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Interoffice Memorandum

To
A. Sharma
Department
Code 311
From
K. Sahu KS
Department
7809
Subject
Radiation Report on GPEP
Part No. AD7541ATQ
(Control No. 3800)

PPM-91-710
Date
December 30, 1991
Location
GSFC
Telephone
731-8954
Location
Lanham
cc
S. Archer-Davies
T. Perry
Library/311

A radiation evaluation was performed on AD7541 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 V and Figure 1.

The total dose testing was performed on twenty-four parts using a cobalt-60 gamma ray source. The twenty-four parts were separated into two test groups (TG1 & TG2) of twelve parts each. In addition, two other parts were used as control samples. Before radiation testing began, all 26 parts were electrically tested according to the test conditions and specification limits listed in Table III, at temperatures of -55°C, 25°C and 125°C.

Parts in Test Group 1 (TG1) were tested after total dose exposures of 2.5, 5, 10, 15, 20, 30, 50, 75 and 100 krads*. The dose rate was between 0.1 to 1.3 krads/hour, depending on the total dose level (see Table IIA for the radiation schedule of TG1). After the final radiation exposure to 100 krads, six parts in TG1 were annealed at 25°C under bias and the other six parts were annealed at 25°C unbiased. During annealing all parts in TG1 were tested at cumulative annealing times of 4, 24, 168 and 672 hours.

All twelve parts in TG1 passed all tests to 2.5 krads. At 5 krads ten parts failed to meet the minimum specification limit for IZS1 (the lowest reading was -130nA versus the minimum specification limit of -50nA). At 10 krads, all parts in TG1 failed IZS1 and failed to meet the maximum specification limit of 100uA for IDD1 (readings ranged from 480uA to 7mA). Also, ZERO1 and GAIN1 readings for all parts were way beyond the specification limits. In addition to the above failures, all parts failed IZS2 at cumulative exposures to 15, 20, 30, 50, 75 and 100 krads. One part recovered to pass IDD1 after 696 hours of annealing; however, all other parts continued to fail the above tests. Table IV provides the mean and standard deviation for each electrical parameter at selected steps of TG1 testing.

The radiation exposure to parts in Test Group 2 (TG2) was limited to a single total dose of 5 krads, as the TG1 results showed significant degradation in this part type at this exposure level.

The dose rate was much higher for TG2 - 5.0 krads/hour compared to 0.1 krads/hour used in irradiating the TG1 parts to 5 krads (see Table IIB for radiation schedule). All twelve parts were then annealed at 100°C for 168 hours. Six of the twelve parts were tested at 25°C at cumulative annealing times of 4 and 24 hours. All twelve parts in TG2 were tested at -55°C, 25°C and 125°C after 168 hours of annealing.

All twelve parts in TG2 passed initial electrical measurements. On exposure to 5 krads, all parts exceeded the maximum specification limit for IZS1. IZS1 readings ranged from -94 to -531nA. Of the six parts which were tested after 4 and 24 hours of annealing, two and three parts (respectively) passed all tests. During final annealing measurements (168 hours), all parts passed all tests at -55°C, seven parts passed all tests at 25°C, and all parts failed IZS1 at 125°C (in addition to IZS2 and IDD2 failures). Table V provides the mean and standard deviation for each electrical parameter at each step of TG2 testing.

The effect of dose rate was evident on comparing IZS1 measurements of TG1 & TG2 parts. At 5 krads total dose, the average IZS1 over the 12 parts in TG2 (irradiated at 5 krads/hour) was approximately three times higher than the same average for the 12 parts in TG1 (irradiated at 125 krads/hour). Also, note that the parts in TG2 recovered well when allowed to anneal immediately after failure at 5 krads, whereas parts from TG1 showed no significant recovery on annealing after 100 krads of irradiation.

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

* In this report, the term "rads" is used as an abbreviation for rads (Si).

