross-section when no event is observed.

Test Setup Diagrams

Device Block Diagram

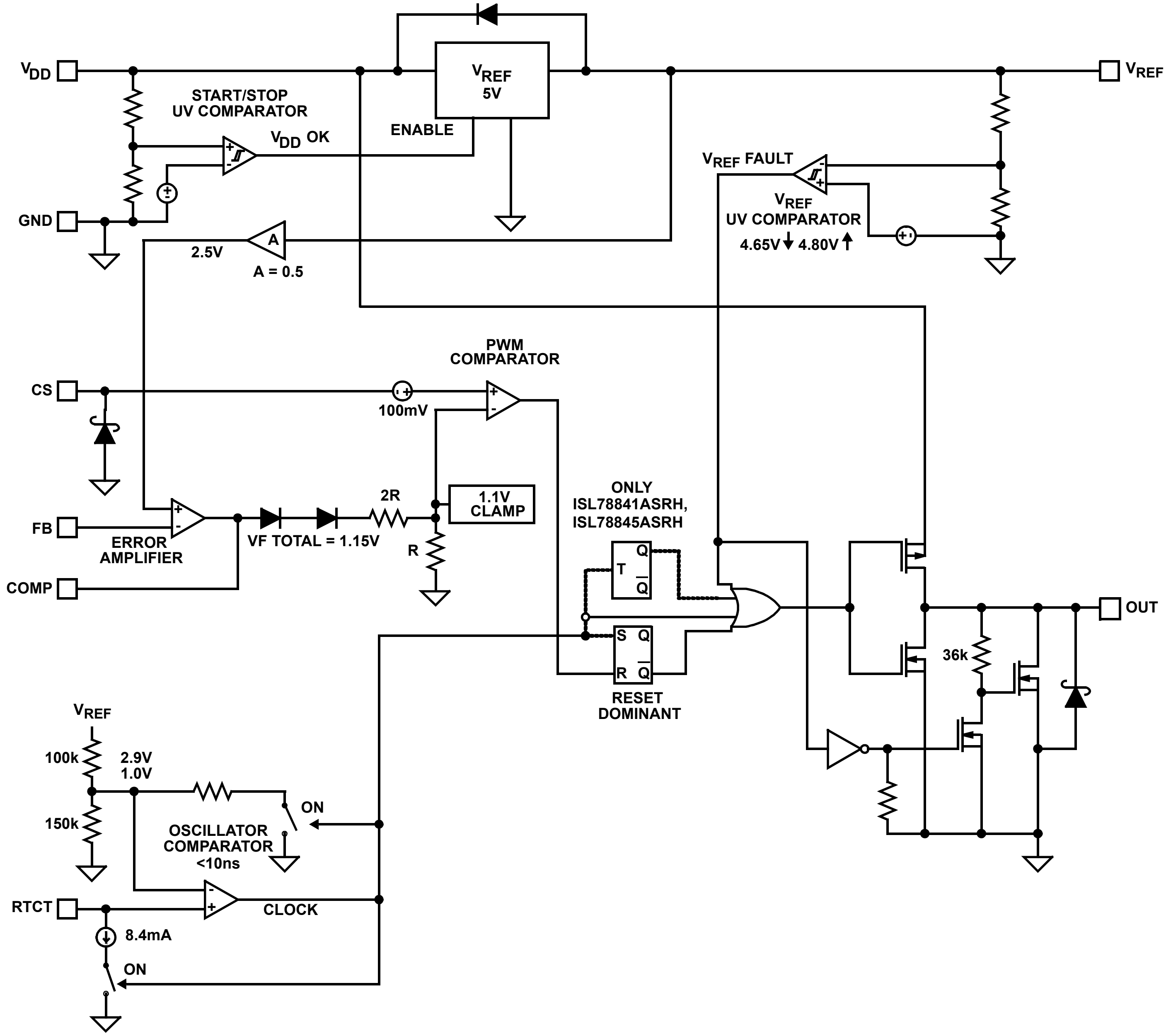


FIGURE 1. BLOCK DIAGRAM

Device Pin Configurations

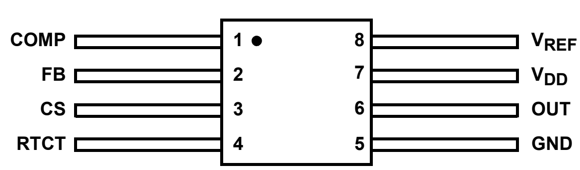


FIGURE 2. PIN CONFIGURATION

SEE Evaluation PWB Layout

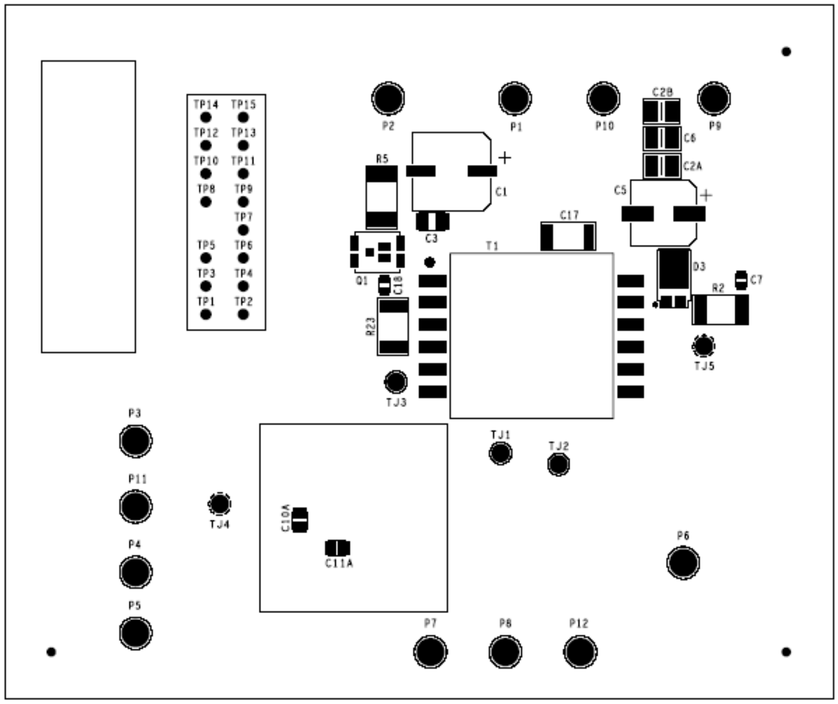


FIGURE 3. SILKSCREEN TOP

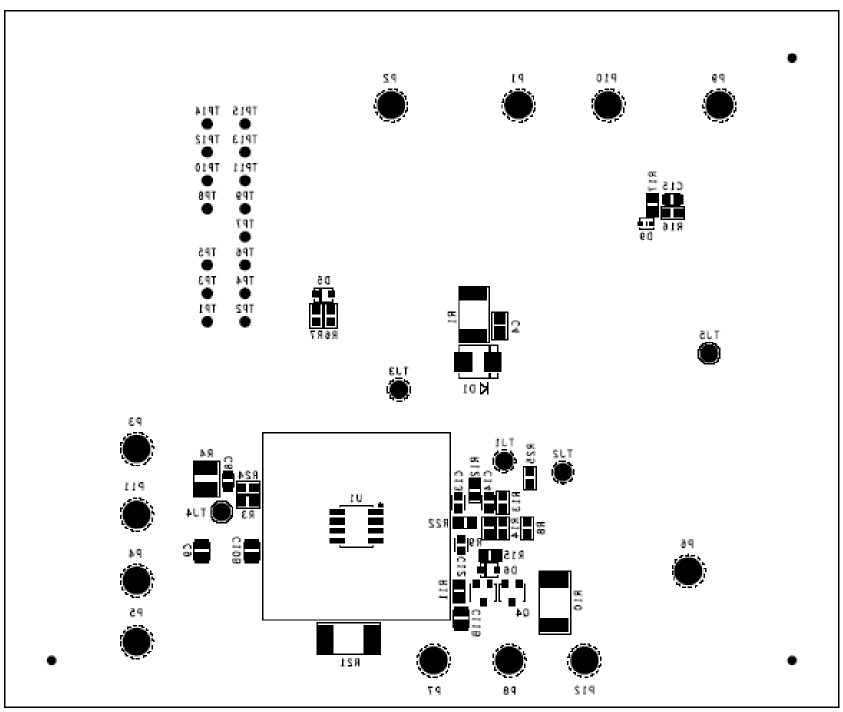


FIGURE 4. SILKSCREEN BOTTOM

Schematic of SEB/L Evaluation Board

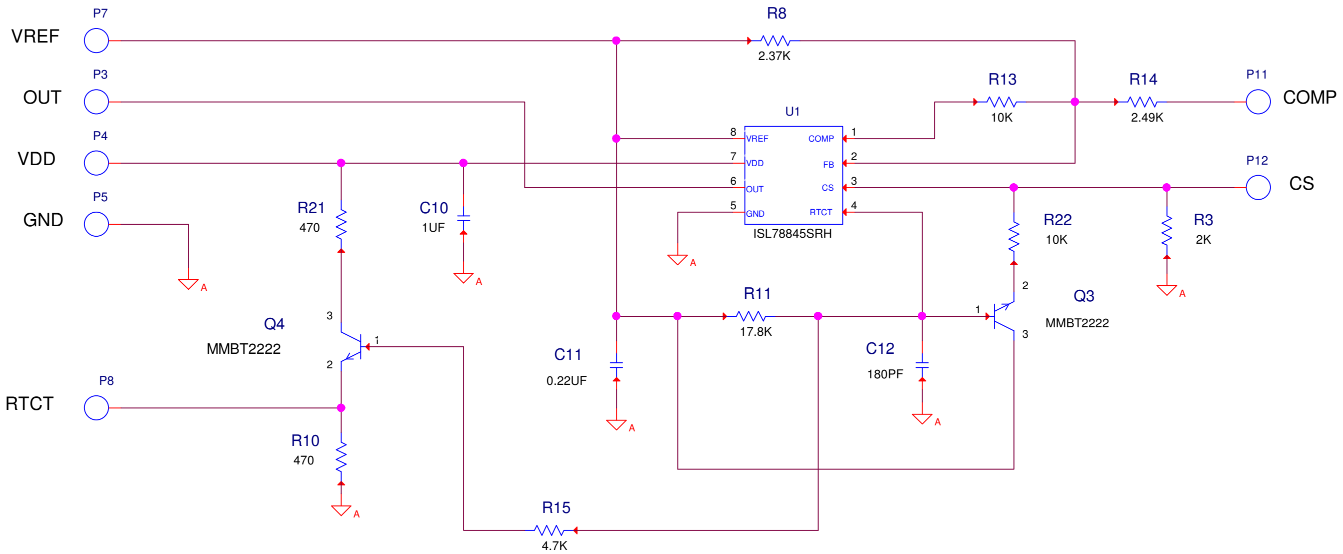
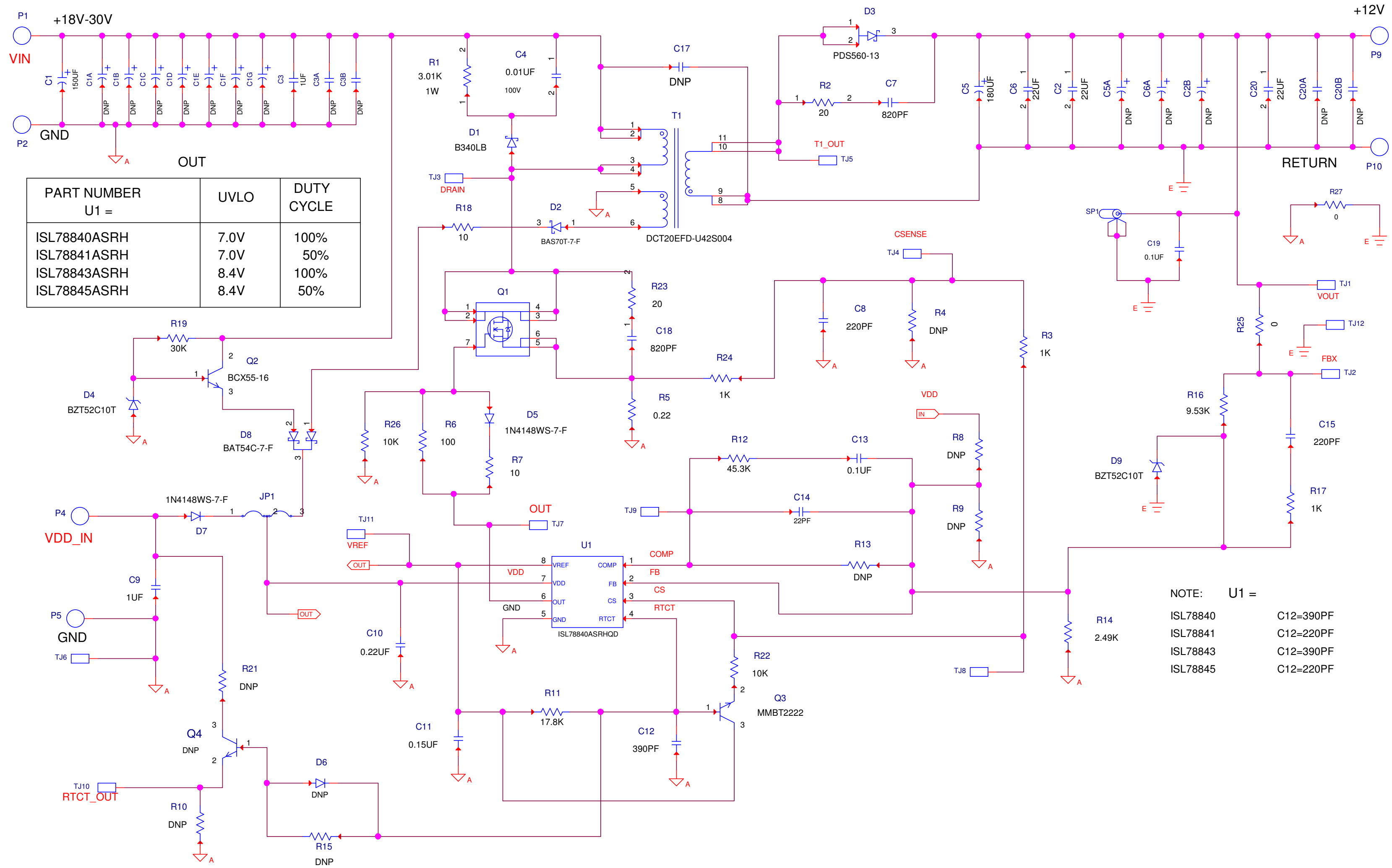


