Unisys

DATE: November 19, 1999 PPM-99-035
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SUBJECT: Radiation Report on **LF155A (Linear Technology) (LDC 9811)**
PROJECT: HST/COS

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A radiation evaluation was performed on **LF155A (M38510/11404BGA) Low Supply Current JFET Input Operational Amplifier (Linear Technology)** to determine the total dose tolerance of these parts. The total dose testing was performed using a Co^{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 2.5, 5.0, 10.0, 20.0, and 30.0kRads.[1] The average dose rate was 0.16kRads/hour (0.04Rads/s). See Table II for the radiation schedule and average dose rate calculation. After the 30.0kRad irradiation, the parts were annealed under bias at 25°C for 168 hours.[2] After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits[3] listed in Table III. An executive summary of the test results is provided below in bold, followed by a detailed summary of the test results after each radiation level and annealing step. See Figures 2-4 for further details.

All parts passed all tests up to 10kRads. After the 20 and 30kRad irradiations, the parts showed some degradation in +Ib and -Ib. After annealing the parts at 25°C for 168 hours, the parts showed some increase in +Ib and -Ib.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 66, 67, 68, 69, 70, 71, 72, and 73) were used as radiation samples while SN's 64 and 65 were used as control samples. During initial electrical testing, all parts gave readings higher than the specification limit of 20pA for Iio. This does not indicate a failure, as the electrical noise in the A540 load board is in the tens of picoamps and could have caused the Iio readings to be greater than 20pA. The readings for Iio averaged 47pA initially. All parts passed all other tests during initial electrical measurements.

All parts showed no significant degradation up to 10.0kRads.

After the 20kRad irradiation, all parts exceeded the specification limit of 100pA for +Ib with readings in the range of 128 to 401pA. Seven parts exceeded the specification limit of 300pA for -Ib with readings in the range of 382 to 437pA. No significant degradation was observed in Iio. **All parts passed all other tests.**

After the 30kRad irradiation, all parts exceeded the specification limit of 100pA for +Ib with readings in the range of 184 to 566pA. Six parts exceeded the specification limit of 300pA for -Ib with readings in the range of 485 to 692pA. No significant degradation was observed in Iio. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, the parts showed an increase in +Ib and -Ib. No significant change was noted in any other 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.

[1] The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.
[2] The temperature 25°C as used in this document implies room temperature.
[3] 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 us at (301) 731-8954.

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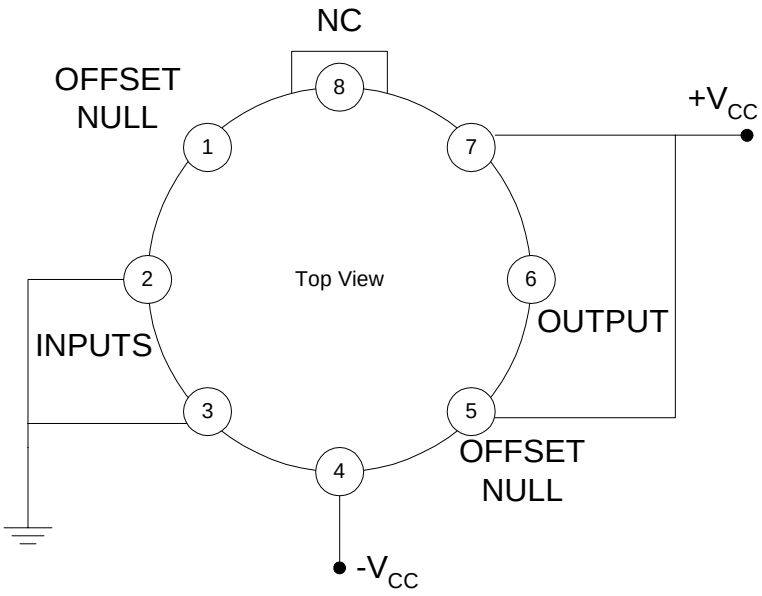
Figure 1. Radiation Bias Circuit for LF155A



Notes:
1. $+V_{CC}$ = +20.0V ±0.5V.
2. $-V_{CC}$ = -20.0V ±0.5V.

TABLE I. Part Information

Generic Part Number:	LF155A
HST/COS Part Number	M38510/11404BGA
HST/COS TID Requirement	10kRads (RDM = 5)
Charge Number:	M90439
Manufacturer:	Linear Technology
Lot Date Code (LDC):	9811
Quantity Tested:	10
Serial Numbers of Control Samples:	64, 65
Serial Numbers of Radiation Samples:	66, 67, 68, 69, 70, 71, 72, 73
Part Function:	Low Supply Current JFET Input Op Amp
Part Technology:	Bipolar/JFET
Package Style:	8 Pin Metal Can
Test Equipment:	A540
Test Engineer:	S. Norris

- The manufacturer for this part guaranteed no radiation tolerance/hardness.

