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Interoffice Memorandum

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Subject  
Radiation Report on GPEP  
Part No. AD574A (JM38510/14002BXA)  
Control No. 4018

A radiation evaluation was performed on AD574A 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. All 26 parts passed all initial (pre-rad) electrical measurements.

Parts in Test Group 1 (TG1) were tested after total dose exposures of 10, 20, 30, 50, 75, 100 and 200 krads\*. The dose rate was between 0.2 to 5.0 krads/hour, depending on the total dose level (see Table IIA for the radiation schedule of TG1). After the final radiation exposure to 200 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 24, 168 and 672 hours.

All twelve parts in TG1 passed all tests to 30 krads. At 50 krads, one part (SN 472) marginally exceeded the maximum specification limit of  $\pm 36.6\text{m}\%FS$  for ZERO1 with a reading of  $-39\text{m}\%FS$ . All parts passed all other tests. At 75 krads, four parts passed all tests while eight parts marginally exceeded the maximum specification limit for Linearity (LIN) and five parts exceeded the specification limits for ZERO1 and Differential Linearity (D LIN). At 100 krads, only two parts passed all tests while the remaining parts exceeded the specification limits for LIN, D LIN and/or ZERO1. However, all parts passed the missing code test up to 100 krads. On continued irradiation to 200 krads, all twelve parts had missing codes and measurements for dFS could not be made due to radiation damage in the parts. Parts showed no recovery on annealing for 24, 168 and 672 hours at 25°C (irrespective of whether they were biased or unbiased

during annealing). Table IV provides the mean and standard deviation for each electrical parameter at selected radiation steps.

The radiation exposure to parts in Test Group 2 (TG2) was limited to a single total dose of 100 krads. The dose rate was 5 krads per hour (see Table IIB for the radiation schedule of TG2). Parts were electrically tested at 25°C and then annealed under bias at 100°C for 168 hours. Final electrical measurements were made as per Table III.

After 100 krads, four of the twelve parts in TG2 passed all tests while eight parts exceeded the specification limits for LIN, D LIN and/or ZERO1. All parts passed the missing code test. After 168 hours of annealing, parts showed partial recovery and only two parts exceeded the specification limits for LIN and D LIN at 25°C. Table V provides the mean and standard deviation for each electrical parameter at each step of TG2 testing.

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 "krads" is used as an abbreviation for rads (Si).

TABLE I. Part Information

Generic Part Number:	AD574AT
GPEP/PPL Part Number:	JM38510/14002BXA
GPEP/PPL Control Number:	4018
Charge Number:	C14015
Manufacturer:	Analog Devices
Lot Date Code:	9039A
Quantity Tested:	26
Serial Numbers of Radiation Samples:	453, 454, 455, 456, 469, 470 (TG1)
	471, 472, 473, 474, 475, 476 (TG1)
	451, 458, 459, 460, 461, 462 (TG2)
	463, 464, 465, 466, 467, 468 (TG2)
Serial Numbers of Control Samples:	452, 457 (TG1 & TG2)
Part Function:	12-Bit ADC
Part Technology:	Bipolar
Package Style:	28-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	05/16/91
2) 10 krads irradiation @ 150 rads/hr Post 10 krads Electrical Measurements	06/07/91 06/10/91
3) 20 krads irradiation @ 600 rads/hr Post 20 krads Electrical Measurements	06/10/91 06/11/91
4) 30 krads irradiation @ 590 rads/hr Post 30 krads Electrical Measurements*	06/11/91 07/11/91
5) 50 krads irradiation @ 300 rads/hr Post 50 krads Electrical Measurements	07/12/91 07/16/91
6) 75 krads irradiation @ 1250 rads/hr Post 75 krads Electrical Measurements	07/16/91 07/17/91
7) 100 krads irradiation @ 1250 rads/hr Post 100 krads Electrical Measurements	07/17/91 07/18/91
8) 200 krads irradiation @ 5000 rads/hr Post 200 krads Electrical Measurements	07/18/91 07/19/91
9) 24 hour annealing at 25°C Post 24 hr Electrical Measurements (only 4 parts tested)	07/19/91 07/20/91
10) 168 hour annealing at 25°C Post 168 hr Electrical Measurements	07/19/91 07/26/91
11) 672 hour annealing at 25°C Post 672 hr Electrical Measurements	07/19/91 09/24/91

\*The test board was out for repair from 06/11/91 to 07/11/91.

