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Code 300.1  
From  
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7809  
Subject  
Radiation Report on 54AC161  
SMEX Common Buy Part No. 5962-8956101EA

PPM-91-252  
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April 8, 1991  
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A radiation evaluation was performed on 54AC161 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 5, 10, 15, 20, 30, 50, 75 and 100 krads. After 100 krads, parts were annealed at 25°C for 24 and 168 hours, and then irradiation was continued to 200 and 300 krads (cumulative). The dose rate was between 0.1 - 5.0 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. These tests included two functional tests (at 1 MHz) after each radiation and annealing step.

All parts passed all tests up to 30 krads. After 50 krads exposure, five parts (SNs 6, 7, 8, 9 and 10) exceeded the specification limits on ICCH and ICCL (readings were in the range of 271 uA to 2.5 mA). However, the parts passed all other tests. At the next radiation steps of 75 and 100 krads, most of the parts showed a large number of failures in the parametric (DC and AC) tests (typically parts were failing 40 out of a total of 60 tests). However, all parts passed functional tests on irradiation up to 100 krads. On annealing the parts for 24 and 168 hours, parts showed partial recovery in DC and AC tests. On continued irradiation to 200 and 300 krads, parts began to fail functionally also. Table IV provides the mean and standard deviation values for each parameter after different radiation exposures and annealing treatments. It also provides a summary of 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 731-8954.

TABLE I. Part Information

Generic Part Number:	54AC161
SMEX Common Buy Part Number:	5962-8956101EA
SMEX Common Buy Control Number:	1655
Manufacturer:	National Semiconductor Corp
Quantity Procured:	100
Lot Date Code:	9036A
Quantity Tested:	10
Serial Numbers of Radiation Samples:	3, 4, 5, 6 7, 8, 9, 10
Serial Numbers of Control Samples:	1, 2
Part Function:	Synchronous Presettable Binary Counter
Part Technology:	CMOS
Package Style:	16-Pin DIP

TABLE II. Radiation Schedule

EVENTS	DATE
1) Initial Electrical Measurements	01/25/91
2) 5 krads irradiation @ 250 rads/hr Post 5 krads Electrical Measurements	01/28/91 01/29/91
3) 10 krads irradiation @ 250 rads/hr Post 10 krads Electrical Measurements	01/29/91 01/30/91
4) 15 krads irradiation @ 250 rads/hr Post 15 krads Electrical Measurements	01/30/91 01/31/91
5) 20 krads irradiation @ 250 rads/hr Post 20 krads Electrical Measurements	01/31/91 02/01/91
6) 30 krads irradiation @ 147 rads/hr Post 30 krads Electrical Measurements	02/01/91 02/04/91
7) 50 krads irradiation @ 1000 rads/hr Post 50 krads Electrical Measurements	02/04/91 02/05/91
8) 75 krads irradiation @ 1250 rads/hr Post 75 krads Electrical Measurements	02/05/91 02/06/91
9) 100 krads irradiation @ 1250 rads/hr Post 100 krads Electrical Measurements	02/06/91 02/07/91
10) 24 hrs annealing Post 24 hr Electrical Measurements	02/07/91 02/08/91
11) 168 hrs annealing Post 168 hr Electrical Measurements	02/08/91 02/14/91
12) 200 krads irradiation @ 5000 rads/hr Post 200 krads Electrical Measurements	02/14/91 02/15/91
13) 300 krads irradiation @ 1087 rads/hr Post 300 krads Electrical Measurements	02/15/91 02/19/91

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

TABLE III. Electrical Characteristics of 54AC161

FUNCTIONAL TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C, -55C, +125C
UNCT 1	3.0V	0.0V	3.0V	FREQ=1.000MHz	ALL I/O	VOL<1.50V , VOH>1.50V
UNCT 2	5.5V	0.0V	5.5V	FREQ=1.000MHz	ALL I/O	VOL<2.75V , VOH>2.75V
				{ IOH = -6.0mA		
				LOAD USED <= [ VREF= VCC/2		
				{ IOL = +6.0mA		

