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JPL PUBLICATION 85-47

# Total Integrated Dose Testing of Solid-State Scientific CD4011, CD4013, and CD4060 Devices by Irradiation With CO-60 Gamma Rays

Armando Roberto V. Dantas  
Michael K. Gauthier  
James R. Coss

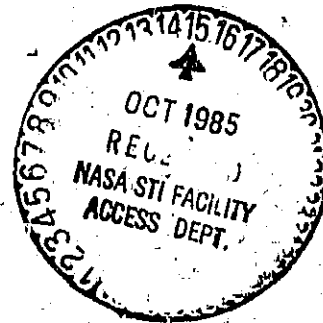
(NASA-CR-176196) TOTAL INTEGRATED DOSE  
TESTING OF SOLID-STATE SCIENTIFIC CD4011,  
CD4013, AND CD4060 DEVICES BY IRRADIATION  
WITH CO-60 GAMMA RAYS (Jet Propulsion Lab.)  
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May 15, 1985



Prepared for and in cooperation with  
TRW Components International  
Through an agreement with  
National Aeronautics and Space Administration  
by  
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Pasadena, California

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## ABSTRACT

The total integrated dose response of three CMOS devices manufactured by Solid State Scientific has been measured using CO-60 gamma rays. Key parameter measurements were made and compared for each device type. The data show that the CD4011, CD4013 and CD4060 produced by this manufacturer should not be used in any environments where radiation levels might exceed 1,000 rad(Si).

## ACKNOWLEDGMENTS

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## I. INTRODUCTION

The purpose of this report is to present the results of an investigation into the total integrated dose (TID) tolerances of three Complementary Metal-Oxide Semiconductor (CMOS) devices manufactured by Solid State Scientific. Their CD4011B (Quad 2 - input NAND), CD4013B (Dual D-type Flip-Flop) and CD4060 (14-stage Counter and Oscillator) were irradiated with cobalt-60 gamma rays as part of JPL Task Plan No. 20-2424, "Radiation Effects: Commercial Microcircuits," per request of TRW Components International.

## II. EXPERIMENTAL PROCEDURES

The JPL cobalt-60 gamma ray source produces primarily 1.17- and 1.33-MeV photons and secondary electrons arising from scattering and absorption. These spectra, passing through the case materials, result in an effective energy of 1.22 MeV at the chip. The gamma field is uniform within  $\pm 10\%$  in the area where devices are exposed, as determined by thermoluminescent dosimetry (TLD), using lithium fluoride/Teflon microrods. Main source calibration was performed with Landsverk ion chambers of  $\pm 2\%$  accuracy, traceable to the National Bureau of Standards. Bimonthly dose rate computations were performed to account for the source decay.

No correction factors for possible dose enhancement effects have been applied to these data. Dose enhancement effects result from Hi-Z metallic overlays on the chip or Hi-Z package materials. In this series of tests, there were no known Hi-Z materials on, or in, the devices tested.

Five samples of each device type were chosen for testing per Radiation Test Requirements (RTR) 112C-2, 114C-2 and 386-1 (see Appendices A, B and C). Each device type sample came from one date code. Bias boards were constructed per the RTRs and bias voltages of 15 volts D.C. furnished by batteries. The

devices were held under bias during irradiation as well as during parametric testing.

After pre-irradiation parametric measurements, the CD4011 and CD4013 devices were irradiated in steps and post-irradiation measurements taken immediately after each irradiation. A specially designed test box was constructed for these measurements (Appendix pages A-3, A-4, B-3, and B-4), which was located just outside the cobalt-60 test cell. Bias power was momentarily switched off, while each device was individually removed from the bias board for testing.

The CD4060 were similarly held under bias (Appendix C), but transported to a different location where a programmed IT200 automatic tester was used to make measurements. In addition to the parametric tests listed on the RTR, the CD4060 program included a bit pattern of 1's and 0's to monitor functionality.

The time interval between irradiation periods for all devices ranged from 45 minutes to 1 hour. Total dose levels ranged from 1,000 to 100,000 rad(Si); but not all devices were tested to the highest levels due to parametric degradation. Dose rates ranged from 3.33 to 10 rad(Si)/sec.

A computer was used to process the data, and calculate the mean, maximum and minimum  $\Delta$ 's. This program presents the data and graphs in Gray(Si) and Gy(Si)/sec\*.

All devices were CMOS and handled in such a manner to prevent damage due to electrostatic discharge.

To test the operational integrity of the test box, stock CD4011 and CD4013 devices were obtained from JPL Electronic Stores and measured under the same conditions as the DUT's. This verified that the test box was performing properly.

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\*1 Gy(Si) = 100 rad(Si).

### III. DISCUSSION OF RESULTS

The test results for CD4011, CD4013, and CD4060 devices are shown in Appendixes D, E, and F respectively. The graphs showing mean values are presented as Figures 1 through 13 following the conclusions. In the graphs, for all three device types, IDD1 represents the Quiescent Current with the outputs tied high, while IDD2 represents the Quiescent Current with the outputs tied low.

In the CD4011 and CD4013 device graphs, VTN represents the N-Threshold Voltage, while VTP represents the P-Threshold Voltage. The number following VTN or VTP (VTN3, etc.) designates the device pin at which the measurement was taken.

In the case of the VTN and VTP graphs for the CD4060, these still designate Threshold Voltage measurements, but the numbers 1 and 2 designate that measurements were taken at device pins 11 and 12 respectively.

#### A. CD4011

These devices appeared to be damaged before arrival at JPL. All initial threshold voltages (VTN) were out of range (-10 volts) on all pins. Initial IDD readings were less than a nanoamp but increased to their maximum specified value at 5,000 rad(Si) TID (Figure 1). There was no measurable recovery noted for these devices one week after their last irradiation.

#### B. CD4013

Threshold voltages showed measurable degradation with 1,000 rad(Si) and were well beyond tolerable levels (> 3 times increase) at 2,000 rad(Si) (Figure 2). Leakage current measurements (IDD) show a similar trend (Figures 3 through 10). As with the CD4011, these devices did not show any measurable recovery one week after their last irradiation.

### C. CD4060

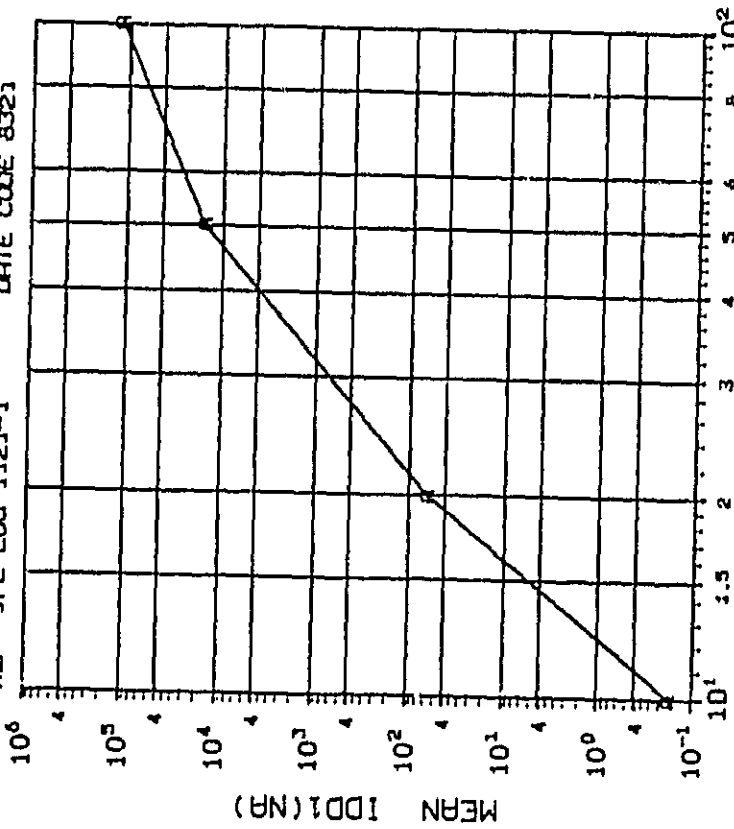
These devices were degraded by radiation in a manner similar to the CD4013 devices (Figures 11 through 13) showing measurable degradation at 1000 rad(Si) and failure by 2,000 rad(Si). It should be noted, however, that the programmed bit pattern was maintained until these devices had received a total dose between 50,000 and 100,000 rad(Si). Further, they did show some recovery by the reinstatement of the bit pattern 24 hours after the last irradiation and some parametric improvement one week later.

### IV. CONCLUSIONS

From these test results, these devices cannot be recommended for use in an environment where they may receive more than very low radiation levels [ $\leq 1,000$  rad(SI)].

Also, it is believed that the SSS CD4011 devices probably sustained ESD damage before arriving at JPL.

MFG: SOLID STATE SCIENTIFIC  
 DEVICE TYPE: CD4011 (4-NAND)  
 MFG: SSS 5 DEVICES TEST DATE 3-20-85  
 REF: JPL LOG 1121-1 DATE CODE 8321

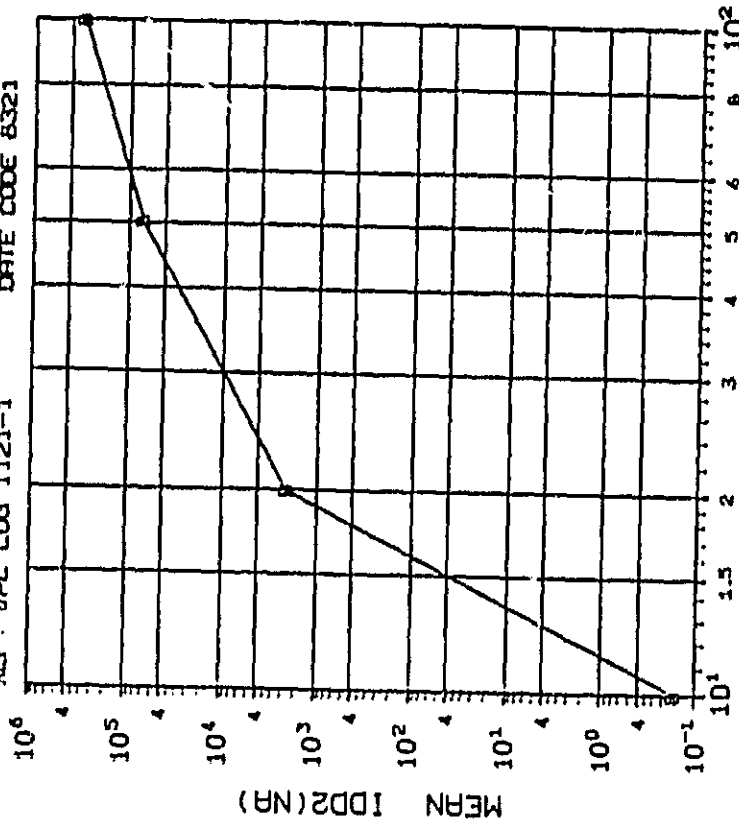


DOSE, Gy(S;) Co<sup>60</sup> Gamma  
 (111IDD1 (VDD=15V) IN NA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kIlGy(S;)
A	.01 .02 .05 .10
	.0188 86.60 ***** *****

INITIAL MEAN VALUE IDD1(NA) = 1.71X10<sup>-1</sup>

DEVICE TYPE: CD4011 (4-NAND)  
 MFG: SSS 5 DEVICES TEST DATE 3-20-85  
 REF: JPL LOG 1121-1 DATE CODE 8321



DOSE, Gy(S;) Co<sup>60</sup> Gamma  
 (211IDD2 (VDD=15V) IN NA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kIlGy(S;)
5	.01 .02 .05 .10
	.0420 664.5 ***** *****

INITIAL MEAN VALUE IDD2(NA) = 1.46X10<sup>-1</sup>

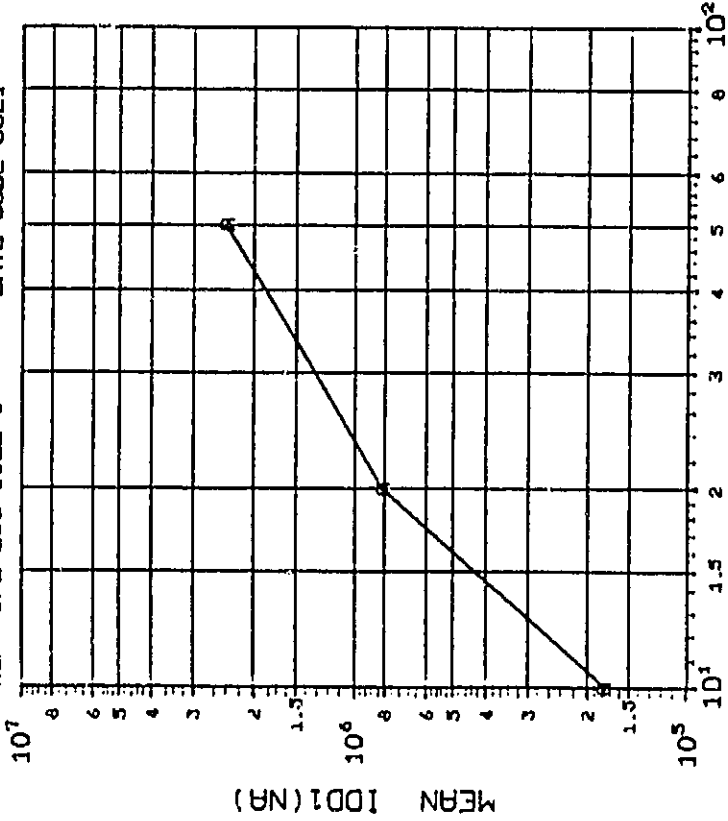
Figure 1. IDD1 and IDD2 for CD4011

MFG: SOLID STATE SCIENTIFIC

DEVICE TYPE: CD4013 (DUAL DF/F)

MFG: SSS 5 DEVICES TEST DATE 3-19-85

REF: JPL LOG 1122-1 DATE CODE 8321



DOSE, Gy(Sj) Co<sup>60</sup> Gammas

(1)IDD1 (VDD=15V) IN NA: VS DOSE

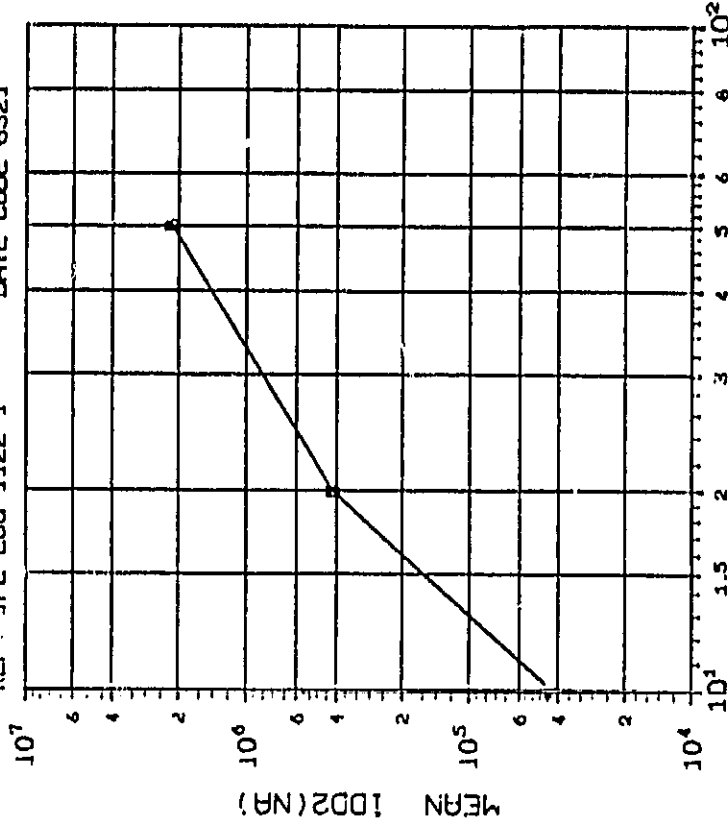
TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJfGy(Sj)
A	.01 .02 .05
	***** ***** *****

INITIAL MEAN VALUE IDD1(NA) = 1.43X10<sup>5</sup>

DEVICE TYPE: CD4013 (DUAL DF/F)

MFG: SSS 5 DEVICES TEST DATE 3-19-85

REF: JPL LOG 1122-1 DATE CODE 8321



DOSE, Gy(Sj) Co<sup>60</sup> Gammas

(2)IDD2 (VDD=15V) IN NA: VS DOSE

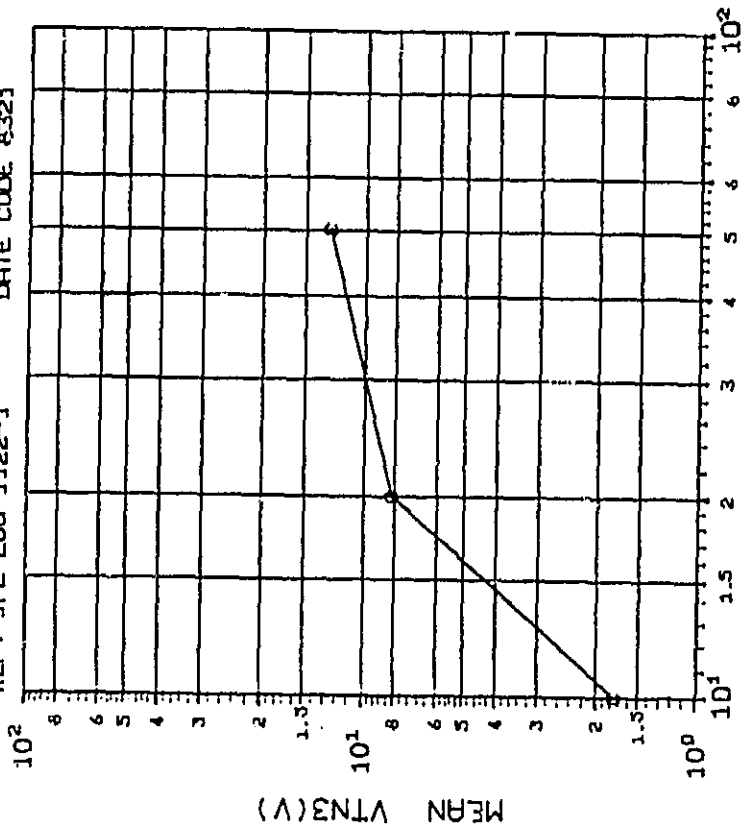
TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJfGy(Sj)
B	.01 .02 .05
	***** ***** *****

