Unisys

DATE: November 17, 1998 PPM-99-008
TO: S Hull/562
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SUBJECT: Radiation Report on **AD536 (Analog Devices) (LDC 9817)**
PROJECT: IRAC

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A radiation evaluation was performed on **AD536 (5962-8980501CA) True RMS-to-DC Converter (Analog Devices)** to determine the total ionizing dose (TID) tolerance of these parts. The TID 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 TID radiation levels were 2.5, 5.0, 10.0, 15.0, 20.0, 30.0, 50.0, and 100.0kRads.[1] The dose rate was 0.219kRads/hour (0.06Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After the 100.0kRad 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.

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. For detailed information, refer to Tables I through IV and Figures 1 and 2.

All parts passed all tests initially and upon irradiation to 10kRads. After the 15 to 100kRad irradiations, all parts showed some degradation in Vos. Figure 2 shows the degradation in Vos with radiation. After the 30 to 100kRad irradiations, all parts showed some degradation in all Vrms parameters. The parts showed no significant recovery in Vos or Vrms after 168 hours of annealing at 25°C.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 32, 33, 34, 35, 36, 37, 38, and 39) were used as radiation samples while SN's 30 and 31 were used as control samples. All parts passed all tests during initial electrical measurements.

All parts passed all tests up to 10kRads.

After the 15.0kRad irradiation, six parts showed marginal degradation in Vos and exceeded the specification limit of 2.00mV with readings in the range of 2.07 to 2.49mV. **All parts passed all other tests.**

After the 20.0kRad irradiation, seven parts showed some degradation in Vos with readings in the range of 2.28 to 3.01mV. **All parts passed all other tests.**

After the 30.0kRad irradiation, seven parts showed some degradation in Vos with readings in the range of 3.06 to 4.52mV. The parts showed some degradation in the Vrms tests, falling below the specification limit of -0.500% with readings in the range of -0.501 to -1.444%. **All parts passed all other tests.**

After the 50.0kRad irradiation, all parts showed degradation in Vos with readings in the range of 2.23 to 4.61mV. The parts fell below the specification limit for the Vrms tests with readings in the range of -0.504 to -0.869%. **All parts passed all other tests.**

[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.

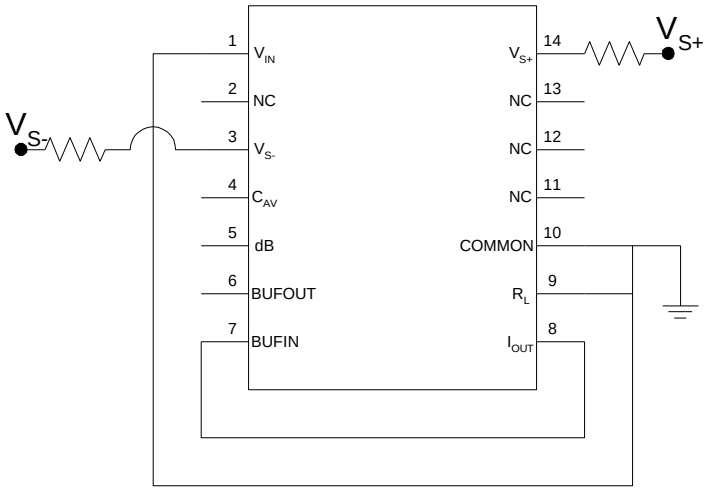
After the 100kRad irradiation, all parts showed degradation in Vos with readings in the range of 3.85 to 7.31mV. All parts fell below the specification limit for Vrms with readings in the range of -0.502 to -2.353%. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, the parts showed no significant recovery in Vos or Vrms.

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.

Figure 1. Radiation Bias Circuit for MX536



Notes:
1. V_{S+} = +20V ±0.5V, V_{S-} = -15V ±0.5V.
2. All R = 100Ω ±5%, ¼W.

TABLE I. Part Information

Generic Part Number:	AD536
IRAC Part Number:	AD536ASQ (5962-8980501CA)
Charge Number:	M88534
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9817
Quantity Tested:	10
Serial Number of Control Samples:	30, 31
Serial Numbers of Radiation Samples:	32, 33, 34, 35, 36, 37, 38, and 39
Part Function:	True RMS-to-DC Converter
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 MX536