FIGURE 5. SCHEMATIC OF SEB/L EVALUATION BOARD

NOTE: The SEE Evaluation board is populated with the components shown in the schematic to place the device in an open loop configuration.

Schematic of SET Evaluation Board



PART NUMBER U1 =	UVLO	DUTY CYCLE
ISL78840ASRH	7.0V	100%
ISL78841ASRH	7.0V	50%
ISL78843ASRH	8.4V	100%
ISL78845ASRH	8.4V	50%

NOTE: U1 =

ISL78840	C12=390PF
ISL78841	C12=220PF
ISL78843	C12=390PF
ISL78845	C12=220PF

FIGURE 6. SCHEMATIC OF SET EVALUATION BOARD

NOTE: The SEE Evaluation board is populated with the components listed above to place the device in a closed loop configuration providing an output of 12V at 1A.

Test Setup Description

The SEB/L evaluation board was wired up in the open loop configuration as shown in Figure 5 on page 5. The SET evaluation board was wired up in the closed loop configuration as shown in Figure 6. The overall test setup includes the test jig containing four evaluation boards mounted and wired through a 20ft cable to the data room. The end of the 20ft cable in the data room was connected to a switchboard. The switchboard was wired to the power supplies and monitoring equipment/scopes.

The biasing used for SET test runs V_{DD} = 13.5V and that for SEB/L tests runs were 14V/14.5V/14.7V/15V. The signals from the switchboard were connected to three LeCroy oscilloscopes, two set to capture transients due to pulse width change and period change, and a third scope was set to monitor SET events in real time.

Test Method

A SET is said to have occurred when a perturbation is detected. This can be a change in pulse width, which can cause missing pulses.

a. Scope 1 is set to trigger to pulse width variations of SEBL = ±90% and SET = ±30% over the nominal value. Measurements on Scope 1 are CH1 = OUT, CH2 = VOUT, CH3 = RTCT, CH4 = VREF, and TRIG = OUT PW.

b. Scope 2 is set to trigger to missing pulse events. This setting triggers when two rising edges are not detected within a SEBL = 2.25T and SET = 1.2T window. Measurements on Scope 2 CH1 = OUT, CH2 = VOUT, CH3 = RTCT, = VREF, and TRIG = OUT PM.

c. Scope 3 is set to monitor events in real time only. Channels monitored on Scope 3 CH1 = OUT, CH2 = VOUT, CH3 = RTCT, CH4 = VREF, and TRIG = VREF.

The switchboard at the end of the 20ft cabling was found to require terminations to keep the noise on the waveforms to a minimum. OUT and RTCT were terminated with a series combination of 1000pF and 51Ω and the VOUT and VREF signals with a 10nF capacitor to GND.

Because the SEB/L test setup is an open loop, there are no VOUT captures, so the CH2 of the scope is not used.

Test Overview

The details of the SET tests performed are summarized in Tables 2 and 3. Waveforms for select typical conditions are shown in Figures 15 through 30. An overall summary is provided in "SEE Test Summary/Conclusion" on page 27.

The details of the SEB/L tests performed are summarized in Table 8 on page 24. An overall summary is in "SEE Test Summary/Conclusion" on page 27. Binomial estimated cross sections are shown in Figure 31 on page 24.

Converter Design Considerations

The converter design is important for the proper evaluation of the SEE performance under beam. In particular, ensure that the magnetic components used in the design do not saturate under wide pulse conditions. This can be made possible by choosing the right magnetic component and appropriately setting the pulse-by-pulse current limit thresholds. Failure to do this can result in the observation of SEE events not related to the device being tested.

Test Details

Details of SET Tests Performed Based on Pulse Width Captures

TABLE 2. SET TESTS BASED ON PULSE WIDTH CAPTURES

TEST ID	DEVICE#	ION	VDD (V)/ PIN 7	EFF LET (cm^2/mg)	FLUENCE PER RUN (PART/cm^2)		TOTAL EVENTS		PW EVENT CS (cm^2)
SET +25°C LET43 CLOSED LOOP, 0.22µF, ISL78843ASRH									
358	2	109Ag	13.50	43.20		1.99E+06		1709	8.59E-04
360	3	109Ag	13.50	43.20		1.99E+06		1064	5.35E-04
					Sum of Fluence run per part/cm^2:	3.98E+06	Sum of Total Events:	2773	6.97E-04
SET +25°C LET43 CLOSED LOOP, 0.22µF, ISL78845ASRH									
378	21	109Ag	13.50	43.20		2.00E+06		1276	6.38E-04
381	22	109Ag	13.50	43.20		2.00E+06		1311	6.56E-04
					Sum of Fluence run per part/cm^2:	4.00E+06	Sum of Total Events:	2587	6.47E-04

NOTE: PW capture indicates that events were captured based on variations in pulse width based on settings shown in "Test Method" on page 7.

Details of SET Tests Performed Based on Period Captures

TABLE 3. SET TESTS BASED ON PERIOD CAPTURES

TEST ID	DEVICE#	ION	VDD (V)/ PIN 7	EFF LET (cm^2/mg)	FLUENCE PER RUN (PART/cm^2)		TOTAL EVENTS		EVENT CS (cm^2)
SET +25°C LET43 CLOSED, 0.22µF, ISL78843ASRH									
358	2	109Ag	13.50	43.20		1.99E+06		144	7.24E-05
360	3	109Ag	13.50	43.20		1.99E+06		196	9.85E-05
					Sum of Fluence run per part/cm^2:	3.98E+06	Sum Of Total Events	340	8.54E-05
SET +25°C LET43 CLOSED, 0.22µF, ISL78845ASRH									
378	21	109Ag	13.50	43.20		2.00E+06		266	1.33E-04
381	22	109Ag	13.50	43.20		2.00E+06		254	1.27E-04
					Sum of Fluence run per part/cm^2:	4.00E+06	Sum Of Total Events	520	1.30E-04

NOTE: Period capture indicates that events were captured based on variations in period of the switching waveform based on settings shown in "Test Method" on page 7.

SET Pulse Width Trigger Histogram Data 0.22µF, ISL78843ASRH

TABLE 4. SET PULSE WIDTH TRIGGER HISTOGRAM DATA

BIN	FREQUENCY	TOL %	BIN	FREQUENCY	TOL %
VREF HISTOGRAM DATA FOR PULSE WIDTH TRIGGER RUNS					
-3.00	0	-3.0	2.20	129	2.2
-2.80	0	-2.8	2.40	193	2.4
-2.60	0	-2.6	2.60	215	2.6
-2.40	0	-2.4	2.80	137	2.8
-2.20	0	-2.2	3.00	112	3.0
-2.00	0	-2.0	3.20	81	3.2
-1.80	1	-1.8	3.40	60	3.4
-1.60	128	-1.6	3.60	40	3.6
-1.40	328	-1.4	3.80	58	3.8
-1.20	684	-1.2	4.00	50	4.0
-1.00	535	-1.0	4.20	73	4.2
-0.80	765	-0.8	4.40	56	4.4
-0.60	332	-0.6	4.60	47	4.6
-0.40	0	-0.4	4.80	42	4.8
-0.20	0	-0.2	5.00	28	5.0
0.00	0	0.0	5.20	34	5.2
0.20	0	0.2	5.40	9	5.4
0.40	0	0.4	5.60	15	5.6
0.60	117	0.6	5.80	7	5.8
0.80	327	0.8	6.00	3	6.0
1.00	207	1.0	6.20	0	6.2

TABLE 4. SET PULSE WIDTH TRIGGER HISTOGRAM DATA (Continued)

BIN	FREQUENCY	TOL %	BIN	FREQUENCY	TOL %
1.20	235	1.2	6.40	0	6.4
1.40	133	1.4	6.60	0	6.6
1.60	121	1.6	6.80	0	6.8
1.80	125	1.8	7.00	0	7.0
2.00	119	2.0			
VOUT HISTOGRAM DATA FOR PULSE WIDTH TRIGGER RUNS					
-3.00	0	-3.0	0.40	1044	0.4
-2.80	0	-2.8	0.60	858	0.6
-2.60	0	-2.6	0.80	419	0.8
-2.40	0	-2.4	1.00	29	1.0
-2.20	0	-2.2	1.20	0	1.2
-2.00	0	-2.0	1.40	0	1.4
-1.80	0	-1.8	1.60	0	1.6
-1.60	0	-1.6	1.80	0	1.8
-1.40	0	-1.4	2.00	0	2.0
-1.20	0	-1.2	2.20	0	2.2
-1.00	0	-1.0	2.40	0	2.4
-0.80	0	-0.8	2.60	0	2.6
-0.60	0	-0.6	2.80	0	2.8
-0.40	83	-0.4	3.00	0	3.0
-0.20	2637	-0.2	3.20	0	3.2
0.00	53	0.0	3.40	0	3.4
0.20	423	0.2	3.60	0	3.6

