Government Systems Group

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DATE: June 21, 1995 PPM-95-158
TO: J. Lohr/311
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on: LP2951
Project: CASSINI/CIRS
Control #: 13087
Job #: EE56385
Project part #: LP2951

cc: B. Posey/300.1
A. Sharma/311
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A radiation evaluation was performed on LP2951 (Programmable Voltage Regulator) 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 ^{60}Co gamma ray source. During the radiation testing, eight parts were irradiated under bias (see Figure 1 for bias configuration) and one part was used as a control sample. This part is a programmable voltage regulator and is capable of a wide range of operation up to 16 V output. These parts were tested with a 5 V output in this case (see Figure 1 and Table III). A subsequent radiation test will be done at a higher output voltage. The total dose radiation levels were 2.5, 5, 10, 15, 20, 30 and 80 krads*. The dose rate was between 0.04 and 2.94 krads/hour (see Table II for radiation schedule). After each radiation exposure, parts were electrically tested according to the test conditions and the specification limits** listed in Table III.

All parts passed initial electrical measurements.

All parts passed all electrical tests throughout all irradiation steps up to and including the 2.5 krad irradiation level.

After the 5 krad irradiation, S/N marginally fell below the minimum specification limit of 4.975 V for Vout_1, with a reading of 4.973 V. All other irradiated parts continued to pass all electrical tests at this irradiation level.

At the 10 krad level, S/N 6, 7, 8, 9, 10 and 13 fell below the minimum specification limit for Vout_1, with readings ranging from 4.953 to 4.975 V. All other irradiated parts continued to pass all electrical tests at this irradiation level.

At the 15 krad level, all irradiated parts fell below the minimum specification limit for Vout_1, with readings ranging from 4.913 to 4.939 V. In addition, S/N 6, 10 and 11 fell below the minimum specification limit of -5.00 mV for V_LOAD, with readings ranging from -5.77 to -5.27 mV, and S/N 6, 10 and 13 exceeded the maximum specification limit of 12.00 mA for I_6V_1, with readings ranging from 12.21 to 12.87 mA. All other irradiated parts continued to pass all electrical tests at this irradiation level. At this level, S/N 10 and 13 became nonfunctional and were removed from further testing.

At the 20 krad level, all irradiated parts exceeded specification limits for Vout_1, V_LOAD and I_6V_1, with readings ranging from 4.859 to 4.874 V, -12.49 to -10.06 mV and 13.18 to 13.57mA, respectively. In addition, all irradiated parts exceeded the maximum specification limit of 250.0 mV for V_OL, with readings ranging from 6549 to 30002 mV, and S/N 6, 7, 8, 9 and 12 fell below the minimum specification limit of 1.220 V for Vref, with readings ranging from 1.214 to 1.219 V.

* 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.

At the 30 krad level, the same degradation was observed, with approximately the same values.

After the 80 krad irradiation, all irradiated parts became nonfunctional and no valid readings could be obtained for any electrical tests.

Table IV provides a summary of the functional test results and the mean and standard deviation values for each parameter for both biased and unbiased parts 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 LP2951

