Government Systems Group

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DATE: July 3, 1995
TO: J. Lohr/311
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on: SE5521
Project: CASSINI/CIRS
Control #: 11824
Job #: EE56097
Project part #: 5962-9087901MVH

PPM-95-162

cc: B. Posey/300.1
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A radiation evaluation was performed on SE5521 (Linear LVDT Signal Conditioner) 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 Co^{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 levels were 5, 10, 20, 30, 50, 75 and 100 krads*. The dose rate was between 0.29 and 1.52 krads/hour (see Table II for radiation schedule). After the 100 krad exposure, parts were annealed at 25°C for 168 hours, after which the parts were annealed at 100°C for 168 hours. After each radiation exposure and anncaling step, parts were electrically tested according to the test conditions and the specification limits** listed in Table III.

During initial (pre-rad) measurements, S/N 53 and 58 (control samples) fell below the minimum specification limit of -50.00 nA for IIOS_0V, with readings of -54.44 and -50.32 nA, respectively. All other parts passed all initial electrical tests.

After the 5 krad irradiation, all irradiated parts fell below the minimum specification limit for IIOS_0V, with readings ranging from -142.2 to -50.28 nA. In addition, S/N 56 exceeded the maximum specification limit of 2.525 V for VREF/2 @ 5V, with a reading of 2.531 V. All other irradiated parts passed all electrical tests at this level.

After the 10 krad irradiation, the same degradation was seen in IIOS_0V, with readings ranging from -273.0 to -50.33 nA. All iradiated parts exceeded the maximum specification limit for VREF/2 @ 5V, with readings ranging from 2.527 to 2.537 V. S/N 50, 51, 54, 55, 56, 57 and 59 also fell below the minimum specification limit of -500.0 nA for P_IIB_0V, with readings ranging from -604.3 to -553.0 nA.

After the 20 krad irradiation, the same degradation was seen in IIOS_0V, with readings ranging from -511.5 to -50.07 nA. All irradiated parts continued to exceed the maximum specification limit for VREF/2 @ 5V, with readings ranging from 2.540 to 2.552 V. The same parts fell below the minimum specification limit for P_IIB_0V, with readings ranging from -1132 to -113.0 nA. In addition, all irradiated parts fell below the minimum specification limit of -500.0 nA for N_IIB_0V and I DEMOD, with readings ranging from -620.7 to -521.8 and -820.5 to -690.6 nA, respectively.

After the 30 krad irradiation, the same degradation was seen in all the above parameters, with slightly increasing values.

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* The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.
** These are manufacturer's pre-irradiation data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

After the 50 krad irradiation, the same degradation was seen in all the above parameters, with slightly increasing values. In addition, all irradiated parts exceeded the maximum specification limit of 5.050 V for VREF/2 @ 10V, with readings ranging from 5.055 to 5.087 V, and fell below the minimum specification limit of 100.0 V/mV for +AOL and -AOL, with readings ranging from 54.6 to 83.4 and 55.6 to 87.4 V/mV, respectively.

After the 75 krad irradiation, the same degradation was seen in all the above parameters, with slightly increasing values.

After the 100 krad irradiation, the same degradation was seen in all the above parameters, with increasing values, for the same parts. All irradiated parts fell below the minimum specification limit of -500.0 nA for I LVDT, with readings ranging from --608.1 to -524.7 nA. In addition, S/N 55 exceeded the maximum specification limit of 5.000% for P_OSC THD and P_OSC THD 300, with readings of 5.343 and 5.333%, respectively.

After annealing for 168 hours at 25°C, all irradiated parts read within specification limits for I LVDT, P_OSC THD and P_OSC THD 300. No other recovery was observed.

After annealing for 168 hours at 100°C, no rebound effects were observed.

Table IV provides a summary of the mean and standard deviation values for each parameter after each irradiation exposure and annealing step.

