Unisys

DATE: May 18, 1998 PPM-98-015
TO: J. Dafnis/303
FROM: K. Sahu/S. Kniffin/300.1
SUBJECT: Radiation Report on **CMP-01 (Analog Devices) (LDC 9729)**
PROJECT: GOES (ITT)

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A radiation evaluation was performed on **CMP-01 Voltage Comparator (Analog Devices)** 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, eight parts were irradiated under bias (see Figure 1 for bias configuration) and three 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 6, 72 and 240 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 Figure 1.

All eight irradiated parts stayed within the specification limits for all tests performed at V_{CC} = 5V through 200kRads. For tests performed at V_{CC} = 15V, parts stayed within the specification limits up to 60kRads. After the 80 to 200kRad exposures, the parts showed some degradation in ±Ibias1 and 2 and CMRR. After annealing the parts under bias at 25°C for 240 hours, the parts showed significant recovery in ios1 and ios2 with all parts passing these tests and some recovery in ±ibias_1 and ±ibias_2. No significant recovery was noted in any other parameter.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 625, 646, 655, 665, 668, 669, 676, and 685) were used as radiation samples while SN's 624 and 654 were used as control samples. All parts passed all tests during initial electrical measurements.

All parts passed all tests up to 60.0 kRads.

After the 80.0 kRad irradiation, four parts exceeded the specification limit of 600nA for ±ibias1_15V with readings in the range of 603 to 663nA. Four parts exceeded the specification limit of 600nA for ±ibias2_15V with readings in the range of 603 to 662nA. SN's 665 and 669 fell marginally below the specification limit of 94dB for cmrr_15V with readings of 74 and 83dB respectively. **All parts passed all other tests.**

After the 100.0 kRad irradiation, most parts exceeded the specification limit for ±ibias1_15V with readings in the range of 601 to 692nA. Five parts exceeded the specification limit for ±ibias2_15V with readings in the range of 608 to 691nA. SN's 665 and 669 fell marginally below the specification limit for cmrr_15V with readings of 74 and 83dB respectively. **All parts passed all other tests.**

After the 150.0 kRad irradiation, all parts exceeded the specification limit for ±ibias1_15V with readings in the range of 915 to 1070nA. All parts exceeded the specification limit for ±ibias2_15V with readings in the range of 914 to 1069nA. SN's 665 and 669 fell marginally below the specification limit for cmrr_15V with readings of 89 and 88dB respectively. **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 200.0 kRad irradiation, all parts exceeded the specification limit for ±ibias1_15V with readings in the range of 736 to 971nA. All parts exceeded the specification limit of 25nA for ios1 and 2 with readings in the range of 32 to 43nA. All parts exceeded the specification limit for ±ibias2_15V with readings in the range of 734 to 970nA. SN's 665 and 669 fell marginally below the specification limit for cmrr_15V with readings of 89 and 88dB respectively. **All parts passed all other tests.**

After annealing the parts for 6 hours at 25°C, parts showed no significant recovery in any parameter.

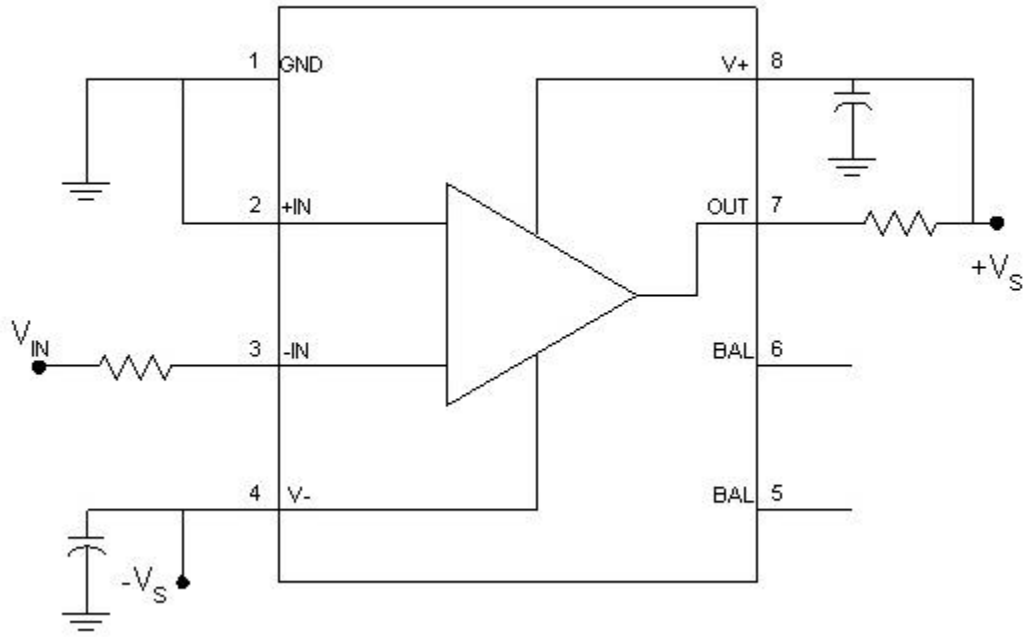
After annealing the parts for 72 hours at 25°C, parts showed modest recovery in ios1, ios2, ±ibias1_15V and ±ibias2_15V and no significant changes in any other parameters.