SET Histograms Pulse Width Trigger 0.22µF, ISL78843ASRH

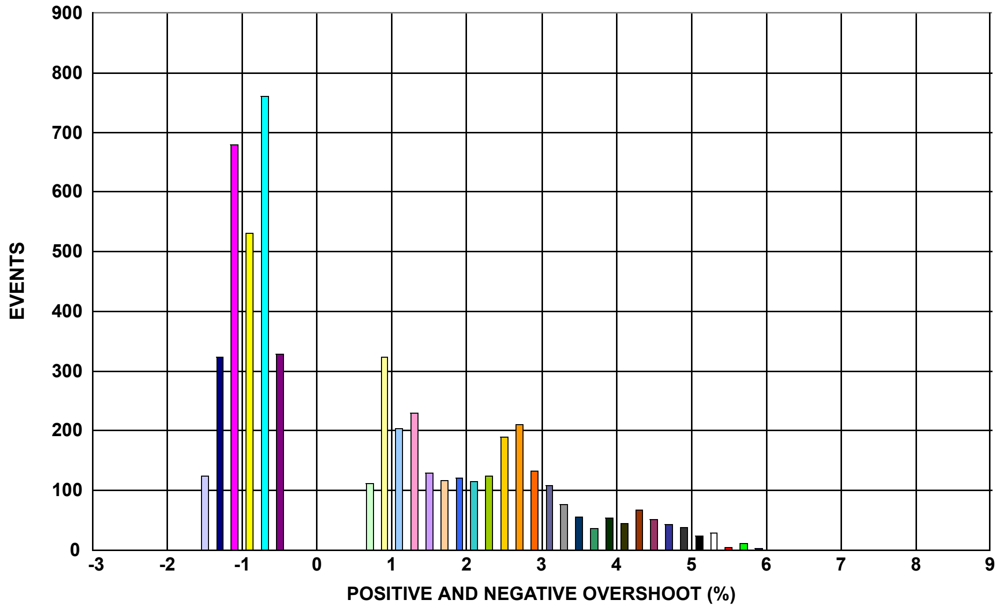


FIGURE 7. % POSITIVE AND NEGATIVE OVERSHOOT, TOTAL EVENTS = 2773, AREA OF CS = 6.96733668341709 x 10^{-4} cm^2

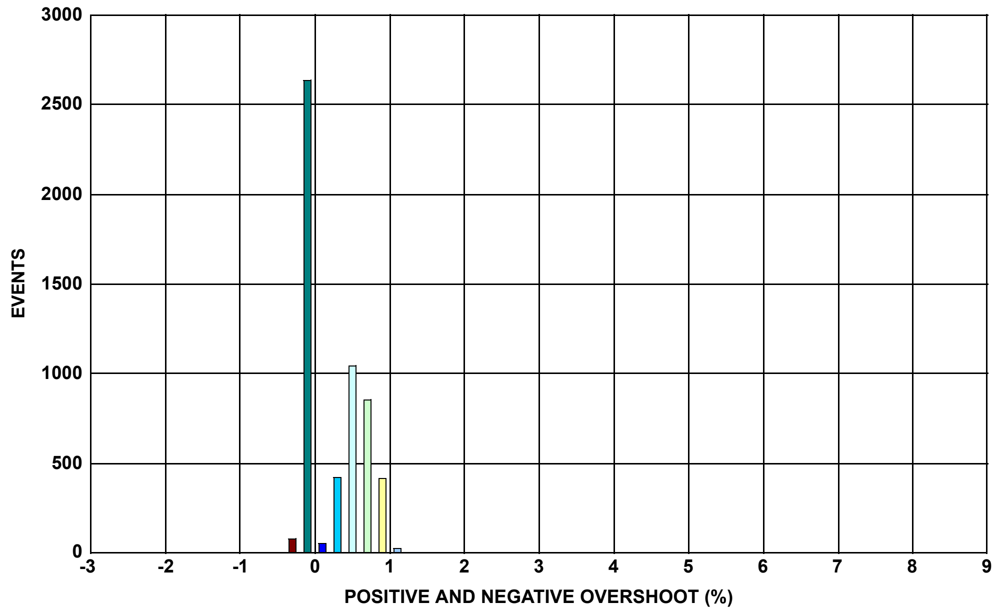


FIGURE 8. % POSITIVE AND NEGATIVE OVERSHOOT, TOTAL EVENTS = 2773, AREA OF CS = 6.96733668341709 x 10^{-4} cm^2

NOTE: The scope set to trigger to pulse width variations of ±30% over the nominal value. The two peaks seen represent positive and negative transients.

SET Period Trigger Histogram Data 0.22µF, ISL78843ASRH

TABLE 5. SET PERIOD TRIGGER HISTOGRAM DATA

BIN	FREQUENCY	TOL %	BIN	FREQUENCY	TOL %
VREF HISTOGRAM DATA FOR PERIOD TRIGGER RUNS					
-3.00	0	-3.0	3.20	0	3.2
-2.80	0	-2.8	3.40	0	3.4
-2.60	0	-2.6	3.60	0	3.6
-2.40	0	-2.4	3.80	0	3.8
-2.20	0	-2.2	4.00	2	4.0
-2.00	0	-2.0	4.20	6	4.2
-1.80	0	-1.8	4.40	3	4.4
-1.60	13	-1.6	4.60	8	4.6
-1.40	17	-1.4	4.80	7	4.8
-1.20	46	-1.2	5.00	9	5.0
-1.00	2	-1.0	5.20	9	5.2
-0.80	12	-0.8	5.40	12	5.4
-0.60	204	-0.6	5.60	10	5.6
-0.40	46	-0.4	5.80	11	5.8
-0.20	0	-0.2	6.00	1	6.0
0.00	0	0.0	6.20	0	6.2
0.20	0	0.2	6.40	0	6.4
0.40	0	0.4	2.20	0	2.2
0.60	47	0.6	2.40	0	2.4
0.80	51	0.8	2.60	0	2.6
1.00	102	1.0	2.80	0	2.8
1.20	62	1.2	3.00	0	3.0
1.40	0	1.4	6.60	0	6.6
1.60	0	1.6	6.80	0	6.8
1.80	0	1.8	7.00	0	7.0
2.00	0	2.0			

TABLE 5. SET PERIOD TRIGGER HISTOGRAM DATA (Continued)

BIN	FREQUENCY	TOL %	BIN	FREQUENCY	TOL %
VOUT HISTOGRAM DATA FOR PERIOD TRIGGER RUNS					
-2.00	0	-2.0	0.60	0	0.6
-1.80	0	-1.8	0.80	57	0.8
-1.60	0	-1.6	1.00	21	1.0
-1.40	0	-1.4	1.20	0	1.2
-1.20	0	-1.2	1.40	0	1.4
-1.00	0	-1.0	1.60	0	1.6
-0.80	0	-0.8	1.80	0	1.8
-0.60	0	-0.6	2.00	0	2.0
-0.40	16	-0.4	2.20	0	2.2
-0.20	317	-0.2	2.40	0	2.4
0.00	7	0.0	2.60	0	2.6
0.20	195	0.2	2.80	0	2.8
0.40	67	0.4	3.00	0	3.0

SET Histograms Period Trigger 0.22µF, ISL78843ASRH

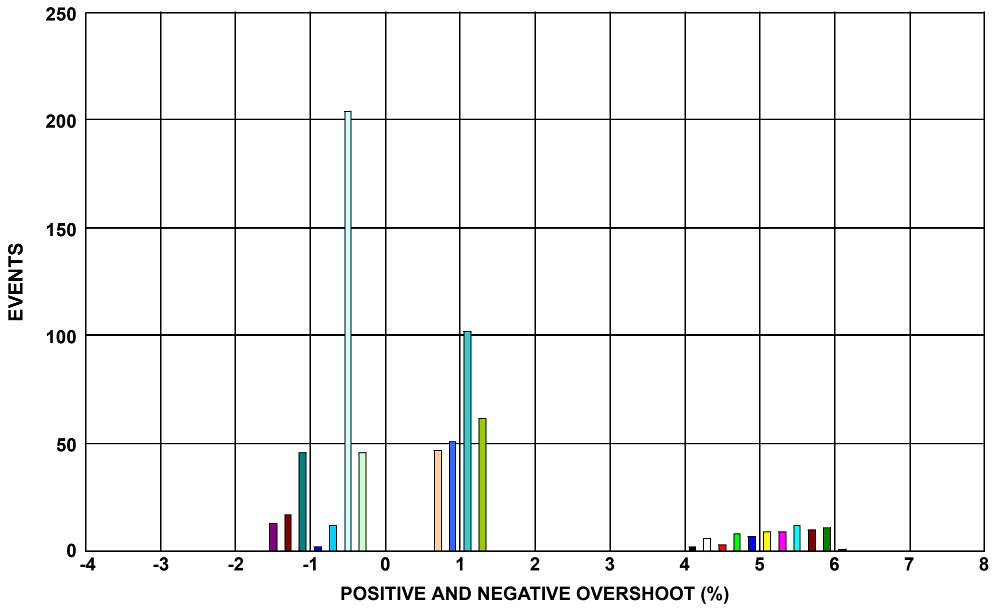


FIGURE 9. % POSITIVE AND NEGATIVE OVERSHOOT, TOTAL EVENTS = 340, AREA OF CS = 0.85427135678392 x 10^{-4} cm^2

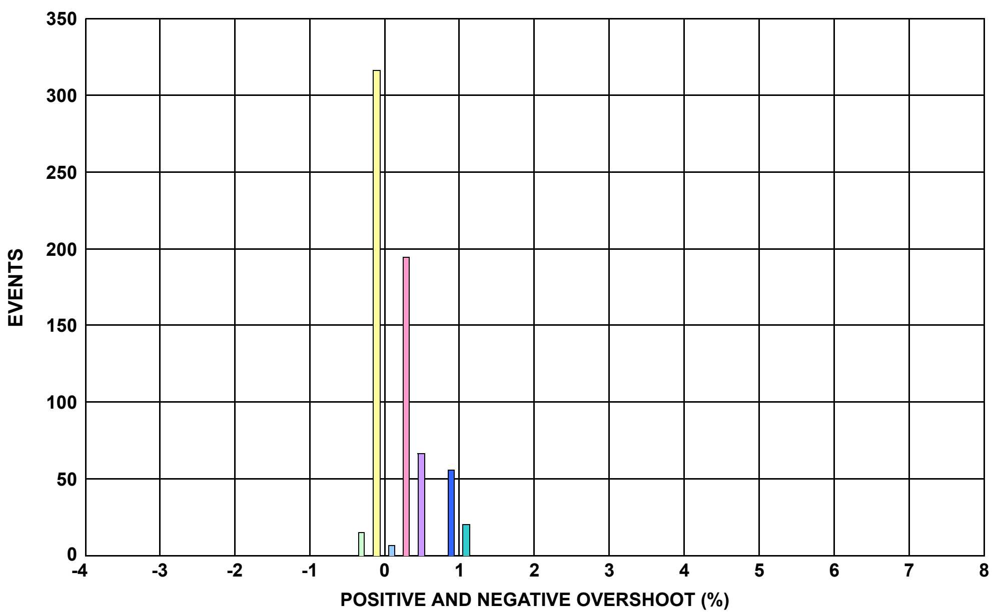


FIGURE 10. % POSITIVE AND NEGATIVE OVERSHOOT, TOTAL EVENTS = 340, AREA OF CS = 0.85427135678392 x 10^{-4} cm^2

NOTE: The scope set to trigger to period, when two rising edges are not detected within a 1.2T window. The two peaks seen represent positive and negative transients.

