PPM92-316

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Paramax Systems
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Memorandum

PARAMAX
A Unisys Company

PPM-92-316

DATE: Jan. 5, 1993
TO: B. Fafaul/311
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on FAST/MUE
Part No. M38510/11704BYA (LM117)
Control No. 6143A

cc: R. Kolecki/740.4
T. Miccolis/300.1
A. Sharma/311
Library/300.1 ✓
L. Cusick/740.4
SMEX, PPM File

A radiation evaluation was performed on LM117 (Resistor Programmed Regulator) 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 Cobalt-60 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 5, 10, 20, 40 and 60 krads*. After 60 krads, parts were annealed at 25°C for 168 hours. The irradiation was then continued to 100 krads (cumulative). Finally, the parts were annealed for 168 hours at 100°C. The dose rate was between 0.15 and 2.0 krads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, parts were electrically tested at 25°C according to the test conditions and the specification limits** listed in Table III.

All ten parts passed initial (pre-rad) electrical tests. All eight irradiated parts passed all electrical tests up to and including the 20-krad level. After the 40-krad exposure, all eight irradiated parts exceeded the maximum specification limit of 5.5 mV for line regulation (REG/ld1), with readings ranging from 5.86 to 8.18 mV. After the 60-krad exposure, the same

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*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.
**These are manufacturers' non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

failures continued, with readings ranging from 8.30 to 11.35 mV. After annealing for 168 hours at 25°C, the same failures continued, with readings ranging from 10.37 to 19.40 mV. Upon continued irradiation to 100 krads (cumulative) REG/ld1 failures continued, with readings ranging from 12.45 to 24.90 mV. In addition, six irradiated parts (SN 82, 83, 85, 86, 88 and 89) exceeded the maximum specification limit of 9.0 mV for line regulation (REG/ln), with readings ranging from 11.16 to 25.08 mV. At the 100-krad level, the values for ripple rejection (Rrj120) could not be read for these same six parts. This indicates functional failure of these parts at this radiation level.

After a final annealing at 100°C, no rebound effects were observed.

Table IV provides a summary of the functional test results, as well as the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps.

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

TABLE I. Part Information

Generic Part Number:	LM117
Part Number:	M38510/11704BYA
FAST/MUE Control Number:	6143A
Charge Number:	C24018
Manufacturer:	Linear Technology Corp.
Lot Date Code:	9208A
Quantity Tested:	10
Serial Numbers of Radiation Samples:	82, 83, 84, 85, 86, 87, 88, 89
Serial Numbers of Control Samples:	80, 81
Part Function:	Resistor Programmed Regulator
Part Technology:	Bipolar
Package Style:	TO-3 can
Test Engineer:	T. Mondy

TABLE II. Radiation Schedule for LM117

EVENTS	DATE
1) Initial Electrical Measurements	11/09/92
2) 5 KRAD IRRADIATION (0.27 krads/hour)	11/18/92
POST-5 KRAD ELECTRICAL MEASUREMENT	11/19/92
3) 10 KRAD IRRADIATION (0.25 krads/hour)	11/19/92
POST-10 KRAD ELECTRICAL MEASUREMENT	11/19/92
4) 20 KRAD IRRADIATION (0.15 krads/hour)	11/20/92
POST-20 KRAD ELECTRICAL MEASUREMENT	11/23/92
5) 40 KRAD IRRADIATION (1.0 KRADS/HOUR)	11/23/92
POST-40 KRAD ELECTRICAL MEASUREMENT	11/24/92
6) 60 KRAD IRRADIATION (1.0 KRADS/HOUR)	11/24/92
POST-60 KRAD ELECTRICAL MEASUREMENT	11/24/92
7) 168 HOUR ANNEALING @25°C	11/25/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/02/92
8) 100 KRAD IRRADIATION (2.0 KRADS/HOUR)	12/02/92
POST-100 KRAD ELECTRICAL MEASUREMENT	12/03/92
9) 168 HOUR ANNEALING @100°C*	12/03/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/10/92

ALL ELECTRICAL MEASUREMENTS WERE PERFORMED AT 25°C.

