

**Total Ionizing Dose Test of  
54ACTQ14 Quiet Series HEX Inverter with Schmitt Trigger  
(National Semiconductor)**

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Report Date: 11/27/06

## 1. Introduction

A radiation evaluation of the 54ACTQ14 Quiet Series HEX Inverter with Schmitt Trigger input was performed in February 2006 to determine its total dose tolerance.

## 2. Part and Test Information

Table I shows the part and test information.

Table I.

Part and Test Information

<b>Generic Part Number:</b>	54ACTQ14
<b>Full Part Number:</b>	5962-9218302MDA
<b>Manufacturer:</b>	National Semiconductor
<b>Lot Date Code (LDC):</b>	0248A
<b>Quantity Tested:</b>	6
<b>Serial Numbers of Control Sample:</b>	0
<b>Serial Numbers of Radiation Samples:</b>	1, 2, 3, 4, 5, and 6
<b>Part Function:</b>	HEX Inverter with Schmitt Trigger
<b>Part Technology:</b>	CMOS
<b>Package Style:</b>	14-Pin Flatpack
<b>Test Equipment:</b>	Parametric analyzer, power supply
<b>Test Engineer:</b>	J. Forney
<b>Case markings:</b>	HIC0248A 54ACTQ14FMQB QS 5962-9218301MDA

### 3. Pin-out and Bias Circuit

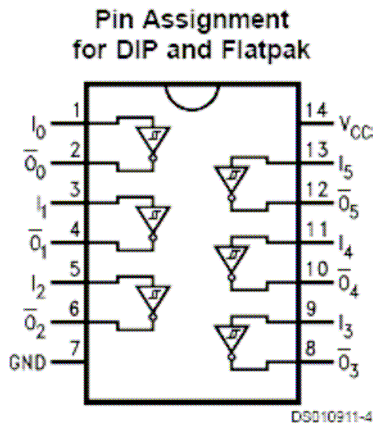


Fig. 1. Pinout for the 54ACTQ14 in a flatpack package.

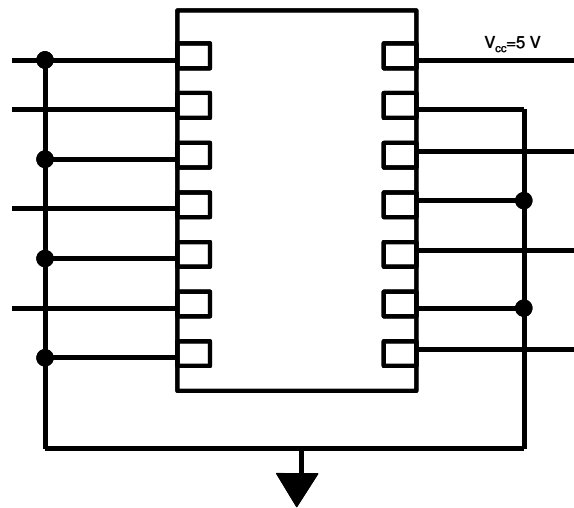


Fig. 2. Radiation Bias Circuit in which all inputs were grounded, all outputs were floating and  $V_{cc}=5V$ .

### 4. Test Method

The total dose testing was performed according to MIL STD 883, Test Method 1019.6 using a  $Co^{60}$  gamma ray source. Six parts were irradiated under bias. No control samples were used. The total dose radiation levels were 0, 20, 40, 60, 80, 100 krad(Si). The target dose rate was approximately 2 rads/s. Fig. 1 shows the pin-out for the part packaged in a flatpack. Fig. 2 shows the bias circuit used during exposure. A parametric analyzer was used to do the measurements.

Initial electrical measurements were made on 6 samples. After each radiation exposure, all parts were electrically tested.

