UNISYS

DATE: December 23, 1993 PPM-93-106
TO: S. Pszcolka/311.1
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on ISTP/SOHO/CELIAS
Part No. 5962-3870501MGA (LP2951)
Control No. 8706

cc: A. Sharma/311
Library/300.1

A radiation evaluation was performed on LP2951 (Adjustable 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 cobalt-60 gamma ray source. During the radiation testing, two parts were irradiated under bias (see Figure 1 for bias configuration), and one part was used as a control sample. The total dose radiation levels were 2, 5, 10, 15, 20 and 50 krads. The dose rate was between .073 and 1.58 krads/hour, depending on the total dose level (see Table II for radiation schedule). After the 50 krad irradiation, 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 annealing treatment, parts were electrically tested according to the test conditions and the specification limits listed in Table III.

All parts passed initial electrical measurements. Both irradiated parts passed all parametric tests up to and including the 5 krad irradiation level. At the 10 krad irradiation level, one part (S/N 456) failed to meet the minimum specification limit of 4.975 V for Vout_1, with a reading of 4.9691 V. At the 15 krad level, S/N 456 read 4.943 V for Vout_1 and marginally failed to meet the minimum specification limit of 1.220 V for Vref with a reading of 1.219 V. In addition, S/N 457 failed to meet the minimum specification limit of 4.975 V for Vout_1, with a reading of 4.964 V. The same failures occurred at the 20 krad level, with S/N 456 reading 4.926 V for Vout_1 and 1.218 V for Vref, and S/N 457 reading 4.949 V for Vout_1. At the 50 krad level, both irradiated parts exceeded specification limits for Vout_1, V_LOAD, Vref and V_OL as follows:

Parameter	Min. spec. lim.	Max. spec. lim.	S/N	Reading
Vout_1	4.975 V	5.025 V	456	4.8411 V
			457	4.8612 V
V-LOAD	-5.00 mV	5.00 mV	456	-11.84 mV
			457	-9.02 mV
Vref	1.22 V	1.25 V	456	1.207 V
			457	1.212 V
V_OL	0 mV	250 mV	456	23984 mV
			457	29999 mV

After annealing for 168 hours at 25°C, the same failures occurred, with only slightly different readings. After annealing for 168 hours at 100°C, both parts read within specification limits for V_LOAD and V_OL, and S/N read within specification limits for Vref. Both parts, however, continued to fail the tests for Vout_1, with only slightly different readings and S/N 456 continued to fail Vref with a reading of 1.217 V. Both parts passed all other electrical tests throughout all irradiation and annealing steps.

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

Table IV provides a summary of the functional test results, as well as the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps.

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

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TABLE 1. Part Information

Generic Part Number:	LP2951
ISTP/SOHO/CELIAS Part Number:	5962-3870501MGA
ISTP/SOHO/CELIAS Control Number:	8706
Charge Number:	C33658
Manufacturer:	National Semiconductor
Lot Date Code:	9317A
Quantity Tested:	3
Serial Number of Control Sample:	455
Serial Numbers of Radiation Samples:	456, 457
Part Function:	Adjustable Voltage Regulator
Part Technology:	HSCMOS
Package Style:	8-pin TOx can
Test Equipment:	Teradyne A540
Test Engineer:	T. Mondy

TABLE II. Radiation Schedule for LP2951

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	09/03/93
2) 2 KRAD IRRADIATION (0.10 KRADS/HOUR)	10/18/93
POST-2 KRAD ELECTRICAL MEASUREMENT	10/19/93
3) 5 KRAD IRRADIATION (0.15 KRADS/HOUR)	10/19/93
POST-5 KRAD ELECTRICAL MEASUREMENT	10/20/93
4) 10 KRAD IRRADIATION (0.15 KRADS/HOUR)	10/20/93
POST-10 KRAD ELECTRICAL MEASUREMENT	10/21/93
5) 15 KRAD IRRADIATION (0.073 KRADS/HOUR)	10/22/93
POST-15 KRAD ELECTRICAL MEASUREMENT	10/25/93
6) 20 KRAD IRRADIATION (0.25 KRADS/HOUR)	10/25/93
POST-20 KRAD ELECTRICAL MEASUREMENT	10/26/93
7) 50 KRAD IRRADIATION (1.58 KRADS/HOUR)	10/26/93
POST-50 KRAD ELECTRICAL MEASUREMENT	10/27/93
8) 168-HOUR ANNEALING @25°C	10/27/93
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/03/93
9) 168-HOUR ANNEALING @100°C**	11/03/93
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/12/93

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

**High temperature annealing is performed to accelerate long term time dependent effects (TDE), namely, the "rebound" effect due to the growth of interface states after the radiation exposure. For more information on the need to perform this test, refer to MIL-STD-883D, Method 1019, Para. 3.10.1.

