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To
A. Sharma
Department
Code 311
From
K. Sahu ks
Department
7809
Subject
Radiation Report on HA2620
GPEP Part No. JM38510/12203BGC
Control Number 3852

PPM-92-023
Date
January 9, 1991
Location
GSFC
Telephone
731-8954
Location
Lanham
cc
S. Archer-Davies
T. Perry
Library/311

A radiation evaluation was performed on HA2620 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 VI and Figure 1.

The total dose testing was performed using a cobalt-60 gamma ray source. Prior to irradiation, the twenty-two parts were electrically tested at 25°C, -55°C and 125°C according to the test conditions and the specification limits listed in Table III. All parts passed all tests at these three temperatures. 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 and 100 krad*. The dose rate was between 0.2 and 1.3 krad/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 4, 24, 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 to 30 krad. At 50 krad, five parts (SNs 142, 186, 233, 313, & 368) failed to meet the minimum specification limit of 100kV/V for AOL. In addition, one part (SN 4) exceeded the maximum specification limit of 15nA for IOS, IB+/- and IBIAS. At 75 krad, all parts failed to meet the minimum specification limit for AOL (readings ranged from 74kV/V to 98kV/V). Also, all parts except one, (SN 313), exceeded the specification limit for IOS, IB+/- and/or Ibias. After the final exposure to 100 krad, AOL continued to degrade (readings ranged from 67kV/V to 90kV/V), but two other parts, SNs 142 and 238, passed input bias current testing (in addition to SN 313). Parts showed recovery on annealing at 25°C for 4 and 24 hours, but none of the parts passed all tests; however, all parts passed all tests after 168 and 672 hours of annealing at 25°C. Table IV

provides the mean and standard deviation values for each parameter after each radiation/annealing step.

Parts in TG2 were subjected to a single total dose of 100 krad at a dose rate of 10 krad/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 168 hours, while parts in Lot 2 were tested only after 168 hours of annealing (see Table IIB for the radiation schedule for TG2). Parts from both lots were also tested at high and low temperatures after the final annealing treatment.

Eight of ten parts in TG2 failed to meet the minimum specification limit for AOL after 100 krad. Failed readings ranged from 64kV/V to 96kV/V. Also, all parts except one (SN 169) exceeded the specification limit for IB+. Four of five parts in Lot 1 passed all tests after annealing at 100°C for 4 hours, and all parts in Lot 1 passed all tests after 24 hours of high temperature annealing. All parts from both lots passed all tests after 168 hours of high temperature annealing at testing temperatures of -55°C, 25°C and 125°C. Table V provides the mean and standard deviation values for each parameter for Test Group 2, separated by Lot 1 and Lot 2. Table VI provides the same information for the initial and final measurements at low and high testing temperatures.

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:	HA2620
GPEP Part Number:	JM38510/12203BGC
GPEP Control Number:	3852
Charge Number:	C13927
Manufacturer:	Harris
Lot Date Code:	9013A
Quantity Tested:	22
Serial Numbers of Radiation Samples:	4, 142, 180, 186, (TG1) 233, 238, 313, 368 (TG1) 164, 191, 194, 254, 264 (TG2, Lot1) 302, 315, 319, 359, 395 (TG2, Lot2)
Serial Numbers of Control Samples:	5, 7 (TG1) 146 (TG2, Lot 1) 152 (TG2, Lot 2)
Part Function:	Operational Amplifier
Part Technology:	Bipolar
Package Style:	8-Pin can
Test Engineer:	C. Arcila

TABLE IIA. Radiation Schedule for TG1

EVENTS	DATE
1) Initial Electrical Measurements at 25°C, -55°C and 125°C	02/25/91
2) 5 krads irradiation @ 250 rads/hr Post 5 krads Electrical Measurements	03/05/91 03/06/91
3) 10 krads irradiation @ 210 rads/hr Post 10 Krads Electrical Measurements	03/06/91 03/07/91
4) 20 krads irradiation @ 500 rads/hr Post 20 krads Electrical Measurements	03/08/91 03/09/91
5) 30 krads irradiation @ 500 rads/hr Post 30 krads Electrical Measurements	03/09/91 03/10/91
6) 50 krads irradiation @ 1000 rads/hr Post 50 krads Electrical Measurements	03/10/91 03/11/91
7) 75 krads irradiation @ 1250 rads/hr Post 75 krads Electrical Measurements	03/11/91 03/12/91
8) 100 krads irradiation @ 1250 rads/hr Post 100 krads Electrical Measurements	03/12/91 03/13/91
9) 4 hrs annealing Post 4 hr Electrical Measurements	03/13/91 03/13/91
10) 24 hrs annealing Post 24 hr Electrical Measurements	03/13/91 03/14/91
11) 168 hrs annealing Post 168 hr Electrical Measurements	03/13/91 03/21/91
12) 672 hrs annealing Post 672 hr Electrical Measurements	03/13/91 04/10/91

