

Unisys

DATE: October 23, 1998 PPM-98-032
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SUBJECT: Radiation Report on **A1280A CQ172B (Actel) (LDC 9740)**
PROJECT:

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A radiation evaluation was performed on **A1280A CQ172B (5962-9215601MYC) FPGA (Actel)** to determine the total dose tolerance of these parts. The total dose testing was performed using a Co⁶⁰ gamma ray source. During the radiation testing, three 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 3.0, 5.0, 10.0, and 15.0kRads.¹ The dose rate was 0.045kRads/hour (0.01 Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After each dose step, the parts were packaged and shipped to SEI for testing. After the 15.0kRad irradiation, the parts were annealed under bias at 25°C for 186 hours and tested again.² After each radiation exposure and annealing treatment, the parts were packaged and shipped to SEI for electrical testing 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.

All parts passed all tests up to 5kRads. After the 10 and 15kRad irradiations, all parts exceeded the specification limit for ICCH and ICCL. After annealing the parts for 168 hours at 25°C, the parts showed significant recovery in ICCH and ICCL with only SN 705 marginally exceeding the specification limit for both.

Initial electrical measurements were made on 4 samples. Three samples (SN's 703, 704 and 705) were used as radiation samples while SN 701 was used as a control sample. All parts passed all tests during initial electrical measurements. SN 702 failed during initial electrical testing as was removed.

All parts passed all tests up to 5kRads.

After the 10.0kRad irradiation, all parts exceeded the specification limit of 25.0mA for ICCH and ICCL with readings in the range of 48.5 to 58.7mA for both. **All parts passed all other tests.**

After the 15.0kRad irradiation, all parts exceeded the specification limit of 25.0mA for ICCH and ICCL with readings in the range of 47.0 to 63.9mA for both. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, the parts showed significant recovery in both ICCH and ICCL with SN's 703 and 704 passing and SN 705 only marginally exceeding specification limits with readings of 26.1 and 26.5mA respectively.

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.

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.

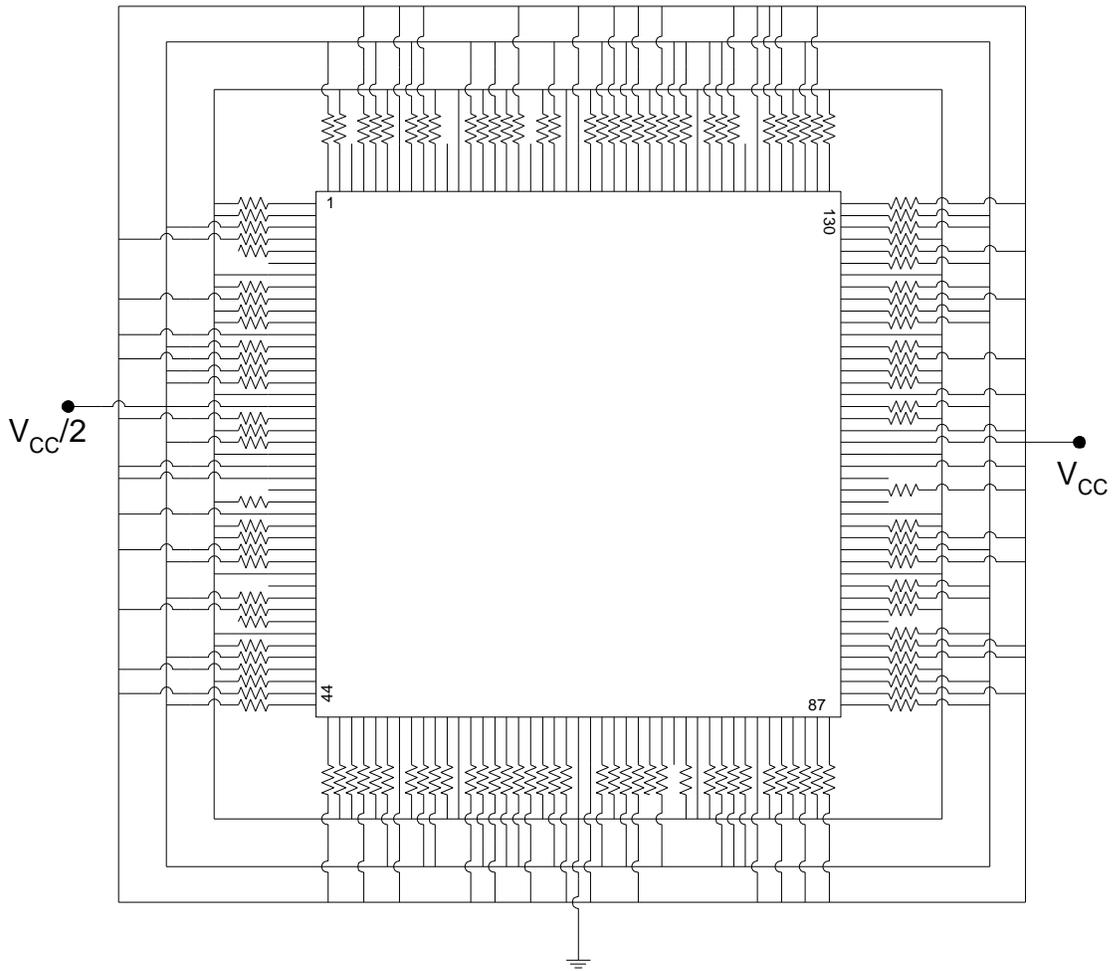
Any further details about this evaluation can be obtained upon request. If you have any questions, please call us at (301) 731-8954.