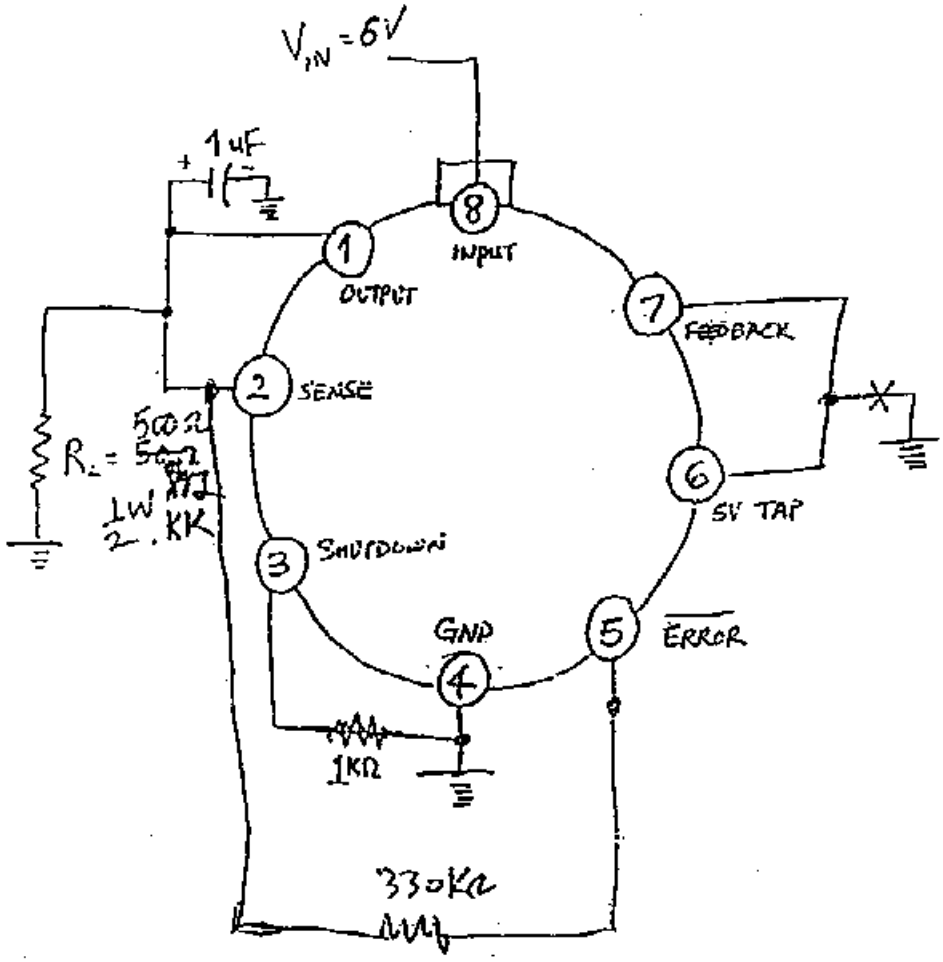

TABLE I. Part Information

Generic Part Number:	LP2951*
CASSINI/CIRS Part Number	LP2951
CASSINI/CIRS Control Number:	13087
Charge Number:	EE56385
Manufacturer:	NSI
Lot Date Code (LDC):	9133B
Quantity Tested:	9
Serial Number of Control Sample:	14
Serial Numbers of Radiation Samples:	6, 7, 8, 9, 10, 11, 12, 13**
Part Function:	Programmable Voltage Regulator
Part Technology:	HSCMOS
Package Style:	8-pin Tox can
Test Equipment:	A540
Engineer:	C. Nguyen

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

** S/N 10 and 13 became nonfunctional and were removed from testing after the 15 krad irradiation.

TABLE II. Radiation Schedule for LP2951

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	06/05/95
2) 2.5 KRAD IRRADIATION (0.15 KRADS/HOUR)	06/05/95
POST-2.5 KRAD ELECTRICAL MEASUREMENT	06/06/95
3) 5.0 KRAD IRRADIATION (0.03 KRADS/HOUR)	06/06/95
POST-5.0 KRAD ELECTRICAL MEASUREMENT	06/07/95
4) 10.0 KRAD IRRADIATION (0.06 KRADS/HOUR)	06/08/95
POST-10.0 KRAD ELECTRICAL MEASUREMENT	06/09/95
5) 15.0 KRAD IRRADIATION (0.06 KRADS/HOUR)	06/09/95
POST-15.0 KRAD ELECTRICAL MEASUREMENT	06/12/95
6) 20 KRAD IRRADIATION (0.30 KRADS/HOUR)	06/12/95
POST-20 KRAD ELECTRICAL MEASUREMENT	06/13/95
7) 30 KRAD IRRADIATION (0.29 KRADS/HOUR)	06/13/95
POST-30 KRAD ELECTRICAL MEASUREMENT	06/14/95
8)80 KRAD IRRADIATION (2.94 KRADS/HOUR)	06/14/95
POST-80 KRAD ELECTRICAL MEASUREMENT	06/15/95
9) 168-HOUR ANNEALING @ 25°C	06/15/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	06/22/95

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

Table III. Electrical Characteristics of LP2951

Unless Otherwise Specified: Vcc = 6.0V, Vout = 5.0V, I_L = 100uA, V_{SD} = 0.6V, T_A = 25·
Note: The 5.0 V output is obtained by straping the feedback pin to the 5V-Tap and Vout to the Sense pin.

