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

May 15, 1985

Prepared for and in cooperation with
TRW Components International
Through an agreement with
National Aeronautics and Space Administration
by
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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

May 15, 1985

Prepared for and in cooperation with
TRW Components International
Through an agreement with
National Aeronautics and Space Administration
by
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

The research described in this publication was carried out by the Jet Propulsion Laboratory, California Institute of Technology, and was sponsored by TRW Components International through an agreement with the National Aeronautics and Space Administration.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. 85-47	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Total Integrated Dose Testing of Solid-State Scientific CD4011, CD4013, and CD4060 Devices by Irradiation With CO-60 Gamma Rays		5. Report Date May 15, 1985 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address JET PROPULSION LABORATORY California Institute of Technology 4800 Oak Grove Drive Pasadena, California 91109		10. Work Unit No. 11. Contract or Grant No. NAS7-918 13. Type of Report and Period Covered JPL Publication
12. Sponsoring Agency Name and Address NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Washington, D.C. 20546		14. Sponsoring Agency Code RE216 PW-323-51-45-00-02

15. Supplementary Notes

16. 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).

17. Key Words (Selected by Author(s))	18. Distribution Statement
Components; Quality Assurance and Reliability, Space Radiation	Unclassified, unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

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

This research task was carried out under the direction of Ron Clarke, Senior Scientist of TRW Components International, One Space Park, Redondo Beach, California 90278. Grateful acknowledgment is made for the assistance of Leroy Craft, Mike Lane, Tetsuo Miyahira, Merlin Raines, Esther Rodriguez, Matt Tuchscherer and Pat Warmer of JPL. Without the aid and expert knowledge of all these people, this task would not have been possible.

CONTENTS

Figures

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 Landswerk 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 Δ'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.

---

*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.

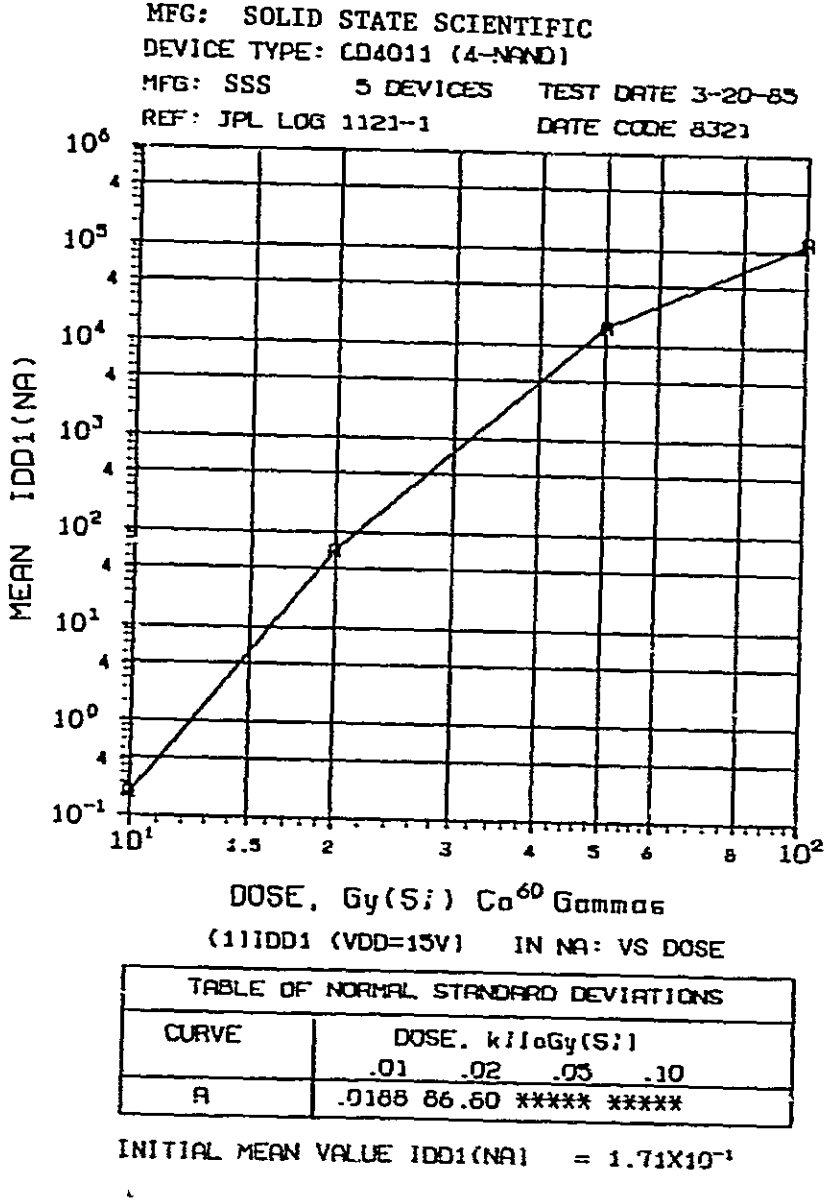


TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.01	.02	.05	.10
A	.0188	86.60	*****	*****

INITIAL MEAN VALUE IDD1(NA) = $1.71X10^{-1}$

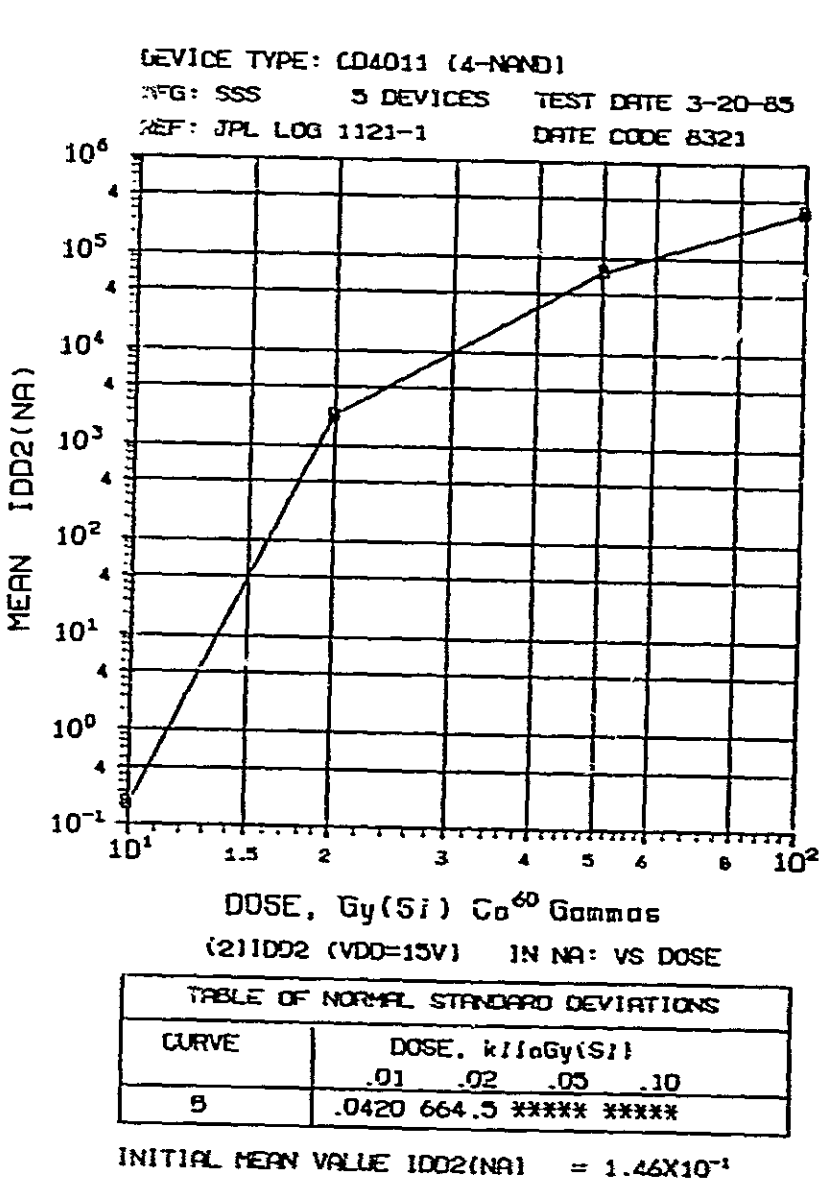


TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.01	.02	.05	.10
B	.0420	664.5	*****	*****

INITIAL MEAN VALUE IDD2(NA) = $1.46X10^{-1}$

Figure 1. IDD1 and IDD2 for CD4011

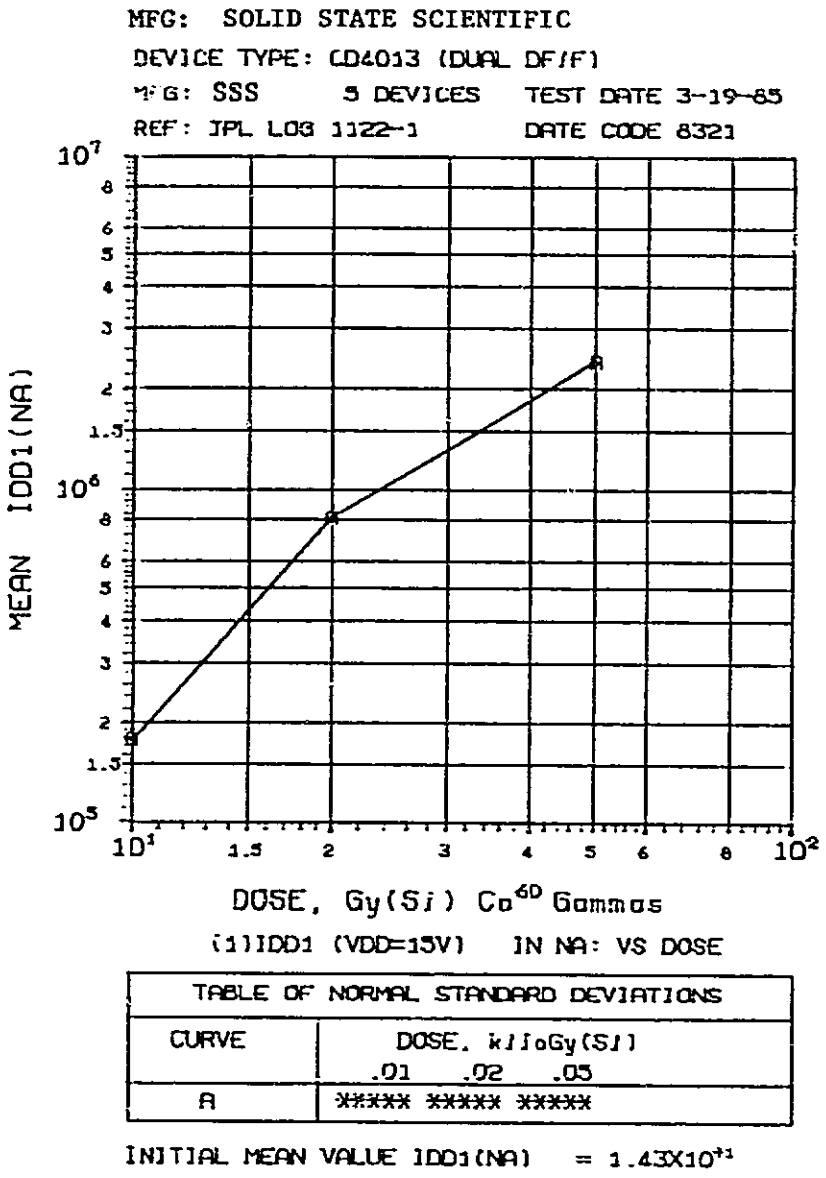


TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .01	.02	.05
A	*****	*****	*****

INITIAL MEAN VALUE IDD1(NA) = $1.43X10^{+1}$

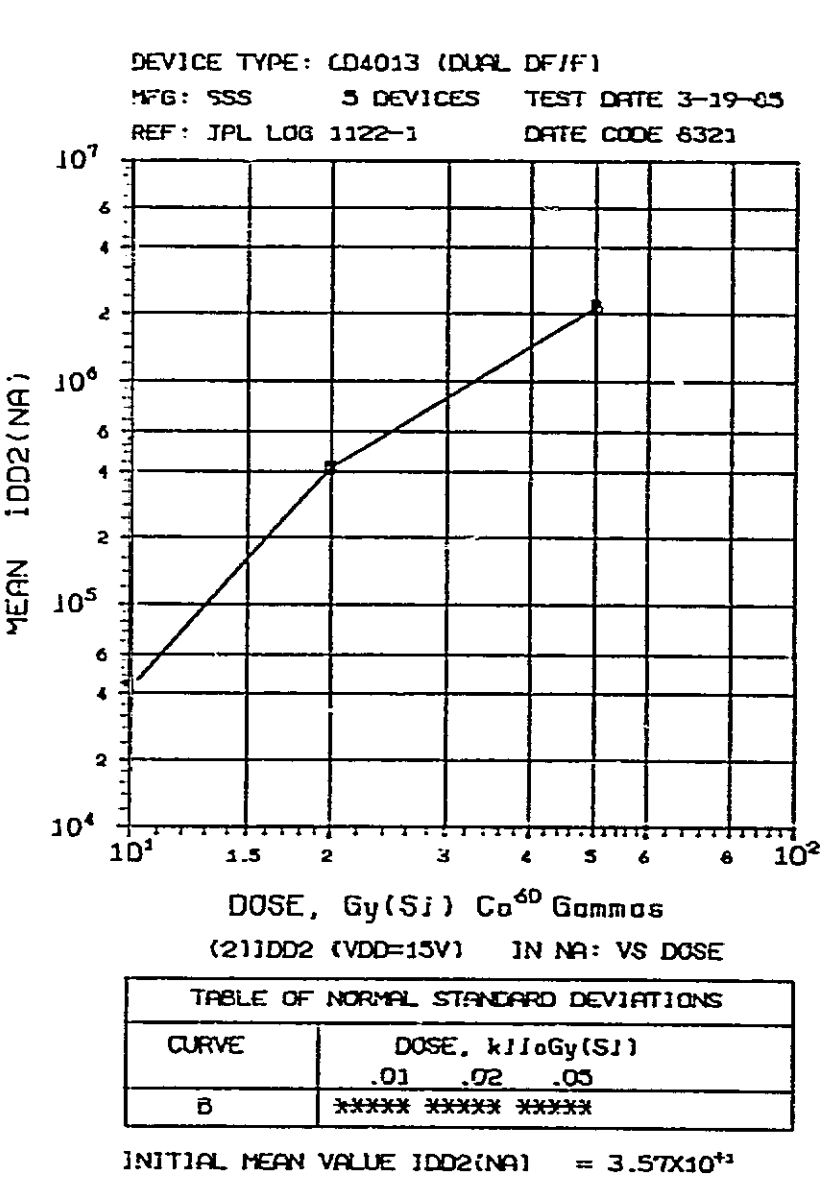


TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .01	.02	.05
B	*****	*****	*****