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Figure 1. Radiation Bias Circuit for A1280A



Notes:

1. $V_{CC} = 5.0V \pm 0.5V$.
2. $V_{CC}/2 = 2.5V \pm 0.25V$
3. $R = 2.2k\Omega \pm 5\%$, $1/4W$.

Pinout:

1. MODE	44. I/O	87. I/O	130.I/O
2. I/O	45. I/O	88. I/O	131.SDI or I/O
3. I/O	46. I/O	89. I/O	132.I/O
4. I/O	47. I/O	90. I/O	133.I/O
5. I/O	48. I/O	91. I/O	134.I/O
6. I/O	49. I/O	92. I/O	135.I/O
7. GND	50. I/O	93. I/O	136.V _{CC}
8. I/O	51. I/O	94. I/O	137.I/O
9. I/O	52. I/O	95. I/O	138.I/O
10. I/O	53. I/O	96. I/O	139.I/O
11. I/O	54. I/O	97. I/O	140.I/O
12. V _{CC}	55. GND	98. GND	141.GND
13. I/O	56. I/O	99. I/O	142.I/O
14. I/O	57. I/O	100.I/O	143.I/O
15. I/O	58. I/O	101.I/O	144.I/O
16. I/O	59. I/O	102.I/O	145.I/O
17. GND	60. I/O	103.GND	146.I/O
18. I/O	61. I/O	104.I/O	147.I/O
19. I/O	62. I/O	105.I/O	148.PRA or I/O
20. I/O	63. I/O	106.VKS	149.I/O
21. I/O	64. I/O	107.VPP	150.CKA or I/O
22. GND	65. GND	108.GND	151.V _{CC}
23. V _{CC}	66. V _{CC}	109.V _{CC}	152.GND
24. VSV	67. I/O	110.VSV	153.I/O
25. I/O	68. I/O	111.I/O	154.CKB or I/O
26. I/O	69. I/O	112.I/O	155.I/O
27. V _{CC}	70. I/O	113.V _{CC}	156.PRB or I/O
28. I/O	71. I/O	114.I/O	157.I/O
29. I/O	72. I/O	115.I/O	158.I/O
30. I/O	73. I/O	116.I/O	159.I/O
31. I/O	74. I/O	117.I/O	160.I/O
32. GND	75. GND	118.GND	161.GND
33. I/O	76. I/O	119.I/O	162.I/O
34. I/O	77. I/O	120.I/O	163.I/O
35. I/O	78. I/O	121.I/O	164.I/O
36. I/O	79. I/O	122.I/O	165.I/O
37. GND	80. V _{CC}	123.GND	166.V _{CC}
38. I/O	81. I/O	124.I/O	167.I/O
39. I/O	82. I/O	125.I/O	168.I/O
40. I/O	83. I/O	126.I/O	169.I/O
41. I/O	84. I/O	127.I/O	170.I/O
42. I/O	85. SDO or I/O	128.I/O	171.DCK or I/O
43. I/O	86. I/O	129.I/O	172.I/O

TABLE I. Part Information

Generic Part Number:	A1280A CQ172B
Part Number:	5962-9215601MYC
Charge Number:	F10138
Manufacturer:	Actel
Lot Date Code (LDC):	9740
Quantity Tested:	4
Serial Number of Control Samples:	701
Serial Numbers of Radiation Samples:	703, 704 and 705
Part Function:	FPGA
Part Technology:	CMOS
Package Style:	172 Pin Flat Pack
Test Equipment:	Tested by SEI
Test Engineer:	D. Krus

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

TABLE II. Radiation Schedule for A1280A

EVENT.....	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	07/28/98
2) 3.0 KRAD IRRADIATION (0.188 KRADS/HOUR)	08/11/98
POST-3.0 KRAD ELECTRICAL MEASUREMENT	08/12/98
3) 5.0 KRAD IRRADIATION (0.031 KRADS/HOUR)	08/14/98
POST-5.0 KRAD ELECTRICAL MEASUREMENT	08/17/98
4) 10.0 KRAD IRRADIATION (0.278 KRADS/HOUR)	08/19/98
POST-10.0 KRAD ELECTRICAL MEASUREMENT	08/20/98
5) 15.0 KRAD IRRADIATION (0.294 KRADS/HOUR)	08/24/98
POST-15.0 KRAD ELECTRICAL MEASUREMENT	08/25/98
6) 168 HOUR ANNEALING @25°C	08/27/98
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	09/10/98

Effective Dose Rate = 15,000 RADS/14 DAYS=44.6 RADS/HOUR=0.01 RADS/SEC

The effective dose rate is lower than that of the individual radiation steps as it takes into account the time needed to ship the parts to SEI for testing and ship them back.