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	10/08/98
2) 2.5 KRAD IRRADIATION (0.038 KRADS/HOUR)	10/16/98
POST-2.5 KRAD ELECTRICAL MEASUREMENT	10/19/98
3) 5.0 KRAD IRRADIATION (0.063 KRADS/HOUR)	10/19/98
POST-5.0 KRAD ELECTRICAL MEASUREMENT	10/21/98
4) 10.0 KRAD IRRADIATION (0.149 KRADS/HOUR)	10/21/98
POST-10.0 KRAD ELECTRICAL MEASUREMENT	10/23/98
5) 15.0 KRAD IRRADIATION (0.077 KRADS/HOUR)	10/23/98
POST-15.0 KRAD ELECTRICAL MEASUREMENT	10/26/98
6) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	10/26/98
POST-20.0 KRAD ELECTRICAL MEASUREMENT	11/28/98
7) 30.0 KRAD IRRADIATION (0.243 KRADS/HOUR)	10/28/98
POST-30.0 KRAD ELECTRICAL MEASUREMENT	10/30/98
8) 50.0 KRAD IRRADIATION (0.307 KRADS/HOUR)	10/30/98
POST-50.0 KRAD ELECTRICAL MEASUREMENT	11/02/98
9) 100.0 KRAD IRRADIATION (1.250 KRADS/HOUR)	11/02/98
POST-100.0 KRAD ELECTRICAL MEASUREMENT	11/04/98
10) 168 HOUR ANNEALING @25°C	11/04/98
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/11/98

Effective Dose Rate = 100,000 RADS/19 DAYS=219.3 RADS/HOUR=0.06 RADS/SEC
The effective dose rate is lower than that of the individual radiation steps as it takes into account the interim annealing step and time needed to test the parts.

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

Table III. Electrical Characteristics of DG403 /1

Test #	Parameter	Units	Test Conditions /2	Spec. Lim. min	Spec. Lim. max
1	Vee	V		0.3	1.3
2	Icc_18V	mA	V_S = +18V		2.0
3	Iee_18V	mA	V_S = -18V	-2.0	
4	Icc_5V	mA	V_S = +5V		2.0
5	Iee_5V	mA	V_S = -5V	-2.0	
6	Vrms_1.050V /3	%	V_{IN} = 1.050V	-0.500	0.500
7	Vrms_1.550V	%	V_{IN} = 1.550V	-0.500	0.500
8	Vrms_2.050V	%	V_{IN} = 2.050V	-0.500	0.500
9	Vrms_2.550V	%	V_{IN} = 2.550V	-0.500	0.500
10	Vrms_3.050V	%	V_{IN} = 3.050V	-0.500	0.500
11	Vrms_3.550V	%	V_{IN} = 3.550V	-0.500	0.500
12	Vrms_4.050V	%	V_{IN} = 4.050V	-0.500	0.500
13	Vrms_4.550V	%	V_{IN} = 4.550V	-0.500	0.500
14	Vrms_5.050V	%	V_{IN} = 5.050V	-0.500	0.500
15	Vrms_5.550V	%	V_{IN} = 5.550V	-0.500	0.500
16	Vrms_6.050V	%	V_{IN} = 6.050V	-0.500	0.500
17	Vrms_6.550V	%	V_{IN} = 6.550V	-0.500	0.500
18	Vo_@5V	V	I_{OUT} to BUFIN, V_S = ±5V	2.0	
19	Vo_@15V	V	I_{OUT} to BUFIN, V_S = ±15V	11.0	
20	Iin_Buf	nA			60.0
A	Vos /4	mV	I_{OUT} to BUFIN, V_{IN} = 0V		2.0

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/ V_S = ±15V, unless otherwise noted.

3/ Due to limitations in the ATE test power supply the RMS to DC conversion could only be tested from 1 to 6.5 volts. The reading is the % difference between the AC input and the DC output.

4/ Due to limitations in the ATE, Vos was measured using a bench setup.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for MX536 /1

