DATE: August 15, 1995 PPM-95-173
TO: J. Lohr/311
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on: LP2951
Project: CASSINI/CIRS
Control #: 13732
Job #: EE56459
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 Co^{60} gamma ray source. During the radiation testing, three 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 15 V output in this case (see Figure 1 and Table III). A previous radiation test was done at a lower output voltage of 5 V (Report no. PPM-95-158).

The total dose radiation levels were 2.5, 5, 10, 15 and 20 krads*. The dose rate was between 0.08 and 0.29 krads/hour (see Table II for radiation schedule). After the 20 krad exposure, the parts were annealed at 25°C for 384 hours. 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 10 krad irradiation level.

After the 15 krad irradiation, S/N 70 and 72 exceeded the maximum specification limit of 450 mV for V_DO15V_1, with readings of 456 and 502 mV, respectively, and the same parts also exceeded the maximum specification limit of 80 mV for V_DO_15V_2, with readings of 249 and 260 mV, respectively. All other irradiated parts continued to pass all electrical tests at this irradiation level.

After the 20 krad irradiation, all irradiated parts exceeded the maximum specification limit for V_DO15V_1, with readings ranging from 2907 to 6137 mV, however, all irradiated parts read within specification limits for V_DO15V_2. In addition, S/N 72 marginally exceeded the maximum specification limit of 12 mA for I_6V_1, with a reading of 12.65 mA.

After annealing for 384 hours at 25°C, no recovery was observed.

In summary, although a direct comparison is difficult because the parts tested in the previous are from a different Lot Date Code, the parts tested at 15 V output voltage first exceeded parametric specification limits at the 15 krad level, compared to first marginal failures at 5 and 10 krads for the parts tested at 5 V output voltage.

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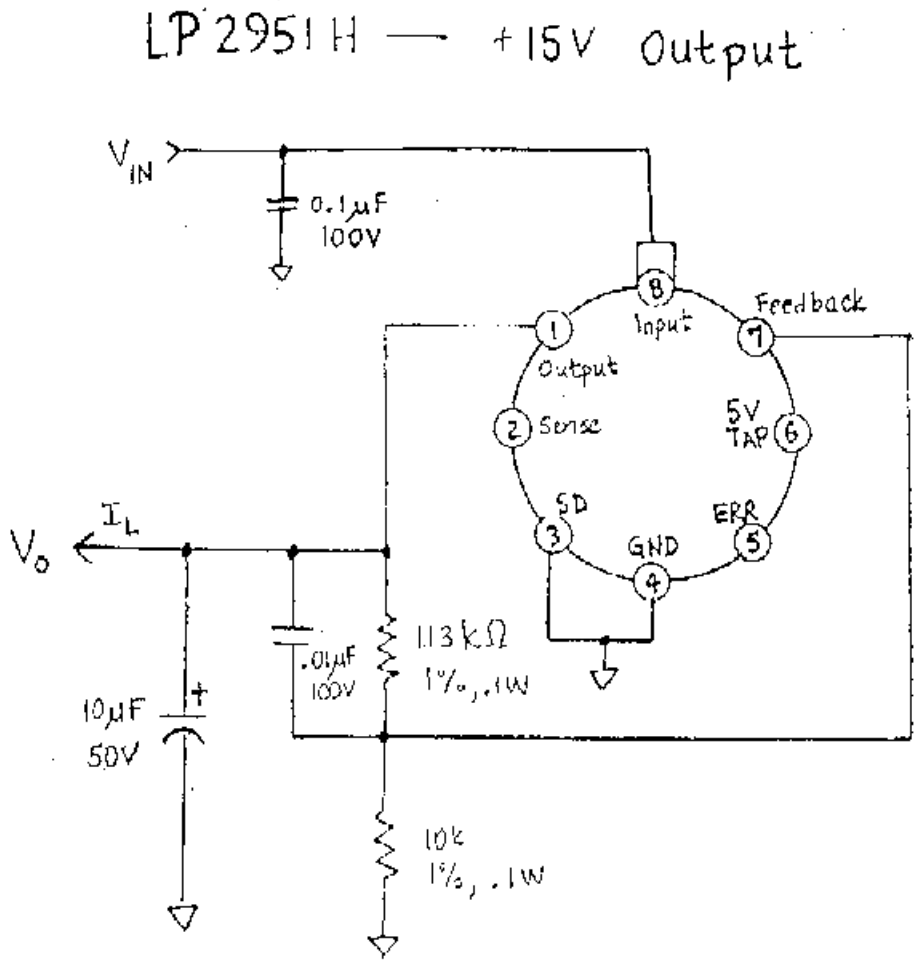
* The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.

