

Unisys

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TO: D. Krus/311 *KS*
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on: LM137 (JM38510/118035XA)
Project: ADFEOS
Job #: F10056
Project part #: LM137 (JM38510/118035XA)

PPM-97-030

cc: A. Sharma/311
OFA Library/300.1

A radiation evaluation was performed on LM137 (JM38510/118035XA) 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, four parts were irradiated under bias (see Figure 1 for bias configuration) and one part was used as a control sample. The total dose radiation levels were 5.0, 10.0, 20.0, 30.0, 50.0, and 100.0 kRads.* The dose rate was between 0.125 and 0.50 kRads/hour (see Table II for radiation schedule). After the 100.0 kRad exposure, the parts were annealed for 168 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 5 samples. Four samples (SN's 2, 3, 4, and 6) were used as radiation samples while SN 1 was used as a control sample. All parts passed all tests during initial electrical measurements.

All parts passed all tests upon irradiation to 5.0 kRads. No significant degradation was noted in any of the parts.

After the 10.0 kRad irradiation, all parts fell below the specification limit for the Delta_IADJ_1 test. All readings for the parts were -5.16µA against the specification limit of ±5µA. **All parts continued to pass all other tests.**

After the 20.0 kRad irradiation, SN's 2,3, and 6 fell below the specification limit of 0.2mA for IQ_-4.25V with readings in the range of -0.01 to -0.008mA. All parts continued to degrade in the Delta_IADJ_1 parameter, with readings in the range of -5.47 to -5.78µA. **All parts continued to pass all other tests.**

After the 30.0 kRad irradiation, all parts except SN 4 showed significant degradation in most parameters. SN's 2 and 3 failed all tests except IQ_-41.25V and V_Line1. SN 6 failed all tests except IQ_-41.25V, V_Line1, V_Load2, V_Out_4, and V_Out_5. SN 4 only fell below the specification limits for IQ_-4.25V, IQ_-14.25V and Delta_IADJ_1.

After the 50.0 and 100.0 kRadirradiations, SN's 2, 3 and 6 failed catastrophically, passing only IQ_-41.25V. SN 4 behaved as it did at 30 kRads.

After annealing the parts for 196 hours at 25°C, the parts did not show any significant recovery in any parameter.

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.

* 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.

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

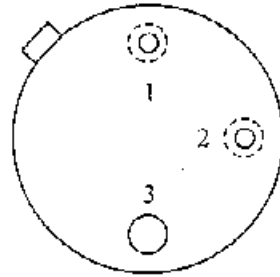
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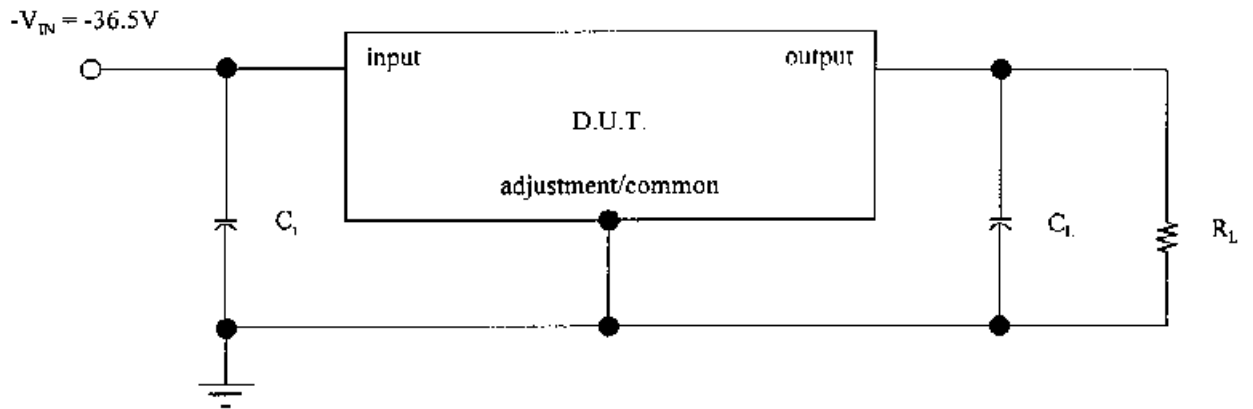
Figure 1. Radiation Bias Circuit for LM137

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 |
| ADEOS Part Number | JM38510/118035XA |
| Charge Number: | F10056 |
| Manufacturer: | National Semiconductor |
| Lot Date Code (LDC): | 9615 |
| Quantity Tested: | 5 |
| Serial Number of Control Samples: | 1 |
| Serial Numbers of Radiation Samples: | 2, 3, 4, 6 |
| Part Function: | Adjustable Negative Voltage Regulator |
| Part Technology: | Bipolar |
| Package Style: | TO-39 |
| Test Equipment: | A540 |
| Test Engineer: | A. Naji |

