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UNISYS

Interoffice Memorandum

To
 Department **A. Sharma**
 From **Code 314**
 Department **K. Sahu KS**
 Subject **7809**
Radiation Report on
GPEP Part No. 54ACTQ374
Control No. 4655

Date **PPM-91-744**
 Location **Dec. 12, 1991**
 Telephone **GSFC**
 Location **731-8954**
 cc **Lanham**
T. Perry
S. Archer-Davies
G. Jacobs
Library/311

A radiation evaluation was performed on 54ACTQ374 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 V and Figure 1.

The total dose testing was performed using a cobalt-60 gamma ray source. During the radiation testing, ten 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 5, 10, 15, 20, 50, 80 and 100 krads*. After 100 krads, parts were annealed without bias at +25°C for 168 hours. The dose rate was between 250 - 1,500 rads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, parts were electrically tested @ +25°C according to the test conditions and the specification limits listed in Table III. These tests included two functional tests (1MHz, at VCC voltages of 4.5V and 5.5V) after each radiation and annealing step.

All ten parts passed initial electrical measurements at testing temperatures of -55°C, 25°C and 125°C. All parts passed functionally throughout the radiation testing to 100 krads and the subsequent 168 hours of annealing at a testing temperature of 25°C. All ten radiation samples passed all tests through 20 krads. After 50 krads of exposure five parts exceeded the specification limits for IOZH and ICC; one exceeded IOZH, ICC, and VOH limits; and three exceeded IOZH, IOZL, and ICC limits. After 80 krads of exposure, seven parts did not meet the specified limits for IOZH, IOZL, and ICC; one part was outside the limits for IOZH, IOZL, ICC, and VOH (S/N 160); and one part exceeded IOZH and ICC limits. After 100 krads of exposure, all ten parts were outside of the specification limits. Nine parts were outside the limits for IOZH, IOZL, and ICC; and one part (S/N 160) was beyond the limits for IOZH, IOZL, ICC, and VOH. After 168 hours of annealing, only one device (S/N 154) passed all tests. However, there were no signs of catastrophic or functional failures after 100 krads of exposure.

Table IV provides the mean and standard deviation values for each parameter after different radiation exposures and annealing treatments. Table V provides this data at high/low temperature pre-irradiation electrical measurements. Tables IV & V also

provide a summary of the functional test results after each radiation/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.

*In this report, the term rads is used as an abbreviation for rads (Si).

TABLE I. Part Information

Generic Part Number:	54ACTQ374
GPEP Part Number:	54ACTQ374
GPEP Control Number:	4655
Charge Number:	C14350
Manufacturer:	National Semiconductor Corp.
Lot Date Code:	9024A
Quantity Tested:	12
Serial Numbers of Radiation Samples:	152, 153, 154, 155, 156, 157, 158, 159, 160, 161
Serial Number of Control Samples:	150, 151
Part Function:	Octal D-Type Flip-Flop with Tri-State
Part Technology:	CMOS -
Package Style:	20-Pin DIP
Test Engineer:	C. Nguyen

TABLE II. Radiation Schedule for 54ACTQ374

EVENTS	DATE
1) Initial (Pre-Irradiation) Electrical Measurements at 25°C, -55°C and 125°C	10/04/91
2) 5 krads irradiation @ 250 rads/hour Post 5 krads Electrical Measurements	11/08/91 11/12/91
3) 10 krads irradiation @ 250 rads/hour Post 10 krads Electrical Measurements	11/12/91 11/13/91
4) 15 krads irradiation @ 250 rads/hour Post 15 krads Electrical Measurements	11/13/91 11/14/91
5) 20 krads irradiation @ 250 rads/hour Post 20 krads Electrical Measurements	11/14/91 11/15/91
6) 50 krads irradiation @ 1,500 rads/hour Post 50 krads Electrical Measurements	11/15/91 11/16/91
7) 80 krads irradiation @ 700 rads/hour Post 80 krads Electrical Measurements	11/16/91 11/18/91
8) 100 krads irradiation @ 1,000 rads/hour Post 100 krads Electrical Measurements	11/18/91 11/19/91
9) 168 hours annealing @ +25°C without bias Post 168 hours Electrical Measurements	11/19/91 11/29/91

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, unless otherwise noted.
- The parts were annealed without bias at 25°C.

