Government Systems Group

Unisys Corporation
4700 Boston Way
Lanham MD 20706

Telephone
301 731 8600

UNISYS

DATE: October 3, 1994 PPM-94-035

TO: J. Denis/311.1
FROM: K. Sahu/300.1 KSahu
SUBJECT: Radiation Report on GOES/SXI
Part No. TC4420
Control No. 9575A

cc: A. Sharma/311
Library/300.1

A radiation evaluation was performed on TC4420 (MOSFET Buffer) 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, four 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, 5, 7.5, 10, 15, 20 and 30 krads*. The dose rate was between 0.04 and 0.59 krads/hour, depending on the total dose level (see Table II for radiation schedule). After the 30 krad irradiation, the 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. All irradiated parts passed all electrical tests up to and including the 7.5 krad irradiation level. At the 10 krad irradiation level, S/N 6, 8 and 9 exceeded the maximum specification limit of 1.5 mA for Icc_3V_18V, with readings of 1.73 mA, 1.88 mA and 1.61 mA, respectively, and S/N 8 exceeded the maximum specification limit of 1.5 mA for Icc_3V_4.5V, with a reading of 1.56 mA. S/N 10 passed all electrical tests at this radiation level.

At the 15 krad level, S/N 6, 8, 9 and 10 exceeded the maximum specification limits for both Icc_3V_4.5V and Icc_3V_18V, with readings in the range of 2.04 to 3.20 mA.

At the 20 krad level, S/N 6, 8, 9 and 10 continued to exceed the maximum specification limit for Icc_3V_4.5V and Icc_3V_18V, with readings in the range of 2.77 to 4.65 mA. In addition, S/N 8 marginally exceeded the maximum specification limit of 2.8 Ω for ROUT_1, with a reading of 2.81 Ω.

At the 30 krad level, S/N 6, 8, 9 and 10 continued to exceed the maximum specification limit for Icc_3V_4.5V and Icc_3V_18V, with readings in the range of 3.91 to 7.39 mA. The same parts also exceeded the maximum specification limit of 2.8 Ω for ROUT_1, with readings in the range of 2.95 to 3.31 Ω. S/N 6 and 8 also fell below the minimum specification limit of 4.475 V for VOH_4.5V, with readings of 4.4742 and 4.4723 V, respectively.

After annealing for 168 hours at 25°C, all irradiated parts read within specification limits for VOH_4.5V. No recovery was observed in other test parameters.

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

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

All parts passed all other electrical tests throughout all irradiation and annealing steps.

Table IV provides a summary of the results 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.

TABLE I. Part Information

Generic Part Number:	TC4420
GOES/SXI Part Number:	TC4420*
GOES/SXI Control Number:	9575A
Charge Number:	C444607
Manufacturer:	Teledyne Corp.
Lot Date Code:	9325
Quantity Tested:	5
Serial Number of Control Sample:	7
Serial Numbers of Radiation Samples:	6, 8, 9, 10
Part Function:	MOSFET Buffer
Part Technology:	CMOS
Package Style:	8-pin DIP
Test Equipment:	A540
Test Engineer:	T. Mondy