SET Pulse Width Trigger Histogram Data 0.22µF, ISL78845ASRH

TABLE 6. SET PULSE WIDTH TRIGGER HISTOGRAM DATA

BIN	FREQUENCY	TOL %	BIN	FREQUENCY	TOL %
VREF HISTOGRAM DATA FOR PULSE WIDTH TRIGGER RUNS					
-3.00	0	-3.0	2.20	156	2.2
-2.80	0	-2.8	2.40	247	2.4
-2.60	0	-2.6	2.60	315	2.6
-2.40	0	-2.4	2.80	268	2.8
-2.20	0	-2.2	3.00	130	3.0
-2.00	0	-2.0	3.20	94	3.2
-1.80	23	-1.8	3.40	72	3.4
-1.60	279	-1.6	3.60	63	3.6
-1.40	487	-1.4	3.80	57	3.8
-1.20	701	-1.2	4.00	58	4.0
-1.00	705	-1.0	4.20	73	4.2
-0.80	153	-0.8	4.40	107	4.4
-0.60	239	-0.6	4.60	97	4.6
-0.40	0	-0.4	4.80	59	4.8
-0.20	0	-0.2	5.00	84	5.0
0.00	0	0.0	5.20	39	5.2
0.20	0	0.2	5.40	53	5.4
0.40	0	0.4	5.60	44	5.6
0.60	49	0.6	5.80	30	5.8
0.80	152	0.8	6.00	8	6.0
1.00	99	1.0	6.20	2	6.2
1.20	36	1.2	6.40	0	6.4
1.40	13	1.4	6.60	0	6.6
1.60	17	1.6	6.80	0	6.8
1.80	52	1.8	7.00	0	7.0
2.00	113	2.0			

TABLE 6. SET PULSE WIDTH TRIGGER HISTOGRAM DATA (Continued)

BIN	FREQUENCY	TOL %	BIN	FREQUENCY	TOL %
VOUT HISTOGRAM DATA FOR PULSE WIDTH TRIGGER RUNS					
-3.00	0	-3.0	0.20	11	0.2
-2.80	0	-2.8	0.40	1206	0.4
-2.60	0	-2.6	0.60	1042	0.6
-2.40	0	-2.4	0.80	327	0.8
-2.20	0	-2.2	1.00	1	1.0
-2.00	0	-2.0	1.20	0	1.2
-1.80	0	-1.8	1.40	0	1.4
-1.60	0	-1.6	1.60	0	1.6
-1.40	0	-1.4	1.80	0	1.8
-1.20	0	-1.2	2.00	0	2.0
-1.00	0	-1.0	2.20	0	2.2
-0.80	0	-0.8	2.40	0	2.4
-0.60	0	-0.6	2.60	0	2.6
-0.40	32	-0.4	2.80	0	2.8
-0.20	2549	-0.2	3.00	0	3.0
0.00	6	0.0			

SET Histograms Pulse Width Trigger 0.22µF, ISL78845ASRH

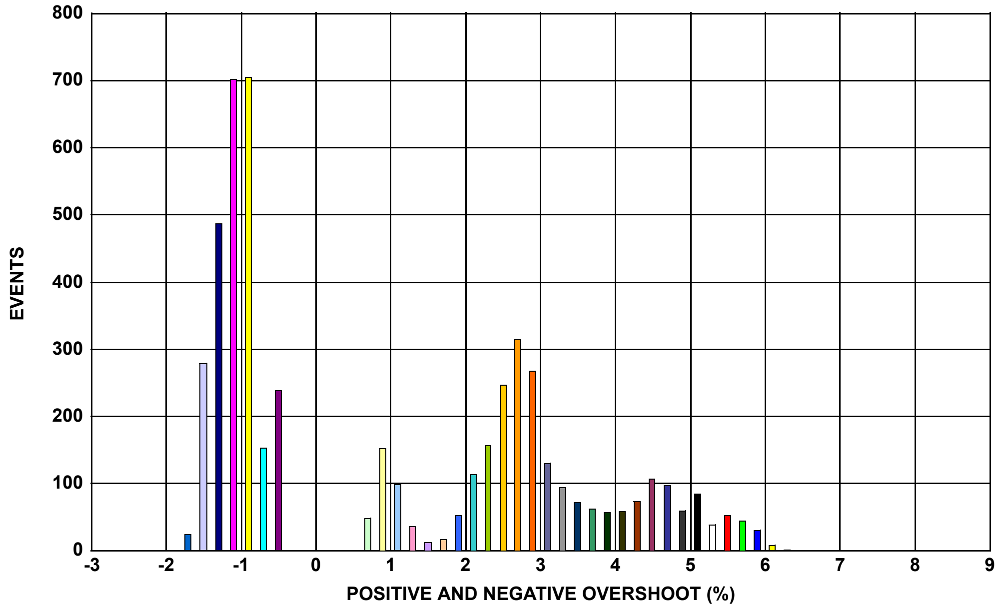


FIGURE 11. % POSITIVE AND NEGATIVE OVERSHOOT, TOTAL EVENTS = 2587, AREA OF CS = 6.5 x 10^{-4} cm^2

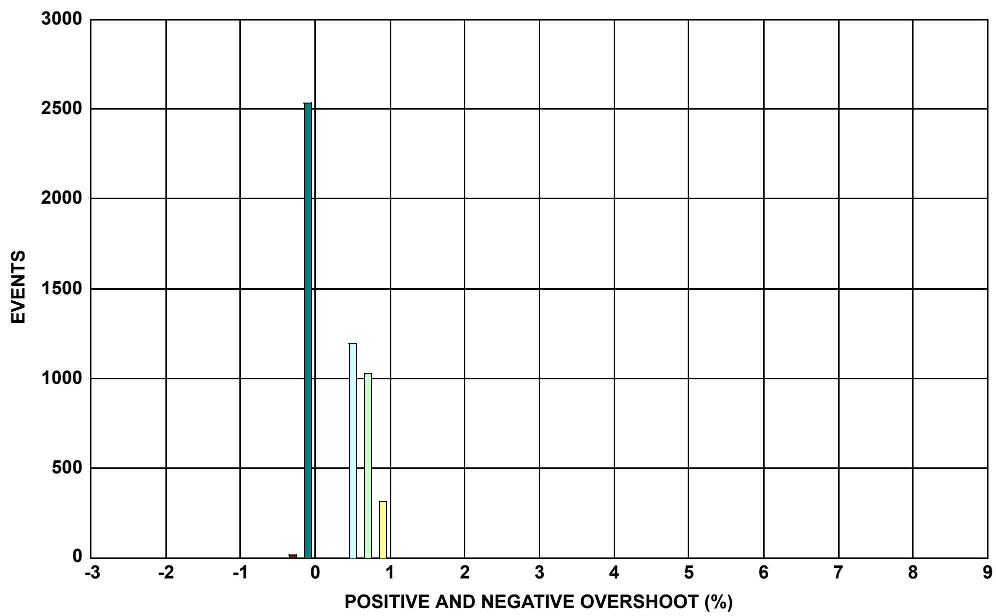


FIGURE 12. % POSITIVE AND NEGATIVE OVERSHOOT, TOTAL EVENTS = 2587, AREA OF CS = 6.5x10^{-4} cm^2

NOTE: The scope set to trigger to pulse width variations of ±30% over the nominal value. The two peaks seen represent positive and negative transients

SET Period Trigger Histogram Data 0.22µF, ISL78845ASRH

TABLE 7. SET PERIOD TRIGGER HISTOGRAM DATA

BIN	FREQUENCY	TOL %	BIN	FREQUENCY	TOL %
VREF HISTOGRAM DATA FOR PERIOD TRIGGER RUNS					
-2.00	0	-2.0	0.60	166	0.6
-1.90	0	-1.9	0.70	74	0.7
-1.80	0	-1.8	0.80	98	0.8
-1.70	1	-1.7	0.90	14	0.9
-1.60	1	-1.6	1.00	75	1.0
-1.50	0	-1.5	1.10	71	1.1
-1.40	0	-1.4	1.20	18	1.2
-1.30	0	-1.3	1.30	1	1.3
-1.20	0	-1.2	1.40	0	1.4
-1.10	0	-1.1	1.50	0	1.5
-1.00	2	-1.0	1.60	0	1.6
-0.90	37	-0.9	1.70	0	1.7
-0.80	63	-0.8	1.80	0	1.8
-0.70	166	-0.7	1.90	0	1.9
-0.60	222	-0.6	2.00	0	2.0
-0.50	28	-0.5	2.10	0	2.1
-0.40	0	-0.4	2.20	0	2.2
-0.30	0	-0.3	2.30	0	2.3
-0.20	0	-0.2	2.40	0	2.4
-0.10	0	-0.1	2.50	0	2.5
0.00	0	0.0	2.60	0	2.6
0.10	0	0.1	2.70	0	2.7
0.20	0	0.2	2.80	0	2.8
0.30	0	0.3	2.90	0	2.9
0.40	0	0.4	3.00	0	3.0
0.50	1	0.5			

TABLE 7. SET PERIOD TRIGGER HISTOGRAM DATA (Continued)

BIN	FREQUENCY	TOL %	BIN	FREQUENCY	TOL %
VOUT HISTOGRAM DATA FOR PERIOD TRIGGER RUNS					
-1.00	0	-1.0	0.60	0	0.6
-0.90	0	-0.9	0.70	0	0.7
-0.80	0	-0.8	0.80	2	0.8
-0.70	0	-0.7	0.90	0	0.9
-0.60	0	-0.6	1.00	0	1.0
-0.50	0	-0.5	1.10	0	1.1
-0.40	2	-0.4	1.20	0	1.2
-0.30	126	-0.3	1.30	0	1.3
-0.20	367	-0.2	1.40	0	1.4
-0.10	25	-0.1	1.50	0	1.5
0.00	0	0.0	1.60	0	1.6
0.10	0	0.1	1.70	0	1.7
0.20	126	0.2	1.80	0	1.8
0.30	392	0.3	1.90	0	1.9
0.40	0	0.4	2.00	0	2.0
0.50	0	0.5			