Table III. Electrical Characteristics of 54ACTQ374

FUNCTIONAL TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS OVER TEMP.
FUNCT 1	4.5V	0.0V	4.5V	FREQ=1.00MHz	I/O	VOL<2.25V; VOH>2.25V
FUNCT 2	5.5V	0.0V	5.5V	FREQ=1.00MHz	I/O	VOL<2.75V; VOH>2.75V

LOAD USED <= IOH = -5.0 mA
VREF = 1.5 V
IOL = +5.0 mA

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ 25°C
VOH1	4.5V	0.8V	2.0V	LOAD=-50uA	OUTS	>4.4V ; <4.5V
VOH2	4.5V	0.8V	2.0V	LOAD=-24mA	OUTS	>3.86V ; <4.5V
VOH3	5.5V	0.8V	2.0V	LOAD=-50uA	OUTS	>5.4V ; <5.5V
VOH4	5.5V	0.8V	2.0V	LOAD=-24mA	OUTS	>4.86V ; <5.5V
VOH5	5.5V	0.8V	2.0V	LOAD=-50mA	OUTS	>3.85V ; <5.5V
VOL1	4.5V	0.8V	2.0V	LOAD=+50uA	OUTS	>0.0V ; <0.1V
VOL2	4.5V	0.8V	2.0V	LOAD=+24mA	OUTS	>0.0V ; <0.36V
VOL3	5.5V	0.8V	2.0V	LOAD=+50uA	OUTS	>0.0V ; <0.1V
VOL4	5.5V	0.8V	2.0V	LOAD=+24mA	OUTS	>0.0V ; <0.36V
VOL5	5.5V	0.8V	2.0V	LOAD=+50mA	OUTS	>0.0V ; <1.65V
I IH	5.5V	0.0V	5.5V	VIN = 5.5V	INS	> 0.0uA; <0.1uA
I IL	5.5V	0.0V	5.5V	VIN = 0.0V	INS	>-0.1uA; <0.0uA
I OZH	5.5V	0.0V	5.5V	VIN = 5.5V	INS	> 0.0uA; <0.5uA
I OZL	5.5V	0.0V	5.5V	VIN = 5.5V	INS	>-0.5uA; <0.0uA
I CCH	5.5V	0.0V	5.5V	VIN = 5.5V	VCC	>0.0uA ; <8.0uA
I CCL	5.5V	0.0V	5.5V	VIN = 0.0V	VCC	>0.0uA ; <8.0uA
I CCZ	5.5V	0.0V	5.5V	VIN = 0.0V	VCC	>0.0uA ; <8.0uA
DEL_ICC	5.5V	0.0V	5.5V	VIN = 3.4V	VCC	>0.0uA ; <1.6mA

AC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	PINS	LIMITS @ 25°C
TPHL_DQ	5.0V	0.0V	5.0V	DN TO QN	>2.0nS; <7.5nS
TPLH_DQ	5.0V	0.0V	5.0V	DN TO QN	>2.0nS; <7.5nS
TPHZ_OQ	5.0V	0.0V	5.0V	OE TO QN	>1.0nS; <10.0nS
TPLZ_OQ	5.0V	0.0V	5.0V	OE TO QN	>1.0nS; <10.0nS
TPZH_OQ	5.0V	0.0V	5.0V	OE TO QN	>2.0nS; <9.0nS
TPZL_OQ	5.0V	0.0V	5.0V	OE TO QN	>2.0nS; <9.0nS

Table III (Continued). Electrical Characteristics of 54ACTQ374

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ -55°C, 125°C
VOH1	4.5V	0.8V	2.0V	LOAD=-50uA	OUTS	>4.4V ; <4.5V
VOH2	4.5V	0.8V	2.0V	LOAD=-24mA	OUTS	>3.7V ; <4.5V
VOH3	5.5V	0.8V	2.0V	LOAD=-50uA	OUTS	>5.4V ; <5.5V
VOH4	5.5V	0.8V	2.0V	LOAD=-24mA	OUTS	>4.7V ; <5.5V
VOH5	5.5V	0.8V	2.0V	LOAD=-50mA	OUTS	>3.85V ; <5.5V
VOL1	4.5V	0.8V	2.0V	LOAD=+50uA	OUTS	>0.0V ; <0.1V
VOL2	4.5V	0.8V	2.0V	LOAD=+24mA	OUTS	>0.0V ; <0.5V
VOL3	5.5V	0.8V	2.0V	LOAD=+50uA	OUTS	>0.0V ; <0.1V
VOL4	5.5V	0.8V	2.0V	LOAD=+24mA	OUTS	>0.0V ; <0.5V
VOL5	5.5V	0.8V	2.0V	LOAD=+50mA	OUTS	>0.0V ; <1.65V
IIH	5.5V	0.0V	5.5V	VIN = 5.5V	INS	> 0.0uA ; <1.0uA
IIL	5.5V	0.0V	5.5V	VIN = 0.0V	INS	>-1.0uA ; <0.0uA
IOZH	5.5V	0.0V	5.5V	VIN = 5.5V	INS	> 0.0uA ; < 10uA
IOZL	5.5V	0.0V	5.5V	VIN = 5.5V	INS	> -10uA ; <0.0uA
ICCH	5.5V	0.0V	5.5V	VIN = 5.5V	VCC	>0.0uA ; <160uA
ICCL	5.5V	0.0V	5.5V	VIN = 0.0V	VCC	>0.0uA ; <160uA
ICCZ	5.5V	0.0V	5.5V	VIN = 0.0V	VCC	>0.0uA ; <160uA
DEL_ICC	5.5V	0.0V	5.5V	VIN = 3.4V	VCC	>0.0uA ; <1.6mA

