



HSYE-117RH Voltage Linear Regulator Total Ionizing Dose Test Report

Megan Casey¹, Anthony Phan², Alyson Topper²

1. NASA Goddard Space Flight Center, Code 561, Greenbelt, MD 20771
2. Science Systems and Applications, Inc. (SSAI), c.o. NASA Goddard Space Flight Center

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1. INTRODUCTION

The purpose of this test was to validate the Intersil HSYE-117RH-Q flight lot for use in the fabrication of Europa Clipper Propulsion subsystem flight hardware. This test shall serve as the radiation lot acceptance test (RLAT) for the flight lot date with wafer lot number G3X3CQC and lot date code (LDC) 1830. Low dose rate (LDR) irradiations have been performed by the manufacturer, but only to 100 krad(Si). This test was a follow-on to the original Radiation Lot-Specific Acceptance Testing (RLAT) performed on this LDC. Application-specific load currents were used for the line regulation and load regulation measurements. All other parameters were measured with standard bias conditions as specified in the datasheet.

2. DEVICES TESTED

2.1. Part Background

The HSYE-117RH is an adjustable positive voltage linear regulator capable of operating with input voltages up to 40 V_{DC}. The output voltage is adjustable from 1.25 V to 37 V with two external resistors, and the device is capable of sourcing from 5 mA to 1.25 A max.

2.2. Device Under Test (DUT) Information

Six (6) parts from the flight lot of HSYE-117RHs were provided by the Europa Clipper Propulsion system to Code 561 for TID testing. One of the six was used as a control. All specifications and descriptions are according to the Intersil datasheet FN4560 Rev 10.00 March 25, 2014, with the exception of the line regulation and load regulation, which were tested with application-specific load currents. More information can be found in Table 1.

Table 1. Part Identification Information

Part Number	HSYE-117RH-Q
REAG ID#	19-007
Manufacturer	Intersil
Lot Date Code	1830
Wafer Lot	G3X3CQC
Quantity Tested	6
Part Function	Voltage Linear Reference
Part Technology	Bipolar
Package	3-Pad Ceramic Leadless Chip Carrier (CLCC) – SMD.5

BOTTOM VIEW

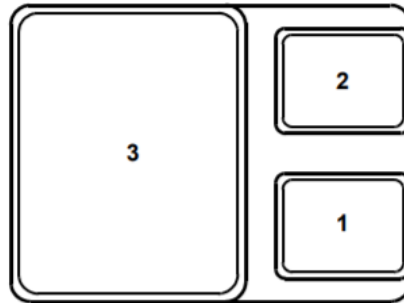


Fig. 1. Pinout of HSYE-117RH.

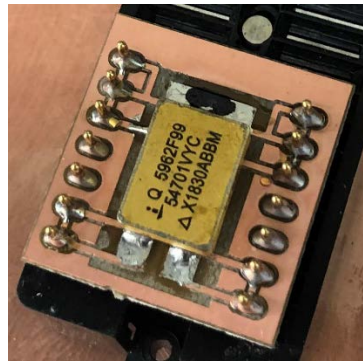


Fig. 2. Picture of HSYE-117RH.

3. TEST SETUP

The HSYE-117RH was soldered to a custom copper daughter card then inserted into a ZIF socket. The ZIF socket was on the test board. Two Keithley 2425s and one HP 34401A voltmeter were used to characterize the HSYE117's parameters.

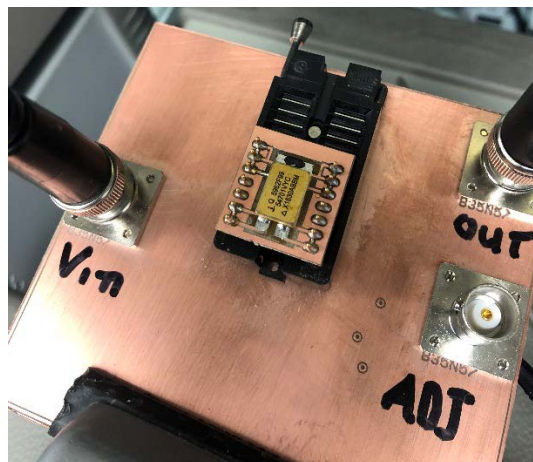


Fig. 3. Picture of DUT on test board

General test procedures were in accordance with MIL-STD-883, Method 1019, Condition D. Parts were serialized randomly. ESD procedures were followed during test and transfer of the devices between irradiation chamber and characterization. Exposures were performed at ambient laboratory temperature.