INITIAL MEAN VALUE IDD2(NA) = 3.57X10<sup>4</sup>

Figure 2. IDD1 and IDD2 for CD4013

MFG: SOLID STATE SCIENTIFIC  
 DEVICE TYPE: CD4013 (DUAL DF/F)

MFG: SSS 5 DEVICES TEST DATE 3-19-85  
 REF: JPL LOG 1122-1 DATE CODE 6321



DOSE, Gy (Si) Co<sup>60</sup> Gammas

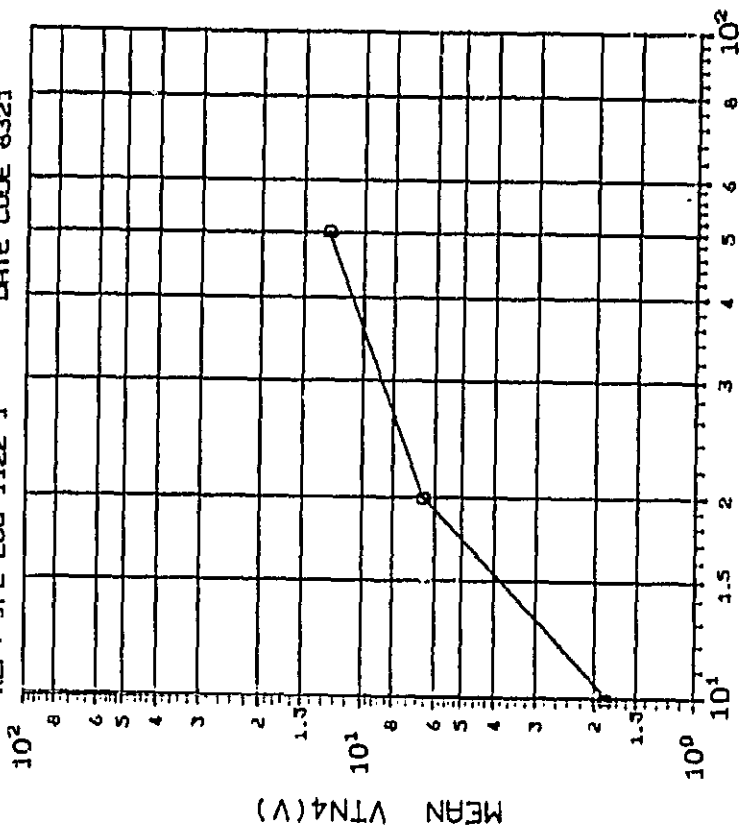
(3)VTN3 (ITN=100A) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ/Gy(Si)
C	.01 .02 .05
	.2670 2.939 1.246

INITIAL MEAN VALUE VTN3(V) = 1.99X10<sup>10</sup>

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DEVICE TYPE: CD4013 (DUAL DF/F)  
 MFG: SSS 5 DEVICES TEST DATE 3-19-85  
 REF: JPL LOG 1122-1 DATE CODE 6321



DOSE, Gy (Si) Co<sup>60</sup> Gammas

(4)VTN4 (ITN=100A) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ/Gy(Si)
D	.01 .02 .05
	.2944 1.058 1.058

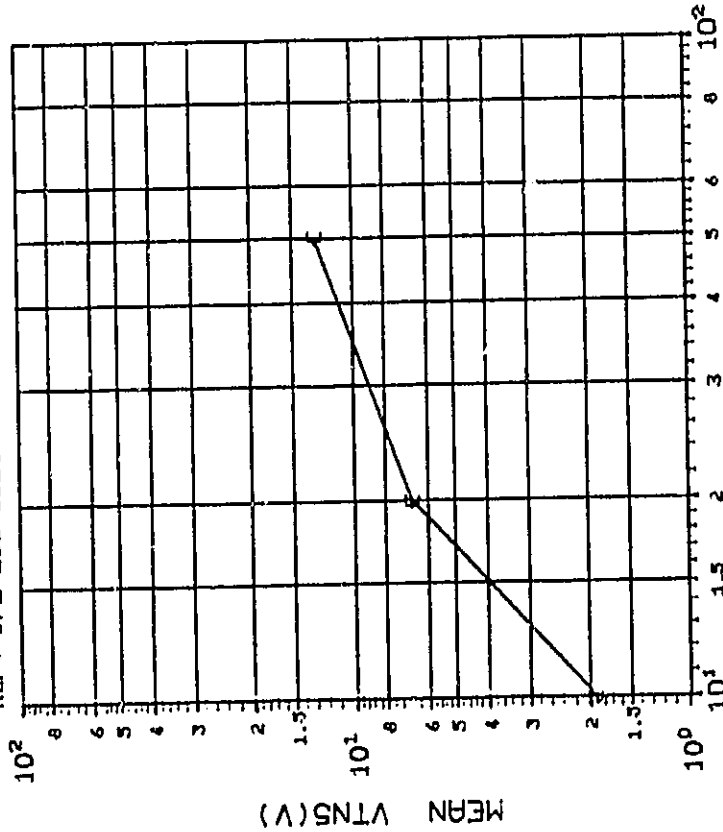
INITIAL MEAN VALUE VTN4(V) = 2.09X10<sup>10</sup>

Figure 3. VTN3 and VTN4 for CD4013



MFG: SOLID STATE SCIENTIFIC

DEVICE TYPE: CD4013 (DUAL DF/F)  
 MFG: SSS 5 DEVICES TEST DATE 3-19-85  
 REF: JPL LOG 1122-1 DATE CODE 8321



DEVICE TYPE: CD4013 (DUAL DF/F)  
 MFG: SSS 5 DEVICES TEST DATE 3-19-85  
 REF: JPL LOG 1122-1 DATE CODE 8321

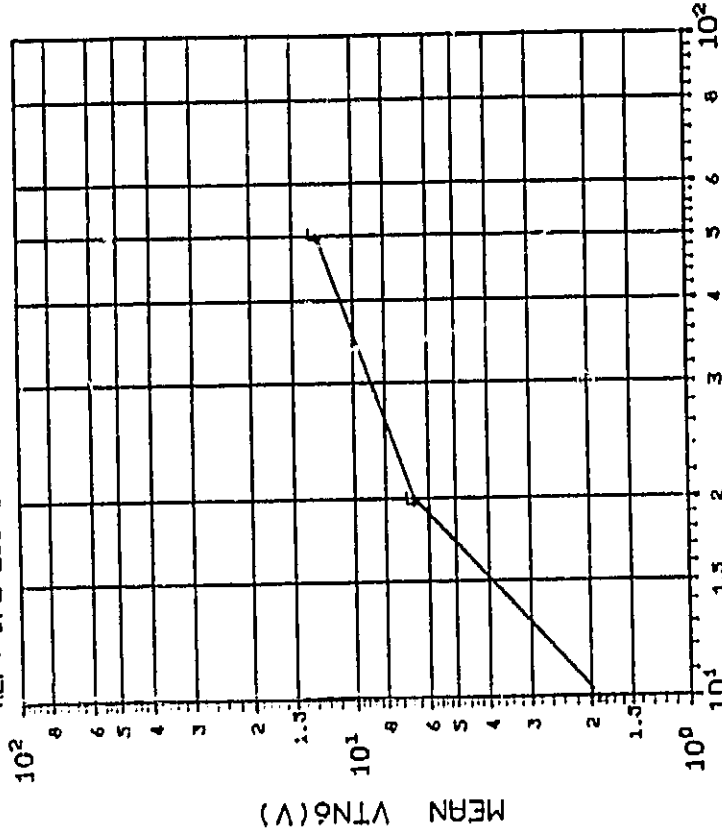
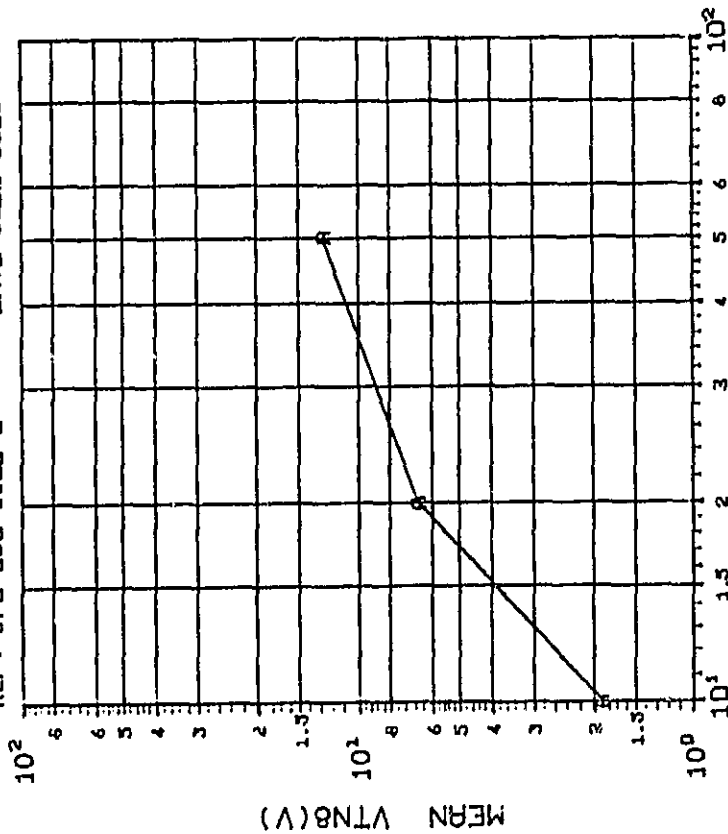


Figure 4. VTN5 and VTN6 for CD4013

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MFG: SOLID STATE SCIENTIFIC  
 DEVICE TYPE: CD4013 (DUAL DF/F)  
 MFG: SSS 5 DEVICES TEST DATE 3-19-85  
 REF: JPL LOG 1122-2 DATE CODE 8321



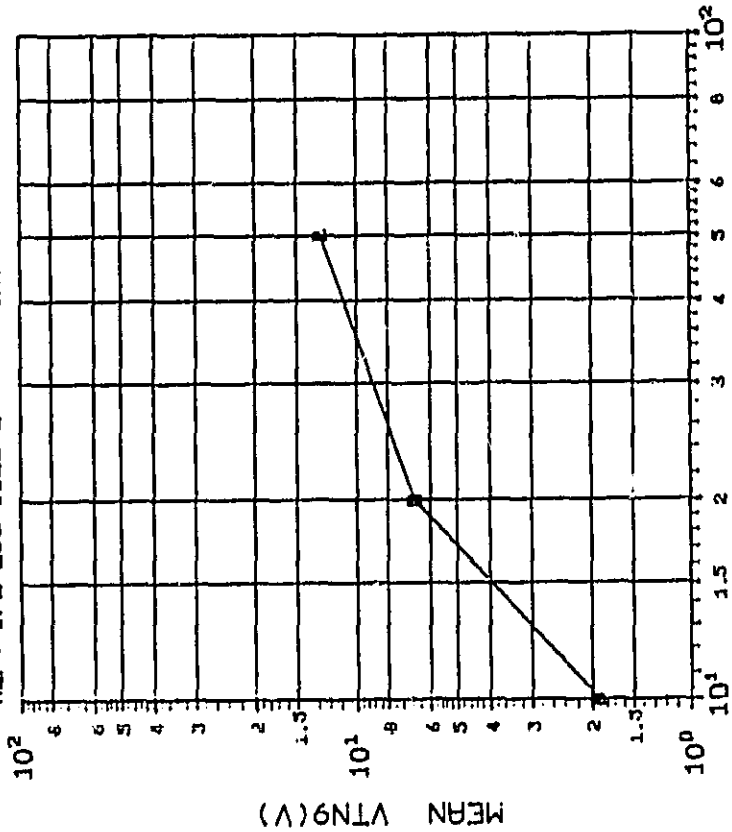
DOSE, Gy(Si) Co<sup>60</sup> Gammas

(7)VTN8 (JTN--10UR) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ/Gy(Si)
A	.01 .02 .05 .2572 1.028 1.169

INITIAL MEAN VALUE VTN8(V) = 2.20X10<sup>00</sup>

DEVICE TYPE: CD4013 (DUAL DF/F)  
 MFG: SSS 5 DEVICES TEST DATE 3-19-85  
 REF: JPL LOG 1122-2 DATE CODE 8321



DOSE, Gy(Si) Co<sup>60</sup> Gammas

(8)VTN9 (ITN--10UR) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ/Gy(Si)
B	.01 .02 .05 .3096 1.061 1.161

INITIAL MEAN VALUE VTN9(V) = 2.11X10<sup>00</sup>

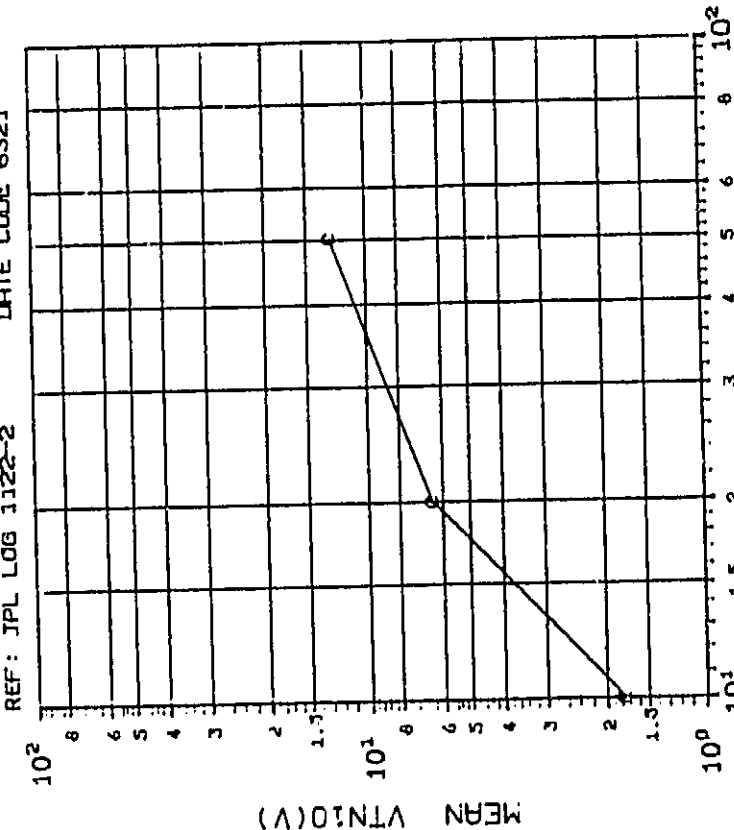
Figure 5. VTN8 and VTN9 for CD4013

MFG: SOLID STATE SCIENTIFIC

DEVICE TYPE: CD4013 (DUAL DF/F)

MFG:SSS 5 DEVICES TEST DATE 3-19-85

REF: JPL LOG 1122-2 DATE CODE 8321



DOSE, Gy(Si) Co<sup>60</sup> Gammas

(9)VTN10 (ITN=10UA) IN VOLTS: VS DOSE

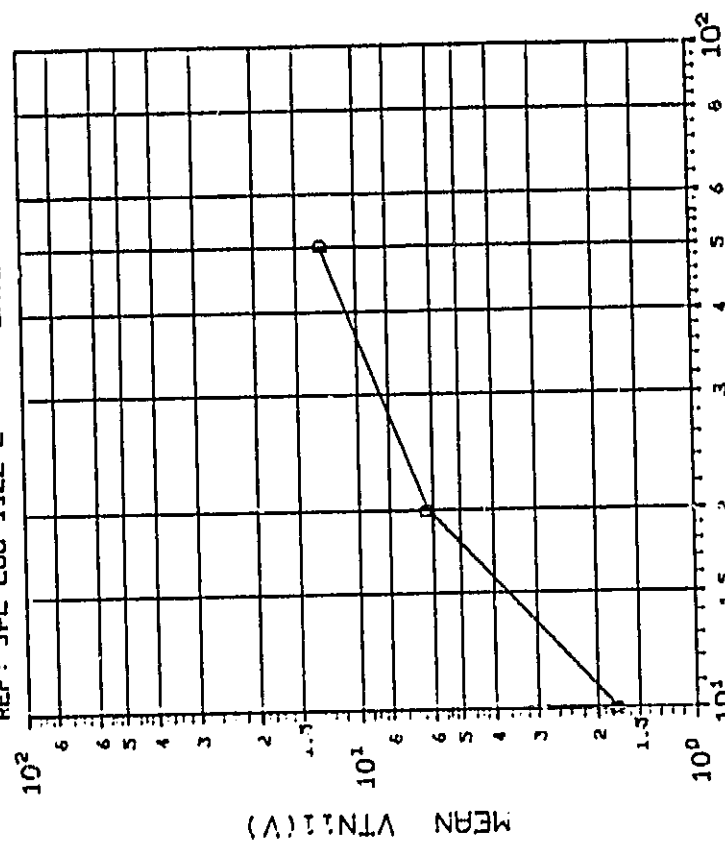
TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJlGy(Si)
C	.01 .02 .05
	.3035 1.037 1.193

INITIAL MEAN VALUE VTN10(V) = 2.10X10<sup>00</sup>

DEVICE TYPE: CD4013 (DUAL DF/F)

MFG: SSS 5 DEVICES TEST DATE 3-19-85

REF: JPL LOG 1122-2 DATE CODE 8321



DOSE, Gy(Si) Co<sup>60</sup> Gammas

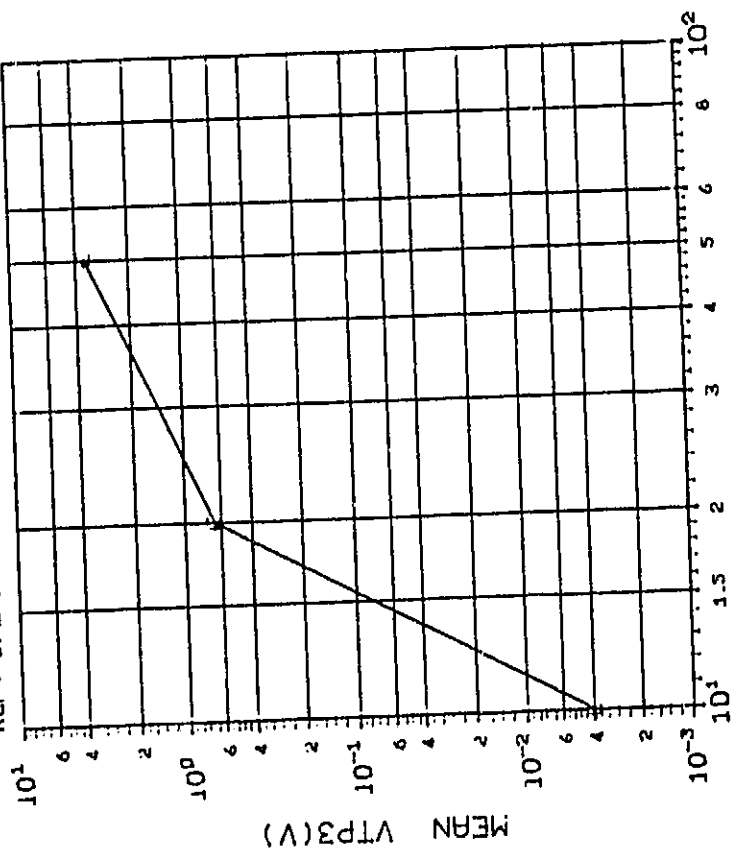
(10)VTN11(ITN=10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJlGy(Si)
D	.01 .02 .05
	.2715 1.179 1.243