TEST NAME	SYMBOL	CONDITIONS	LIMITS	
			MIN	MAX
Out put Voltage	Vout_1		4.975 V	5.025 V
Line Regulation	V_LINE	6V ≤ Vcc ≤ 30V, I_L = 1mA	-5.0 mV	5.0 mV
Load Regulation	V_LOAD	100uA ≤ I_L ≤ 100mA	-5.0 mV	5.0 mV
Dropout Voltage	V_DO_1	I_L = 100mA, delta Vout = 100mV		450 mV
Dropout Voltage	V_DO_2	I_L = 100uA, delta Vout = 100mV		80 mV
GroundCurrent	I_6V_1	I_L = 100mA	0mA	12 mA
GroundCurrent	I_6V_2		0uA	120 uA
GroundCurrent	I_30V_1	Vcc = 30V, Vout = 15V	0uA	120 uA
GroundCurrent	I_30V_2	Vcc = 30V, Vout = 15V, I_L = 100mA	0mA	15 mA
delta I_GND	I_GDIFF	6V ≤ Vcc ≤ 30V	-30 uA	30 uA
DropoutCurrent	I_GDO	Vcc = 4.5V	0uA	170 uA
V_Reference	Vref	Vout = Vref	1.220 V	1.250 V
Ref Line Reg.	V_RLn	2.3V ≤ Vcc ≤ 30V	-1.9 mV	1.9 mV
Ref Load Reg.	V_RLd	1.2V ≤ Vout ≤ 29V, Vcc = 30V	-1.2 mV	1.2 mV
Error Output	I_OH	V_{ERROR} = 30V	0uA	1.0 uA
Error Output	V_OL	I_{ERROR} = 400uA, Vcc = 4.5V	0mV	250 mV
Shutdown Input	I_SD1	V_{ERROR} = 30V, $V_{SHUTDOWN}$ = 2.4V	0uA	50 uA
Shutdown Input	I_SD2	V_{ERROR} = 30V, $V_{SHUTDOWN}$ = 30V	0uA	600 uA
Output Leakage	I_LKG	$V_{SHUTDOWN}$ = 2V, Vcc = 30V, Vout = 0V	-10uA	10 uA
Comparator Threashold	VLT	V_ERROR < 0.8V	40.0mV	95.0mV
Comparator Threashold	VUT	V_ERROR > 2.0V	40.0mV	95.0mV
I-SHORT CURCUIT	ISC	V_ERROR < 0.8V		200mA

Note: Comparator Threshold tests are performed with Vout = Vref and incrementally loading the output until the ERROR FLAG toggles to the appropriate logic state. The Threshold voltage is calculated as (Vref - Vout) were Vref is the value of Vout with Iout=100uA.

The Short Circuit Current is measured at the VLT threshold.

Exceptions: The Feedback Current Test and the Reference Thermal Regulation Test are not performed.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for LP2951 /1