4. TEST DESCRIPTION

4.1 Irradiation Conditions

Radiation testing was done by exposing the parts to gamma radiation at a low dose rate. Six (6) parts were tested, five (5) exposed to radiation and one as a control. Prior to the first radiation dose, all six parts were electrically tested. After each exposure level, the parts were tested again and returned to radiation within the time limits defined by MIL-STD-883, Method 1019. All five (5) parts were unbiased during the irradiation steps. See Table 2 for more information.

Table 2. Device Grouping

Group	Qty	Bias	Dose Rate	Exposure Level Steps (krad(Si))
1	5	Unbiased	10 mrad(Si)/s	0, 23, 50, 75, 100, 122.5, 128.5
3	1	Control	N/A	N/A

The biased parts were placed in ZIF socket adapters on a wire wrapped board. During irradiation, DUTs were grounded.

4.2 Electrical Tests

Specification thresholds were set in accordance with the Intersil datasheet FN4560 Rev 10.00 March 25, 2014.

All data from the DC electrical tests in Table 3 were logged in excel spreadsheet files. Data for all parts were measured and logged.

Table 3. List of Electrical Tests Performed

Test	Symbol	Conditions $T_A = +25^\circ\text{C}$ $V_{\text{DIFF}} = 3\text{ V}$	Specifications		
			Min	Typ	Max
Reference Voltage	V_{REF}	$V_{\text{DIFF}} = 3\text{ V}$ $V_{\text{DIFF}} = 40\text{ V}$ $5.0\text{ mA} \leq I_{\text{OUT}} \leq 5.5\text{ mA}$	1.20 V	1.255 V	1.30 V
Line Regulation	R_{LINE}	$V_{\text{REF}} = V_{\text{OUT}} - V_{\text{ADJ}}$ $3\text{ V} \leq V_{\text{DIFF}} \leq 40\text{ V}$ $I_{\text{OUT}} = 20, 50\text{ mA}$	-0.02%	0.005%	0.02%
Load Regulation	R_{LOAD}	$V_{\text{DIFF}} = 3\text{ V}$ $I_{\text{OUT}} = 20, 50\text{ mA}$	-1.5%	-0.1%	1.5%
Adjust Pin Current	I_{ADJ}	$V_{\text{DIFF}} = 3\text{ V}$ $V_{\text{DIFF}} = 40\text{ V}$ $5.0\text{ mA} \leq I_{\text{OUT}} \leq 5.5\text{ mA}$		64 μA	100 μA

5. FAILURE CRITERIA

The parameter limits are defined as those listed in the HSYE117RH datasheet FN4560 Rev 10.00 March 25, 2014.

6. SOURCE REQUIREMENTS

The total dose source is in a room air source gamma ray facility, which is compliant with MIL-STD-883, Method 1019. Dosimetry is NIST traceable.

7. RESULTS

Reference Voltage, Load Regulation, and Adjust Pin Current thresholds were not exceeded during any of the irradiation steps. Line Regulation parameters increased above the maximum specification after 75 krad(Si). All results, in graphical form and raw table form, are shown below.

