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PPM-92-227

DATE: September 3, 1992

TO: J. Lohr/311

FROM: K. Sahu/7809 KS

SUBJECT: Radiation Report on GGS/WIND/TGPS Project
Part No. M38510/119-06BCA (control no.6906)

cc: J. Jermakian/721
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A radiation evaluation was performed on the M38510/119-06BCA (LF147) Quad Op Amp 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. The total dose radiation steps were 2.5, 5, 10, 15 and 20 krads (the term rad as used here means rad(Si)). The parts were kept under bias during irradiation and annealing (see Figure 1 for bias configuration). Two parts were used as a control sample. After 20 krads, parts were annealed at +25°C for 168 hours. The dose rate was between 0.125 and 0.25 krads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, the parts were electrically tested at +25°C according to the test conditions and the specification limits listed in Table III.

All parts passed the initial as well as the post-2.5- and post-5-krad electrical tests. After the 10-krad irradiation, all eight parts exceeded the maximum specification limit of 200 pA for Ib+2 and five of eight parts exceeded the maximum specification limit of 200 pA for Ib-2. After the 15-krad and 20-krad irradiations, all eight parts exceeded the maximum specification limits for Ib+2 and Ib-2, and after the 20-krad irradiation, all eight parts also exceeded the maximum specification limit of 200 pA for Ib+1, Ib+3 and Ib-3.

After 168 hours of annealing at 25°C, all eight parts showed partial recovery for Ib+1, Ib+2, Ib+3, Ib-2 and Ib-3. All other parameters remained within specification limits throughout all irradiation and annealing steps. No functional failures occurred during irradiation or annealing.

Table IV gives 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.

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TABLE I. Part Information

Generic Part Number:	LF147
GGS/WIND/TGRS Part Number:	M38510/116-09BCA
Control Number:	6906
Charge Number:	C23924
Manufacturer:	National Semiconductor
Lot Date Code:	9040A
Quantity Tested:	10
Serial Number of Radiation Samples:	3, 4, 5, 6, 7, 8, 9, 10
Serial Number of Control Samples:	1, 2
Part Function:	Quad Op Amp
Part Technology:	BiFET
Package Style:	14-pin DIP
Test Engineer:	T. Mondy

TABLE II. Radiation Schedule for LF147

EVENTS	DATE
1) INITIAL (PRE-IRRADIATION) ELECTRICAL MEASUREMENT	07/01/92
2) 2.5- KRAD IRRADIATION (0.125 krads/hour)* POST-2.5-KRAD ELECTRICAL MEASUREMENT	07/20/92 07/21/92
3) 5-KRAD IRRADIATION (0.125 krads/hour) POST-5-KRAD ELECTRICAL MEASUREMENT	07/21/92 07/22/92
4) 10-KRAD IRRADIATION (0.25 krads/hour) POST-10-KRAD ELECTRICAL MEASUREMENT	07/23/92 07/23/92
5) 15-KRAD IRRADIATION (0.25 KRAD/HOUR) POST-15-KRAD ELECTRICAL MEASUREMENT	07/23/92 07/24/92
6) 20-KRAD IRRADIATION (0.125 KRAD/HOUR) POST-20-KRAD ELECTRICAL MEASUREMENT	07/24/92 07/27/92
7) 168 HOURS ANNEALING AT +25°C POST-168-HOUR ELECTRICAL MEASUREMENTS	07/27/92 08/03/92

ALL ELECTRICAL MEASUREMENTS WERE PERFORMED AT +25°C.

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

Table III. Electrical Characteristics of LF147

Test	Units	Spec. Lim.		Test Conditions
		min	max	
+I _{cc}	mA	0	14	V _{cc} + = 15V, V _{cc} - = -15V, V _o = 0
-I _{cc}	mA	14	0	V _{cc} + = 15V, V _{cc} - = -15V, V _o = 0
V _{os1@50}	mV	-5	5	V _{cc} + = 26V, V _{cc} - = -4V
V _{os2@50}	mV	-5	5	V _{cc} + = 4V, V _{cc} - = -26V
V _{os3@50}	mV	-5	5	V _{cc} + = 15V, V _{cc} - = -15V
V _{os4@50}	mV	-5	5	V _{cc} + = 5V, V _{cc} - = -5V
I _{os}	pA	-100	100	V _{cc} + = 15V, V _{cc} - = -15V
I _{b+1}	pA	-200	200	V _{cc} + = 26V, V _{cc} - = -4V
I _{b+2}	pA	-200	200	V _{cc} + = 4V, V _{cc} - = -26V
I _{b+3}	pA	-200	200	V _{cc} + = 15V, V _{cc} - = -15V
I _{b-1}	pA	-200	200	V _{cc} + = 26V, V _{cc} - = -4V
I _{b-2}	pA	-200	200	V _{cc} + = 4V, V _{cc} - = -26V
I _{b-3}	pA	-200	200	V _{cc} + = 15V, V _{cc} - = -15V
A _{o11}	kV/V	50	-	V _o = ±10V, R _L = 2K, V _{cc} = ±15V
A _{o12}	kV/V	50	-	V _o = ±2V, R _L = 2K, V _{cc} = ±5V
CMRR	dB	80	-	V _{cm} = ±11V
+PSRR	dB	80	-	V _{cc} + = (+20, +10), V _{cc} - = -15V
-PSRR	dB	80	-	V _{cc} + = +15V, V _{cc} - = (-20, -10)
+V _{o1}	V	-	12	R _L = 10K
+V _{o2}	V	-	10	R _L = 2K
-V _{o1}	V	-12	-	R _L = 10K
-V _{o2}	V	-10	-	R _L = 2K