INITIAL MEAN VALUE IDD2(NA) = $3.57X10^{+1}$

Figure 2. IDD1 and IDD2 for CD4013

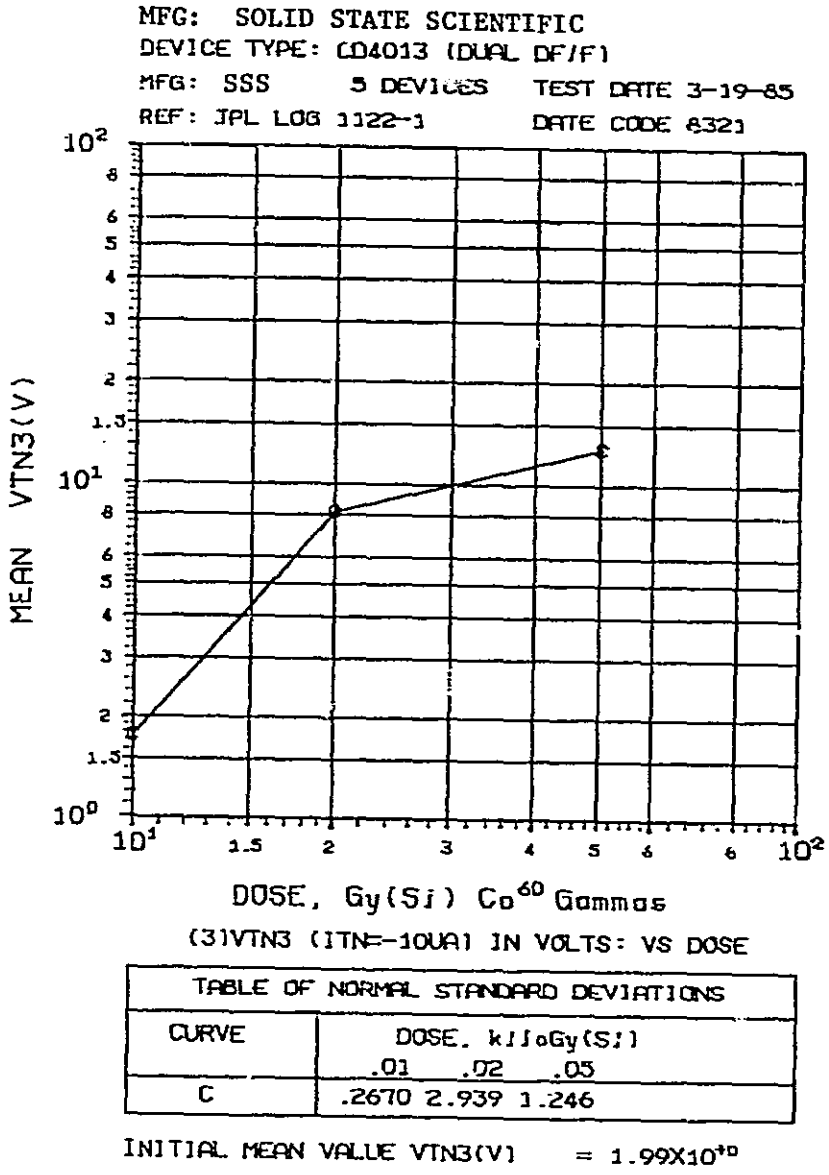


TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.01	.02	.05
C	.2670	2.939	1.246

INITIAL MEAN VALUE VTN3(V) = $1.99 \times 10^{+0}$

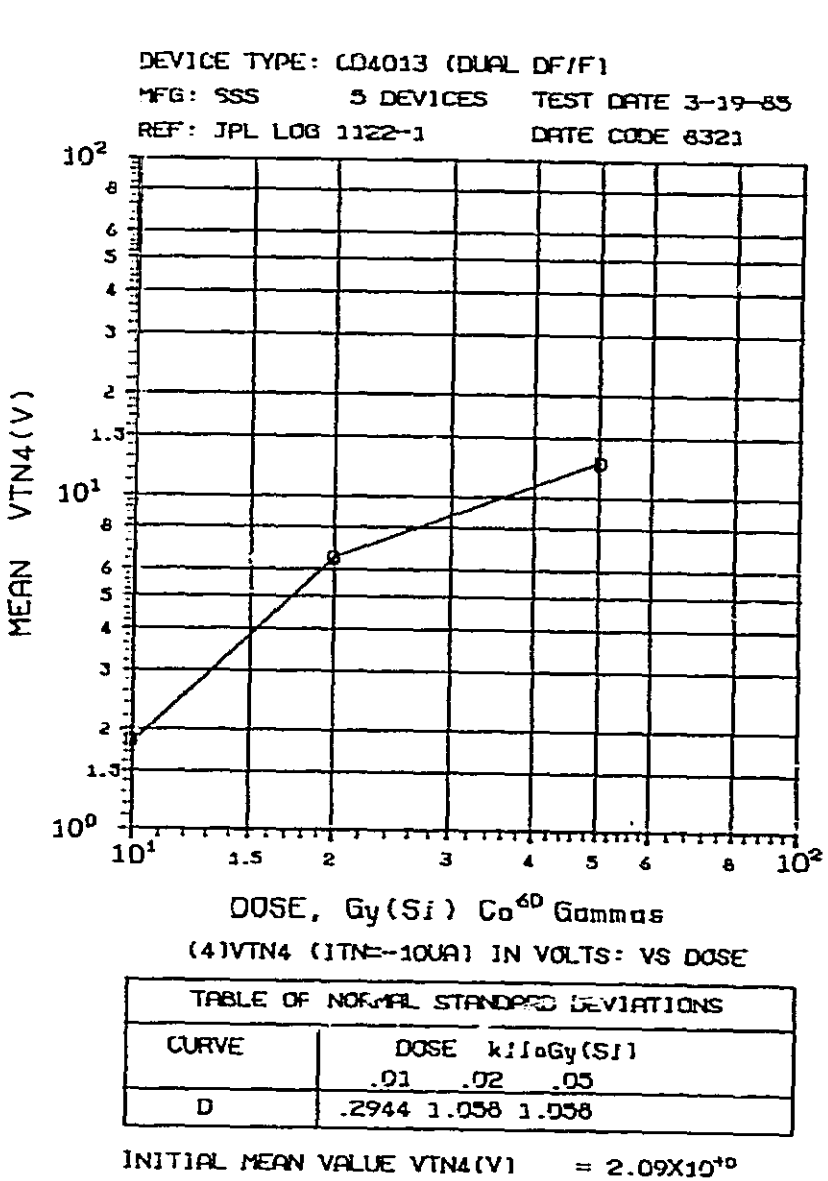


TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE kiloGy(Si)		
	.01	.02	.05
D	.2944	1.058	1.058

INITIAL MEAN VALUE VTN4(V) = $2.09 \times 10^{+0}$

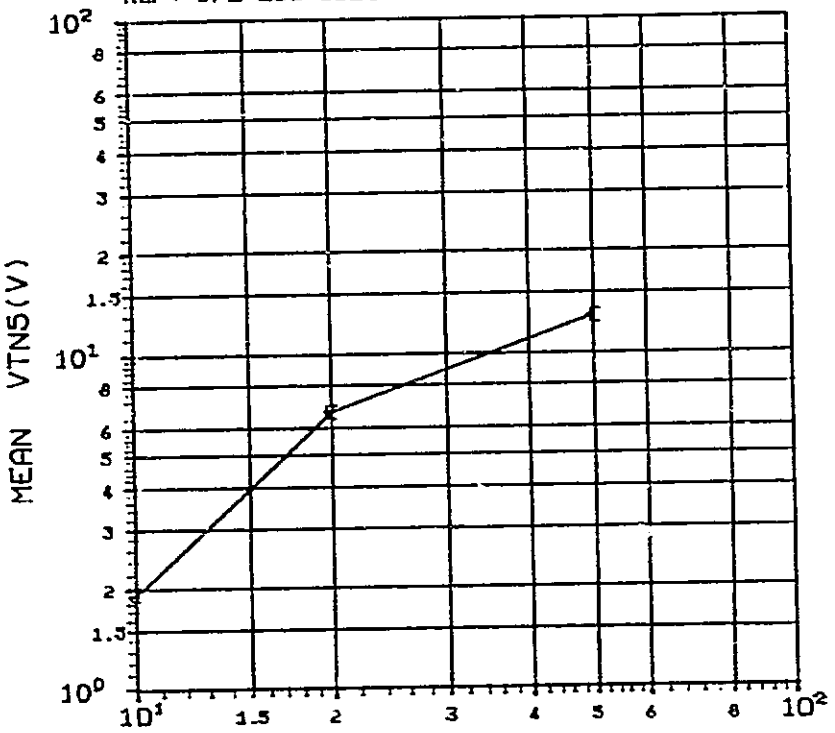
Figure 3. VTN3 and VTN4 for CD4013

MFG: SOLID STATE SCIENTIFIC

DEVICE TYPE: CD4013 (DUAL D/F)

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

REF: JPL LOG 1122-1 DATE CODE 8321



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

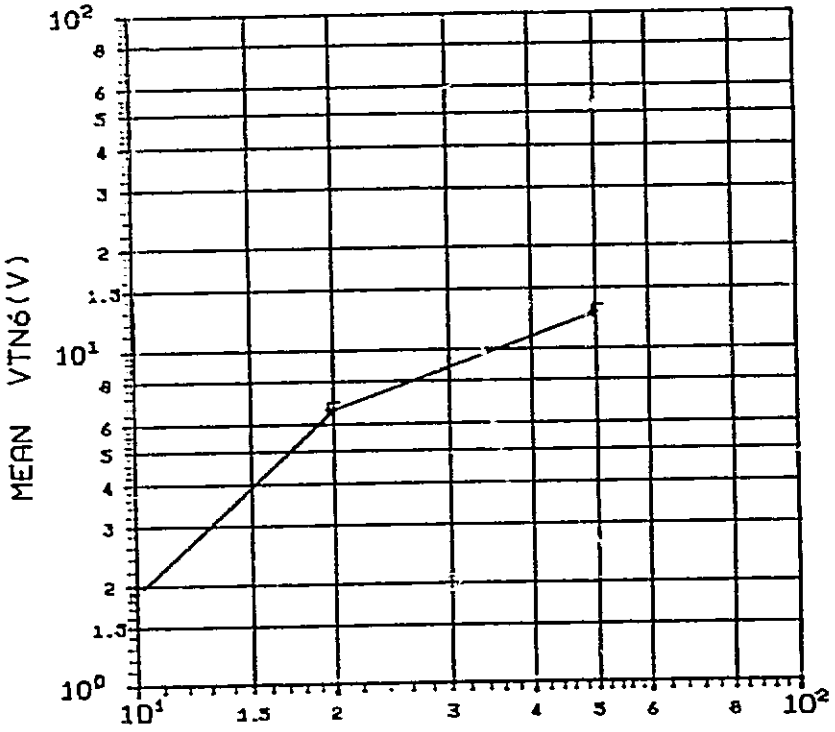
TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.01	.02	.05
E	.2953	1.150	1.201

INITIAL MEAN VALUE VTN5(V) = 2.10X10+0

DEVICE TYPE: CD4013 (DUAL D/F)

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

REF: JPL LOG 1122-1 DATE CODE 8321

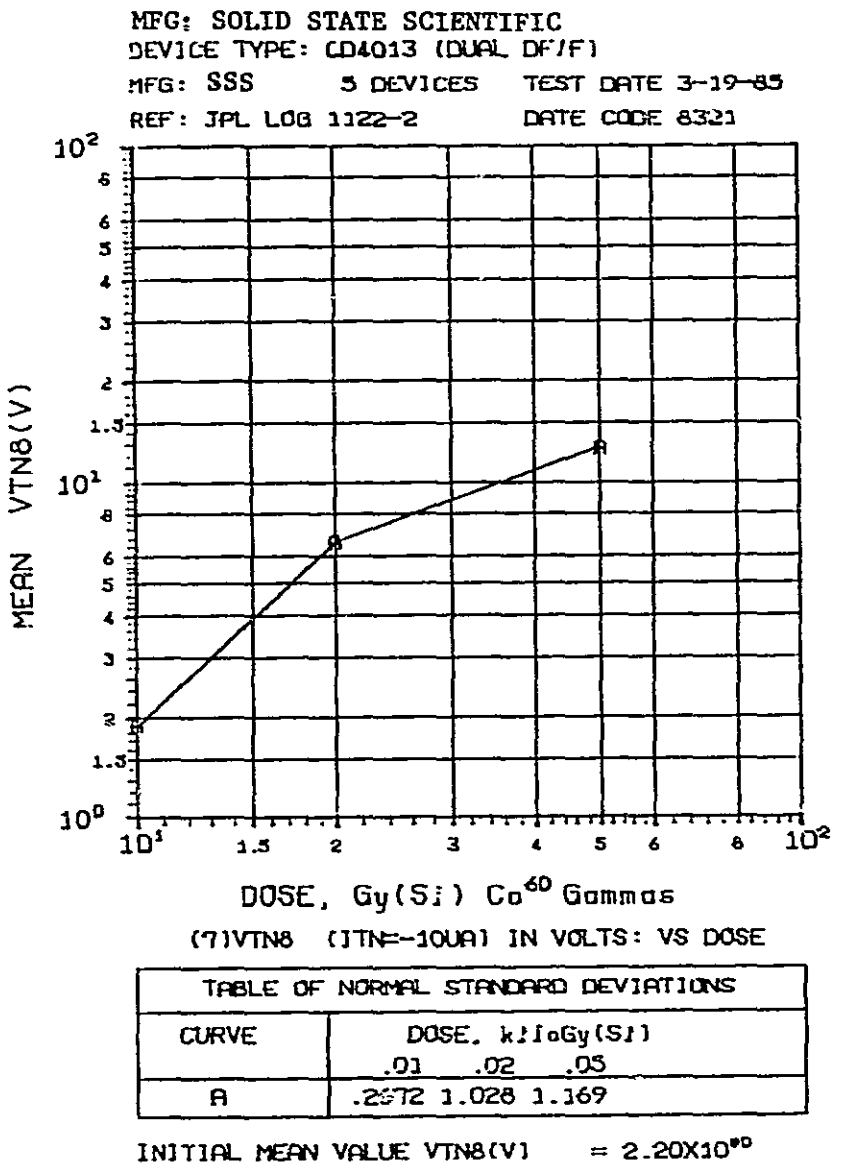


(6)VTN6 (ITN=-10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.01	.02	.05
F	.2643	1.118	1.218