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C, -55C, +125C
VOH1	3.0V	0.9V	2.1V	LOAD=-50UA	OUTS	>+2.9V , <+3.0V
VOH2	4.5V	1.35V	3.15V	LOAD=-50UA	OUTS	>+4.4V , <+4.5V
VOH3	5.5V	1.65V	3.85V	LOAD=-50UA	OUTS	>+5.4V , <+5.5V
VOL1	3.0V	0.9V	2.1V	LOAD=-04MA	OUTS	>+2.4V , <+3.0V
VOL2	4.5V	1.35V	3.15V	LOAD=-24MA	OUTS	>+3.7V , <+4.5V
VOL3	5.5V	1.65V	3.85V	LOAD=-24MA	OUTS	>+4.7V , <+5.5V
VOH4	5.5V	1.65V	3.85V	LOAD=-50MA	OUTS	>+3.85V , <+5.5V
VOL4	3.0V	0.9V	2.1V	LOAD=+50UA	OUTS	>+0.0V , <+0.1V
VOL5	4.5V	1.35V	3.15V	LOAD=+50UA	OUTS	>+0.0V , <+0.1V
VOL6	5.5V	1.65V	3.85V	LOAD=+50UA	OUTS	>+0.0V , <+0.1V
VOL7	3.0V	0.9V	2.1V	LOAD=+12MA	OUTS	>+0.0V , <+0.5V
VOL8	4.5V	1.35V	3.15V	LOAD=+24MA	OUTS	>+0.0V , <+0.5V
VOL9	5.5V	1.65V	3.85V	LOAD=+24MA	OUTS	>+0.0V , <+0.5V
VOL10	5.5V	1.65V	3.85V	LOAD=+50MA	OUTS	>+0.0V , <+1.65V
IIL	5.5V	0.0V	5.5V	VIN = 0.0V	INS	>-1.0UA , <+0.0UA
IIH	5.5V	0.0V	5.5V	VIN = 5.5V	INS	>+0.0UA , <+1.0UA
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

TABLE III. (continued)

AC PARAMETRIC TESTS PERFORMED

PARAMETER =====	VCC ===	VIL ===	VIH ===	CONDITIONS =====	LIMITS AT +25C ONLY =====	
H_CP_QN	3.0V	0.0V	3.0V	CP TO QN	> 1NS	< 12NS
H_CP_TC	3.0V	0.0V	3.0V	CP TO TC	> 1NS	< 14NS
L_CP_QN	3.0V	0.0V	3.0V	CP TO QN	> 1NS	< 12NS
L_CP_TC	3.0V	0.0V	3.0V	CP TO TC	> 1NS	< 14NS
H_ET_TC	3.0V	0.0V	3.0V	CET TO TC	> 1NS	< 10NS
HL_ET_TC	3.0V	0.0V	3.0V	CET TO TC	> 1NS	< 11.5NS
HL_MR_QN	3.0V	0.0V	3.0V	MR TO QN	> 1NS	< 11.5NS
HL_MR_TC	3.0V	0.0V	3.0V	MR TO TC	> 1NS	< 15NS
HH_CP_QN	4.5V	0.0V	4.5V	CP TO QN	> 1NS	< 8.5NS
HH_CP_TC	4.5V	0.0V	4.5V	CP TO TC	> 1NS	< 10NS
HL_QN	4.5V	0.0V	4.5V	CP TO QN	> 1NS	< 8.5NS
HL_TC	4.5V	0.0V	4.5V	CP TO TC	> 1NS	< 10.5NS
HH_ET_TC	4.5V	0.0V	4.5V	CET TO TC	> 1NS	< 6.5NS
HL_ET_TC	4.5V	0.0V	4.5V	CET TO TC	> 1NS	< 8.5NS
HL_MR_QN	4.5V	0.0V	4.5V	MR TO QN	> 1NS	< 8.5NS
HL_MR_TC	4.5V	0.0V	4.5V	MR TO TC	> 1NS	< 11.5NS

LOAD USED (= { IOH = -6.0mA  
 { VREF = VCC/2  
 { IOL = +6.0mA

COMMENTS/EXCEPTIONS

(1) VIL & VIH were tested during VOL & VOH tests as Go/NoGo.