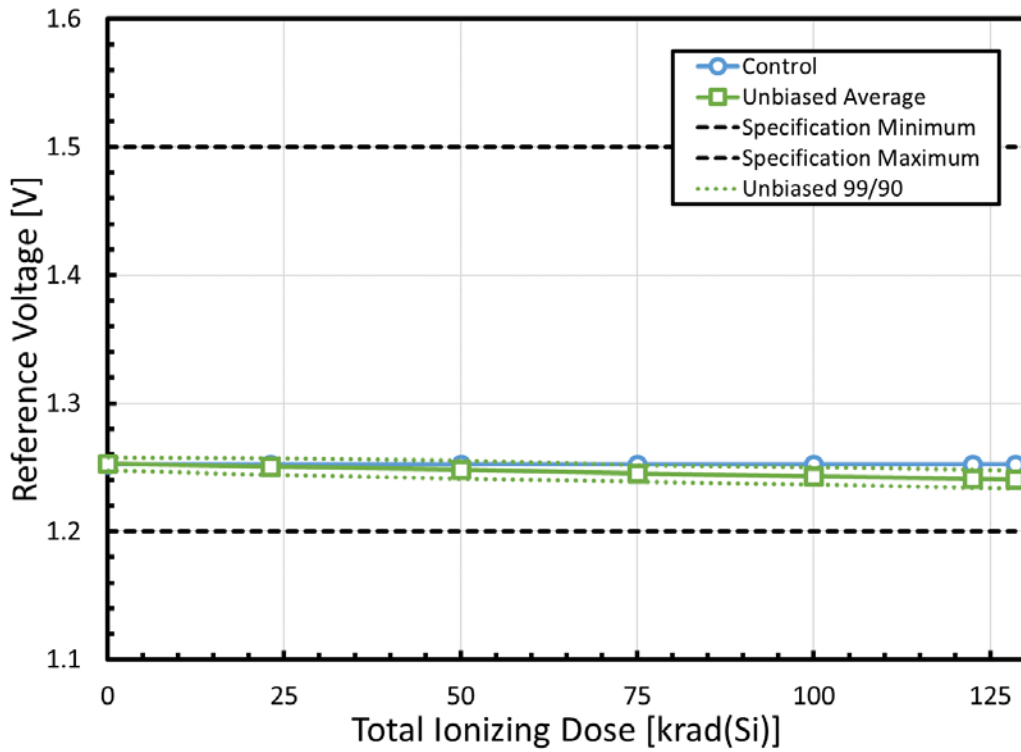


Fig. 5. Reference voltage over dose.

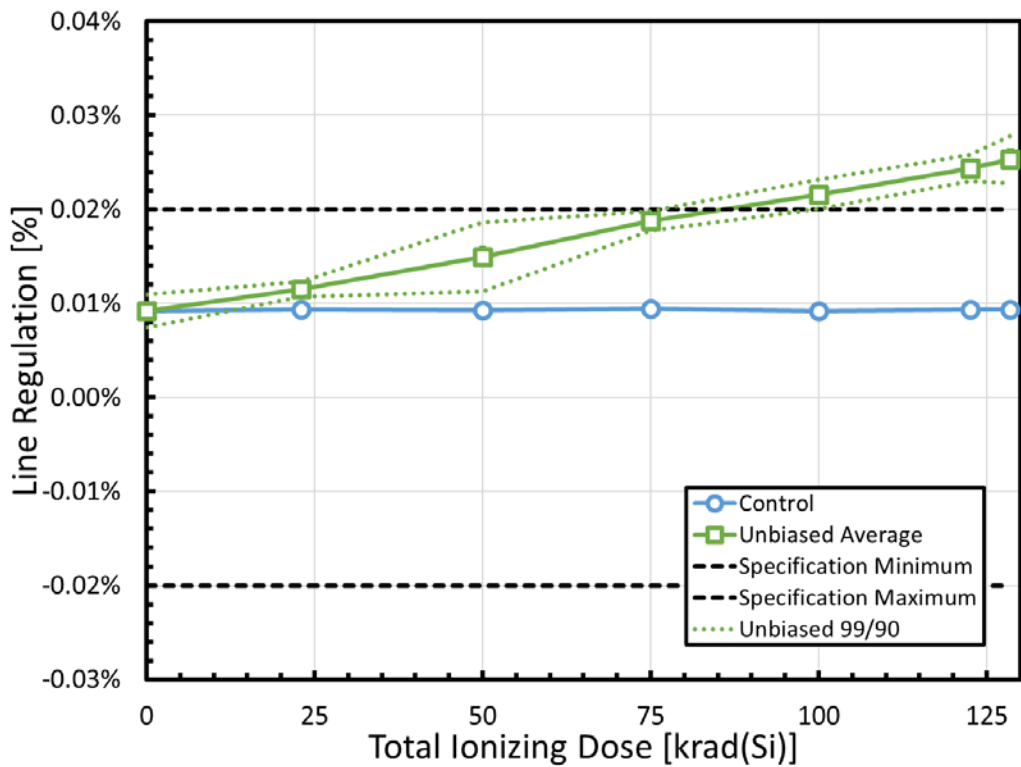


Fig. 6. Line regulation over dose.

