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To
A. Sharma
Department
Code 311
From
K. Sahu *KS*
Department
7809
Subject
Radiation Report on AD524
GPEP Part No. 5962-8853901EA
Control Number 3734

PPM-92-029
Date
January 14, 1991
Location
GSFC
Telephone
731-8954
Location
Lanham
cc
S. Archer-Davies
T. Perry
Library/311

A radiation evaluation was performed on AD524 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 using a cobalt-60 gamma ray source. Prior to irradiation, twenty-two parts were electrically tested at 25°C according to the test conditions and the specification limits listed in Table III, and all parts passed all tests. The parts were then separated into two test groups. Ten parts were used for Test Group 1 (TG1) and twelve parts were used for Test Group 2 (TG2). During the radiation testing, eight parts in TG1 and ten parts in TG2 were irradiated while the remaining two parts from each group were used as control samples.

Parts in TG1 were tested after total dose exposures of 5, 10, 20, 30, 50, 75, 100 and 200 krads*. The dose rate was between 0.3 and 5.0 krads/hour, depending on the total dose level (see Table IIA for the radiation schedule of TG1). Parts were then annealed under bias at 25°C for 68, 168 and 672 hours. After each radiation/annealing step, parts were electrically tested at 25°C according to the test conditions and specification limits listed in Table III.

All eight parts in TG1 passed all tests on irradiation to 100 krads. At 200 krads, one part (SN 53) exceeded the maximum specification limit of $\pm 100\mu\text{V}$ for VOSI with a reading of $-123\mu\text{V}$. However, all other parts passed all tests. On annealing the parts for 68 hours at 25°C, SN 53 recovered to pass all tests. On continued annealing for 168 and 672 hours, all parts passed all tests. Table IV provides the mean and standard deviation values for each parameter tested after each radiation/annealing step, for the parts in Test Group 1.

Parts in TG2 were subjected to a single total dose exposure (STDE) of 200 krads. The dose rate was 10 krads/hour. The parts in TG2 were then separated into two lots, Lot 1 and Lot 2, and annealed at 100°C. Parts in Lot 1 were tested at cumulative annealing times of 4, 24 and 264 hours, while parts in Lot 2 were

tested only after 264 hours of annealing (see Table IIB for the radiation schedule for TG2).

After the STDE of 200 krads, four parts (SNs 62,70,73 & 79) in TG2 exceeded the maximum specification limit of $\pm 50\text{m}\%$ for 1X Gain Error (GE1). Three parts had readings of $-56\text{m}\%$ and one part (SN 73) had a reading of $-87\text{m}\%$. All parts in Lot 1 passed all tests after annealing for 4 hours at 100°C ; however, after 24 hours of annealing at 100°C , two parts marginally exceeded the specification limit of 3mV for the output offset voltage (VOSO) with readings of 3.2mV and 3.6mV. After 264 hours of annealing at 100°C , all parts in TG2 (Lot 1 and Lot 2) were tested, and three parts marginally exceeded the specification limit for VOSO (readings ranged from 3.1mV to 4.0mV). Table V provides the mean and standard deviation values for each parameter tested after each radiation/annealing step for the parts in Test Group 2.

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:	AD524
GPEP Part Number:	5962-8853901EA
GPEP Control Number:	3734
Charge Number:	C13847
Manufacturer:	Analog Devices
Lot Date Code:	9013C
Quantity Tested:	22
Serial Numbers of Radiation Samples:	52, 53, 54, 55 (TG1) 56, 57, 58, 59 (TG1) 62, 67, 70, 72, 73 (TG2, Lot 1) 68, 79, 80, 81, 82 (TG2, Lot 2)
Serial Numbers of Control Samples:	50, 51 (TG1) 60, 61 (TG2)
Part Function:	Precision Instrumentation Amplifier
Part Technology:	Bipolar
Package Style:	16-Pin DIP
Test Engineer:	T. Mondy