## 5. Specifications

DC Characteristics for 'ACTQ Family Devices					
Symbol	Parameter	V <sub>CC</sub> (V)	54ACTQ	Units	Conditions
			T <sub>A</sub> = -55°C to +125°C		
			Guaranteed Limits		
V <sub>IH</sub>	Minimum High Level Input Voltage	4.5 5.5	2.0 2.0	V	V <sub>OUT</sub> = 0.1V or V <sub>CC</sub> - 0.1V
V <sub>IL</sub>	Maximum Low Level Input Voltage	4.5 5.5	0.8 0.8	V	V <sub>OUT</sub> = 0.1V or V <sub>CC</sub> - 0.1V
V <sub>OH</sub>	Minimum High Level Output Voltage	4.5 5.5	4.4 5.4	V	I <sub>OUT</sub> = -50 µA
		4.5 5.5	3.70 4.70	V	(Note 3) V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> I <sub>OH</sub> = -24 mA I <sub>OH</sub> = -24 mA
		4.5 5.5	0.1 0.1	V	I <sub>OUT</sub> = 50 µA
		4.5 5.5	0.50 0.50	V	(Note 3) V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> I <sub>OL</sub> = 24 mA I <sub>OL</sub> = 24 mA
V <sub>OL</sub>	Maximum Low Level Output Voltage	4.5 5.5	0.1 0.1	V	I <sub>OUT</sub> = 50 µA
I <sub>IN</sub>	Maximum Input Leakage Current	5.5	±1.0	µA	V <sub>I</sub> = V <sub>CC</sub> , GND
V <sub>H(max)</sub>	Maximum Hysteresis	4.5 5.5	1.4 1.8	V	T <sub>A</sub> = Worst Case
V <sub>H(min)</sub>	Minimum Hysteresis	4.5 5.5	0.4 0.5	V	T <sub>A</sub> = Worst Case
V <sub>I+</sub>	Maximum Positive Threshold	5.5	2.0	V	T <sub>A</sub> = Worst Case
V <sub>I-</sub>	Minimum Negative Threshold	5.5	0.8	V	T <sub>A</sub> = Worst Case
I <sub>CC</sub>	Maximum I <sub>CC</sub> /Input	5.5	1.8	mA	V <sub>I</sub> = V <sub>CC</sub> - 2.1V

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DC Characteristics for 'ACTQ Family Devices (Continued)					
Symbol	Parameter	V <sub>CC</sub> (V)	54ACTQ	Units	Conditions
			T <sub>A</sub> = -55°C to +125°C		
			Guaranteed Limits		
I <sub>OLD</sub>	Minimum Dynamic Output Current (Note 4)	5.5	60	mA	V <sub>OLD</sub> = 1.65V Max
I <sub>OHD</sub>	Maximum Dynamic Output Current (Note 4)	5.5	-50	mA	V <sub>OHD</sub> = 3.85V Min
I <sub>CC</sub>	Maximum Quiescent Supply Current	5.5	40.0	µA	V <sub>IN</sub> = V <sub>CC</sub> or GND (Note 5)
V <sub>OLP</sub>	Quiet Output Maximum Dynamic V <sub>OL</sub>	5.0	1.5	V	(Note 6)
V <sub>OLV</sub>	Quiet Output Minimum Dynamic V <sub>OL</sub>	5.0	-1.2	V	(Note 6)

**Note 3:** All outputs loaded; thresholds on input associated with output under test.  
**Note 4:** Maximum test duration 2.0 ms, one output loaded at a time.  
**Note 5:** I<sub>CC</sub> for 54ACTQ @ 25°C is identical to 74ACTQ @ 25°C.  
**Note 6:** Max number of outputs defined as (n). Data Inputs are 0V to 3V. One output @ GND.

**AC Electrical Characteristics**

Symbol	Parameter	V <sub>CC</sub> (V) (Note 7)	54ACTQ		Units
			T <sub>A</sub> = -55°C to +125°C C <sub>L</sub> = 50 pF		
			Min	Max	
t <sub>PLH</sub>	Propagation Delay Data to Output	5.0	1.0	12.5	ns
t <sub>PHL</sub>	Propagation Delay Data to Output	5.0	1.0	11.5	ns

Note 7: Voltage Range 5.0 Is 5.0V ±0.5V.

**6. Results**

The following parameters were measured:

- Delay 1 – (Max = 12.5 ns)
- Delay 2 – (Max = 11.5 ns)
- V<sub>OH</sub> – (Min = 5.4 V)
- V<sub>OL</sub> – (Max = 0.1 V)
- I<sub>in</sub>(Lo) – (Max = 1 µA)
- I<sub>in</sub>(Hi) – (Max = 1 µA)

The specifications from the data sheet are shown in brackets.

