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To
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Department
Code 300.1
From
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7809
Subject
Radiation Report on ISTP
Non-Common Buy Part No. CS7820-UD

PPM-91-384
Date
June 6, 1991
Location
Lanham
Reference
731-8954
Location
Lanham

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A radiation evaluation was performed on CS7820-UD 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, 15, and 18.1 krad. After 18.1 krad, parts were annealed at 25°C for 24 and 168 hours. The dose rate was between 125 - 250 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. For a detailed description of each test, refer to Appendix I.

All eight parts passed all tests up to 2.5 krad. After 5 krad irradiation, one part (SN 206) began failing functionally* and five of the eight parts failed to meet the maximum specification limit of 1uA for IIL (WR) with readings ranging from -0.4uA to -6.0uA. SN 206 was reading 192 code against the maximum specification limit of 138 code for the RD/RD-WR functional tests. In addition, SN 206 failed Missing Codes (reading was 16DEC against the specification of 1DEC) and failed Non-Linearity2 (reading was -14LSB against the specification limit of ±1LSB). After 10 krad four parts failed functional tests - including RD mode, RD-WR mode, RD-WR Stand Alone, Convert to 0s, Missing Codes, First/Last Transition locations, Non-Linearity and Code Width. In addition, all parts failed IIL and IOZL. Also, parts began failing VOL and Power Supply sensitivity.

After 15 krads exposure, all parts failed functionally as well as failing IIL, IOZL, VOL and VOH. In addition, two parts (SNs 206 and 207) failed to meet the maximum specification limit of 15mA for IS (readings were 17.9mA and 15.5 mA, respectively). Also four parts (SNs 202, 204, 205 and 208) began failing IIH (CS) with failing readings ranging from 1.3uA to 1.5uA against the maximum specification limit of 1uA.

Further degradation in all of the above tests resulted after 18.1 krads, and no significant recovery was observed after annealing the parts for 24 and 168 hours. Table IV provides the mean and standard deviation values for each parameter after different radiation exposures and annealing treatments.

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

* Refer to Note 2 in Table IV for definition of functional failure.

TABLE I. Part Information

Generic Part Number:	CS7820-UD
ISTP Non-Common Buy Part Number:	CS7820-UD
ISTP Non-Common Buy Control Number:	2011
Manufacturer:	Crystal Semiconductor
Quantity Procured:	40
Lot Date Code:	9008
Quantity Tested:	10
Serial Numbers of Radiation Samples:	202, 203, 204, 205 206, 207, 208, 209
Serial Numbers of Control Samples:	200, 201
Part Function:	8 BIT A/D Converter
Part Technology:	Bipolar
Package Style:	20 Pin Metal

TABLE II. Radiation Schedule

EVENTS	DATE
1) Initial Electrical Measurements	03/14/91
2) 2.5 krads irradiation @ 125 rads/hr Post 2.5 krads Electrical Measurements	03/18/91 03/19/91
3) 5 krads irradiation @ 125 rads/hr Post 5 krads Electrical Measurements	03/19/91 03/20/91
4) 10 krads irradiation @ 250 rads/hr Post 10 krads Electrical Measurements	03/20/91 03/21/91
5) 15 krads irradiation @ 250 rads/hr Post 15 krads Electrical Measurements	03/21/91 03/22/91
6) 18.1 krads* irradiation @ 250 rads/hr Post 18.1 krads Electrical Measurements	03/22/91 03/23/91
7) 24 hrs annealing Post 24 hr Electrical Measurements	03/23/91 03/24/91
8) 168 hrs annealing Post 168 hr Electrical Measurements	03/23/91 04/01/91

* An alarm at the radiation facility during the last radiation exposure resulted in a final cumulative dose of 18.13 krads instead of the scheduled 20.0 krads.

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 performed at 25°C under bias.

Table III. Electrical Characteristics of CS7820-UD

TEST#	DESCRIPTION	MIN	MAX
1	+5V Supply Current	-0.1ma	15ma
2	Vref Input Resistance	1 Kohm	4 Kohm
3	RD Mode Conversion	118code	138code
4	WR-RD Mode Conversion	118code	138code
5	WR-RD Mode Stand Alone	118code	138code
6	Convert to 0's	0 code	0 code
7	VOL @ 1.6ma	0V	0.4V
8	Fullscale Convert	255code	255code
9	VOH @ -360ua	4V	5.1V
10	TRI-STATE Leakage Current @ 0V	-3ua	3ua
11	TRI-STATE Leakage Current @ 5V	-3ua	3ua
12	Analog Input Current @ 0V	-3ua	3ua
13	Analog Input Current @ 5V	-3ua	3ua
14.1	Iinh @ 5V (CS,RD)	-1ua	1ua
14.3	Iinh @ 5V (WR)	-3ua	3ua
15	Iinl @ 0V (CS,RD,WR)	-1ua	1ua
16.1	Power Supply Sensitivity +5%	-4.88mv	4.88mv
16.2	Power Supply Sensitivity -5%	-4.88mv	4.88mv
17	Missing Codes Test	---	---
18	Total Unadjusted Error	-1LSB	1LSB