INITIAL MEAN VALUE VTN11(V) = 2.01X10<sup>00</sup>

Figure 6. VTN10 and VTN11 for CD4013

MFG: SOLID STATE SCIENTIFIC  
 DEVICE TYPE: CD4013 (DUAL DF/F)  
 MFG: SSS 5 DEVICES TEST DATE 3-19-85  
 REF: JPL LOG 1122-2 DATE CODE 8321

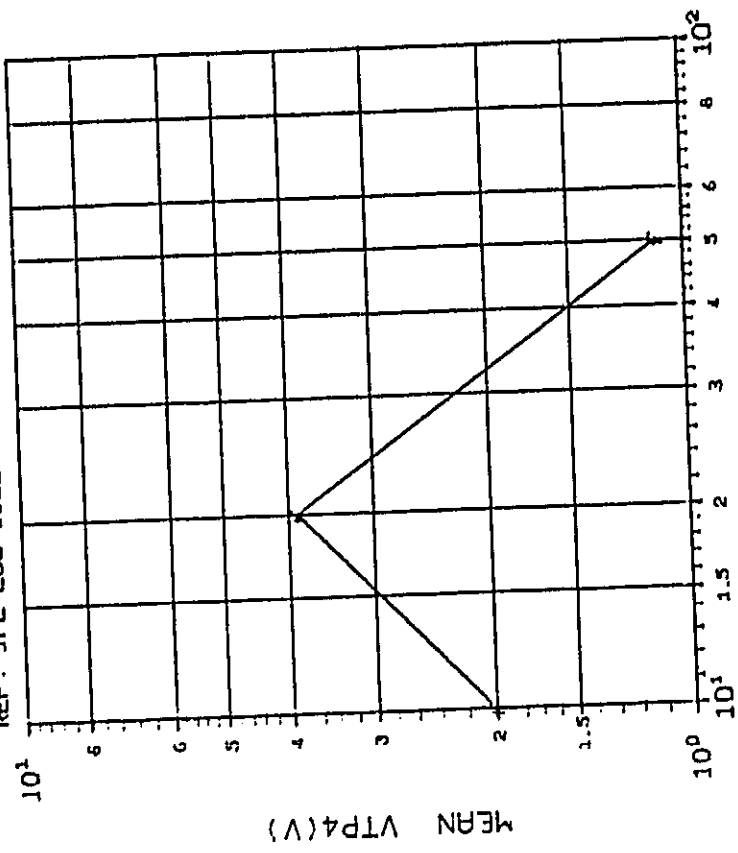


DOSE, Gy (Si) Co<sup>60</sup> Gammas  
 (11)VTP3 (ITP=+10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ/aGy (SI)
E	.01 .02 .05
	3.912 .0222 6.352

INITIAL MEAN VALUE VTP3(V) = 1.64X10<sup>00</sup>

DEVICE TYPE: CD4013 (DUAL DF/F)  
 MFG: SSS 5 DEVICES TEST DATE 3-19-85  
 REF: JPL LOG 1122-2 DATE CODE 8321



DOSE, Gy (Si) Co<sup>60</sup> Gammas  
 (12)VTP4 (ITP=+10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ/aGy (SI)
F	.01 .02 .05
	1.498 6.367 .5174

INITIAL MEAN VALUE VTP4(V) = 1.70X10<sup>00</sup>

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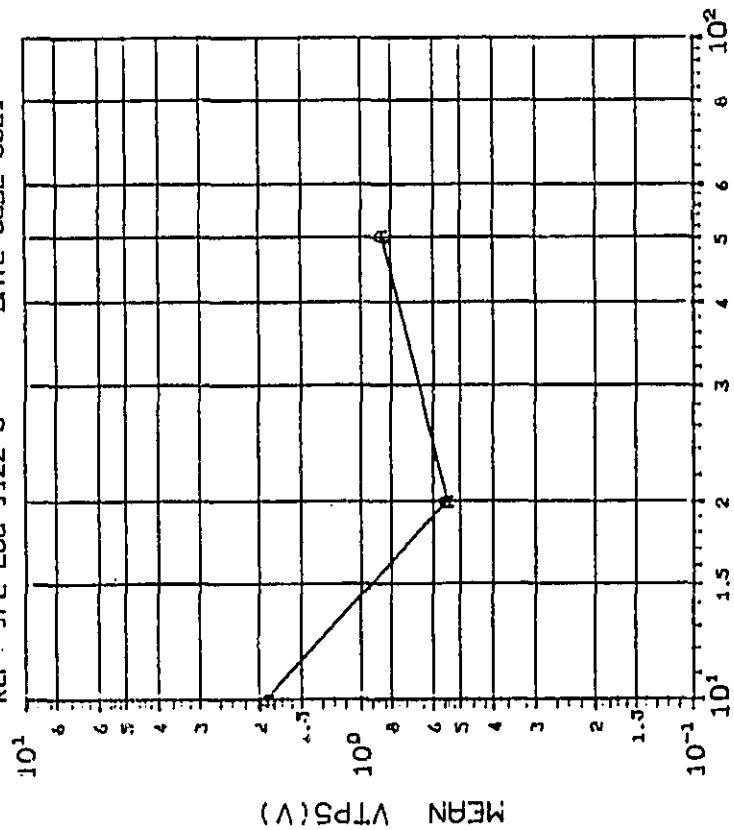
Figure 7. VTP3 and VTP4 for CD4013

MFG: SOLID STATE SCIENTIFIC

DEVICE TYPE: CD4013 (DUAL DF/F)

MFG: SSS 5 DEVICES TEST DATE 3-19-85

REF: JPL LOG 1122-3 DATE CODE 8321



DEVICE TYPE: CD4013 (DUAL DF/F)

MFG: SSS 5 DEVICES TEST DATE 3-19-85

REF: JPL LOG 1122-3 DATE CODE 8321

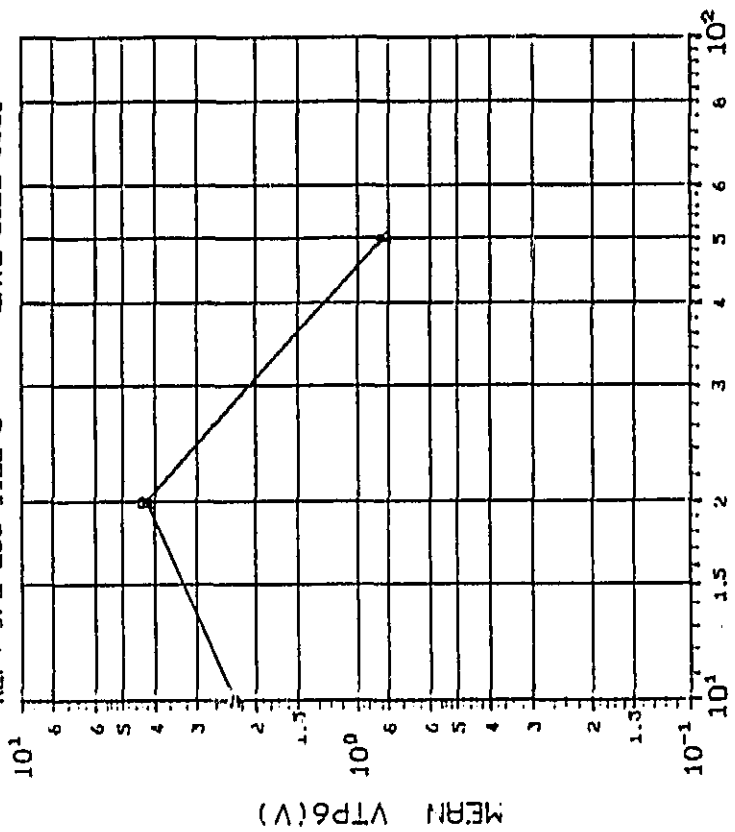


TABLE OF NORMAL STANDARD DEVIATIONS

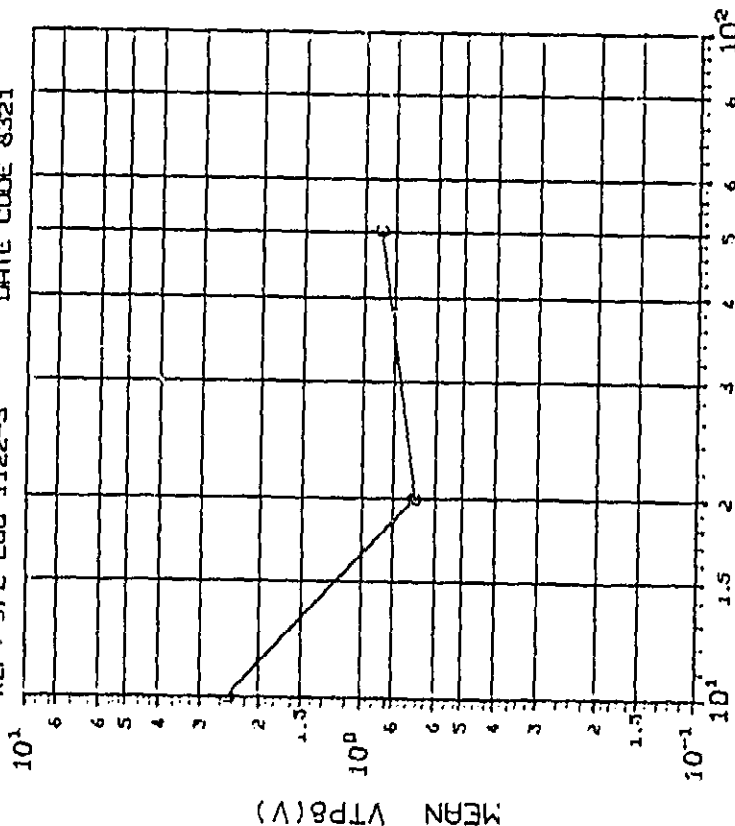
CURVE	DOSE, kJ/Gy(S)	DOSE, kJ/Gy(S)
A	.01	.02
A	1.532	.2805
A		.0310

TABLE OF NORMAL STANDARD DEVIATIONS

CURVE	DOSE, kJ/Gy(S)	DOSE, kJ/Gy(S)
B	.01	.02
B	1.724	7.197
B		.0238

Figure 8. VTP5 and VTP6 for CD4013

MFG: SOLID STATE SCIENTIFIC  
 DEVICE TYPE: LD4013 (DUAL DF/F)  
 MFG: SSS 5 DEVICES TEST DATE 3-19-85  
 REF: JPL LOG 1122-3 DATE CODE 8321

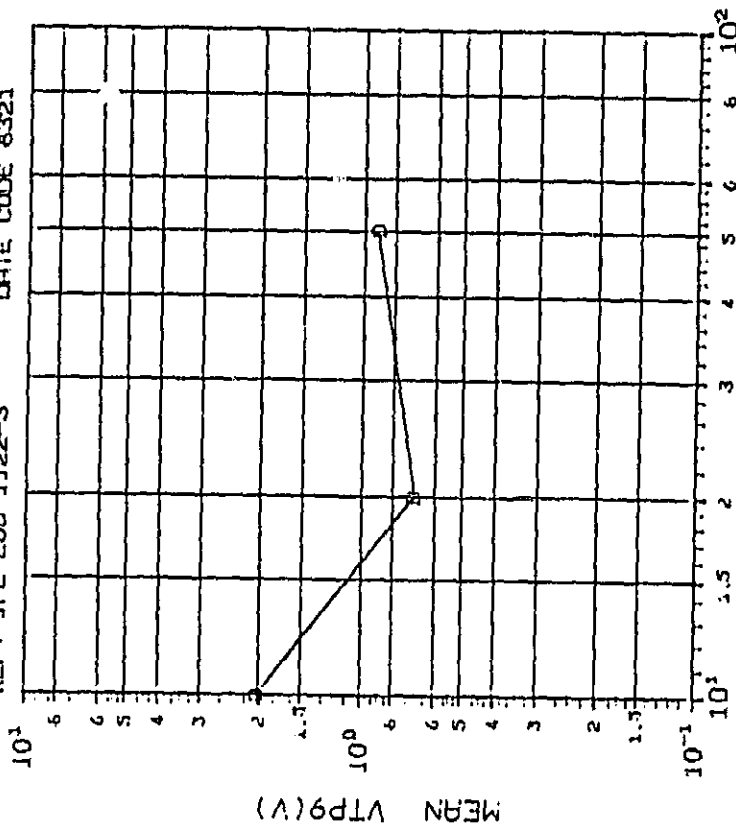


DOSE, Gy(S;) Co<sup>60</sup> Gamma  
 (15)VTP8 (ITP=+10uA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ/Gy(S;)
C	.01 .02 .05 1.801 .0292 .0337

INITIAL MEAN VALUE VTP8(V) = 1.86X10<sup>0</sup>

DEVICE TYPE: CD4013 (DUAL DF/F)  
 MFG: SSS 5 DEVICES TEST DATE 3-19-85  
 REF: JPL LOG 1122-3 DATE CODE 8321



DOSE, Gy(S;) Co<sup>60</sup> Gamma  
 (16)VTP9 (ITP=+10uA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ/Gy(S;)
D	.01 .02 .05 1.503 .0200 .0399

INITIAL MEAN VALUE VTP9(V) = 1.67X10<sup>0</sup>

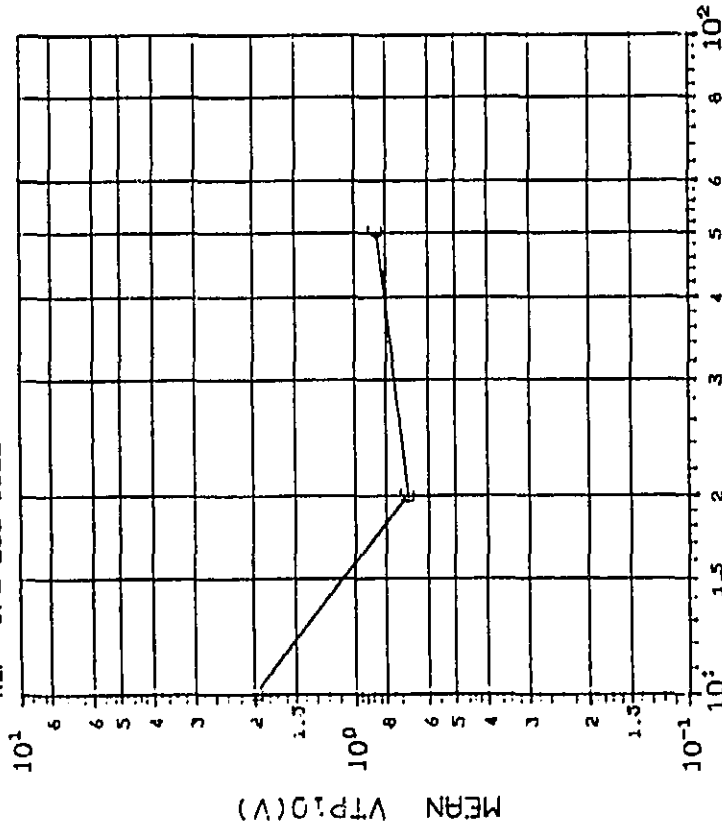
Figure 9. VTP8 and VTP9 for CD4013

MFG: SOLID STATE SCIENTIFIC

DEVICE TYPE: CD4013 (DUAL DF/F)

MFG: SSS 5 DEVICES TEST DATE 3-19-85

REF: JPL LOG 1122-3 DATE CODE 6321



DOSE, Gy(Si) Co<sup>60</sup> Gammas

(17)VTP10(ITP=+10UA) IN VOLTS: VS DOSE

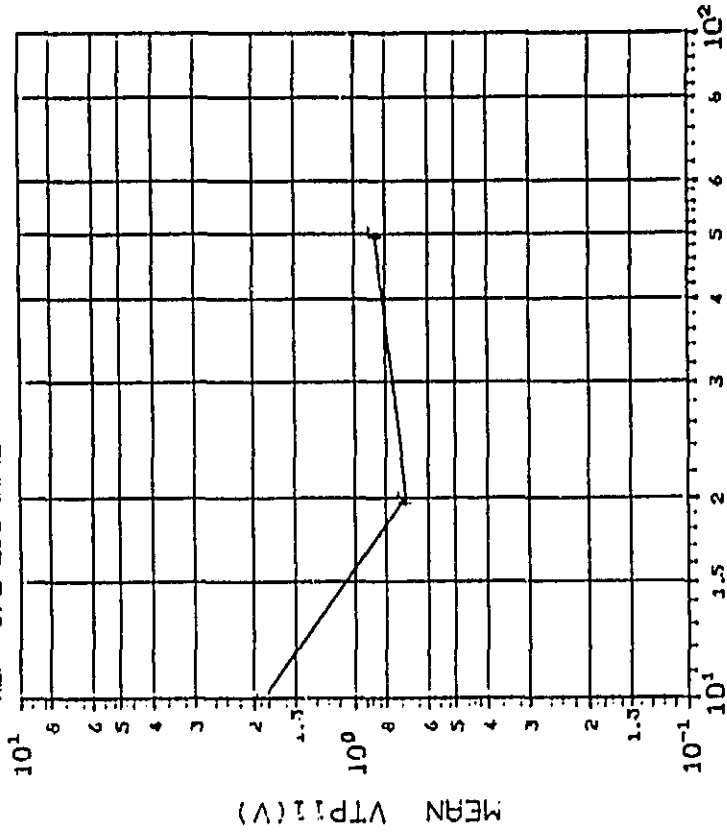
TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ10Gy(SI)
E	.01 .02 .05
	1.476 .0200 .0350