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 thresbold.

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

				Total Dose Exposure (krads)												Annealing			
				Initials		2		5		10		15		20		50		168 hrs @25øC		168 hrs @100øC	
Parameters		min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Vout_1	V	4.975	5.025	5.008	0	5.005	0	4.991	.01	4.975	.01	4.954	.01	4.938	.02	4.851	.01	4.857	.03	4.899	.02
V_LINE	mV	-5	5	1.75	.05	1.61	.22	1.67	.06	1.61	.01	1.38	0	1.39	.08	1.20	.12	1.33	.01	1.23	.17
V_LOAD	mV	-5	5	-1.4	0.5	-1.44	.68	-1.79	.35	-1.96	.31	-2.7	.78	-2.9	.78	-11.4	.63	-6.66	2.25	-3.34	.83
V_DO_1	mV	-	450	417	3.5	416	.62	417	5.3	412	10	402	12	416	.99	416	29	396	6.7	406	1.5
V_DO_2	mV	-	80	52.9	.85	51.2	.94	53	.78	55	2	57	.74	60	1.2	63	2.9	61	1.8	59	1.6
I_6V_1	mA	0	12	7.06	.33	7.14	0.4	7.42	.44	7.96	.45	8.59	.78	8.89	.75	10.7	.83	10.7	1.2	9.73	1
I_6V_2	µA	0	120	55	5	64	4	82	4	79	3	76	3	73	2	63	1	68	2	77	2
I_30V_1	mA	0	.12	.064	0	.062	0	.060	0	.058	0	.056	.01	.054	0	.046	0	.048	0	.053	0
I_30V_2	mA	0	10	4.34	.33	4.36	.39	4.56	.42	4.97	.44	5.4	.66	5.6	.65	6.62	.75	6.84	1	6.16	.85
I_GDIF	µA	-30	30	3	1	1	0.1	2	0.5	2	0.6	0.73	.09	3	.89	1	1	0.66	.83	0.89	.41
I_GDO	µA	0	170	117	3	115	3	112	2	108	2	103	2	100	0	93	1	96	2	99	1
Vref	V	1.22	1.25	1.23	0	1.23	0	1.23	0	1.23	0	1.22	0	1.22	0	1.21	0	1.21	.01	1.22	0
V_RLn	mV	-1.9	1.9	0.67	.03	0.66	.03	0.67	.04	0.68	.08	0.73	.05	0.74	.08	1.03	.12	0.97	.13	0.73	.03
V_RLd	mV	-1.2	1.2	0.09	.01	0.05	.01	0.07	.03	0.13	.05	.002	.01	-0.03	.03	-0.05	.08	-0.03	.06	-0.04	.01
I_OH	µA	0	1	0.01	0	0.01	0	0.01	0	0.02	0	0.01	0	0.01	0	0.01	0	0.01	.01	0.01	0
V_OL	mV	0	250	160	12	157	7.2	162	6.6	172	7.2	182	10	192	8.8	26392	4253	24446	7849	198	9.4
I_SD1	µA	0	50	28	2	28	2	28	2	27	1	27	2	26	1	26	1	26	1	26	1
I_SD2	mA	0	.6	0.38	.03	0.38	.03	0.38	.02	0.37	.02	0.35	.03	0.35	.02	0.34	.01	0.35	.02	0.35	.02
I_LKG	µA	-10	10	-3	0.1	-3	0.1	-3	0.1	-3	0.1	-3	.01	-3	.05	-3	0.1	-3	0.1	-3	0.1
VLT	mV	40	95	81.5	.71	87.5	3.5	85.5	2.1	82	2.8	79	0	72.5	0.7	65.5	.71	67	0	76	0
VUT	mV	40	95	67	1.4	65.5	0.7	66	0	66.5	0	66.5	0.7	67	0	45.5	0.7	65.5	.71	65	0
ISC	mA	-	200	193	1.6	193	3.8	189	4.2	183	5.3	175	4.9	170	6.2	163	5	168	8.3	162	7.6

1/ The mean and standard deviation values were calculated over the two parts irradiated in this testing. The control sample remained constant throughout the testing and is not included in this table.

Figure 1. Radiation Bias Circuit for LP2951