PPM-91-124

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UNISYS

Interoffice Memorandum

PPM-91-124

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Department
Code 310.1

From
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Department
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Date
March 4, 1991

Location
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Subject
Radiation Report on SMEX
Common Buy Part No. SI9110AK

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A radiation evaluation was performed on SI9110AK 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, eight parts were irradiated under bias (see Figure 1 for bias configuration), and two parts were used as control samples. The total dose radiation steps were 2.5, 5, 7.5, 10, 15, 20, 30, 50, 75 and 100 krads. After 100 krads, parts were annealed at 25°C for 48 and 168 hours. The dose rate was between 0.07 - 1.25 krads/hour, depending on the total dose level (see Table II for radiation schedule). 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 except two (SNs 62 and 63) passed all tests on irradiation up to 10 krads. The failures of SNs 62 and 63 were marginal, as these parts showed lower readings than the minimum specification limit for Error Amp VFB and Error Amp Source Current, at 7.5 krads and 10 krads respectively. At the following radiation steps of 15 and 20 krads, all (8) parts showed degradation of Error Amp VFB, Error Amp Source Current, and Supply Current beyond the specified limits. After 30 krads, parts failed to meet the specification limits on the following parameters: Oscillator Accuracy, Oscillator Voltage Stability, Error Amp AVOL, Error Amp Source/Sink, PreRegulator Input Leakage, Supply Current and Output High Voltage.

Parts continued to degrade more and more with increasing radiation exposures. At 50 krads, the oscillator accuracy measurements on all parts were 0kHz. A zero reading on this parameter indicates that the oscillator and the output sections were not functioning correctly. The failure of these sections was

also evident from the fact that no rise time measurements could be made on some parts after 50 krads of radiation exposure. The degradation in parts continued at 75 and 100 krads, with parts failing a large number of the parametric measurements, including Reference Output Voltage, Maximum Oscillator Frequency, Oscillator Accuracy, Oscillator Stability, VFB, I source/sink, Current Limit Threshold Voltage, Input Leakage, Turn Off Threshold Voltage, Under Voltage Lockout, Supply Current, VOH, and Output Rise Time.

Parts showed partial recovery on annealing for 48 and 168 hours, but the recovery was not enough to bring the failing parameters within the specification limits. Table IV provides the mean and standard deviation values for each parameter after different radiation exposures and annealing treatments.

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

TABLE I. Part Information

Generic Part Number:	SI9110AK
SMEX Common Buy Part Number:	SI9110AK
SMEX Common Buy Control Number:	1735
Manufacturer:	Siliconix
Quantity Procured:	45
Lot Date Code:	9024
Quantity Tested:	10
Serial Numbers of Radiation Samples:	60, 61, 62, 63 64, 65, 66, 67
Serial Numbers of Control Samples:	58, 59
Part Function:	Switch Mode Controller
Part Technology:	CMOS
Package Style:	14-Pin DIP

TABLE II. Radiation Schedule

EVENTS	DATE
1) Initial Electrical Measurements	11/30/90
2) 2.5 krads irradiation @ 125 rads/hr	12/10/90
Post 2.5 krads Electrical Measurements	12/11/90
3) 5.0 krads irradiation @ 125 rads/hr	12/11/90
Post 5.0 krads Electrical Measurements	12/12/90
4) 7.5 krads irradiation @ 125 rads/hr	12/12/90
Post 7.5 krads Electrical Measurements	12/13/90
5) 10 krads irradiation @ 125 rads/hr	12/13/90
Post 10 krads Electrical Measurements	12/14/90
6) 15 krads irradiation @ 73 rads/hr	12/14/90
Post 15 krads Electrical Measurements	12/17/90
7) 20 krads irradiation @ 250 rads/hr	12/17/90
Post 20 krads Electrical Measurements	12/18/90
8) 30 krads irradiation @ 500 rads/hr	12/18/90
Post 30 krads Electrical Measurements	12/19/90
9) 50 krads irradiation @ 1000 rads/hr	12/19/90
Post 50 krads Electrical Measurements	12/20/90
10) 75 krads irradiation @ 1250 rads/hr	12/20/90
Post 75 krads Electrical Measurements	12/21/90
11) 100 krads irradiation @ 397 rads/hr	12/21/90
Post 100 krads Electrical Measurements	12/24/90
12) 48 hrs annealing	12/24/90
Post 48 hr Electrical Measurements	12/26/90
13) 168 hrs annealing	12/26/90
Post 168 hr Electrical Measurements	12/31/90

