Unisys

DATE: June 15, 1998 PPM-98-018
TO: R. Koehler/303
FROM: K. Sahu/S. Kniffin/300.1
SUBJECT: Radiation Report on **MAX494 (LDC 9639)**
PROJECT: Integral Spectrometer

cc: F. Duttweiler/UCSD, R. Reed/562, A. Sharma/562, OFA Library/300.1

A radiation evaluation was performed on **MAX494MJD Quad, Micro Power, Single-Supply, Rail-to-Rail, Op Amp (Maxim)** 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, five 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, 15.0, 20.0, 30.0, 50.0, 75.0, and 100.0 kRads.[1] The dose rate was between 0.125 and 0.625 kRads/hour (0.035 to 0.174 Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After the 100.0 kRad irradiation, the parts were annealed under bias at 25°C and tested after 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. A summary of the test results is provided below, for detailed information, refer to Tables I through IV and Figure 1.

Initial electrical measurements were made on 6 samples. Five samples (SN's 322, 323, 324, 325 and 326) were used as radiation samples while SN 321 was used as a control sample. All parts passed all tests during initial electrical measurements.

All parts passed all tests up to 10.0 kRads.

After the 15.0 kRad irradiation, SN's 323, 325 and 326 all fell marginally below the specification limit of -60nA for Ib_1 and Ib_2 with readings in the range of -61 to -79nA for both. **All parts passed all other tests.**

After the 20.0 to 100.0 kRad irradiations, all parts fell below the specification limit for Ib_1 and Ib_2 with readings in the range of -77 to -102nA at 15.0kRads and gradually falling to -195 to -200nA at 100.0kRads for both parameters. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, parts showed some increased degradation in Ib_1 and Ib_2 with readings in the range of -195 to -266nA for both parameters. **All parts passed all other tests.**

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. Figure 2 shows the variation of the radiation sensitive parameters Ib_1 and Ib_2 with increasing radiation exposures and annealing.

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

---

[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.

ADVISORY ON THE USE OF THIS DOCUMENT

The information contained in this document has been developed solely for the purpose of providing general guidance to employees of the Goddard Space Flight Center (GSFC). This document may be distributed outside GSFC only as a courtesy to other government agencies and contractors. Any distribution of this document, or application or use of the information contained herein, is expressly conditional upon, and is subject to, the following understandings and limitations:

(a) The information was developed for general guidance only and is subject to change at any time;

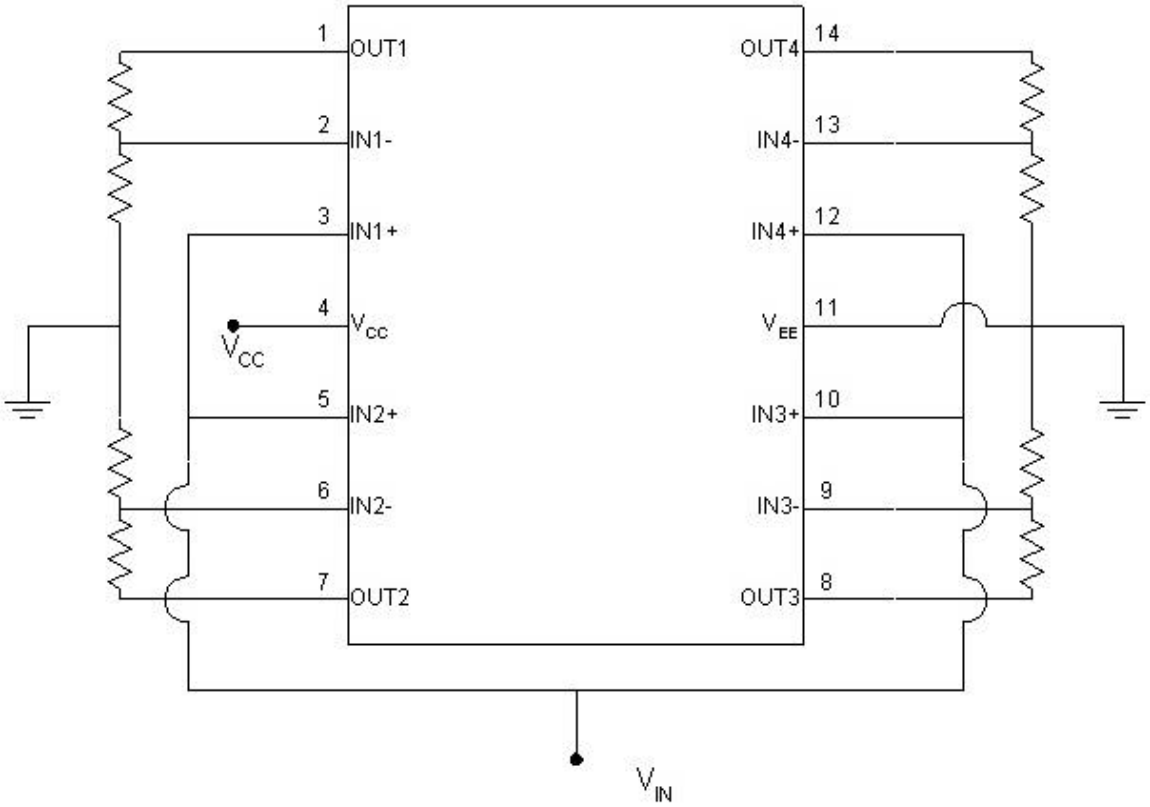
(b) The information was developed under unique GSFC laboratory conditions which may differ substantially from outside conditions;