SET Histograms Period Trigger 0.22µF, ISL78845ASRH

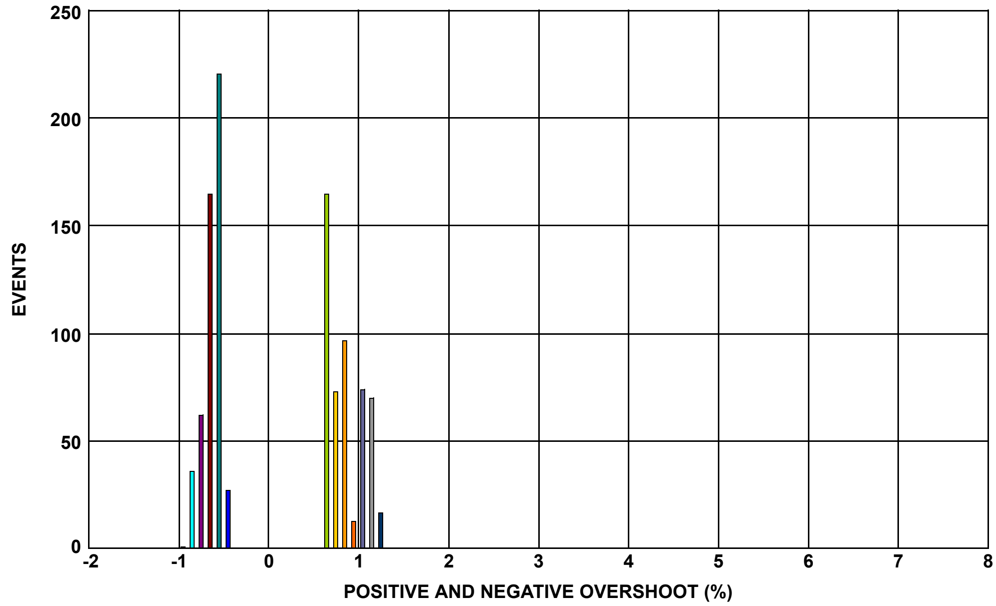


FIGURE 13. % POSITIVE AND NEGATIVE OVERSHOOT, TOTAL EVENTS = 520, AREA OF CS = 1.30653266331658 x 10^{-4} cm^2

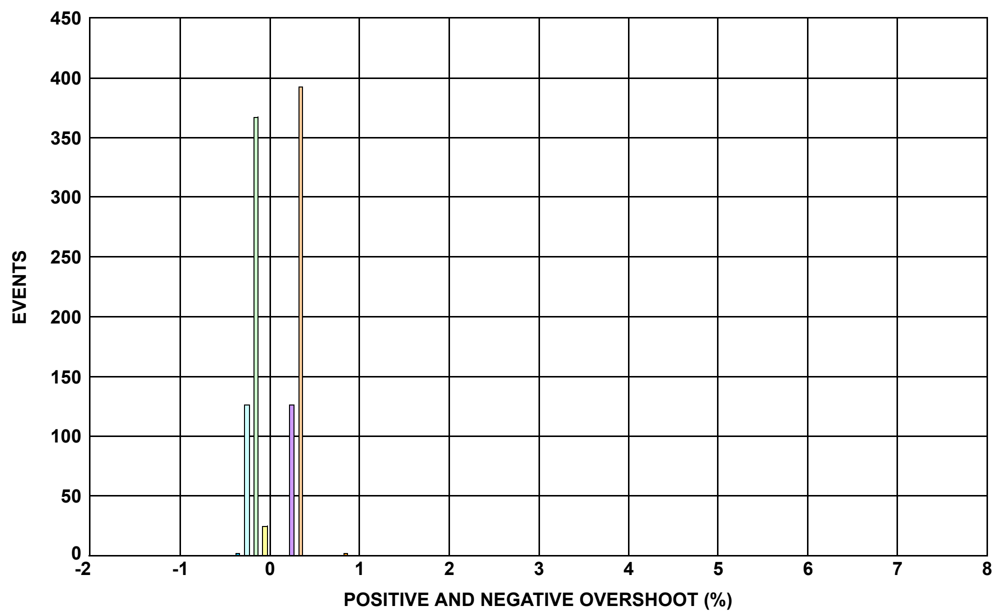


FIGURE 14. % POSITIVE AND NEGATIVE OVERSHOOT, TOTAL EVENTS = 520, AREA OF CS = 1.30653266331658 x 10^{-4} cm^2

NOTE: The scope set to trigger to period, when two rising edges are not detected within a 1.2T window. The two peaks seen represent positive and negative transients.

Typical Captures on Pulse Width Trigger

ISL78843ASRH

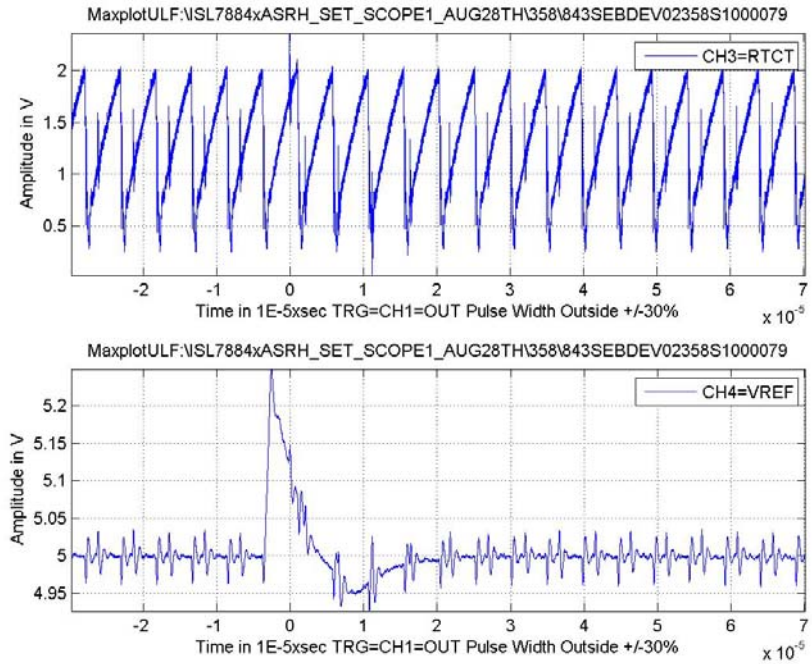


FIGURE 15. SET +25°C LET43 CLOSED, 0.22µF, V_{REF} POSITIVE TRANSIENT

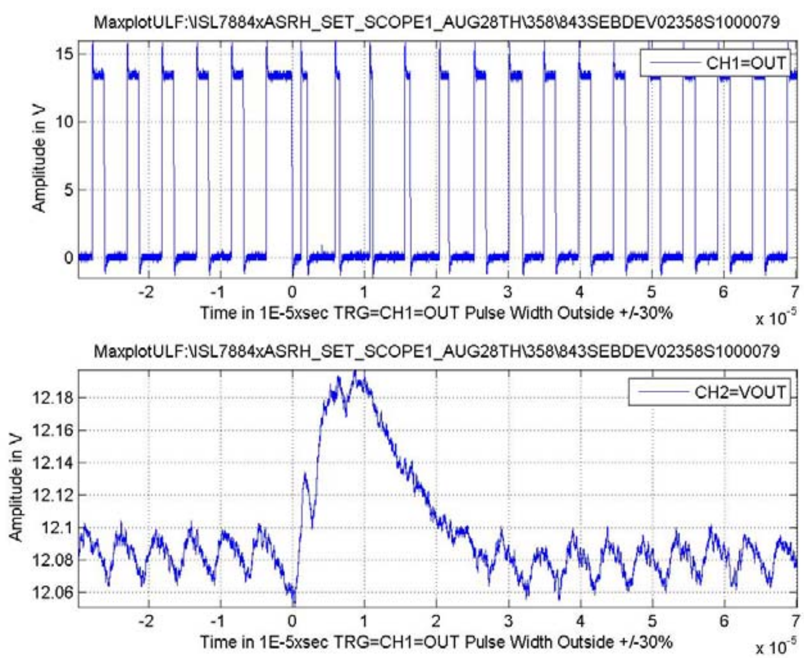


FIGURE 16. SET +25°C LET43 CLOSED, 0.22µF, V_{OUT} POSITIVE TRANSIENT

ISL78843ASRH (CONTINUED)

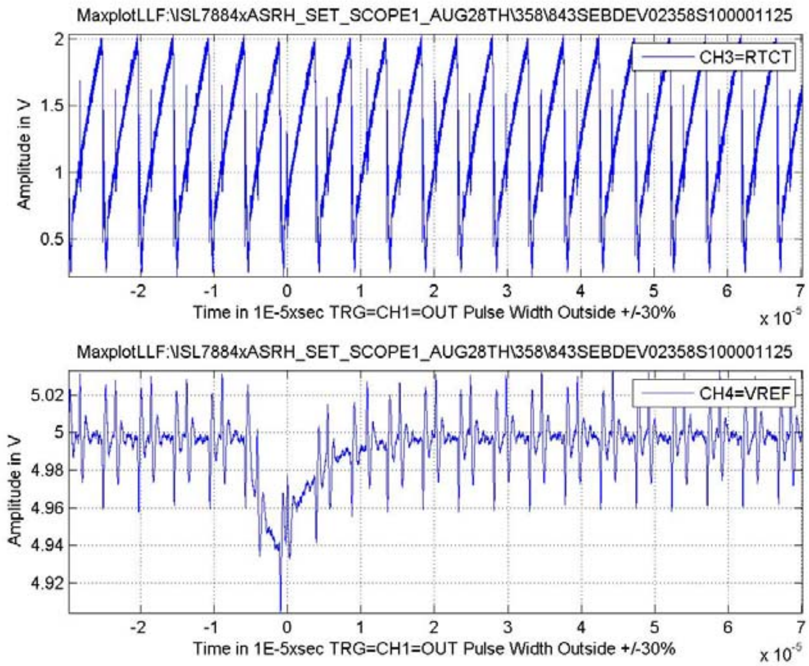


FIGURE 17. SET +25°C LET43 CLOSED, 0.22µF, V_{REF} NEGATIVE TRANSIENT

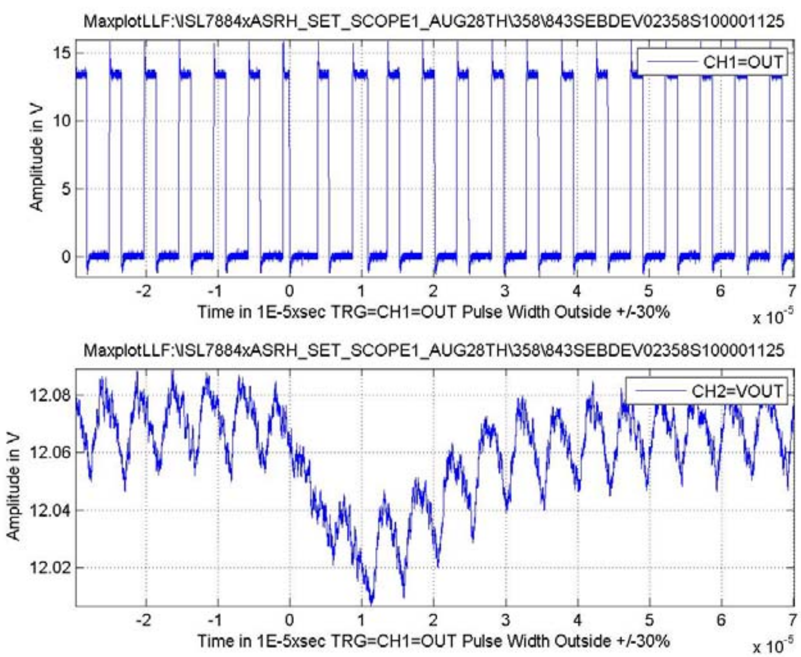


FIGURE 18. SET +25°C LET43 CLOSED, 0.22µF, V_{OUT} NEGATIVE TRANSIENT

ISL78845ASRH

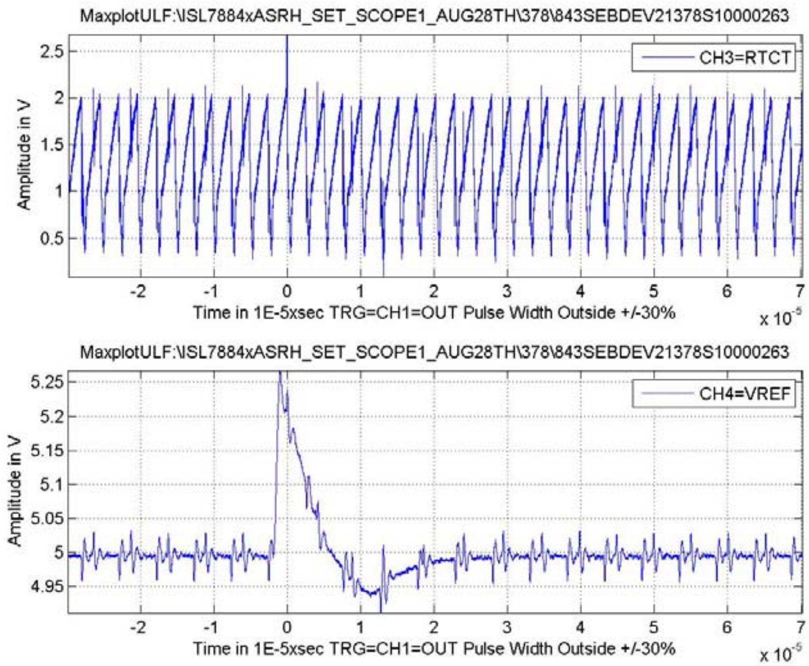


FIGURE 19. SET +25°C LET43 CLOSED, 0.22µF, V_{REF} POSITIVE TRANSIENT

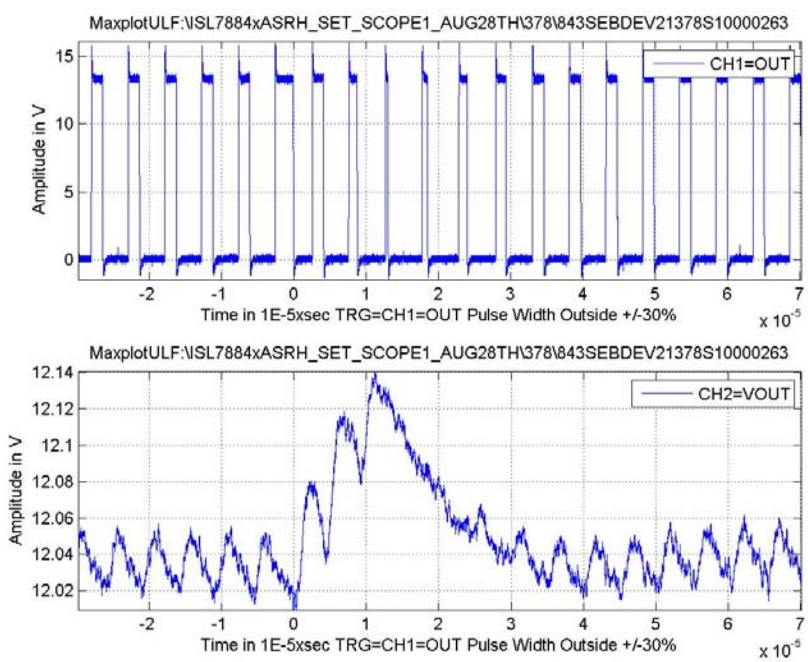


FIGURE 20. SET +25°C LET43 CLOSED, 0.22µF, V_{OUT} POSITIVE TRANSIENT/OUT WIDE FOLLOWED BY NARROW PULSES

ISL78845ASRH (CONTINUED)