AC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	PINS	LIMITS @ -55°C, 125°C
TPHL_DQ	5.0V	0.0V	5.0V	DN TO QN	>1.5nS ; <10.5nS
TPLH_DQ	5.0V	0.0V	5.0V	DN TO QN	>1.5nS ; <10.5nS
TPHZ_OQ	5.0V	0.0V	5.0V	OE TO QN	>1.5nS ; <10.5nS
TPLZ_OQ	5.0V	0.0V	5.0V	OE TO QN	>1.5nS ; <10.5nS
TPZH_OQ	5.0V	0.0V	5.0V	OE TO QN	>1.5nS ; <11.0nS
TPZL_OQ	5.0V	0.0V	5.0V	OE TO QN	>1.5nS ; <11.0nS

COMMENTS/EXCEPTIONS

- 1 - VIL & VIH tested during VOL & VOH tests as GO/NO GO.
- 2 - IOLD & IOHD are tested in VOL5 & VOH5 as GO/NO GO.
- 3 - Tests not performed per GPEP memo : VOLP, VOLV, VIHD, VILD
- 4 - TS, TH, TW, TOSHL, TOSLH are not tested due the discrepancies between GPEP and manufacturer specs.

TABLE IV: Summary of Electrical Measurements After
Total Dose Exposures and Annealing for 54ACTQ374 1/2/3/