TABLE I. Part Information

Generic Part Number:	AD7541
GPEP/PPL Part Number:	AD7541ATQ
GPEP/PPL Control Number:	3800
Charge Number:	C13919
Manufacturer:	Analog Devices
Lot Date Code:	9040
Quantity Tested:	26
Serial Numbers of Radiation Samples:	201, 202, 203, 204, 210, 211 (TG1) 212, 213, 214, 215, 216, 217 (TG1) 206, 207, 208, 209, 218, 219 (TG2) 220, 221, 222, 223, 224, 225 (TG2)
Serial Numbers of Control Samples:	200, 205 (TG1 & TG2)
Part Function:	12-Bit DAC
Part Technology:	CMOS
Package Style:	18-Pin DIP
Test Engineer:	C. Nguyen

TABLE IIA. Radiation Schedule for TG1

EVENTS	DATE
1) Initial Electrical Measurements at -55°C, 25°C and 125°C	05/15/91
2) 2.5 krads irradiation @ 140 rads/hr Post 2.5 krads Electrical Measurements	06/04/91 06/05/91
3) 5 krads irradiation @ 125 rads/hr Post 5 krads Electrical Measurements	06/05/91 06/07/91
4) 10 krads irradiation @ 75 rads/hr Post 10 krads Electrical Measurements	06/07/91 06/10/91
5) 15 krads irradiation @ 300 rads/hr Post 15 krads Electrical Measurements	06/10/91 06/11/91
6) 20 krads irradiation @ 300 rads/hr Post 20 krads Electrical Measurements	06/11/91 06/13/91
7) 30 krads irradiation @ 570 rads/hr Post 30 krads Electrical Measurements	06/13/91 06/14/91
8) 50 krads irradiation @ 315 rads/hr Post 50 krads Electrical Measurements	06/14/91 06/17/91
9) 75 krads irradiation @ 1280 rads/hr Post 75 krads Electrical Measurements	06/17/91 06/18/91
10) 100 krads irradiation @ 1250 rads/hr Post 100 krads Electrical Measurements	06/18/91 06/19/91
11) 4 hour annealing Post 4 hr Electrical Measurements	06/19/91 06/19/91
12) 24 hour annealing Post 24 hr Electrical Measurements	06/19/91 06/20/91
13) 168 hour annealing Post 168 hr Electrical Measurements	06/19/91 06/26/91
14) 696 hour annealing Post 696 hr Electrical Measurements at 25°C at 25°C, -55°C and 125°C	06/19/91 07/18/91

Notes:

- All parts were radiated at the cobalt-60 gamma ray facility at GSFC.
- All electrical measurements were performed off-site at 25°C, unless otherwise noted.
- Annealing performed at 25°C under bias for 6 parts, at 25°C unbiased for other six parts.

Table IIB. Radiation Schedule for TG2

EVENTS	DATE
1) Initial Electrical Measurements at -55°C, 25°C and 125°C	05/15/91
2) 5 krads irradiation @ 5 krads/hr Post 5 Krads Electrical Measurements	09/16/91 09/17/91
3) 4 hour annealing Post 4 hr Electrical Measurements (6 parts)	09/17/91 09/17/91
4) 24 hour annealing Post 24 hr Electrical Measurements (6 parts)	09/17/91 09/23/91
5) 168 hour annealing Post 168 hr Electrical Measurements at -55°C, 25°C and 125°C	09/17/91 09/24/91

Notes:

- All parts were radiated at the cobalt-60 gamma ray facility at GSFC.
- Annealing performed at 100°C under bias.
- All electrical measurements were performed off-site at 25°C, unless otherwise noted.

Table III. Electrical Characteristics of AD7541

$V_{DD} = 15V$, $V_{REF} = 10V$, $OUT1 = OUT2 = 0V$, unless otherwise specified.

