

**UNISYS**

DATE: October 6, 1994

TO: B Fafaul/311.1

FROM: K. Sahu/300.1 *KS*

SUBJECT: Radiation Report on HST/BASE  
Part No. 82C54  
Control No. 10620

PPM-94-036

cc: A. Sharma/311  
Library/300.1

A radiation evaluation was performed on 82C54 (CMOS Programmable Interval Timer) 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 levels were 2.5, 5, 10, 15, 20 and 30 krad\*. The dose rate was between 0.03 and 0.35 krad/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 5 krad irradiation level.

At the 10 krad irradiation level, all parts exceeded the maximum specification limits for ICCSBH, ICCSBL and ICCOP. The range of readings for ICCSBH were from 28.3 to 51.3 mA, against a maximum specification limit of 10.0  $\mu$ A; the range of readings for ICCSBL was from 29.8 to 53.4 mA, against a maximum specification limit of 150.0  $\mu$ A, and the range of readings for ICCOP was from 29.2 to 54.6 mA, against a maximum specification limit of 10.0 mA.

At the 15 krad level, the same results were observed, with readings in the range of 76.4 to 188 mA for ICCSBH, 80.7 to 121 mA for ICCSBL and 78.7 to 115 mA for ICCOP. In addition, S/N 173 failed Functional Test # 2.

At the 20 krad level, all parts passed all functional tests. The same failures in ICC tests continued, with readings for all three tests in the range of 88.6 to 131 mA.

At the 30 krad level, all parts continued to fail the ICC tests, with readings in the range of 220 to 284 mA. S/N 173, 176 and 180 exceeded the maximum specification limit of 150.0 ns for TOD\_LH, with readings of 1.001 ms and S/N 177 fell below the minimum specification limit of -10.0  $\mu$ A for IOZL, with a reading of -13.8  $\mu$ A. In addition, S/N 173 failed Functional Tests # 1, 2 and 3, S/N 175 failed Functional Test # 2, S/N 176 failed Functional Tests # 1 and 2, S/N 177 failed Functional Test 3 2, S/N 178 failed Functional Test 3 2, S/N 179 failed Functional Test # 1 and S/N 180 failed Functional Tests # 1 and 3.

\*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 25°C, S/N 177 passed all functional tests, but S/N 174 failed Functional Test # 2 and S/N 180 exceeded the maximum specification limit of 120  $\mu$ s for TDR\_HL, with a reading of 1.001 ms. All other irradiated parts continued to fail at least one functional test. No other significant recovery was observed.

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

All parts passed all electrical and functional 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.

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TABLE I. Part Information

Generic Part Number:	82C54
HST/BASE Part Number:	840601JA*
HST/BASE Control Number:	10620
Charge Number:	C44494
Manufacturer:	Intel Corp.
Lot Date Code:	9407
Quantity Tested:	10
Serial Number of Control Samples:	171, 172
Serial Numbers of Radiation Samples:	173, 174, 175, 176, 177, 178, 179, 180
Part Function:	CMOS Programmable Interval Timer
Part Technology:	CMOS
Package Style:	24-pin DIP
Test Equipment:	S-50
Test Engineer:	T. Scharer

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

TABLE II. Radiation Schedule for 82C54

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	08/29/94
2) 2.5 KRAD IRRADIATION (0.15 KRADS/HOUR)	09/01/94
POST-2.5 KRAD ELECTRICAL MEASUREMENT	09/02/94
3) 5 KRAD IRRADIATION (0.03 KRADS/HOUR)	09/02/94
POST-5 KRAD ELECTRICAL MEASUREMENT	09/06/94
4) 10 KRAD IRRADIATION (0.29 KRADS/HOUR)	09/06/94
POST-10 KRAD ELECTRICAL MEASUREMENT	09/07/94
5) 15 KRAD IRRADIATION (0.29 KRADS/HOUR)	09/07/94
POST-15 KRAD ELECTRICAL MEASUREMENT	09/08/94
6) 20 KRAD IRRADIATION (0.29 KRADS/HOUR)	09/08/94
POST-20 KRAD ELECTRICAL MEASUREMENT	09/09/94
7) 30 KRAD IRRADIATION (0.35 KRADS/HOUR)	09/09/94
POST-30 KRAD ELECTRICAL MEASUREMENT	09/12/94
8) 168-HOUR ANNEALING @25°C	09/13/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	09/20/94
9) 168-HOUR ANNEALING @100°C*	09/20/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	09/28/94