Table IV. Summary of Electrical Measurements
after Total Dose Exposures and Annealing for CS7820-UD

17, 21

Tst#	Parameters	Spec. Limits		Initials	Total Dose Exposure (krads)												Annealing			
					2.5		5		10		15		18.1		24 hrs		168 hrs			
					min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	IS mA	-0.1	15.0	5.7	0	6.0	0.4	6.0	0.4	10.5	1.0	14.8	1.3	17.3	1.4	16.1	1.4	14.5	1.1	
2	RIN kOhm	1.0	4.0	2.2	0	2.2	0	2.2	0.1	2.2	0.1	2.1	0.1	2.1	0.1	2.1	0.1	2.1	0.1	
3	RD mode code	118	138	128	0	128	0	136	20	188	60	200	59	246	7	244	6	220	45	
4	WR-RD ccode	118	138	128	0	128	0	136	20	182	54	194	54	253	5	251	6	220	45	
5	WR-RD SA ccode	118	138	128	0	128	0	136	20	182	54	194	54	253	5	251	6	220	45	
6	Convst 0 code	0	0	0	0	0	0	0	0	1.9	1.5	128	50	255	0	252	4	220	50	
7.1	VOL V	0	0.4	0.1	0	0.1	0	0.1	0	0.3	1.5	2.5	1.0	4.3	1.0	4.2	1.0	4.0	1.0	
7.2	/OFL VOL V	0	0.4	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	
8	FS conv code	255	255	255	0	255	0	255	0	255	0	248	4	242	6	246	4	246	4	
9	VOH V	4.0	5.1	4.94	0	4.94	0	4.94	0	4.94	0	4.0	1.3	2.6	0.8	3.7	0.5	4.0	1.0	
9.1	/INTR VOH V	4.0	5.1	4.94	0	4.94	0	4.94	0	4.93	.01	4.93	0	4.92	.01	4.93	.01	4.93	0	
9.2	/OFL VOH V	4.0	5.1	4.94	0	4.94	0	4.94	0	4.94	0	2.47	1.0	2.47	1.0	2.47	1.0	2.47	1.0	
10	IOZL uA	-3.0	3.0	0	0	0	0	-0.2	0.2	-3.0	1.0	-5.9	0.5	-8.1	1.0	-7.0	1.0	-6.8	1.0	
11	IOZH uA	-3.0	3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12	AIC 30V uA	-3.0	3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	AIC 5V uA	-3.0	3.0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	
14.1	IinH CS uA	-1.0	1.0	0	0	0	0	0	0	0.3	0.1	0.9	0.2	1.4	0.3	1.2	0.2	1.0	0.2	
14.2	IinH RD uA	-1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.3	IinH WR uA	-3.0	3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15.1	IinL CS uA	-1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15.2	IinL RD uA	-1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15.3	IinL WR uA	-1.0	1.0	0.1	0	0	0	-2.8	1.0	-18	6.0	-32	10	-52	12	-45	10	-30	10	

Table IV. (continued)

Tst#	Parameters	Spec. Limits min max		Initials mean sd	Total Dose Exposure (krads)										Annealing				
					2.5		5		10		15		18.1		24 hrs		168 hr		
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
15.1	PS sens 5% mV	-4.88	4.88	0.1	0.2	0.2	0.1	0.3	0.1	40	50	90	80	300	40	190	100	160	50
16.2	PS sens -5% mV	-4.88	4.88	0.2	0.1	0.1	0.1	0.2	0.1	5.5	15	60	80	170	60	400	200	170	300
17	Missing codes	1	1	1	0	1	0	2.9	4	35	60	2.5	1.2	1.0	0	1.0	0	1.4	1.0
18.1	1st Trans V	-.01	.03	.01	0	.01	0	.01	0	-.03	.02	.01	0.1	-.08	0	-.08	0	-.04	.03
18.2	Last Trans V	4.95	4.99	4.97	0	4.97	0	4.97	0	5.1	0.2	5.1	0.2	5.2	0.2	5.0	0.2	5.0	0.2
18.3	Non-Lin 1 LSB	-1	1	0.2	.07	0.2	.07	0.2	0.1	3.3	0.3	1.4	4.0	32	9.0	38	3.0	8	4
18.4	Code-Wdth1 LSB	0	2	0.9	0.1	1.0	0.1	0.6	0.2	3.1	3.0	12.0	4.0	0	0.1	0	0	12	4
18.5	Non-Lin 2 LSB	-1	1	-0.3	0.1	-0.3	0.1	-2.0	5.0	-6.0	2.5	-14	0	-14	0	-14	0	-14	0
18.6	Code-Wdth2 LSB	0	2	0.9	0.1	1.0	0	0.8	0.2	4.0	9.0	0	0	0	0	0	0	13	10
18.7	Step by 1	1	1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	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 the testing and are not included in this table.

