

UNISYS

DATE: May 15, 1997
 TO: J.Lohr/311
 FROM: K. Sahu/300.1 *KS*
 SUBJECT: Radiation Report on: LM137 (7703403XA)
 Project: MAP SUBSYSTEMS
 Job #: M78117
 Project part #: LM137 (7703403XA)

PPM-97-020

cc: T. Miccolis/311
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A radiation evaluation was performed on LM137 (7703403XA) to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through IV and Figure 1.

The total dose testing was performed using a Co⁶⁰ gamma ray source. During the radiation testing, eight parts were irradiated under bias (see Figure 1 for bias configuration) and two parts were used as control samples. The total dose radiation levels were 2.5, 5.0, 7.5, 10.0, 15.0, 20.0, 30.0, and 50.0 kRads.^{*} The dose rate was between 0.06 and 0.50 kRads/hour (see Table II for radiation schedule). After the 50.0 kRad exposure, the parts were annealed for 120 hours at 25°C. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits^{**} listed in Table III.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 13, 14, 15, 16, 17, 18, 19, and 20) were used as radiation samples while SN's 11 and 12 were used as control samples. All parts passed all tests during initial electrical measurements.

All parts passed all tests upon irradiation to 7.5 kRads. No significant degradation was noted in any of the parts.

After the 10.0 kRad irradiation, only SN 16 met the specification limit for the Delta_IADJ_1 test. Readings for the parts were within the range of -4.1 to -10.6µA against the specification limit of ±5µA. **All parts continued to pass all other tests.**

After the 15.0 kRad irradiation, all parts exceeded the specification limits for the IADJ_-41.25V and Delta_IADJ_1 tests. Readings were within the range of -66 to -160 µA against specification limits of 25 µA (min) and 100 µA (max) for IADJ_-41.25V and 144 to 272 µA for Delta_IADJ_1. Four parts (SN's 14, 15, 18, and 19) failed IADJ_-4.25V with all readings within the range of 89 to 111 µA against specification limits of 25 µA (min) and 100 µA (max). **All parts continued to pass all other tests.**

After the 20.0 kRad irradiation, all parts continued to degrade in both IADJ_-41.25V and Delta_IADJ_1. Only SN 20 passed IADJ_-41.25V with readings within the range of 88 to 219 µA. Readings for Delta_IADJ_1 were within the range of -22 to -122 µA. **All parts continued to pass all other tests.**

After the 30.0 kRad irradiation, the parts continued to degrade with all parts failing IADJ_-4.25V, IADJ_-41.25V and Delta_IADJ_1. Readings were within the range of 380 to 621 µA, 697 to 1276 µA, and -339 to -654 µA, respectively. **All parts continued to pass all other tests.**

^{*} The term Rads, as used in this document, means Rads(silicon). All radiation levels cited are cumulative.

^{**} These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

After annealing the parts for 120 hours at 25°C, the parts did not show any significant recovery in IADJ_-4.25V, IADJ_-41.25V and Delta_IADJ_1. Readings were in the range of 181 to 360 μ A, 474 to 762 μ A, and -281 to -529 μ A, respectively. All parts continued to pass all other tests.

Table IV provides a summary of the test results with the mean and standard deviation values for each parameter after each irradiation exposure and annealing step.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

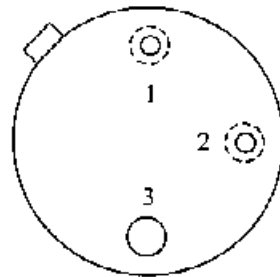
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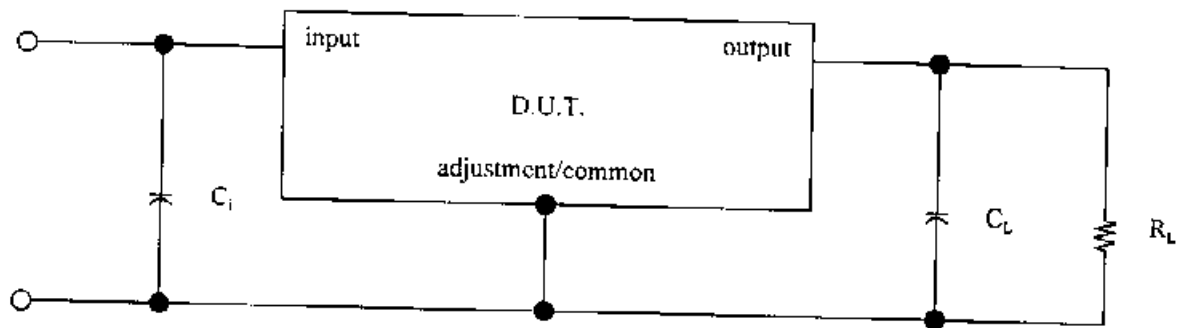
Figure 1. Radiation Bias Circuit for LM137

TO-39 Metal Can Package



- 1. Adjustment
- 2. Output
- 3. Input (Case is Input)

Bottom View



Note: Resistor is $250\Omega \pm 5\%$ $\frac{1}{4}W$. Capacitors are $1\mu f$, 50V; however, capacitors may not be required if the parts do not oscillate (are stable).