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

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\*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 82C54

FUNCTIONAL TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
FUNCT#1	4.5V	0.8V	4.5V	FREQ = 1.0MHZ	I/O	VOL < 2.25V, VOH > 2.25V
FUNCT#2	5.5V	0.0V	2.6V	FREQ = 1.0MHZ	I/O	VOL < 2.75V, VOH > 2.75V
FUNCT#3	5.0V	0.0V	5.5V	FREQ = 1.0MHZ	I/O	VOL < 1.5V, VOH > 1.5V

\* VIL IS PERFORMED GO/NOGO IN THE FUNCTIONAL TEST# 1.  
 \* THE SPECIFIED VIH OF 2.2V IS NOT TESTED DUE TO LEVEL PROBLEMS INDUCED BY THE LOAD BOARD. A LEVEL OF 2.6V IS TESTED DURING FUNCTIONAL TEST# 2.

DC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
VOH1	4.5V	0.0V	4.5V	IOH = -2.5MA	OUTS	> +3.0V < +4.5V
VOH2	4.5V	0.0V	4.5V	IOH = -100UA	OUTS	> +4.1V < +4.5V
VOL	4.5V	0.0V	4.5V	IOL = +2.5MA	OUTS	> 0.0V < +0.40V
IIL	5.5V	0.0V	5.5V	VI = 0.0V	DI/O	> -2UA < +2UA
IIH	5.5V	0.0V	5.5V	VI = 5.5V	DI/O	> -2UA < +2UA
IOZL	5.5V	0.0V	5.5V	VI = 0.0V	DI/O	> -10UA < +10UA
IOZH	5.5V	0.0V	5.5V	VO = 5.5V	DI/O	> -10UA < +10UA
ICCSBH	5.5V	0.0V	5.5V	[OUTS: OPEN ; CTR PROGRAMMED]	INS	HIGH < +10UA
ICCSBL	5.5V	0.0V	5.5V	[OUTS: OPEN ; CTR PROGRAMMED]	INS	LOW < +150UA
ICCP	5.5V	0.0V	5.5V	[OUTPUT: OPEN ; CLK = 8MHZ]		< -10MA

AC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
TRD_ZH	4.50V	0.4V	2.6V	DATA DELAY FROM RD	I/O	> 0NS < 120NS
TRD_ZL	4.5V	0.4V	2.6V	DATA DELAY FROM RD	I/O	> 0NS < 120NS
TOD_LH	4.5V	0.4V	2.6V	OUTPUT DELAY FROM CLOCK	OUTS	> 0NS < 150NS
TOD_HL	4.5V	0.4V	2.6V	OUTPUT DELAY FROM CLOCK	OUTS	> 0NS < 150NS

FOLLOWING AC PARAMETERS ARE PERFORMED GO/NOGO IN FUNCTIONAL TEST# 2 :

- IN READ CYCLE :  
 TAR = 30NS ; TSR = 0NS ; TRA = 0NS ; TRR = 150NS ;
- IN WRITE CYCLE :  
 TSW = 0NS ; TWW = 95NS ; TWD = 25NS ;
- CLOCK AND GATE :  
 TPWH = 60NS ; TGS = 50NS ;
- TESTS ARE NOT PERFORMED CIN ; COUT ; C I/O ; TAD ; TRW ; TAW ; TWA ;  
 TCLK ; TPWL ; TGW ; TGL ; TODG ; TWO ; TGH ; TDW ; VIH ;