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.
- Annealing was performed at 25°C under bias.

TABLE III. Electrical Characteristics of SI9110AK

Test	MIN	MAX
Reference Output Voltage (VREF)	3.90V	4.10V
Reference Short Circuit Current (ISC)	80uA	200uA
Maximum Oscillator Frequency (Max Freq)	1.0MHz	5.0MHz
Initial Oscillator Accuracy (Osc. Acc.)	80kHz	120kHz
OSC Voltage Stability (Volt. Stab.)	0.0%	10.0%
Error Amp VFB	3.95V	4.04V
Error Amp IBIAS	0.0nA	500nA
Error Amp AVOL	60.0dB	200.0dB
Error Amp ISOURCE	1.40mA	14.0mA
Error Amp ISINK	0.12mA	1.2mA
Error Amp PSRR	40.0dB	200.0dB
Current Limit Threshold Voltage (VCLT)	1.0V	1.4V
PreRegulator Input Leakage (IIL)	0.0uA	10.0uA
VCC Turn-Off Threshold Voltage (VTHOFF)	7.0V	9.40V
Undervoltage Lockout (VLKOUT)	6.50V	8.90V
Supply Current (ICC)	0.1mA	1.0mA
Supply Bias Current (IBIAS)	0.0uA	50.0uA
Shutdown IIH (IIH1)	-5.0uA	5.0uA
Shutdown IIL (IIL1)	-35.0uA	35.0uA
Reset IIH (IIH2)	-5.0uA	5.0uA
Reset IIL (IIL2)	-35.0uA	35.0uA
Output High Voltage (VOH)	9.9V	10.5V
Output Low Voltage (VOL)	-0.1V	0.1V
Output Rise Time (TR)	0.0ns	75.0ns
Output Fall Time (TF)	0.0ns	75.0ns

Table IV. Summary of Elec[illegible]al Measurements after Total Dose Exposures and An[illegible]ing for SI9110AK 1/