Parameters	Spec Limits @ 25°C min max		Total Dose Exposure (TDE) (krads)														Anneal				
			0		5		10		15		20		50		80		100		168 hours		
			(Pre-Rad)		mean	sd	mean	sd	mean	sd	mean	sd	mean								
FUNC1 @ 1 MHz			P		P		P		P		P		P		P		P		P		
FUNC2 @ 1 MHz			P		P		P		P		P		P		P		P		P		
VOH1_4.5V V	4.4	4.5	4.49	0	4.49	0	4.49	0	4.49	0	4.43	0.50	4.92	0.85	4.38	0.70	4.83	0.50	4.38	0.70	
VOH2_4.5V V	3.86	4.5	4.20	0.03	4.19	0.03	4.22	0.01	4.22	0.01	4.22	0.01	4.21	0.01	4.21	0.01	4.20	0.02	4.21	0.02	
VOH3_5.5V V	5.4	5.5	5.49	0	5.49	0	5.50	0	5.49	0	5.50	0	5.49	0	5.49	0	5.49	0	5.49	0	
VOH4_5.5V V	4.86	5.5	5.23	0.03	5.23	0.03	5.26	0.01	5.25	0.01	5.26	0.01	5.25	0.01	5.25	0.01	5.25	0.01	5.25	0.01	
VOH5_5.5V V	3.85	5.5	4.92	0.08	4.93	0.06	4.98	0.02	4.98	0.02	4.98	0.02	4.97	0.02	4.97	0.02	4.96	0.03	4.96	0.03	
VOL1_4.5V V	0	0.10	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	
VOL2_4.5V V	0	0.36	0.15	0.02	0.15	0.03	0.14	0.01	0.13	0.01	0.13	0.01	0.13	0.01	0.13	0.01	0.13	0.01	0.13	0.01	
VOL3_5.5V V	0	0.10	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	
VOL4_5.5V V	0	0.36	0.14	0.02	0.15	0.03	0.12	0.01	0.12	0.01	0.12	0.01	0.12	0.01	0.11	0	0.11	0	0.11	0	
VOL5_5.5V V	0	1.65	0.30	0.07	0.32	0.07	0.25	0.01	0.25	0.01	0.25	0.01	0.25	0.01	0.24	0.01	0.24	0.01	0.25	0.01	
I IH	nA	0	100	0	-	0	-	0	-	0	-	0	-	0	-	0.32	-	0.99	3.05	0.07	0.70
I IL	nA	-100	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
IOZH	uA	0	0.50	0	-	0	-	0	-	0	-	0	-	5.59	8.98	16.88	25.44	24.78	32.48	3.72	5.84
IOZL	uA	-0.50	0	0	-	0	-	0	-	0	-	0	-	0	0.01	0.02	24.27	19.91	0.03	0.69	0
ICCH	uA	0	8.0	0.02	-	0.02	-	0.05	0.01	0.38	0.12	1.20	0.45	52.83	78.58	47.68	24.61	56.40	29.10	38.30	51.88
ICCL	uA	0	8.0	0.02	-	0	-	0.04	0.01	0.25	0.09	0.65	0.35	15.94	12.68	27.35	25.42	33.83	29.44	10.40	5.69
ICCZ	uA	0	8.0	0.02	-	0	-	0.09	0.01	0.18	0.05	0.58	0.25	39.41	32.00	84.59	59.41	109.3	90.78	14.73	13.53
DELTA ICC	nA	0	1.60	0.58	0.05	0.58	0.06	0.58	0.06	0.57	0.06	0.56	0.06	0.54	0.07	0.51	84.58	485.6	94.62	448.9	87.45
TPHL_DQ	ns	2.0	7.5	4.90	0.20	6.55	0.25	5.79	0.25	5.94	0.26	5.82	0.25	6.65	0.25	5.90	0.28	6.75	0.29	5.99	0.31
TPHL_OQ	ns	2.0	7.5	6.24	0.51	8.45	0.39	7.88	0.46	7.98	0.44	7.84	0.44	8.86	0.51	7.67	0.52	8.90	0.60	7.91	0.44
TPLZ_OQ	ns	1.0	10.0	6.59	0.35	5.81	0.44	5.53	0.51	5.54	0.51	5.50	0.51	6.28	0.52	5.46	0.50	5.23	0.52	5.49	0.52
TPHZ_OQ	ns	1.0	10.0	5.95	0.50	5.29	0.50	6.37	1.22	6.35	0.97	5.52	0.81	5.60	0.71	4.98	0.68	5.05	0.54	5.65	0.70
TPZL_OQ	ns	2.0	9.0	6.78	0.25	6.21	0.19	5.79	0.16	5.83	0.17	5.79	0.17	6.64	0.21	5.06	0.19	5.69	0.23	5.93	0.20
TPZH_OQ	ns	2.0	9.0	5.99	0.31	5.14	0.31	4.76	0.32	4.82	0.33	4.75	0.33	5.59	0.35	4.89	0.32	5.66	0.35	4.97	0.34

1/ These statistics do not include the control samples which remained constant throughout testing.

2/ Prior to irradiation the two control samples and ten radiation samples were electrically tested at 25°C, -55°C and 125°C. This test data, as well as data collected at 25°C after all of the radiation steps, is available upon request.

3/ It shall be noted that all A.C. measurements shifted by 1 ns to 2 ns from the initial readings after the routine calibration of the ATE (S-50). This shift caused all ten radiation samples and both control samples to marginally exceed the limits for TPHL. Therefore, all marginal A.C. failures are disregarded in this report due to the shift in the ATE after calibration.