INITIAL MEAN VALUE VTP10(V) = 1.66X10<sup>00</sup>

DEVICE TYPE: CD4013 (DUAL DF/F)

MFG: SSS 5 DEVICES TEST DATE 3-19-85

REF: JPL LOG 1122-3 DATE CODE 8321



DOSE, Gy(Si) Co<sup>60</sup> Gammas

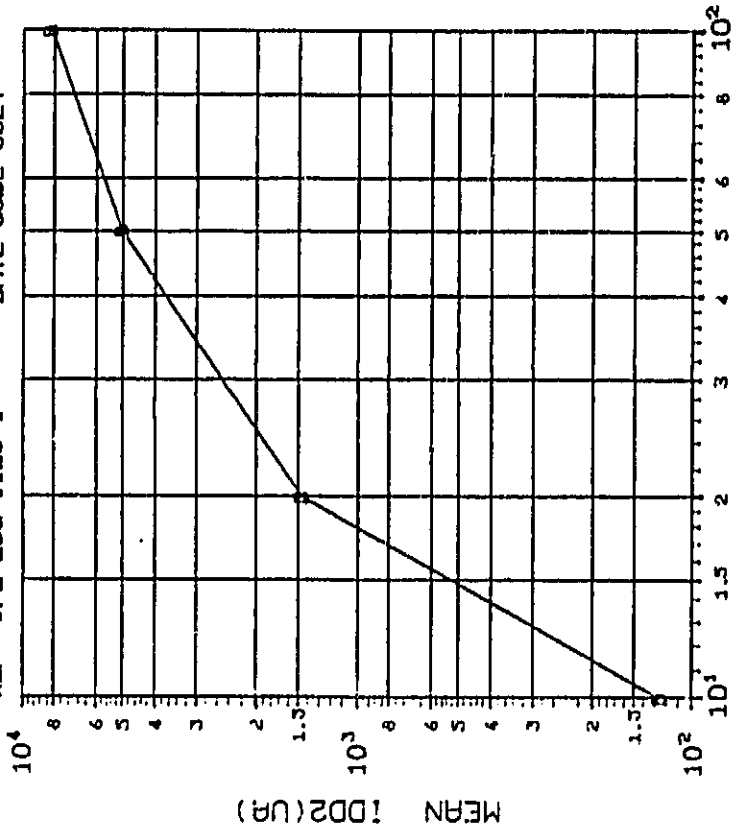
(18)VTP11(ITP=+10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ10Gy(SI)
F	.01 .02 .05
	1.414 .0200 .0271

INITIAL MEAN VALUE VTP11(V) = 1.64X10<sup>00</sup>

Figure 10. VTP10 and VTP11 for CD4013

DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
MFG:SSS 5 DEVICES TEST DATE 3-6-85  
REF: JPL LOG 1123-1 DATE CODE 8327



DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
MFG: SSS 5 DEVICES TEST DATE 3-6-85  
REF: JPL LOG 1123-1 DATE CODE 8327

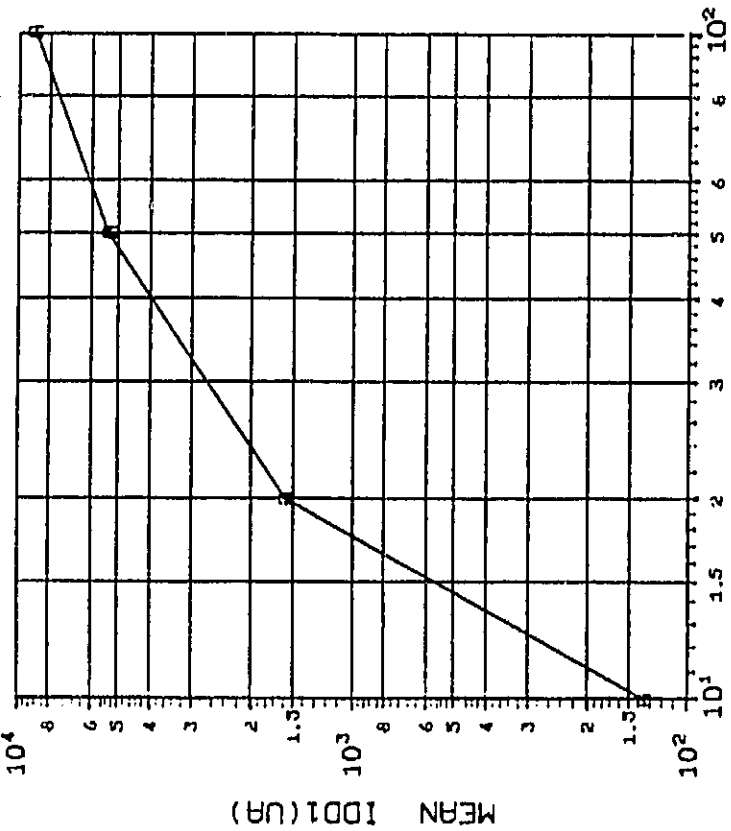
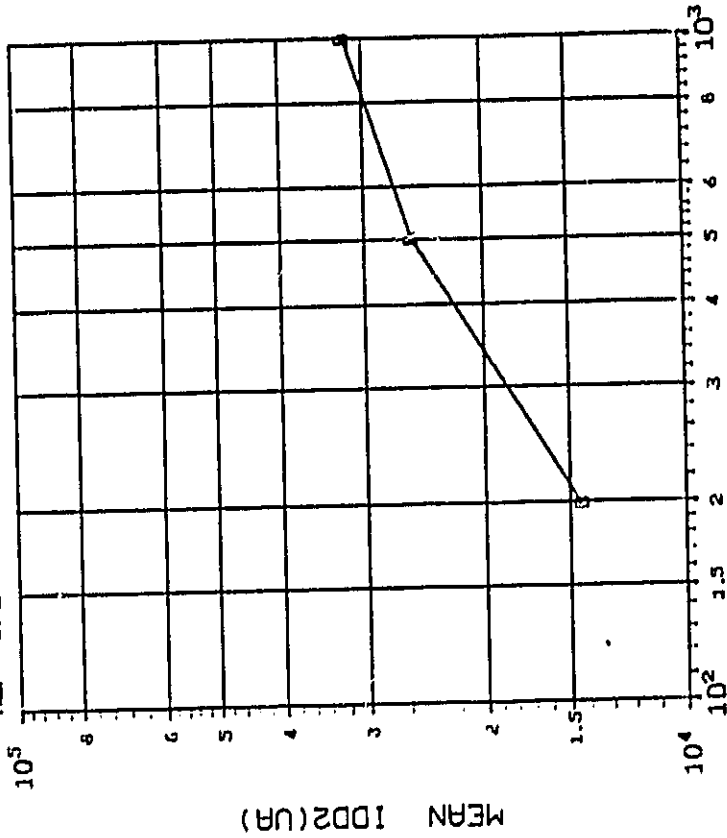


Figure 11. IDD1 and IDD2 for CD4060



DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
 MFG: SSS 5 DEVICES TEST DATE 3-6-85  
 REF: JPL LOG 1123-2 DATE CODE 8327



DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
 MFG: SSS 5 DEVICES TEST DATE 3-6-85  
 REF: JPL LOG 1123-2 DATE CODE 8327

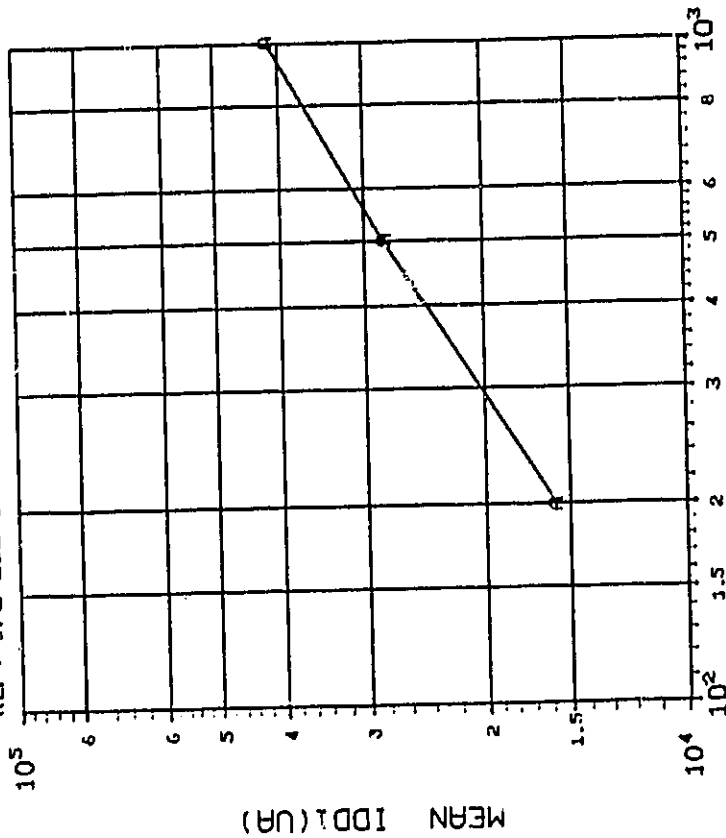
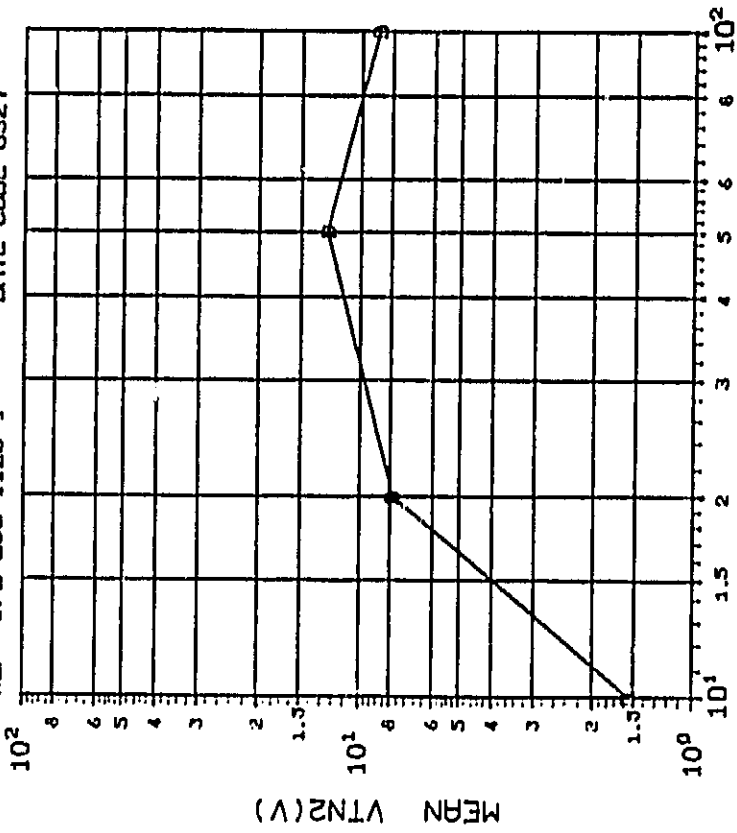


Figure 11. IDD1 and IDD2 for CD4060 (Continued)

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DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
MFG: SSS 5 DEVICES TEST DATE 3-6-85  
REF: JPL LOG 1123-1 DATE CODE 8327

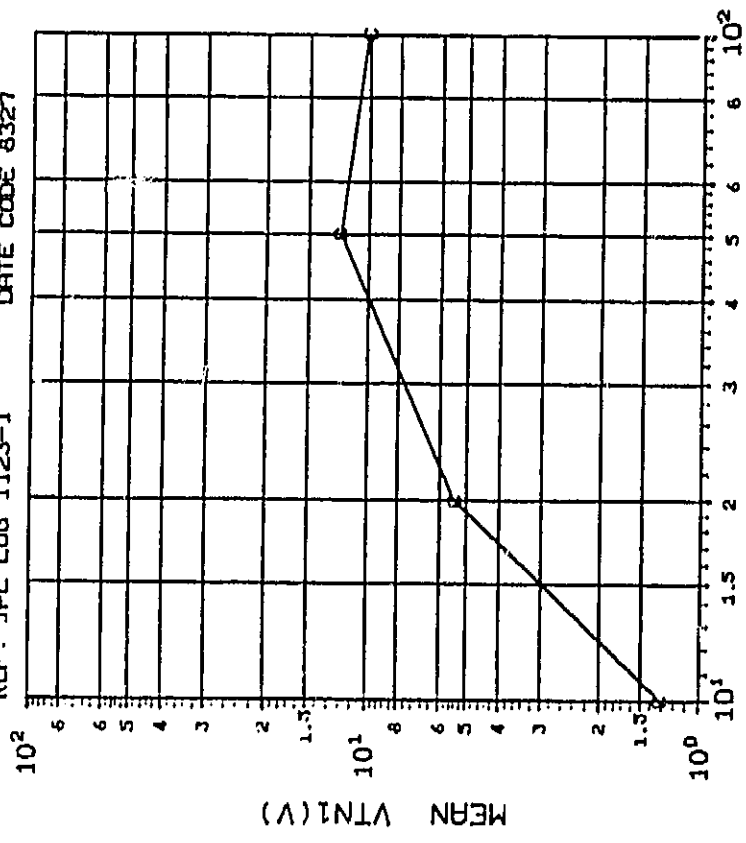


DOSE, Gy (Si) Co<sup>60</sup> Gammas  
(4)VTN2 (ITN2=-10uA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, k.r./Gy (Si)
D	.01 .02 .05 .10 .1910 .5325 .0219 3.194

INITIAL MEAN VALUE VTN2(V) = 1.77X10<sup>-9</sup>

DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
MFG: SSS 5 DEVICES TEST DATE 3-6-85  
REF: JPL LOG 1123-1 DATE CODE 8327



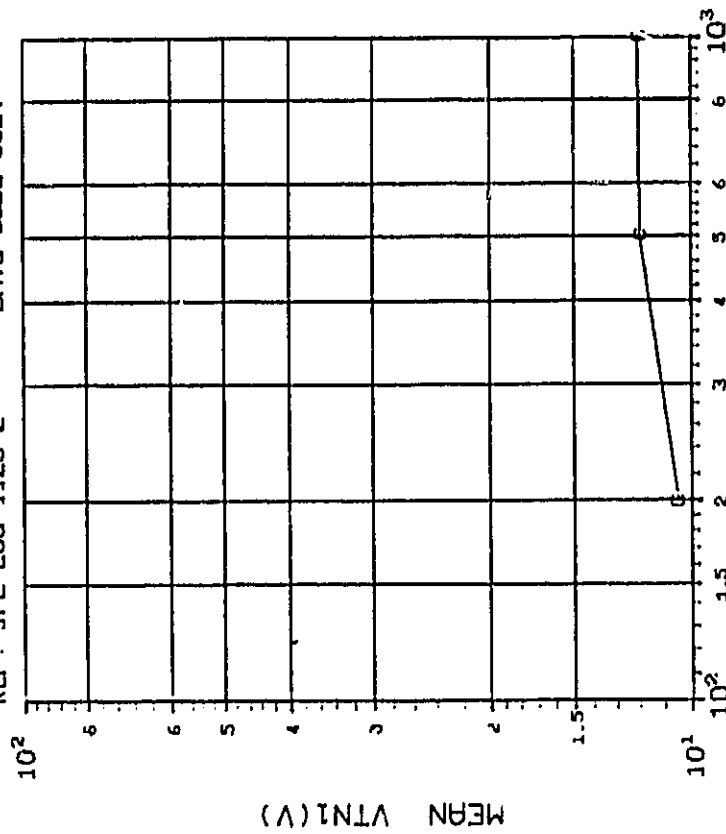
DOSE, Gy (Si) Co<sup>60</sup> Gammas  
(3)VTN1 (ITN1=-10uA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, k.r./Gy (Si)
C	.01 .02 .05 .10 .2063 .2713 .1320 3.140

INITIAL MEAN VALUE VTN1(V) = 1.57X10<sup>-9</sup>

Figure 12. VTN1 and VTN2 for CD4060

DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
 MFG:SSS 5 DEVICES TEST DATE 3-6-85  
 REF: JPL LOG 1123-2 DATE CODE 8327

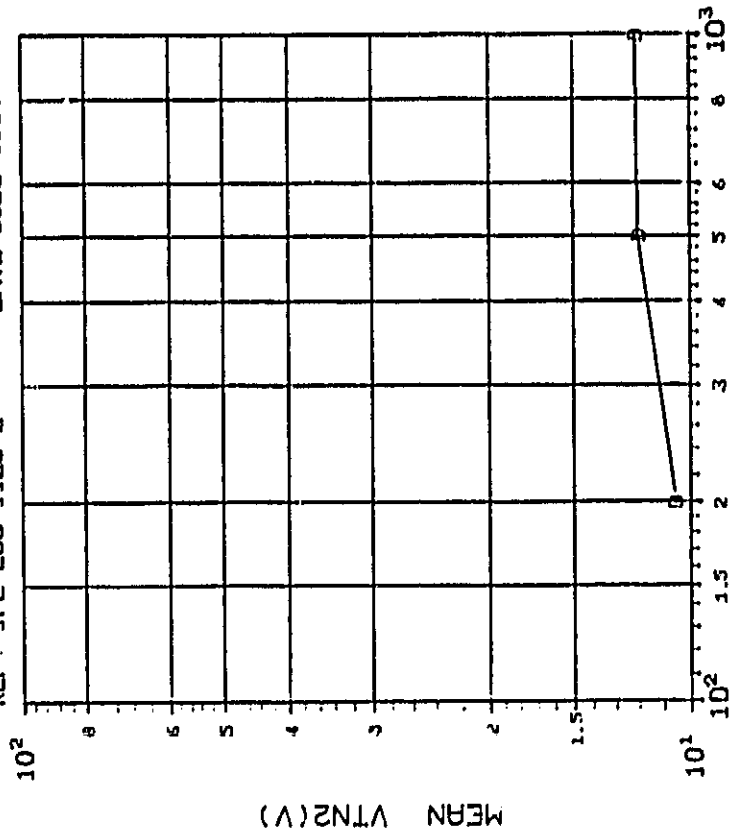


(3) (JTN1=-10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ/Gy(Si)
C	.20 .50 1.00
	2.252 .1623 .0950

