

Unisys

DATE: April 29, 1998 PPM-98-012
TO: J. Dafnis/303
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SUBJECT: Radiation Report on: **REF-10 (Analog Devices) (LDC 9720A)**
PROJECT: GOES (ITT)

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A radiation evaluation was performed on **REF-10 Voltage Reference (Analog Devices)** to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. The total dose testing was performed using a Co⁶⁰ 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 total dose radiation levels were 20.0, 40.0, 60.0, 80.0, 100.0, 150.0, and 200.0 kRads.¹ The dose rate was 1.200 kRads/hour (0.33 Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After the 200.0 kRad irradiation, the parts were annealed under bias at 25°C and tested after 24, 48 and 168 hours.² After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits³ 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 Figure 1.

No significant degradation was observed in any test parameter after exposures from 20 to 200kRads although some parts marginally exceeded the specification limits for Load Regulation and VREF. No significant change was observed in any parameter after annealing the parts under bias at 25°C for 24, 48 and 168 hours.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 232, 243, 244, 249, 250, 254, 265, and 269) were used as radiation samples while SN's 222 and 231 were used as control samples. Four parts fell below the specification limit of -0.080% for Load Regulation with readings in the range of -0.084 to -0.206%. All parts passed all other tests during initial electrical measurements.

After the 20.0 kRad irradiation, three parts fell below the specification limit of -0.080% for Load Regulation with readings of -0.091, -0.147 and -0.151%. **All parts passed all other tests.**

After the 40.0 kRad irradiation, all parts were within the specification limits for Load Regulation. Three parts marginally exceeded the specification limit of 10.030V for VREF with readings in the range of 10.032 to 10.040V. **All parts passed all other tests.**

After the 60.0 kRad irradiation, three parts marginally exceeded the specification limit for VREF with readings in the range of 10.031 and 10.037V. Two parts fell marginally below the specification limit for Load Regulation with readings of -0.089 and -0.097%. **All parts passed all other tests.**

After the 80.0 kRad irradiation, two parts exceeded the specification limit for VREF with readings of 10.037 and 10.034V. Two parts fell below the specification limit for Load Regulation with readings of -0.090 and -0.097%. **All parts passed all other tests.**

After annealing the parts for 72 hours at 25°C, parts showed no significant change in any parameter.

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

² The temperature 25°C used in this document refers to 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 100.0 kRad irradiation, two parts exceeded the specification limit for VREF with readings of 10.036 and 10.033V. Two parts fell below the specification limit for Load Regulation with readings of -0.104 and -0.103%. **All parts passed all other tests.**

After the 150.0 kRad irradiation, one part exceeded the specification limit for VREF with a reading of 10.035V. Two parts fell below the specification limit for Load Regulation with readings of -0.122 and -0.106%. One part exceeded the specification limit of 0.200% for Line Regulation with a reading of 0.223%. **All parts passed all other tests.**

After the 200.0 kRad irradiation, one part exceeded the specification limit for VREF with a reading of 10.035V. Two parts fell below the specification limit for Load Regulation with readings of -0.121 and -0.107%. **All parts passed all other tests.**

After annealing the parts for 24, 48 and 168 hours at 25°C, parts showed no significant change in any parameter with readings much the same as at 200kRads.

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.

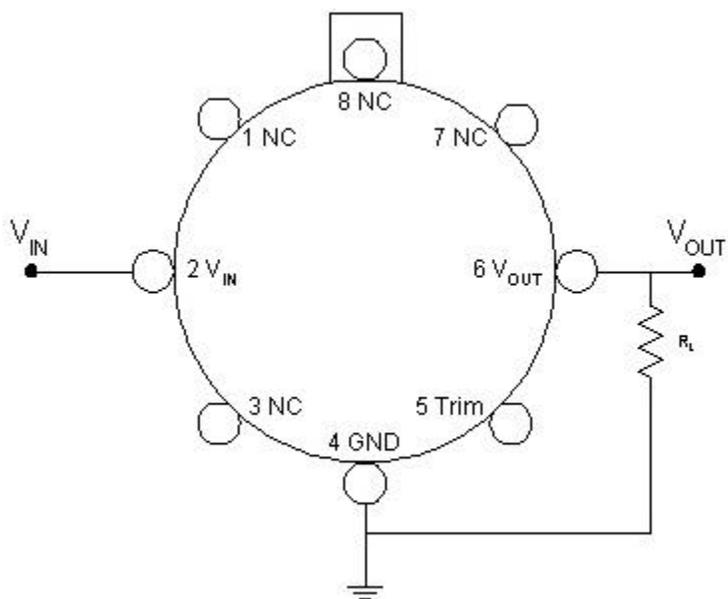
Any further details about this evaluation can be obtained upon request. If you have any questions, please call us at (301) 731-8954.

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Figure 1. Radiation Bias Circuit for REF-10



Notes:

1. $R_L = 10\text{k}\Omega \pm 10\%$, $\frac{1}{4}\text{W}$.
2. $V_{IN} = +30.0\text{V}$, $V_{OUT} = +10\text{V} \pm 0.05\text{V}$.