TABLE I. Part Information

Generic Part Number:	LM137
MAP-POWER Part Number	7703403XA
Charge Number:	EE78117
Manufacturer:	Linear Technology Corp.
Lot Date Code (LDC):	9638
Quantity Tested:	10
Serial Number of Control Samples:	11, 12
Serial Numbers of Radiation Samples:	13, 14, 15, 16, 17, 18, 19, 20
Part Function:	Adjustable Negative Voltage Regulator
Part Technology:	Bipolar
Package Style:	TO-39
Test Equipment:	A540
Test Engineer:	A. Najj

- No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

TABLE II. Radiation Schedule for LM137

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	04/07/97
2) 2.5 KRAD IRRADIATION (0.062 KRADS/HOUR)	04/18/97
POST-2.5 KRAD ELECTRICAL MEASUREMENT	04/21/97
3) 5.0 KRAD IRRADIATION (0.062 KRADS/HOUR)	04/21/97
POST-5.0 KRAD ELECTRICAL MEASUREMENT	04/23/97
4) 7.5 KRAD IRRADIATION (0.062 KRADS/HOUR)	04/23/97
POST-7.5 KRAD ELECTRICAL MEASUREMENT	04/25/97
5) 10.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	04/25/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT	04/28/97
6) 15.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	04/28/97
POST-15.0 KRAD ELECTRICAL MEASUREMENT	04/30/97
7) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	04/30/97
POST-20.0 KRAD ELECTRICAL MEASUREMENT	05/02/97
8) 30.0 KRAD IRRADIATION (0.250 KRADS/HOUR)	05/02/97
POST-30.0 KRAD ELECTRICAL MEASUREMENT	05/05/97
9) 120 HOUR ANNEALING @25°C	05/05/97
POST-120 HOUR ANNEAL ELECTRICAL MEASUREMENT	05/09/97

Effective Dose Rate = 30,000 RADS/22 DAYS = 56.8 RADS/HOUR=0.016 RADS/SEC

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS, SEE FIGURE 1.

Table III. Electrical Characteristics of LM137 1/ 2

Test #	Parameters /1	Units	Test Conditions	Spec. Lim.	
				min	max
1	IQ -4.25V	mA	$V_{IN} = -4.25$	0.2	3.0
2	IQ -14.25V	mA	$V_{IN} = -14.25$	0.2	3.0
3	IQ -41.25V	mA	$V_{IN} = -41.25$	1.0	5.0
4	IADJ -4.25V	μ A	$V_{IN} = -4.25, I_L = 5mA$	25	100
5	IADJ -41.25V	μ A	$V_{IN} = -41.25, I_L = 5mA$	25	100
6	Delta IADJ 1	μ A	$-41.25 < V_{IN} < -4.25, I_L = 5mA$	-5.0	5.0
7	V Out 1	V	$V_{IN} = -4.25V, I_L = 5mA$	-1.275	-1.225
8	V Out 2	V	$V_{IN} = -41.25V, I_L = 5mA$	-1.275	-1.225
9	V Out 3	V	$V_{IN} = -6.25V, I_L = 5mA$	-1.275	-1.225
10	V Line1	mV	$-41.25 < V_{IN} < -4.25$	-9.0	9.0
11	V Load1	mV	$V_{IN} = -6.25V, 5mA < I_L < 200mA$	-6.0	6.0
12	V Load2	mV	$V_{IN} = -4.25V, 5mA < I_L < 400mA$	-12.0	12.0
13	V Out 4	V	$V_{IN} = -41.25V, 5mA < I_L < 50mA$	-1.275	-1.225
14	V Out 5	V	$V_{IN} = -4.25V, 5mA < I_L < 50mA$	-1.275	-1.225

Notes:

1/ These are the manufacturer's non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed

2/ Refer to MIL-M-38510/11803, Table I, for details of test parameters and conditions.