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for LF147 /1, /2

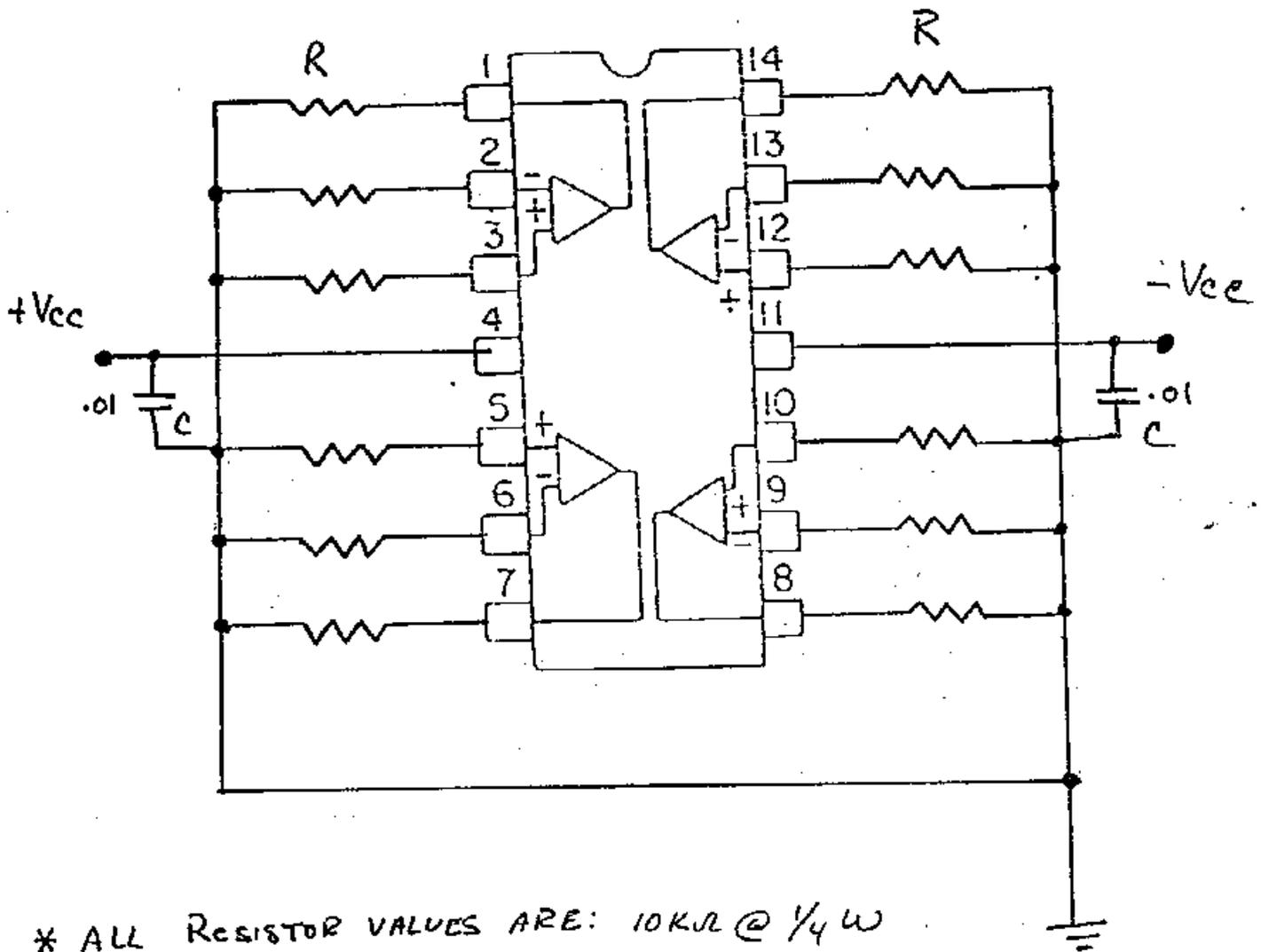
Parameters	min	max	Total Dose Exposure (krads)														
			Initials		2.5		5		10		15		20		168 hrs @25°C		
			mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
+Icc	mA	0	14	8.67	0.5	8.52	0.5	8.48	0.5	8.32	0.4	8.32	0.5	8.13	0.5	8.15	0.5
-Icc	mA	14	0	-8.7	0.5	-8.5	0.5	-8.5	0.5	-8.4	0.5	-8.3	0.5	-8.2	0.5	-8.1	0.5
Vos1@50	mV	-5	5	0.87	1	0.88	0.9	0.85	0.9	0.92	1	0.87	1	0.99	1	0.98	1
Vos2@50	mV	-5	5	1.05	0.9	1.03	0.9	1.04	0.9	1.05	0.9	1.05	0.9	1.07	0.9	1.07	0.9
Vos3@50	mV	-5	5	1.04	0.9	1.02	0.9	1.03	0.9	1.04	0.9	1.05	0.9	1.07	0.8	1.07	0.9
Vos4@50	mV	-5	5	1.04	0.9	1.03	0.9	1.05	0.9	1.06	0.9	1.07	0.9	1.1	0.9	1.09	0.9
Ios	pA	-100	100	12.4	9	12.2	9	12.7	8.9	14.1	8.9	14.9	8.9	26.5	8.9	22.9	9.1
Ib+1	pA	-200	200	19.4	11	28.4	8	38	7.4	67.8	7.8	71.4	10	220	15	177	14
Ib+2	pA	-200	200	62.8	11	90.1	11	126	9	214	18	246	8.9	633	36	482*	4.6
Ib+3	pA	-200	200	42.1	10	60.6	10	87.5	6.4	155	9.3	173	8.1	443	16	354	20
Ib-1	pA	-200	200	6.91	4.6	16.2	3.2	25.3	4.3	53.7	6.3	56.4	2.9	193	14	154	12
Ib-2	pA	-200	200	50.2	9.3	77.8	7.3	113	9.2	205	11	230	13	603	37	453*	13
Ib-3	pA	-200	200	29.5	3.9	48.3	4.2	74.8	4.7	143	11	157	11	413	17	341	17
Ao11	kV/V	50	-	316	14	307	13	300	12	288	8.9	284	13	264	14	267	9.3