TABLE IV: Summary of Electrical Measurements  
after Total Dose Exposures and Annealing for 54AC161

1/ 2/

Parameters	Spec. Limits min max	Initials mean sd		Total Dose Exposure (krads)								Anneal		Total Dose (krads)					
				10		20		50		100		168 hrs		200		300			
				mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd		
Func1 @ 1MHz		Pass		Pass		Pass		Pass		Pass		Pass		Pass		3P/5F		3P/5F	
Func2 @ 1MHz		Pass		Pass		Pass		Pass		Pass		Pass		Pass		7P/1F		3P/5F	
VOH1 V	2.9 3.0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	.01	2.96	.03	2.97	.02	2.78	0.6	2.60	1.0
VOH2 V	4.4 4.5	4.49	0	4.49	0	4.49	0	4.49	0	4.49	.01	4.45	.03	4.46	.03	4.41	.05	3.89	1.5
VOH3 V	5.4 5.5	5.49	0	5.49	0	5.49	0	5.49	0	5.49	.01	4.91	1.6	4.65	2.0	5.15	1.2	3.54	2.6
VOH4 V	2.4 3.0	2.93	0	2.93	0	2.93	0	2.92	.01	2.60	0.9	2.47	1.0	2.70	0.6	1.88			
VOH5 V	3.7 4.5	4.20	.02	4.20	.01	4.20	.02	4.19	.02	3.72	1.2	3.52	1.5	3.87	0.9	2.68			
VOH6 V	4.7 5.5	5.24	.01	5.24	.01	5.23	.01	5.23	.02	4.68	1.6	4.29	2.0	4.87	1.1	3.36			
VOH7 V	3.85 5.5	4.94	.03	4.94	.03	4.94	.03	4.92	.03	4.38	1.5	3.77	2.0	4.54	1.0	3.14			
VOL1 mV	0 100	0	0	0	0	0	0	0	0	201	601	301	716	100	437	177			
VOL2 mV	0 100	0	0	0	0	0	0	0	0	201	601	302	716	101	437	-24			
VOL3 mV	0 100	0	0	0	0	0	0	0	0	201	601	303	715	103	436	-24			
VOL4 mV	0 500	136	5	136	4	136	4	136	4	318	563	420	666	222	409	8			
VOL5 mV	0 500	196	8	195	6	197	0	195	7	374	544	481	641	286	395	25			
VOL6 mV	0 500	172	7	171	6	173	7	171	7	355	550	462	649	268	399	18			
VOL7 mV	0 1650	367	16	366	13	369	16	367	15	529	492	638	576	455	357	69			
IIL nA	-1000 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIL nA	0 1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ICCH uA	0 160	0	0	0.4	0.2	11.1	10.9	791	974	5E3	4E3	3E3	4E3	7E3	5E3	1E4			
ICCL uA	0 160	0	0	0.2	0.1	7.4	7.8	219	241	1E3	1E3	946	1E3	4E3	3E3	1E4			

TABLE IV. (continued)

Parameters	ns	Spec. Limits		Initials		Total Dose Exposure (krads)								Anneal		Total Dose (krads)			
		min	max	mean	sd	10		20		50		100		168 hrs		200		300	
						mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
LH CP QN	ns	1	12	6.2	0.7	6.2	0.7	6.2	0.7	6.0	0.7	36.8	120	52.6	143	52.0	144	260	246
LH CP TC	ns	1	14	8.2	1.0	8.1	1	8.1	1	8.5	1	132	213	193	237	101	191	438	162
HL CP QN	ns	1	12	7.9	0.7	7.8	0.7	7.8	0.7	6.8	0.8	37.4	119	52.5	144	29.2	104	114	253
HL CP TC	ns	1	14	11.1	0.7	11.1	0.7	11.1	0.7	10.2	0.7	132	212	193	237	101	192	438	162
LH ET TC	ns	1	10	4.1	0.5	4.0	0.5	4.0	0.5	5.4	0.5	241	409	360	460	183	358	832	312
HL ET TC	ns	1	11.5	6.8	0.3	6.9	0.3	6.8	0.3	7.1	0.3	243	408	361	460	184	368	832	311
HL MR QN	ns	1	11.5	9.3	0.8	9.3	0.8	9.3	0.8	8.3	0.5	63.7	216	92	250	50.2	188	621	413
HL MR TC	ns	1	15	11.4	0.8	11.3	0.8	11.4	0.8	10.6	0.8	232	385	344	431	177	347	788	294