							Total Dose Exposure (kRads Si)																Annealing	
					Initial		2.5		5.0		10.0		15.0		20.0		30.0		50.0		100.0		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	mean	sd	mean	sd	mean	sd
1	Vee	V	0.3	1.3	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0
2	Icc_18V	mA		2.0	1.4	0	1.4	0	1.4	0	1.4	0	1.3	0	1.3	0	1.3	0	1.3	0	1.3	0	1.3	0
3	Iee_18V	mA	-2.0		-1.4	0	-1.4	0	-1.4	0	-1.4	0	-1.3	0	-1.3	0	-1.3	0	-1.3	0	-1.3	0	-1.3	0
4	Icc_5V	mA		2.0	1.2	0	1.1	0	1.1	0	1.1	0	1.1	0	1.1	0	1.1	0	1.1	0	1.0	0	1.0	0
5	Iee_5V	mA	-2.0		-1.2	0	-1.1	0	-1.1	0	-1.1	0	-1.1	0	-1.1	0	-1.1	0	-1.1	0	-1.0	0	-1.0	0
6	Vrms_1.050V	%	-0.500	0.500	0.110	0.058	0.084	0.001	-0.002	0.063	-0.048	0.101	-0.179	0.107	-0.337	0.154	-1.102	0.269	-0.557	0.236	-1.819	0.462	-1.728	0.372
7	Vrms_1.550V	%	-0.500	0.500	0.105	0.040	0.034	0.072	0.017	0.072	-0.078	0.064	-0.127	0.128	-0.212	0.123	-0.743	0.187	-0.441	0.204	-1.302	0.353	-1.271	0.309
8	Vrms_2.050V	%	-0.500	0.500	0.029	0.031	0.008	0.043	-0.047	0.046	-0.150	0.064	-0.147	0.080	-0.231	0.095	-0.666	0.167	-0.406	0.176	-1.101	0.311	-1.079	0.265
9	Vrms_2.550V	%	-0.500	0.500	-0.015	0.051	-0.070	0.059	-0.101	0.053	-0.150	0.072	-0.181	0.107	-0.243	0.037	-0.580	0.131	-0.396	0.154	-0.987	0.258	-0.950	0.241
10	Vrms_3.050V	%	-0.500	0.500	-0.038	0.044	-0.089	0.030	-0.119	0.058	-0.155	0.031	-0.202	0.065	-0.270	0.086	-0.582	0.145	-0.397	0.119	-0.911	0.238	-0.896	0.184
11	Vrms_3.550V	%	-0.500	0.500	-0.071	0.032	-0.113	0.057	-0.135	0.035	-0.166	0.063	-0.215	0.082	-0.277	0.073	-0.506	0.108	-0.395	0.116	-0.842	0.198	-0.816	0.198
12	Vrms_4.050V	%	-0.500	0.500	-0.070	0.035	-0.123	0.020	-0.131	0.041	-0.193	0.033	-0.216	0.046	-0.274	0.069	-0.514	0.102	-0.378	0.112	-0.801	0.195	-0.771	0.148
13	Vrms_4.550V	%	-0.500	0.500	-0.102	0.034	-0.120	0.044	-0.141	0.047	-0.172	0.030	-0.221	0.077	-0.276	0.072	-0.465	0.110	-0.368	0.098	-0.728	0.171	-0.738	0.173
14	Vrms_5.050V	%	-0.500	0.500	-0.080	0.032	-0.145	0.032	-0.149	0.032	-0.201	0.054	-0.230	0.049	-0.277	0.059	-0.472	0.088	-0.385	0.113	-0.733	0.171	-0.703	0.130
15	Vrms_5.550V	%	-0.500	0.500	-0.119	0.032	-0.132	0.042	-0.162	0.043	-0.203	0.047	-0.234	0.064	-0.271	0.063	-0.434	0.100	-0.350	0.093	-0.676	0.154	-0.661	0.150
16	Vrms_6.050V	%	-0.500	0.500	-0.121	0.034	-0.153	0.032	-0.168	0.021	-0.187	0.035	-0.229	0.056	-0.296	0.065	-0.438	0.091	-0.366	0.089	-0.649	0.160	-0.644	0.130
17	Vrms_6.550V	%	-0.500	0.500	-0.115	0.021	-0.149	0.029	-0.180	0.047	-0.226	0.040	-0.260	0.041	-0.263	0.056	-0.432	0.080	-0.358	0.097	-0.667	0.135	-0.648	0.139
18	Vo_@5V	V	2.0		3.2	0	3.2	0	3.2	0	3.2	0	3.2	0	3.2	0	3.2	0	3.2	0	3.2	0	3.2	0
19	Vo_@15V	V	11.0		13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	13.2	0	13.2	0	13.2	0
20	Iin_Buf	nA		60.0	-6.0	0.7	-9.2	0	-9.1	0	-8.4	0	-8.3	0.6	-6.3	0	-9.2	0.6	-7.7	0.7	-8.3	0.6	0.5	0.6
A	Vos /3	mV		2.0	0.3	0.2	0.6	0.2	0.8	0.3	1.5	0.3	2.0	0.4	2.4	0.5	3.5	0.8	3.7	0.7	5.9	1.0	5.7	0.9

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 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/ Due to limitations in the ATE, Vos was measured with a bench setup.

Radiation sensitive parameter: Vos.

Figure 2: Vos vs Total Ionizing Dose (kRads Si)