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for 82C54 /1

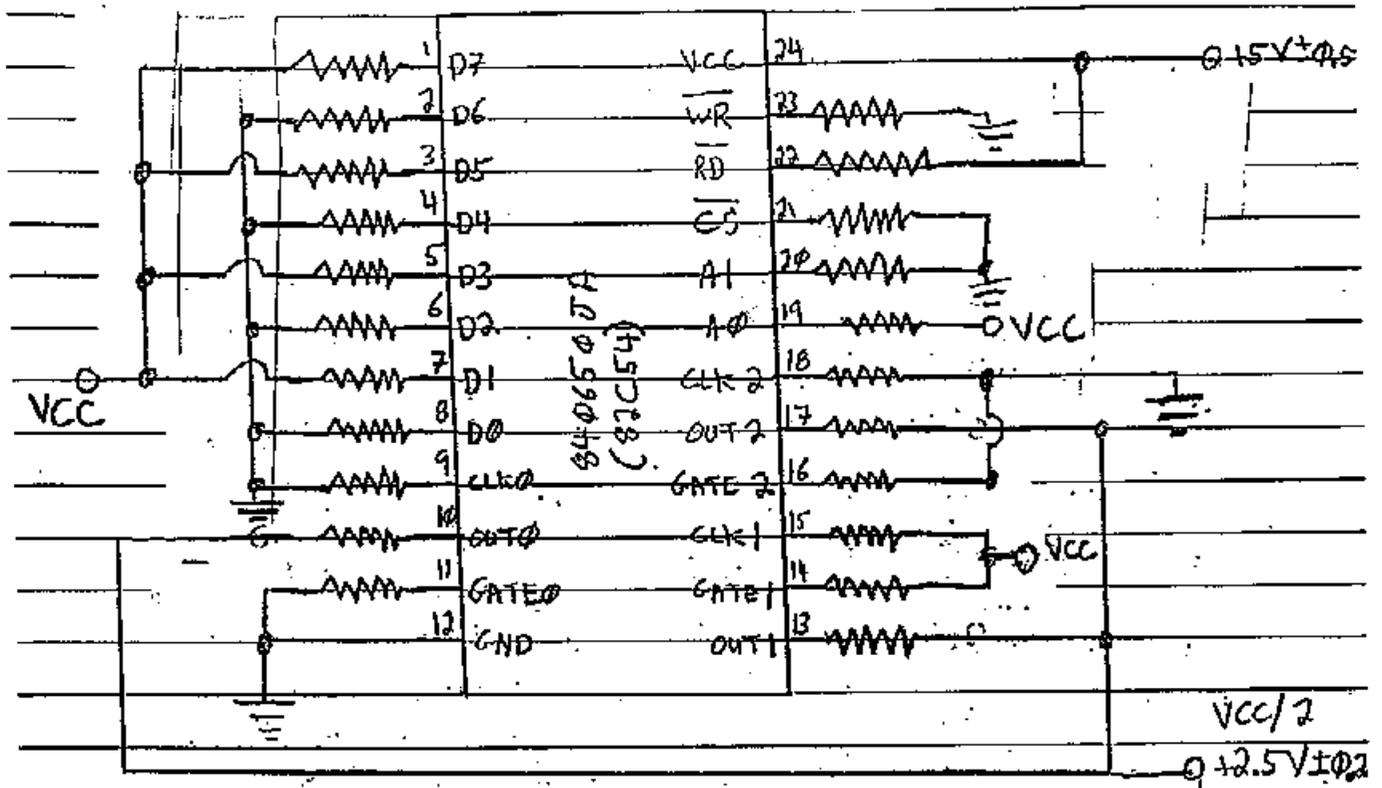
est/2 #	Parameter	Units	Spec. Lim./3		Total Dose Exposure (krads)														Annealing			
			Min	Max	Initials		2.5		5		10		15		20		30		168 hrs @25°C		168 hrs @100°C	
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	V <sub>OH1</sub>	V	3.00	4.50	4.24	.01	4.24	.01	4.24	.01	4.23	.01	4.21	.02	4.17	.06	4.11	.07	4.11	.06	4.18	.04
2	V <sub>OH2</sub>	V	4.10	4.50	4.49	0	4.49	0	4.49	0	4.48	0	4.45	.01	4.44	.05	4.49	.07	4.40	.05	4.44	.03
3	V <sub>OL</sub>	mV	0	400	85.9	2.4	87.6	2.8	88.1	2.9	100	5.7	117	14	126	20	206	44	210	47	141	34
4	I <sub>IL</sub>	µA	-2.00	2.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	I <sub>IH</sub>	µA	-2.00	2.00	0	0	0	0	0	0	0	0	0	0	0	0	-0.08	0.1	-0.11	.20	0	0
6	I <sub>OZL</sub>	µA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	I <sub>OZH</sub>	µA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0	0	-0.01	.03	-6.32	7.0	-4.99	6.7
8	ICCSBH	µA	0	10.0	0	0	0.69	1.1	1.24	1.5	3.8E4	6628	9.4E4	1.2E4	1.1E5	1.2E4	2.5E5	1.7E4	2.4E5	1.5E4	1.5E5	7219
9	ICCSBL	µA	0	150	22.2	7.4	20.7	6.6	19.0	5.1	3.9E4	6907	9.7E4	1.2E4	1.1E5	1.2E4	2.5E5	1.8E4	2.4E5	1.6E4	1.5E5	7554
10	ICCOP	mA	0	10.0	2.19	.01	2.19	.02	2.19	.02	39.7	7.6	93.3	11	102	11	238	17	230	16	199	6.4