** 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.

Table IV provides a summary of the functional test results and 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 LP2951



V_o = +15 V
I_L = 27 mA
V_{IN}(min) = 16.25 V
V_{IN}(max) = 17.0 V

TABLE I. Part Information

Generic Part Number:	LP2951*
CASSINI/CIRS Part Number	LP2951
CASSINI/CIRS Control Number:	13732
Charge Number:	EE56459
Manufacturer:	NSC
Lot Date Code (LDC):	9443S, 9435A
Quantity Tested:	4
Serial Number of Control Sample:	14
Serial Numbers of Radiation Samples:	70, 71, 72
Part Function:	Programmable Voltage Regulator
Part Technology:	HSCMOS
Package Style:	8-pin Tox can
Test Equipment:	A540
Engineer:	L. Mondy

TABLE II. Radiation Schedule for LP2951

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	07/07/95
2) 2.5 KRAD IRRADIATION (0.15 KRADS/HOUR)	07/10/95
POST 2.5 KRAD ELECTRICAL MEASUREMENT	07/11/95
3) 5.0 KRAD IRRADIATION (0.15 KRADS/HOUR)	07/11/95
POST 5.0 KRAD ELECTRICAL MEASUREMENT	07/12/95
4) 10.0 KRAD IRRADIATION (0.29 KRADS/HOUR)	07/12/95
POST-10.0 KRAD ELECTRICAL MEASUREMENT	07/13/95
5) 15.0 KRAD IRRADIATION (0.29 KRADS/HOUR)	07/13/95
POST-15.0 KRAD ELECTRICAL MEASUREMENT	07/14/95
6) 20 KRAD IRRADIATION (0.08 KRADS/HOUR)	07/14/95
POST-20 KRAD ELECTRICAL MEASUREMENT	07/18/95
7) 384-HOUR ANNEALING @ 25°C	07/18/95
POST-384 HOUR ANNEAL ELECTRICAL MEASUREMENT	08/03/95

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 Threshold	VUT	V_ERROR < 0.8V	40.0mV	95.0mV
Comparator Threshold	VUT	V_ERROR > 2.0V	40.0mV	95.0mV
I-SHORT CURCUIT	ISC	V_ERROR < 0.8V		200mA

ADDITIOANAL TESTS: Vout = 15V
Unless Otherwise Specified: T_A = 25°C, Vout = 15V

TEST NAME	SYMBOL	CONDITIONS	LIMITS	
			MIN	MAX
$V_{LINE15V}$	V_{LINE}	(16V ≤ V_{IN} < 30V), I_L = -1mA	-15.00mV	15.00mV
$V_{LOAD15V}$	V_{LOAD}	(-100mA < I_L ≤ -100uA)	-15.00mV	15.00mV
V_{DO15V_1}	V_{DO}	I_L = -100mA		450mV
V_{DO15V_2}	V_{DO}	I_L = -100uA		80mV