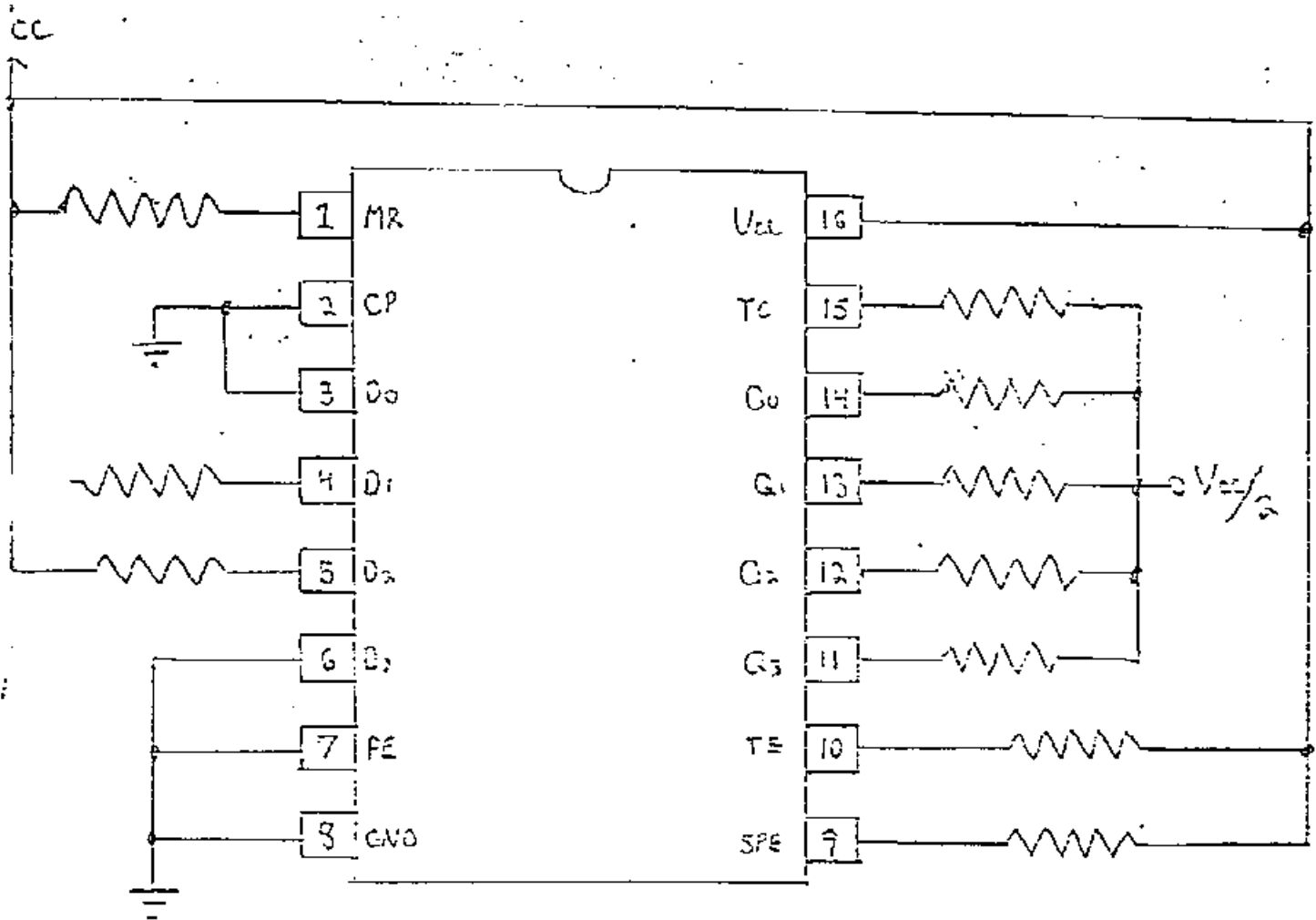
Notes:

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/ Table IV provides radiation characteristics of parts at selected total dose exposures and annealing treatments. The data at other radiation exposures and annealing treatments is available and can be obtained upon request.



Figure 1. Radiation Bias Circuit for 54AC161



$$V_{cc} = 5.0V \pm 0.5V$$

$$V_{cc}/2 = 2.5V \pm 0.25V$$

All resistors = 1 KOHM  $\pm$  10% 1/4 WATT