**DUT#1**

Delay 1								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	7.19E-09	6.59E-09	6.19E-09	7.19E-09	1.04E-08	6.39E-09	7.32E-09	1.55E-09
20	6.59E-09	6.19E-09	6.39E-09	6.39E-09	6.59E-09	5.99E-09	6.35E-09	2.33E-10
40	6.39E-09	5.99E-09	6.19E-09	4.99E-09	5.79E-09	5.79E-09	5.85E-09	4.83E-10
60	5.59E-09	5.79E-09	6.19E-09	5.39E-09	5.79E-09	5.79E-09	5.76E-09	2.65E-10
80	5.39E-09	4.99E-09	5.59E-09	5.39E-09	5.59E-09	5.79E-09	5.46E-09	2.73E-10
100	5.59E-09	5.79E-09	5.99E-09	5.79E-09	5.19E-09	5.79E-09	5.69E-09	2.75E-10

Delay 2								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	7.59E-09	8.38E-09	8.58E-09	8.18E-09	7.78E-09	8.38E-09	8.15E-09	3.87E-10
20	8.78E-09	8.78E-09	8.38E-09	8.78E-09	8.78E-09	8.18E-09	8.62E-09	2.65E-10
40	8.78E-09	8.78E-09	8.78E-09	9.38E-09	9.18E-09	8.98E-09	8.98E-09	2.53E-10
60	8.58E-09	8.98E-09	8.58E-09	8.38E-09	8.78E-09	8.58E-09	8.65E-09	2.06E-10
80	9.18E-09	8.78E-09	8.78E-09	8.18E-09	8.78E-09	8.18E-09	8.65E-09	3.92E-10
100	9.38E-09	9.18E-09	8.58E-09	9.18E-09	8.78E-09	9.18E-09	9.05E-09	3.01E-10

VOH								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	5.62	5.62	5.62	5.62	5.62	5.62	5.62	0.00
20	5.25	5.25	5.25	5.25	5.31	5.25	5.26	0.03
40	5.25	5.31	5.25	5.25	5.25	5.31	5.27	0.03
60	5.25	5.25	5.25	5.25	5.25	5.25	5.25	0.00
80	5.25	5.25	5.31	5.25	5.25	5.25	5.26	0.03
100	5.31	5.31	5.31	5.25	5.31	5.31	5.30	0.03

VOL								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	0.165	0.165	0.1647	0.1647	0.1647	0.1647	1.65E-01	0.00E+00
20	0.165	0.165	0.1647	0.1647	0.1647	0.1647	1.65E-01	0.00E+00
40	0.165	0.165	0.1647	0.1647	0.1647	0.1647	1.65E-01	0.00E+00
60	5.184	5.247	5.247	5.184	5.184	5.184	5.21E+00	3.25E-02
80	0.165	0.165	0.1647	0.1647	0.1647	0.1647	1.65E-01	0.00E+00
100	0.165	0.167	0.1647	0.1647	0.1647	0.1647	1.65E-01	9.39E-04

lin-Lo								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	-1.56E-06	-7.82E-07	-1.04E-06	2.61E-07	-2.61E-07	-9.12E-07	-7.17E-07	6.37E-07
20	-2.74E-06	-6.52E-07	-1.69E-06	-1.17E-06	-9.12E-07	-3.91E-07	-1.26E-06	8.51E-07
40	-1.43E-06	1.17E-06	-1.56E-06	-6.52E-07	-7.82E-07	-3.65E-06	-1.15E-06	1.57E-06
60	1.30E-06	5.21E-07	5.21E-07	2.61E-07	2.61E-07	7.82E-07	6.08E-07	3.92E-07
80	2.61E-07	-5.21E-07	3.91E-07	-2.61E-07	0.00E+00	1.30E-06	1.95E-07	6.37E-07
100	-2.61E-07	-7.82E-07	-7.82E-07	1.04E-06	2.61E-07	2.61E-07	-4.34E-08	7.07E-07