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

*High temperature annealing is performed to accelerate long term time dependent effects (TDE), namely, the "rebound" effect due to the growth of interface states after the radiation exposure. For more information on the need to perform this test, refer to MIL-STD-883D, Method 1019, Para. 3.10.1.

Table III. Electrical Characteristics of LM117

TEST CONDITIONS	LIMITS		UNITS
	Min	Max	
Minimum Load Current: I_Q+			
VIN = 4.25V		3	mA
VIN = 14.3V		3	mA
VIN = 41.3V		5	mA
Adjustment Pin Current: $I_{ref/M}$ (MAX)			
VIN = 4.25V		100	uA
VIN = 41.3V		100	uA
Adjustment Pin Current: $I_{ref/m}$ (MIN)			
VIN = 4.25V	15		uA
VIN = 41.3V	15		uA
Load Regulation: REG/ld			
VIN = 6.25V, 5mA < I_L < 1.5A	-5.5	5.5	mV
VIN = 41.3V, 5mA < I_L < 200mA	-3.5	3.5	mV
Line Regulation: REG/ln			
4.25V < VIN < 41.3V	-9	9	mV
Reference Voltage: $V_{REF/m}$, $V_{REF/M}$			
VIN = 4.25V I_L = 5mA	1.2	1.3	V
VIN = 4.25V I_L = 1.5A	1.2	1.3	V
VIN = 41.3V I_L = 5mA	1.2	1.3	V
VIN = 41.3V I_L = 200mA	1.2	1.3	V
Current Limit: Ipk/m			
VIN = 4.25V		1.5	A
VIN = 40V		0.18	A
Ripple Rejection: R_{rj120}			
VIN = 6.25V, I_L = 60mA, Freq. = 120Hz	65		dB

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing Steps for LM117 1/

Parameters		Spec. Lim./2 min	Spec. Lim./2 max	Total Dose Exposure (TDE) (krads) 0 (Pre-Rad.) mean	0 (Pre-Rad.) sd	5 mean	5 sd	10 mean	10 sd	20 mean	20 sd	40 mean	40 sd	60 mean	60 sd	Anneal 168 hrs @25°C mean	Anneal 168 hrs @25°C sd	TDE 100 krads mean	TDE 100 krads sd	Anneal 168 hrs @+100°C mean	Anneal 168 hrs @+100°C sd
Iq+1	mA	0	3	1.32	.01	1.31	0	1.32	.01	1.33	.02	1.34	.03	1.35	.04	1.32	.03	1.29	.02	1.30	.01
Iq+2	mA	0	3	1.35	.07	1.34	.05	1.36	.05	1.36	.05	1.37	.07	1.38	.07	1.35	.05	1.34	.05	1.33	.03
Iq+3	mA	0	3	2.13	.46	2.13	.45	2.17	.41	2.23	.31	2.28	.29	2.34	.22	2.26	.21	2.24	.11	2.12	.37
Iref/m1	uA	0	15	36.0	.56	35.8	.53	35.8	.50	35.8	.49	35.6	.46	35.4	.45	35.2	.44	33.4	.58	34.7	.46
Iref/m2	uA	0	15	36.1	.58	35.9	.53	36.0	.50	35.9	.47	35.8	.45	35.6	.43	35.3	.45	39.3	.40	34.9	.45
Iref/M1	uA	0	100	36.0	.54	35.8	.52	35.8	.51	35.7	.49	35.6	.47	35.4	.41	35.2	.42	33.4	.58	34.7	.47
Iref/M2	uA	0	100	36.1	.55	35.9	.51	36.0	.49	35.9	.48	35.9	.48	35.6	.43	35.3	.45	34.4	.36	34.9	.43
REG/ld1	mV	-5.5	5.5	3.54	.22	4.23	.46	4.60	.36	4.95	.36	6.85	.80	9.34	1.1	13.0	3.1	17.6	4.3	16.1	7.0
REG/ld2	mV	-3.5	3.5	-.21	.18	-.18	.14	0.01	.26	-.02	.22	-.02	.20	0.01	.17	-.02	.12	-.08	.20	-.16	.18
REG/ln	mV	-9	9	0.77	.30	0.87	.26	0.88	.23	1.08	.30	1.39	.27	2.14	.58	1.94	.33	13.3	6.3	2.81	.48
Rrj120/3	dB	65	-	91.2	.28	91.2	.27	91.3	.31	90.9	.30	88.8	1.1	83.9	2.3	83.9	2.0	2P6F	-	78.6	1.1
Vref/m1	V	1.2	1.3	1.25	0	1.25	0	1.25	0	1.25	0	1.24	0	1.24	0	1.23	0	1.24	0	1.23	0
Vref/m2	V	1.2	1.3	1.24	0	1.24	0	1.24	0	1.24	0	1.24	0	1.23	0	1.23	0	1.23	0	1.23	0
Vref/m3	V	1.2	1.3	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.24	0
Vref/m4	V	1.2	1.3	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0
Vref/M1	V	1.2	1.3	1.25	0	1.25	0	1.25	0	1.25	0	1.24	0	1.24	0	1.23	0	1.24	0	1.23	0
Vref/M2	V	1.2	1.3	1.24	0	1.24	0	1.24	0	1.24	0	1.23	0	1.23	0	1.23	0	1.23	0	1.23	0
Vref/M3	V	1.2	1.3	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0
Vref/M4	V	1.2	1.3	1.25	0	1.25	0	1.25	0	1.25	0	1.25	0	1.24	0	1.24	0	1.24	0	1.24	0
Ipk/m1	A	0	1.5	PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
Ipk/m2	A	0	0.18	PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	