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

PARTS WERE SHIPPED UNBIASED.

Table III. Electrical Characteristics of A1280A /1

Test #	Parameter	Units	Test Conditions /2	Spec. min	Lim. max
DC Tests					
1	Continuity Verification	V		-1.5	
2	Functional Verify @VCC _{MIN}	P/F	V _O = 0V		
3	Functional Verify @VCC _{NOM}	P/F	V _O = 0V		
4	Functional Verify @VCC _{MAX}	P/F	V _O = 0V		
5	ICCH	mA	V _{CC} = 5.5V, V _{IN} = V _{CC}		25
6	ICCL	mA	V _{CC} = 5.5V, V _{IN} = GND		25
7	IIH	mA	V _{DD} = 5.5V, V _{IN} = V _{DD}	-10.0	10.0
8	IIL	mA	V _{DD} = 5.5V, V _{IN} = GND	-10.0	10.0
9	VOL@IOL	mV	Test one output at a time. V _{DD} = 4.5V, I _{OL} = 4.0mA	0	400
10	VOH@IOH	V	Test one output at a time. V _{DD} = 4.5V, I _{OL} = -3.2mA	3.7	4.5
11	IOS	mA		-100	100
Timing Tests					
12	OUTX1	ns			350
13	OUTA	ns			100
14	OAND3	ns			100
15	OAND4	ns			100
16	OOR3	ns			100
17	OOR4	ns			100
18	ONAND4	ns			100
19	ONOR4	ns			100
20	OLOUT 0-18	ns			100
21	ILOUT 0-17	ns			200

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/ All parameters measured by SEI in California. 4.5V ≤ V_{CC} ≤ 5.5V unless otherwise specified.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for A1280A /1

Test #	Parameters	Units	Spec. Lim. /2		Total Dose Exposure (kRads Si)										Annealing	
					Initial		3.0		5.0		10.0		15.0		168 hours @25°C	
			min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	Continuity Verification	V	-1.5		-0.3	0	-0.3	0	-0.3	0	-0.3	0	-0.3	0	-0.3	0
2	Functional Verify @VCCMIN	P/F			P		P		P		P		P		P	
3	Functional Verify @VCCNOM	P/F			P		P		P		P		P		P	
4	Functional Verify @VCCMAX	P/F			P		P		P		P		P		P	
5	ICCH	mA		25	0.6	0.05	0.7	0.05	2.6	0.4	54.3	3.8	57.3	7.4	22.3	3.9
6	ICCL	mA		25	1.7	0.05	1.7	0.05	3.6	0.4	56.0	3.6	57.7	6.9	23.0	4.3
7	IIH	?A	-10.0	10.0	1	1	1	1	1	1	1	1	1	1	1	1
8	II L	?A	-10.0	10.0	-1	1	-1	1	-1	1	-1	1	-1	1	-1	1
9	VOL@IOL	mV	0	400	138	4	136	5	140	4	157	5	155	5	138	4
10	VOH@IOH	V	3.7	4.5	4.25	0.01	4.25	0.01	4.25	0.01	4.22	0.01	4.22	0.01	4.25	0.01
11	IOS	mA	-100	100	-31	1	-31	1	-31	1	-31	1	-31	1	-31	1
	Timing Tests															
12	OUTX1	ns		350	208.4	10.5	207.3	9.6	196.6	9.8	213.2	7.3	210.9	11.6	196.4	9.6
13	OUTA	ns		100	17.7	0.2	17.8	0.0	17.4	0.2	19.1	0.1	18.7	0.2	17.6	0.2
14	OAND3	ns		100	31.5	0.2	31.5	0.1	31.0	0.2	32.1	0.2	32.4	0.2	30.8	0.2
15	OAND4	ns		100	34.3	0.2	34.4	0.2	34.0	0.2	34.6	0.2	35.5	0.3	33.4	0.2
16	OOR3	ns		100	31.4	0.4	31.5	0.3	31.0	0.4	32.7	0.2	32.2	0.3	32.4	0.2
17	OOR4	ns		100	29.9	0.4	30.1	0.2	29.6	0.4	30.6	0.3	31.0	0.4	29.7	0.2
18	ONAND4	ns		100	40.2	0.2	40.2	0.1	39.8	0.2	41.1	0.2	40.9	0.2	39.9	0.1
19	ONOR4	ns		100	40.2	0.2	40.3	0.1	39.8	0.4	40.8	0.3	40.9	0.2	39.8	0.2
20	OLOUT 0-18	ns		100	19.7	13.8	19.7	13.8	19.2	13.6	19.7	13.5	19.3	14.3	19.2	14.0
21	ILOUT 0-17	ns		200	128.3	0.8	128.1	0.9	127.9	0.8	123.9	0.9	127.9	1.1	123.5	0.8

Notes:

- 1/ The mean and standard deviation values were calculated over the three 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: ICCH, ICCL.