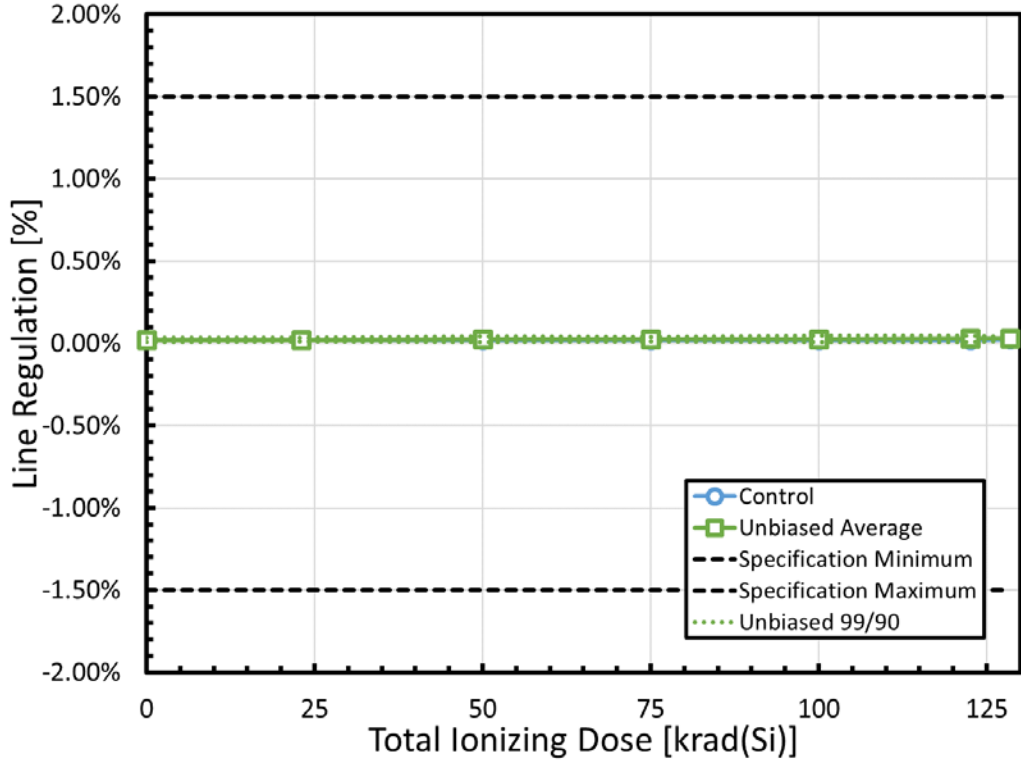


Fig. 7. Load Regulation over dose.

