

# Unisys

DATE: July 15, 1997  
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 FROM: K. Sahu/300.1 *ks*  
 SUBJECT: Radiation Report on: MX7847  
           Project: SMEX/LITE  
           Job #: EE77034  
           Project part #: MX7847BR

PPM-97-025

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A radiation evaluation was performed on MX7847BR (Dual, 12-bit multiplying DAC) 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 Co<sup>60</sup> gamma ray source. During the radiation testing, four 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 2.5, 5.0, 7.5, 10.0, 15.0, 20.0, 30.0, 50.0, and 100.0 kRads.\* The dose rate was between 0.06 and 0.50 kRads/hour (0.02 and 0.14 Rads/s), see Table II for radiation schedule. After the 100.0 kRad exposure, the parts were annealed for 168 hours at 25°C and 168 hours at 100°C. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits\*\* listed in Table III.

Initial electrical measurements were made on 5 samples. Four samples (SN's 11, 12, 13, and 14) were used as radiation samples while SN 10 was used as a control sample. All parts passed all tests during initial electrical measurements.

All parts passed all tests to 15.0 kRads. No significant degradation was noted in any parameter.

After the 20.0 kRad irradiation, SN 13 fell below the specification limit of -6.0mA for ISS\_L, ISS\_HSS\_vih, and ISS\_vih, with readings of -9.52, -9.50, -8.54, and -9.53mA respectively. **All parts passed all other tests.**

After the 30.0 kRad irradiation, SN 11 fell below the specification limit for ISS\_L, ISS\_ISS\_vih, and ISS\_vih, with readings of -13.3, -14.5, -14.2, and -7.3mA respectively. SN 11 also marginally exceeded the specification limit of 20.0mA for IDD\_H and IDD\_vih with readings of 25.9 and 23.4mA respectively. SN's 12 and 13 fell marginally below the specification limit for ISS\_vih with readings of -7.6mA and -7.7mA respectively. SN 14 fell below the specification limit for ISS\_H, ISS\_vih and ISS\_vih, with readings of -11.8, -11.8 and -10.3mA respectively. SN 14 also marginally exceeded the specification limit of 20.0mA for IDD\_H and IDD\_vih with readings of 29.4 and 26.9mA respectively. **All parts passed all other tests.**

After the 50.0 kRad irradiation, all parts fell below the specification limit for ISS\_L, ISS\_HSS\_vih, and ISS\_vih with readings in the range of -11.2 to -16.5mA for all. **All parts passed all other tests.**

After the 100.0 kRad irradiation, SN12 was not tested at this level due to a connection failure. Only SN 14 fell below the specification limits for ISS\_H, ISS\_vih and ISS\_vih with readings of -7.90, -6.17 and -9.66 mA respectively. SN 14 also exceeded the specification limits for A\_INL ( $\pm 0.5$ lsb), A\_DNL ( $\pm 1.0$ lsb), B\_INL

\* The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.

\*\* These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

( $\pm 0.5$ lsb), and B\_DNI, ( $\pm 1.0$ lsb) with readings of 0.686, 2.235, 0.895, and 2.285 lsb respectively. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, the parts showed some recovery in several parameters. Most parameters annealed to post 20 kRad levels; however, SN I3 readings were slightly higher for radiation sensitive parameters.

After annealing the parts for 168 hours at 100°C, the parts showed no rebound effect. In summary, the parts showed little degradation upon irradiation up to 100 kRads.

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 me at (301) 731-8954.