TABLE IIA. Radiation Schedule for TG1

EVENTS	DATE
1) Initial Electrical Measurements	11/27/90
2) 5 krads irradiation @ 250 rads/hr Post 5 krads Electrical Measurements	11/27/90 11/28/90
3) 10 krads irradiation @ 250 rads/hr Post 10 krads Electrical Measurements	11/28/90 11/29/90
4) 20 krads irradiation @ 500 rads/hr Post 20 krads Electrical Measurements	11/29/90 11/30/90
5) 30 krads irradiation @ 147 rads/hr Post 30 krads Electrical Measurements	11/30/90 12/03/90
6) 50 krads irradiation @ 300 rads/hr Post 50 krads Electrical Measurements	12/03/90 12/04/90
7) 75 krads irradiation @ 1250 rads/hr Post 75 krads Electrical Measurements	12/04/90 12/05/90
8) 100 krads irradiation @ 1250 rads/hr Post 100 krads Electrical Measurements	12/05/90 12/06/90
9) 200 krads irradiation @ 5000 rads/hr Post 200 krads Electrical Measurements	12/06/90 12/07/90
10) 68 hrs annealing Post 68 hr Electrical Measurements	12/07/90 12/10/90
11) 168 hrs annealing Post 168 hr Electrical Measurements	12/07/90 12/14/90
12) 672 hrs annealing Post 672 hr Electrical Measurements	12/07/90 01/11/91

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 IIB. Radiation Schedule for TG2 (Lot 1 and Lot 2)

EVENTS	DATE
1) Initial Electrical Measurements (EM) (Lot 1 and Lot 2)	08/28/91
2) 200 krads irradiation @ 10 krads/hour Post 200 krad EM (Lot 1 and Lot 2)	08/28/91 08/29/91
3) 4 Hours Annealing ^{1/} Post 4 Hour Annealing EM at +25°C (Lot 1 only)	08/29/91 08/29/91
4) 24 Hours Annealing ^{1/} Post 24 Hours Annealing EM at +25°C (Lot 1 only)	08/29/91 08/30/91
5) 264 Hours Annealing Post 264 Hours Annealing EM (Lot 1 and Lot 2)	08/29/91 09/09/91

Notes:

1/ Parts from Lot 1 were tested at interim annealing times of 4 and 24 hours, while parts from Lot 2 were allowed to anneal without interruption for 264 hours.

- 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.
- All annealing was performed at 100°C under bias.

Table III. Electrical Characteristics of AD524

$V_S = \pm 15V$, $R_L = 2k\Omega$ unless otherwise specified.

Test	Symbol	Condition	Limits		Unit
			Min	Max	
Gain Error 1, GE_1		$G=1, V_O=\pm 10V$	-0.05	0.05	%
Gain Error 10, GE_{10}		$G=10, V_O=\pm 10V$	-0.25	0.25	%
Gain Error 100, GE_{100}		$G=100, V_O=\pm 10V$	-0.5	0.5	%
Gain Error 1000, GE_{1000}		$G=1000, V_O=\pm 10V$	-2.0	2.0	%
Input Offset Voltage	V_{OSI}	$V_{IN} = 0V$	-100	100	μV
Output Offset Voltage	V_{OSO}	$V_{IN} = 0V$	-3.0	3.0	mV
Input Bias Current	I_B	$G = 1$	-50	50	nA
Input Offset Current	I_{IO}	$I_{IO}=(I_B^+) - (I_B^-)$ $G = 1$	-35	35	nA
Common Mode Rejection					
	CMRR1	$G=1, V_{IN}=0$ to +10V	70	--	dB
	-CMRR1	$G=1, V_{IN}=0$ to -10V	70	--	dB
	CMRR10	$G=10, V_{IN}=0$ to +10V	90	--	dB
	-CMRR10	$G=10, V_{IN}=0$ to -10V	90	--	dB
	CMRR100	$G=100, V_{IN}=0$ to +10V	100	--	dB
	-CMRR100	$G=100, V_{IN}=0$ to -10V	100	--	dB
	CMRR1000	$G=1000, V_{IN}=0$ to +10V	110	--	dB
	-CMRR1000	$G=1000, V_{IN}=0$ to -10V	110	--	dB
Power Supply Current	I_{CC}	$G = 1$	--	5	mA
Power Supply Rejection					
	PSRR1	$G = 1, V_S=\pm 12V, \pm 15V$	75	--	dB
	PSRR10	$G = 10, "$	95	--	dB
	PSRR100	$G = 100, "$	105	--	dB
	PSRR1000	$G = 1000, "$	110	--	dB