TABLE II. Radiation Schedule for LF155A

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	09/16/99
2) 2.5 KRAD IRRADIATION (0.147 KRADS/HOUR)	10/13/99
POST-2.5 KRAD ELECTRICAL MEASUREMENT	10/14/99
3) 5.0 KRAD IRRADIATION (0.116 KRADS/HOUR)	10/14/99
POST-5.0 KRAD ELECTRICAL MEASUREMENT	10/15/99
4) 10.0 KRAD IRRADIATION (0.069 KRADS/HOUR)	10/15/99
POST-10.0 KRAD ELECTRICAL MEASUREMENT	10/18/99
5) 20.0 KRAD IRRADIATION (0.238 KRADS/HOUR)	10/18/99
POST-20.0 KRAD ELECTRICAL MEASUREMENT	10/20/99
6) 30.0 KRAD IRRADIATION (0.262 KRADS/HOUR)	10/20/99
POST-30.0 KRAD ELECTRICAL MEASUREMENT	10/22/99
7) 168 HOUR ANNEALING @25°C	10/22/99
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/02/99

Average Dose Rate = 30,000 RADS/193 HOURS=155.4 RADS/HOUR=0.04RADS/SEC

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

Table III. Electrical Characteristics LF155A (1)

Test #	Parameter	Units	Spec. Limit min	Spec. Limit max	Test Conditions
1	Icc	mA		4.00	$\pm V_{CC} = \pm 15V$
2	Voffset	mV	-2.00	2.00	$\pm V_{CC} = \pm 5V$, $V_{CM} = 0V$
3	+Ib	pA	-100	100	$\pm V_{CC} = \pm 20V$, $-15V \leq V_{CM} \leq 0V$, $t \leq 25ms$
4	-Ib	pA	-100	300	$\pm V_{CC} = \pm 20V$, $-15V \leq V_{CM} \leq 0V$, $t \leq 25ms$
5	Iio	pA	-20	20	$\pm V_{CC} = \pm 20V$, $V_{CM} = 0V$
6	P_PSRR	dB	85		$+V_{CC} = +10V$, $-V_{CC} = -20V$
7	N_PSRR	dB	85		$+V_{CC} = +20V$, $-V_{CC} = -10V$
8	CMRR	dB	85		$\pm V_{CC} = \pm 20V$, $V_{IN} = \pm 15V$
9	Gain	dB	94		$\pm V_{CC} = \pm 5V$, $R_L = 2k\Omega$, $V_{OUT} = \pm 2V$
10	+Swing	V	15.0		$\pm V_{CC} = \pm 5V$, $R_L = 2k\Omega$
11	-Swing	V		-15.0	$\pm V_{CC} = \pm 5V$, $R_L = 2k\Omega$
12	Slew Rate	V/μs	3.00		$V_{IN} = \pm 5V$, $\pm V_{CC} = \pm 15V$, AV = 1

Notes:

(1) These are the manufacturer's non-irradiated data sheet specification limits. The manufacturer provided no post-irradiation limits at the time the tests were performed.

ABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for LF155A

					Total Dose Exposure (kRads Si)												Annealing	
					Initial		2.5		5.0		10.0		20.0		30.0		168 hours @25°C	
Test #	Parameters	Units	Spec. Lim. (2) min	Spec. Lim. (2) max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	Icc	mA		4.00	812	0.11	2.28	0.11	2.28	0.11	2.25	0.11	2.21	0.11	2.18	0.12	2.17	0.12
2	Voffset	mV	-2.00	2.00	-0.09	0.79	-0.15	0.80	-0.10	0.79	-0.09	0.80	-0.07	0.79	-0.07	0.79	1.20	0.75
3	+Ib	pA	-100	100	13	41	38	30	56	43	113	31	343	101	463	126	812	231
4	-Ib	pA	-100	300	7	43	-6	48	18	26	82	48	365	98	469	145	862	257
5	Iio (3)	pA	-20	20	47	36	66	35	50	32	55	33	60	31	51	32	59	27
6	P_PSRR	dB	85		104	14	104	15	105	14	106	15	105	14	105	15	101	11
7	N_PSRR	dB	85		114	15	116	16	112	12	113	12	115	14	112	12	114	18
8	CMRR	dB	85		106	13	105	12	108	15	108	15	108	14	107	13	106	15
9	Gain	dB	94		111	4	115	4	115	4	116	9	113	3	114	2	113	4
10	+Swing	V	15.0		17.7	0.5	17.7	0.5	17.7	0.5	17.7	0.5	17.7	0.5	17.7	0.5	17.7	0.5
11	-Swing	V		-15.0	-17.2	0	-17.3	0.5	-17.2	0.5	-17.3	0.5	-17.3	0.5	-17.3	0.5	-17.3	0.5
12	Slew Rate	V/ms	3.00		10.33	0.23	10.21	0.27	10.05	0.33	9.85	0.37	9.86	0.32	9.91	0.53	9.84	0.50

Notes:

(1) The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout testing and are not included in this t

(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

(3) During initial electrical testing, all parts gave readings greater than the specification limit of 20pA. This could be due to noise in the ATE load board. The general stability of the Iio reading up to 30kRads indicates that there is no radiation induced degradation in this parameter.

Radiation sensitive parameters: +Ib, -Ib.