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

TABLE II. Radiation Schedule for TC4420

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	09/07/94
2) 2.5 KRAD IRRADIATION (0.13 KRADS/HOUR)	09/07/94
POST-2.5 KRAD ELECTRICAL MEASUREMENT	09/08/94
3) 5 KRAD IRRADIATION (0.13 KRADS/HOUR)	09/08/94
POST-5 KRAD ELECTRICAL MEASUREMENT	09/09/94
4) 7.5 KRAD IRRADIATION (0.04 KRADS/HOUR)	09/09/94
POST-7.5 KRAD ELECTRICAL MEASUREMENT	09/12/94
5) 10 KRAD IRRADIATION (0.15 KRADS/HOUR)	09/12/94
POST-10 KRAD ELECTRICAL MEASUREMENT	09/13/94
6) 15 KRAD IRRADIATION (0.25 KRADS/HOUR)	09/13/94
POST-15KRAD ELECTRICAL MEASUREMENT	09/14/94
7) 20 KRAD IRRADIATION (0.25 KRADS/HOUR)	09/14/94
POST-20KRAD ELECTRICAL MEASUREMENT	09/15/94
8) 30 KRAD IRRADIATION (0.50 KRADS/HOUR)	09/15/94
POST-30 KRAD ELECTRICAL MEASUREMENT	09/16/94
9) 168-HOUR ANNEALING @25°C	09/16/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	09/26/94
10) 168-HOUR ANNEALING @100°C*	09/26/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/03/94

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 TC4420

Unless Otherwise Specified: T_A =25°C, VCC = +(4.5, 18)Vdc, V_{IL}=0.8Vdc, V_{IH}=2.4Vdc

TEST NAME	SYMBOL	CONDITIONS	LIMITS	
			MIN	MAX
		SUPPLY CURRENT		
I_{CC}	Icc_0V_4.5V	Vcc = 4.5Vdc, V_{IN}=0Vdc	0.0uA	150.00uA
I_{CC}	Icc_3V_4.5V	Vcc = 4.5Vdc, V_{IN}=3Vdc	0.0uA	1.50mA
I_{CC}	Icc_0V_18V	Vcc = 18Vdc, V_{IN}=0Vdc	0.0uA	150.00uA
I_{CC}	Icc_3V_18V	Vcc = 18Vdc, V_{IN}=3Vdc	0.0uA	1.500mA
		INPUT LOGIC THREASHOLDS		
V_{IH}	VIH_4.5V	Vcc = 4.5V, Vout > 2.5V	2.4V	
V_{IL}	VIL_4.5V	Vcc = 4.5V, Vout < 0.025V		0.8V
V_{IH}	VIH_18V	Vcc = 18V, Vout > 16.5V	2.4V	
V_{IL}	VIL_18V	Vcc = 18V, Vout < 0.025V		0.8V
		OUTPUT TESTS		
VOL	VOL_4.5V	Vcc = 4.5Vdc, Vin = 0.8Vdc		0.025V
VOH	VOH_4.5V	Vcc = 4.5Vdc, Vin = 2.4Vdc	4.475V	
VOL	VOL18V	Vcc = 18Vdc, Vin = 0.8Vdc		0.025V
VOH	VOH18V	Vcc = 18Vdc, Vin = 2.4Vdc	17.975V	
		OUTPUT RESISTANCE		
R_OUT	ROUT_1	Vcc = 18Vdc, Vin = 2.4Vdc, Iout = 10mA		2.8Ω
R_OUT	ROUT_0	Vcc = 18Vdc, Vin = 0.8Vdc, Iout = -10mA		2.5Ω
		INPUT LEAKAGE CURRENT		
I_{IL}	IIL_4.5V	Vcc = 4.5Vdc, Vin = 0.0Vdc	-10.00uA	10.00uA
I_{IH}	IIH_4.5V	Vcc = 4.5Vdc, Vin = 4.5Vdc	-10.00uA	10.00uA
I_{IL}	IIL_18V	Vcc = 18Vdc, Vin = 0.0Vdc	-10.00uA	10.00uA
I_{IH}	IIH_18V	Vcc = 18Vdc, Vin = 18Vdc	-10.00uA	10.00uA