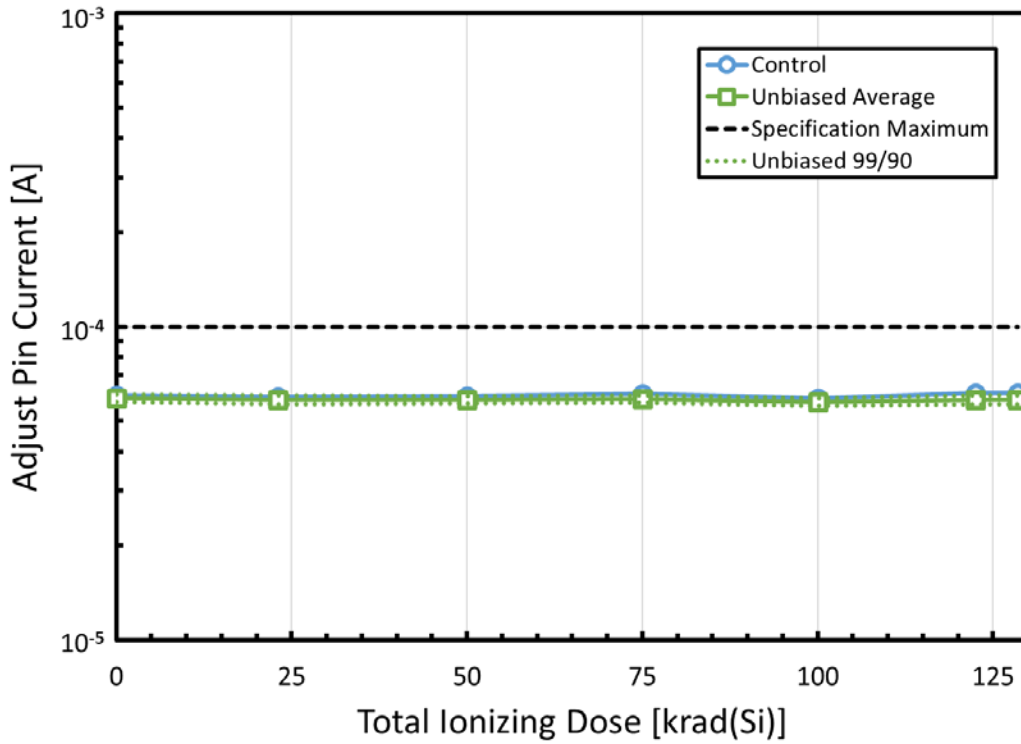


Fig. 8. Adjust Pin Current over dose.

Table 5. Raw data

Reference Voltage	Total Ionizing Dose						
	Pre-Rad	23 krad(Si)	50 krad(Si)	75 krad(Si)	100 krad(Si)	122.5 krad(Si)	128.5 krad(Si)
Control (DUT11)	1.25	1.25	1.25	1.25	1.25	1.25	1.25
DUT12	1.25	1.25	1.25	1.25	1.25	1.24	1.24
DUT13	1.25	1.25	1.25	1.24	1.24	1.24	1.24
DUT14	1.25	1.25	1.25	1.25	1.24	1.24	1.24
DUT15	1.25	1.25	1.25	1.24	1.24	1.24	1.24
DUT16	1.25	1.25	1.25	1.24	1.24	1.24	1.24
Specification Minimum	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Specification Maximum	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Unbiased Avg	1.25	1.25	1.25	1.25	1.24	1.24	1.24
Unbiased Std Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unbiased +99/90	1.26	1.26	1.26	1.25	1.25	1.25	1.25
Unbiased -99/90	1.25	1.24	1.24	1.24	1.24	1.23	1.23
+Unbiased Error Bar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-Unbiased Error Bar	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Line Regulation	Total Ionizing Dose						
	Pre-Rad	23 krad(Si)	50 krad(Si)	75 krad(Si)	100 krad(Si)	122.5 krad(Si)	128.5 krad(Si)
Control (DUT11)	0.009%	0.009%	0.009%	0.009%	0.009%	0.009%	0.009%
DUT12	0.010%	0.012%	0.014%	0.019%	0.021%	0.025%	0.025%
DUT13	0.009%	0.012%	0.016%	0.019%	0.022%	0.025%	0.026%
DUT14	0.009%	0.012%	0.014%	0.019%	0.022%	0.024%	0.025%
DUT15	0.010%	0.011%	0.016%	0.019%	0.021%	0.024%	0.025%
DUT16	0.009%	0.011%	0.014%	0.019%	0.021%	0.024%	0.025%
Specification Minimum	-0.020%	-0.020%	-0.020%	-0.020%	-0.020%	-0.020%	-0.020%
Specification Maximum	0.020%	0.020%	0.020%	0.020%	0.020%	0.020%	0.020%
Unbiased Avg	0.009%	0.012%	0.015%	0.019%	0.022%	0.024%	0.025%
Unbiased Std Dev	0.000%	0.000%	0.001%	0.000%	0.000%	0.000%	0.001%
Unbiased +99/90	0.011%	0.012%	0.019%	0.020%	0.023%	0.026%	0.028%
Unbiased -99/90	0.007%	0.011%	0.011%	0.018%	0.020%	0.023%	0.023%
+Unbiased Error Bar	0.000%	0.000%	0.001%	0.000%	0.000%	0.000%	0.001%
-Unbiased Error Bar	0.001%	0.000%	0.001%	0.000%	0.000%	0.000%	0.000%

