

## Unisys

DATE: January 23, 2000 PPM-99-041  
TO: R. Reed/562  
FROM: K. Sahu/S. Kniffin/300.1  
SUBJECT: Radiation Report on **LMC6464A (National Semiconductor) (LDC 9608)**  
PROJECT: GLAS

cc: G. Henegar/564.9, R. Hardesty/550.0, A. Sharma/562, OFA Library/300.1

A radiation evaluation was performed on **LMC6464A (5962-9560302QXA) Quad Micro Power, Rail-to-Rail Input and Output CMOS Op Amp (National Semiconductor)** to determine the total dose tolerance of these parts. The total dose testing was performed using a Co<sup>60</sup> gamma ray source. During the radiation testing, one part was irradiated under bias to determine the initial degradation level. Four parts were then irradiated under bias (see Figure 1 for bias configuration) and two parts were used as control samples. The total dose radiation levels were 5.0 and 10.0kRads.<sup>1</sup> The average dose rate was 0.09kRads/hour (0.03Rads/s). See Table II for the radiation schedule and average dose rate calculation. After the 10.0kRad irradiation, the parts were so severely degraded that testing was halted at this point.<sup>2</sup> After each radiation exposure, parts were electrically tested according to the test conditions and the specification limits<sup>3</sup> 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.

**During initial electrical testing, all parts gave readings greater than the specification limit for +Ib, -Ib and Ios. These readings are the result of noise in the ATE, not in the part. All parts passed all other tests during initial electrical measurements. All parts showed significant degradation after 5.0 and 10.0kRads.**

Initial electrical measurements were made on 7 samples. One part was used to determine the initial degradation level (SN 63). Four samples (SN's 61, 62, 64, and 65) were used as radiation samples while SN's 50 and 51 were used as control samples. Other than +Ib, -Ib and Ios which gave high readings due to noise in the ATE, all parts passed all other tests during initial electrical measurements.

After the 5.0kRad irradiation, SN65 showed catastrophic degradation in +Ib, -Ib, Ios, Voh\_100k, Vol\_100k, Slew\_Rate, and GBW. **All parts passed all other tests.**

After the 10.0kRad irradiation, SN62 showed catastrophic degradation in +Ib, -Ib, Ios, Voh\_100k, and Slew\_Rate. SN 61 and 64 showed significant degradation in Voh\_100k and Slew\_Rate. **All parts passed all other tests.**

These parts were not annealed due to the severity of the degradation.

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 us at (301) 731-8954.

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<sup>1</sup> The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.

<sup>2</sup> The temperature 25°C as used in this document implies room temperature.

<sup>3</sup> These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

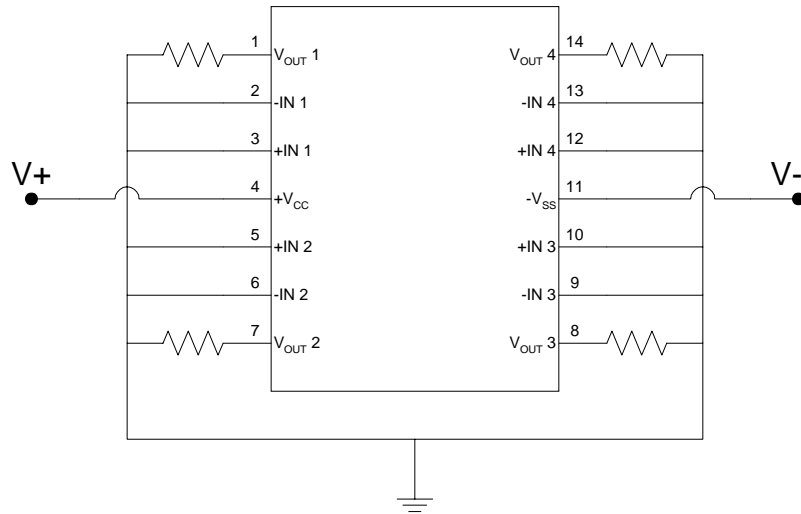
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Figure 1. Radiation Bias Circuit for LMC6464A



Notes:

1.  $+V = +15V \pm 0.5V$ .
2.  $-V = -15V \pm 0.5V$ .
3.  $R_1 = 25k\Omega \pm 10\%$ ,  $\frac{1}{2}W$ .