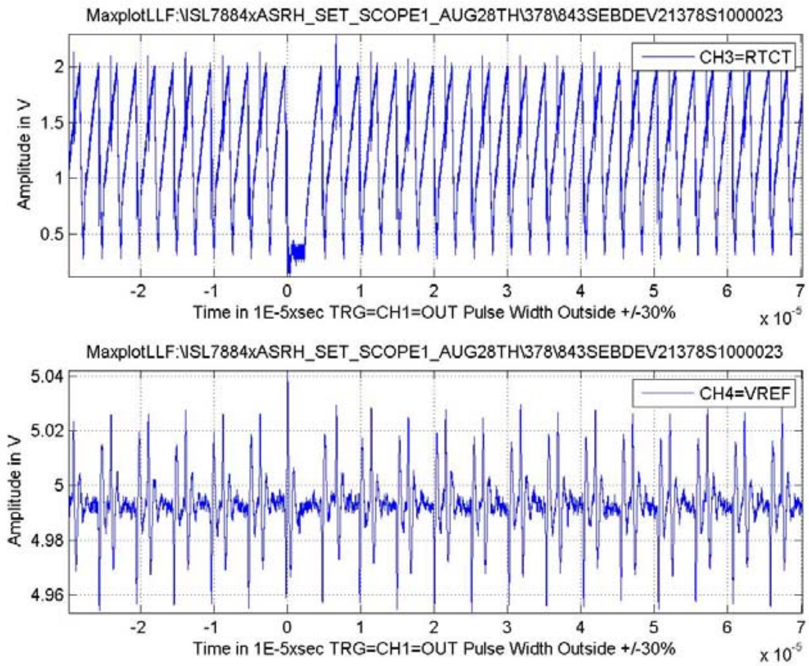


FIGURE 21. SET +25°C LET43 CLOSED, 0.22µF, V_{REF} NEGATIVE TRANSIENT

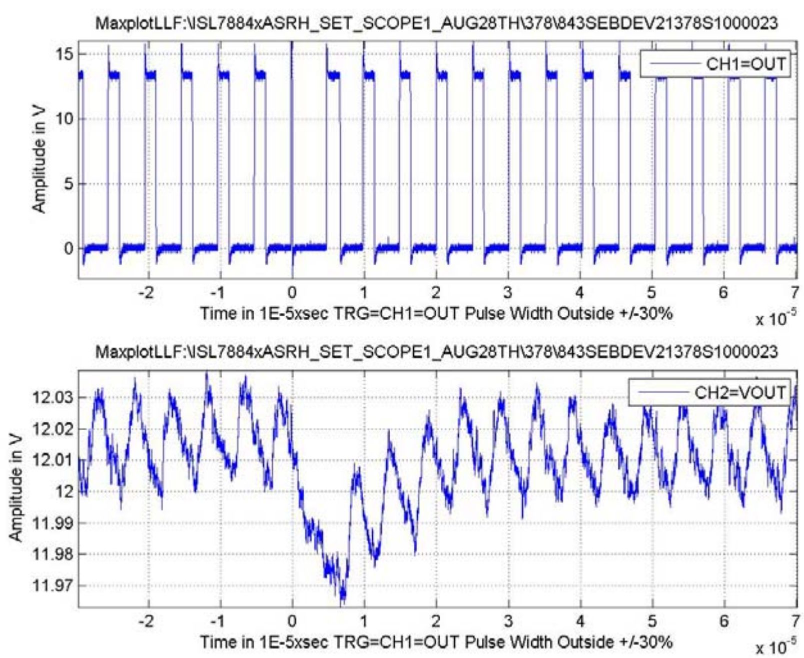


FIGURE 22. SET +25°C LET43 CLOSED, 0.22µF, V_{OUT} NEGATIVE TRANSIENT/OUT NARROW PULSE

NOTE: Worst case transient waveforms shown. For a distribution on the transients on V_{REF} and V_{OUT} refer to histograms on pages 8 through 15.

Typical Captures on Period Trigger

ISL78843ASRH

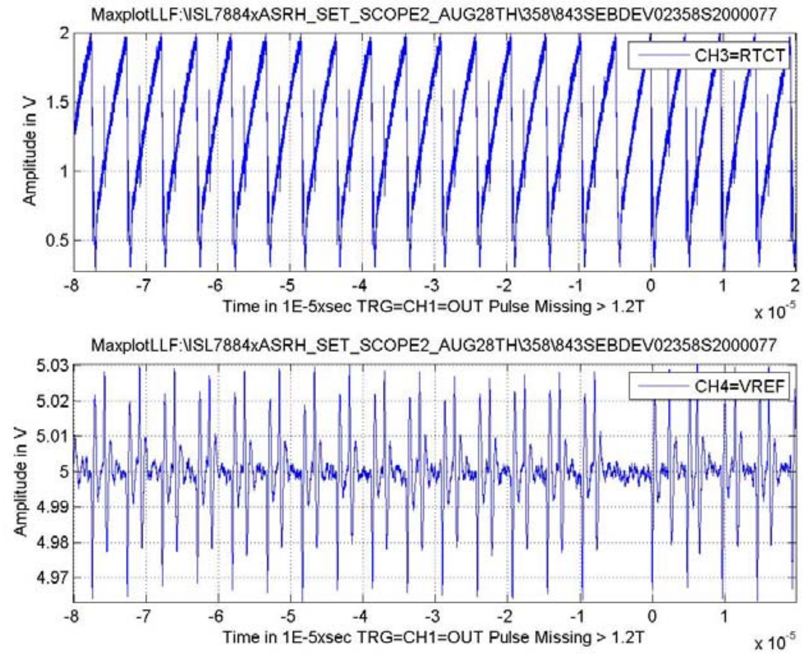


FIGURE 23. SET +25°C LET43 CLOSED, 0.22µF, V_{REF} NO TRANSIENT

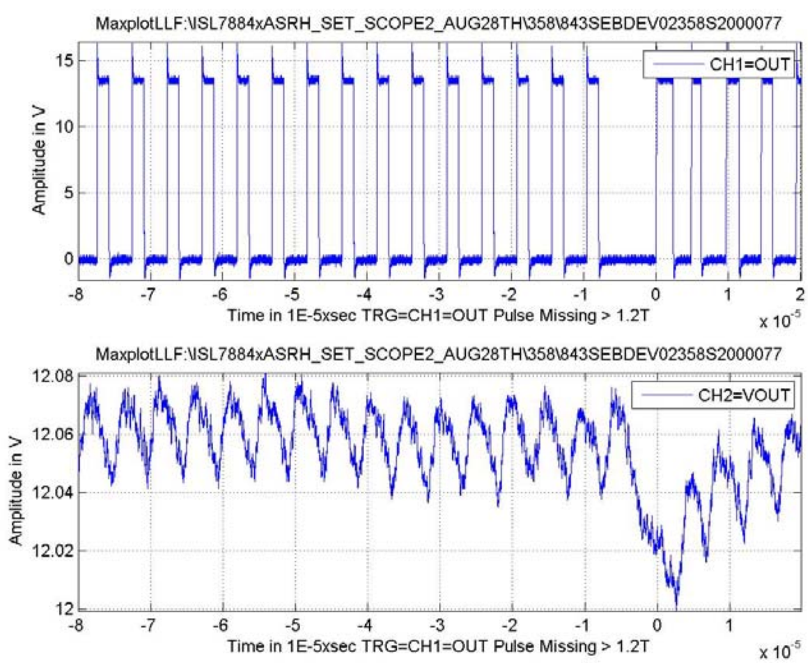


FIGURE 24. SET +25°C LET43 CLOSED, 0.22µF, V_{OUT} NEGATIVE TRANSIENT/OUT PULSE MISS

ISL78843ASRH (CONTINUED)