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

Figure 1. Radiation Bias Circuit for SE5521

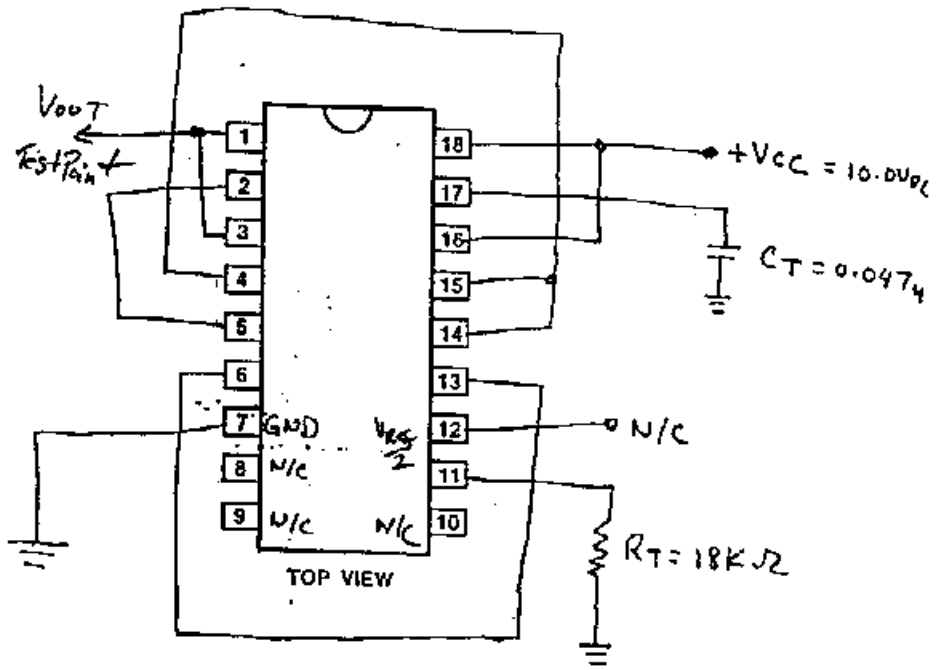

TABLE I. Part Information

Generic Part Number:	SE5521*
CASSINI/CIRS Part Number	5962-9087901MVH
CASSINI/CIRS Control Number:	11824
Charge Number:	EE56097
Manufacturer:	Signetics
Lot Date Code (LDC):	9346
Quantity Tested:	10
Serial Number of Control Samples:	53, 58
Serial Numbers of Radiation Samples:	50, 51, 52, 54, 55, 56, 57, 59
Part Function:	Linear LVDT Signal Conditioner
Part Technology:	Bipolar
Package Style:	18-pin DIP
Test Equipment:	A540
Engineer:	T. Mondy

* No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

TABLE II. Radiation Schedule for SE5521

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	06/06/95
2) 5 KRAD IRRADIATION (0.30 KRADS/HOUR)	06/06/95
POST-5 KRAD ELECTRICAL MEASUREMENT	06/07/95
3) 10 KRAD IRRADIATION (0.29 KRADS/HOUR)	06/07/95
POST-10 KRAD ELECTRICAL MEASUREMENT	06/08/95
4) 20 KRAD IRRADIATION (0.61 KRADS/HOUR)	06/08/95
POST-20 KRAD ELECTRICAL MEASUREMENT	06/09/95
5) 30 KRAD IRRADIATION (0.16 KRADS/HOUR)	06/09/95
POST-30 KRAD ELECTRICAL MEASUREMENT	06/12/95
6) 50 KRAD IRRADIATION (1.21 KRADS/HOUR)	06/12/95
POST-50 KRAD ELECTRICAL MEASUREMENT	06/13/95
7) 75 KRAD IRRADIATION (1.56 KRADS/HOUR)	06/13/95
POST-75 KRAD ELECTRICAL MEASUREMENT	06/14/95
8) 100 KRAD IRRADIATION (1.52 KRADS/HOUR)	06/14/95
POST-100 KRAD ELECTRICAL MEASUREMENT	06/15/95
9) 168-HOUR ANNEALING @ 25°C	06/15/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	06/22/95
10) 168-HOUR ANNEALING @ 100°C	06/22/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	06/29/95

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS; SEE FIGURE 1.