TABLE I. Part Information

Generic Part Number:	REF-10
GOES ITT Part Number	REF-10
Charge Number:	C80709/C80825
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9720A
Quantity Tested:	10
Serial Number of Control Samples:	222, 232
Serial Numbers of Radiation Samples:	232, 243, 244, 249, 250, 254, 265, and 269
Part Function:	Voltage Reference
Part Technology:	Bipolar
Package Style:	TO-99 Can
Test Equipment:	A540
Test Engineer:	S. Archer-Davies

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

TABLE II. Radiation Schedule for REF-10

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS.....	03/23/98
2) 20.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	04/06/98
POST-20.0 KRAD ELECTRICAL MEASUREMENT	04/07/98
3) 40.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	04/07/98
POST-40.0 KRAD ELECTRICAL MEASUREMENT	04/08/98
4) 60.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	04/08/98
POST-60.0 KRAD ELECTRICAL MEASUREMENT	04/09/98
5) 80.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	04/09/98
POST-80.0 KRAD ELECTRICAL MEASUREMENT	04/10/98
6) 72 HOUR ANNEALING @25°C *	04/10/98
POST-72 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/13/98
7) 100.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	04/13/98
POST-100.0 KRAD ELECTRICAL MEASUREMENT	04/14/98
8) 150.0 KRAD IRRADIATION (1.250 KRADS/HOUR)	04/14/98
POST-150.0 KRAD ELECTRICAL MEASUREMENT	04/16/98
9) 200.0 KRAD IRRADIATION (0.450 KRADS/HOUR) **	04/16/98
POST-200.0 KRAD ELECTRICAL MEASUREMENT	04/20/98
10) 24 HOUR ANNEALING @25°C	04/20/98
POST-24 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/21/98
11) 48 HOUR ANNEALING @25°C	04/20/98
POST-48 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/22/98
12) 168 HOUR ANNEALING @25°C	04/20/98
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/27/98

Effective Dose Rate = 200,000 RADS/14 DAYS=595.2 RADS/HOUR=0.17 RADS/SEC
 The effective dose rate is lower than that of the individual radiation steps as it takes into account the interim-annealing step.

* This 72 hour annealing step was added to maintain the prescribed dose rate due to the weekend.
 ** The dose rate was adjusted to allow the parts to receive radiation dose over the weekend.

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

Table III. Electrical Characteristics of REF-10 /1

Test #	Parameter	Units	Test Conditions	Spec. min	Lim. max
1	I _q	mA	No Load	0.0	1.4
2	VREF	V	No Load	9.97	10.03
3	Load Reg	%	I _L = 0mA to 10mA	-0.08	0.08
4	Line Reg	%	V _{IN} = 13V to 33V	-0.20	0.20
5	ISC	mA	V _{OUT} = 0V	-60	-15
6	I _{sink}	mA	V _{OUT} = 10V	0.3	2.0
7	I _{load}	mA	V _{OUT} = 10V	-30	-10

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.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for REF-10 /1

Test #	Parameters	Units	Spec. Lim. /2		Total Dose Exposure (kRads Si)												Annealing		Total Dose Exposure (kRads Si)						Annealing					
					Initial		20.0		40.0		60.0		80.0		72 hours @25°C		100.0		150.0		200.0		24 hours @25°C		48 hours @25°C		168 hours @25°C			
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	I _q	mA	0.0	1.4	1.126	0.015	1.122	0.014	1.122	0.014	1.118	0.015	1.117	0.015	1.121	0.015	1.121	0.016	1.116	0.014	1.124	0.016	1.122	0.013	1.123	0.014	1.118	0.015		
2	VREF	V	9.970	10.030	10.014	0.008	10.020	0.008	10.029	0.008	10.027	0.009	10.026	0.009	10.025	0.007	10.025	0.009	10.024	0.009	10.024	0.008	10.024	0.008	10.024	0.008	10.025	0.009		
3	Load Reg	%	-0.080	0.080	-0.091	0.077	-0.046	0.070	0.011	0.048	-0.003	0.059	-0.005	0.060	-0.009	0.062	-0.009	0.063	-0.016	0.067	-0.016	0.062	-0.015	0.061	-0.014	0.065	-0.013	0.066		
4	Line Reg	%	-0.200	0.200	0.003	0.006	0.027	0.025	0.076	0.044	0.093	0.057	0.112	0.064	0.091	0.058	0.111	0.068	0.111	0.074	0.104	0.065	0.109	0.066	0.103	0.067	0.111	0.070		
5	ISC	mA	-60	-15	-25	0.3	-25	0.5	-25	0.2	-25	0.2	-25	0.3	-25	0.2	-25	0.3	-25	0.3	-25	0.3	-25	0.7	-25	0.2	-25	0.3		
6	I _{sink}	mA	0.3	2.0	0.63	0.01	0.63	0.01	0.64	0.01	0.64	0.01	0.64	0.01	0.64	0.01	0.64	0.01	0.64	0.01	0.64	0.01	0.64	0.01	0.64	0.01	0.64	0.01		
7	I _{load}	mA	-30	-10	-21	5.3	-23	2.8	-25	0.2	-25	0.2	-25	0.2	-25	0.3	-25	0.2	-25	0.7	-25	0.7	-25	0.7	-25	0.4	-25	0.4		

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.

Radiation sensitive parameters: VREF, Load Reg.