lin-Hi								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	-2.35E-06	1.30E-07	0	-7.82E-07	-5.21E-07	-2.61E-07	-6.30E-07	9.04E-07
20	-1.04E-06	-1.56E-06	-1.43E-06	-1.56E-06	-1.56E-06	-3.91E-07	-1.26E-06	4.71E-07
40	-5.21E-07	-2.61E-07	-1.30E-06	-2.61E-07	-1.17E-06	-5.21E-07	-6.73E-07	4.55E-07
60	-6.52E-07	7.82E-07	1.56E-06	-1.30E-07	1.17E-06	1.30E-07	4.78E-07	8.39E-07
80	-5.21E-07	-1.17E-06	3.91E-07	2.61E-07	-2.61E-07	0.00E+00	-2.17E-07	5.75E-07
100	5.21E-07	-3.91E-07	-2.08E-06	-6.52E-07	-1.43E-06	-7.82E-07	-8.04E-07	8.93E-07

**DUT #2**

Delay 1								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	6.39E-09	5.79E-09	5.99E-09	7.59E-09	5.99E-09	5.39E-09	6.19E-09	7.58E-10
20	6.59E-09	5.79E-09	5.59E-09	5.19E-09	5.19E-09	5.59E-09	5.66E-09	5.15E-10
40	6.79E-09	-4.79E-09	6.19E-09	5.99E-09	6.19E-09	5.79E-09	4.36E-09	4.49E-09
60	7.59E-09	5.99E-09	5.79E-09	5.39E-09	5.59E-09	5.59E-09	5.99E-09	8.08E-10
80	7.19E-09	5.79E-09	5.99E-09	5.59E-09	5.19E-09	5.59E-09	5.89E-09	6.89E-10
100	6.39E-09	5.99E-09	6.59E-09	5.79E-09	5.59E-09	5.99E-09	6.05E-09	3.72E-10

Delay 2								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	8.38E-09	8.58E-09	8.78E-09	9.38E-09	9.18E-09	8.58E-09	8.82E-09	3.87E-10
20	7.98E-09	8.38E-09	9.18E-09	9.18E-09	9.18E-09	9.78E-09	8.95E-09	6.49E-10
40	8.58E-09	8.38E-09	8.78E-09	9.18E-09	8.98E-09	8.98E-09	8.82E-09	2.94E-10
60	8.38E-09	9.18E-09	9.38E-09	8.98E-09	9.38E-09	9.58E-09	9.15E-09	4.27E-10
80	8.38E-09	8.38E-09	8.98E-09	9.18E-09	8.98E-09	9.78E-09	8.95E-09	5.27E-10
100	8.18E-09	7.98E-09	9.18E-09	8.18E-09	9.18E-09	9.18E-09	8.65E-09	5.88E-10

VOH								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	5.62	5.25	5.25	5.25	5.25	5.31	5.32	0.15
20	5.62	5.25	5.25	5.31	5.25	5.25	5.32	0.15
40	5.62	5.25	5.25	5.25	5.25	5.25	5.31	0.15
60	5.62	5.25	5.31	5.25	5.25	5.31	5.33	0.15
80	5.62	5.25	5.25	5.25	5.31	5.25	5.32	0.15
100	5.62	5.25	5.31	5.25	5.25	5.31	5.33	0.15

VOL								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	0.165	0.165	0.1647	5.184	0.1647	0.1647	1.00E+00	2.05E+00
20	0.165	0.165	0.1647	5.184	0.1647	0.1647	1.00E+00	2.05E+00
40	0.102	0.165	0.1647	5.247	0.1647	0.1647	1.00E+00	2.08E+00
60	0.165	0.165	0.1647	5.184	0.1647	0.1647	1.00E+00	2.05E+00
80	0.165	0.165	0.1647	5.184	0.1647	0.1647	1.00E+00	2.05E+00
100	0.165	0.165	0.1647	5.184	0.1647	0.1648	1.00E+00	2.05E+00