After annealing the parts for 240 hours at 25°C, parts showed significant recovery in ios1 and ios2 with all parts passing these tests. Parts also showed significant recovery in ±ibias_1 and _2 with readings in the range of 595 to 760nA for all.

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 CMP-01



Notes:
1. R_L = 1kΩ ±10%, ¼W.
2. $+V_S$ = +15V ±5%, $-V_S$ = -15V ±5%, V_{IN} = 2.5V ±5%.
3. C = 0.1µF only if oscillations are observed on pin 7. (Not used in this testing.)

TABLE I. Part Information

Generic Part Number:	CMP-01
GOES ITT Part Number	CMP-01
Charge Number:	C80709/C80825
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9729
Quantity Tested:	10
Serial Number of Control Samples:	624, 654
Serial Numbers of Radiation Samples:	625, 646, 655, 665, 668, 669, 676, and 685
Part Function:	Voltage Comparator
Part Technology:	Bipolar
Package Style:	8-Pin DIP
Test Equipment:	A540
Test Engineer:	S. Archer-Davies

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

TABLE II. Radiation Schedule for CMP-01

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	04/20/98
2) 20.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	04/20/98
POST-20.0 KRAD ELECTRICAL MEASUREMENT	04/21/98
3) 40.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	04/21/98
POST-40.0 KRAD ELECTRICAL MEASUREMENT	04/22/98
4) 60.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	04/22/98
POST-60.0 KRAD ELECTRICAL MEASUREMENT	04/23/98
5) 80.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	04/23/98
POST-80.0 KRAD ELECTRICAL MEASUREMENT	04/24/98
6) 100.0 KRAD IRRADIATION (0.278 KRADS/HOUR) *	04/24/98
POST-100.0 KRAD ELECTRICAL MEASUREMENT	04/27/98
7) 150.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	04/27/98
POST-150.0 KRAD ELECTRICAL MEASUREMENT	04/29/98
8) 200.0 KRAD IRRADIATION (0.450 KRADS/HOUR)	04/29/98
POST-200.0 KRAD ELECTRICAL MEASUREMENT	05/01/98
9) 6 HOUR ANNEALING @25°C	05/01/98
POST-4 HOUR ANNEAL ELECTRICAL MEASUREMENT	05/01/98
10) 72 HOUR ANNEALING @25°C **	05/01/98
POST-72 HOUR ANNEAL ELECTRICAL MEASUREMENT	05/04/98
11) 240 HOUR ANNEALING @25°C ***	05/01/98
POST-240 HOUR ANNEAL ELECTRICAL MEASUREMENT	05/11/98

Effective Dose Rate = 200,000 RADS/11 DAYS=757.5 RADS/HOUR=0.21 RADS/SEC
The effective dose rate is lower than that of the individual radiation steps as it takes into account the interim-annealing step.

* The dose rate was adjusted to allow the parts to receive radiation dose over the weekend.
** This annealing time was increased to 72 hours due to the weekend.
*** This annealing step was extended due to the weekend.

