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Interoffice Memorandum

To
K. Reed
Department
Code 711
From
K. Sahu KS
Department
7809
Subject
Radiation Report on PALCE22V10H
(Project Modis-T)

Rad-91-4
Date
April 3, 1991
Location
GSFC
Telephone
731-8954
Location
Lanham
cc
S. Esmacher
G. Krishnan
A. Sharma

A radiation evaluation was performed on PALCE22V10H 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 cobalt-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 total dose radiation steps were 2.5, 5, 10, 20, 30 and 40 krads. After 40 krads, parts were annealed at 25°C for 24 and 216 hours. The dose rate was between 125 - 500 rads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits listed in Table III. These tests included a total of three functional tests at 4.5V, 5.0V and 5.5V at 1.0 MHz after each radiation and annealing step. The VIL and VIH tests were also performed during functional testing. Refer to Appendix I for the test procedures for VIH and VIL tests.

The initial electrical measurements on all ten parts (SNs 1 thru 10) were made at 25°C, -55°C and 125°C. At 25°C, SN 8 failed functional testing at 5.5V. At -55°C and 125°C, SNs 3 and 8 failed functional testing at 5.5V. Also at 5.5V, SNs 3 and 9 failed VOL tests (see Table IV for summary of electrical measurements). However all parts passed all other tests. SNs 1 and 2 were maintained as control samples, while SNs 3 thru 10 were used as radiation samples. The post irradiation electrical measurements were made only at 25°C.

All parts passed all tests after 2.5 krads, except for SN 8 which failed functional testing at 5.5V. However, after the next radiation exposure to 5 krads, SN 8 passed the functional testing at 5.5V for the first time. All other parts also passed all tests.

After 10 krads exposure, SNs 3 and 8 failed functional testing at 5.5V. Also all parts showed a very significant increase in IOZL.

Some of the output pins on these parts were reading 99.99mA, which is the maximum reading that the test equipment can make. After 20 krads exposure, SNs 3 and 8 failed functional testing at 5.5V. SN 3 also failed functional testing at 5.0V. Also all parts failed IOZL, IOZH and AC timing parameters.

After 30 krads exposure, SNs 3, 4, 5, 6, 7 and 9 failed all functional tests at 4.5V, 5.0V and 5.5V. SN 8 failed functional testing at 5.5V but passed at 4.5V and 5.0V. SN 10 passed all functional tests. All parts failed IOZL, IOZH and AC timing parameters. SN 3 failed an IOS test. Some tests (VOH, VOL and AC parameters) cannot be performed properly when the device is failing functional testing.

After 40 krads exposure, all parts failed functional testing at 4.5V, 5.0V and 5.5V. Also, all parts failed IOZL, IOZH and AC timing parameters. There were also several IOS failures.

After annealing for 24 hours at 25°C, SN 4 passed all functionals, while SN 3 passed functional tests at 4.5V and 5.0V. The remaining parts failed all functional tests. Also, all devices continued to fail IOZL and IOZH tests, but there were fewer failures than at the post 40 krads electrical measurements.

After annealing for 216 hours, SNs 3, 4, 8, 9 and 10 passed all functional tests, while SNs 5, 6 and 7 failed all functional tests. Table IV provides the mean and standard deviation values for each parameter after different radiation exposures and annealing treatments. It also provides a summary of functional test results after each radiation/annealing step.

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

TABLE I. Part Information

Generic Part Number:	PALCE22V10H
Manufacturer:	Advanced Micro Devices
Lot Date Code:	9032RP
Quantity Tested:	10
Serial Numbers of Radiation Samples:	3, 4, 5, 6 7, 8, 9, 10
Serial Numbers of Control Samples:	1, 2
Part Function:	Programmable Logic Array
Part Technology:	EECMOS
Package Style:	24-Pin DIP

TABLE II. Radiation Schedule

EVENTS	DATE
1) Initial Electrical Measurements	02/26/91
2) 2.5 krads irradiation @ 125 rads/hr Post 2.5 krads Electrical Measurements	02/26/91 02/27/91
3) 5 krads irradiation @ 125 rads/hr Post 5 krads Electrical Measurements	02/27/91 02/28/91
4) 10 krads irradiation @ 250 rads/hr Post 10 krads Electrical Measurements	02/28/91 03/01/91
5) 20 krads irradiation @ 500 rads/hr Post 20 krads Electrical Measurements	03/01/91 03/02/91
6) 30 krads irradiation @ 500 rads/hr Post 30 krads Electrical Measurements	03/02/91 03/03/91
7) 40 krads irradiation @ 500 rads/hr Post 40 krads Electrical Measurements	03/03/91 03/04/91
8) 24 hrs annealing Post 24 hr Electrical Measurements	03/04/91 03/05/91
9) 216 hrs annealing Post 216 hr Electrical Measurements	03/04/91 03/13/91

Notes:

- All parts were radiated under bias at the cobalt-60 gamma ray facility at GSFC.
- All electrical measurements were performed off-site at 25°C.
- Annealing was performed at 25°C under bias.