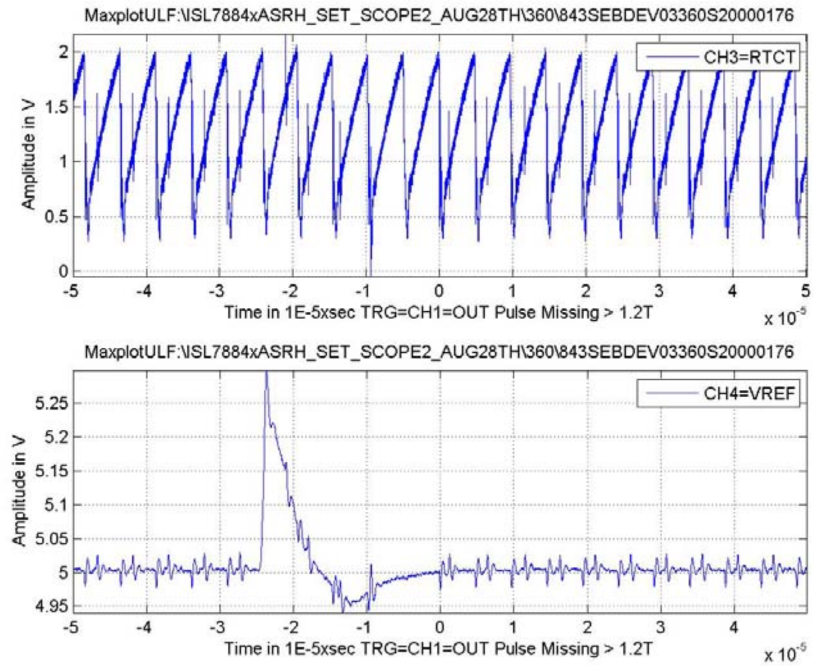


FIGURE 25. SET +25°C LET43 CLOSED, 0.22µF, V_{REF} POSITIVE TRANSIENT

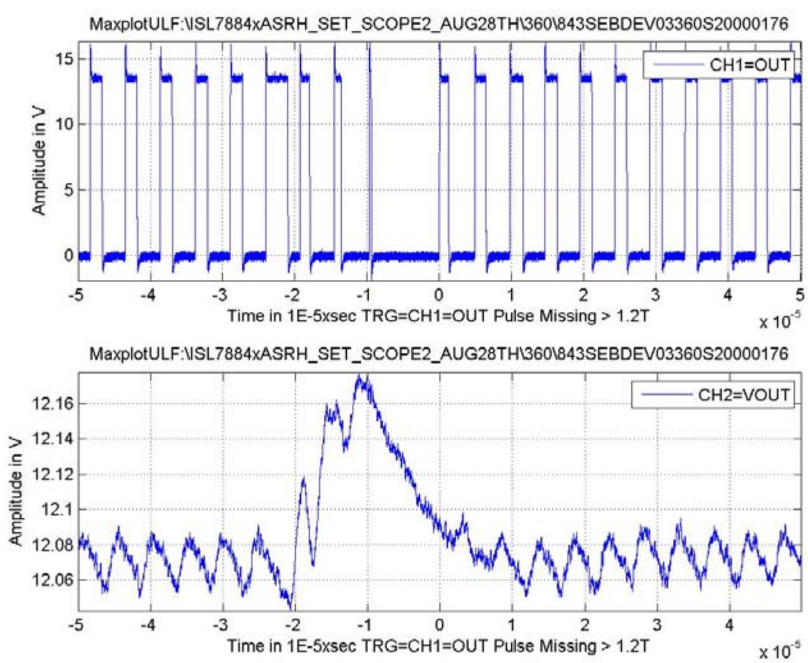


FIGURE 26. SET +25°C LET43 CLOSED, 0.22µF, V_{OUT} POSITIVE TRANSIENT/OUT PULSE MISS

ISL78845ASRH

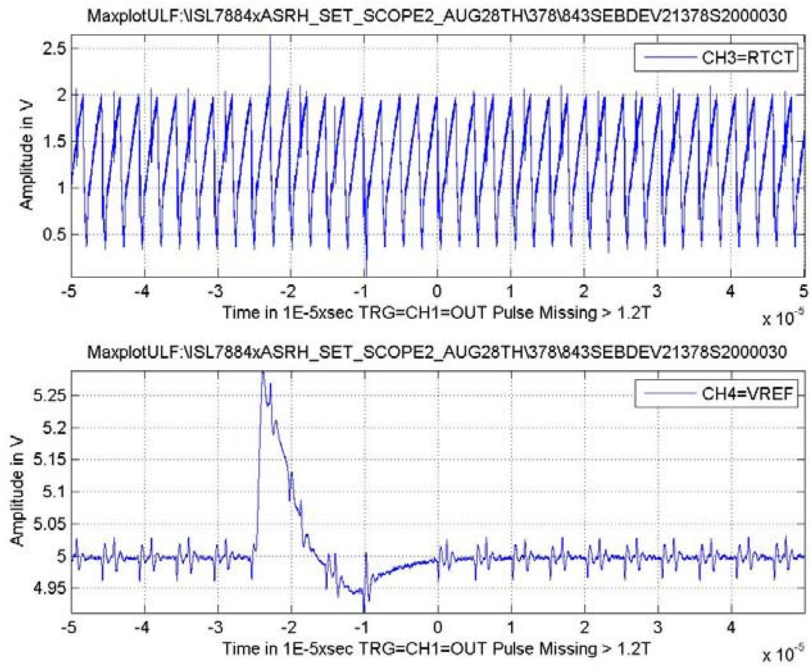


FIGURE 27. SET +25°C LET43 CLOSED, 0.22µF, V_{REF} POSITIVE TRANSIENT

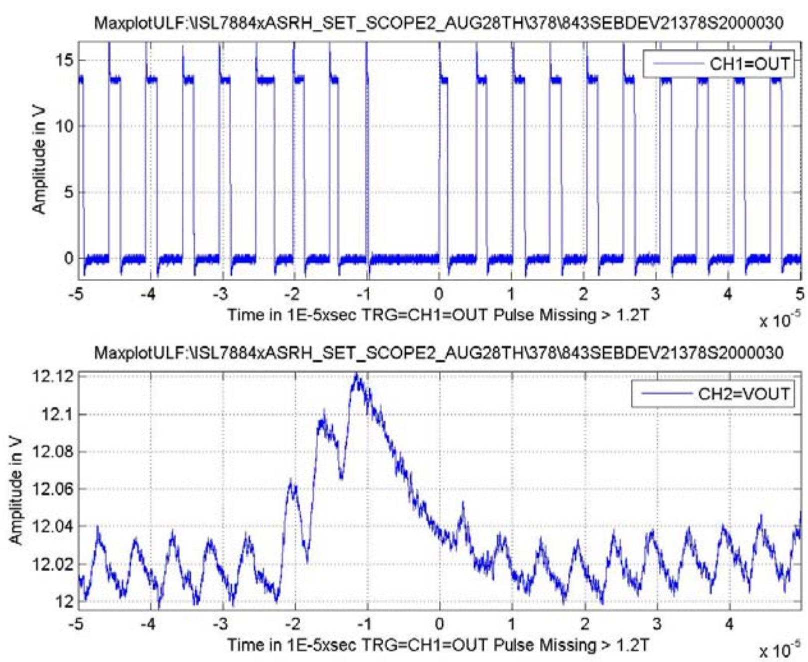


FIGURE 28. SET +25°C LET43 CLOSED, 0.22µF, V_{OUT} POSITIVE TRANSIENT/OUT PULSE MISS

ISL78845ASRH (CONTINUED)

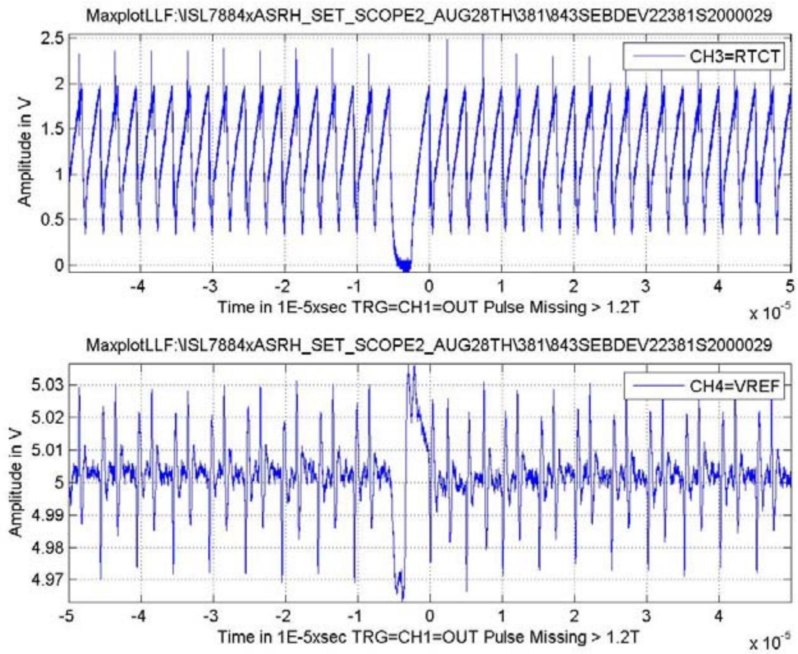


FIGURE 29. SET +25°C LET43 CLOSED, 0.22µF, RTCT/V_{REF} TRANSIENT

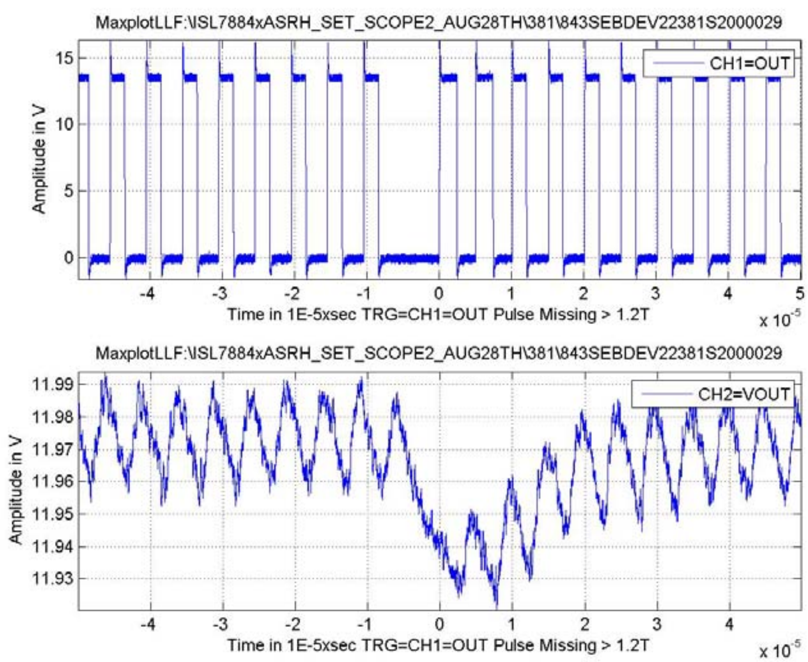


FIGURE 30. SET +25°C LET43 CLOSED, 0.22µF, V_{OUT} NEGATIVE TRANSIENT/OUT PULSE MISS

NOTE: Worst case transient waveforms shown. For a distribution on the transients on V_{REF} and V_{OUT} refer to histograms on pages 9 through 15.

Details of Destructive SEB/L Tests Performed

TABLE 8. DESTRUCTIVE SEB/L TESTS

TEMP (°C)	LET Mev (mg/cm^2)	V_{REF} CAP (µF)	V_{DD} (V)	LATCH EVENTS		CUMULATIVE FLUENCE (PARTICLES/cm^2)		CUMULATIVE CROSS SECTION (cm^2)		UNITS		SEB/L
+125	86	0.22	14.7		0		9.98E+06		1.00E-07		1	PASS
+125	86	0.22	14.7		0		9.98E+06		1.00E-07		1	PASS
+125	86	0.22	14.7		0		1.00E+07		1.00E-07		1	PASS
+125	86	0.22	14.7		0		9.98E+06		1.00E-07		1	PASS
				Total Events:	0	Overall Fluence:	3.99E+07	Overall CS:	2.50E-08	Total Units:	4	

NOTE: SEB/L tests were performed on the ISL78843ASRH, which is a metal mask variant of the ISL7884xASRH family of devices. The differences between the variants are listed in "Test Setup Diagrams" on page 3 under part details.

TABLE 9. SUBSEQUENT SEB TESTING RESULTS IN NOVEMBER AND DECEMBER, 2014

TEMP (°C)	LET (MeV-cm^2/mg) AND ANGLE	V_{REF} CAP (µF)	V_{DD} (V)	TOTAL FLUENCE (ions/cm^2)	NET CROSS SECTION (cm^2)	UNITS TESTED	SEB
+125	86∠0°	0.22	13.5	$1.6x10^7$	$6.25x10^{-8}$	8	PASS
+125	43∠60°	0.22	14.4	$1.6x10^7$	$6.25x10^{-8}$	8	PASS

Subsequent SEB testing in November and December of 2014 yielded the results (shown in Table 9) using two new production lots. SEB failures occurred above the V_{DD} limits cited in Table 9. The results are marginally worse than the original characterization above which used LET = 43 MeV•cm^2/mg at 60° incidence for an effective LET of 86 MeV•cm^2/mg.

Binomial Estimated Cross Section for LET86

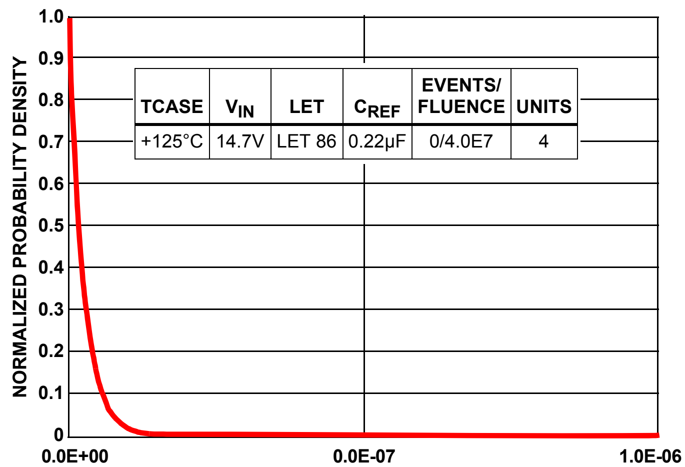


FIGURE 31. BINOMIAL ESTIMATED CROSS SECTION FOR DESTRUCTIVE SEL (cm^2)

NOTE: During the single event latch-up testing of the four devices, no destructive latch-up events were observed at a total fluence of $3.99x10^7$ particles/cm^2. The above chart aims at estimating the area of cross section for destructive single event latch-up that provides for a 99% confidence level. This turns out to be $1.2x10^{-7}$ cm^2.