		Spec. Limits		Initials		Total Dose Exposure (krads)													
						5 ✓		7.5 ✓		10		15		20		30 X		50	
	Parameters	min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
	VREF V	3.9	4.1	3.98	.02	3.97	.02	3.96	.05	3.96	.05	3.96	.05	3.95	.05	3.95	.05	3.93	.05
	ISC uA	80	200	114	3	113	2	112	2	110	2	110	2	108	3	109	3	110	2
	Max Freq. MHz	1.0	5.0	3.2	0.2	3.0	0	2.9	0.1	2.7	0.1	2.5	0.2	2.3	0.1	1.8	0.1	1.2	0
	Osc. Acc. kHz	80	120	86	1	93	1	95	1	99	2	114	2	123	3	144	5	*	
	Volt. Stab %	0.0	10.0	6.9	0.4	4.7	0.6	4.2	1.0	2.7	0.2	5.5	0.8	10.8	1.0	18	2	100	0
X	Error Amp VFB V	3.95	4.04	3.96	.02	3.95	.01	3.95	0	3.95	0	3.95	0	3.95	0	3.94	.01	3.91	.05
X	" IBIAS nA	0.0	500	161	59	150	10	135	40	150	10	90	35	36	10	65	15	157	1.0
X	" AVOL dB	60	200	79	1	75	1	75	1	73	1.3	73	1.3	133	5	64	4.0	63	5.0
X	" ISOURCE mA	1.4	14.0	2.5	0.3	2.0	0.2	1.7	0.2	1.45	0.2	1.1	0.1	0.5	0	0.6	.05	0.2	0
X	" ISINK mA	0.12	1.2	0.15	.01	0.15	.01	0.13	0	0.12	0	0.10	0	0.09	0	0.07	0	0.04	0
X	" PSRR dB	40	200	47	3	49	3	47	4	48	5	45	3	130	5	66	4	45	3
X	VCLT V	1.0	1.4	1.25	.03	1.25	.02	1.21	.02	1.20	.04	1.17	.04	1.18	.04	1.15	0.1	0.95	0.0
	IIL uA	0.0	10.0	0.11	.01	0.12	.03	0.15	0.0	0.2	0	0.1	0.1	32	3	300	100	1E3	50
X	VTHOFF V	7.0	9.4	8.7	0.2	8.6	0.2	8.6	0.2	8.6	0.1	8.6	0.1	8.8	0.1	9.2	0.2	9.5	0
	VLKOUT V	6.5	8.9	7.9	0.2	7.8	0.2	7.8	0.2	7.8	0.2	7.7	0.3	7.5	0.3	7.8	0.2	9.0	0.0
	ICC mA	0.1	1.0	0.6	0	0.6	0	0.6	0	0.7	0.1	0.9	0.2	1.8	0.5	3.5	0.8	-2.0	1.0
	IBIAS uA	0.0	50	11.9	0.2	4.1	0.1	2.0	0.1	0.6	0	.01	0	.02	0	.02	0	.02	0
	IIH1 uA	-5.0	5.0	0.8	0.3	0.7	0.2	0.7	0.2	0.7	0.2	0.4	0.3	0.4	0.3	0.1	0.1	.01	0
	IIL1 uA	-35	35	-.02	0	-.02	0	-.03	0	-.03	0	-.03	0	-.03	0	-.03	0	-.03	0
X	IIH2 uA	-5.0	5.0	.04	0	0.12	.04	0.3	0.2	0.4	0.2	0.6	0.2	0.4	0.2	0.2	0.1	0.1	0
X	IIL2 uA	-35	35	-0.1	0.1	-0.1	0.1	-0.1	0	0	0	0	0	0	0	0	0	0	0
	VOH V	9.9	10.5	10.0	0	10.0	0	10.0	0	10.0	0	10.0	0	10.0	0	9.89	.05	0	0
	VOL V	-0.1	0.1	-.02	0	-.02	0	-.02	0	-.02	0	-.02	0	-.02	0	-.02	0	-.02	0
	TR ns	0.0	75	10.7	0.9	11.0	1.0	11.3	1.3	11.8	1.0	12.0	1.0	14.0	2.0	19.0	1.5	**	
	TF ns	0.0	75	3.8	1.7	4.0	0.5	3.9	0.4	3.9	0.3	5.0	1.0	5.5	1.0	8.5	1.5	6.0	1.0

* At 50 krads and above, oscillator accuracy readings varied from 0 to 500 kHz. A zero reading implies that the part would not oscillate under the measurement conditions of this test, and is indicative of functional failure of the oscillator and output sections.