INITIAL MEAN VALUE VTNI(V) = 1.57X10<sup>-9</sup>

DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
 MFG:SSS 5 DEVICES TEST DATE 3-6-85  
 REF: JPL LOG 1123-2 DATE CODE 8327



(4) (JTN2=-10UA) IN VOLTS: VS DOSE

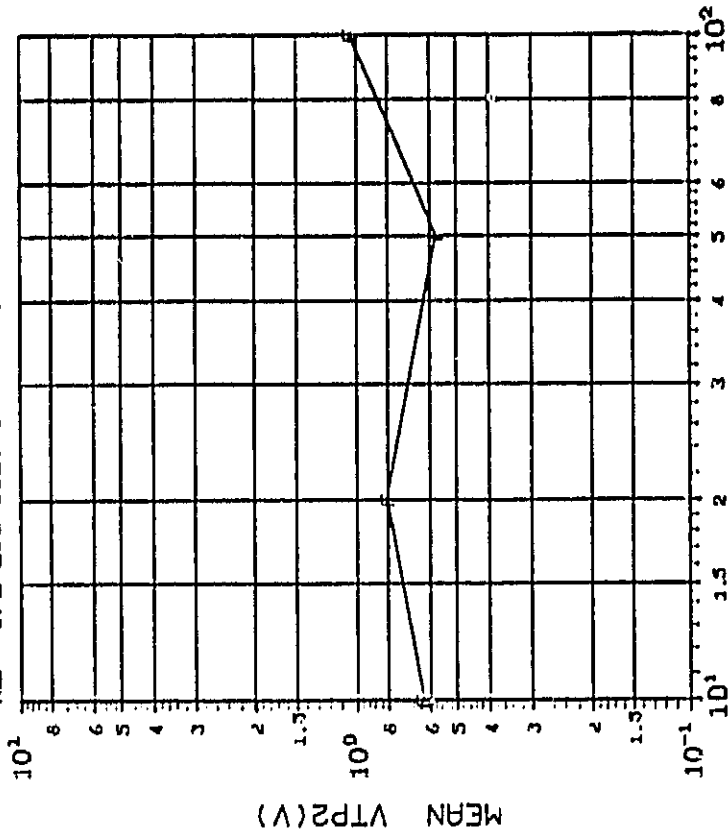
TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kJ/Gy(Si)
D	.20 .50 1.00
	2.371 .1066 .1354

INITIAL MEAN VALUE VTN2(V) = 1.77X10<sup>-9</sup>

Figure 12. VTNI and VTN2 for CD4060 (Continued)

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DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
MFG: SSS 5 DEVICES TEST DATE 3-6-85  
REF: JPL LOG 1123-1 DATE CODE 8327



DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
MFG: SSS 5 DEVICES TEST DATE 3-6-85  
REF: JPL LOG 1123-1 DATE CODE 8327

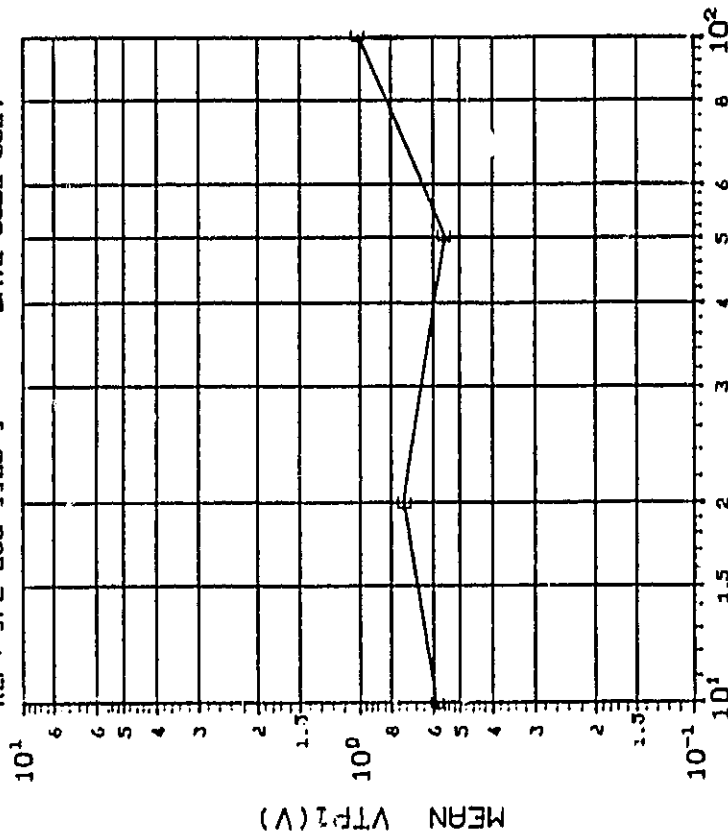
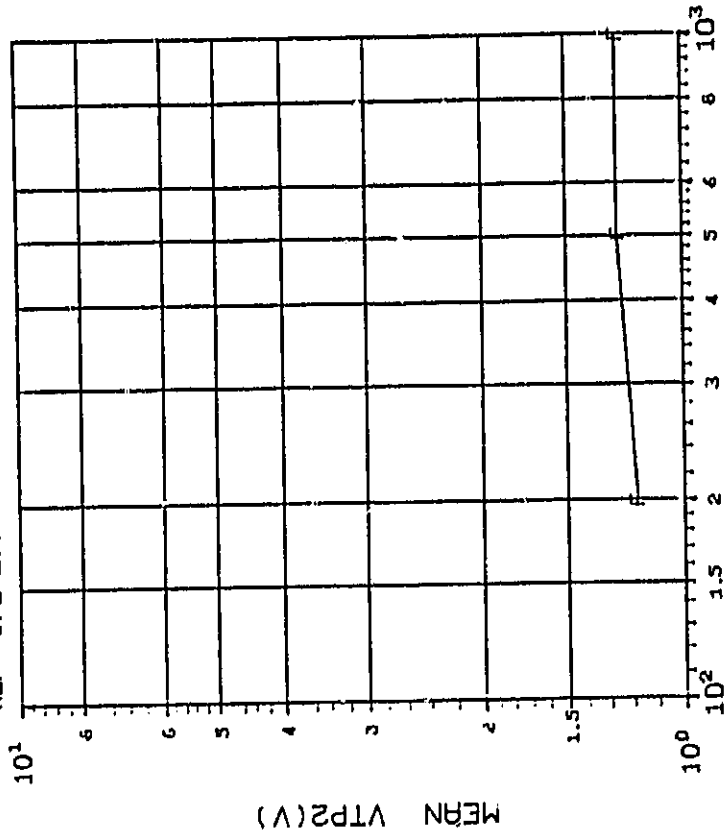


Figure 13. VTP1 and VTP2 for CD4060

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DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
MFG:SSS 5 DEVICES TEST DATE 3-6-85  
REF: JPL LOG 1123-2 DATE CODE 8327



DEVICE TYPE: CD4060 COUNTER/DIVIDE/OSC  
MFG:SSS 5 DEVICES TEST DATE 3-6-85  
REF: JPL LOG 1123-2 DATE CODE 8327

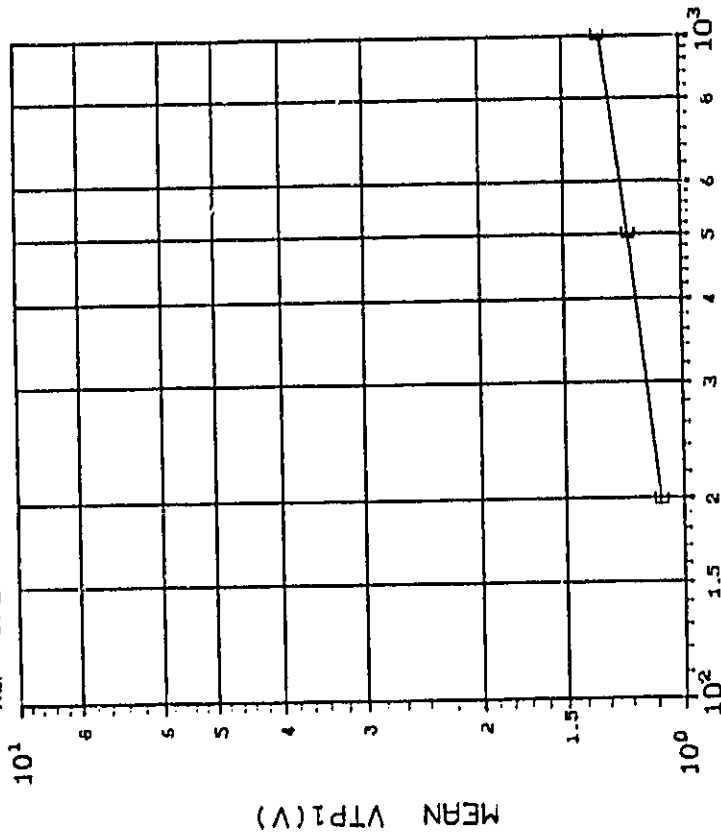


Figure 13. VTP1 and VTP2 for CD4060 (Continued)

APPENDIX A  
RADIATION TEST REQUIREMENTS

RADIATION TEST REQUIREMENTS

Device Type CD 4011 (4-NAND) RTR S/N Y12C-2

Manufacturer SSS

Device Package

Lot No. \_\_\_\_\_ Date Code \_\_\_\_\_

No. of Devices Supplied \_\_\_\_\_

No. of Devices to be tested 5

Type	No. of Leads
DIP	14

535-64408-0-5140

RADIATION CONDITIONS:

Facility: Co60

Energy: 1.25 MeV

	UNITS	RADIATION LEVELS			
Fluence		see	table	below	
Flux					

BIAS CONDITIONS DURING IRRADIATION:

Pin No.	Parameter	Voltage	Remarks	Bias Circuit	
				Fluence rad(Si)	Flux rad(Si)/sec.
1	In	10K to 15V		1E3	3.33E0
2	In	"		2E3	3.33E0
3	Out	100K to 15V	low	5E3	1E1
4	Out	100k to GND	high	1E4	1E1
5	In	Ground		2E4	1E1
6	In	Ground		5E4	1E1
7	V <sub>SS</sub>	Ground		1E5*	1E1
8	In	10k to 15V			
9	In	"			
10	Out	100K to 15V	low		
11	Out	100K to GND	high		
12	In	Ground			
13	In	Ground			
14	V <sub>DD</sub>	15V-10k			

\*Further radiations at the discretion of test engineer/customer.

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RADIATION TEST REQUIREMENTS

RTR 5/N 112C-2

Device Type: CD4011 (4-NAND)-1

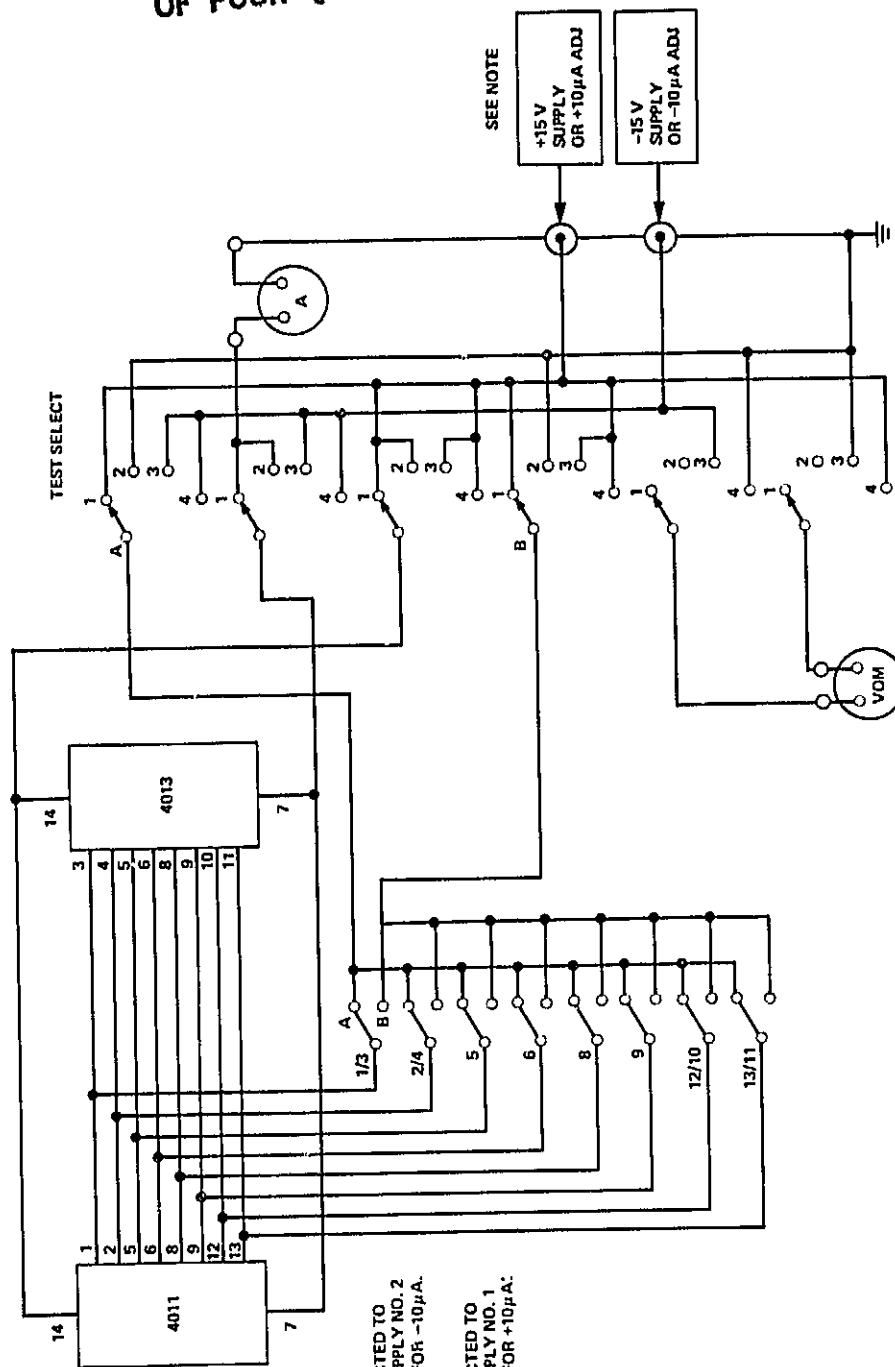
JPL Contact:		
Name	Subsystem	Phone
M. Gauthier	514	2126
B. Dantas	514	4932
J. Coss	514	7463
E. Powell	514	6175

MEASUREMENT CONDITIONS: (Measurements Shall Be Made at Room Ambient in Sequence Shown)

Test Sequence Number	In Situ		Parameter	Test Conditions *	Remarks
	Yes	No			
1		x	Quiescent Current	7 through current meter to Ground, 1,2,5,6,8,9, 12,13,14 to 15V	
2		x	Quiescent Current	14 to 15V, 7 through current meter to Ground, 1,2,5,6,8,9,12,13 to Ground	
3		x	N threshold**	1 to Ground, 14 to 15V, 2,5,6,8,9,12,13 and 7 to $-10\mu A$	Record $V_{TN}$ , 7 to GND
4		x	P threshold**	1 to Ground, 2,5,6,8,9, 12,13 and 7 to $-15V$ , 14 to $+10\mu A$	Record $V_{TP}$ , 14 to GND
			**N and P threshold to be taken for pins 1,2,5,6,8,9,12,13 respectively to ground as per test box design.		
			NOTE: All above electrical parameters to be retested at 24 hours and 1 week time periods after the final irradiation, parts to be kept under bias till these readings are completed.		
			*Use special test box constructed, see page A-4		



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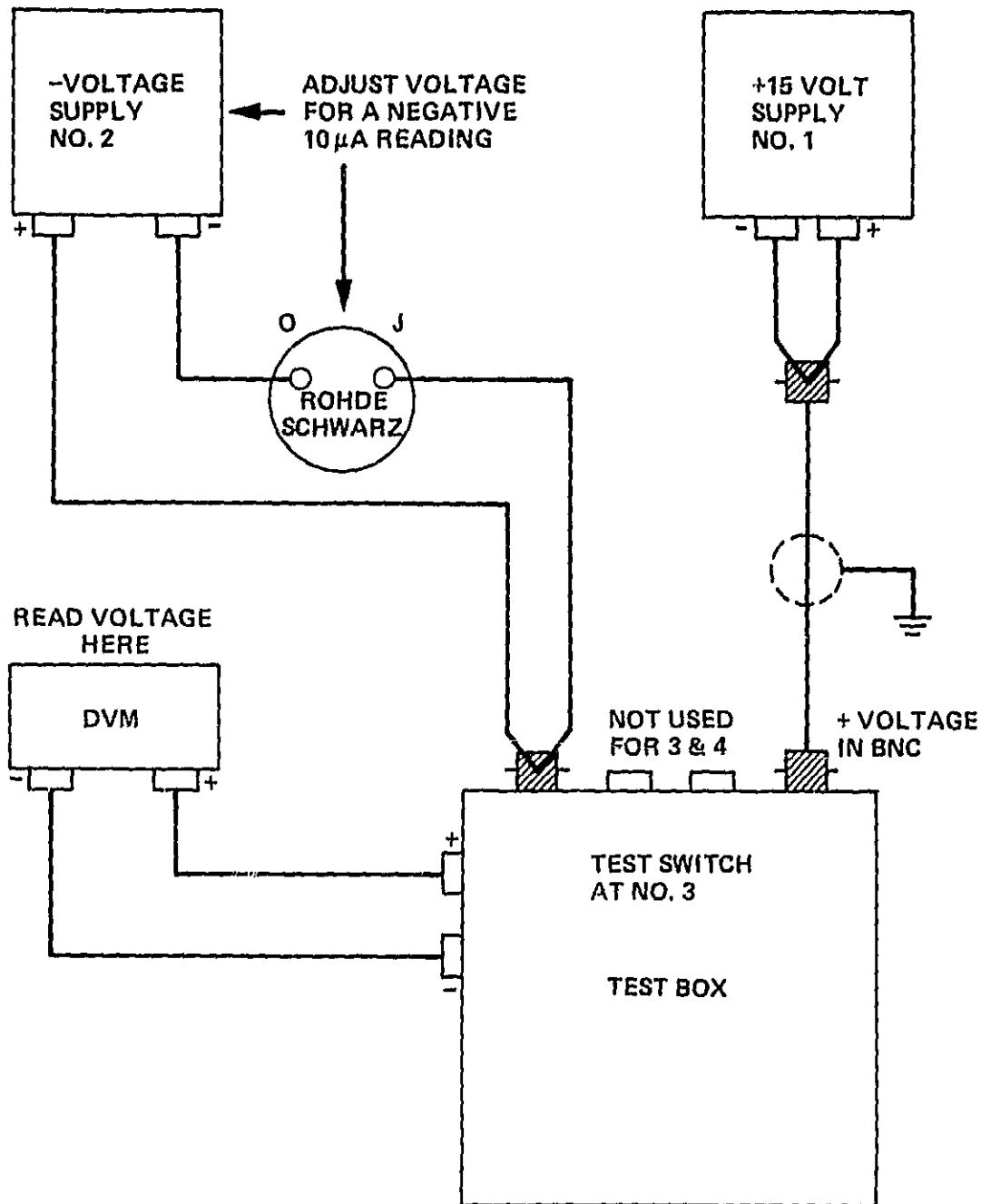


SEE NOTE  
+15V SUPPLY OR +10µA ADJ  
-15V SUPPLY OR -10µA ADJ

NOTE:  
MICROAMMETER MUST BE CONNECTED TO  
NEGATIVE VOLTAGE LINE ON SUPPLY NO. 2  
FOR TEST 3. ADJUST VOLTAGE FOR -10µA.  
READ VOLTAGE ON VOM.