Nondestructive Latch-up Events

Further SEL/B testing of the ISL78843ASRH and ISL78845ASRH conducted in May 2014 demonstrated that the DUTs experienced a disruption to normal operation (shutdown), which requires manual intervention to restart. Previously reported momentary disruptions or SEFIs have been identified incorrectly as such due to the accelerated nature of single event effect testing. A new test approach, in which the ion beam was stopped after the DUT shuts down, proves that the device enters a nondestructive latch-off state and a power cycle is needed to return to normal operation. The soft latch causes no damage to the device, indicated by no increase in operating current after restart. Full details are presented in Table 10.

Additional latch-up testing was done in a closed loop configuration at a lower input voltage and temperature. The device was verified to experience the nondestructive latch-ups. Details of the test are summarized in Table 11.

TABLE 10.

TEMP (°C)	LET (Mev mg/cm^2)	V_{REF} CAP (µF)	V_{DD} (V)	PART NUMBER	I_{DD} PREEXPOSURE (mA)	LATCH EVENTS	I_{DD} POSTEXPOSURE (mA)	FLUENCE (PARTICLES/cm^2)	CROSS SECTION (cm^2)	UNIT ID
+125	86	0.22	14.7	ISL78843ASRH	10	15	10	1.00E+07	1.50E-06	1
+125	86	0.22	14.7	ISL78845ASRH	10	12	10	1.00E+07	1.20E-06	2
+125	60	0.22	14.7	ISL78843ASRH	10	3	10	1.00E+07	3.00E-07	1
+125	60	0.22	14.7	ISL78845ASRH	10	1	10	1.00E+07	1.00E-07	2
+125	43	0.22	14.7	ISL78843ASRH	10	0	10	1.00E+07	1.00E-07	1
+125	43	0.22	14.7	ISL78845ASRH	10	0	10	1.00E+07	1.00E-07	2

TABLE 11.

TEMP (°C)	LET (Mev mg/cm^2)	V_{REF} CAP (µF)	V_{DD} (V)	PART NUMBER	I_{DD} PREEXPOSURE (mA)	LATCH EVENTS	I_{DD} POSTEXPOSURE (mA)	FLUENCE (PARTICLES/cm^2)	CROSS SECTION (cm^2)	V_{IN} (V)	V_{OUT} (V)	I_{OUT} (A)
+45	86	0.22	13	ISL78840ASRH	33	14	33	2.00E+07	7.00E-07	24	12	1

Die and Mask Number Details

ISL78843ASRH

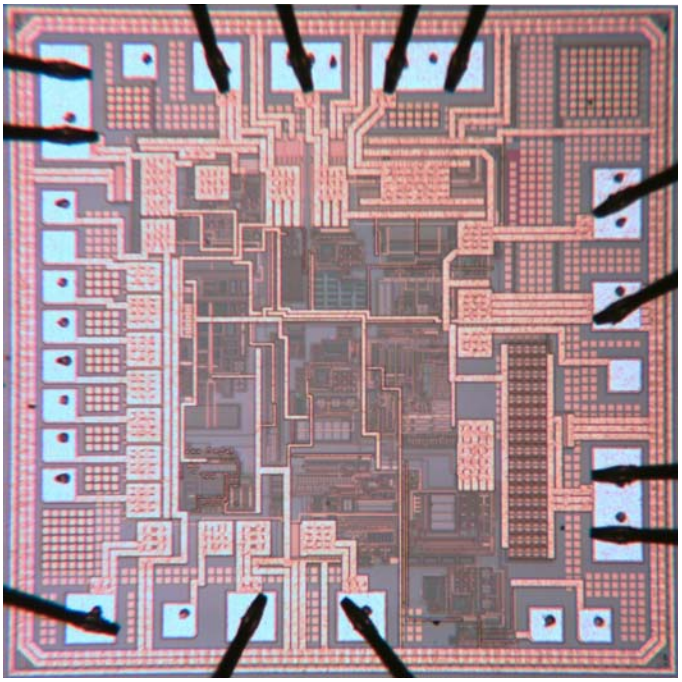


FIGURE 32. DIE MAP

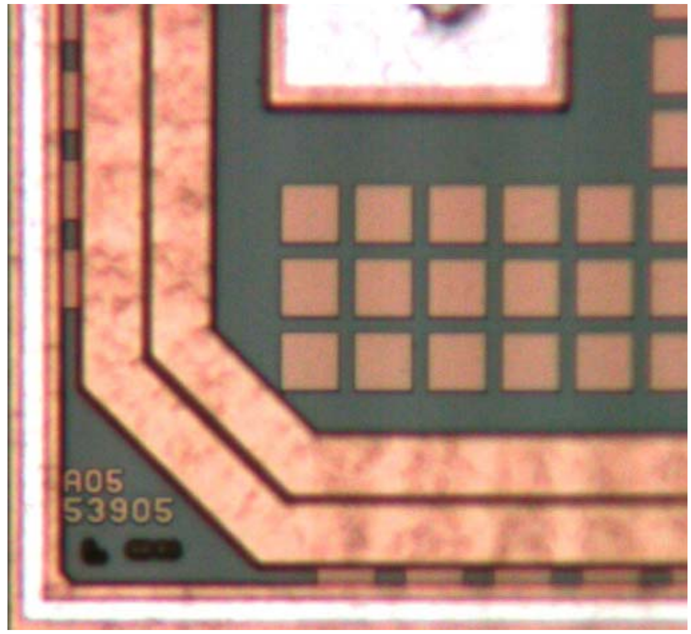


FIGURE 33. MASK NUMBER

ISL78845ASRH

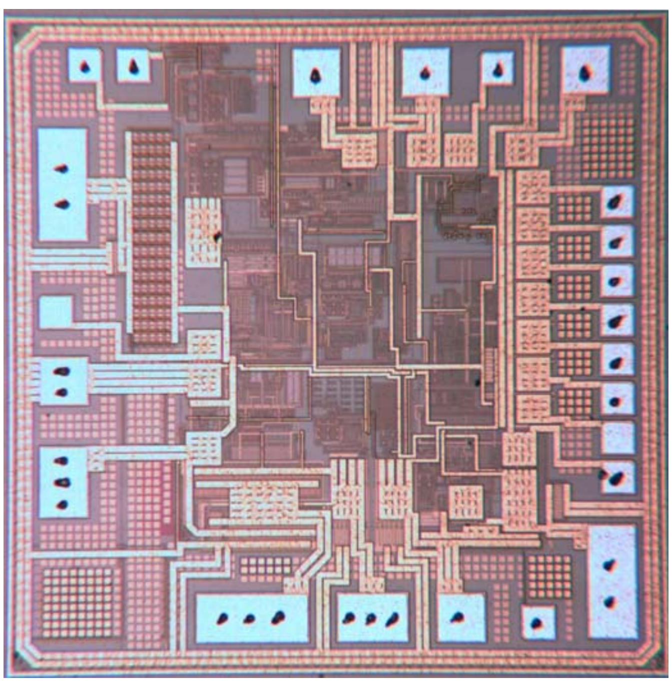


FIGURE 34. DIE MAP

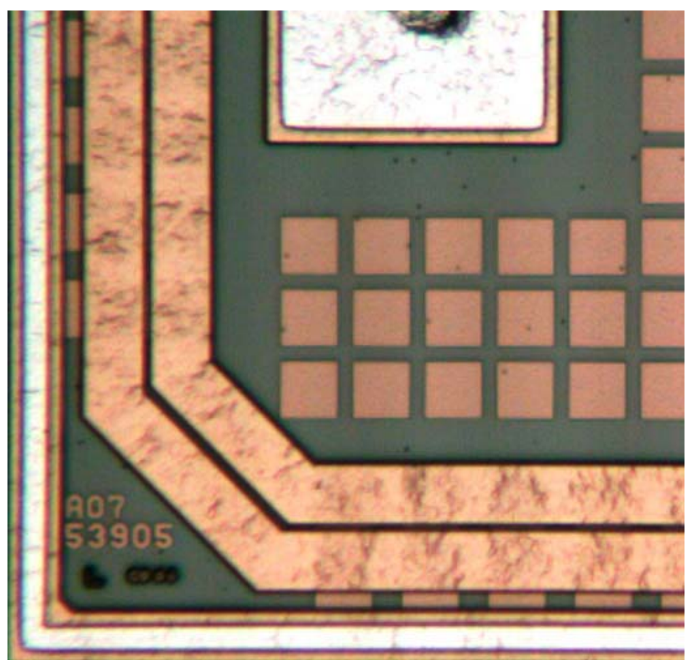


FIGURE 35. MASK NUMBER

SEE Test Summary/Conclusion

Single Event Burnout/Latch-Up: No Single Event Burnout (SEB) was observed for the device up to an LET value of 86 MeV•cm^2/mg (+125°C) and V_{DD} ≤ 13.5V. No destructive Single Event Latch-up (SEL) events were observed for the device up to an LET value of 86 MeV•cm^2/mg (+125°C, V_{REF} CAP = 0.22µF). A destructive event occurs when the supply current of the device increases greater than 5% as indicated in Notes 3 and 4. Nondestructive latch-up events that shut down part operation and required a power cycle to restore the part to pre-event operation were observed and are described in section "Nondestructive Latch-up Events" on page 25

Single Event Transient: The device, however, is sensitive to soft errors with a LET threshold around 43 MeV•cm^2/mg. No soft error was observed which caused more than one PWM output pulse dropout at LET value of 43 MeV.cm^2/mg.

Table 12 provides an overall summary of the SEE tests results.

TABLE 12. OVERALL SUMMARY OF THE SEE TESTS RESULTS

TEST	MISSED PULSES (TYP)	MISSED PULSES (MAX)	TEMP (°C)	LET (Note 2)	UNITS	REMARKS
SEB/L	–	–	+125	86	MeV•cm^2/mg	No destructive single event burnouts or destructive latch-up events occurred up to V_{DD} = 13.5V using gold at 86 MeV•cm^2/mg and 0° incidence, at a fluence of 1.6E+7 particles/cm^2 (Notes 3, 4, 5)
SEB/L	–	–	+125	86	MeV•cm^2/mg	No destructive single event burnouts or destructive latch-up events occurred up to V_{DD} = 14.4V using silver at 43 MeV-cm2/mg and 60° incidence, at a fluence of 1.6E+7 particles/cm^2 (Notes 3, 4, 5)
SET	1	–	+25	43	MeV•cm^2/mg	V_{DD} = 13.5V

NOTES:

1. LET86 was achieved by using a LET43 beam and rotating the test sample by 60°.
2. SEE tests performed at a switching frequency of 200kHz, RT = 17.8k, CT = 390pF for the ISL78843ASRH and CT = 220pF for the ISL78845ASRH. SEB/L test done in a standalone open loop configuration and the SET tests a closed loop configuration.
3. SEB is said to have occurred if an increase in the I_{DD} of greater than 5% is measured after exposure to the beam. A 0.22µF capacitor was connected from the VREF pin to GND for the purpose of bypass.
4. SEL results: No destructive latch-up conditions were observed, a destructive SEL is categorized by an increase in the I_{DD} current greater than 5% after exposure. A 0.22µF capacitor was used from VREF pin to GND for bypass.
5. The recommended highest operating V_{DD} for the device is 13.2V, which is below the single event breakdown survival voltage of 13.5V for normal incidence LET = 86 MeV•cm^2/mg.
6. The acronym "SEB/L" in this report refers to single effect burnout and latch-up.
7. The acronym "SET" in this report refers to single event transient.

Revision History

DATE	REV.	DESCRIPTION
Feb 6, 2018	1.00	Applied New Header/Footer. Updated Figures 5 and 6. Updated Related Literature. Added Revision History. Updated Disclaimer
May 15, 2015	0.00	Initial release

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