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

Table III. Electrical Characteristics of CMP-01 /1

Test #	Parameter /2	Units	Test Conditions	Spec. min	Lim. max
1	Idd_+5V	mA	$V_{IN} \leq$ -10mV	0.01	3.20
2	Idd_+15V	mA	$V_{IN} \leq$ -10mV	0.01	8.00
3	Idd_-15V	mA	$V_{IN} \leq$ -10mV	-2.20	0
4	power_diss	mW	$V_{IN} \leq$ -10mV	0	153
5	vos_0.4_at_5V	mV	V_O = 0.4V, $R_S \leq 5k\Omega$	-1.50	1.50
6	vos_2.4_at_5V	mV	V_O = 2.4V, $R_S \leq 5k\Omega$	-1.50	1.50
7	vos_0.4_at_15V	mV	V_O = 0.4V, $R_S \leq 5k\Omega$	-0.80	0.80
8	vos_2.4_at_15V	mV	V_O = 2.4V, $R_S \leq 5k\Omega$	-0.80	0.80
9	+ibias1_5V	nA	R_S = 5kΩ, V_S = ±2.5V		500
10	-ibias1_5V	nA	R_S = 5kΩ, V_S = ±2.5V		500
11	ios1_5V	nA	R_S = 10kΩ, V_S = ±2.5V	-21	21
12	+ibias2_5V	nA	R_S = 5kΩ, V_S = ±2.5V		500
13	-ibias2_5V	nA	R_S = 5kΩ, V_S = ±2.5V		500
14	ios2_5V	nA	R_S = 10kΩ, V_S = ±2.5V	-21	21
15	+ibias1_15V	nA	R_S = 5kΩ		600
16	-ibias1_15V	nA	R_S = 5kΩ		600
17	ios1_15V	nA	R_S = 10kΩ	-25	25
18	+ibias2_15V	nA	R_S = 5kΩ		600
19	-ibias2_15V	nA	R_S = 5kΩ		600
20	ios2_15V	nA	R_S = 10kΩ	-25	25
21	vol1_15V	V	$V_{IN} \leq$ -10mV, I_{sink} = 0mA	0	0.40
22	vol2_15V	V	$V_{IN} \leq$ -10mV, $I_{sink} \leq$ 6.4mA	0	0.45
23	vol3_15V	V	$V_{IN} \leq$ -10mV, $I_{sink} \leq$ 12mA	0	0.50
24	voh1_15V	V	$V_{IN} \geq$ 3mV, I_O = 320µA	2.4	6.0
25	voh2_15V	V	$V_{IN} \geq$ 3mV, I_O = 240µA	2.4	6.0
26	voh3_15V	V	$V_{IN} \geq$ 3mV, I_O = 0µA	2.4	6.0
27	Avo_15V	V/mV	V_O = 0.4V to 2.4V	200	
28	I_leak	nA	$V_{IN} \geq$ 10mV, V_O = +30V	0	2000
29	+psrr	dB	5V ≤ $+V_S \leq$18V	80	
30	-psrr	dB	-18V ≤ $-V_S \leq$ 0V	80	
31	cmrr_15V	dB	V_S+ = 15V, V_S- = 0V	94	
32	cmrr_5V	dB	V_S+ = 5V, V_S- = 0V	80	

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, those with _5V imply V_S = ±5V and those with _15V imply V_S = ±15V except where otherwise noted.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for CMP-01 /1