lin-Lo								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	-7.82E-07	-1.95E-06	0.00E+00	-1.56E-06	-5.21E-07	-1.04E-06	-9.77E-07	7.08E-07
20	3.91E-07	-1.69E-06	-2.61E-07	1.04E-06	2.61E-07	-1.56E-06	-3.04E-07	1.11E-06
40	2.61E-07	-1.04E-06	-5.21E-07	2.61E-07	-1.82E-06	-1.30E-06	-6.95E-07	8.51E-07
60	-5.21E-07	-9.12E-07	-3.91E-07	-2.61E-07	-5.21E-07	-1.04E-06	-6.08E-07	3.05E-07
80	-5.21E-07	-1.04E-06	0.00E+00	9.12E-07	5.21E-07	-1.04E-06	-1.95E-07	8.15E-07
100	0.00E+00	-1.43E-06	-7.82E-07	2.61E-07	-2.61E-07	-1.04E-06	-5.43E-07	6.51E-07

lin-Hi								
TID (krad)	Inverter 1	Inverter 2	Inverter 3	Inverter 4	Inverter 5	Inverter 6	Average	St. Dev.
0	-2.61E-07	-1.95E-06	-5.21E-07	-6.52E-07	7.82E-07	-1.04E-06	-6.08E-07	9.02E-07
20	-5.21E-07	-2.48E-06	-7.82E-07	1.82E-06	0.00E+00	-5.21E-07	-4.13E-07	1.38E-06
40	-2.61E-07	-1.17E-06	-5.21E-07	2.61E-07	-5.21E-07	-1.30E-06	-5.86E-07	5.81E-07
60	7.82E-07	-1.43E-06	-5.21E-07	2.61E-07	-5.21E-07	-1.56E-06	-5.00E-07	9.19E-07
80	-2.61E-07	-6.52E-07	0.00E+00	-7.82E-07	-2.61E-07	-1.95E-06	-6.52E-07	6.99E-07
100	5.21E-07	-1.56E-06	-9.12E-07	1.04E-06	2.61E-07	-7.82E-07	-2.39E-07	9.97E-07

**DUT #3**

Delay 1								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	7.19E-09	6.59E-09	6.19E-09	7.78E-09	6.59E-09	7.19E-09	6.92E-09	5.74E-10
20	6.19E-09	5.79E-09	5.59E-09	5.99E-09	5.59E-09	5.59E-09	5.79E-09	2.53E-10
40	5.99E-09	5.79E-09	6.19E-09	6.19E-09	6.19E-09	5.99E-09	6.05E-09	1.63E-10
60	5.59E-09	5.79E-09	5.59E-09	5.59E-09	5.99E-09	5.79E-09	5.72E-09	1.63E-10
80	5.99E-09	5.19E-09	5.59E-09	4.99E-09	5.59E-09	5.59E-09	5.49E-09	3.51E-10
100	5.79E-09	5.19E-09	5.99E-09	5.99E-09	6.19E-09	5.19E-09	5.72E-09	4.31E-10

Delay 2								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	8.38E-09	8.38E-09	8.38E-09	8.38E-09	8.58E-09	8.58E-09	8.45E-09	1.03E-10
20	8.38E-09	8.18E-09	7.98E-09	8.38E-09	8.78E-09	8.58E-09	8.38E-09	2.82E-10
40	8.38E-09	8.78E-09	9.38E-09	8.98E-09	8.98E-09	9.18E-09	8.95E-09	3.44E-10
60	8.98E-09	9.38E-09	9.38E-09	8.58E-09	8.38E-09	9.58E-09	9.05E-09	4.83E-10
80	8.38E-09	8.98E-09	8.38E-09	8.98E-09	9.18E-09	9.58E-09	8.92E-09	4.67E-10
100	9.18E-09	8.98E-09	9.18E-09	9.18E-09	8.98E-09	9.58E-09	9.18E-09	2.19E-10

VOH								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	5.62E+00	5.62E+00	5.62E+00	5.62E+00	5.62E+00	5.62E+00	5.62E+00	0.00E+00
20	5.25E+00	5.31E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.26E+00	2.57E-02
40	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	0.00E+00
60	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	0.00E+00
80	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	0.00E+00
100	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	5.25E+00	0.00E+00