INITIAL MEAN VALUE VTN6(V) = 2.20X10+0

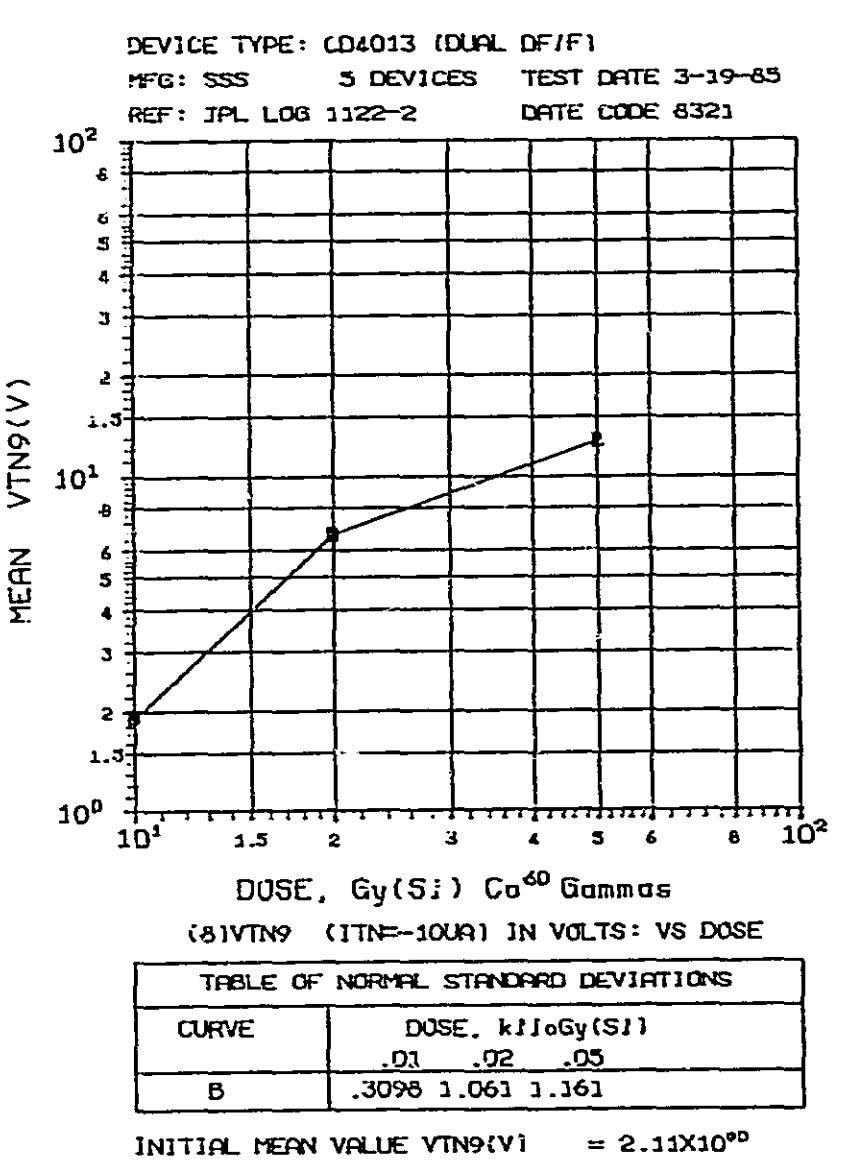
Figure 4. VTN5 and VTN6 for CD4013



(7)VTN8 (ITN=-10UA) IN VOLTS: VS DOSE

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

INITIAL MEAN VALUE VTN8(V) = 2.20X10^{00}

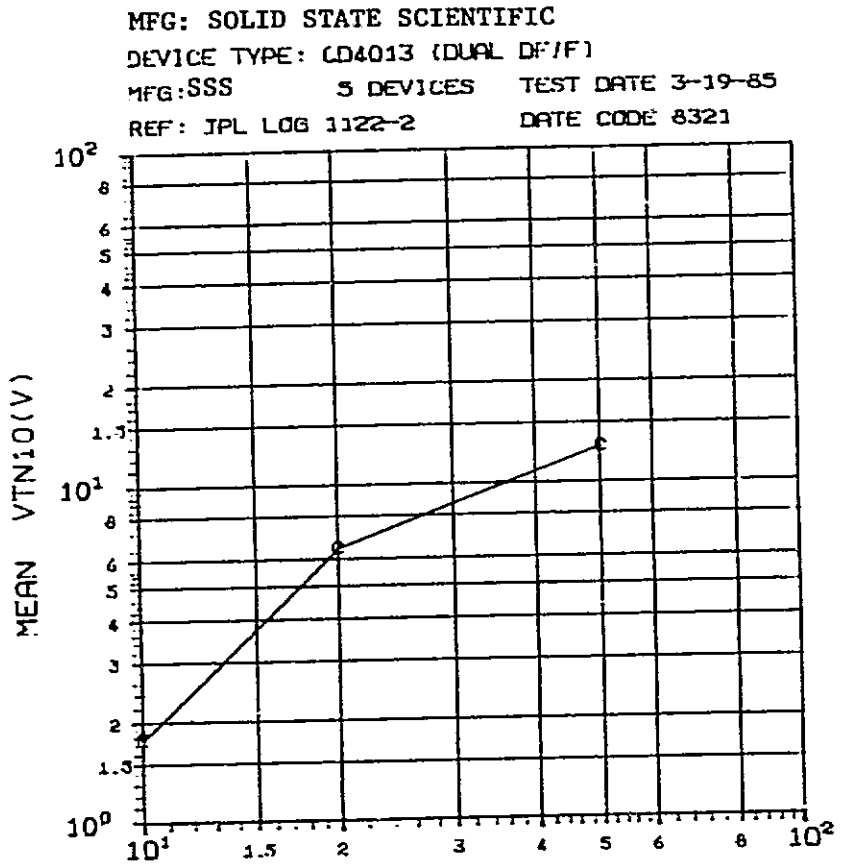


(8)VTN9 (ITN=-10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kRad(Si) .01	.02	.05
B	.3098	1.061	1.161

INITIAL MEAN VALUE VTN9(V) = 2.11X10^{00}

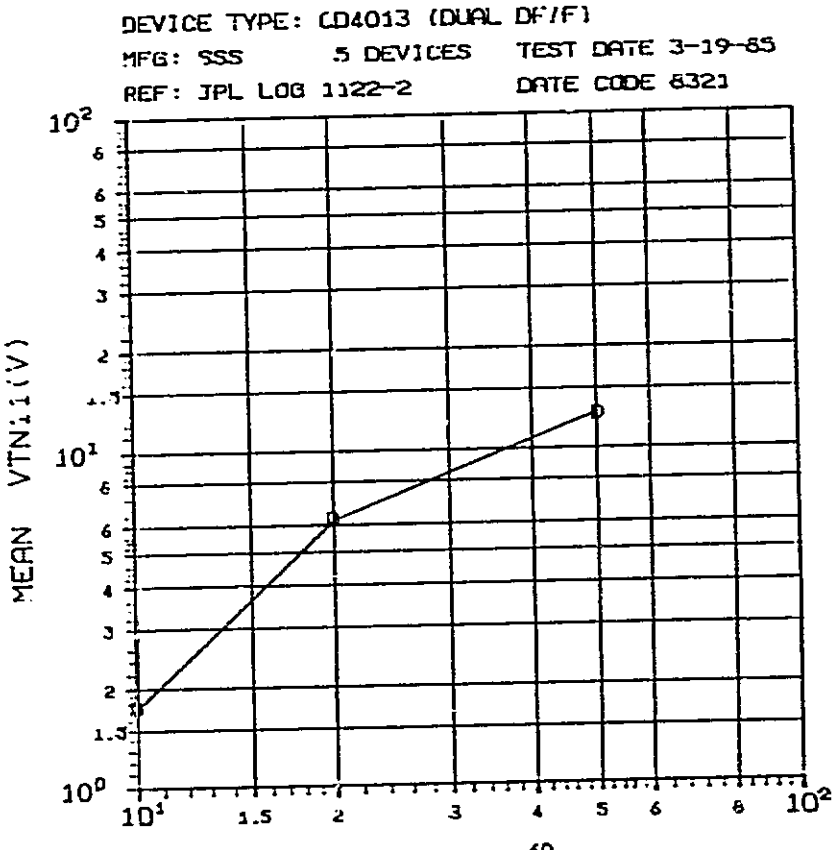
Figure 5. VTN8 and VTN9 for CD4013



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

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

INITIAL MEAN VALUE VTN10(V) = 2.10X10^{00}

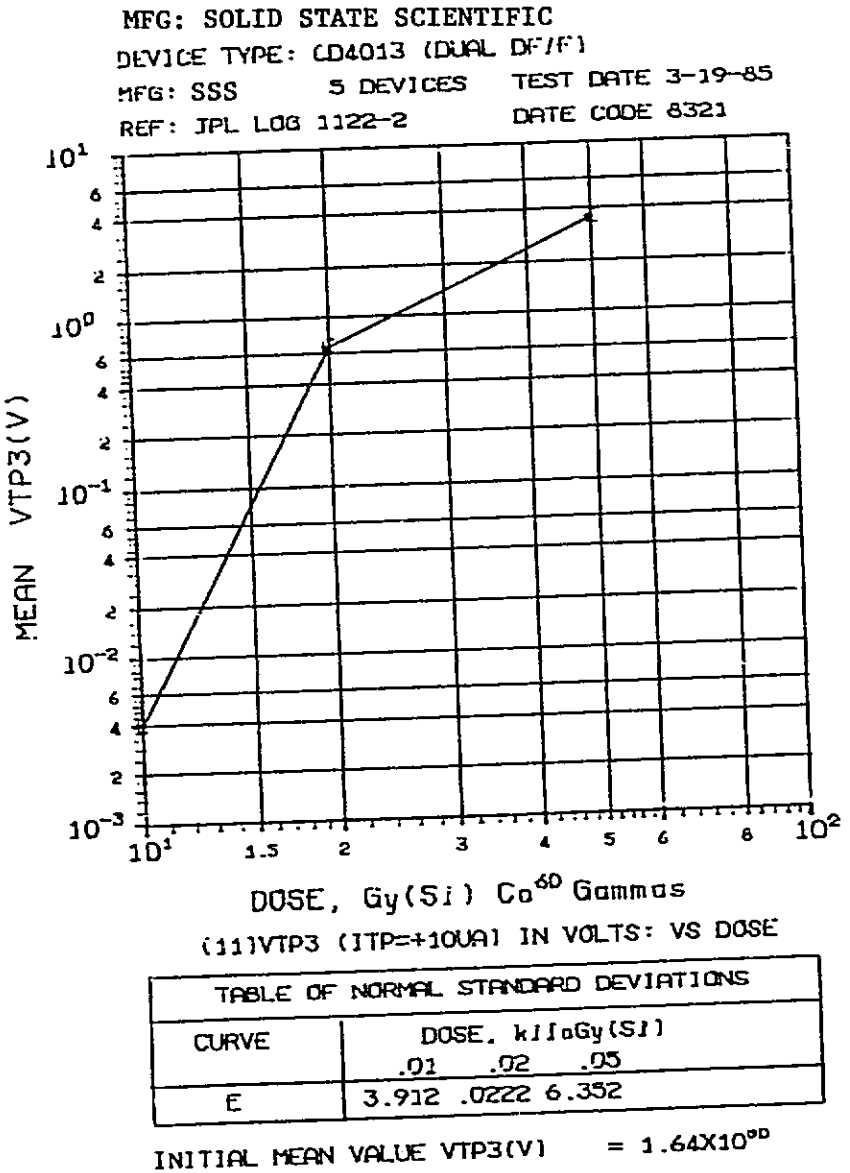


(10)VTN11(ITN=-10UA) IN VOLTS: VS DOSE

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

INITIAL MEAN VALUE VTN11(V) = 2.01X10^{00}

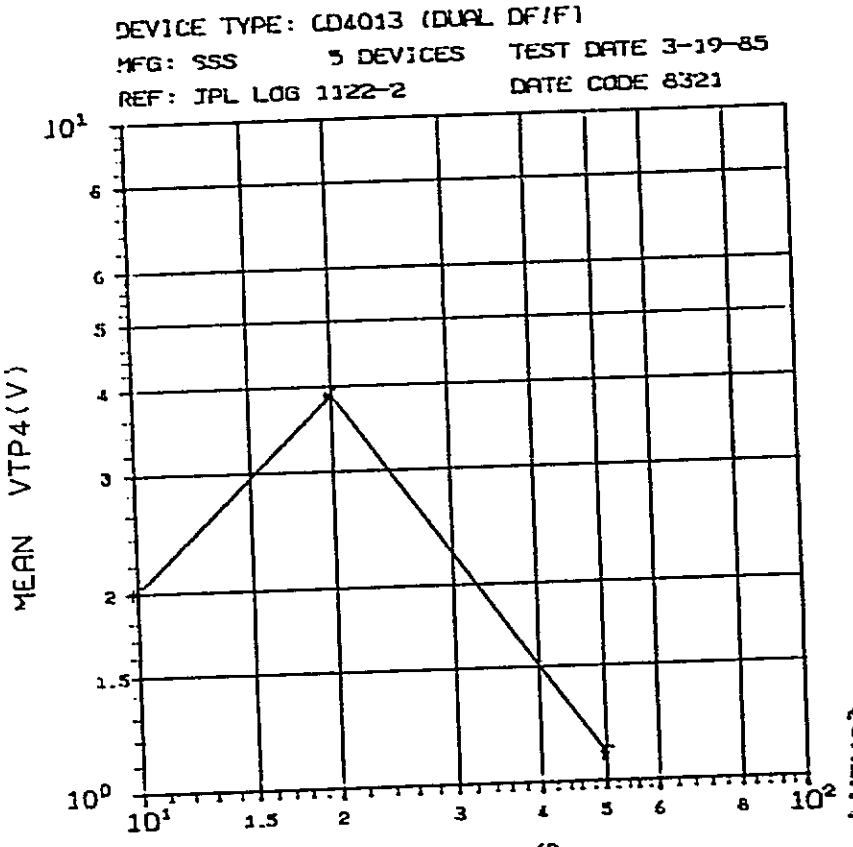
Figure 6. VTN10 and VTN11 for CD4013



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

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kRaGy(Si)		
	.01	.02	.05
E	3.912	.0222	6.352