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

TABLE II. Radiation Schedule for LM137

| EVENT | DATE |
|--|----------|
| 1) INITIAL ELECTRICAL MEASUREMENTS | 06/05/97 |
| 2) 5.0 KRAD IRRADIATION (0.125 KRADS/HOUR) | 06/05/97 |
| POST-5.0 KRAD ELECTRICAL MEASUREMENT | 06/06/97 |
| 3) 10.0 KRAD IRRADIATION (0.125 KRADS/HOUR) | 06/09/97 |
| POST-10.0 KRAD ELECTRICAL MEASUREMENT | 06/11/97 |
| 4) 20.0 KRAD IRRADIATION (0.250 KRADS/HOUR) | 06/11/97 |
| POST-20.0 KRAD ELECTRICAL MEASUREMENT | 06/13/97 |
| 5) 30.0 KRAD IRRADIATION (0.250 KRADS/HOUR) | 06/13/97 |
| POST-30.0 KRAD ELECTRICAL MEASUREMENT | 06/16/97 |
| 6) 50.0 KRAD IRRADIATION (0.500 KRADS/HOUR) | 06/20/97 |
| POST-50.0 KRAD ELECTRICAL MEASUREMENT | 06/23/97 |
| 7) 100.0 KRAD IRRADIATION (0.500 KRADS/HOUR) | 06/23/97 |
| POST-100.0 KRAD ELECTRICAL MEASUREMENT | 06/25/97 |
| 8) 168 HOUR ANNEALING @25°C | 06/25/97 |
| POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT | 07/01/97 |

Effective Dose Rate = 100,000 RADS/27 DAYS = 154.3 RADS/HOUR=0.043 RADS/SEC

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

Table III. Electrical Characteristics of LMI37 /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 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 | | 5.0 | | 10.0 | | 20.0 | | 30.0 | | 50.0 /3 | | 100.0 | | 168 hours @25°C | |
| | | | | | 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 | 0.487 | 0.006 | 0.444 | 0.009 | 0.397 | 0.012 | 0.082 | 0.159 | -0.014 | 0.002 | 4F | | 4F | | 4F | |
| 2 | IQ_-14.25V | mA | 0.2 | 3.0 | 0.538 | 0.007 | 0.503 | 0.010 | 0.463 | 0.013 | 0.400 | 0.018 | 0.012 | 0.005 | 4F | | 4F | | 4F | |
| 3 | IQ_-41.25V | mA | 1.0 | 5.0 | 1.700 | 0.013 | 1.657 | 0.014 | 1.622 | 0.024 | 1.582 | 0.020 | 1.228 | 0.192 | 1.118 | 0.011 | 1.217 | 0.183 | 1.219 | 0.187 |
| 4 | IADJ_-4.25V | uA | 25 | 100 | 63.3 | 0.4 | 60.4 | 0.6 | 56.84 | 0.84 | 51.64 | 1.47 | -3750 | 2137 | 1P/3F | | 1P/3F | | 1P/3F | |
| 5 | IADJ_-41.25V | uA | 25 | 100 | 65.4 | 2.2 | 65.1 | 0.7 | 61.99 | 0.84 | 57.28 | 1.30 | -2750 | 1625 | 1P/3F | | 1P/3F | | 1P/3F | |
| 6 | Delta_IADJ_1 | uA | -5.0 | 5.0 | -4.34 | 0.13 | -4.69 | 0.11 | -5.16 | 0 | -5.66 | 0.13 | -947 | 578 | 4F | | 4F | | 4F | |
| 7 | V_Out_1 | V | -1.275 | -1.225 | -1.254 | 0.002 | -1.254 | 0.003 | -1.251 | 0.002 | -1.246 | 0.003 | -0.273 | 0.560 | 1P/3F | | 1P/3F | | 1P/3F | |
| 8 | V_Out_2 | V | -1.275 | -1.225 | -1.254 | 0.002 | -1.254 | 0.003 | -1.251 | 0.002 | -1.247 | 0.003 | -0.273 | 0.560 | 1P/3F | | 1P/3F | | 1P/3F | |
| 9 | V_Out_3 | V | -1.275 | -1.225 | -1.256 | 0.002 | -1.254 | 0.002 | -1.253 | 0.002 | -1.249 | 0.003 | -0.274 | 0.562 | 1P/3F | | 1P/3F | | 1P/3F | |
| 10 | V_Line1 | mV | -9.0 | 9.0 | -1.714 | 0.035 | -1.946 | 0.036 | -2.329 | 0.035 | -2.317 | 0.223 | 0.107 | 2.717 | 1P/3F | | 1P/3F | | 1P/3F | |
| 11 | V_Load1 | mV | -6.0 | 6.0 | 3.517 | 0.285 | 3.626 | 0.079 | 3.844 | 0.103 | 3.938 | 0.395 | 1.162 | 2.089 | 1P/3F | | 1P/3F | | 1P/3F | |
| 12 | V_Load2 | mV | -12.0 | 12.0 | 8.91 | 0.67 | 9.16 | 0.20 | 9.64 | 0.35 | 9.68 | 0.77 | 5.45 | 5.43 | 1P/3F | | 1P/3F | | 1P/3F | |
| 13 | V_Out_4 | V | -1.275 | -1.225 | -1.246 | 0.003 | -1.244 | 0.003 | -1.242 | 0.003 | -1.239 | 0.002 | -0.592 | 0.642 | 1P/3F | | 1P/3F | | 1P/3F | |
| 14 | V_Out_5 | V | -1.275 | -1.225 | -1.250 | 0.002 | -1.248 | 0.02 | -1.247 | 0.002 | -1.243 | 0.002 | -0.594 | 0.644 | 1P/3F | | 1P/3F | | 1P/3F | |

Notes:

- 1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing. The control samples remained constant throughout 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.
- 3/ "P" ("F") indicates that all parts passed (failed) this test at this irradiation level or annealing step. "nP/mF" indicates that n parts passed and m parts failed this test at this irradiation level or annealing step. The failing parts had degraded so much that no measurements could be made for these parameters

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