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 (SNs 453, 454, 469, 470, 471 & 472), and unbiased for the other six parts (SNs 455, 456, 473, 474, 475 & 476)

Table IIB. Radiation Schedule for TG2

EVENTS	DATE
1) Initial Electrical Measurements at -55°C, 25°C and 125°C	05/16/91
2) 100 krads irradiation @ 5 krads/hr	10/07/91
Post 100 krads Electrical Measurements	10/08/91
3) 168 hour annealing	10/08/91
Post 168 hr Electrical Measurements at 25°C	10/28/91
and at -55°C & 125°C	11/15/91

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 AD574AT

VCC = 15V, VEE = -15V, VLOGIC = 5V unless otherwise indicated.  
 $T_A = +25^\circ\text{C}$

Parameter	Conditions	Min	Max	Unit
+ICC1 *	Output Code all ones &	1	40	mA
-ICC1 *	Output Code all zeros	1	30	mA
ICC2 *		1	16	mA
VREF	Output Code all zeros VFS=20V, IL = 1.5mA	9.95	10.05	V
ZERO1	VFS = 10V, Unipolar mode	-36.6	36.6	m%FS
ZERO2	VFS = 20V, Bipolar mode	-110	110	m%FS
ZERO3	VFS = 10V, Bipolar mode	-110	110	m%FS
GAIN1	VFS = 10V, Unipolar mode	-250	250	m%FS
GAIN2	VFS = 20V, Bipolar mode	-250	250	m%FS
GAIN3	VFS = 10V, Bipolar mode	-250	250	m%FS
LIN		-12.2	12.2	m%FS
D LIN		-24.4	24.4	m%FS
dFS1+	13.5V < VCC < 16.5V	-24.4	24.4	m%FS
dFS1-	-16.5V < VEE < -13.5V	-24.4	24.4	m%FS
dFS2	4.5V < VLOG < 5.5V	-24.4	24.4	m%FS
CE_I1H *	VIN = 0V, VTEST = 5.5V	-20	20	uA
RC_I1H *	VIN = 0V, VTEST = 5.5V	-20	20	uA
CE_I1L *	VIN = 0V, VTEST = 0.0V	-20	20	uA
RC_I1L *	VIN = 0V, VTEST = 0.0V	-20	20	uA
IZH *	ZH, VIN = 10V, VTEST = 5.5V	-20	20	uA
IZL *	ZL, VIN = 0V, VTEST = 0.0V	-20	20	uA
VOH *	VIN = 10V, ILOAD = -500uA	2.4	6.0	V
VOL *	VIN = 0V, ILOAD = 1.6mA	0	400	mV
IEE_H *	VIN = 10V, all outputs high	-30	-1	mA
IEE_L *	VIN = 0V, all outputs low	-30	-1	mA
ICC_H *	VIN = 10V, all outputs high	1	16	mA
ICC_L *	VIN = 0V, all outputs low	1	16	mA
ILOGIC_H *	VIN = 10V, all outputs high	1	40	mA
ILOGIC_L *	VIN = 0V, all outputs low	1	40	mA

\*These tests were also performed at  $-55^\circ\text{C}$  and  $125^\circ\text{C}$  during initial and final electrical measurements (see Table II for details). The specification limits for these tests, over the temperature range of  $-55^\circ\text{C}$  to  $+125^\circ\text{C}$ , are the same as in Table III. The remaining tests could not be performed reliably at low and high temperatures, due to problems with the Genrad test board.

TABLE IV: Summary of Electrical Measurements after  
Total Dose Exposures and Annealing for AD574, Test Group 1 1/. 2/

Parameters	spec. limits min max	Pre-Rad		Total Dose Exposure (krads)											
		EM @25°C		20		50		75		100		200			
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd		
CE_I1H	UA	-20	20	1.3	0.1	1.2	0.1	1.3	0.1	1.4	0.2	1.5	0.2	1.7	0.2
RC_I1H	UA	-20	20	0.9	0.1	0.9	0.1	1	0.1	1	0.1	1.1	0.2	1.2	0.2
CE_I1L	UA	-20	20	-4.7	0.5	-5.6	0.7	-7.8	1.6	-9	1.8	-9.4	1.8	-11	1.9
RC_I1L	UA	-20	20	-4.8	0.5	-5.4	0.6	-7.2	1.2	-8.2	1.3	-9	1.3	-10	1.1
IZH	UA	-20	20	0	0	0	0	0	0	0	0	0	0	0	0
IZL	UA	-20	20	0	0	0	0	0	0	0	0	0	0	0	0
V0H	V	2.4	6.0	3.8	0.07	3.8	0.02	3.7	0.02	3.7	0.02	3.7	0.02	3.7	0.02
V0L	mV	0	400	110	7	116	6	117	5	119	6	121	7	130	22
IEE_H	mA	-30	-1	-18	0.3	-18	0.3	-18	0.5	-17	0.4	-17	0.4	-17	0.4
IEE_L	mA	-30	-1	-20	0.4	-20	0.4	-19	0.4	-19	0.5	-19	0.4	-18	0.5
ICC_H	mA	1	16	2.1	0.1	2.1	0.1	2.1	0.1	2.1	0.1	2.1	0.1	2.2	0.1
ICC_L	mA	1	16	2.2	0.1	2.1	0.1	2.1	0.1	2.1	0.1	2.2	0.1	2.2	0.1
ILOGIC_H	mA	1	40	25	0.7	25	0.9	24	0.9	24	0.8	24	0.8	24	0.8
ILOGIC_L	mA	1	40	25	0.6	24	0.8	24	0.9	24	0.7	24	0.8	24	0.8