Test #	Parameters	Units	Spec. Lim. /2 min	Spec. Lim. /2 max	Initial mean	Initial sd	Total Dose Exposure (kRads Si) 20.0 mean	20.0 sd	40.0 mean	40.0 sd	60.0 mean	60.0 sd	80.0 mean	80.0 sd	100.0 mean	100.0 sd	150.0 mean	150.0 sd	200.0 mean	200.0 sd	Annealing 6 hours @25°C mean	6 hours @25°C sd	72 hours @25°C mean	72 hours @25°C sd	240 hours @25°C mean	240 hours @25°C sd
1	Idd_+5V	mA	0.01	3.20	0.94	0.09	0.95	0.10	0.97	0.12	0.97	0.12	0.96	0.12	0.98	0.12	0.95	0.11	1.03	0.14	1.03	0.14	1.03	0.14	1.03	0.14
2	Idd_+15V	mA	0.01	8.00	5.46	0.16	5.34	0.16	5.29	0.14	5.26	0.14	5.23	0.13	5.20	0.13	5.09	0.15	5.17	0.14	5.18	0.15	5.20	0.15	5.22	0.15
3	Idd_-15V	mA	-2.20	0	-1.43	0.06	-1.35	0.06	-1.30	0.05	-1.28	0.05	-1.27	0.05	-1.27	0.05	-1.16	0.06	-1.25	0.05	-1.26	0.05	-1.28	0.05	-1.30	0.06
4	power_diss	mW	0	153	60	1.6	60	1.6	60	1.6	60	1.6	59	1.5	59	1.4	59	1.6	59	1.5	59	1.5	59	1.5	59	1.5
5	vos_0.4_at_5V	mV	-1.50	1.50	0.6	0.2	0.4	0.2	0.4	0.2	0.4	0.2	0.4	0.2	0.4	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
6	vos_2.4_at_5V	mV	-1.50	1.50	-0.3	0.2	-0.5	0.2	-0.5	0.2	-0.5	0.2	-0.5	0.2	-0.6	0.2	-0.7	0.2	-0.7	0.3	-0.7	0.3	-0.7	0.3	-0.7	0.3
7	vos_0.4_at_15V	mV	-0.80	0.80	0.8	0.1	0.6	0.1	0.6	0	-0.4	0.2	0.2	0.4	0.1	0.3	0.2	0.3	-0.1	0	-0.1	0	-0.1	0	-0.1	0.3
8	vos_2.4_at_15V	mV	-0.80	0.80	-0.3	0.1	-0.4	0	-0.4	0	-0.4	0	-0.4	0	-0.4	0	-0.4	0	-0.4	0	-0.4	0	-0.4	0.2	-0.4	0.2
9	+ibias1_5V	nA		500	0	1	0	1	0	0	0	1	0	1	0	0	-1	1	-1	1	0	1	0	1	0	0
10	-ibias1_5V	nA		500	0	0	0	0	0	1	0	0	0	1	0	0	0	1	-1	1	0	1	0	1	0	0
11	ios1_5V	nA	-21	21	1	2	0	1	0	1	0	1	0	1	0	0	0	2	0	1	1	2	0	2	0	0
12	+ibias2_5V	nA		500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	-ibias2_5V	nA		500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	ios2_5V	nA	-21	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	+ibias1_15V	nA		600	288	29	396	34	483	44	543	48	610	48	626	46	1048	92	895	66	859	62	759	52	692	53
16	-ibias1_15V	nA		600	290	30	390	34	474	44	533	47	594	50	609	44	1048	92	858	63	824	59	730	50	670	52
17	ios1_15V	nA	-25	25	-2	2	7	3	9	3	10	3	16	9	17	5	0	3	37	4	35	4	25	5	22	3
18	+ibias2_15V	nA		600	287	29	395	34	482	44	542	48	609	48	626	46	1047	92	894	65	858	61	758	51	691	53
19	-ibias2_15V	nA		600	290	30	390	34	473	44	532	47	593	50	608	44	1047	92	857	63	823	59	729	49	670	52
20	ios2_15V	nA	-25	25	-3	2	7	3	9	2	10	3	16	8	17	5	-1	3	37	4	35	4	25	5	21	3
21	vol1_15V	V	0	0.40	0.14	0.03	0.14	0.03	0.14	0.03	0.14	0.03	0.14	0.03	0.14	0.03	0.14	0.02	0.13	0.03	0.13	0.03	0.13	0.03	0.14	0.03
22	vol2_15V	V	0	0.45	0.29	0.03	0.29	0.03	0.29	0.03	0.29	0.03	0.30	0.03	0.30	0.03	0.30	0.03	0.30	0.03	0.29	0.03	0.29	0.03	0.30	0.04
23	vol3_15V	V	0	0.50	0.40	0.03	0.40	0.03	0.40	0.03	0.40	0.03	0.42	0.04	0.42	0.03	0.42	0.04	0.41	0.03	0.41	0.04	0.41	0.04	0.42	0.05
24	voh1_15V	V	2.4	6.0	5.4	0.1	5.4	0.1	5.4	0.1	5.3	0.1	5.3	0.1	5.3	0.1	5.3	0.1	5.3	0.1	5.4	0.1	5.4	0.1	5.3	0.1
25	voh2_15V	V	2.4	6.0	4.1	0.1	4.1	0.1	4.1	0.1	4.0	0.1	4.0	0.1	4.0	0.1	4.0	0.1	4.0	0.1	4.0	0.1	4.0	0.1	4.0	0.1
26	voh3_15V	V	2.4	6.0	3.8	0.1	3.8	0.1	3.8	0.1	3.7	0.1	3.7	0.1	3.7	0.1	3.7	0.1	3.7	0.1	3.7	0.1	3.7	0.1	3.7	0.1
27	Avo_15V	V/mV	200		262	3	262	3	261	2	260	1	260	1	260	1	261	1	261	1	261	1	260	1	260	1
28	I_leak	nA	0	2000	5	0	5	0	5	0	5	1	5	1	5	0	5	0	5	0	5	1	5	0	5.7	2
29	+psrr	dB	80		102	21	106	22	110	23	111	24	109	24	111	23	116	24	118	24	118	24	117	24	116	25
30	-psrr	dB	80		125	9	124	8	123	7	122	6	124	9	123	7	120	4	122	6	121	6	122	5	122	5
31	cmrr_15V	dB	94		101	21	101	20	101	19	101	18	102	16	104	14	104	10	103	11	103	11	101	14	99	16
32	cmrr_5V	δB	80		117	1	83	0	83	0	83	0	83	0	83	0	83	0	83	0	83	0	83	0	83	0

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: ?ibias1_15V, ?ibias2_15V, ios1, ios2, cmrr_15V.