VOL								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	3.04E-17
20	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	3.04E-17
40	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	3.04E-17
60	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	3.04E-17
80	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	3.04E-17
100	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	3.04E-17

linLO								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	-1.30E-06	2.61E-07	-7.82E-07	2.61E-07	-1.17E-06	-6.52E-07	-5.65E-07	6.83E-07
20	-1.30E-07	-3.91E-07	-9.12E-07	-9.12E-07	-1.95E-06	-1.30E-06	-9.34E-07	6.51E-07
40	-1.43E-06	-3.91E-07	-1.04E-06	-7.82E-07	-2.08E-06	-2.61E-07	-9.99E-07	6.83E-07
60	-2.61E-07	-3.91E-07	-1.04E-06	1.30E-07	-1.56E-06	1.30E-06	-3.04E-07	9.91E-07
80	-1.30E-07	-1.17E-06	-2.61E-07	-7.82E-07	1.30E-07	5.21E-07	-2.82E-07	6.14E-07
100	2.61E-07	3.91E-07	-5.21E-07	-5.21E-07	-1.04E-06	-1.17E-06	-4.34E-07	6.47E-07



Delay 1								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	7.784E-09	7.385E-09	7.784E-09	7.186E-09	7.784E-09	7.186E-09	7.51817E-09	3.00135E-10
20	6.387E-09	6.188E-09	5.788E-09	5.589E-09	5.589E-09	5.788E-09	5.88817E-09	3.27964E-10
40	6.188E-09	6.188E-09	6.188E-09	5.788E-09	5.988E-09	6.387E-09	6.12117E-09	2.06301E-10
60	5.988E-09	5.389E-09	6.188E-09	5.988E-09	5.788E-09	6.188E-09	5.9215E-09	3.00755E-10
80	5.788E-09	5.788E-09	5.988E-09	5.19E-09	5.589E-09	5.589E-09	5.65533E-09	2.72471E-10
100	5.788E-09	5.988E-09	5.589E-09	5.988E-09	5.389E-09	5.788E-09	5.755E-09	2.33353E-10
Post Anneal	5.788E-09	5.988E-09	5.19E-09	5.589E-09	5.589E-09	5.988E-09	5.68867E-09	3.02524E-10

Delay 2								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	7.984E-09	8.383E-09	8.383E-09	8.184E-09	8.184E-09	7.784E-09	8.15033E-09	2.3341E-10
20	8.383E-09	8.782E-09	8.583E-09	8.184E-09	8.383E-09	8.383E-09	8.44967E-09	2.05978E-10
40	9.182E-09	9.182E-09	8.982E-09	8.782E-09	8.982E-09	8.782E-09	8.982E-09	1.78885E-10
60	8.982E-09	9.78E-09	8.982E-09	8.782E-09	8.982E-09	8.782E-09	9.04833E-09	3.71592E-10
80	9.381E-09	8.782E-09	8.782E-09	8.982E-09	9.98E-09	8.982E-09	9.14817E-09	4.62501E-10
100	8.982E-09	8.184E-09	9.182E-09	9.182E-09	8.782E-09	9.182E-09	8.91567E-09	3.92531E-10
Post Anneal	9.381E-09	8.583E-09	8.383E-09	8.383E-09	8.184E-09	8.383E-09	8.5495E-09	4.26444E-10

[illegible][illegible]

VOH								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	5.62	5.62	5.62	5.62	5.62	5.62	5.62E+00	0.00E+00
20	5.25	5.25	5.25	5.25	5.25	5.31	5.26E+00	2.45E-02
40	5.25E+00	5.31	5.25	5.25	5.25	5.25	5.26E+00	2.45E-02
60	5.25E+00	5.25	5.25	5.25	5.25	5.25	5.25E+00	0.00E+00
80	5.25	5.25	5.25	5.25	5.25	5.25	5.25E+00	0.00E+00
100	5.31	5.31	5.25	5.25	5.31	5.31	5.29E+00	3.10E-02
Post Anneal	5.31	5.25	5.25	5.25	5.25	5.25	5.26E+00	2.45E-02