Table IV. Summary of Electrical Measurements after
Total Dose Exposures and Annealing for AD524, Test Group 1

1/, 2/

Parameters	Spec. Limits min max	Pre-Rad		Total Dose Exposure (krads)												
		mean	sd	5		10		20		30		50		75		
				mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
VOSO	mV	3	0.5	0.1	0.6	0.1	0.6	0.2	0.7	0.3	0.7	0.2	0.8	0.3	0.6	0.3
GE 1	m%	50	8.8	9.0	5.0	4.1	6.9	5.9	5.8	6.7	7.4	3.1	8.6	10.8	15.6	17.6
GE 10	m%	250	41.8	18.6	36.6	15.9	40.0	14.0	36.5	13.4	44.1	14.3	41.5	12.6	54.0	12.9
VOSI	uV	100	11.4	6.0	5.6	3.9	10.4	8.4	8.4	4.9	12.3	6.5	14.5	11.0	27.9	15.3
IBP	nA	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IBN	nA	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIO	nA	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMRR 1	dB	70	90	6	90	6	91	9	90	7	85	8	88	6	91	7
-CMRR1	dB	70	87	8	88	8	86	6	87	7	82	7	84	4	86	6
CMRR 2	dB	90	111	7	112	7	113	10	111	9	107	10	110	8	115	10
-CMRR2	dB	90	108	8	106	6	105	5	105	6	101	5	102	4	106	9
CMRR 3	dB	100	132	10	125	2	125	3	124	1	124	5	127	7	126	7
-CMRR3	dB	100	120	5	117	3	117	3	117	5	116	4	115	2	117	5
CMRR 4	dB	110	145	14	143	5	135	7	137	7	134	5	138	5	135	8
-CMRR4	dB	110	134	8	133	5	130	7	130	4	134	15	130	7	129	16
PSRR1	dB	75	94	5	94	5	95	5	96	5	95	6	95	5	98	9
PSRR2	dB	95	114	6	115	6	114	5	115	7	118	9	116	9	116	8
PSRR3	dB	105	136	16	133	11	132	6	135	10	138	11	131	10	133	12
PSRR4	dB	110	138	9	141	11	132	5	140	12	135	12	133	9	129	8
+ICC	mA	5	3.6	0.1	3.4	0.1	3.4	0.1	3.3	0.1	3.2	0.1	3.1	0.1	3.1	0.1
-ICC	mA	5	3.6	0.1	3.4	0.1	3.4	0.1	3.3	0.1	3.2	0.1	3.2	0.1	3.1	0.1

<Table IV continued on next page>

Table IV. (continued)