MICROAMMETER MUST BE CONNECTED TO  
POSITIVE VOLTAGE LINE ON SUPPLY NO. 1  
FOR TEST 4. ADJUST VOLTAGE FOR +10µA.  
READ VOLTAGE ON VOM.

Circuit Diagram for CD4011 and CD4013 Tester Box



SWITCH TO 4:  
 FOR TEST NO. 4, PLACE CURRENT METER ON  
 POSITIVE LINE OF SUPPLY NO. 1, INCREASE  
 VOLTS ON SUPPLY NO. 2 TO 15.00 READING  
 WITH DVM! INCREASE VOLTAGE FROM ZERO  
 TO OBTAIN A  $+10\ \mu\text{A}$  READING ON ROHDE SCHWARZ  
 METER. READ VOLTAGE AT DVM JACKS

Procedural Use for CD4011 and CD4013 Tester Box  
 (Example shown is Test No. 3 for CD4011)

APPENDIX B  
RADIATION TEST REQUIREMENTS

RADIATION TEST REQUIREMENTS

Device Type CD 4013 (Dual D F/f) RTR S/N 114C-2

Manufacturer SSS

Device Package

Lot No. \_\_\_\_\_ Date Code \_\_\_\_\_

Type	No. of Leads
DIP	14

No. of Devices Supplied \_\_\_\_\_

No. of Devices to be tested 5

535-64408-0-5140

RADIATION CONDITIONS:

Facility: Co60

Energy: 1.25 MeV

	UNITS	RADIATION LEVELS			
Fluence		see table below			
Flux					

BIAS CONDITIONS DURING IRRADIATION:

Pin No.	Parameter	Voltage	Remarks	Bias Circuit	
				Fluence rad(Si)	Flux rad(Si)/sec
1	out	100k to Gnd	high		
2	out	100k to 15V	low	1E3	3.33E0
3	clock	10k to 15V		2E3	3.33E0
4	reset	gnd		5E3	1E1
5	In-D <sub>1</sub>	10k to 15V		1E4	1E1
6	set	10k to 15V		2E4	1E1
7	V <sub>SS</sub>	gnd		5E4	1E1
8	set	gnd		1E5*	1E1
9	In-D <sub>2</sub>	gnd			
10	reset	10k to 15V			
11	clock	gnd			
12	output	100k to gnd	high		
13	output	100k to 15V	low		
14	V <sub>DD</sub>	10k to 15V			

\*Further radiations at the discretion of test engineer/customer.

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RADIATION TEST REQUIREMENTS

RTR S/N 114C-2

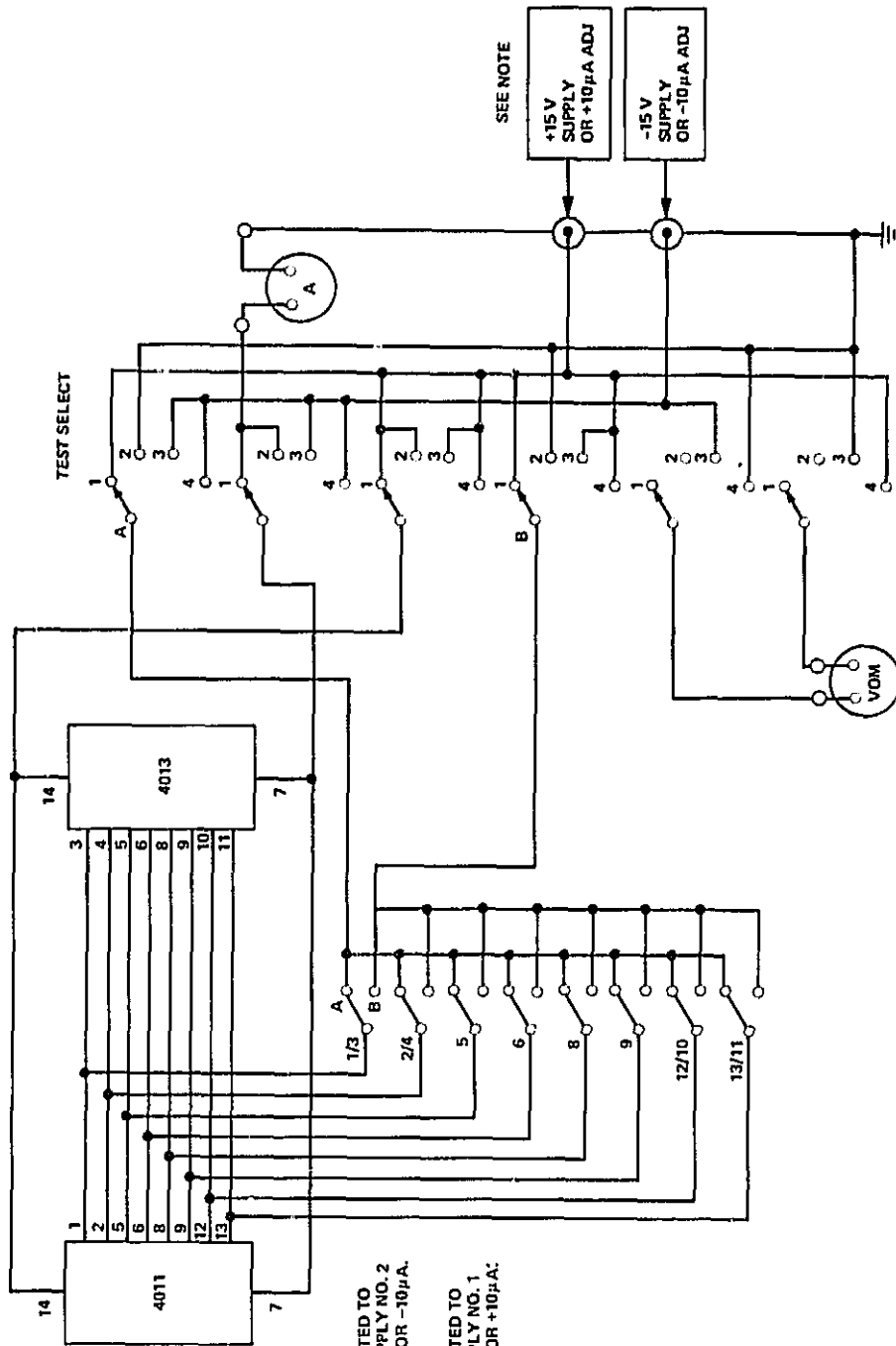
Device Type: CD4013 (Dual D F/F)

JPL Contact:		
Name	Subsystem	Phone
M. Gauthier	514	2126
B. Dantas	514	4932
J. Coss	514	7463
E. Powell	514	6175

MEASUREMENT CONDITIONS: (Measurements Shall Be Made at Room Ambient in Sequence Shown)

Test Sequence Number	In Situ		Parameter	Test Conditions *	Remarks
	Yes	No			
1		x	Quiescent Current	3,4,5,6,8,9,10,11,14 to 15V, 7 through current meter to ground	
2		x	Quiescent Current	14 to 15V, 7 through current meter to ground 3,4,5,6,8,9,10,11 to gnd	
3		x	N threshold**	3 to ground, 14 to 15V, 4,5,6,7,8,9,10,11 to -10 $\mu$ A	record $V_{TN}$ , 7 to gnd
4		x	P threshold**	3 to ground, 4,5,6,7,8,9, 10, 11 to -15V, 14 to +10 $\mu$ A.	record $V_{TP}$ , 14 to gnd
			**N and P threshold to be taken for pins 3,4,5,6,8,9,10,11 respectively to ground as per test box design.		
			NOTE: All above electrical parameters to be retested at 24 hours and 1 week time periods after the final irradiation, parts to be kept under bias till these readings are completed.		
			*To be tested in special box constructed, see page B-4		

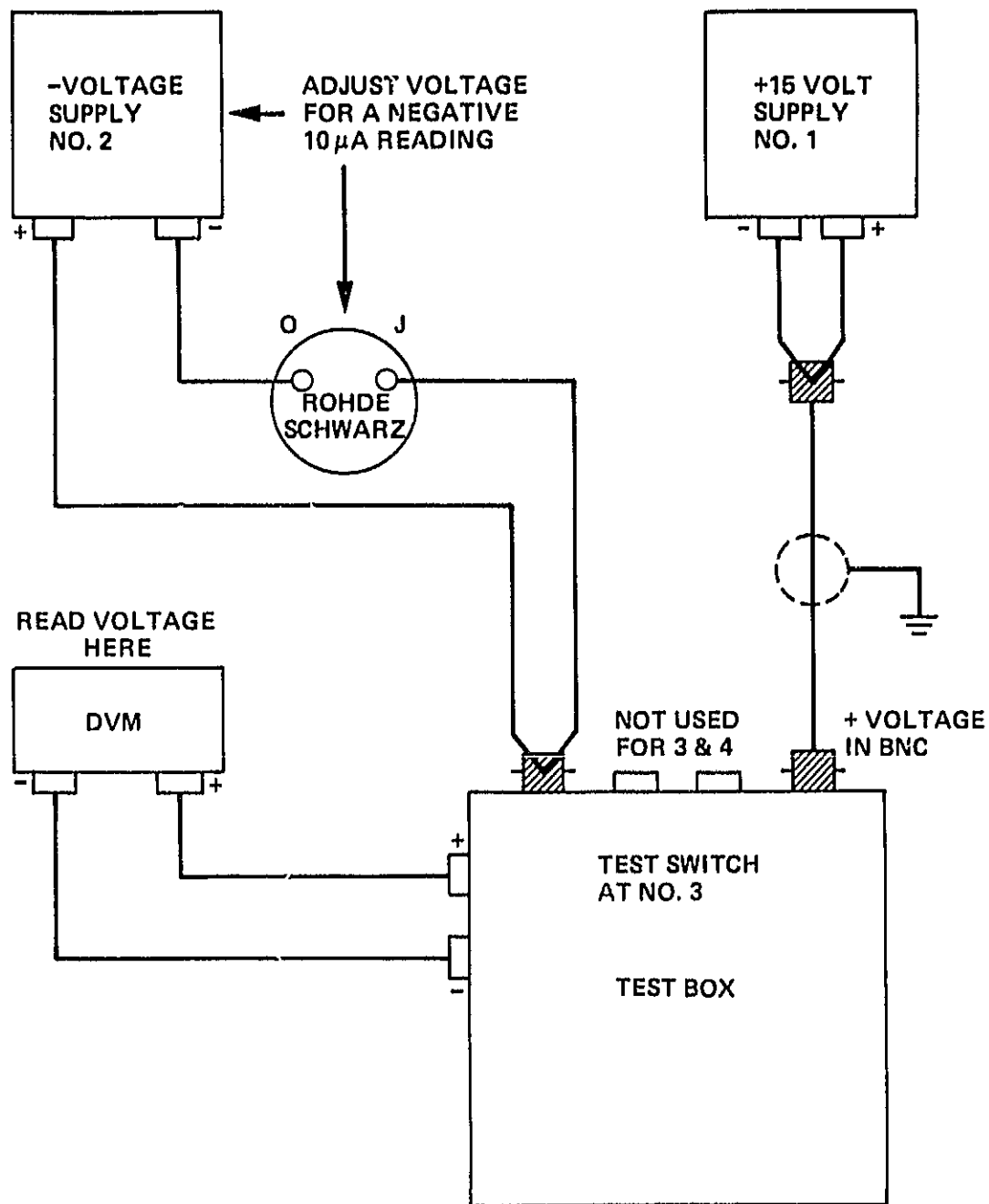
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NOTE:  
MICROAMETER MUST BE CONNECTED TO  
NEGATIVE VOLTAGE LINE ON SUPPLY NO. 2  
FOR TEST 3. ADJUST VOLTAGE FOR  $-10\mu\text{A}$ .  
READ VOLTAGE ON VOM.

MICROAMETER MUST BE CONNECTED TO  
POSITIVE VOLTAGE LINE ON SUPPLY NO. 1  
FOR TEST 4. ADJUST VOLTAGE FOR  $+10\mu\text{A}$ .  
READ VOLTAGE ON VOM.

Circuit Diagram for CD4011 and CD4013 Tester Box



**SWITCH TO 4:**  
 FOR TEST NO. 4, PLACE CURRENT METER ON POSITIVE LINE OF SUPPLY NO. 1, INCREASE VOLTS ON SUPPLY NO. 2 TO 15.00 READING WITH DVM. INCREASE VOLTAGE FROM ZERO TO OBTAIN A  $+10\mu\text{A}$  READING ON ROHDE SCHWARZ METER. READ VOLTAGE AT DVM JACKS

Procedural Use for CD4011 and CD4013 Tester Box  
 (Example shown is Test No. 3 for CD4011)

APPENDIX C  
RADIATION TEST REQUIREMENTS



**RADIATION TEST REQUIREMENTS**

Device Type CD4060 (Counter/Divide/OSC) RTR S/N 386-1

Manufacturer SSS

Lot No. \_\_\_\_\_ Date Code \_\_\_\_\_

No. of Devices Supplied \_\_\_\_\_

No. of Devices to be tested 5

**Device Package**

Type	No. of Leads
DIP	16

535-64408-0-5140

**RADIATION CONDITIONS:**

Facility: Co60

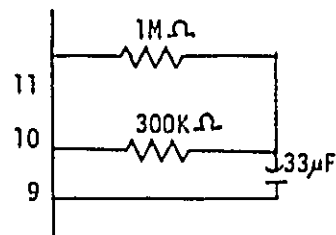
Energy: 1.25 MeV

	UNITS	RADIATION LEVELS			
Fluence	see table below				
Flux					

**BIAS CONDITIONS DURING IRRADIATION:**

Pin No.	Parameter	Voltage	Remarks	Bias Circuit	
				Fluence rad(Si)	Flux rad(Si)/sec
1	Q12	100k to gnd		1E3	3.33E0
2	Q13	100k to gnd		2E3	3.33E0
	Q14	100k to gnd		5E3	1E1
4	Q6	100k to gnd		1E4	1E1
5	Q5	100k to gnd		2E4	1E1
6	Q7	100k to gnd		5E4	1E1
7	Q4	100k to gnd		1E5*	1E1
8	V <sub>SS</sub>	ground			
9	Φ0	see diagram			
10	Φ0	#1			
11	Φ1	"			
12	reset	gnd			
13	Q9	100k to gnd			
14	Q8	100k to gnd			
15	Q10	100k to gnd			
16	V <sub>DD</sub>	10k to 15V			

Diagram #1



\*Further radiations at the discretion of test engineer/customer.

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RADIATION TEST REQUIREMENTS

RTR S/N 386-1

Device Type: CD4060 (Counter/Divide/OSC)

JPL Contact:		
Name	Subsystem	Phone
M. Gauthier	514	2126
B. Dantas	514	4932
J. Coss	514	7463
E. Powell	514	6175

MEASUREMENT CONDITIONS: (Measurements Shall Be Made at Room Ambient in Sequence Shown)

Test Sequence Number	In Situ		Parameter	Test Conditions	Remarks
	Yes	No			
1		x	Quiescent Current	8 through current meter to ground, 11,12,14 to 15V	
2		x	Quiescent Current	8 through current meter to ground, 16 to 15V 11,12 to ground	
3		x	$N_1$ threshold	11 to ground, 16 to 15V 8,12 to $-10\mu A$	record $V_{TN}$ , 8 to gnd
4		x	$P_1$ threshold	11 to ground, 8,12 to $-15V$ 16 to $+10\mu A$	record $V_{TP}$ , 16 to gnd
5			$N_2$ threshold	12 to gnd, 16 to 15V, 8&11 to $-10\mu A$	record $V_{TN}$ , 8 to gnd
6			$P_2$ threshold	12 to gnd, 8&11 to $-15V$ , 16 to $+10\mu A$	record $V_{TP}$ , 16 to gnd
			NOTE: All above electrical parameters to be tested at 24 hours and 1 week time periods after the final irradiation, parts to be kept under bias till these readings are completed.		

APPENDIX D  
RADIATION TEST RESULTS

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RADIATION TEST RESULTS

03/25/85

DEVICE TYPE C04011  
MANUFACTURER Solid State Scientific  
PACKAGE TYPE DIP  
TEST DATE 3-20-85

FACILITY C060  
ENERGY 1.25MEV  
RAD TEST REV 112-2  
CIRCUIT NO.