VOL								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	0.165	0.165	0.165	0.165	0.165	0.165	1.65E-01	0.00E+00
20	0.165	0.165	0.165	0.165	0.165	0.165	1.65E-01	0.00E+00
40	1.65E-01	0.165	0.165	0.165	0.165	0.165	1.65E-01	0.00E+00
60	1.65E-01	0.165	0.165	0.165	0.165	0.165	1.65E-01	0.00E+00
80	0.165	0.165	0.165	0.165	0.165	0.165	1.65E-01	0.00E+00
100	0.165	0.165	0.165	0.165	0.165	0.165	1.65E-01	0.00E+00
Post Anneal	0.165	0.165	0.165	0.165	0.165	0.165	1.65E-01	0.00E+00

linLO								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	-0.0000013	0	0	-5.21E-07	-1.04E-06	0.0000013	-2.60E-07	9.30E-07
20	-1.82E-06	-2.22E-06	-1.30E-07	-2.08E-06	-1.43E-06	-9.12E-07	-1.43E-06	7.95E-07
40	-5.21E-07	-1.30E-06	-2.61E-07	0.00E+00	0.00E+00	2.61E-07	-3.04E-07	5.56E-07
60	5.21E-07	5.21E-07	0.00E+00	0.00E+00	-1.04E-06	-5.21E-07	-8.65E-08	6.08E-07
80	7.82E-07	-5.21E-07	-2.61E-07	-2.61E-07	-2.61E-07	-1.30E-07	-1.09E-07	4.55E-07
100	-9.12E-07	-9.12E-07	-1.43E-06	-1.30E-06	-1.17E-06	-9.12E-07	-1.11E-06	2.28E-07
Post Anneal	-6.52E-07	-6.52E-07	-1.43E-06	-1.95E-06	-2.22E-06	-1.17E-06	-1.35E-06	6.53E-07

linHI								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	-1.17E-06	-7.82E-07	-2.61E-07	-1.56E-06	-9.12E-07	-3.91E-07	-8.46E-07	4.84E-07
20	-3.91E-07	-9.12E-07	-9.12E-07	-9.12E-07	-1.17E-06	-1.69E-06	-9.98E-07	4.24E-07
40	-5.21E-07	-5.21E-07	-2.61E-07	-3.91E-07	-2.61E-07	-1.00E-07	-3.43E-07	1.66E-07
60	-2.61E-07	-1.82E-06	-2.61E-07	-1.04E-06	-2.61E-07	-3.91E-07	-6.72E-07	6.39E-07
80	-5.21E-07	-2.61E-07	-5.21E-07	3.91E-07	2.61E-07	-7.82E-07	-2.39E-07	4.69E-07
100	-1.30E-06	-2.61E-07	-7.82E-07	-1.82E-06	-3.91E-06	-1.04E-06	-1.52E-06	1.28E-06
Post Anneal	-9.12E-07	-9.12E-07	-3.91E-07	-3.91E-07	-1.69E-06	-1.17E-06	-9.11E-07	4.93E-07

**DUT #6**

Delay 1								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	1.078E-08	6.587E-09	7.385E-09	6.986E-09	7.186E-09	7.186E-09	7.69E-09	1.54E-09
20	5.589E-09	5.589E-09	6.387E-09	5.589E-09	5.788E-09	5.389E-09	5.72E-09	3.49E-10
40	5.988E-09	6.188E-09	6.188E-09	5.788E-09	5.988E-09	5.988E-09	6.02E-09	1.51E-10
60	5.389E-09	5.389E-09	5.988E-09	5.19E-09	6.587E-09	5.788E-09	5.72E-09	5.15E-10
80	5.19E-09	5.389E-09	5.788E-09	5.988E-09	5.788E-09	6.188E-09	5.72E-09	3.72E-10
100	5.788E-09	5.589E-09	5.988E-09	5.589E-09	4.99E-09	5.19E-09	5.52E-09	3.72E-10
Post Anneal	5.988E-09	5.988E-09	4.99E-09	4.391E-09	4.99E-09	5.589E-09	5.32E-09	6.40E-10