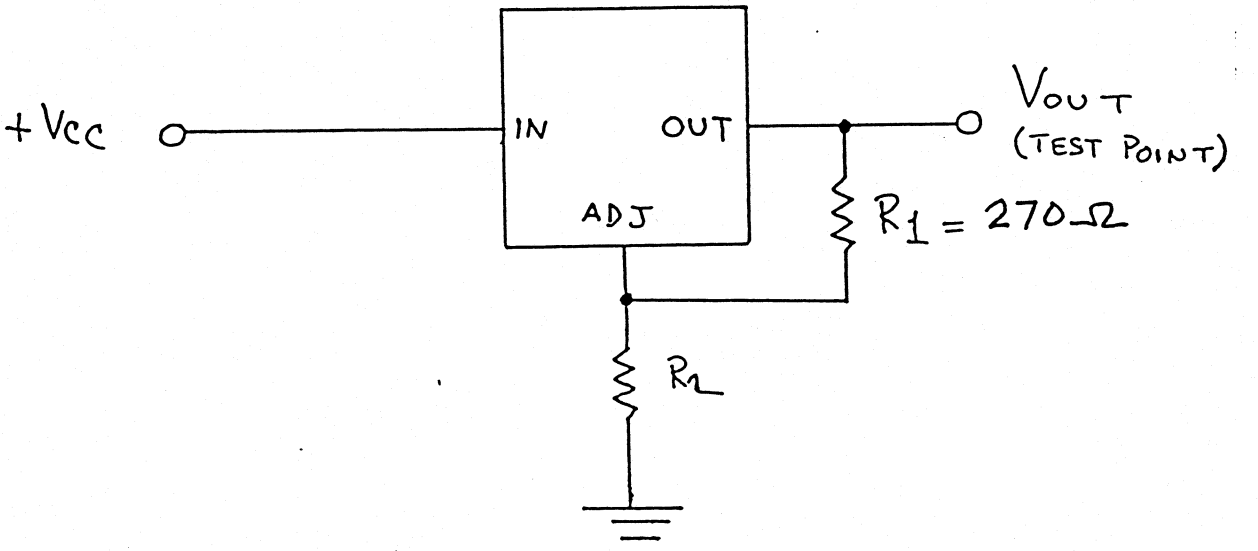
Note:

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 manufacturers' non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

3/ The notation "nPmF" for this parameter means that n parts passed and m parts failed at this radiation or annealing level. No reliable readings were available at the 100-krad level for the six failing parts.

Figure 1. Radiation Bias Circuit for LM117



+Vcc = 30.0V ±0.5VDC

R_1 = 270Ω ±5%, ½W

R_2 = 2.7KΩ ±5%, ½W

CHECK: VOUT ≈ 15V