Test			Spec. Lim./2		Total Dose Exposure (krads)																Annealing	
					Initial		2.5		5		10		15		20 /3		30		80 /4		168 hrs@25°C	
#	Parameters	Units	min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	Vout_1	V	4.975	5.025	5.01	.01	4.99	.01	4.99	.01	4.97	.01	4.93	.01	4.87	.01	4.87	.01	F		F	
2	V_LINE	mV	-5	5	2.26	.15	2.28	.20	2.24	.15	2.19	.24	2.28	.26	2.04	.27	2.24	.27	F		F	
3	V_LOAD	mV	-5	5	-0.54	.44	-0.58	.46	-0.70	.51	-1.61	.45	-4.96	.59	-11.1	.87	-11.4	.87	F		F	
4	V_DO_1	mV	-	450	429	2.6	426	3.1	421	2.2	410	3.6	412	3.6	426	.79	425	1.4	F		F	
5	V_DO_2	mV	-	80	52.4	.48	53.5	2.0	54.6	2.1	56.5	1.7	60.1	1.6	63.2	.55	63.6	.69	F		F	
6	I_6V_1	mA	0	12	8.76	.12	9.26	.45	9.71	.46	10.7	.47	12.1	.48	13.5	.17	13.5	.17	F		F	
7	I_6V_2	µA	0	120	88.0	2.0	83.0	7.0	81.0	7.0	77.0	7.0	72.0	6.0	69.0	1.0	69.0	1.0	F		F	
8	I_30V_1	mA	0	0.12	0.07	0	0.06	.01	0.06	.01	0.06	.01	0.06	0	0.05	0	0.05	0	F		F	
9	I_30V_2	mA	0	10	5.97	.11	6.39	.41	6.75	.43	7.55	.44	8.67	.46	9.65	.17	9.67	.17	F		F	
10	I_GDIF	µA	-30	30	3.00	.74	2.00	1.0	3.00	.79	2.00	1.0	2.00	1.0	3.00	2.0	3.00	2.0	F		F	
11	I_GDO	µA	0	170	61.0	2.0	55.0	9.0	52.0	9.0	47.0	8.0	42.0	7.0	38.0	1.0	38.0	1.0	F		F	
12	Vref	V	1.22	1.25	1.23	0	1.23	0	1.23	0	1.23	0	1.23	0	1.22	0	1.22	0	F		F	
13	V_RLn	mV	-1.9	1.9	0.61	.03	0.62	.03	0.63	.03	0.68	.03	0.79	.08	1.01	.04	1.03	.05	F		F	
14	V_RLd	mV	-1.2	1.2	-0.02	.03	-0.03	.02	-0.06	.03	-0.07	.03	-0.06	.03	-0.07	.03	-0.08	.04	F		F	
15	I_OH	µA	0	1	0.01	0	0.01	0	0.02	0	0.01	0	0.02	0	0.02	0	0.02	0	F		F	
16	V_OL	mV	0	250	161	3.0	165	6.2	169	6.1	181	6.6	216	19	22548	8826	23833	7771	F		F	
17	I_SD1	µA	0	50	29.0	.73	28.0	3.0	27.0	3.0	27.0	3.0	26.0	3.0	27.0	.63	26.0	.63	F		F	
18	I_SD2	mA	0	0.6	0.40	.01	0.37	.04	0.37	.04	0.36	.04	0.35	.04	0.36	.01	0.36	.01	F		F	
19	I_LKG	µA	-10	10	-6.00	.01	-6.00	.36	-6.00	.37	-7.00	.38	-7.00	.39	-7.00	.09	-7.00	.09	F		F	
20	VLT	mV	40	95	84.3	2.0	80.8	2.6	79.1	2.8	73.9	2.2	67.8	1.9	65.0	1.3	65.0	1.3	F		F	
21	VUT	mV	40	95	61.0	1.3	60.5	1.1	60.5	1.3	61.4	1.3	63.0	1.2	64.0	1.3	64.0	1.3	F		F	
22	ISC	mA	-	200	180	1.5	176	4.1	171	4.0	159	3.6	142	3.3	125	1.2	125	1.4	F		F	

Notes:

1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control sample remained constant throughout the testing and is 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.

3/ After the 15 krad irradiation, S/N 10 and 13 became nonfunctional and were removed from further testing. Statistics for this and higher irradiation levels are therefore for six samples.

4/ After the 80 krad irradiation, all irradiated parts became nonfunctional and no valid measurements could be made. After annealing for 168 hours @25°C, all irradiated parts remained nonfunctional.

Radiation-sensitive parameters: Vout_1, V_LOAD, I_6V_1, V_OL and Vref.