2/ Parts were considered to be failing functionally if they failed to meet the specification limits on any of the following tests: RD Mode Conversion, WR-RD Mode Conversion, WR-RD Mode Conversion, WR-RD Mode Stand Alone, Convert to 0's, Fullscale Convert, Missing Codes, 1st/last transition locations, Non-linearity 1,2, Code Width 1,2, and Step by 1.

Appendix I

Test# 1 +5V Supply Current 15ma Max .

VSA is set to 5V and connected to VCC (pin 20). Current is measured through VSA.

Test# 2 Vref Input Resistance 4Kohm Max

The V/I source is connected to Vref input. The V/I is set to force 5V and current is measured through V/I. The input resistance is calculated as $5V/meas\ I$.

Test# 3 RD Mode Conversion 118-138 code

The main DAC (0 to 10V unipolar range) on the the family board is set to force 2.5 volts. MODE pin is grounded to put the DUT in the Read mode. When RD is set low, /INT line goes low and the output code is read. A code between 118 and 138 indicates conversion is done.

Test# 4 WR-RD Mode Conversion 118-138 code

MODE pin is set high to put the DUT in the WR-RD mode. RD is set high and /WR is pulsed low. When /INT line goes low, RD is set low and the output code is read. A code between 118 and 138 indicates conversion is done.

The output voltage is measured through the V/I.

Test# 10 TRI-STATE Leakage Current @ 0V 3ua Max

/RD and /CS are set high. All digital outputs should be in the high impedance state. The V/I is set to force 0V. It is connected to each output (T#10.01=LSB, T#10.08=MSB) and the current measured.

Test# 11 TRI-STATE Leakage Current @ 5V 3ua Max

Same as test# 10, except V/I is set to 5 volts.

Test# 12 Analog Input Leakage Current @ 0V 3ua Max

/CS is set to 5V and the analog input is connected to the V/I source. The V/I source is set to force 0V and the current is measured.

Test# 13 Analog Input Leakage Current @ 5V 3ua Max

Same as test# 12, except V/I is set to force 5V.

Test# 14.1 I_{inh} @ 5V (CS,RD) 1ua Max

V/I is set to force 5V and connected one at a time to /CS and /RD input lines. Current is measured through V/I source.

Test# 14.3 I_{inh} @ 5V (WR)

3ua Max

V/I is set to force 5V and connected to /WR input line. Current is measured through V/I source.

Test# 15 I_{inl} @ 0V (CS, RD, WR)

1ua Max

Set V/I to force 0V and connect one at a time to the digital input lines (T#15.1 to 15.4 = pins 13, 8 and 6) Current is measured through V/I source.

Test# 16.1 Power Supply Sensitivity +5%

4.88mv Max

VSA is set to 5.25V and LST of Code 255 is located within 6 averages. Next, with the source set to 5.00V the procedure is repeated. The result is the difference between the two locations.

Test# 16.2 Power Supply Sensitivity -5%

4.88mv Max

Same as test# 16.1, except VSA is set to 4.75V and 5.00V.

Test# 17 Missing Codes Test

Analog input is connected to the main DAC. The Slave Processor takes control of the main DAC and runs through the entire analog input range in search of each code from 0 to full-scale in sequence. Any missing codes will be datalogged.

Test# 18 Total Unadjusted Error

1 LSB Max

The transition voltage for LST of Code 1 (V1) is located and remembered as offset (V3=1) from the ideal voltage of 0.61 mv. (V2). The transition voltage for LST of code 255 (V1) is located and remembered as gain (V3=2) from the ideal voltage of 4.99817V (V2). JNT(36), unadjusted -FS error, is set using data from offset test. JNT(37), unadjusted +FS error, is set using data from gain test. These variables are used in the linearity subroutine to calculate the Total Unadjusted Error. All of the major transition codes, (1 to 254), +/- 3 codes are tested (V2=4, V3=3) with 5 averages (NUM=5). The Integral Non-Linearity limit is initially set to +/- 1 LSB (INL=1) and the Differential Non-Linearity is initially set to +/- 1 LSB (DNL=1) and a GOSUB 21000 (Linearity Subroutine) is performed. Values tested will be on the worst case INL code (V1=08H).