Ao12	kV/V	50	-	86.5	10	82.5	8	82.9	8.6	80.9	8.7	80.3	7.8	75.7	7.5	76.9	8.6
CMRR	dB	80	-	105	3.9	105	4	105	4.2	106	5.9	107	6.7	111	14	113	16
+PSRR	dB	80	-	112	2.7	112	2.7	113	2.4	114	2.8	114	3.2	118	5.4	118	5.6
-PSRR	dB	80	-	113	3	113	3.3	113	3.6	114	4.1	115	4.2	117	5.5	116	4.8
+Vo1	V	-	12	14.1	.03	14.2	.01	14.2	0	14.2	0	14.2	0	14.2	.01	14.2	0
+Vo2	V	-	10	14	.03	14	.01	14	.01	14	.01	14	.01	14	.01	14	.01
-Vo1	V	-12	-	-13	.02	-13	.02	-13	.02	-13	.02	-13	.02	-13	.02	-13	.02
-Vo2	V	-10	-	-13	.02	-13	.02	-13	.02	-13	.02	-13	.02	-13	.02	-13	.02

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/ Each part consisted of four sections. The data presented in this table are for one section of each part. Similar responses were obtained for all other sections of each part. Data for all other sections are available on request.

*No reliable measurements were obtained for Ib+2 and Ib-2 after 168 hours of annealing. The parts were remeasured after 30 days annealing without bias. The mean and standard deviation values for Ib+2 and Ib-2 reflect the measurements after 720 hours.

Figure 1. Radiation Bias Circuit for LF147



* ALL RESISTOR VALUES ARE: 10K Ω @ 1/4 W

$$+V_{cc} = 15.0V \pm 0.5V_{DC}$$

$$T_A = 25^{\circ}C$$

$$-V_{cc} = -15.0V \pm 0.5V_{DC}$$

$$C = 0.01\mu f @ 50V_{DC}$$