Table III. Electrical Characteristics of SE5521

Unless Otherwise Specified: T_A =25°C, +Vcc = 10.0V, -Vcc= 0.0, V_{REF} =10.0V, RT = 18KΩ , CT = 0.047uF

TEST NAME	SYMBOL	CONDITIONS	LIMITS	
			MIN	MAX
REFERENCE SECTION				
Plus Icc	I_T			18.0mA
IREF	I_{REF}			8.00mA
VREF/2 @ 10V	V_{R2}	V_{REF} = 10.0V	4.950V	5.050V
VREF/2 @ 5V	V_{R2}	V_{REF} = 5.0V	2.475V	2.525V
AUXILIARY AMPLIFIER SECTION				
V_{OS} @ 0V	V_{IO}	-Vcc= -10.0V, V_{OUT} = 0V *(SEE NOTE : 1)*	-5.0mV	5.0mV
V_{OS} @ 5V	V_{IO}	-Vcc= -10.0V, V_{OUT} = 5.0V *(SEE NOTE : 1)*	-5.0mV	5.0mV
P IIB @ 0V	$+I_{IB}$	-Vcc= -10.0V, V_{OUT} = 0V *(SEE NOTE : 1)*	-500.0nA	500.0nA
N IIB @ 0V	$-I_{IB}$	-Vcc= -10.0V, V_{OUT} = 0V *(SEE NOTE : 1)*	-500.0nA	500.0nA
I_DEMOD	I_{IB}	-Vcc= -10.0V, V_{OUT} = 0V *(SEE NOTE : 1)*	-500.0nA	500.0nA
I_LVDT	I_{IB}	-Vcc= -10.0V, V_{OUT} = 0V *(SEE NOTE : 1)*	-500.0nA	500.0nA
IIOS @ 0V	I_{IO}	-Vcc= -10.0V, V_{OUT} = 0V *(SEE NOTE : 1)*	-50.0nA	50.0nA
+VOUT_SWING	Vo	-Vcc= -10.0V, R_L = 10KΩ *(SEE NOTE: 2)*	7.00V	
-VOUT_SWING	Vo	-Vcc= -10.0V, R_L = 10KΩ *(SEE NOTE: 2)*		-7.00V
+AOL V/mV	A_V	-Vcc= -10.0V, R_L = 10KΩ *(SEE NOTE: 2)*	100V/mV	
-AOL V/mV	A_V	-Vcc= -10.0V, R_L = 10KΩ *(SEE NOTE: 2)*	100V/mV	
Plus ISC		-Vcc= -10.0V *(SEE NOTE: 2)*		100mA
MINUS ISC		-Vcc= -10.0V *(SEE NOTE: 2)*	-100mA	
DEMODULATOR SECTION				
P OSC THD		*(SEE NOTE: 3)*		5.0%
N OSC THD		*(SEE NOTE: 3)*		5.0%
P OSC THD 300	R_L			5.0%
N OSC THD 300	R_L			5.0%
DEMOD Lin	ΔL	V_{in} = 5Vpk-pk @ 1KHz		0.1 %FS