Parameters	Spec. Limits min max	Pre-Rad		Total Dose (krads)				Annealing (hours) at 25°C						
		mean	sd	100		200		68		168		672		
				mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
VOSO	mV	3	0.5	0.1	0.8	0.3	0.6	0.4	0.8	0.5	0.8	0.4	0.9	0.6
GE 1	m%	50	8.8	9.0	18.3	17.5	21.5	20.2	18.6	25.1	14.9	17.1	*	
GE 10	m%	250	41.8	18.6	51.0	51.0	67.8	25.6	93.4	76.2	59.3	17.3	*	
VOSI	uV	100	11.4	6.0	20.0	19.7	44.8	33.4	28.2	25.2	22.4	26.6	14.4	10.1
IBP	nA	50	0	0	0	0	0	0	0	0	0	0	0	0
IBN	nA	50	0	0	0	0	0	0	0	0	0	0	0	0
IIO	nA	35	0	0	0	0	0	0	0	0	0	0	0	0
CMRR 1	dB	70	90	6	85	10	90	11	80	16	92	8	82	12
-CMRR1	dB	70	87	8	82	9	84	7	76	13	86	10	81	12
CMRR 2	dB	90	111	7	106	11	112	12	106	19	113	7	103	12
-CMRR2	dB	90	108	8	101	8	103	7	98	13	106	5	101	12
CMRR 3	dB	100	132	10	119	7	122	6	123	18	128	12	129	17
-CMRR3	dB	100	120	5	115	6	118	6	112	10	117	3	116	10
CMRR 4	dB	110	145	14	131	8	136	12	133	10	134	14	137	12
-CMRR4	dB	110	134	8	131	10	140	12	130	8	131	4	135	16
PSRR1	dB	75	94	5	96	6	96	6	96	7	95	5	98	9
PSRR2	dB	95	114	6	117	7	117	9	117	9	114	5	118	8
PSRR3	dB	105	136	16	127	8	136	8	131	11	131	6	131	7
PSRR4	dB	110	138	9	134	13	137	8	133	6	137	8	135	7
+ICC	mA	5	3.6	0.1	3.1	0.1	3.1	0.1	3.1	0.1	3.2	0.1	3.2	0.1
-ICC	mA	5	3.6	0.1	3.1	0.1	3.1	0.1	3.2	0.1	3.2	0.1	3.2	0.1

Notes:

1/ The mean and standard deviation values were calculated over the eight parts irradiated in Test Group 1.

2/ GE 100 and GE 1000 are not provided due to problems with the test equipment for these parameters.

* No reliable measurements made for this parameter at the noted annealing step.

TABLE V: Summary of Electrical Measurements
after STDE and Annealing for AD524, Test Group 2

Parameters	Units	Spec. Limits min max		Pre-Rad mean sd		Total Dose		Annealing (hours) at 100°C							
						200 krads		Lot 1				Lot 2			
						mean	sd	4	sd	24	sd	264	sd	264	sd
VOSO	mV		3	0.7	0.1	0.6	0.3	0.3	0.3	2.7	0.6	2.7	0.8	2.4	0.4
GE 1	m%		50	6.1	5.4	34	27	18	11	*		*		*	
GE 10	m%		250	70.2	63.3	88	29	59	12	19	13	36	31	24	11
VOSI	uV		100	15.1	8.4	20	8	18	18	23	13	19	6	13	8
IBP	nA		50	0	0	0	0	0	0	0	0	0	0	0	0
IBN	nA		50	0	0	0	0	0	0	0	0	0	0	0	0
IIO	nA		35	0	0	0	0	0	0	0	0	0	0	0	0
CMRR 1	dB	70		86	4	87	6	92	9	95	11	79	5	80	2
-CMRR1	dB	70		86	4	85	6	94	12	95	12	79	5	79	1
CMRR 2	dB	90		106	3	107	6	110	6	113	8	99	5	100	2
-CMRR2	dB	90		106	4	106	8	111	8	114	10	99	5	99	2
CMRR 3	dB	100		128	7	129	7	130	4	135	10	119	5	120	3
-CMRR3	dB	100		124	4	125	5	123	5	132	6	121	7	119	2
CMRR 4	dB	110		140	9	139	10	135	7	147	12	133	6	143	6
-CMRR4	dB	110		133	7	131	7	127	2	140	4	139	8	137	4
PSRR1	dB	75		95	8	92	7	101	11	94	2	91	6	93	9
PSRR2	dB	95		118	14	111	6	121	12	113	2	112	6	113	10
PSRR3	dB	105		126	5	133	9	132	6	128	1	137	14	138	20
PSRR4	dB	110		133	8	130	7	131	3	134	3	142	7	137	4
+ICC	mA		5	3.7	0.2	3.3	0.1	3.3	0.2	3.4	0.2	3.5	0.2	3.5	0.2
-ICC	mA		5	3.7	0.2	3.3	0.1	3.4	0.1	3.4	0.2	3.5	0.2	3.5	0.1