(c) GSFC does not warrant the accuracy of the information when applied or used under other than unique GSFC laboratory conditions;

(d) The information should not be construed as a representation of product performance by either GSFC or the manufacturer;

(e) Neither the United States government nor any person acting on behalf of the United States government assumes any liability resulting from the application or use of the information.

Figure 1. Radiation Bias Circuit for MAX494



Notes:
1. R = 1kΩ ±5%, ¼W.
2. V_{CC} = 5.0V ±5%.
3. V_{IN} = 2.0V, ±5%.

TABLE I. Part Information

Generic Part Number:	MAX494
Integral Spectrometer Part Number	MAX494MJD
Charge Number:	C80777
Manufacturer:	MAXIM
Lot Date Code (LDC):	9639
Quantity Tested:	6
Serial Number of Control Samples:	321
Serial Numbers of Radiation Samples:	322, 323, 324, 325, and 326
Part Function:	Quad, Micro-Power, Single-Supply, Rail-to-Rail Op Amps
Part Technology:	Bipolar
Package Style:	14-Pin DIP
Test Equipment:	A540
Test Engineer:	S. Norris

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

TABLE II. Radiation Schedule for MAX494

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	04/27/98
2) 5.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	05/11/98
POST-5.0 KRAD ELECTRICAL MEASUREMENT	05/13/98
3) 10.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	05/13/98
POST-10.0 KRAD ELECTRICAL MEASUREMENT	05/15/98
4) 15.0 KRAD IRRADIATION (0.077 KRADS/HOUR)	05/15/98
POST-15.0 KRAD ELECTRICAL MEASUREMENT	05/18/98
5) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	05/18/98
POST-20.0 KRAD ELECTRICAL MEASUREMENT	05/20/98
6) 30.0 KRAD IRRADIATION (0.250 KRADS/HOUR)	05/20/98
POST-30.0 KRAD ELECTRICAL MEASUREMENT	05/22/98
7) 50.0 KRAD IRRADIATION (0.225 KRADS/HOUR)	05/22/98
POST-50.0 KRAD ELECTRICAL MEASUREMENT	05/26/98
8) 75.0 KRAD IRRADIATION (0.625 KRADS/HOUR)	05/26/98
POST-75.0 KRAD ELECTRICAL MEASUREMENT	05/28/98
9) 100.0 KRAD IRRADIATION (0.625 KRADS/HOUR)	05/29/98
POST-100.0 KRAD ELECTRICAL MEASUREMENT	06/01/98
10) 168 HOUR ANNEALING @25°C	06/01/98
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	06/08/98