Delay 2								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	2.315E-08	8.184E-09	7.784E-09	7.984E-09	8.583E-09	8.782E-09	1.07E-08	6.09E-09
20	8.583E-09	8.782E-09	8.383E-09	8.982E-09	9.381E-09	7.984E-09	8.68E-09	4.85E-10
40	8.982E-09	8.583E-09	8.982E-09	8.982E-09	9.381E-09	9.381E-09	9.05E-09	3.00E-10
60	9.381E-09	9.182E-09	8.782E-09	9.581E-09	9.182E-09	9.581E-09	9.28E-09	3.03E-10
80	9.381E-09	9.381E-09	9.182E-09	9.381E-09	9.581E-09	9.182E-09	9.35E-09	1.50E-10
100	8.982E-09	9.182E-09	9.78E-09	9.182E-09	9.381E-09	9.381E-09	9.31E-09	2.72E-10
Post Anneal	8.583E-09	8.583E-09	8.782E-09	8.782E-09	8.583E-09	8.982E-09	8.72E-09	1.63E-10

VOH								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	5.624	5.624	5.624	5.624	5.624	5.624	5.624	0.00E+00
20	5.247	5.247	5.247	5.247	5.247	5.247	5.247	0.00E+00
40	5.247	5.31	5.247	5.247	5.247	5.247	5.2575	2.57E-02
60	5.31	5.247	5.247	5.247	5.247	5.247	5.2575	2.57E-02
80	5.31	5.247	5.247	5.247	5.247	5.247	5.2575	2.57E-02
100	5.31	5.247	5.247	5.247	5.247	5.247	5.2575	2.57E-02
Post Anneal	5.247	5.247	5.247	5.247	5.247	5.247	5.247	0.00E+00

VOL								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.00E+00
20	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.00E+00
40	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.00E+00
60	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.00E+00
80	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.00E+00
100	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.00E+00
Post Anneal	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.00E+00

linLO								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	1.20E-06	1.04E-06	-1.30E-06	0.00E+00	-1.04E-06	-7.82E-07	-1.47E-07	1.08E-06
20	-1.56E-06	-1.43E-06	-7.82E-07	-1.04E-06	-1.43E-06	-9.12E-07	-1.19E-06	3.24E-07
40	0.00E+00	-2.61E-07	-3.91E-07	-3.91E-07	-5.21E-07	-1.30E-06	-4.78E-07	4.41E-07
60	2.61E-07	-2.61E-07	5.21E-07	-3.91E-07	1.30E-06	2.61E-07	2.82E-07	6.08E-07
80	0.00E+00	-2.61E-07	0.00E+00	5.21E-07	-5.21E-07	2.61E-07	0.00E+00	3.69E-07
100	-7.82E-07	-5.21E-07	-1.04E-06	-7.82E-07	-1.04E-06	-1.82E-06	-9.99E-07	4.49E-07
Post Anneal	-6.52E-07	-1.17E-06	1.30E-07	6.52E-07	0.00E+00	-1.30E-07	-1.95E-07	6.37E-07

linHI								
TID	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Average	St. Dev.
0	-3.00E-07	-7.82E-07	-2.61E-07	-2.61E-07	3.91E-07	-1.04E-06	-3.76E-07	4.96E-07
20	-2.48E-06	-1.56E-06	-1.56E-06	-1.17E-06	-1.30E-06	-1.04E-06	-1.52E-06	5.12E-07
40	-2.61E-07	-1.30E-07	2.61E-07	-5.21E-07	-1.30E-07	-9.12E-07	-2.82E-07	3.99E-07
60	-1.04E-06	-6.52E-07	-1.17E-06	-5.21E-07	1.43E-06	-2.61E-07	-3.69E-07	9.45E-07
80	-1.30E-07	2.61E-07	0.00E+00	-2.61E-07	2.61E-07	0.00E+00	2.17E-08	2.09E-07
100	-7.82E-07	-9.12E-07	2.61E-07	0.00E+00	-2.61E-06	-5.21E-07	-7.60E-07	1.01E-06
Post Anneal	-1.30E-07	-1.95E-06	-1.30E-07	-7.82E-07	1.30E-07	7.82E-07	-3.47E-07	9.35E-07

## 7. Summary

All the parametric values were within specifications up to a total ionizing dose of 100 krad (Si).