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, unless otherwise noted.
- 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) at -55°C, +25°C, +125°C (Lot 1 and Lot 2)	07/17/91
2) 100 krads irradiation @ 10 krads/hour Post 100 krad EM at +25°C (Lot 1 and Lot 2)	08/12/91 08/12/91
3) 4 Hours Annealing ^{1/} Post 4 Hour Annealing EM at +25°C (Lot 1 only)	08/12/91 08/12/91
4) 24 Hours Annealing ^{1/} Post 24 Hours Annealing EM at +25°C (Lot 1 only)	08/12/91 08/13/91
5) 168 Hours Annealing ^{2/} Post 168 Hours Annealing EM at +25°C, -55°C and +125°C (Lot 1 and Lot 2)	08/12/91 08/19-27/91

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 168 hours.

2/ Lot 1 and Lot 2 were tested at +25°C after 168 hours of annealing, but measurements at -55°C and +125°C were performed at a later time due to equipment problems.

- All parts were radiated under bias at the cobalt-60 gamma ray facility at GSFC.

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

Table III. Electrical Characteristics of HA2620

TEST	SYMBOL	CONDITIONS $V_{CC} \geq \pm 15V$ unless otherwise stated	LIMITS ($T_A=25^\circ C$)		LIMITS ($T_A=-55^\circ C$ to $125^\circ C$)		UNITS
			Min	Max	Min	Max	
Input Offset Voltage	V_{IO}	$R_S=100$	-4.0	4.0	-6.0	6.0	mV
Input Offset Current	I_{IO}		-15	15	-30	30	nA
Input Bias Current	$+I_B$		-15	15	-30	30	nA
	$-I_B$		-15	15	-30	30	nA
Power Supply Rejection Ratio	$+PSRR$	$+V_{CC}=10V, 20V$	80	--	80	--	dB
	$-PSRR$	$-V_{CC}=-10V, -20V$	80	--	80	--	dB
Input Voltage Common Mode Rejection Ratio	CMRR	$+V_{CC}=5V, 25V$ $-V_{CC}=-5V, -25V$	80	--	80	--	dB
Supply Current	I_{CC}	$\pm V_{CC}=\pm 15.0V$	--	3.7	--	4.0	mA
Output Voltage Swing	$+V_{OP}$	$R_L = 2K$	10.0	--	10.0	--	V
	$-V_{OP}$	$R_L = 2K$	--	-10.0	--	-10.0	V
Open Loop Voltage Gain	$+A_{VS}$ and $-A_{VS}$	$V_{out}=\pm 10V, 0V;$ $R_L = 2K$	100	--	70	--	V/mV

TABLE IV: Summary of Electrical Measurements at 25°C
after Total Dose Exposures and Annealing for HA2620, Test Group 1 1/

Parameters	Units	Spec. Limits		Pre-Rad	Total Dose Exposure (krads)														
					5		10		20		30		50		75		100		
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
+ICC	mA	3.7		3.5	0.0	3.4	0.1	3.4	0.1	3.4	0.1	3.3	0.1	3.3	0.1	3.2	0.1	3.2	0.1
-ICC	mA	3.7		3.5	0.0	3.4	0.1	3.4	0.1	3.4	0.1	3.3	0.1	3.3	0.1	3.2	0.1	3.2	0.1
VOS@50	mV	4		0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.4	0.3	0.4	0.4
IOS	nA	15		1.1	0.9	1.4	0.6	3.6	1.4	5.2	1.6	4.3	3.0	11.5	18.1	27.3	16.3	16.3	15.6
IB+	nA	15		0.6	0.3	0.5	0.6	3.0	1.1	4.9	1.3	4.4	2.3	18.3	27.3	23.9	22.0	12.5	18.4
IB-	nA	15		1.5	1.2	1.2	0.9	1.1	0.5	1.1	0.4	1.5	0.6	7.3	9.2	7.0	3.8	8.2	4.8
IBIAS	nA	15		1.0	0.7	0.8	0.4	1.3	0.8	2.3	0.9	2.3	1.2	12.9	18.3	10.1	14.1	7.3	9.0
VOSRs	mV	4		0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.4	0.3	0.4	0.4
AOL	kV/V	100		316	22	235	19	197	18	147	14	123	13	97	10	84	7	78	7
CMRR	dB	80		106	6	106	6	106	6	106	5	106	5	105	6	105	6	106	5
+PSRR	dB	80		109	7	110	7	108	5	107	5	107	5	106	4	106	4	104	4
-PSRR	dB	80		104	2	105	3	105	3	108	4	111	5	119	13	118	8	116	6
+VO	V	10		12.5	0.0	12.5	0.0	12.6	0.0	12.5	0.0	12.5	0.0	12.5	0.0	12.5	0.0	12.5	0.0
-VO	V	10		13.3	0.0	13.3	0.0	13.2	0.0	13.3	0.0	13.3	0.0	13.3	0.0	13.3	0.0	13.3	0.1