INITIAL MEAN VALUE VTP3(V) = 1.64X10^{00}



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

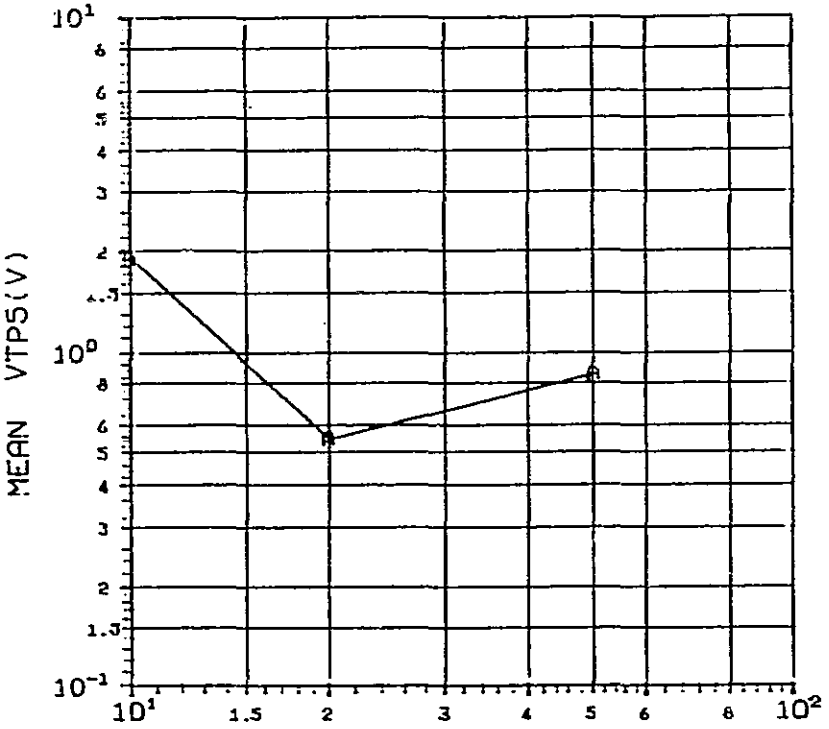
TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kRaGy(Si)		
	.01	.02	.05
F	1.498	6.367	.5174

INITIAL MEAN VALUE VTP4(V) = 1.70X10^{00}

Figure 7. VTP3 and VTP4 for CD4013

MFG: SOLID STATE SCIENTIFIC

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

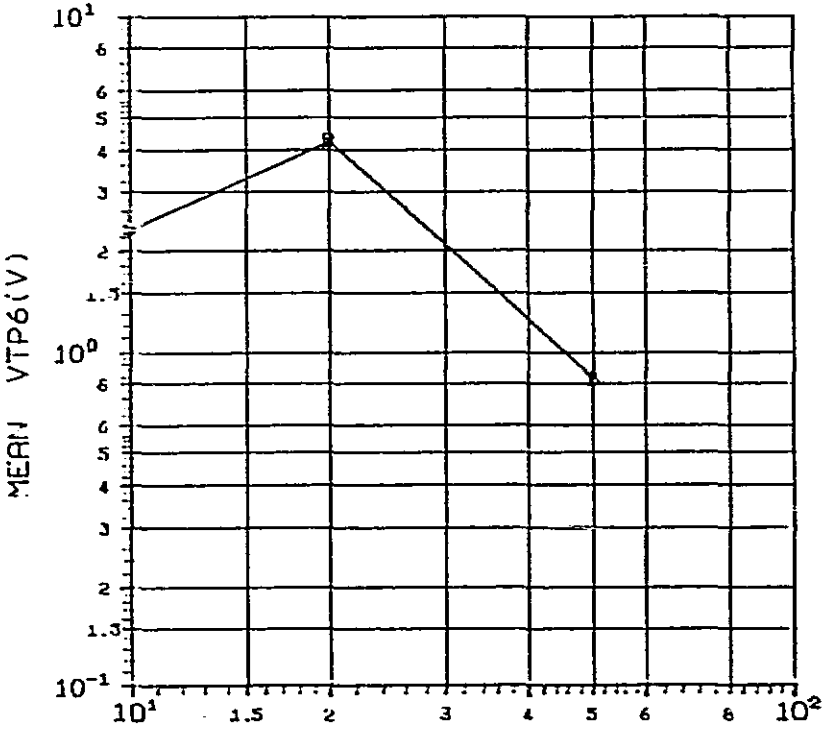


(13)VTP5 (ITP=+10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .01	.02	.05
A	1.432	.2805	.0310

INITIAL MEAN VALUE VTP5(V) = 1.62X10^{00}

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

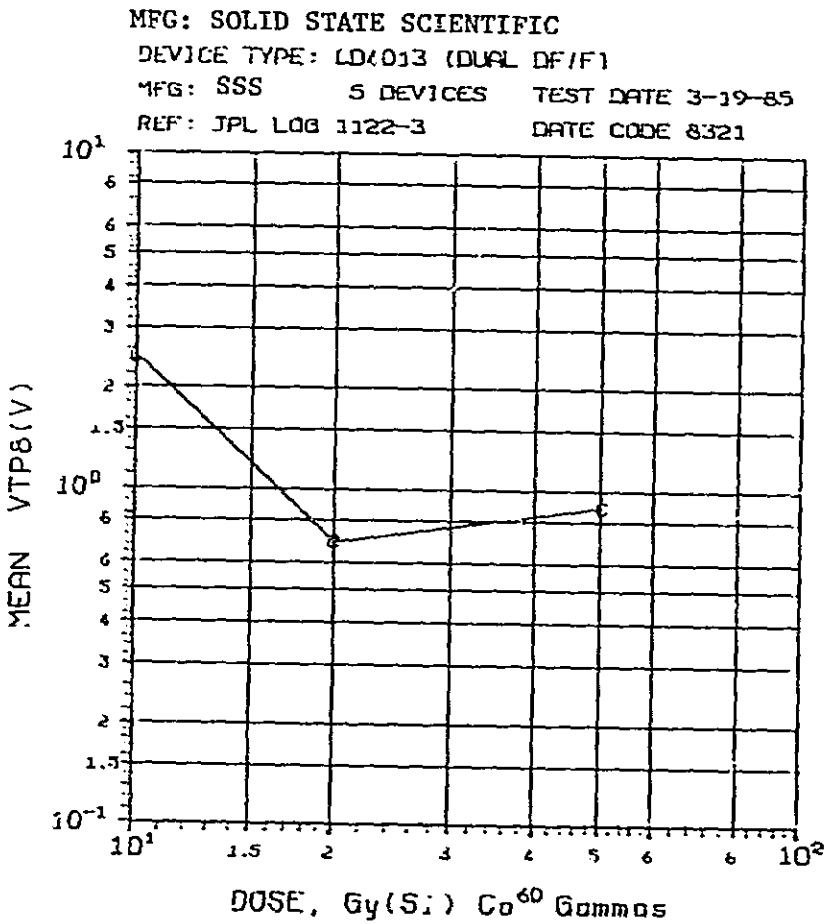


(14)VTP6 (ITP=+10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .01	.02	.05
B	1.724	7.197	.0238

INITIAL MEAN VALUE VTP6(V) = 1.82X10^{00}

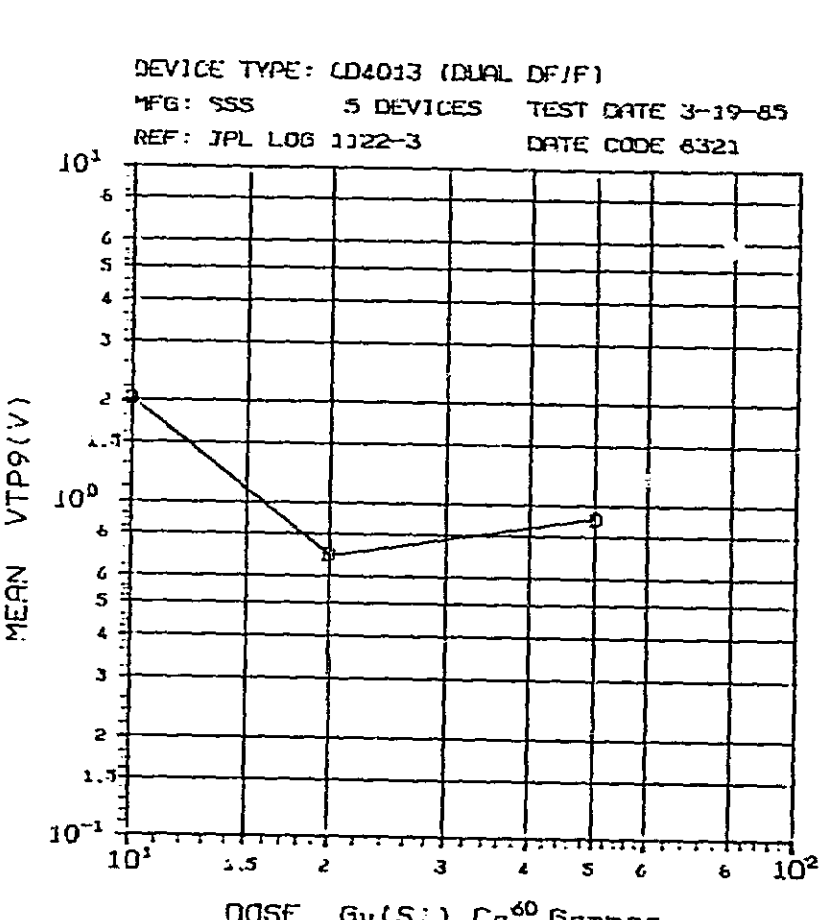
Figure 8. VTP5 and VTP6 for CD4013



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

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.01	.02	.05
C	1.801	.0252	.0337

INITIAL MEAN VALUE VTP8(V) = $1.86X10^{00}$



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

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.01	.02	.05
D	1.503	.0200	.0359

INITIAL MEAN VALUE VTP9(V) = $1.67X10^{00}$

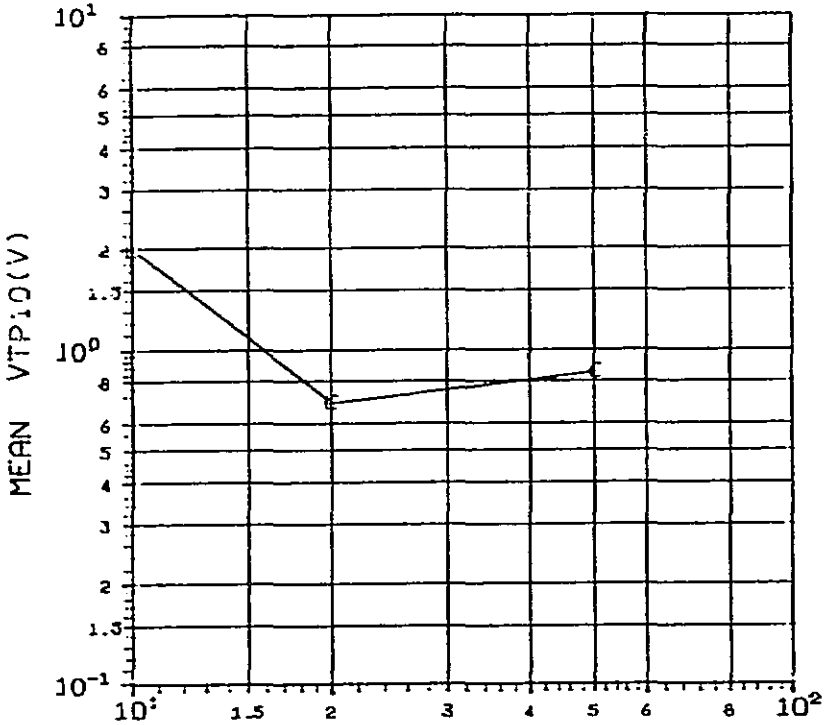
Figure 9. VTP8 and VTP9 for CD4013

MFG: SOLID STATE SCIENTIFIC

DEVICE TYPE: CD4013 (DUAL D-F/F)

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

REF: JPL LOG 1122-3 DATE CODE 8321



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

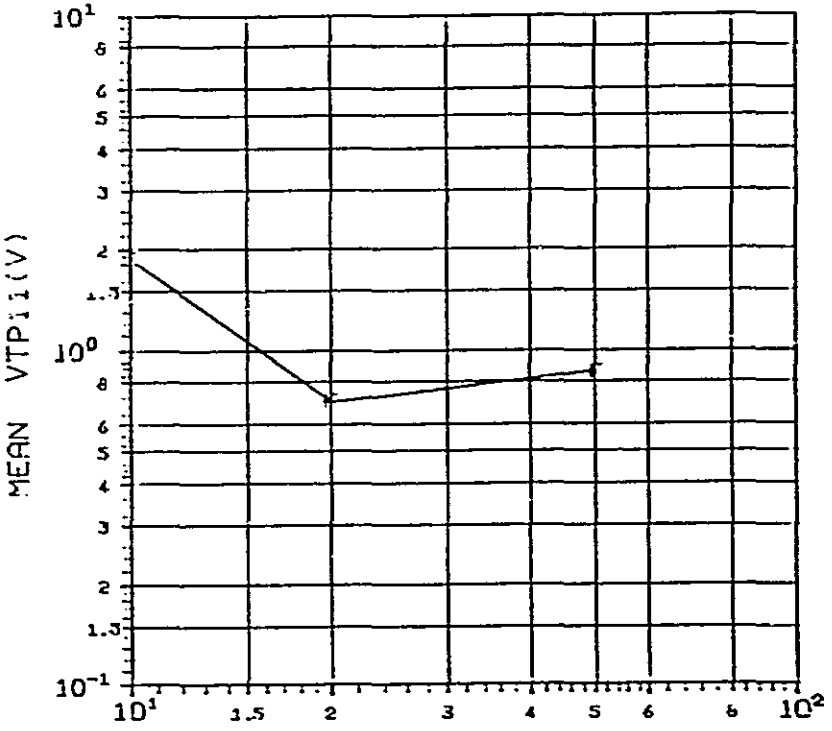
TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, k/loGy(Si)		
	.01	.02	.05
E	1.478	.0200	.0350

INITIAL MEAN VALUE VTP10(V) = 1.68X10^{00}

DEVICE TYPE: CD4013 (DUAL D-F/F)

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

REF: JPL LOG 1122-3 DATE CODE 8321



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

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, k/loGy(Si)		
	.01	.02	.05
F	1.414	.0200	.0271