Effective Dose Rate = 100,000 RADS/20 DAYS=208.3 RADS/HOUR=0.06 RADS/SEC

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

Table III. Electrical Characteristics of MAX494 /1

Test #	Parameter /2 /3	Units	Test Conditions /2	Spec. min	Lim. max
1-4	Vos	µV	$V_{CM} = V_{EE}$ to V_{CC}	-500	500
5,8,11,14	Ib_1	nA	$V_{CM} = V_{EE}$ to V_{CC}	-60	60
6,9,12,15	Ib_2	nA	$V_{CM} = V_{EE}$ to V_{CC}	-60	60
7,10,13,16	Ios	nA	$V_{CM} = V_{EE}$ to V_{CC}	-6.0	6.0
17,18	P_PSRR	dB	V_{CC} = 2.7V to 6V	88	
19,20	N_PSRR	dB	V_{CC} = 2.7V to 6V	88	
21-24	CMRR	dB	$(V_{EE} - 0.25V) \leq V_{CM} \leq (V_{CC} + 0.25V)$	74	
25-28	Gain_100k	dB	V_{CC} = 5.0V, R_L = 100kΩ, V_{OUT} = 0.25V to 4.75V	98	
29-32	Gain_1k	dB	V_{CC} = 5.0V, R_L = 1kΩ, V_{OUT} = 0.5V to 4.5V	98	
33,35,37,39	Voh_100k	V	R_L = 100kΩ	4.925	
34,36,38,40	Vol_100k	V	R_L = 100kΩ		0.075
41,43,45,47	Voh_1k	V	R_L = 1kΩ	4.800	
42,44,46,48	Vol_1k	V	R_L = 1kΩ		0.200
A	Icc /4	µA	$V_{CM} = V_{OUT} = V_{CC}/2$, V_{CC} = 5.0V		900

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/ For all tests: V_{CC} = 5V, V_{EE} = GND, V_{CM} = 0V, $V_{OUT} = V_{CC}/2$ unless otherwise noted.

3/ Each of the tests were performed on each of the four Op Amps in the quad package.

4/ Icc was measured with a bench setup due to current measurement restrictions on the ATE.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for MAX494 /1

							Total Dose Exposure (kRads Si)																Annealing	
					Initial		5.0		10.0		15.0		20.0		30.0		50.0		75.0		100.0		168 hours @25°C	
Test #	Parameters /3	Units	Spec. Lim. /2 min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1-4	Vos	?V	-500	500	24	34	26	32	29	45	31	50	31	48	29	49	25	43	33	53	36	53	30	53
5,8,11,14	Ib_1	nA	-60	60	20	1	28	3	43	5	66	9	88	12	119	14	170	18	196	5	200	0	237	24
6,9,12,15	Ib_2	nA	-60	60	20	1	28	3	42	5	65	9	87	12	119	14	168	17	192	4	195	0	235	26
7,10,13,16	Ios	nA	-6.0	6.0	-0.6	0.4	-0.9	1.7	-0.6	0.8	-0.8	1.0	-1.0	1.0	-1.5	0.8	-1.6	1.1	-3.7	1.7	-5.1	0	-1.4	1.9
17,18	P_PSRR	dB	88		143	8	149	11	143	12	149	12	144	8	148	9	156	5	145	8	146	11	148	3
19,20	N_PSRR	dB	88		135	3	149	10	146	12	141	8	152	8	147	3	153	5	148	6	150	4	153	7
21-24	CMRR	dB	74		132	1	132	2	132	1	131	4	132	3	132	1	132	1	132	1	133	1	133	2
25-28	Gain_100k	dB	98		107	0	107	0	107	0	107	0	107	0	107	0	107	0	107	0	107	0	107	0
29-32	Gain_1k	dB	98		107	0	107	0	107	0	107	0	107	0	107	0	107	0	107	0	107	0	107	0
33,35,37,39	Voh_100k	V	4.925		4.988	0.001	4.985	0.014	4.986	0	4.976	0.022	4.985	0	4.984	0	4.983	0.002	4.982	0.002	4.981	0	4.981	0.002
34,36,38,40	Vol_100k	V		0.075	0.008	0.001	0.011	0.007	0.009	0.001	0.016	0.016	0.009	0	0.010	0.001	0.011	0.001	0.011	0.001	0.011	0.002	0.011	0.001
41,43,45,47	Voh_1k	V	4.800		4.988	0.001	4.982	0.010	4.986	0.002	4.978	0.017	4.985	0.002	4.984	0.002	4.983	0.001	4.982	0.001	4.981	0.002	4.982	0.001
42,44,46,48	Vol_1k	V		0.200	0.008	0.001	0.010	0.004	0.008	0	0.014	0.008	0.009	0.001	0.009	0	0.010	0.001	0.010	0.001	0.011	0	0.011	0.001
A	Icc /4	?A		900	705	13	708	12	716	10	734	10	757	9	766	10	803	9	810	11	834	8	825	9

Notes:

1/ The mean and standard deviation values were calculated over the five parts irradiated in this testing. The control samples remained constant throughout testing and are not included in this tabl

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/ Each of the tests were performed on each of the four op amps in the quad package. All parts tracked very closely for all tests.
The numbers shown on the table represent the average of the one op amp closest too, or farthest over, the specification limit.

4/ Due to the complexity of this test, this measuement was made using a bench setup.

Radiation sensitive parameters: Ib_1, Ib_2.

Figure 2: Ib vs Total Ionizing Dose for MAX494