<Table IV continued on next page>

Table IV. (continued)

Parameters	Spec. Limits min max	Annealing (hours) at 25°C											
		Pre-Rad		4		24		168		672			
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd		
+ICC	mA	3.7	3.5	0.0	3.2	0.1	3.2	0.1	3.3	0.1	3.3	0.1	
-ICC	mA	3.7	3.5	0.0	3.2	0.1	3.2	0.1	3.3	0.1	3.3	0.1	
VOS@50	mV	4	0.3	0.2	0.4	0.3	0.4	0.3	0.4	0.3	0.3	0.3	
IOS	nA	15	1.1	0.9	14.0	14.7	9.2	12.5	5.7	8.3	5.6	5.8	
IB+	nA	15	0.6	0.3	9.1	16.7	8.6	12.7	8.6	6.9	7.3	4.4	
IB-	nA	15	1.5	1.2	7.7	4.3	5.6	3.7	3.4	2.5	2.3	1.9	
IBIAS	nA	15	1.0	0.7	7.1	8.3	6.7	5.9	5.8	3.0	4.6	2.2	
VOSRs	mV	4	0.3	0.2	0.4	0.3	0.4	0.3	0.4	0.3	0.3	0.3	
AOL	kV/V	100	316	22	81	7	87	7	99	8	110	9	
CMRR	dB	80	106	6	106	5	106	6	106	5	106	5	
+PSRR	dB	80	109	7	106	4	106	4	106	5	107	5	
-PSRR	dB	80	104	2	116	4	118	8	117	8	114	9	
+VO	V	10	12.5	0.0	12.5	0.0	12.5	0.0	12.5	0.0	12.5	0.1	
-VO	V	10	13.3	0.0	13.3	0.0	13.3	0.1	13.3	0.0	13.3	0.1	

Note:

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.

TABLE V: Summary of Electrical Measurements at 25°C
after Total Dose Exposures and Annealing for HA2620, Test Group 2 1/, 2/

Parameters	Spec. Limits min max	Pre-Irradiation		Total Dose (krads)				Annealing @ 100°C										
		Lot 1		Lot 2		100 Lot 1		100 Lot 2		4 hrs Lot 1		24 hrs Lot 1		168 hrs Lot 1		168 hrs Lot 2		
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
+ICC	mA	3.7	3.4	0.1	3.5	0.1	3.2	0.1	3.3	0.2	3.3	0.1	3.4	0.1	3.4	0.1	3.4	0.1
-ICC	mA	3.7	3.4	0.1	3.5	0.1	3.2	0.1	3.3	0.1	3.3	0.1	3.4	0.1	3.4	0.1	3.4	0.1
VOS@50	mV	4	0.6	0.4	0.4	0.4	0.7	0.4	0.5	0.4	0.5	0.4	0.5	0.4	0.5	0.4	0.4	0.4
IOS	nA	15	4.6	2.4	4.0	1.0	5.8	3.0	10.9	7.1	4.9	2.1	3.6	1.9	3.5	1.8	4.2	2.6
IB+	nA	15	4.0	2.5	3.4	1.6	15.6	2.2	19.5	3.0	7.5	0.9	5.5	0.6	4.4	0.6	5.2	1.5
IB-	nA	15	0.8	0.7	0.6	2.0	8.8	2.6	8.5	4.6	2.6	1.4	1.9	1.5	.9	1.3	1.1	2.1
IBIAS	nA	15	1.8	1.1	1.4	1.8	12.2	1.9	14.0	1.6	5.1	0.6	3.7	0.6	2.7	0.4	3.1	1.2
VOSRs	mV	4	0.5	0.4	0.4	0.4	0.7	0.4	0.5	0.4	0.5	0.4	0.5	0.4	0.5	0.4	0.4	0.4
AOL	kV/V	100	308	44	317	33	86	14	89	14	130	20	157	25	192	31	201	26
CMRR	dB	80	107	2	111	10	108	21	112	11	107	2	107	2	107	2	113	11
+PSRR	dB	80	109	5	114	12	106	2	109	6	108	4	108	4	109	4	112	11
-PSRR	dB	80	105	1	107	4	122	12	114	8	117	8	112	4	109	3	112	6
+VO	V	10	12.6	.02	12.5	.04	12.5	.02	12.5	.03	12.5	.03	12.5	.02	12.5	.03	12.5	.02
-VO	V	10	13.3	.02	13.2	.06	13.3	.04	13.3	.04	13.3	.02	13.3	.03	13.3	.02	13.2	.05