INITIAL MEAN VALUE VTP11(V) = 1.64X10^{00}

Figure 10. VTP10 and VTP11 for CD4013

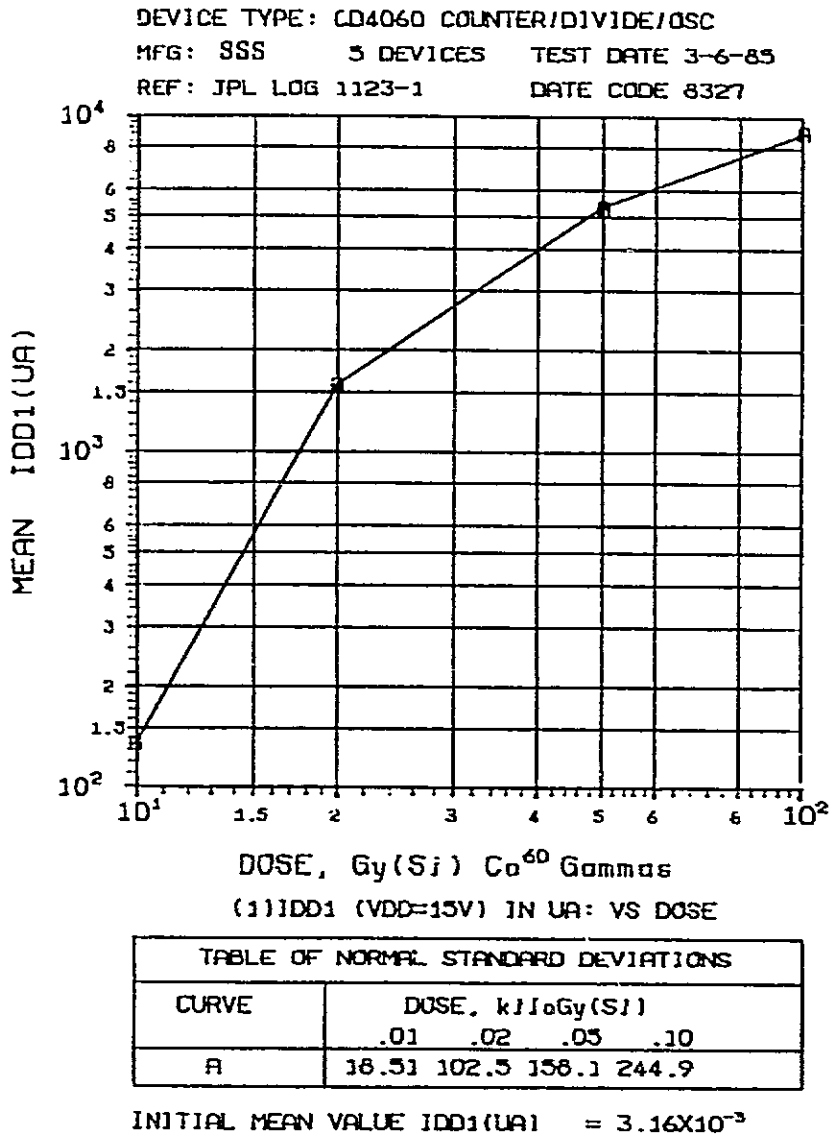


TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.01	.02	.05	.10
A	16.51	102.5	158.1	244.9

INITIAL MEAN VALUE IDD1(UA) = $3.16X10^{-3}$

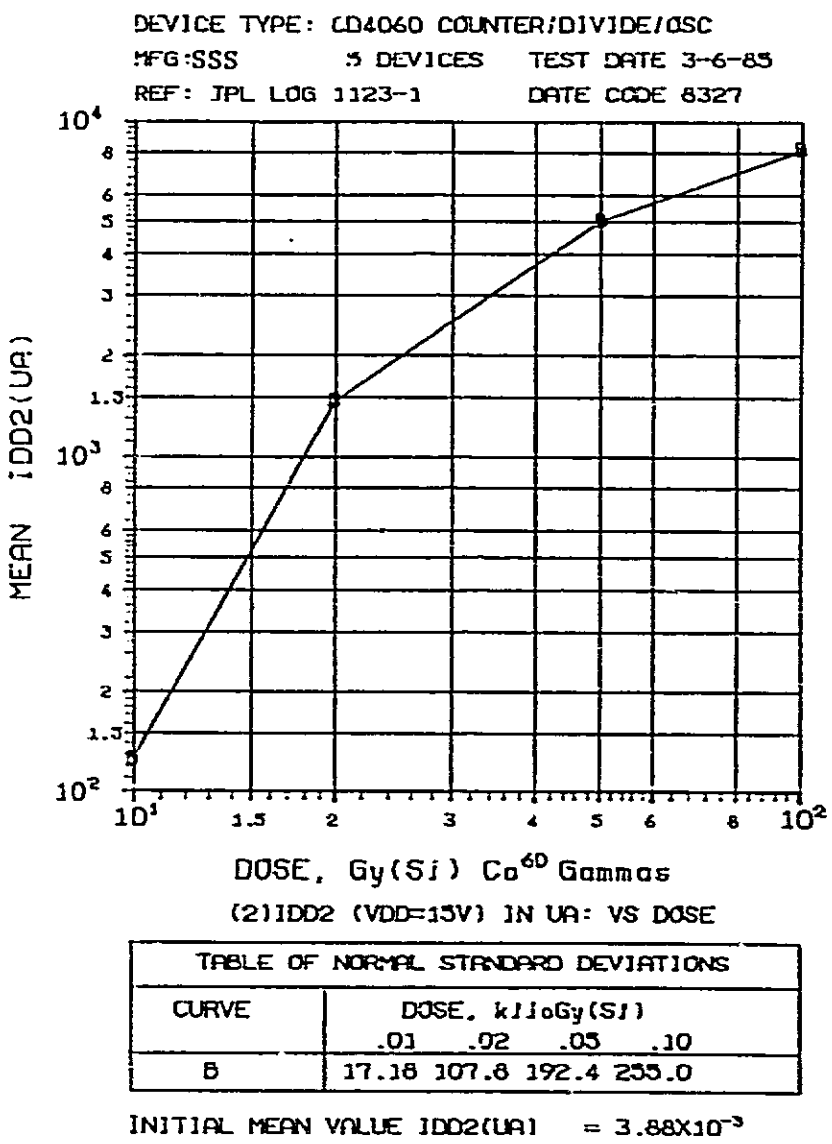
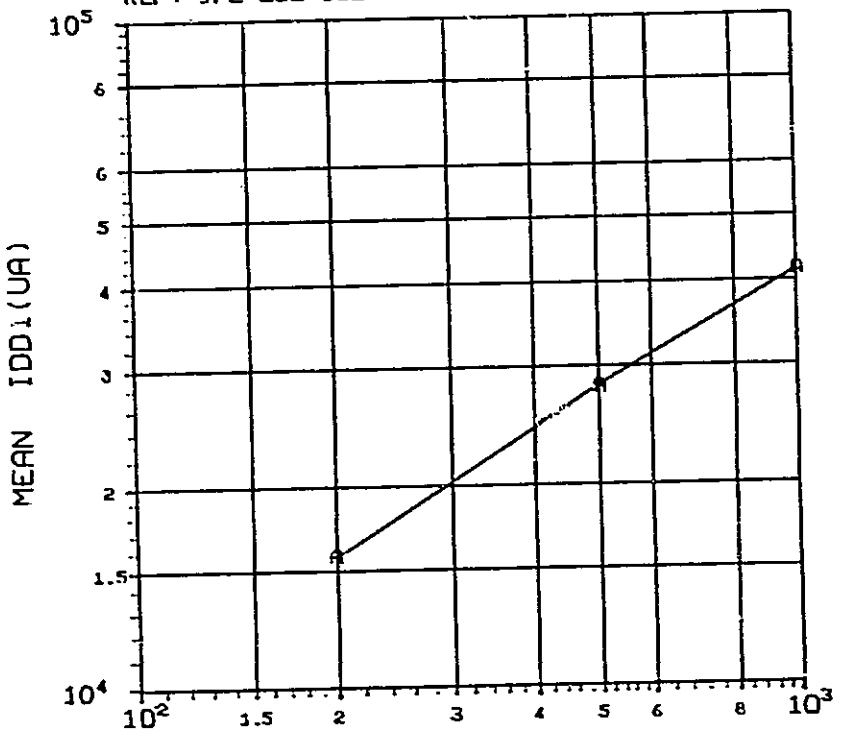


TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.01	.02	.05	.10
B	17.18	107.8	192.4	255.0

INITIAL MEAN VALUE IDD2(UA) = $3.88X10^{-3}$

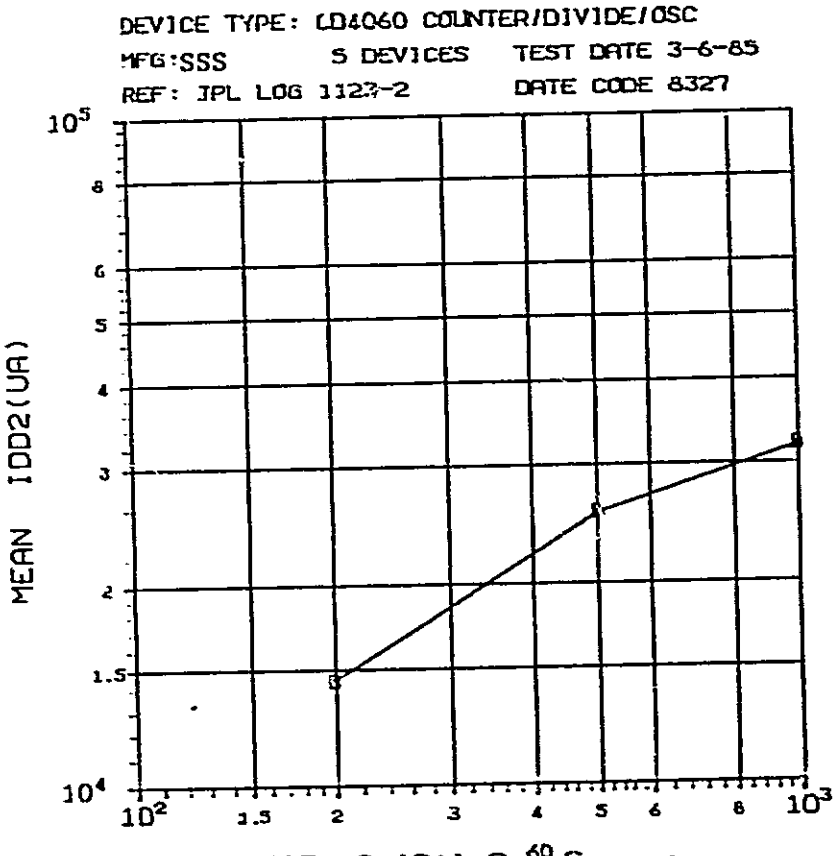
Figure 11. IDD1 and IDD2 for CD4060



(1) (VDD1=15V) IN UA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.20	.50	1.00
A	736.2	894.4	1949.

INITIAL MEAN VALUE IDD1(UA) = $3.16X10^{-3}$



(2) (VDD2=15V) IN UA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.20	.50	1.00
B	691.4	1070.	.0000

INITIAL MEAN VALUE IDD2(UA) = $3.88X10^{-3}$

Figure 11. IDD1 and IDD2 for CD4060 (Continued)

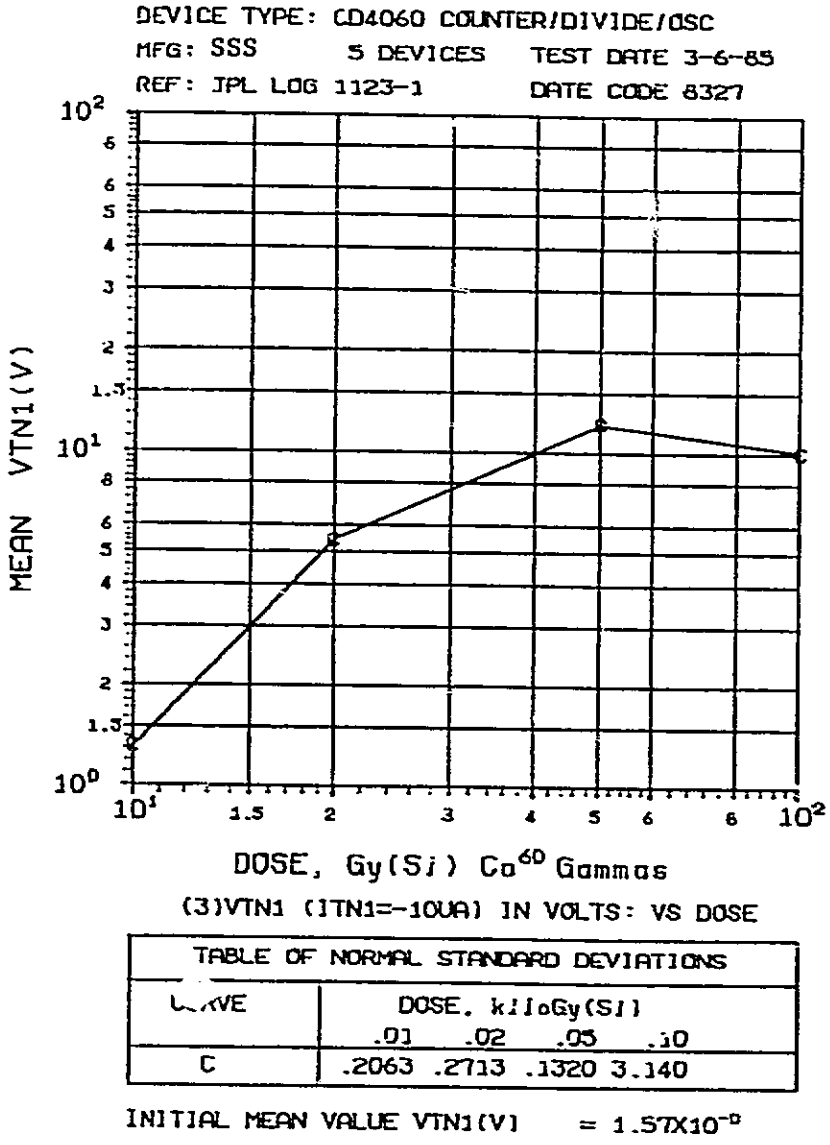


TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.01	.02	.05	.10
C	.2063	.2713	.1320	3.140