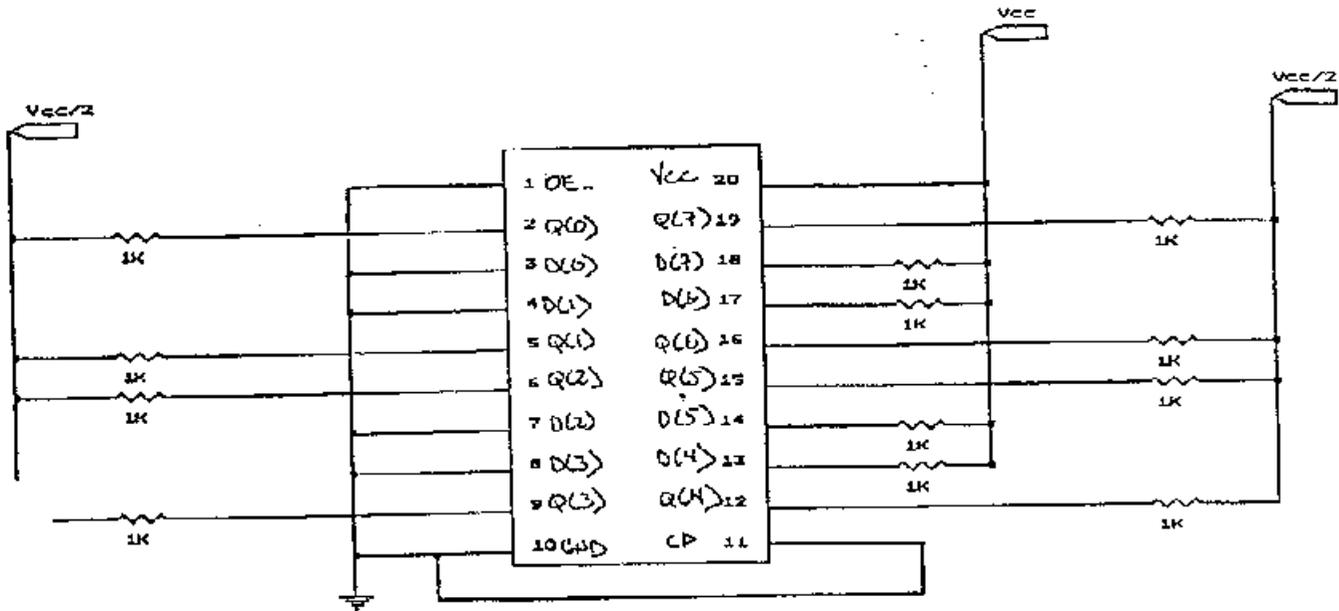
Table V. Summary of Low and High Temperature Pre-Rad Electrical Measurements for 54ACTQ374

Parameters		Spec. Limits		Low Temp. -55°C		High Temp. 125°C	
		min	max	mean	sd	mean	sd
Func1 @VCC=4.5V				P	-	P	-
Func2 @VCC=5.5V				P	-	P	-
VOH1	V	4.4	4.5	4.49	0	4.49	0
VOH2	V	3.7	4.5	4.26	0.06	4.10	0.04
VOH3	V	5.4	5.5	5.49	0	5.49	0
VOH4	V	4.7	5.5	5.29	0.06	5.16	0.05
VOH5	V	3.85	5.5	5.07	0.09	4.77	0.08
VOL1	mV	0	100	0	-	0	-
VOL2	mV	0	500	118.3	46.85	213.2	33.26
VOL3	mV	0	100	0.49	5.81	0	-
VOL4	mV	0	500	104.5	37.07	185.2	36.36
VOL5	mV	0	1650	222.8	70.46	398.3	63.72
I _{IH}	nA	0	1000	0.46	4.11	3.98	4.36
I _{IL}	nA	-1000	0	-0.03	0.45	26.39	47.11
I _{OZH}	uA	0	10.0	0	2.16	0	0
I _{OZL}	uA	-10.0	0	0	-	-0.03	0.05
I _{CCH}	uA	0	160	0	1.37	0.58	0.65
I _{CCL}	uA	0	160	0	-	0.84	1.07
I _{CCZ}	uA	0	160	0	-	0.71	0.86
DEL _{ICC}	mA	0	1.6	0.65	0.06	0.53	46.42
T _{PLH_DQ}	ns	1.5	10.5	4.30	0.17	5.70	0.23
T _{PHL_DQ}	ns	1.5	10.5	5.86	0.63	7.13	0.51
T _{PLZ_OQ}	ns	1.5	10.5	6.40	0.37	6.91	0.33
T _{PHZ_OQ}	ns	1.5	10.5	6.24	0.56	6.10	0.48
T _{PZL_OQ}	ns	1.5	11.0	6.19	0.24	7.61	0.28
T _{PZH_OQ}	ns	1.5	11.0	5.55	0.30	6.59	0.33

Note:

1/ The mean and standard deviation values were calculated over eighteen parts tested prior to radiation testing. Of these eighteen parts ten were used for radiation testing, two were used as control samples, and the remaining six were spares not used in this evaluation.

Figure 1. Radiation Bias Circuit for 54ACT0374



$V_{cc} = 5.0 \text{ volts} \pm .5 \text{ volts}$
 $V_{cc}/2 = 2.5 \text{ volts} \pm .25 \text{ volts}$
 ALL RESISTORS ARE 1/4 WATT