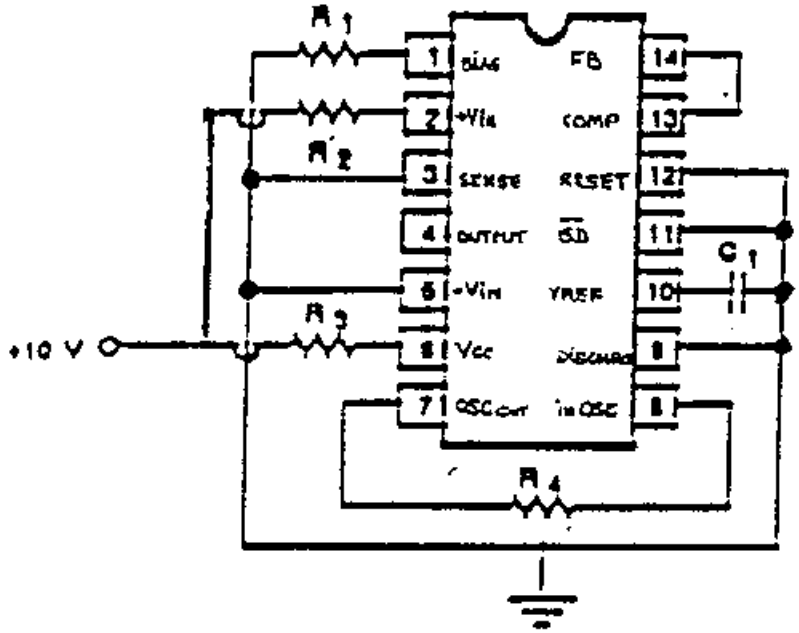
** No rise time measurements could be made on several parts at 50 krads and above. This is indicative of functional failure of the oscillator section of the parts.

Table IV. (continued)

Parameters		Spec. Limits min	max	Total Dose (krads) 75 mean	sd	100 mean	sd	Annealing 48 hrs mean	sd	168 hrs mean	sd
VREF	V	3.9	4.1	3.90	.05	3.78	0.2	3.86	0.1	3.89	0.1
ISC	uA	80	200	107	2.5	95	6	105	4	106	5
Max Freq.	MHz	1.0	5.0	1.2	.05	1.2	.03	0.9	0.3	0.9	0.3
Osc. Acc.	kHz	80	120	*		*		*		*	
Volt. Stab	%	0.0	10.0	80	30	85	30	50	30	35	25
Error Amp VFB	V	3.95	4.04	3.65	0.1	3.6	0.2	3.6	0.2	3.7	0.2
" IBIAS	nA	0.0	500	158	2.0	155	1.0	158	3.0	160	1.0
" AVOL	dB	60	200	131	5.0	138	4.0	140	8.0	133	4.0
" ISOURCE	mA	1.4	14.0	0.1	0	.01	0	.02	0	.02	0
" ISINK	mA	0.12	1.2	.02	0	.01	0	.01	0	.01	0
" PSRR	dB	40	200	122	5	130	5	135	7	134	7
VCLT	V	1.0	1.4	0.95	0	0.95	0	0.95	0	0.95	0
IIL	uA	0.0	10.0	1E3	50	1E3	50	1E3	50	850	200
VTHOFF	V	7.0	9.4	9.5	0	9.5	0	9.5	0	9.3	0.2
VLKOUT	V	6.5	8.9	9.0	0	9.0	0	9.0	0	9.0	0.1
ICC	mA	0.1	1.0	-2.0	1.0	-2.4	1.0	-2.0	2.0	-0.4	0.3
IBIAS	uA	0.0	50	.02	0	.02	0	.02	0	.02	0
IIH1	uA	-5.0	5.0	.01	0	.01	0	.01	0	.01	0
IIL1	uA	-35	35	-.03	0	-.03	0	-.03	0	-.03	0
IIH2	uA	-5.0	5.0	.04	0	.04	0	.04	0	.04	0
IIL2	uA	-35	35	0	0	0	0	0	0	0	0
VOH	V	9.9	10.5	***		***		***		***	
VOL	V	-0.1	0.1	-.02	0	-.02	0	-.02	0	-.02	0
TR	ns	0.0	75	**		**		**		**	
TF	ns	0.0	75	40	25	12	3	120	100	30	8

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.
*** No VOH measurements could be made on several parts at 75 krads and above.

Figure 1. Radiation Bias Circuit for SI9110AK



NOTES: R_1 = 390 kΩ, 1/4 W
R_2 = 1 kΩ, 2 W
R_3 = 1 kΩ, 2 W
R_4 = 330 kΩ, 1/4 W
C_1 = 0.1 µF, 50 V

All resistors are ±10% Tolerance.