INITIAL MEAN VALUE VTN1(V) = 1.57X10^{0}

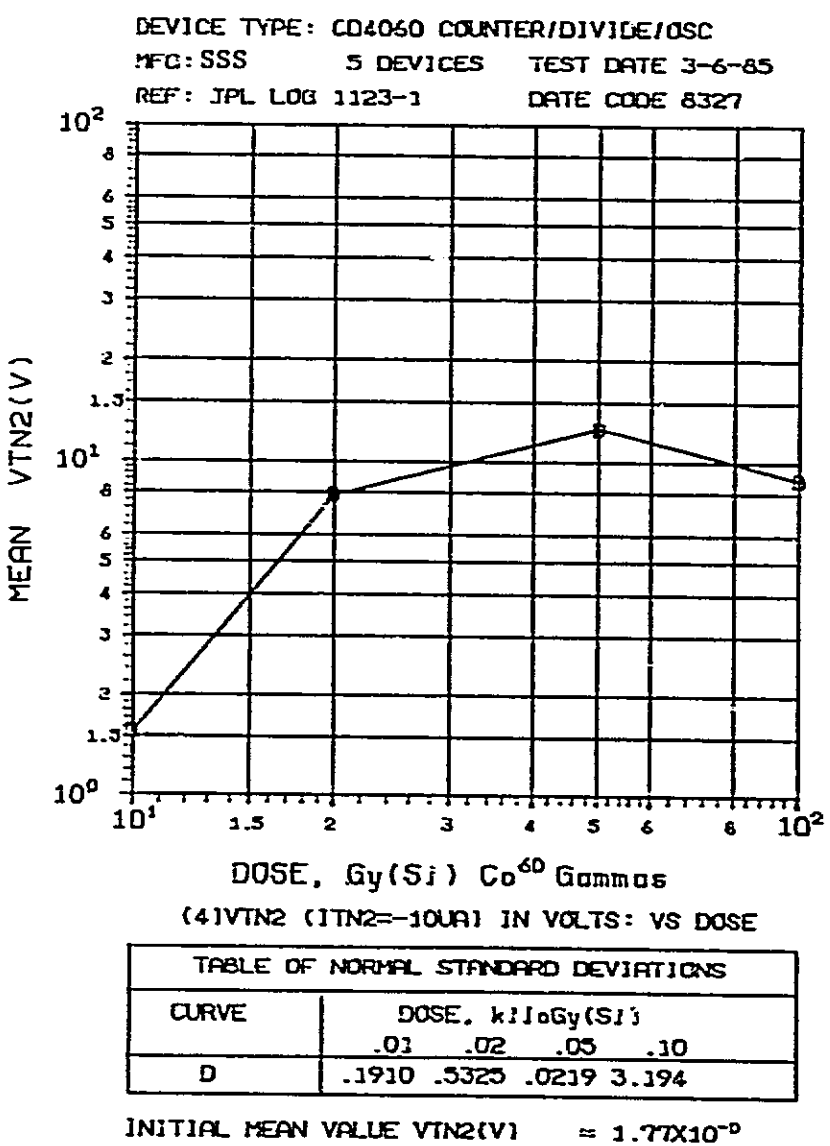
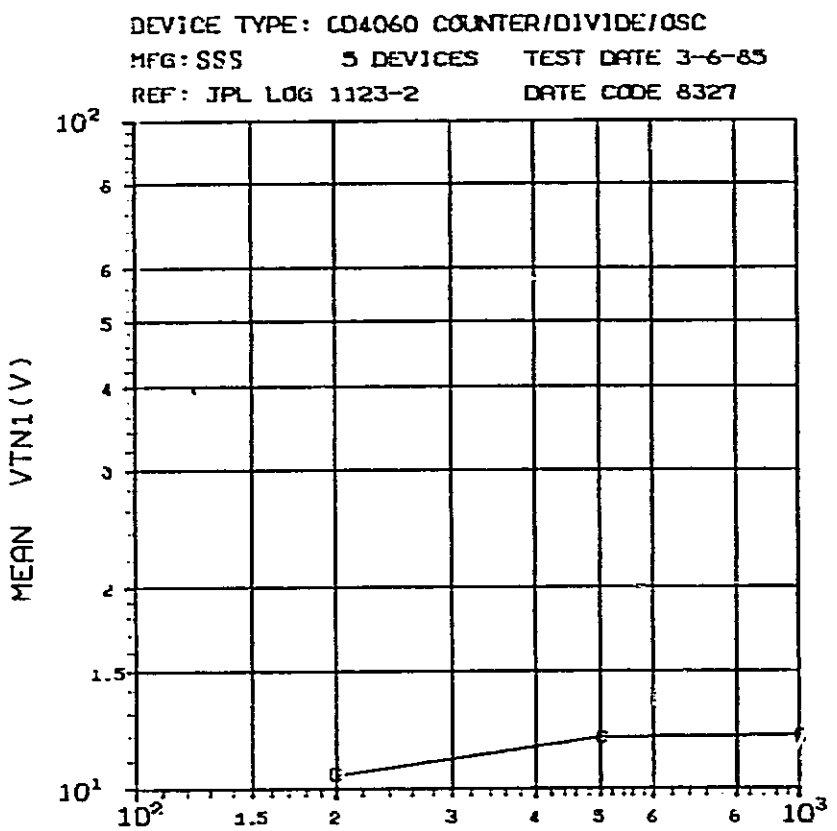


TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.01	.02	.05	.10
D	.1910	.5325	.0219	3.194

INITIAL MEAN VALUE VTN2(V) = 1.77X10^{0}

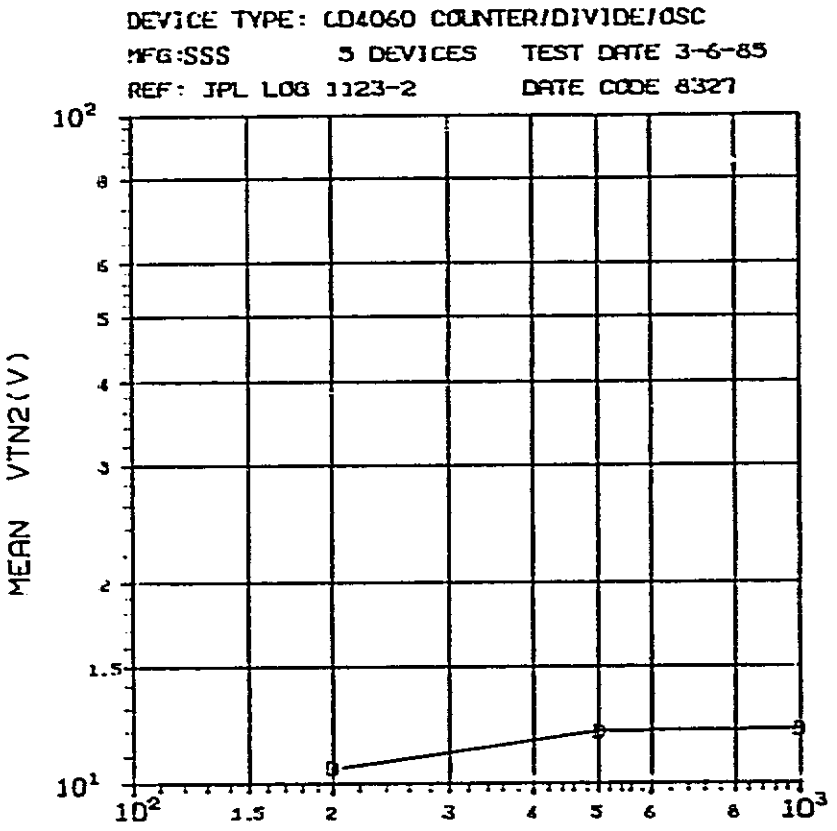
Figure 12. VTN1 and VTN2 for CD4060



(3) (ITN1=-10UA) IN VOLTS: VS DOSE

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

INITIAL MEAN VALUE VTN1(V) = 1.57X10^{-0}

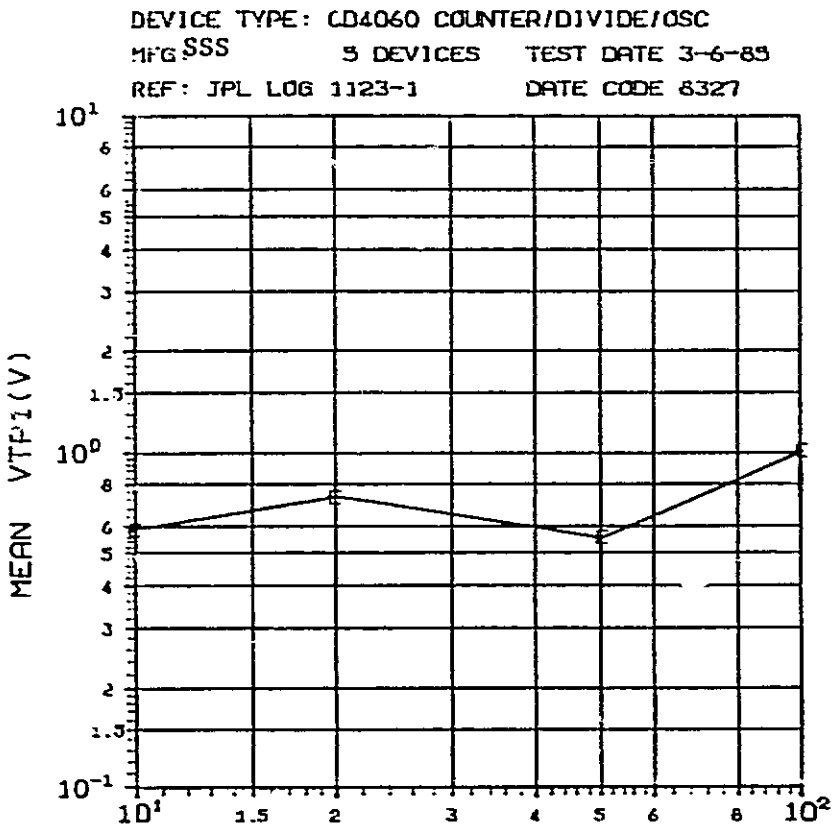


(4) (ITN2=-10UA) IN VOLTS: VS DOSE

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

INITIAL MEAN VALUE VTN2(V) = 1.77X10^{-0}

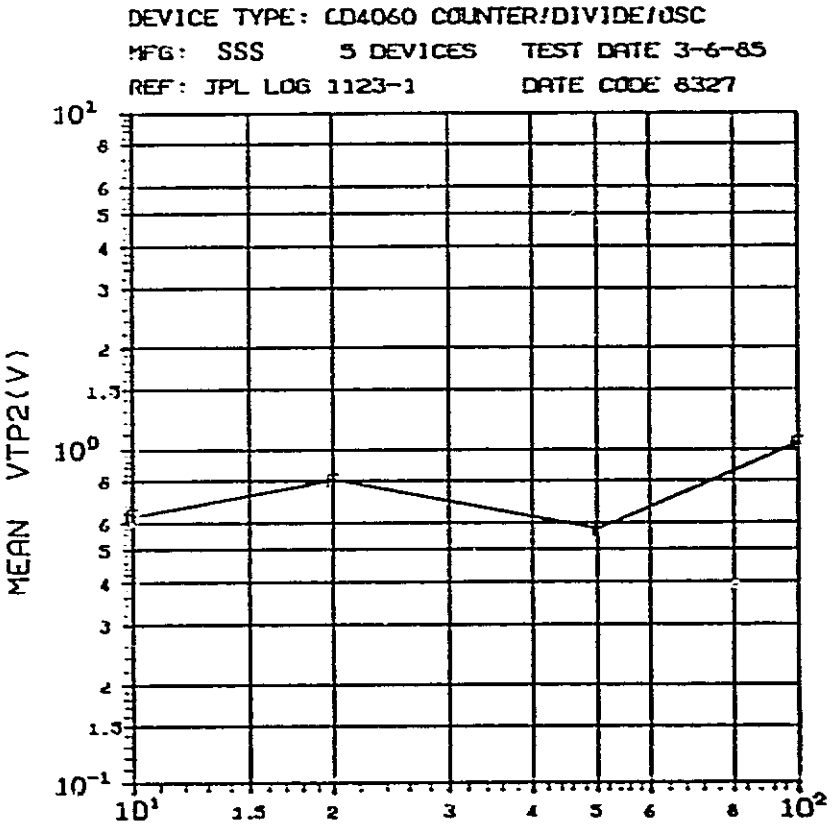
Figure 12. VTN1 and VTN2 for CD4060 (Continued)



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

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.01	.02	.05	.10
E	.0134	.0000	.6318	.0164

INITIAL MEAN VALUE VTP1(V) = 1.54X10^{-0}

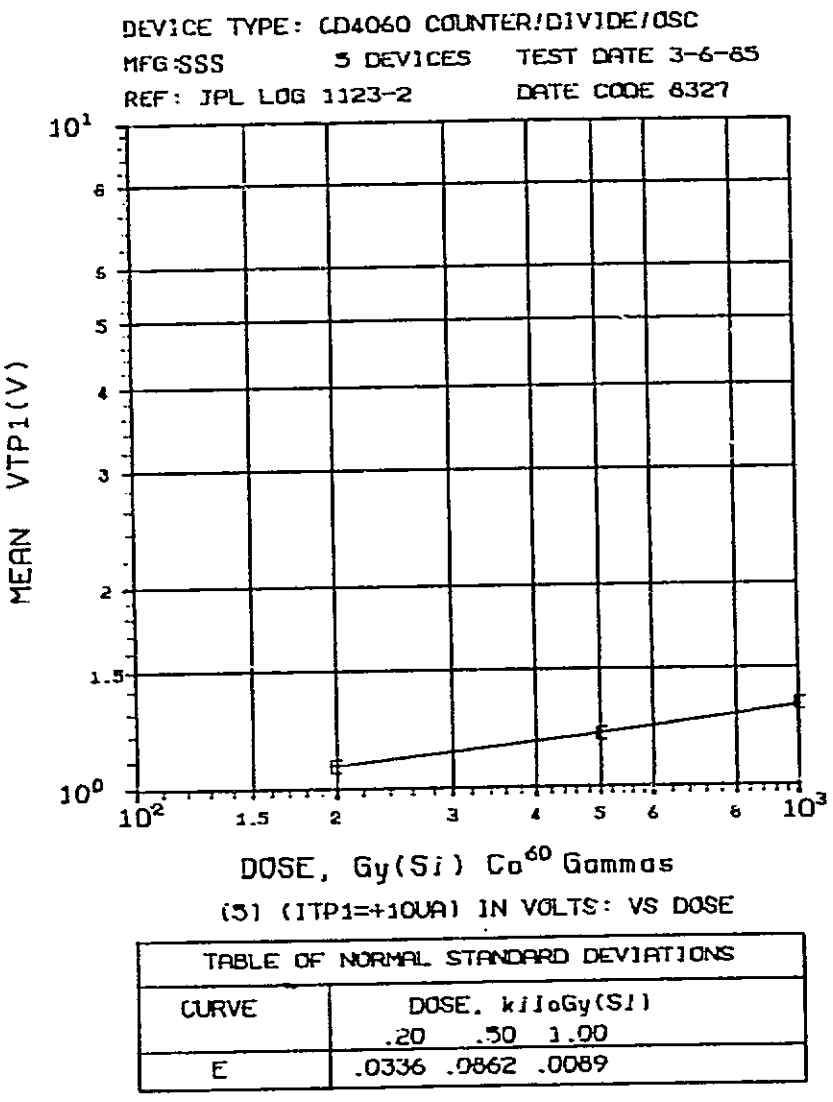


(6)VTP2 (ITP2=+10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.01	.02	.05	.10
F	.0134	.0134	.8598	.0055