SERIAL NUMBER ALL LOT NUMBER DATE CODE 8321 LOG NUMBER 1121-1

DOSE GRAY(SI) INITIAL 1.00E01 2.00E01 5.00E01 1.00E02  
RATE (GRAY/SEC) 3.33-02 3.33-02 1.00-01 1.00-01

(1) IDD1 (VDD=15V) IN mA:

2052V	.181	.195	1.48	17.9E3	13.1E4
2053V	.165	.180	168.0	26.1E3	15.0E4
2054V	.191	.198	1.21	8.5E3	68.8E3
2055V	.170	.175	.178	8.15	81.0E3
2056V	.15	.151	150.0	24.9E3	17.0E4
MAX	.191+00	.198+00	.168+03	.261+05	.170+06
MEAN	.171+00	.180+00	.642+02	.155+05	.120+06
MIN	.150+00	.151+00	.178+00	.815+01	.880+05
MEAN + 3 SIGMA	.218+00	.236+00	.325+03	.489+05	.252+06

(2) IDD2 (VDD=15V) IN mA:

2052V	.155	.172	2.42E3	81.0E3	37.0E4
2053V	.141	.145	1.9E3	69.1E3	30.0E4
2054V	.165	.165	1.58E3	56.0E3	23.0E4
2055V	.139	.141	1.54E3	65.0E3	27.5E4
2056V	.13	.245	3.12E3	86.0E3	39.0E4
MAX	.165+00	.245+00	.312+04	.860+05	.390+06
MEAN	.146+00	.174+00	.211+04	.714+05	.313+06
MIN	.130+00	.141+00	.154+04	.560+05	.230+06
MEAN + 3 SIGMA	.188+00	.300+00	.411+04	.108+06	.512+06

(3) VTN1 (ITN=10UA) IN VOLTS:

2052V	-10.29	*****	*****	*****	*****
2053V	-10.37	*****	*****	*****	*****
2054V	-10.41	*****	*****	*****	*****
2055V	-10.15	*****	*****	*****	*****
2056V	-10.32	*****	*****	*****	*****
MAX	-.101+02	*****	*****	*****	*****
MEAN	-.103+02	*****	*****	*****	*****
MIN	-.104+02	*****	*****	*****	*****
MEAN + 3 SIGMA	-.100+02	*****	*****	*****	*****

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RADIATION TEST RESULTS

03/25/85

DEVICE TYPE C04011  
MANUFACTURER SOLID STATE SCIENTIFIC  
PACKAGE TYPE DIP  
TEST DATE 3-20-85

FACILITY C060  
ENERGY 1.25MEV  
RAD TEST REQ 112-2  
CIRCUIT NO.

SERIAL NUMBER ALL      LOT NUMBER      DATE CODE 8321      LOG NUMBER 1121-1

DOSE GRAY(SI)      INITIAL 1.00E01      2.00E01      5.00E01      1.00E02  
RATE (GRAY/SEC)      3.33-02      3.33-02      1.00-01      1.00-01

(4)VTN2 (ITN=-10UA) IN VOLTS:

2052V	=10.29	*****	*****	*****	*****
2053V	=10.37	*****	*****	*****	*****
2054V	=10.41	*****	*****	*****	*****
2055V	=10.14	*****	*****	*****	*****
2056V	=10.33	*****	*****	*****	*****
MAX	= .101+02	*****	*****	*****	*****
MEAN	= .103+02	*****	*****	*****	*****
MIN	= .104+02	*****	*****	*****	*****
MEAN + 3 SIGMA	= .100+02	*****	*****	*****	*****

(5)VTN5 (ITN=-10UA) IN VOLTS:

2052V	=10.29	*****	*****	*****	*****
2053V	=10.36	*****	*****	*****	*****
2054V	=10.41	*****	*****	*****	*****
2055V	=10.16	*****	*****	*****	*****
2056V	=10.32	*****	*****	*****	*****
MAX	= .102+02	*****	*****	*****	*****
MEAN	= .103+02	*****	*****	*****	*****
MIN	= .104+02	*****	*****	*****	*****
MEAN + 3 SIGMA	= .100+02	*****	*****	*****	*****

(6)VTN6 (ITN=-10UA) IN VOLTS:

2052V	=10.29	*****	*****	*****	*****
2053V	=10.37	*****	*****	*****	*****
2054V	=10.41	*****	*****	*****	*****
2055V	=10.13	*****	*****	*****	*****
2056V	=10.32	*****	*****	*****	*****
MAX	= .101+02	*****	*****	*****	*****
MEAN	= .103+02	*****	*****	*****	*****
MIN	= .104+02	*****	*****	*****	*****
MEAN + 3 SIGMA	= .99A+01	*****	*****	*****	*****

RADIATION TEST RESULTS

03/25/85

DEVICE TYPE	CD4011	FACILITY	C060
MANUFACTURER	SOLID STATE SCIENTIFIC	ENERGY	1.25MEV
PACKAGE TYPE	DIP	RAD TEST REQ	112-2
TEST DATE	3-20-85	CIRCUIT NO.	1

SERIAL NUMBER	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8321	1121-2

DOSE	GRAY(SI)	INITIAL	1.00E01	2.00E01	5.00E01	1.00E02
RATE	(GRAY/SEC)		3.33-02	3.33-02	1.00-01	1.00-01

(7) VTN8 (ITN=10UA) IN VOLTS:

2052V	=10.29	*****	*****	*****	*****
2053V	=10.37	*****	*****	*****	*****
2054V	=10.42	*****	*****	*****	*****
2055V	=10.13	*****	*****	*****	*****
2056V	=10.32	*****	*****	*****	*****
MAX	= .101+02	*****	*****	*****	*****
MEAN	= .103+02	*****	*****	*****	*****
MIN	= .104+02	*****	*****	*****	*****
MEAN + 3 SIGMA	= .998+01	*****	*****	*****	*****

(8) VTN9 (ITN=10UA) IN VOLTS:

2052V	=10.29	*****	*****	*****	*****
2053V	=10.37	*****	*****	*****	*****
2054V	=10.43	*****	*****	*****	*****
2055V	=10.13	*****	*****	*****	*****
2056V	=10.32	*****	*****	*****	*****
MAX	= .101+02	*****	*****	*****	*****
MEAN	= .103+02	*****	*****	*****	*****
MIN	= .104+02	*****	*****	*****	*****
MEAN + 3 SIGMA	= .997+01	*****	*****	*****	*****

(9) VTN12 (ITN=10UA) IN VOLTS:

2052V	=10.28	*****	*****	*****	*****
2053V	=10.37	*****	*****	*****	*****
2054V	=10.41	*****	*****	*****	*****
2055V	=10.13	*****	*****	*****	*****
2056V	=10.32	*****	*****	*****	*****
MAX	= .101+02	*****	*****	*****	*****
MEAN	= .103+02	*****	*****	*****	*****
MIN	= .104+02	*****	*****	*****	*****
MEAN + 3 SIGMA	= .998+01	*****	*****	*****	*****

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RADIATION TEST RESULTS

03/25/85

DEVICE TYPE	CD4011	FACILITY	C060
MANUFACTURER	SOLID STATE SCIENTIFIC	ENERGY	1.25MEV
PACKAGE TYPE	DIP	RAD TEST REQ	112-2
TEST DATE	3-20-85	CIRCUIT NO.	1

SERIAL NUMBER	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8321	1121-2

DOSE	GRAY(SI)	INITIAL	1.00E01	2.00E01	5.00E01	1.00E02
RATE	(GRAY/SEC)		3.33-02	3.33-02	1.00-01	1.00-01

(10)VTN13 (ITN=-10UA) IN VOLTS:

2052V	=10.28	*****	*****	*****	*****
2053V	=10.37	*****	*****	*****	*****
2054V	=10.41	*****	*****	*****	*****
2055V	=10.13	*****	*****	*****	*****
2056V	=10.32	*****	*****	*****	*****
MAX	.101+02	*****	*****	*****	*****
MEAN	=.103+02	*****	*****	*****	*****
MIN	=.104+02	*****	*****	*****	*****
MEAN + 3 SIGMA	-.998+01	*****	*****	*****	*****

(11)VTP1 (ITP=+10UA) IN VOLTS:

2052V	10.29	*****	*****	*****	*****
2053V	10.37	*****	*****	*****	*****
2054V	10.41	*****	*****	*****	*****
2055V	10.11	*****	*****	*****	*****
2056V	10.33	*****	*****	*****	*****
MAX	.104+02	*****	*****	*****	*****
MEAN	.103+02	*****	*****	*****	*****
MIN	.101+02	*****	*****	*****	*****
MEAN + 3 SIGMA	.107+02	*****	*****	*****	*****

(12)VTP2 (ITP=+10UA) IN VOLTS:

2052V	10.29	*****	*****	*****	*****
2053V	10.37	*****	*****	*****	*****
2054V	10.42	*****	*****	*****	*****
2055V	10.11	*****	*****	*****	*****
2056V	10.33	*****	*****	*****	*****
MAX	.104+02	*****	*****	*****	*****
MEAN	.103+02	*****	*****	*****	*****
MIN	.101+02	*****	*****	*****	*****
MEAN + 3 SIGMA	.107+02	*****	*****	*****	*****

RADIATION TEST RESULTS

03/25/85

DEVICE TYPE CD4011 FACILITY C060  
 MANUFACTURER SOLID STATE SCIENTIFIC ENERGY 1.25MEV  
 PACKAGE TYPE DIP RAD TEST REQ 112=2  
 TEST DATE 3-20-85 CIRCUIT NO.

SERIAL NUMBER ALL LOT NUMBER DATE CODE LOG NUMBER  
 8321 1121=3

DOSE GRAY(SI) INITIAL 1.00E01 2.00E01 5.00E01 1.00E02  
 RATE (GRAY/SEC) 3.33=02 3.33=02 1.00=01 1.00=01

(13)VTP5 (ITP=+10UA) IN VOLTS:

2052V	10.29	*****	*****	*****	*****
2053V	10.37	*****	*****	*****	*****
2054V	10.42	*****	*****	*****	*****
2055V	10.13	*****	*****	*****	*****
2056V	10.33	*****	*****	*****	*****
MAX	.104+02	*****	*****	*****	*****
MEAN	.103+02	*****	*****	*****	*****
MIN	.101+02	*****	*****	*****	*****
MEAN + 3 SIGMA	.106+02	*****	*****	*****	*****

(14)VTP6 (ITP=+10UA) IN VOLTS:

2052V	10.29	*****	*****	*****	*****
2053V	10.37	*****	*****	*****	*****
2054V	10.42	*****	*****	*****	*****
2055V	10.11	*****	*****	*****	*****
2056V	10.33	*****	*****	*****	*****
MAX	.104+02	*****	*****	*****	*****
MEAN	.103+02	*****	*****	*****	*****
MIN	.101+02	*****	*****	*****	*****
MEAN + 3 SIGMA	.107+02	*****	*****	*****	*****

(15)VTP8 (ITP=+10UA) IN VOLTS:

2052V	10.29	*****	*****	*****	*****
2053V	10.37	*****	*****	*****	*****
2054V	10.42	*****	*****	*****	*****
2055V	10.11	*****	*****	*****	*****
2056V	10.33	*****	*****	*****	*****
MAX	.104+02	*****	*****	*****	*****
MEAN	.103+02	*****	*****	*****	*****
MIN	.101+02	*****	*****	*****	*****
MEAN + 3 SIGMA	.107+02	*****	*****	*****	*****



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RADIATION TEST RESULTS

03/25/85

DEVICE TYPE C04011  
MANUFACTURER SOLID STATE SCIENTIFIC  
PACKAGE TYPE DIP  
TEST DATE 3-20-85

FACILITY C060  
ENERGY 1.25MFV  
RAD TEST REQ 112-2  
CIRCUIT NO.

SERIAL NUMBER ALL LOT NUMBER DATE CODE 8321 LOG NUMBER 1121-3

DOSE GRAY(81) INITIAL 1.00E01 2.00E01 5.00E01 1.00E02  
RATE (GRAY/SEC) 3.33-02 3.33-02 1.00-01 1.00-01

(16)VTP9 (ITP=+10UA) IN VOLTS:

2052V	10.30	*****	*****	*****	*****
2053V	10.38	*****	*****	*****	*****
2054V	10.44	*****	*****	*****	*****
2055V	10.11	*****	*****	*****	*****
2056V	10.33	*****	*****	*****	*****
MAX	.104+02	*****	*****	*****	*****
MEAN	.103+02	*****	*****	*****	*****
MIN	.101+02	*****	*****	*****	*****
MEAN + 3 SIGMA	.107+02	*****	*****	*****	*****

(17)VTP12 (ITP=+10UA) IN VOLTS:

2052V	10.29	*****	*****	*****	*****
2053V	10.38	*****	*****	*****	*****
2054V	10.41	*****	*****	*****	*****
2055V	10.11	*****	*****	*****	*****
2056V	10.33	*****	*****	*****	*****
MAX	.104+02	*****	*****	*****	*****
MEAN	.103+02	*****	*****	*****	*****
MIN	.101+02	*****	*****	*****	*****
MEAN + 3 SIGMA	.107+02	*****	*****	*****	*****

(18)VTP13 (ITP=+10UA) IN VOLTS:

2052V	10.29	*****	*****	*****	*****
2053V	10.37	*****	*****	*****	*****
2054V	10.41	*****	*****	*****	*****
2055V	10.11	*****	*****	*****	*****
2056V	10.33	*****	*****	*****	*****
MAX	.104+02	*****	*****	*****	*****
MEAN	.103+02	*****	*****	*****	*****
MIN	.101+02	*****	*****	*****	*****
MEAN + 3 SIGMA	.107+02	*****	*****	*****	*****

APPENDIX E  
RADIATION TEST RESULTS

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RADIATION TEST RESULTS

03/25/85

DEVICE TYPE	C04013	FACILITY	C060
MANUFACTURER	Solid State Scientific	ENERGY	1.25MEV
PACKAGE TYPE	DIP	RAD TEST REQ	114C-2
TEST DATE	3-14-85	CIRCUIT NO.	

SERIAL NUMBER	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8321	1122-1

DOSE	GRAY(SI)	INITIAL	1.00E01	2.00E01	5.00E01
RATE	(GRAY/SEC)		3.33E-02	3.33E-02	1.00E-01

(1)IDD1 (VDD=15V) IN NAI

2064V	1.15	18E4	89E4	4.6E3
2065V	1.18	14.0E4	77E4	.02
2066V	45.0	23.8E4	95E4	4.1E6
2067V	23.1	20.2E4	86E4	4.4E6
2068V	1.15	13.1E4	64E4	3.6E6
MAX	.450+02	.238+06	.950+06	.440+07
MEAN	.143+02	.178+06	.822+06	.242+07
MIN	.115+01	.131+06	.640+06	.200+01
MEAN + 3 SIGMA	.731+02	.311+06	.118+07	.910+07

(2)IDD2 (VDD=15V) IN NAI

2064V	.91	4.1E4	41E4	3.8E3
2065V	1.12	4.2E4	28E4	.18
2066V	16.2	5.4E4	52E4	3.4E6
2067V	159.0	5.2E4	51E4	4.0E6
2068V	1.20	2.6E4	38E4	3.5E6
MAX	.159+03	.540+05	.520+06	.400+07
MEAN	.357+02	.430+05	.420+06	.218+07
MIN	.910+00	.260+05	.280+06	.180+00
MEAN + 3 SIGMA	.243+03	.764+05	.718+06	.819+07

(3)VTN3 (ITN=10UA) IN VOLTSI

2064V	-2.12	2.00	6.85	12.12
2065V	-2.15	1.52	13.44	19.01
2066V	-1.89	2.00	7.72	12.3
2067V	-1.82	1.89	7.17	12.26
2068V	-1.97	1.45	6.20	12.23
MAX	-.182+01	.200+01	.134+02	.150+02
MEAN	-.199+01	.177+01	.828+01	.128+02
MIN	-.215+01	.145+01	.620+01	.121+02
MEAN + 3 SIGMA	-.156+01	.257+01	.171+02	.165+02

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RADIATION TEST RESULTS

03/25/85

DEVICE TYPE	CD4013	FACILITY	C060
MANUFACTURER	SOLID STATE SCIENTIFIC	ENERGY	1.25MFV
PACKAGE TYPE	DIP	RAD TEST REQ	114C-2
TEST DATE	3-19-85	CIRCUIT NO.	

SERIAL NUMBER	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8321	1122-1

DOSE	GRAY(SI)	INITIAL	1.00E01	2.00E01	5.00E01
RATE	(GRAY/SEC)		3.33-02	3.33-02	1.00-01

(4)VTN4 (ITN=10UA) IN VOLTS:

2064V	=2.22	2.12	7.04	12.19
2065V	=2.29	1.62	4.77	14.61
2066V	=1.95	2.12	7.02	12.26
2067V	=1.96	1.91	7.47	12.26
2068V	=2.04	1.47	6.53	12.27
MAX	=.195+01	.212+01	.747+01	.146+02
MEAN	=.209+01	.185+01	.657+01	.127+02
MIN	=.229+01	.147+01	.477+01	.122+02
MEAN + 3 SIGMA	=.163+01	.273+01	.974+01	.159+02

(5)VTN5 (ITN=10UA) IN VOLTS:

2064V	=2.24	2.15	6.92	12.24
2065V	=2.28	1.63	4.82	15.01
2066V	=1.97	2.21	7.63	12.35
2067V	=1.97	2.03	7.62	12.34
2068V	=2.04	1.58	6.72	12.3A
MAX	=.197+01	.221+01	.763+01	.150+02
MEAN	=.210+01	.192+01	.674+01	.129+02
MIN	=.228+01	.158+01	.482+01	.122+02
MEAN + 3 SIGMA	=.165+01	.281+01	.102+02	.165+02

(6)VTN6 (ITN=10UA) IN VOLTS:

2064V	=2.39	2.12	6.81	12.19
2065V	=2.45	1.64	4.84	15.01
2066V	=2.01	2.17	7.68	12.29
2067V	=2.02	1.98	7.45	12.31
2068V	=2.13	1.61	6.78	12.37
MAX	=.201+01	.217+01	.768+01	.150+02
MEAN	=.220+01	.190+01	.671+01	.126+02
MIN	=.245+01	.161+01	.484+01	.122+02
MEAN + 3 SIGMA	=.158+01	.270+01	.101+02	.165+02

RADIATION TEST RESULTS

03/25/85

DEVICE TYPE CD4013 FACILITY C060  
 MANUFACTURER SOLID STATE SCIENTIFIC ENERGY 1.25MEV  
 PACKAGE TYPE DIP RAD TEST REV 114C-2  
 TEST DATE 3-19-85 CIRCUIT NO.