11	TRD_LH	ns	0	120	29.3	1.5	25.1	1.5	25.4	1.5	28.4	1.4	24.4	1.5	25.3	2.1	27.6	2.8	28.5	2.2	24.4	1.3
12	TRD_HL	ns	0	120	29.6	1.0	26.4	1.0	25.5	1.0	28.4	1.0	24.7	1.1	25.1	1.2	27.1	1.6	1.6E4	1.2E5	25.9	1.2
13	TOD_LH	ns	0	150	29.1	1.1	26.2	1.0	25.4	1.1	28.5	1.2	24.4	1.3	24.8	1.5	1.3E5	3.9E5	1.3E5	3.3E5	25.4	1.3
14	TOD_HL	ns	0	150	31.0	1.0	28.0	1.1	27.1	1.1	30.0	1.0	26.0	1.2	26.5	1.2	28.7	1.8	30.3	1.5	28.5	1.4
15	FUNC1, V <sub>cc</sub> =4.5V, Freq.= 1 MHz				P		P		P		P		P		P		4P4F		4P4F		P	
16	FUNC2, V <sub>cc</sub> =5.5V, Freq.= 1 MHz				P		P		P		P		7P1F		P		3P5F		3P5F		P	
17	FUNC3, V <sub>cc</sub> =5.0V, Freq.= 1 MHz				P		P		P		P		P		P		6P2F		6P2F		P	

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.
- 2/ In the Functional Tests, "PASS" means that all parts passed this Functional Test at this irradiation or annealing level, "FAIL" means that all parts failed this test at this irradiation or annealing level, and "nPmF" means that n parts passed at this level and m parts failed at this level.
- 3/ 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 ICCSBH, ICCSBL, ICCOP, TRD\_HL, TOD\_LH, IOZL and Functional Tests.

Figure 1. Radiation Bias Circuit for 82C54



$VCC = +5V \pm 0.5V$

$VCC/2 = +2.5V \pm 0.25V$

$T_A = +25^{\circ}C, +100^{\circ}C$