<Table IV continued on next page>

Table IV. (continued)

Parameters	spec. limits		Total Dose Exposure (krads)											
	min	max	Pre-Rad		20		50		75		100		200	
			mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
+Icc1	1	40	24.9	0.7	24.7	0.8	24.3	0.8	24.3	0.8	24.0	0.9	23.8	0.8
-Icc1	1	30	20.5	0.5	20.3	0.3	19.8	0.5	19.3	0.5	19.1	0.6	18.9	0.5
Icc2	1	16	2.0	0.0	2.0	0.0	1.5	0.0	1.5	0.0	1.5	0.1	1.5	0.0
VREF	9.95	10.05	10.0	0.0	10.0	0.0	10.0	0.0	10.0	0.0	10.0	0.0	10.0	0.0
ZER01	m%FS	-	4.1	2.7	22.2	10.1	24	12.0	28.9	15.7	28.8	20.2	**	
GAIN1	m%FS	-	40.2	14.1	29.7	19.5	49.3	24.3	32.2	23.4	42.0	15.4	**	
ZER02	m%FS	-	8.1	5.2	16.8	18.7	12.4	8.5	21.6	14.6	29.6	22.8	**	
GAIN2	m%FS	-	42.9	14.0	44.1	26.2	58.3	24.1	43.9	26.9	39.0	18.5	**	
ZER03	m%FS	-	7.3	3.4	29.0	32.6	14.3	8.9	24.3	16.4	32.2	24.7	**	
GAIN3	m%FS	-	48.2	14.7	26.5	18.6	48.3	23.7	32.8	23.0	42.6	15.6	**	
LIN	m%FS	-	6.1	0.8	*		8.4	3.0	12.5	3.3	12.9	5.8	**	
D LIN	m%FS	-	7.2	1.4	8.2	6.7	11.3	6.3	16.8	9.5	21.0	11.6	**	
dFS1+	m%FS	-	2.3	1.8	3.0	1.9	1.6	1.1	1.9	0.9	1.8	1.3	**	
dFS1-	m%FS	-	1.3	1.2	3.3	3.9	1.5	1.5	2.2	1.6	2.2	1.2	**	
dFS2	m%FS	-	5.4	2.0	6.0	4.2	1.3	1.1	0.9	0.8	1.3	1.3	**	

Notes:

1/ The mean and standard deviation for the pre-irradiation electrical measurements (EM) were calculated over the 26 parts used in this testing, ie. both test groups and the two control samples. The mean and standard deviation for all other radiation and annealing steps were calculated only over the 12 parts irradiated in Test Group 1.  
 2/ Table IV provides radiation characteristics of parts at selected total dose exposures. The data at other radiation exposures and annealing treatments is available and can be obtained upon request.

\* No reliable data available at the noted radiation step for this parameter.

\*\* Due to radiation induced degradation in the parts, no measurements could be made for these parameters.