TABLE I. Part Information

Generic Part Number:	LMC6464A
GLAS Part Number	5962-9560302QXA
GLAS TID Requirement	25kRads (RDM = 5)
Charge Number:	M90422
Manufacturer:	National Semiconductor
Lot Date Code (LDC):	9608
Quantity Tested:	7
Serial Numbers of Control Samples:	50, 51
Serial Number of Initial Degradation Sample:	63
Serial Numbers of Radiation Samples:	61, 62, 64, 65
Part Function:	Quad Micro Power, Rail-to-Rail Input and Output CMOS Op Amp
Part Technology:	CMOS
Package Style:	14 Pin SOIC
Test Equipment:	A540
Test Engineer:	S. Archer-Davies

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

TABLE II. Radiation Schedule for LMC6464A

EVENT .....	DATE
1) INITIAL ELECTRICAL MEASUREMENTS .....	09/24/99
2) 5.0 KRAD IRRADIATION (0.071 KRADS/HOUR).....	09/24/99
POST 5.0 KRAD ELECTRICAL MEASUREMENT .....	09/27/99
3) 10.0 KRAD IRRADIATION (0.114 KRADS/HOUR).....	09/27/99
POST-10.0 KRAD ELECTRICAL MEASUREMENT .....	09/29/99

Average Dose Rate = 10,000 RADS/111 HOURS=90.1 RADS/HOUR=0.03RADS/SEC

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

Table III. Electrical Characteristics LMC6464A (1)

Test #	Parameter	Units	Spec. Limit		Test Conditions (2)
			min	max	
1	I <sub>cc</sub>	μA		110	
2-5	Out_A - Out-D	μV	-500	1800	
6 9 12 15	+I <sub>b</sub> A-D	pA	-25	25	
7 10 13 16	-I <sub>b</sub> A-D	pA	-25	25	
8 11 14 17	I <sub>os</sub> A-D	pA	-25	25	
18-21	PSRR A-D	dB	70		5V ≤ V <sub>+</sub> ≤ 15V, V <sub>-</sub> = 0V, V <sub>O</sub> = 2.5V
22-25	CMRR A-D	dB	70		0V ≤ V <sub>CM</sub> ≤ 15V
26-29	Gain_100k A-D	dB	110		R <sub>L</sub> = 100kΩ
30 32 34 36	V <sub>oh</sub> _100k A-D	V	14.975		R <sub>L</sub> = 100kΩ
31 33 35 37	V <sub>ol</sub> _100k A-D	V		0.025	R <sub>L</sub> = 100kΩ
38 40 42 44	Slew_Rate A-D	V/μs	0.015		2.5V ≤ V <sub>IN</sub> ≤ 12.5V
39 41 43 45	GBW A-D	kHz	60		

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.

(2) V<sub>+</sub> = +15V, V<sub>-</sub> = 0V, V<sub>CM</sub> = V<sub>O</sub> - V<sub>+</sub>/2, R<sub>L</sub> = 1MΩ unless otherwise specified.

**TABLE IV: Summary of Electrical Measurements After Total Dose Exposures for LMC6464 (1)**

Test #	Parameters	Units	Spec. Lim. (2)		Total Dose Exposure (kRads Si)								
					Initial			5.0			10.0		
			min	max	min	max	P/F	min	max	P/F	min	max	P/F
1	Icc	mA		110	77	100	4P/0F	0	99	4P/0F	64	98	3P/0F
2-5	Out_A - Out-D	mV	-500	1800	0	70	4P/0F	0	70	4P/0F	-0.1	0	3P/0F
6 9 12 15	+Ib A-D	pA	-25	25	-400	400	(4)	-1960	-53	3P/1F (5)	-1119	-30	0P/3F (5)
7 10 13 16	-Ib A-D	pA	-25	25	-400	400	(4)	<-200,000	51	3P/1F (5)	<-200,000	-26	0P/3F (5)
8 11 14 17	Ios A-D	pA	-25	25	-400	400	(4)	5	>200,000	3P/1F (5)	58	>200,000	0P/3F (5)
18-21	PSRR A-D	dB	70		107	180	4P/0F	107	180	4P/0F	154	180	3P/0F
22-25	CMRR A-D	dB	70		107	180	4P/0F	107	180	4P/0F	157	180	3P/0F
26-29	Gain_100k A-D	dB	110		110.5	125	4P/0F	110.1	110.4	4P/0F	110.2	110.2	3P/0F
30 32 34 36	Voh_100k A-D	V	14.975		14.999	15.003	4P/0F	1.206	15.801	3P/1F (5)		0.8	0P/3F
31 33 35 37	Vol_100k A-D	V		0.025	0.0015	0.0046	4P/0F	0.0014	1.2075	3P/1F (5)	0.0014	0.0041	3P/0F
38 40 42 44	Slew_Rate A-D	V/ms	0.015		0.023	0.030	4P/0F	0	0.039	3P/1F (5)	(6)		0P/3F (5)
39 41 43 45	GBW A-D	kHz	60		212	268	4P/0F	0.035	437	3P/1F (5)	(6)		0P/3F (5)

Notes:

- (1) The minimum and maximum readings are for 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) SN 65 failed catastrophically and was removed from further testing after 5kRads.
- (4)
- (5) Pass/Fail confirmed by bench measurement.
- (6) The readings for these tests were unreliable for all three parts.

**Radiation sensitive parameters: +Ib, -Ib, Ios, Voh\_100k A-D, Vol\_100k A-D, Slew Rate A-D, GBW A-D.**