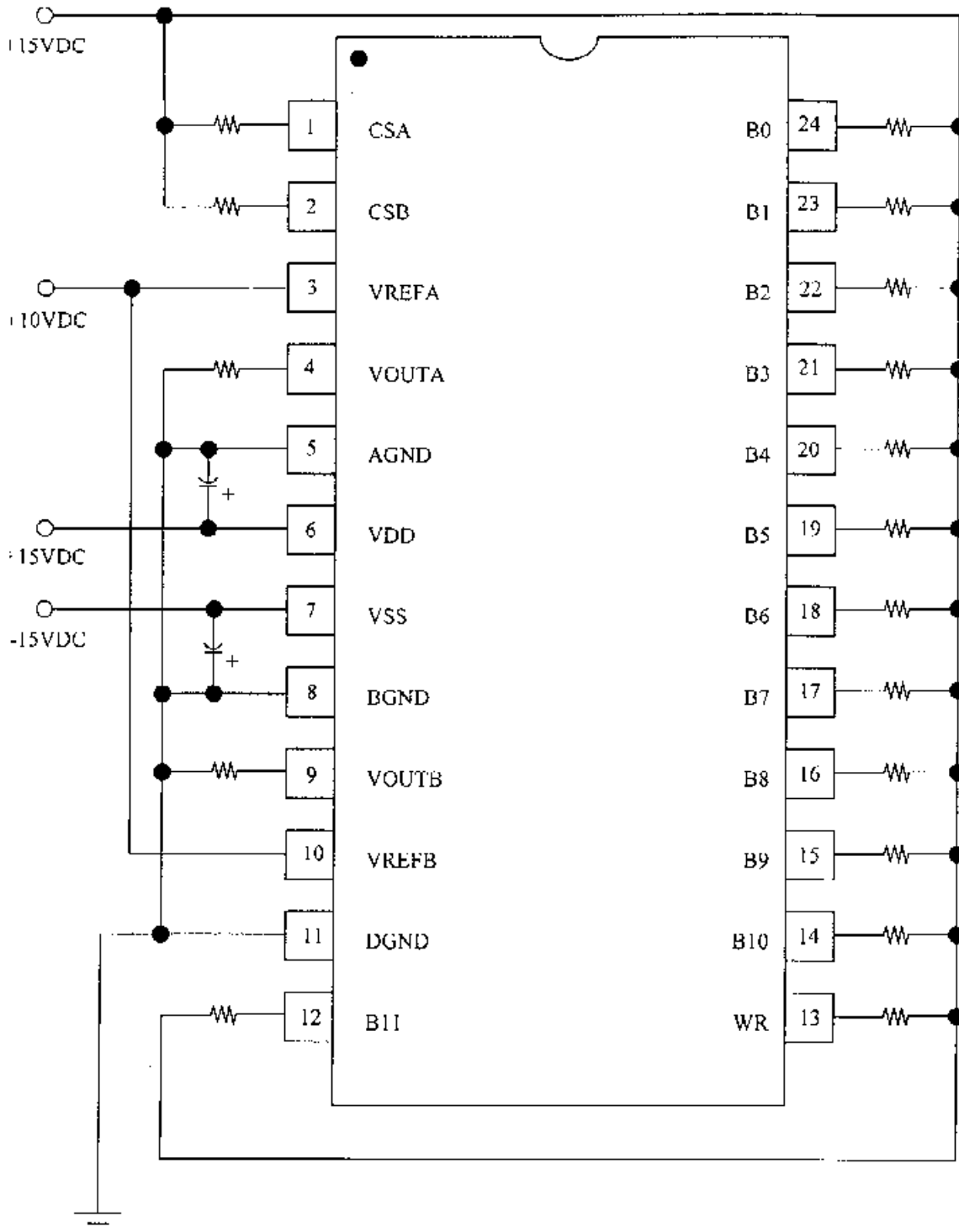
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Figure 1. Radiation Bias Circuit for MX7847



Notes: All resistors are 10kΩ +5%, ½W. All capacitors are 0.1μF

TABLE I. Part Information

Generic Part Number:	MX7847
SMEX/LITE Part Number	MX7847BR
Charge Number:	EE77034
Manufacturer:	MAXIM
Lot Date Code (LDC):	9707
Quantity Tested:	5
Serial Number of Control Sample:	10
Serial Numbers of Radiation Samples:	11, 12, 13, and 14
Part Function:	Dual, 12-bit Multiplying DAC's
Part Technology:	Hybrid
Package Style:	24 Pin DIP
Test Equipment:	A510
Test Engineer:	A. Naji

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

TABLE II. Radiation Schedule for MX7847

EVENT .....	DATE
1) INITIAL ELECTRICAL MEASUREMENTS .....	05/21/97
2) 2.5 KRAD IRRADIATION (0.062 KRADS/HOUR) .....	05/23/97
POST-2.5 KRAD ELECTRICAL MEASUREMENT .....	05/27/97
3) 5 KRAD IRRADIATION (0.062 KRADS/HOUR) .....	05/27/97
POST-5 KRAD ELECTRICAL MEASUREMENT .....	05/29/97
4) 7.5 KRAD IRRADIATION (0.062 KRADS/HOUR) .....	05/29/97
POST-7.5 KRAD ELECTRICAL MEASUREMENT .....	06/02/97
5) 10.0 KRAD IRRADIATION (0.062 KRADS/HOUR) .....	06/02/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT .....	06/04/97
6) 15.0 KRAD IRRADIATION (0.125 KRADS/HOUR) .....	06/04/97
POST-15.0 KRAD ELECTRICAL MEASUREMENT .....	06/06/97
7) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR) .....	06/09/97
POST-20.0 KRAD ELECTRICAL MEASUREMENT .....	06/11/97
8) 30.0 KRAD IRRADIATION (0.250 KRADS/HOUR) .....	06/11/97
POST-30.0 KRAD ELECTRICAL MEASUREMENT .....	06/13/97
9) 50.0 KRAD IRRADIATION (0.250 KRADS/HOUR) .....	06/13/97
POST-50.0 KRAD ELECTRICAL MEASUREMENT .....	06/16/97
10) 100.0 KRAD IRRADIATION (0.500 KRADS/HOUR) .....	06/17/97
POST-100.0 KRAD ELECTRICAL MEASUREMENT .....	06/20/97
11) 168 HOUR ANNEALING @25°C .....	06/20/97
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT .....	06/27/97
12) 168 HOUR ANNEALING @100°C .....	06/27/97
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT .....	07/08/97
Effective Dose Rate = 100,000 RADS/29 DAYS=143.7 RADS/HOUR=0.040 RADS/SEC	