Load Regulation I _{LOAD} = 50 mA	Total Ionizing Dose						
	Pre-Rad	23 krad(Si)	50 krad(Si)	75 krad(Si)	100 krad(Si)	122.5 krad(Si)	128.5 krad(Si)
Control (DUT11)	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%
DUT12	0.02%	0.02%	0.02%	0.02%	0.03%	0.03%	0.03%
DUT13	0.02%	0.02%	0.03%	0.02%	0.02%	0.03%	0.03%
DUT14	0.02%	0.03%	0.02%	0.03%	0.03%	0.03%	0.03%
DUT15	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.03%
DUT16	0.02%		0.03%	0.03%	0.03%	0.03%	0.03%
Specification Minimum	-1.50%	-1.50%	-1.50%	-1.50%	-1.50%	-1.50%	-1.50%
Specification Maximum	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%
Unbiased Avg	0.02%	0.02%	0.02%	0.02%	0.03%	0.03%	0.03%
Unbiased Std Dev	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Unbiased +99/90	0.03%	0.03%	0.04%	0.04%	0.05%	0.05%	0.04%
Unbiased -99/90	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.02%
+Unbiased Error Bar	0.00%	0.00%	0.01%	0.00%	0.01%	0.01%	0.00%
-Unbiased Error Bar	0.00%	0.00%	0.01%	0.00%	0.01%	0.01%	0.00%

Adjust Pin Current	Total Ionizing Dose						
	Pre-Rad	23 krad(Si)	50 krad(Si)	75 krad(Si)	100 krad(Si)	122.5 krad(Si)	128.5 krad(Si)
Control (DUT11)	6.04E-05	5.99E-05	6.02E-05	6.10E-05	5.91E-05	6.13E-05	6.14E-05
DUT12	5.94E-05	5.91E-05	5.89E-05	5.93E-05	5.79E-05	5.90E-05	5.90E-05
DUT13	5.86E-05	5.78E-05	5.78E-05	5.82E-05	5.68E-05	5.78E-05	5.78E-05
DUT14	5.90E-05	5.85E-05	5.84E-05	5.87E-05	5.75E-05	5.84E-05	5.84E-05
DUT15	5.90E-05	5.87E-05	5.85E-05	5.87E-05	5.77E-05	5.86E-05	5.86E-05
DUT16	5.97E-05	5.88E-05	5.85E-05	5.87E-05	5.75E-05	5.85E-05	5.86E-05
Specification Maximum	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04
Unbiased Avg	5.91E-05	5.86E-05	5.84E-05	5.87E-05	5.75E-05	5.85E-05	5.85E-05
Unbiased Std Dev	3.77E-07	4.27E-07	3.52E-07	3.58E-07	3.53E-07	3.88E-07	3.86E-07
Unbiased +99/90	6.09E-05	6.06E-05	6.00E-05	6.04E-05	5.91E-05	6.03E-05	6.03E-05
Unbiased -99/90	5.74E-05	5.66E-05	5.68E-05	5.71E-05	5.58E-05	5.67E-05	5.67E-05
+Unbiased Error Bar	5.35E-07	4.91E-07	4.99E-07	5.73E-07	3.70E-07	5.51E-07	5.50E-07
-Unbiased Error Bar	5.64E-07	7.70E-07	5.98E-07	5.58E-07	6.57E-07	6.60E-07	6.46E-07

8. SUMMARY

Reference voltage, load regulation, and adjustment pin current parameters did not go out of specification during the entire irradiation up to 128 krad(Si). Line regulation went above maximum specifications after 75 krad(Si).

9. REFERENCES

- 1) Department of Defense "Test Method Standard Microcircuits," MIL-STD-883 Test Method 1019.9 Ionizing radiation (total dose) test procedure, June 7, 2013, <https://landandmaritimeapps.dla.mil/Downloads/MilSpec/Docs/MIL-STD-883/std883.pdf>.
- 2) Intersil datasheet FN4560 Rev 10.00 March 25, 2014