TABLE V: Summary of Electrical Measurements after  
Total Dose Exposures and Annealing for AD574, Test Group 2 1/

Parameters	Spec. Limits	min	max	Pre-Rad														
				EM @25°C			EM @-55°C			EM @125°C			100 krad			168 hrs Annealing @ 100°C		
				mean	sd	n	mean	sd	n	mean	sd	n	mean	sd	n	mean	sd	n
CE_IH	uA	-20	20	1.3	0.1	1.7	0.1	0.8	0.2	1.2	0.2	1.3	0.1	1.7	0.1	1.3	1.7	
RC_IH	uA	-20	20	0.9	0.1	1.0	0.1	0.6	0.1	1	0.2	1.1	0.1	1.4	0.1	0.9	0.2	
CE_IL	uA	-20	20	-4.7	0.5	-5.9	0.4	-1.2	0.5	-6.9	2.3	-8.4	0.3	-10	0.3	-4.7	0.3	
RC_IL	uA	-20	20	-4.8	0.5	-6	0.4	-1.1	0.5	-6.3	1.1	-7.2	0.4	-8.9	0.3	-3.7	0.3	
IZH	uA	-20	20	0	0	0	0	0.2	0.1	0	0	0	0	0.01	0.1	0.1	0.03	
IZL	uA	-20	20	0	0	0	0	-0.2	0.05	0	0	0	0	0	0	0	0.01	
VOH	V	2.4	6.0	3.8	0.07	3.6	0.02	4	0.05	3.7	0.02	3.8	0.02	3.6	0.02	3.9	0.02	
VOL	mV	0	400	110	7	95	5	147	8	114	6	113	7	99	7	145	5	
IEE_H	mA	-30	-1	-18	0.3	-18	0.4	-18	0.3	-18	0.3	-18	0.3	-17	0.2	-18	0.3	
IEE_L	mA	-30	-1	-20	0.4	-19	0.3	-20	0.3	-20	0.3	-19	0.3	-19	0.1	-19	0.2	
ICC_H	mA	1	16	2.1	0.1	2.2	0.1	2.2	0.1	1.9	0	2	0.1	2	0	2	0.1	
ICC_L	mA	1	16	2.2	0.1	2.1	0.1	2	0.1	1.9	0.07	2	0.1	2	0	2	0	
ILOGIC_H	mA	1	40	25	0.7	25	0.7	21	0.8	24.5	0.6	25	0.3	25	0.4	22	0.3	
ILOGIC_L	mA	1	40	25	0.6	25	0.7	21	0.8	24.5	0.6	25	0.3	25	0.4	21	0.3	

<Table V continued on next page>

Table V. (continued)

Parameters	Spec. Limits min max	Pre-Rad															
		EM @25°C		EM @-55°C		EM @125°C		100 krad		168 hrs Annealing @ 100°C		EM @-55°C		EM @125°C			
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd		
+ICC1	mA	1	40	24.9	0.7	25.3	0.7	22.1	0.9	24.1	0.6	24.6	0.6	24.6	0.6	21.1	0.6
-ICC1	mA	1	30	20.5	0.5	20.1	0.3	20.2	0.4	19.2	0.3	19.9	0.3	15.0	0.5	15.4	1.1
ICC2	mA	1	16	2.0	0.0	2.0	0.1	2.0	0.0	1.5	0.0	1.5	0.0	1.6	0.4	1.8	0.8
VREF	V	9.95	10.05	10.0	0.0	**		**		10.0	0.0	10.0	0.0	**		**	
ZER01	m%FS	-	36.6	4.1	2.7	**		**		38.9	40.3	16.6	8.8	**		**	
GAIN1	m%FS	-	250	40.2	14.1	**		**		31.9	25.5	*		**		**	
ZER02	m%FS	-	110	8.1	5.2	**		**		36.8	21.4	*		**		**	
GAIN2	m%FS	-	250	42.9	14.0	**		**		29.5	21.8	*		**		**	
ZER03	m%FS	-	110	7.3	3.4	**		**		41.7	24.8	*		**		**	
GAIN3	m%FS	-	250	48.2	14.7	**		**		28.3	16.5	*		**		**	
LIN	m%FS	-	12.2	6.1	0.8	**		**		14.1	5.6	13.6	21.2	**		**	
D LIN	m%FS	-	24.4	7.2	1.4	**		**		21.9	12.1	8.2	2.7	**		**	
dFS1+	m%FS	-	24.4	2.3	1.8	**		**		2.1	2.2	1.2	0.9	**		**	
dFS1-	m%FS	-	24.4	1.3	1.2	**		**		4.0	4.0	2.5	3.6	**		**	
dFS2	m%FS	-	24.4	5.4	2.0	**		**		1.5	1.8	0.9	0.8	**		**	

Notes:

1/ The mean and standard deviation for the pre-irradiation electrical measurements (EM) were calculated over the 26 parts used in this testing, ie. both test groups and the two control samples. The mean and standard deviation for all other radiation and annealing steps were calculated only over the 12 parts irradiated in Test Group 2.

\* No reliable data available at the noted radiation step for this parameter.

\*\* No measurements made at low and high temperatures for these parameters.