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for SE5521 /1

Test #	Parameters	Units	Spec. Lim./2 min	Spec. Lim./2 max	Initial mean	Initial sd	Total Dose Exposure (krads) 5 mean	5 sd	10 mean	10 sd	20 mean	20 sd	30 mean	30 sd	50 mean	50 sd	75 mean	75 sd	100 mean	100 sd	Annealing 168 hrs@25°C mean	168 hrs@25°C sd	168 hrs@100°C mean	168 hrs@100°C sd
1	Plus_Icc	mA	0	18.000	8.65	.39	8.38	.39	8.15	.39	7.75	.37	7.74	.39	6.76	.33	7.01	.33	6.92	.32	7.32	.34	8.07	.38
2	IREF	mA	0	8.000	5.51	.03	5.51	.02	5.52	.03	5.54	.02	5.54	.02	5.61	.03	5.52	.03	5.51	.02	5.47	.03	5.34	.20
3	VREF/2 @ 10V	V	4.950	5.050	5.01	.01	5.08	.18	5.03	.01	5.04	.01	5.04	.01	5.07	.01	5.07	.01	5.07	.01	5.06	.02	5.02	.01
4	VREF/2 @ 5V	V	2.475	2.525	2.51	0	2.52	.01	2.53	0	2.55	0	2.55	0	2.58	0	2.58	0	2.58	.01	2.57	.01	2.52	.01
5	VOS @ 0V	mV	-5.00	5.00	0.11	.34	0.20	.36	0.29	.37	0.48	.39	0.52	.38	1.25	.46	1.10	.42	1.26	.44	0.82	.37	0.32	.34
6	VOS @ 5V	mV	-5.00	5.00	0.11	.34	0.19	.36	0.28	.37	0.46	.38	0.50	.38	1.20	.46	1.05	.42	1.21	.43	0.78	.37	0.31	.33
7	P_IIB_0V	nA	-500.0	500.0	-96.5	6.0	-301	13	-561	32	-1062	61	-1000	71	-1000	.06	-2000	106	-2000	119	-1000	17	-392	44
8	N_IIB_0V	nA	-500.0	500.0	-41.3	37	-166	7.2	-308	18	-582	34	-600	39	-800	.13	-1000	58	-1000	65	-800	9.9	-223	27
9	I DEMOD	nA	-500.0	500.0	-69.9	4.2	-218	9.2	-406	23	-770	44	-800	51	-1000	.02	-1000	77	-2000	86	-1000	11	-284	32
10	I LVDT	nA	-500.0	500.0	-25.8	1.5	-80.0	3.3	-149	8.4	-282	16	-300	19	-400	.02	-500	28	-600	31	-400	4.1	-104	12
11	IIOS_0V	nA	-50.00	50.00	-42.8	2.5	-136	5.7	-253	14	-480	27	-500	32	-600	.09	-900	48	-1000	54	-600	6.9	-177	20
12	+VOUT_SWING	V	7.00	-	9.21	.01	9.21	.01	9.21	.01	9.20	0	9.20	0	9.20	0	9.20	0	9.20	0	9.20	0	9.21	0
13	-VOUT_SWING	V	-	-7.00	-9.22	.01	-9.21	.01	-9.19	.01	-9.18	.01	-9.17	.01	-9.16	.01	-9.15	.01	-9.13	.02	-9.13	.03	-9.18	.02
14	+AOL	V/mV	100.0	-	441	21	647	76	9955	18567	531	151	465	159	69.2	10	74.1	12	59.2	6.6	114	19	8435	13677
15	-AOL	V/mV	100.0	-	372	19	524	49	1514	769	597	196	436	101	72.1	10	71.4	11	55.3	8.4	111	18	2627	1426
16	Plus_ISC	mA	-100.0	-	-38.7	1.5	-36.6	1.5	-34.3	1.4	-30.0	1.4	-29.7	1.5	-20.9	1.2	-21.7	1.4	-20.3	1.3	-24.3	1.4	-34.0	1.5
17	MINUS_ISC	mA	-	100.0	35.6	1.6	35.0	1.5	35.0	1.5	35.6	1.4	35.8	1.5	35.8	1.5	35.3	1.4	35.3	1.5	36.5	1.5	35.3	1.4
18	P_OSC THD	%	-	5.000	2.05	.35	2.21	.37	2.42	.36	2.84	.42	2.87	.42	4.27	.39	4.00	.42	4.35	.55	3.34	.37	10.0	4.5
19	N_OSC THD	%	-	5.000	1.91	.33	2.03	.37	2.23	.38	2.63	.39	2.64	.40	3.97	.38	3.74	.44	4.09	.52	3.12	.38	9.33	4.7
20	P_OSC THD 300	%	-	5.000	2.06	.36	2.21	.37	2.40	.37	2.85	.39	2.85	.43	4.25	.38	4.00	.42	4.37	.54	3.35	.38	9.33	4.0
21	N_OSC THD 300	%	-	5.000	1.91	.33	2.04	.34	2.21	.37	2.59	.39	2.61	.40	3.96	.39	3.71	.42	4.05	.51	3.05	.37	8.99	4.7
22	DEMOD Linearity	%	-	0.100	0.07	.02	0.05	.03	-0.01	.03	-0.07	.03	-0.06	.03	0.14	.02	0.01	.02	0.04	.03	-0.02	.03	0.09	.03

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/ These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

Radiation-sensitive parameters: IIOS_0V, VREF/2 @ 5V, P_IIB_0V, N_IIB_0V, I DEMOD, VREF/2 @ 10V, +AOL, -AOL, I LVDT, P_OSC THD and P_OSC THD 300.