Table III. Electrical Characteristics of PALCE22V10H

TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT -55C,+25C,+125C
=====	===	===	===	=====	----	=====
FUNCT 1	4.5V	0.0V	4.5V	FREQ = 1MHz	ALL I/O	VOL<1.5V , VOH>1.5V
FUNCT 2	5.0V	0.0V	5.0V	FREQ = 1MHz	ALL I/O	VOL<1.5V , VOH>1.5V
FUNCT 3	5.5V	0.0V	5.5V	FREQ = 1MHz	ALL I/O	VOL<1.5V , VOH>1.5V
DC PARAMETERS						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT -55C,+25C,+125C
=====	===	===	===	=====	----	=====
VIH1	4.5V	0.0V	2.0V	GO/NOGO	INS	VIH MIN = +2.0V
VIH2	5.5V	0.0V	2.0V	GO/NOGO	INS	VIH MIN = +2.0V
VIL1	4.5V	0.8V	4.5V	GO/NOGO	INS	VIL MAX = +0.8V
VIL2	5.5V	0.8V	5.5V	GO/NOGO	INS	VIL MAX = +0.8V
VOH	4.5V	0.0V	4.5V	LOAD=-2.0MA	OUTS	>+2.4V , <+5.5V
VOL	4.5V	0.0V	4.5V	LOAD=+12.0MA	OUTS	>+0.0V , <+0.4V
I IH	5.5V	0.0V	5.5V	VTST= 5.5V	INS	>-10.0UA , <+10.0UA
I IL	5.5V	0.0V	5.5V	VTST= 0.0V	INS	>-10.0UA , <+10.0UA
IOZH	5.5V	0.0V	5.5V	VTST= 5.5V	OUTS	>-10.0UA , <+10.0UA
IOZL	5.5V	0.0V	5.5V	VTST= 0.0V	OUTS	>-10.0UA , <+10.0UA
IOS	5.0V	0.0V	5.0V	VTST= 2.0V	OUTS	>-135.0MA , <-50.0MA
ICC	5.5V	0.0V	5.5V	VIN = 0.0V	VCC	>+0.0A , <+100MA

Table III. (continued)

AC PARAMETERS

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT -55C,+25C,+125C
=====	===	===	===	=====	====	=====
TPLH	4.5V	0.0V	4.0V	CLK -> Q	OUTS	>0.0NS , <15.0NS
TFHL	4.5V	0.0V	4.0V	CLK -> Q	OUTS	>0.0NS , <15.0NS

COMMENTS/EXCEPTIONS

- (1) VIH IS TESTED GO/NOGO BY EXECUTING A FUNCTIONAL TEST AT VIH = 2.0V. IF THE FUNCTIONAL FAILS VIH IS INCREMENTED BY 0.05V UNTIL IT PASSES. WHEN THE DEVICE PASSES FUNCTIONAL THAT VIH IS RECORDED.
- (2) VIL IS TESTED GO/NOGO BY EXECUTING A FUNCTIONAL TEST AT VIL = 0.8V. IF THE FUNCTIONAL FAILS VIL IS DECREMENTED BY 0.05V UNTIL IT PASSES. WHEN THE DEVICE PASSES FUNCTIONAL THAT VIL IS RECORDED.
- (3) THE AC PARAMETERS TESTED ARE USED TO EVALUATE THE PART DURING RADIATION AND ARE NOT INTENDED TO SCREEN THE DEVICE.