Notes:

1/ The mean and standard deviation values were calculated over the five parts (separated by lot) irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

2/ SNs 164, 191, 194, 254 and 264 comprised Lot 1. SNs 302, 315, 319, 359, and 395 comprised Lot 2. See Table IIB for further details on radiation and annealing steps.

TABLE VI: Summary of Initial and Final Electrical Measurements
at Low and High Temperatures for HA2620, Test Group 2 1/, 2/

Parameters	Spec. Limits @ -55°C & +125°C min max	Pre-Irradiation								168 Hours Annealing at 100°C								
		-55°C lot 1		-55°C lot 2		+125°C lot 1		+125°C lot 2		-55°C lot 1		-55°C lot 2		+125°C lot 1		+125°C lot 2		
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
+ICC	mA	4	2.9	0.1	3.0	0.1	3.7	0.1	3.7	0.1	2.8	0.1	3.0	0.3	3.6	0.1	3.5	0.4
-ICC	mA	4	2.9	0.1	2.9	0.1	3.7	0.1	3.7	0.1	2.8	0.1	3.0	0.3	3.6	0.1	3.5	0.4
VOS@50	mV	6	0.4	0.4	0.4	0.6	0.6	0.5	0.4	0.4	0.4	0.4	0.2	0.3	0.6	0.5	0.4	0.4
IOS	nA	30	5.3	7.7	2.7	11	7.0	3.6	8.1	4.2	1.8	5.7	4.3	7.8	4.2	1.1	3.3	1.3
IB+	nA	30	11.3	4.8	6.6	6.3	4.8	2.5	6.3	2.7	8.0	4.1	10	5.2	4.6	0.4	5.2	0.5
IB-	nA	30	6.0	12.0	3.9	7.9	2.2	2.0	1.8	2.0	6.1	4.3	5.8	6.8	0.4	0.9	1.9	1.8
IBIAS	nA	30	8.6	8.0	5.3	4.5	1.3	1.3	2.2	1.0	7.0	3.1	7.9	4.6	2.5	0.4	3.5	1.1
VOSRs	mV	6	0.4	0.4	0.4	0.6	0.6	0.5	0.4	0.4	0.4	0.4	0.5	0.6	0.6	0.5	0.4	0.4
AOL	kV/V	70	231	51	247	40	327	34	352	35	168	36	351	364	*		*	
CMRR	dB	80	114	4	112	10	101	2	105	9	114	3	110	13	102	2	107	7
+PSRR	dB	80	113	9	113	7	108	6	112	10	112	9	113	7	107	5	110	12
-PSRR	dB	80	123	11	117	4	100	1	102	3	135	30	117	9	102	1	109	11
+VO	V	10	12.2	.03	12.2	.03	13.0	.02	13.0	.02	12.2	.02	12.3	.04	13.0	.01	12.8	.35
-VO	V	10	13.4	.03	13.4	.04	13.1	.03	13.1	.08	13.4	.02	13.3	.13	13.0	.03	13.1	.20

Notes:

1/ The mean and standard deviation values were calculated over the five parts (separated by lot) irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.
2/ SNs 164, 191, 194, 254 and 264 comprised Lot 1. SNs 302, 315, 319, 359, and 395 comprised Lot 2.

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

Figure 1. Radiation Bias Circuit for HA2620