INITIAL MEAN VALUE VTP2(V) = 1.71X10^{-0}

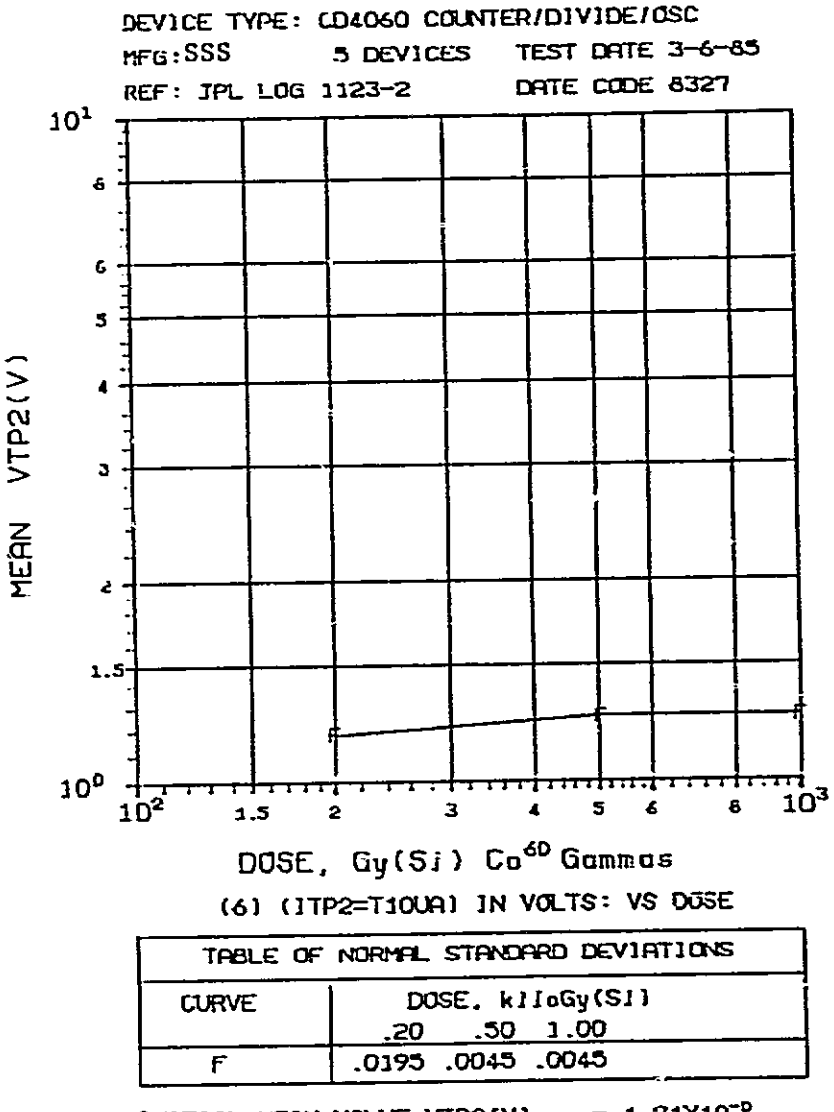
Figure 13. VTP1 and VTP2 for CD4060



(5) (ITP1=+10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.20	.50	1.00
E	.0336	.0862	.0089

INITIAL MEAN VALUE VTP1(V) = $1.54X10^{-0}$



(6) (ITP2=T10UA) IN VOLTS: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.20	.50	1.00
F	.0195	.0045	.0045

INITIAL MEAN VALUE VTP2(V) = $1.71X10^{-0}$

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 112C-2

Manufacturer SSS

Lot No. _____ Date Code _____

No. of Devices Supplied _____

No. of Devices to be tested 5

535-64408-0-5140

Device Package

Type	No. of Leads
DIP	14

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
1		In	10K to 15V	
2		In	"	
3		Out	100K to 15V	low
4		Out	100k to GND	high
5		In	Ground	
6		In	Ground	
7		V_{SS}	Ground	
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_{DD}	15V-10k	

Bias Circuit

Fluence rad(Si)	Flux rad(Si)/sec.
1E3	3.33E0
2E3	3.33E0
5E3	1E1
1E4	1E1
2E4	1E1
5E4	1E1
1E5*	1E1

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

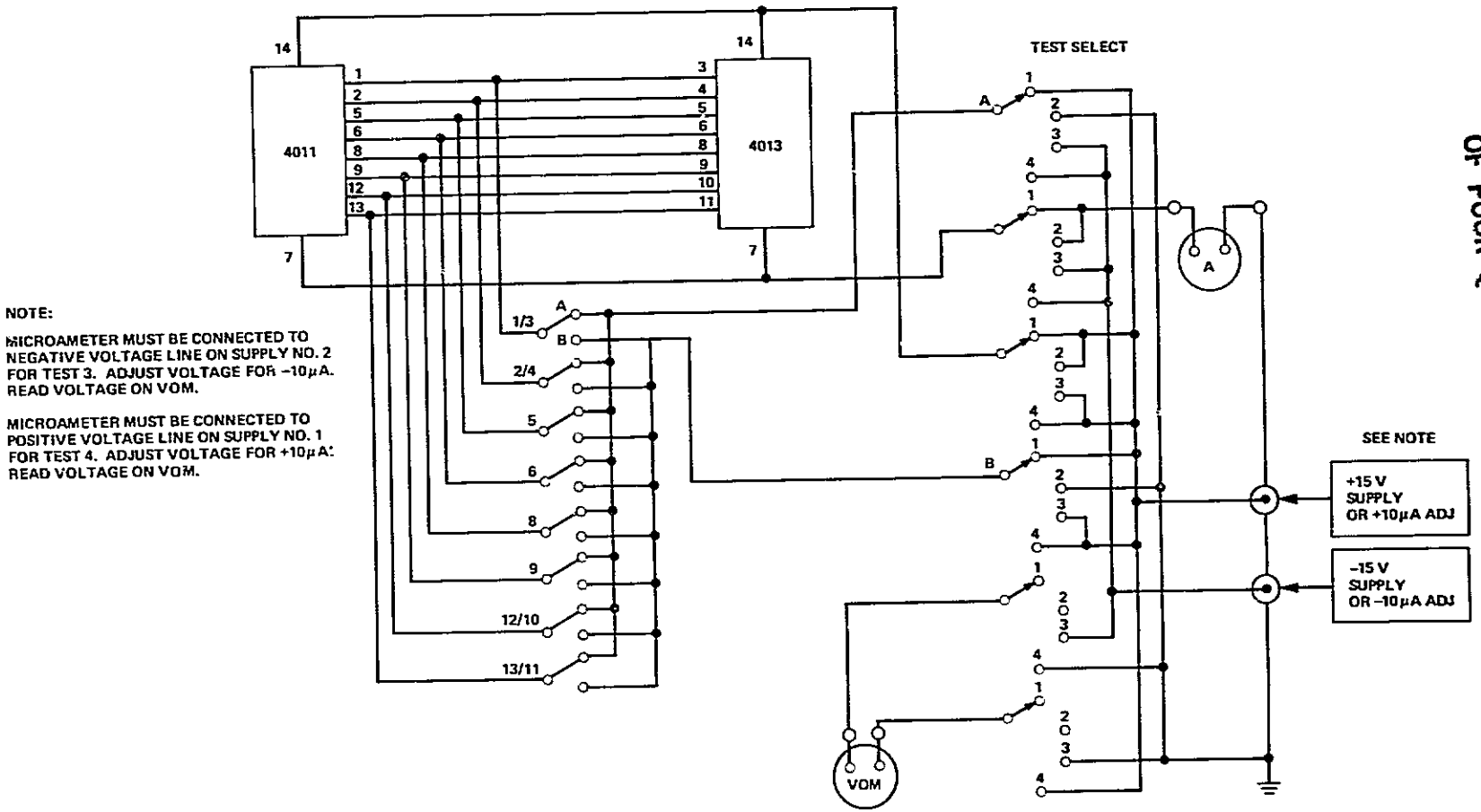
RADIATION TEST REQUIREMENTS RTR S/N 112C-2

Device Type: CD4011 (4-NAND)-1

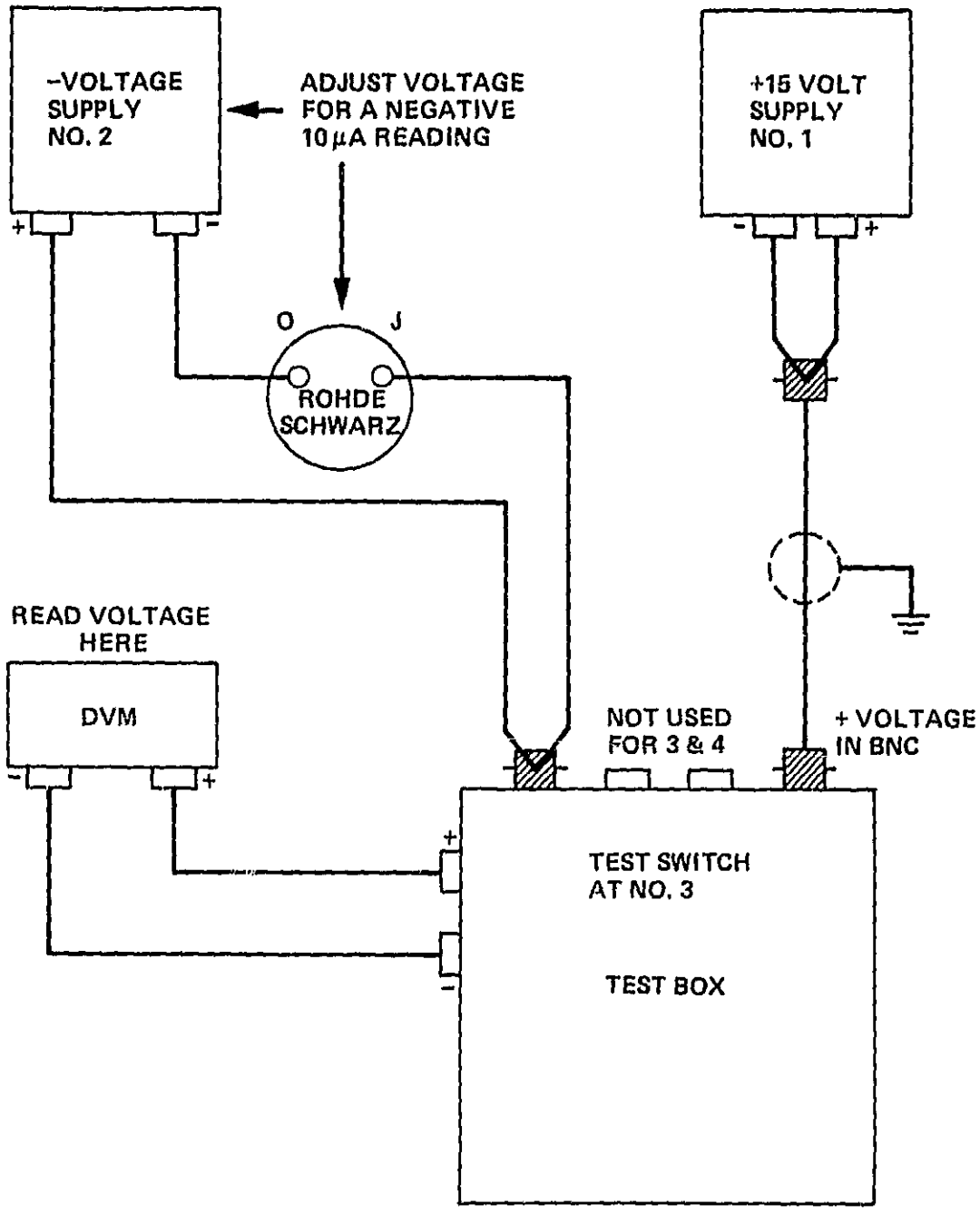
JPL Contact:		
Name	Subsystem	Phone
M. Gauthier	514	2126
B. Dantas	514	4932
J. Coss	514	7463
E. Powell	514	6175

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

Test Sequence Number	In Situ Yes	In Situ No	Parameter	Test Conditions *	Remarks
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	Record V_{TN}, 7 to GND
				to -10μA	
4		x	P threshold**	1 to Ground, 2,5,6,8,9, 12,13 and 7 to -15V,	Record V_{TP}, 14 to GND
				14 to +10μA	
			**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		



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 μA 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

Lot No. _____ Date Code _____

No. of Devices Supplied _____

No. of Devices to be tested 5

535-64408-0-5140

Device Package

Type	No. of Leads
DIP	14

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
1	Q_1	out	100k to Gnd	high
2	$\bar{Q}_1$	out	100k to 15V	low
3		clock	10k to 15V	
4		reset	gnd	
5		In-D_1	10k to 15V	
6		set	10k to 15V	
7		V_{SS}	gnd	
8		set	gnd	
9		In-D_2	gnd	
10		reset	10k to 15V	
11		clock	gnd	
12	Q_2	output	100k to gnd	high
13	$\bar{Q}_2$	output	100k to 15V	low
14		V_{DD}	10k to 15V	

Bias Circuit

Fluence rad(Si)	Flux rad(Si)/sec
1E3	3.33E0
2E3	3.33E0
5E3	1E1
1E4	1E1
2E4	1E1
5E4	1E1
1E5*	1E1