$T_A = 25^\circ C$

Parameter	Test Conditions	Min	Max	Unit
I_{IL}	$V_{IL} = 0V$	-1	1	μA
I_{IH}	$V_{IH} = 2.4V$	-1	1	μA
I_{ZS1}	$V_{IL} = 0.8V$	-50	50	nA
I_{ZS2}	$V_{IH} = 2.4V$	-50	50	nA
I_{REF_POS}	$V_{IH} = 15V$, $V_{REF} = 10V$	0	0.5	mA
I_{REF_NEG}	$V_{IH} = 15V$, $V_{REF} = -10V$	-2	0	mA
I_{DD1}	$V_{IL} = 0V$, $V_{IH} = 15V$	0	0.1	mA
I_{DD2}	$V_{IL} = 0.8V$, $V_{IH} = 2.4V$	0	2	mA
Gain1		-407	407	m%FS
LIN	$V_{IH} = 15V$, $V_{IL} = 0V$	-	12.2	m%FS
D LIN	$V_{IH} = 15V$, $V_{IL} = 0V$	-	12.2	m%FS
dFS1+		-	10	m%
ZERO1 *				

* No specification limits for ZERO1 were provided by the manufacturer.

TABLE IV: Summary of Electrical Measurements for AD7541, Test Group I

1/, 2/, 3/, 4/

Parameters	Spec. Limits @25°C	Pre-Rad		Total Dose Exposure (krads)												Anneal			
		min	max	2.5		5		10		20		50		100		696 hrs @25°C			
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd		
UIL	uA	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
UIH	uA	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
IJS1	nA	-50	50	0	0	-94	32	-6E5	2E4	-6E5	2E4	-6E5	2E4	-7E5	2E4	-7E5	2E4	2E4	
IJS2	nA	-50	50	0	0	0	0	-30	7	-425	78	-615	20	-664	21	-669	20	20	
IREF_POS	uA	0	500	94	2	94	1	102	2	102	4	107	4	112	3	112	3	3	
IREF_NEG	mA	-2	0	0.6	0	-0.6	0	-0.6	0	-0.6	0	-0.6	0	-0.6	0	-0.6	0	0	
IDD1	uA	0	100	0	0	0	0	4E3	2E3	1E3	129	1E3	129	1E3	82	733	221	221	
IDD2	mA	0	2	0.2	0.1	0.4	0.1	0.8	0.1	0.95	0.05	0.86	0.1	0.83	0.07	0.83	0.07	0.82	0.07
GAIN_1	m%FS	-407	407	206	15	168	14	156	49	-1E5	0	-1E5	0	-1E5	0	-1E5	0	-1E5	0
LIN	m%FS	-	12.2	5.5	1.4	3.4	0.8	3.4	0.7	0.6	0.2	-0.4	0.3	3.4	0.8	4.5	1.2	5.2	1.1
D LIN	m%FS	-	12.2	2.4	0.8	2.6	0.9	2.6	1.0	0.4	0.1	N/A		5.3	1.2	6.8	2.3	8.5	2.0
DFS1+	m%	-	10	0.4	0.5	0.0	0.0	-0.3	0.5	-0.3	0.2	-0.1	0.1	-0.4	0.2	-0.6	0.4	-0.4	0.3
ZERO1	m%FS	see note 4		-0.7	0.1	-0.1	0.2	1.4	1.1	1E5	0	1E5	0	1E5	0	1E5	0	1E5	0

Notes:

- 1/ The mean and standard deviation values were calculated over the twelve parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.
- 2/ Table IV provides radiation characteristics of parts at selected total dose exposures and annealing treatments. The data at other radiation exposures and annealing treatments is available and can be obtained upon request.
- 3/ SNs 201,202,210,211,212, and 213 were biased during annealing and SNs 203,204,214,215,216 and 217 were not. Because there was no significant recovery in any of the parts during annealing, Table IV provides the mean and standard deviation calculated over all twelve parts at the final annealing step.
- 4/ No specification limits for ZERO1 were provided by the manufacturer.

Figure 1. Radiation Bias Circuit for AD7541