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

Test #	Parameters	Units	Spec. Lim./2 min	Spec. Lim./2 max	Initial mean	Initial sd	Total Dose Exposure (krads) 2.5 mean	2.5 sd	5 mean	5 sd	10 mean	10 sd	15 mean	15 sd	20 mean	20 sd	Annealing 168 hrs@25°C mean	Annealing 168 hrs@25°C sd
1	Vout_1	V	4.975	5.025	5.006	0	5.010	0	5.009	0	5.007	0	5.002	0	4.991	0	4.992	0
2	V_LINE	mV	-5	5	2.39	.28	2.32	.21	2.297	.16	2.33	.20	2.31	.12	2.33	.13	2.36	.06
3	V_LOAD	mV	-5	5	-0.81	.47	-0.71	.53	-0.93	.55	-1.26	.32	-1.83	.40	-3.01	.39	-2.57	.46
4	V_LINE_15	mV	-15	15	8.87	1.1	9.17	1.5	9.15	.56	9.37	.23	9.67	.33	10.2	.52	10.4	.38
5	V_LOAD_15	mV	-15	15	4.29	2.6	4.92	2.5	5.36	2.3	5.75	1.7	6.16	1.3	4.61	2.0	6.39	2.5
6	V_DO_1	mV	-	450	427	2.2	427	4.6	422	2.1	420	4.6	414	7.5	415	4.8	414	2.2
7	V_DO_2	mV	-	80	52.8	1.3	52.6	1.4	53.4	.99	54.5	.66	56.3	1.0	58.0	.93	57.8	.94
8	V_DO15V_1	mV	-	450	379	4.2	380	6.4	381	5.2	399	8.5	461	29	4141	1424	4032	1462
9	V_DO15V_2	mV	-	80	39.4	1.6	39.2	1.5	40.1	1.2	40.4	1.2	114	103	44.8	.89	44.4	1.3
10	I_6V_1	mA	0	12	9.42	.72	9.63	.71	9.87	.59	10.4	.52	11.0	.49	11.9	.49	12.1	.57
11	I_6V_2	µA	0	120	84.7	3.7	84.2	3.6	83.4	2.7	82.1	2.2	79.3	1.9	77.1	2.0	77.1	2.2
12	I_30V_1	mA	0	0.12	0.07	0	0.07	0	0.06	0	0.06	0	.06	0	.06	0	.06	0
13	I_30V_2	mA	0	15	6.43	.67	6.53	.67	6.73	.54	7.17	.52	7.63	.54	8.33	.54	8.34	.59
14	I_GDIF	µA	-30	30	1.42	.06	1.66	.22	2.52	1.1	2.21	.83	2.51	.49	2.23	1.0	1.78	1.2
15	I_GDO	µA	0	170	57.2	5.2	56.7	4.9	55.4	3.6	53.6	3.0	50.4	2.5	47.5	2.8	47.6	2.9
16	Vref	V	1.22	1.25	1.23	0	1.23	0	1.23	0	1.23	0	1.23	0	1.23	0	1.23	0
17	V_RLn	mV	-1.9	1.9	0.59	.07	0.61	.07	0.59	.06	.87	.26	.66	.05	.67	06	.69	.02
18	V_RLd	mV	-1.2	1.2	-0.03	.03	-0.05	.03	-0.07	.01	-0.06	.02	-0.05	.03	-0.06	.04	-0.05	.03
19	I_OH	µA	0	1	0.02	0	0.01	0	0.02	0	.03	0	.02	0	.02	0	.02	0
20	V_OL	mV	0	250	165	3.4	165	.87	168	1.7	175	2.8	182	3.8	193	3.2	192	3.1
21	I_SD1	µA	0	50	28.8	1.2	28.5	1.1	27.3	2.3	27.9	.82	27.2	.93	27.4	.73	27.3	.82
22	I_SD2	mA	0	0.6	0.39	.01	0.39	.02	0.38	.01	.38	.01	0.37	.02	.37	0	.37	.01
23	I_LKG	µA	-10	10	-5.78	.20	-5.81	.20	-5.83	.15	-5.93	.16	-6.07	.19	-6.1	0	-6.11	.15
24	VLT	mV	40	95	81.3	3.1	80.3	3.1	78.7	2.1	76.1	1.6	74.0	.82	70.3	1.2	71.7	.94
25	VLT	mV	40	95	60.3	1.5	60.3	1.5	60.3	1.2	61.3	1.2	61.7	.94	61.3	1.2	61.7	.95
26	ISC	mA	-	200	174	2.7	172	2.4	169	1.7	164	.85	157	.82	104	64	148	.94

Notes:

1/ The mean and standard deviation values were calculated over the three 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.

Radiation-sensitive parameters: V_DO15V_1, V_DO15V_2 and I_6V_1.