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

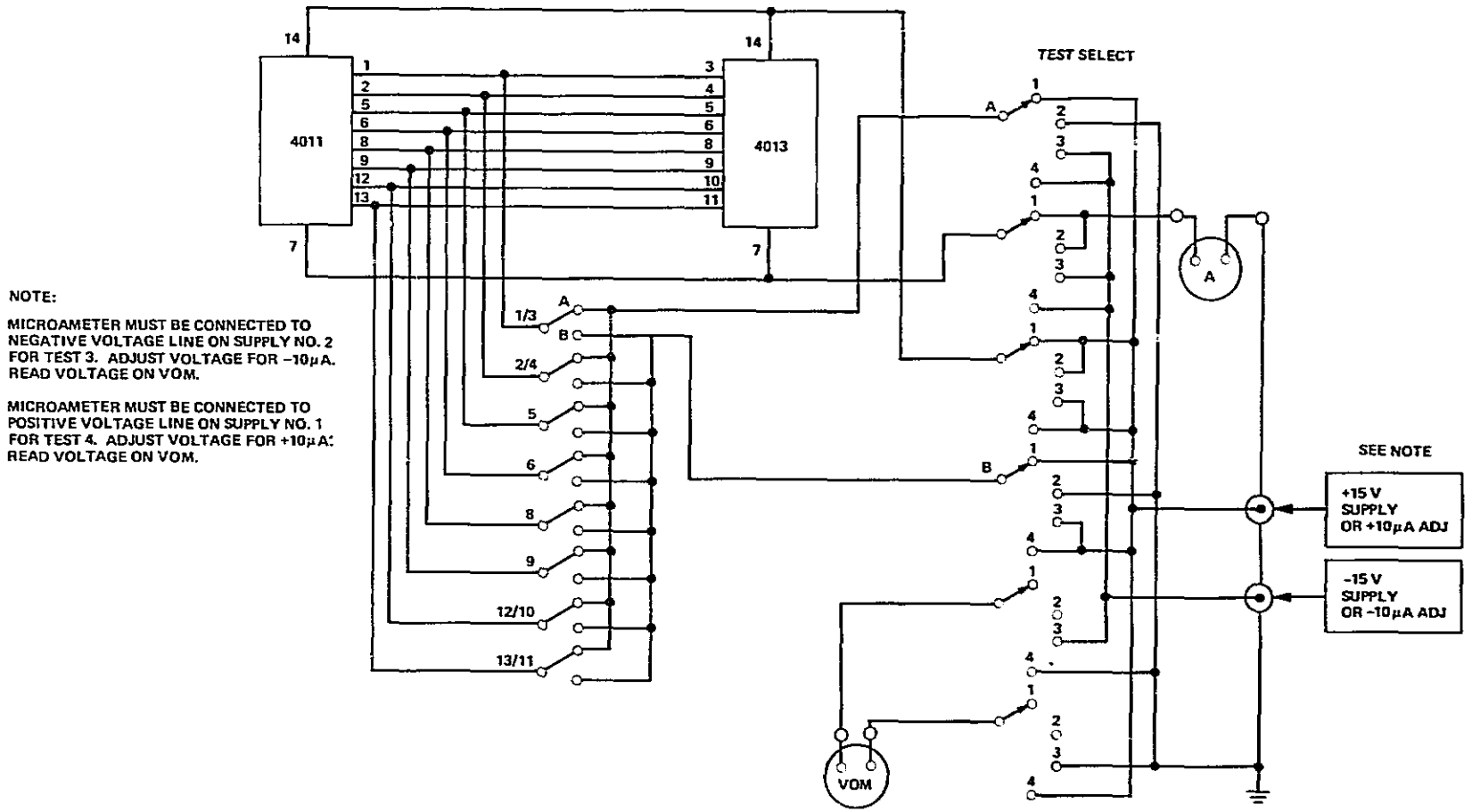
RADIATION TEST REQUIREMENTS RTR S/N 1140.2

Device Type: CD4013 (Dual D F/F)

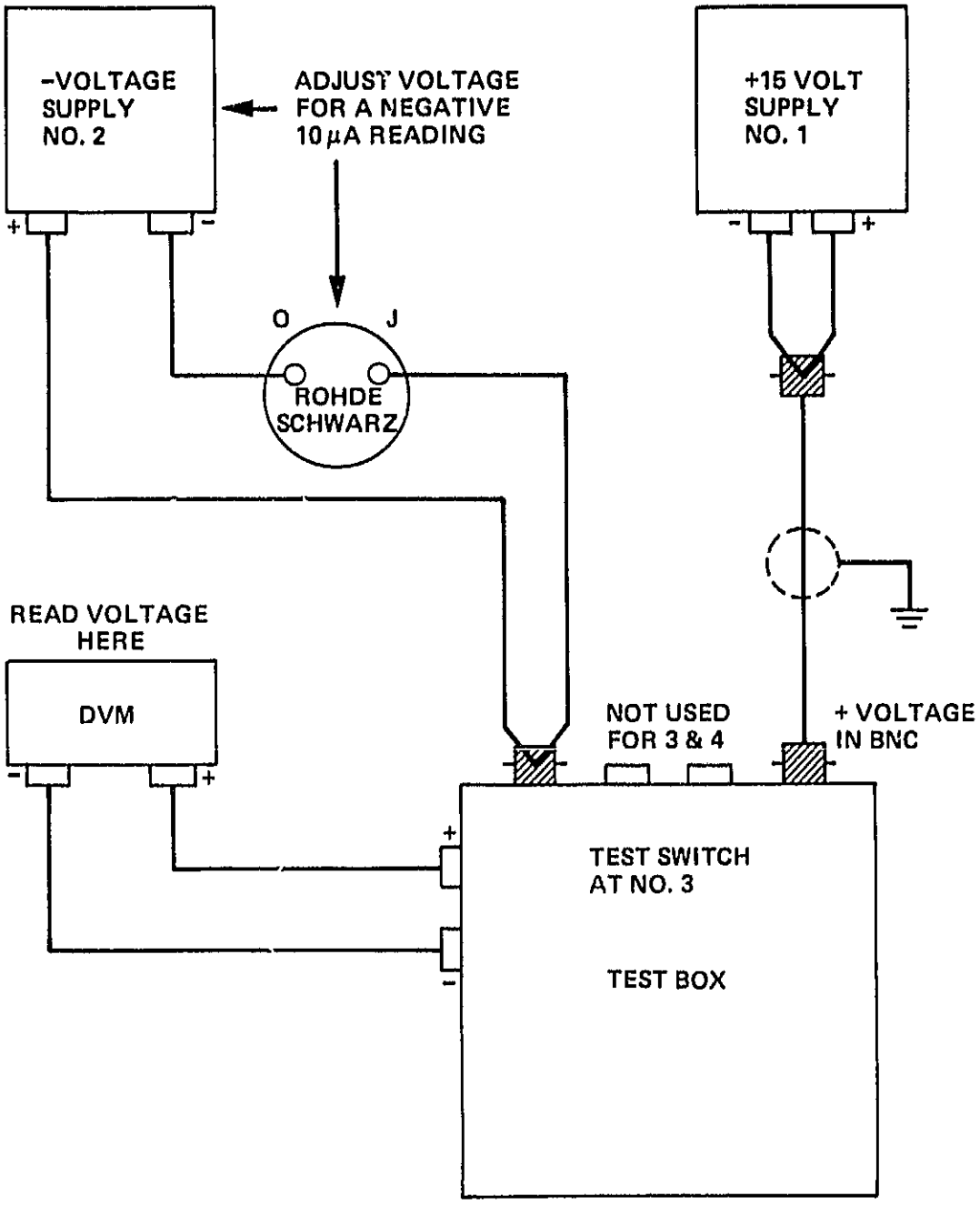
JPL Contact:		
Name	Subsystem	Phone
M. Gauthier	514	2126
B. Dantas	514	4932
J. Coss	514	7463
E. Powell	514	6175

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

Test Sequence Number	In Situ Yes	In Situ No	Parameter	Test Conditions *	Remarks
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	record V_{TN}, 7 to gnd
				-10μA	
4		x	P threshold**	3 to ground,4,5,6,7,8,9, 10, 11 to -15V,	record V_{TP}, 14 to gnd
				14 to +10μA.	
			**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 wee		
			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		



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 μA 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*

535-64408-0-5140

Device Package

Type	No. of Leads
DIP	16

RADIATION CONDITIONS:

Facility: Co60

Energy: 1.25 MeV

	UNITS	RADIATION LEVELS				
Fluence	see table below					
Flux						

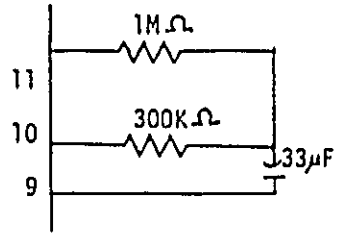
BIAS CONDITIONS DURING IRRADIATION:

Pin No.		Parameter	Voltage	Remarks
1		Q12	100k to gnd	
2		Q13	100k to gnd	
		Q14	100k to gnd	
4		Q6	100k to gnd	
5		Q5	100k to gnd	
6		Q7	100k to gnd	
7		Q4	100k to gnd	
8		V_{SS}	ground	
9		$\phi 0$	see diagram	
10		$\bar{\phi}0$	#1	
11		$\phi 1$	"	
12		reset	gnd	
13		Q9	100k to gnd	
14		Q8	100k to gnd	
15		Q10	100k to gnd	
16		V_{DD}	10k to 15V	

Bias Circuit

Fluence rad(Si)	Flux rad(Si)/sec
1E3	3.33E0
2E3	3.33E0
5E3	1E1
1E4	1E1
2E4	1E1
5E4	1E1
1E5*	1E1

Diagram #1



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

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 Yes	In Situ No	Parameter	Test Conditions	Remarks
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 -10μA	record V_{TN}, 8 to gnd
4		x	P_1 threshold	11 to ground, 8,12 to -15V; 16 to +10μA	record V_{TP}, 16 to gnd
5			N_2 threshold	12 to gnd, 16 to 15V, 8&11 to -10μA	record V_{TN}, 8 to gnd
6			P_2 threshold	12 to gnd, 8&11 to -15V, 16 to +10 μA	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

RADIATION TEST RESULTS 03/25/85

DEVICE TYPE CD4011
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	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8321	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 NA:

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.E3
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	.680+05
MEAN + 3 SIGMA	.218+00	.236+00	.325+03	.489+05	.252+06

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

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+05
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	********	********	********	********

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	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8321	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 CO60
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	********	********	********	********

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
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	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8321	1121-3

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

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	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		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

(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

RADIATION TEST RESULTS 03/25/85

DEVICE TYPE CD4013
MANUFACTURER Solid State Scientific
PACKAGE TYPE DIP
TEST DATE 3-19-85

FACILITY CO60
ENERGY 1.25MEV
RAD TEST REQ 1140-2
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

(1)IDD1 (VDD=15V) IN NA!

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 NA!

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 VOLTS!

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

RADIATION TEST RESULTS 03/25/85

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

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

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

DOSE / RATE	GRAY(SI) / (GRAY/SEC)	INITIAL	1.00E01 / 3.33-02	2.00E01 / 3.33-02	5.00E01 / 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	12.38
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
MANUFACTURER SOLID STATE SCIENTIFIC
PACKAGE TYPE DIP
TEST DATE 3-19-85

FACILITY CO60
ENERGY 1.25MEV
RAD TEST REQ 114C-2
CIRCUIT NO.

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

DOSE RATE	GRAY(SI) (GRAY/SEC)	INITIAL	1.00E01 3.33-02	2.00E01 3.33-02	5.00E01 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	10.84
2066V	-2.03	2.18	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	10.86
2066V	-1.96	2.19	7.54	12.26
2067V	-1.96	1.98	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	10.93
2066V	-1.97	2.12	7.61	12.24
2067V	-1.98	1.79	6.99	12.26
2068V	-2.03	1.48	6.48	12.35

MAX	-.197+01	.212+01	.701+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

RADIATION TEST RESULTS 03/25/85

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

FACILITY CO60
ENERGY 1.25MEV
RAD TEST REQ 114C-2
CIRCUIT NO.

SERIAL NUMBER	LOT NUMBER	DATE CODE	LOG NUMBER
ALL		8321	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)VTN1 (ITN=-10UA) IN VOLTS:

2064V	-2.13	1.95	6.34	12.07
2065V	-2.18	1.48	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 CO60
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)		3.33-02	3.33-02	1.00-01

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

2064V	1.69	-2.80	********	.82
2065V	1.78	-2.62	.13	********
2066V	1.33	.63	.67	.88
2067V	1.85	-2.47	.71	.89
2068V	1.44	-2.28	.69	.84
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 (ITP6+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	.860+00
MEAN + 3 SIGMA	.286+01	.292+01	.772+00	.991+00

RADIATION TEST RESULTS 03/25/85

DEVICE TYPE CD4013 FACILITY CD60
MANUFACTURER SOLID STATE SCIENTIFIC ENERGY 1.25MEV
PACKAGE TYPE DIP RAD TEST REQ 1140-2
TEST DATE 3-19-85 CIRCUIT NO.

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

DOSE RATE	GRAY(SI) (GRAY/SEC)	INITIAL	1.00E01 3.33-02	2.00E01 3.33-02	5.00E01 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	.88
2067V	1.91	-2.36	.73	.89
2068V	1.51	-2.66	.71	.88
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 CD4060
MANUFACTURER SOLID STATE SCIENTIFIC
PACKAGE TYPE DIP
TEST DATE 3-6-85

FACILITY CO60
ENERGY 1.25MEV
RAD TEST REQ 386-1
CIRCUIT NO.

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

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

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

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	.200-02	.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 UA:

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)VTN1 (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	7.20
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

RADIATION TEST RESULTS 03/13/85

DEVICE TYPE CD4060
MANUFACTURER SOLID STATE SCIENTIFIC
PACKAGE TYPE DIP
TEST DATE 3-6-85

FACILITY CD60
ENERGY 1.25MEV
RAD TEST REQ 386-1
CIRCUIT NO.

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

DOSE RATE	GRAY(SI) (GRAY/SEC)	INITIAL	2.00E02 1.00-01	5.00E02 1.00-01	1.00E03 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	.286+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	.782+01	.117+02	.119+02
MEAN + 3 SIGMA	-.147+01	.173+02	.125+02	.123+02

RADIATION TEST RESULTS 03/13/85

DEVICE TYPE CD4060
MANUFACTURER SOLID STATE SCIENTIFIC
PACKAGE TYPE DIP
TEST DATE 3-6-85

FACILITY CO60
ENERGY 1.25MEV
RAD TEST REQ 386-1
CIRCUIT NO.

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

DOSE RATE	GRAY(SI) (GRAY/SEC)	INITIAL	1.00E01 3.33-02	2.00E01 3.33-02	5.00E01 1.00-01	1.00E02 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	.168+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

RADIATION TEST RESULTS 03/13/85

DEVICE TYPE CD4060
MANUFACTURER SOLID STATE SCIENTIFIC
PACKAGE TYPE DIP
TEST DATE 3-6-85

FACILITY CO60
ENERGY 1.25MEV
RAD TEST REQ 386-1
CIRCUIT NO.

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

DOSE RATE	GRAY(SI) (GRAY/SEC)	INITIAL	2.00E02 1.00-01	5.00E02 1.00-01	1.00E03 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	-.130+01

(6) (ITP2=T10UA) IN VOLTS (Continued)

2058V	1.74	-1.17	-1.20	-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