Notes:

1/ The mean and standard deviation values were calculated over the ten parts irradiated in Test Group 2, separated by lot after the STDE.

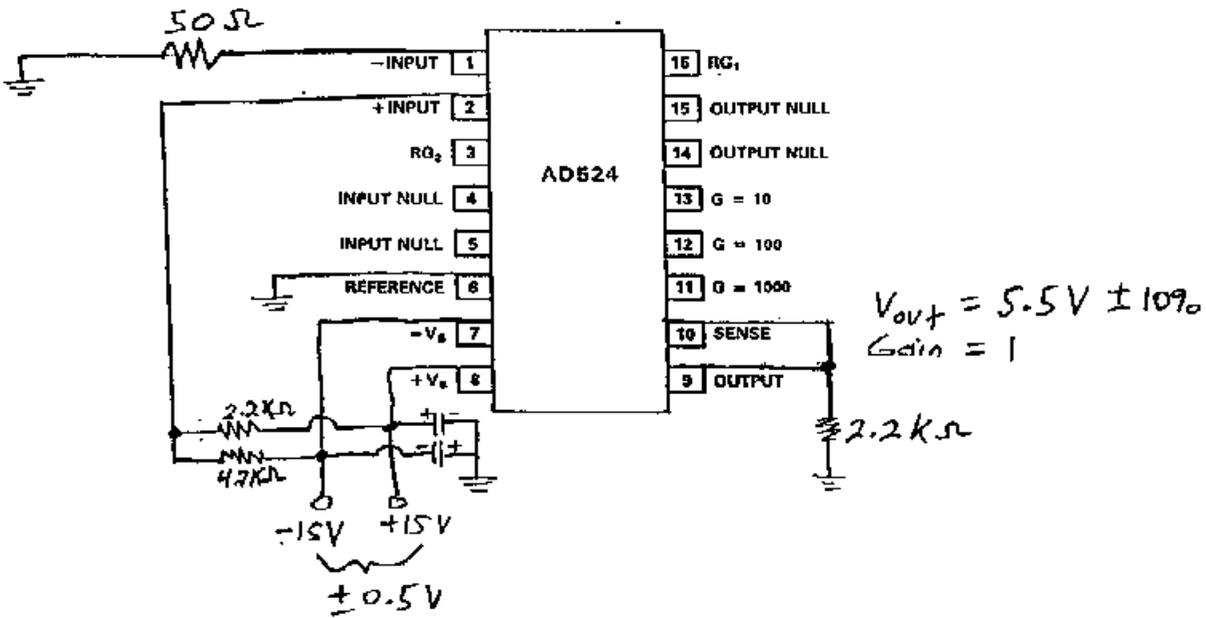
2/ Lot 1 comprised SNs 62, 67, 70, 72, and 73. Lot 2 comprised SNs 79, 80, 81, 82, and 68. See Table II for more details.

3/ GE 100 and GE 1000 are not provided due to problems with the test equipment for these parameters.

4/ SN 82 is not included in the calculations for this table since it almost exceeded the specification limit for GE10 during pre-irradiation electrical measurements and did not behave as the other parts throughout the testing.

* No reliable measurements made at the noted annealing step for this parameter.

Figure 1. Radiation Bias Circuit for AD524



Note: All resistors are 10%, 1/4W
 Capacitors are 1μF, 35V