Table III. Electrical Characteristics of LM137 /1 /2

Test #	Parameters /1	Units	Test Conditions	Spec. Lim.	
				min	max
1	IQ -4.25V	mA	$V_{IN} = -4.25$	0.2	3.0
2	IQ -14.25V	mA	$V_{IN} = -4.25$	0.2	3.0
3	IQ -41.25V	mA	$V_{IN} = -4.25$	1.0	5.0
4	IADJ -4.25V	μ A	$V_{IN} = -4.25, I_L = 5mA$	25	100
5	IADJ -41.25V	μ A	$V_{IN} = -4.25, I_L = 5mA$	25	100
6	Delta IADJ 1	μ A	$-41.25 < V_{IN} < -4.25, I_L = 5mA$	-5.0	5.0
7	V Out 1	V	$V_{IN} = -4.25V, I_L = 5mA$	-1.275	-1.225
8	V Out 2	V	$V_{IN} = -41.25V, I_L = 5mA$	-1.275	-1.225
9	V Out 3	V	$V_{IN} = -6.25V, I_L = 5mA$	-1.275	-1.225
10	V Line1	mV	$-41.25 < V_{IN} < -4.25$	-9.0	9.0
11	V Load1	mV	$V_{IN} = -6.25V, 5mA < I_L < 200mA$	-6.0	6.0
12	V Load2	mV	$V_{IN} = -4.25V, 5mA < I_L < 400mA$	-12.0	12.0
13	V Out 4	V	$V_{IN} = -41.25V, 5mA < I_L < 50mA$	-1.275	-1.225
14	V Out 5	V	$V_{IN} = -4.25V, 5mA < I_L < 50mA$	-1.275	-1.225

Notes:

1/ These are the manufacturer's non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed

2/ Refer to MIL-M-38510/11803, Table I, for details of test parameters and conditions.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for LM137 /1

Test #	Parameters	Units	Spec. Lim. /2		Total Dose Exposure (kRads)																Annealing	
					Initial		2.5		5.0		7.5		10.0		15.0		20.0		30.0		168 hours @25°C	
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	IQ_-4.25V	mA	0.2	3.0	1.3	0.04	1.3	0.04	1.3	0.04	1.3	0.04	1.3	0.04	1.3	0.05	1.3	0.04	1.3	0.04	1.3	0.04
2	IQ_-14.25V	mA	0.2	3.0	1.3	0.04	1.3	0.04	1.3	0.04	1.3	0.04	1.3	0.04	1.3	0.05	1.3	0.04	1.3	0.04	1.4	0.02
3	IQ_-41.25V	mA	1.0	5.0	2.1	0.06	2.1	0.06	2.1	0.05	2.1	0.06	2.1	0.06	2.1	0.06	2.1	0.05	2.1	0.06	2.1	0.06
4	IADJ_-4.25V	uA	25	100	71	1.6	69	1.8	69	1.9	68	1.5	69	2.1	99	12.9	83	10.5	485	103	256	54
5	IADJ_-41.25V	uA	25	100	74	1.8	72	1.7	72	1.7	71	1.8	76	3.1	228	48	172	48	978	223	681	133
6	Delta_IADJ_1	uA	-5.0	5.0	-2.0	0.05	-3.1	0.05	-3.0	0.1	-3.0	0	-7.9	2.1	-130	35	-89	38	-493	120	-125	83
7	V_Out_1	V	-1.275	-1.225	-1.256	0.001	-1.254	0.002	-1.253	0.002	-1.251	0.002	-1.250	0.002	-1.247	0.003	-1.243	0.003	-1.239	0.003	-1.240	0.003
8	V_Out_2	V	-1.275	-1.225	-1.256	0.001	-1.254	0.002	-1.253	0.002	-1.251	0.002	-1.250	0.002	-1.247	0.003	-1.243	0.003	-1.239	0.003	-1.240	0.003
9	V_Out_3	V	-1.275	-1.225	-1.258	0.001	-1.246	0.002	-1.255	0.002	-1.252	0.002	-1.251	0.002	-1.248	0.003	-1.244	0.003	-1.240	0.003	-1.241	0.003
10	V_Line1	mV	-9.0	9.0	-0.6	0.1	-0.5	0.1	-0.5	0.1	-0.6	0.1	-0.6	0.1	-0.6	0.1	-0.7	0.1	-0.5	0.2	-0.6	0.2
11	V_Load1	mV	-6.0	6.0	3.3	0.9	3.3	0.9	3.0	0.6	3.0	0.6	3.3	1.7	2.7	0.5	2.6	0.5	2.5	0.3	2.47	0.7
12	V_Load2	mV	-12.0	12.0	6.1	2.0	6.0	1.7	5.2	1.0	5.3	1.4	6.1	3.5	4.6	1.0	4.5	1.2	4.4	0.7	4.3	0.9
13	V_Out_4	V	-1.275	-1.225	-1.249	0.002	-1.248	0.002	-1.248	0.002	-1.246	0.003	-1.244	0.005	-1.242	0.003	-1.239	0.003	-1.235	0.003	-1.236	0.003
14	V_Out_5	V	-1.275	-1.225	-1.252	0.001	-1.251	0.002	-1.250	0.002	-1.249	0.003	-1.247	0.003	-1.245	0.003	-1.241	0.003	-1.237	0.003	-1.238	0.003

Notes:

- 1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.
- 2/ These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

Radiation sensitive parameters: IADJ_-4.25V, IADJ_-41.25V, and Delta_IADJ_1.