Table IV. Summary of Electrical Measurements

after Total Dose Exposures and Annealing for PALCE22V10H

11/27

Parameters	Spec. Limits min max	Initials mean sd	Total Dose Exposure (krads)														Annealing		
			2.5		5		10		20		30		40		216 hrs.				
			mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd			
Func1, 1Mhz		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Func2, 1Mhz		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Func3, 1Mhz		7P/1F	7P/1F	Pass	Pass	Pass	Pass	Pass	Pass										
(VIH1)min V	2.0	2.71	0.10	2.76	0.11	2.78	0.09	2.77	0.10	3.06	0.56	4.13	0.73	4.55	0	3.43	0.88		
(VIH2)min V	2.0	2.71	0.10	2.76	0.10	2.78	0.11	2.74	0.11	3.19	0.89	4.89	1.15	5.55	0	3.60	1.36		
(VIL1)max V	0.8	0.78	0.03	0.79	0.02	0.80	0	0.80	0	0.69	0.28	0.16	0.37	-0.05	0	0.48	0.41		
(VIL2)max V	0.8	0.60	0.25	0.72	0.08	0.71	0.12	0.50	0.23	0.64	0.28	0.06	0.3	-0.05	0	0.43	0.37		
VOH V	2.4 5.5	3.16	0.05	3.18	0.04	3.18	0.04	3.19	0.04	3.15	0.38	2.22	1.47	0.63	1.3	2.28	1.46		
VOL V	0 0.4	0.11	0.04	0.10	0.02	0.10	0.01	0.09	0.01	0.11	0.04	0.05	0.5	-0.02	1.1	-0.05	0.5		
I IH uA	-10 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I IL uA	-10 10	0	0	0	0	0	0.1	-0.1	0.2	-0.4	1	-0.5	1.2	-0.5	1.2	-0.3	0.7		
IOZL uA	-10 10	0	0	0	0	0	0	36E3	48E3	80	59	183	133	249	186	14	48		
IOZH uA	-10 10	0	0	0	0	0	0	-1	1	-12	20	-21	38	-43	140	-2	13		
I OS mA	-135 -50	-95	10	-98	7	-100	5	-102	4	-99	7	-95	28	-17	115	-61	98		
I CC mA	0 200	67	3	68	4	68	3	64	2	65	3	70	2	75	2	71	2		
T PLH ns	0 15	6.0	3	5.9	3.0	5.9	3.0	5.0	3.1	13.4	50	4E5	5E5	1E6	2E5	3E5	5E5		
T PHL ns	0 15	5.3	2	5.4	1.8	5.3	1.8	5.2	1.7	1E4	1E5	5E5	5E5	1E6	2E5	3E5	5E5		

Notes:

1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

2/ The post 24 hour annealing measurement data is not included in Table IV. This data is available and can be obtained upon request.

Figure 1. Radiation Bias Circuit for PALCE22V10H

PINS		24--PIN		PINS	
=====	=====	MINI	DIP	=====	=====
GND-----CLK	INPUT	= 1	24 =	VCC	VCC ---/\/\/\----- VCC
VCC-/\/\--RS_	INPUT	= 2	23 =	OUTPUT	Q(5)---/\/\/\----- VCC/2
VCC-/\/\--CLR	INPUT	= 3	22 =	OUTPUT	Q(7)---/\/\/\----- VCC/2
VCC-/\/\--ST	INPUT	= 4	21 =	OUTPUT	Q(6)---/\/\/\----- VCC/2
N.C	I/O	= 5	D 20 =	INPUT	HLD ----- GND
N.C	I/O	= 6	U 19 =	OUTPUT	Q(8)---/\/\/\----- VCC/2
N.C	I/O	= 7	T 18 =	OUTPUT	Q(4)---/\/\/\----- VCC/2
N.C	I/O	= 8	17 =	OUTPUT	Q(3)---/\/\/\----- VCC/2
N.C	I/O	= 9	16 =	OUTPUT	Q(2)---/\/\/\----- VCC/2
N.C	I/O	= 10	15 =	OUTPUT	Q(1)---/\/\/\----- VCC/2
N.C	I/O	= 11	14 =	OUTPUT	Q(0)---/\/\/\----- VCC/2
GND-----GND	GND	= 12	13 =	INPUT	OE_ ----- GND

NOTES:

- (1) VCC = 5V +/- 0.5V
- (2) VCC/2 = 2.5V +/- 0.25V
- (3) ALL RESISTORS 1.5K +/- 10% 1/4 WATT
- (4) ICC MAX = 100MA

Appendix I

This program performs dynamic VIH and VIL tests. This procedure is equivalent to performing a Schmoop plot for VIH and VIL during functional testing. During the VIH test, VIH is set at 2.0V and a functional pattern is executed. If the device fails the functional test, VIH is incremented by 0.05V until a functional is successfully completed. The VIL test is performed in a similar fashion, but VIL is decremented from its original value (VIL max) until it passes functional testing. The VIH and VIL tests are typically performed go/nogo during VOL and VOH under static conditions. When the device requires several vectors in order to have the output transition from low to high, the VIH and VIL tests cannot be performed statically. This procedure is included to provide additional information about the behavior of the device. All devices failed the VIH and VIL tests under dynamic conditions throughout the job, beginning with the initial electricals. The manufacturer usually guarantees these parameters only under static conditions.