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for TC4420 /1

Test #	Parameter	Units	Spec. Lim./2 min	Spec. Lim./2 max	Initials mean	Initials sd	Total Dose Exposure (krads) 2.5 mean	2.5 sd	5 mean	5 sd	7.5 mean	7.5 sd	10 mean	10 sd	15 mean	15 sd	20 mean	20 sd	30 mean	30 sd	Annealing 168 hrs @25°C mean	168 hrs @25°C sd	168 hrs @100°C mean	168 hrs @100°C sd
1	Icc_0V_4.5	mA	0	0.150	.046	0	.046	0	.045	0	.045	0	.044	0	.042	0	.040	0	.038	0	.036	0	.036	0
2	Icc_3V_4.5	mA	0	1.500	.877	.01	.905	.01	.553	.02	.924	.07	1.38	.14	2.30	.24	3.15	.37	4.41	.54	*		1.67	.18
3	Icc_0V_18V	mA	0	0.150	.064	0	.064	0	.063	0	.063	0	.062	0	.061	0	.060	0	.058	0	.056	0	.050	0
4	Icc_3V_18V	mA	0	1.500	.623	.04	.613	.04	.791	.03	1.18	.08	1.67	.17	2.81	.32	4.03	.54	6.95	.93	*		*	
5	VIH_4.5V	V	-	2.40	1.62	.01	1.62	.01	1.64	.01	1.66	.01	1.67	.01	1.68	.02	1.68	.03	1.68	.04	1.75	.04	1.77	.02
6	VIL_4.5V	V	0.80	-	1.53	.01	1.52	.01	1.51	.01	1.52	.01	1.51	.02	1.51	.03	1.51	.04	1.50	.05	1.57	.05	1.58	.03
7	VIH_18V	V	-	2.40	2.00	0	2.02	.04	2.02	.04	2.04	.05	2.04	.05	2.02	.06	2.03	.07	2.03	.09	2.08	.10	2.05	.06
8	VIL_18V	V	0.80	-	1.58	.02	1.57	.03	1.57	.03	1.57	.04	1.56	.05	1.55	.05	1.53	.06	1.52	.07	1.55	.06	1.54	.04
9	VOL_4.5V	V	-	0.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	VOH_4.5V	V	4.4750	-	4.4864	0	4.4858	0	4.4847	0	4.4830	0	4.4810	0	4.4788	0	4.4824	0	4.4756	0	4.4781	0	4.4889	0
11	VOL_18V	V	-	0.025	.001	0	.001	0	.001	0	.001	0	.001	0	.001	0	.001	0	.001	0	.001	0	.001	0
12	VOH_18V	V	17.9750	-	18.0009	0	18.0000	0	18.0003	0	17.9993	0	17.9972	0	17.9954	0	17.9932	0	17.9903	0	17.9920	0	17.9977	0
13	ROUT_1	Ohms	-	2.80	2.01	.01	2.03	.01	2.06	.01	2.14	.01	2.24	.03	2.46	.06	2.69	.10	3.11	.18	2.90	.14	2.42	.06
14	ROUT_0	Ohms	-	2.50	1.35	.01	1.35	.01	1.36	.01	1.37	.01	1.37	.01	1.39	.01	1.40	.01	1.41	.01	1.41	.02	1.45	.01
15	IIL_4.5V	µA	-10	10	-.006	0	-.005	0	-.007	0	-.006	0	-.006	0	-.008	0	-.007	0	-.007	0	-.007	0	-.008	0
16	IIH_4.5V	µA	-10	10	.043	0	.043	0	.040	0	.042	0	.041	0	.040	0	.042	0	.039	0	.039	0	.039	0
17	IIL_18V	µA	-10	10	-.014	0	-.013	0	-.014	0	-.012	0	-.013	0	-.015	0	-.013	0	-.015	0	-.014	0	-.014	0
18	IIH_18V	µA	-10	10	.087	0	.088	0	.085	0	.085	0	.084	0	.081	0	.083	0	.082	0	.085	0	.085	0

1/ The mean and standard deviation values were calculated over the four 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 non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

The radiation sensitive parameters were Icc_3V_4.5V, Icc_3V_18V, ROUT_1 and VOH_4.5V.

* No reliable readings could be obtained at this point.

Figure 1. Radiation Bias Circuit for TC4420