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

Table III. Electrical Characteristics of MX7847 /1

Test #	Parameter	Units	Test Conditions /2	Spec. min	Lim. max
1	IDD_L	mA	Output Unloaded		20.0
2	ISS_L	mA	Output Unloaded	-6.0	
3	IDD_H	mA	Output Unloaded		20.0
4	ISS_H	mA	Output Unloaded	-6.0	
5	IDD_vil	mA	Output Unloaded		20.0
6	ISS_vil	mA	Output Unloaded	-6.0	
7	IDD_vih	mA	Output Unloaded		20.0
8	ISS_vih	mA	Output Unloaded	-6.0	
9	REFA_res	kΩ		8.0	23.0
10	REFB_res	kΩ		8.0	23.0
11	R_match	%		-3.0	3.0
12-26	Iih1	μA	Digital inputs at 0V and V <sub>DD</sub>		1.00
27-41	Iil1	μA	Digital inputs at 0V and V <sub>DD</sub>	-1.00	
42-56	Iih2	μA	Digital inputs at 0V and V <sub>DD</sub>		1.00
57-71	Iil2	μA	Digital inputs at 0V and V <sub>DD</sub>	-1.00	
72	+psrr_15v /3	% fs	V <sub>DD</sub> = 15V ±5%, V <sub>REF</sub> = -10V	-0.01	0.01
73	-psrr_15v /3	% fs	V <sub>SS</sub> = -15V ±5%, V <sub>REF</sub> = 10V	-0.01	0.01
74	+psrr_12v /3	% fs	V <sub>DD</sub> = 12V ±5%, V <sub>REF</sub> = -8.9V	-0.01	0.01
75	-psrr_12v /3	% fs	V <sub>SS</sub> = -12V ±5%, V <sub>REF</sub> = 8.9V	-0.01	0.01
76	A_INL /4	lsb		-0.5	0.5
77	A_DNL /4	lsb	guaranteed monotonic	-1.0	1.0
78	B_INL /4	lsb		-0.5	0.5
79	B_DNL /4	lsb	guaranteed monotonic	-1.0	1.0

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/ The following parameters apply to all tests except where noted. V<sub>DD</sub> = 11.4V to 16.5V, V<sub>SS</sub> = -11.4V to -16.5V, AGNDA = AGNDB = DGND = 0V, V<sub>REFA</sub> = V<sub>REFB</sub> = +10V, R<sub>L</sub> = 2kΩ, C<sub>L</sub> = 100pF, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>.

3/ The units are % full scale.

4/ The units are least significant bit.

**TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for MX7847 /1**

Test #	Parameters	Units	Spec. Lim. /2	min	max	Total Dose Exposure (kRad/s)												Annealing								
						Initial		5.0		10.0		15.0		20.0		30.0		50.0		100.0		168 hours @25°C		168 hours @100°C		
						mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
1	IDD_I	mA		20.0		4.25	0.19	4.71	0.14	5.58	0.89	5.72	0.89	6.96	2.26	13.5	3.1	17.0	1.9	3.13	1.75	8.44	4.00	7.40	1.88	
2	ISS_I	mA	-6.0		-3.46	0.19	-3.89	0.14	-4.64	0.85	-4.67	0.81	-5.85	2.16	-6.38	4.08	-13.6	1.6	-2.31	1.66	-7.69	4.06	-6.33	1.90		
3	IDD_II	mA		20.0	4.38	0.18	4.87	0.10	5.84	0.94	5.97	0.95	7.18	2.29	21.9	5.9	18.1	1.9	6.31	1.98	8.76	4.59	7.50	1.88		
4	ISS_II	mA	-6.0		-3.51	0.19	-3.96	0.12	-4.71	0.87	-4.73	0.79	-5.85	2.15	-8.83	4.42	-14.9	1.8	-5.28	1.85	-7.95	4.66	-6.69	1.92		
5	IDD_vil	mA		20.0	4.28	0.11	4.81	0.12	5.71	0.93	5.88	0.92	7.09	2.28	19.6	5.7	17.7	1.8	5.59	1.15	8.70	4.42	7.44	1.87		
6	ISS_vil	mA	-6.0		-3.49	0.19	-3.93	0.13	-4.68	0.87	-4.71	0.82	-5.85	2.17	-8.78	4.31	-14.6	1.8	-4.63	1.09	-7.91	4.48	-6.65	1.90		
7	IDD_vih	mA		20.0	4.62	0.19	6.01	0.16	6.70	0.85	6.71	0.80	7.83	2.13	11.6	1.3	17.8	1.9	7.73	2.70	10.25	4.09	7.87	1.27		
8	ISS_vih	mA	-6.0		-3.49	0.19	-3.92	0.13	-4.67	0.87	-4.70	0.82	-5.85	2.17	-8.23	1.21	-14.6	1.8	-5.80	2.73	-8.22	4.34	-6.64	1.90		
9	REFA_res	kΩ	8.0	23.0	10.28	0.01	10.28	0.01	10.29	0.01	10.29	0.01	10.29	0.01	10.29	0.01	10.29	0.02	10.31	0.01	10.32	0.01	10.33	0.01		
10	REFB_res	kΩ	8.0	23.0	10.30	0.62	10.30	0.01	10.31	0.01	10.31	0.01	10.32	0.02	10.28	0.02	10.28	0.05	10.33	0.02	10.34	0.02	10.35	0.02		
11	R_match	%	-3.0	3.0	-0.2	0.2	-0.2	0.2	-0.2	0.2	-0.2	0.2	-0.2	0.2	0.05	0.38	0.85	0.35	-0.2	0.2	-0.2	0.2	-0.2	0.2		
12-26	Ih1	µA		1.00	0.242	0.006	0.298	0.021	0.213	0	0.187	0	0.193	0	0.327	0.0004	0.181	0.007	0.162	0.006	0.100	0	0.080	0		
27-41	Ih1	µA	-1.00		-0.227	0.005	-0.273	0.012	-0.207	0	-0.187	0	-0.193	0	-0.320	0.0004	-0.188	0.004	-0.160	0.011	-0.100	0	-0.070	0		
42-56	Ih2	µA		1.00	0.080	0	0.093	0	0.087	0	0.073	0	0.080	0	0.108	0	0.071	0.004	0.069	0.003	0.333	0	0.020	0		
57-71	Ih2	µA	-1.00		-0.080	0	-0.080	0	-0.080	0	-0.067	0	-0.065	0.003	-0.100	0	-0.059	0.004	-0.056	0.006	-0.333	0	-0.020	0		
72	+psrr_15v	%	-0.01	0.01	0.0004	0.0001	0.0004	0.0001	0.0004	0.0002	0.0004	0.0003	0.0002	0.0002	0.0002	0.0	0.0	0.0	-0.0002	0.0007	0.0001	0.0002	0.0004	0.0002		
73	-psrr_15v	%	-0.01	0.01	0.0010	0.0001	0.0011	0.0002	0.0011	0.0002	0.0013	0.0003	0.0010	0.0002	0.0008	0.0004	0.0008	0.0003	0.0011	0.0001	0.0012	0.0002	0.0004	0.0002		
74	+psrr_12v	%	-0.01	0.01	-0.0016	0.0003	-0.0016	0.0006	-0.0008	0.0008	-0.0010	0.0015	-0.0006	0.0010	0.0000	0.0000	0	0.0001	0.0001	-0.0006	0.0027	-0.0002	0.0004	0.0002		
75	-psrr_12v	%	-0.01	0.01	0.0064	0.0011	0.0051	0.0007	0.026	0.0003	0.0012	0.0002	0.0011	0.0002	0.0006	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		
76	A_INL	lsb	-0.5	0.5	0.130	0.009	0.141	0.019	0.111	0.042	0.103	0.045	0.141	0.048	0.177	0.025	0.088	0.065	0.338	0.248	-0.050	0.141	-0.064	0.138		
77	A_DNL	lsb	-1.0	1.0	0.728	0.042	0.752	0.090	0.461	0.253	0.410	0.064	0.553	0.189	0.564	0.043	0.556	0.089	0.394	0.303	-0.466	0.322	0.564	0.225		
78	B_INL	lsb	-0.5	0.5	0.110	0.015	0.017	0.051	0.174	0.037	0.252	0.035	0.180	0.056	0.189	0.017	0.096	0.053	0.237	0.257	0.062	0.035	0.029	0.062		
79	B_DNL	lsb	-1.0	1.0	0.520	0.066	0.429	0.047	0.392	0.054	0.555	0.057	0.541	0.056	0.724	0.085	0.795	0.139	0.461	0.358	0.571	0.110	0.547	0.005		

Notes:

- 1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing. The control samples remained constant throughout the 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 12 was not tested at this level due to a connection failure.

Radiation sensitive parameters: ISS\_L, IDD\_II, ISS\_II, IDD\_vil, ISS\_vil, ISS\_vih.