SERIAL NUMBER ALL LOT NUMBER DATE CODE 8321 LOG NUMBER 1122-2

DOSE GRAY(SI) INITIAL 1.00E01 2.00E01 5.00E01  
 RATE (GRAY/SEC) 3.33-02 3.33-02 1.00-01

(7)VTN8 (ITN=10UA) IN VOLTS:

2064V	-2.37	2.13	6.83	12.15
2065V	-2.46	1.64	4.92	14.84
2066V	-2.03	2.1A	7.53	12.24
2067V	-1.99	1.95	7.29	12.22
2068V	-2.13	1.61	6.79	12.31
MAX	-.199+01	.218+01	.753+01	.148+02
MEAN	-.220+01	.190+01	.667+01	.128+02
MIN	-.246+01	.161+01	.492+01	.121+02
MEAN + 3 SIGMA	-.157+01	.270+01	.976+01	.163+02

(8)VTN9 (ITN=10UA) IN VOLTS:

2064V	-2.25	2.24	7.09	12.21
2065V	-2.30	1.59	4.94	14.86
2066V	-1.96	2.19	7.54	12.26
2067V	-1.96	1.9A	7.44	12.26
2068V	-2.06	1.61	6.85	12.33
MAX	-.196+01	.224+01	.754+01	.149+02
MEAN	-.211+01	.192+01	.677+01	.128+02
MIN	-.230+01	.159+01	.494+01	.122+02
MEAN + 3 SIGMA	-.162+01	.285+01	.995+01	.163+02

(9)VTN10 (ITN=10UA) IN VOLTS:

2064V	-2.23	2.05	6.71	12.21
2065V	-2.28	1.48	4.83	14.93
2066V	-1.97	2.12	7.61	12.24
2067V	-1.98	1.79	6.99	12.26
2068V	-2.03	1.4A	6.48	12.35
MAX	-.197+01	.212+01	.761+01	.149+02
MEAN	-.210+01	.178+01	.652+01	.128+02
MIN	-.228+01	.148+01	.483+01	.122+02
MEAN + 3 SIGMA	-.166+01	.269+01	.964+01	.164+02

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RADIATION TEST RESULTS

03/25/85

DEVICE TYPE C04013  
MANUFACTURER SOLID STATE SCIENTIFIC  
PACKAGE TYPE DIP  
TEST DATE 3-19-85

FACILITY C060  
ENERGY 1.25MEV  
RAD TEST REN 114C-2  
CIRCUIT NO.

SERIAL NUMBER ALL LOT NUMBER DATE CODE 8321 LOG NUMBER 1122-2

DOSE GRAY(SI) INITIAL 1.00E01 2.00E01 5.00E01  
RATE (GRAY/SEC) 3.33-02 3.33-02 1.00-01

(10)VTH1 (ITN=10UA) IN VOLTS:

2064V	-2.13	1.95	6.34	12.07
2065V	-2.18	1.45	4.42	14.93
2066V	-1.90	2.05	7.52	12.11
2067V	-1.88	1.64	7.02	12.22
2068V	-1.96	1.46	6.18	12.22
MAX	-.188+01	.205+01	.752+01	.149+02
MEAN	-.201+01	.176+01	.630+01	.127+02
MIN	-.218+01	.146+01	.442+01	.121+02
MEAN + 3 SIGMA	-.160+01	.257+01	.983+01	.164+02

(11)VTP3 (ITP=+10UA) IN VOLTS:

2064V	1.66	-2.57	****	.73
2065V	1.69	6.60	.69	15.01
2066V	1.42	.61	.65	.81
2067V	1.92	-2.35	.70	.83
2068V	1.51	-2.27	.69	.86
MAX	.192+01	.660+01	.700+00	.150+02
MEAN	.164+01	.400+02	.682+00	.365+01
MIN	.142+01	-.257+01	.650+00	.730+00
MEAN + 3 SIGMA	.221+01	.117+02	.749+00	.227+02

(12)VTP4 (ITP=+10UA) IN VOLTS:

2064V	1.65	-2.64	*****	.84
2065V	1.84	-3.05	13.43	2.03
2066V	1.44	.63	.67	.90
2067V	2.03	-2.66	.72	.91
2068V	1.55	-2.34	.70	.85
MAX	.203+01	.630+00	.134+02	.203+01
MEAN	.170+01	-.201+01	.388+01	.111+01
MIN	.144+01	-.305+01	.670+00	.840+00
MEAN + 3 SIGMA	.241+01	.248+01	.230+02	.266+01

RADIATION TEST RESULTS

03/25/85

DEVICE TYPE CD4013 FACILITY CD60  
 MANUFACTURER SOLID STATE SCIENTIFIC ENERGY 1.25MEV  
 PACKAGE TYPE DIP RAD TEST REQ 114C-2  
 TEST DATE 3-19-85 CIRCUIT NO.

SERIAL NUMBER LOT NUMBER DATE CODE LOG NUMBER  
 ALL 8321 1122-3

DOSE GRAY(SI) INITIAL 1.00E01 2.00E01 5.00E01  
 RATE (GRAY/SEC) 3.33E-02 3.33E-02 1.00E-01

(13) VTP5 (ITP=+10UA) IN VOLTS:

2064V	1.69	-2.80	*****	.82
2065V	1.7A	-2.62	.13 *****	
2066V	1.33	.63	.67	.88
2067V	1.85	-2.47	.71	.89
2068V	1.44	-2.28	.69	.8A

MAX	.185+01	.630+00	.710+00	.890+00
MEAN	.162+01	-.191+01	.550+00	.862+00
MIN	.133+01	-.280+01	.130+00	.820+00
MEAN + 3 SIGMA	.229+01	.239+01	.139+01	.955+00

(14) VTP6 (ITP=+10UA) IN VOLTS:

2064V	1.90	-3.34	*****	.80
2065V	2.00	-3.63	15.08 *****	
2066V	1.43	.63	.67	.85
2067V	2.17	-2.97	.70	.85
2068V	1.58	-2.41	.69	.84

MAX	.217+01	.630+00	.151+02	.850+00
MEAN	.182+01	-.234+01	.428+01	.835+00
MIN	.143+01	-.363+01	.670+00	.800+00
MEAN + 3 SIGMA	.273+01	.283+01	.259+02	.906+00

(15) VTP8 (ITP=+10UA) IN VOLTS:

2064V	1.91	-3.57	*****	.84
2065V	1.98	-3.74	*****	*****
2066V	1.51	.61	.67	.91
2067V	2.33	-3.29	.72	.91
2068V	1.56	-2.45	.70	.90

MAX	.233+01	.610+00	.720+00	.910+00
MEAN	.186+01	-.249+01	.697+00	.890+00
MIN	.151+01	-.374+01	.670+00	.840+00
MEAN + 3 SIGMA	.286+01	.292+01	.772+00	.991+00

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RADIATION TEST RESULTS

03/25/85

DEVICE TYPE CD4013  
MANUFACTURER SOLID STATE SCIENTIFIC  
PACKAGE TYPE DIP  
TEST DATE 3-19-85

FACILITY CD60  
ENERGY 1.25MEV  
RAD TEST REQ 114C-2  
CIRCUIT NO.

SERIAL NUMBER	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8321	1122-3

DOSE RATE	GRAY(SI)	INITIAL	1.00E01	2.00E01	5.00E01
	(GRAY/SEC)		3.33-02	3.33-02	1.00-01

(16)VTP9 (ITP=+10UA) IN VOLTS:

2064V	1.67	=2.79	*****	.86
2065V	1.80	=3.07	*****	*****
2066V	1.33	.61	.68	.93
2067V	2.08	=2.61	.72	.94
2068V	1.46	=2.29	.70	.92
MAX	.208+01	.610+00	.720+00	.940+00
MEAN	.167+01	-.203+01	.700+00	.912+00
MIN	.133+01	-.307+01	.680+00	.860+00
MEAN + 3 SIGMA	.255+01	.248+01	.760+00	.102+01

(17)VTP10 (ITP=+10UA) IN VOLTS:

2064V	1.72	=2.75	*****	.81
2065V	1.73	=2.85	*****	*****
2066V	1.50	.63	.68	.88
2067V	1.92	=2.66	.72	.88
2068V	1.52	=2.31	.70	.88
MAX	.192+01	.630+00	.720+00	.880+00
MEAN	.168+01	-.199+01	.700+00	.862+00
MIN	.150+01	-.285+01	.680+00	.810+00
MEAN + 3 SIGMA	.220+01	.244+01	.760+00	.967+00

(18)VTP11 (ITP=+10UA) IN VOLTS:

2064V	1.60	=2.39	*****	.83
2065V	1.73	=2.62	*****	*****
2066V	1.47	.64	.69	.8A
2067V	1.91	=2.36	.73	.89
2068V	1.51	=2.60	.71	.8A
MAX	.191+01	.640+00	.730+00	.890+00
MEAN	.164+01	-.188+01	.710+00	.870+00
MIN	.147+01	-.266+01	.690+00	.830+00
MEAN + 3 SIGMA	.218+01	.236+01	.770+00	.951+00



APPENDIX F  
RADIATION TEST RESULTS

RADIATION TEST RESULTS

03/13/85

DEVICE TYPE	C04060	FACILITY	C060
MANUFACTURER	SOLID STATE SCIENTIFIC	ENERGY	1.25MEV
PACKAGE TYPE	DIP	RAD TEST REQ	386-1
TEST DATE	3-6-85	CIRCUIT NO.	

SERIAL NUMBER	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8327	1123-1

DOSE	GRAY(SI)	INITIAL	1.00E01	2.00E01	3.00E01	1.00E02
RATE	(GRAY/SEC)		3.33-02	3.33-02	1.00-01	1.00-01

(1)IDD1 (VDD=15V) IN UAI

2058V	0.0026	130.	1600.	5400.	9000.
2059V	0.0029	115.	1500.	5300.	9000.
2060V	0.0029	140.	1600.	5500.	9200.
2061V	0.0047	130.	1500.	5200.	8600.
2062V	0.0027	165.	1750.	5600.	9200.
MAX	.470-02	.165+03	.175+04	.560+04	.920+04
MEAN	.336-02	.136+03	.159+04	.540+04	.900+04
MIN	.260-02	.115+03	.150+04	.520+04	.860+04
MEAN + 3 SIGMA	.577-02	.192+03	.190+04	.587+04	.975+04

(2)IDD2 (VDD=15V) IN UAI

2058V	0.0019	120.	1500.	5100.	8200.
2059V	0.0022	110.	1400.	5000.	8400.
2060V	0.0066	130.	1500.	5200.	8500.
2061V	0.0058	120.	1350.	4800.	7900.
2062V	0.0029	155.	1630.	5300.	8500.
MAX	.660-02	.155+03	.163+04	.530+04	.850+04
MEAN	.388-02	.127+03	.148+04	.508+04	.830+04
MIN	.190-02	.110+03	.135+04	.480+04	.790+04
MEAN + 3 SIGMA	.104-01	.179+03	.180+04	.566+04	.906+04

(3)VTH1 (ITN1=10UA) IN VOLTS

2058V	=1.55	1.63	5.26	12.26	5.95
2059V	=1.55	1.33	5.15	12.13	12.26
2060V	=1.59	1.24	5.68	12.04	12.27
2061V	=1.62	1.06	5.62	12.05	12.32
2062V	=1.54	1.33	5.76	12.34	7.28
MAX	=.154+01	.163+01	.576+01	.123+02	.123+02
MEAN	=.157+01	.132+01	.549+01	.122+02	.100+02
MIN	=.162+01	.106+01	.515+01	.120+02	.595+01
MEAN + 3 SIGMA	=.147+01	.194+01	.631+01	.126+02	.194+02

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RADIATION TEST RESULTS

03/13/85

DEVICE TYPE	CD4060	FACILITY	CD60
MANUFACTURER	SOLID STATE SCIENTIFIC	ENERGY	1.25MEV
PACKAGE TYPE	DIP	RAD TEST REQ	386-1
TEST DATE	3-6-85	CIRCUIT NO.	

SERIAL NUMBER	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8327	1123-2

DOSE	GRAY(81)	INITIAL	2.00E02	5.00E02	1.00E03
RATE	(GRAY/SEC)		1.00-01	1.00-01	1.00-01

(1) (VDD1=15V) IN UA: (Continued)

2058V	0.0026	15500.	27000.	41000.
2059V	0.0029	16000.	27500.	41000.
2060V	0.0029	16000.	28000.	41000.
2061V	0.0047	14800.	29000.	40000.
2062V	0.0027	16800.	29000.	45000.
MAX	.470-02	.168+05	.290+05	.450+05
MEAN	.316-02	.158+05	.281+05	.416+05
MIN	.260-02	.148+05	.270+05	.400+05
MEAN + 3 SIGMA	.577-02	.180+05	.308+05	.474+05

(2) (VDD2=15V) IN UA: (Continued)

2058V	0.0019	14200.	25000.	32000.
2059V	0.0022	14800.	24700.	32000.
2060V	0.0066	14700.	25000.	32000.
2061V	0.0058	13400.	27300.	32000.
2062V	0.0029	15200.	26000.	32000.
MAX	.660-02	.152+05	.273+05	.320+05
MEAN	.388-02	.145+05	.256+05	.320+05
MIN	.190-02	.134+05	.247+05	.320+05
MEAN + 3 SIGMA	.104-01	.165+05	.288+05	.320+05

(3) (ITN1=10UA) IN VOLTS: (Continued)

2058V	-1.55	7.82	12.04	12.08
2059V	-1.55	12.16	11.89	12.10
2060V	-1.59	12.13	11.73	12.02
2061V	-1.62	8.33	12.10	11.89
2062V	-1.54	12.23	12.11	12.13
MAX	-.154+01	.122+02	.121+02	.121+02
MEAN	-.157+01	.105+02	.120+02	.120+02
MIN	-.162+01	.078+02	.117+02	.119+02
MEAN + 3 SIGMA	-.147+01	.173+02	.125+02	.123+02

RADIATION TEST RESULTS

03/13/85

DEVICE TYPE	C04060	FACILITY	C060
MANUFACTURER	SOLID STATE SCIENTIFIC	ENERGY	1.25MEV
PACKAGE TYPE	DIP	RAD TEST REQ	386-1
TEST DATE	3-6-85	CIRCUIT NO.	

SERIAL NUMBER	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8327	1123-1

DOSE	GRAY(SI)	INITIAL	1.00E01	2.00E01	5.00E01	1.00E02
RATE	(GRAY/SEC)		3.33-02	3.33-02	1.00-01	1.00-01

(4)VTN2 (ITN2=-10UA) IN VOLTS:

2058V	=1.76	1.39	7.93	12.54	5.95
2059V	=1.76	1.45	7.84	12.54	12.26
2060V	=1.79	1.56	7.82	12.54	6.34
2061V	=1.80	1.51	7.36	12.58	12.35
2062V	=1.73	1.68	8.82	12.58	7.56
MAX	=.173+01	.188+01	.882+01	.126+02	.124+02
MEAN	=.177+01	.156+01	.795+01	.126+02	.885+01
MIN	=.180+01	.139+01	.736+01	.125+02	.595+01
MEAN + 3 SIGMA	=.168+01	.213+01	.955+01	.126+02	.184+02

(5)VTP1 (ITP1=+10UA) IN VOLTS:

2058V	1.56	=0.60	=0.74	=0.93	=1.02
2059V	1.56	=0.60	=0.74	0.93	=0.99
2060V	1.50	=0.60	=0.74	=0.93	=1.02
2061V	1.51	=0.57	=0.74	=0.93	=0.99
2062V	1.56	=0.60	=0.74	=0.93	=1.02
MAX	.156+01	-.570+00	-.740+00	.930+00	-.990+00
MEAN	.154+01	-.594+00	-.740+00	-.558+00	-.101+01
MIN	.150+01	-.600+00	-.740+00	-.930+00	-.102+01
MEAN + 3 SIGMA	.163+01	-.554+00	-.740+00	.194+01	-.959+00

(6)VTP2 (ITP2=+10UA) IN VOLTS:

2058V	1.74	=0.63	=0.82	=0.96	=1.04
2059V	1.74	=0.63	=0.82	0.96	=1.05
2060V	1.66	=0.63	=0.82	=0.97	=1.05
2061V	1.69	=0.63	=0.79	=0.96	=1.04
2062V	1.74	=0.66	=0.82	=0.96	=1.04
MAX	.174+01	-.630+00	-.790+00	.960+00	-.104+01
MEAN	.171+01	-.636+00	-.814+00	-.578+00	-.104+01
MIN	.166+01	-.660+00	-.820+00	-.970+00	-.105+01
MEAN + 3 SIGMA	.183+01	-.596+00	-.774+00	.200+01	-.103+01

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RADIATION TEST RESULTS

03/13/85

DEVICE TYPE	CO4060	FACILITY	CO60
MANUFACTURER	SOLID STATE SCIENTIFIC	ENERGY	1.25MEV
PACKAGE TYPE	DIP	RAD TEST REQ	386-1
TEST DATE	3-6-85	CIRCUIT NO.	

SERIAL NUMBER	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8327	1123-2

DOSE	GRAY(SI)	INITIAL	2.00E02	5.00E02	1.00E03
RATE	(GRAY/SEC)		1.00=01	1.00=01	1.00=01

(4) (ITN2=-10UA) IN VOLTS: (Continued)

2058V	-1.76	12.16	11.86	12.16
2059V	-1.76	12.25	12.04	12.23
2060V	-1.79	9.13	12.05	12.10
2061V	-1.80	7.09	12.11	11.89
2062V	-1.73	12.29	12.13	12.20
MAX	-.173+01	.123+02	.121+02	.122+02
MEAN	-.177+01	.106+02	.120+02	.121+02
MIN	-.180+01	.709+01	.119+02	.119+02
MEAN + 3 SIGMA	-.168+01	.177+02	.124+02	.125+02

(5) (ITP1=+10UA) IN VOLTS: (Continued)

2058V	1.56	-1.07	-1.23	-1.32
2059V	1.56	-1.10	-1.16	-1.32
2060V	1.50	-1.08	-1.08	-1.34
2061V	1.51	-1.04	-1.27	-1.32
2062V	1.56	-1.13	-1.29	-1.32
MAX	.156+01	-.104+01	-.108+01	-.132+01
MEAN	.154+01	-.108+01	-.121+01	-.132+01
MIN	.150+01	-.113+01	-.129+01	-.134+01
MEAN + 3 SIGMA	.163+01	-.983+00	-.947+00	-.150+01

(6) (ITP2=+10UA) IN VOLTS: (Continued)

2058V	1.74	-1.17	-1.26	-1.26
2059V	1.74	-1.20	-1.26	-1.26
2060V	1.66	-1.20	-1.27	-1.27
2061V	1.69	-1.16	-1.26	-1.26
2062V	1.74	-1.20	-1.26	-1.26
MAX	.174+01	-.116+01	-.126+01	-.126+01
MEAN	.171+01	-.119+01	-.126+01	-.126+01
MIN	.166+01	-.120+01	-.127+01	-.127+01
MEAN + 3 SIGMA	.183+01	-.113+01	-.125+01	-.125+01