

## **Total Dose Radiation Test Report**

**MSK5978RH,  
MSK5980RH**

### **RAD Hard Positive Adjustable Voltage Regulator**

Sept 24, 2010 (TID, First Test)  
May 11, 2012 (TID, Second Test, LOT H0923840.4 WF#3)  
Jan 29, 2014 (TID, Third Test, LOT H0923840.4 WF#5)  
October 28, 2015 (TID, Fourth Test, LOT H0852403.1 WF#10)  
November 23, 2016 (TID, Fifth Test, LOT H0923840.1W#13)  
March 29, 2017 (TID, Sixth Test, LOT H0923840.1 WF#10)  
Revised May 23, 2017

B. Horton  
P. Dinneen  
N. Kresse

Anaren, Inc – MSK Products

**I. Introduction:**

The total dose radiation test plan for the MSK5978RH was developed to qualify the devices as RAD Hard to 300 KRADS(Si). The testing was performed beyond 300 KRADS(Si) to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the device, but simply offers designers insight to the critical parameter-shifts up to the specified total dose level. The MSK 5980RH uses the same active components and package material.

The data herein is from direct measurement of the MSK5978RH response to total dose irradiation, but is indicative of the response of both device types.

MIL-STD-883 Method 1019.7 and ASTM F1892-06 were used as guidelines in the development and implementation of the total dose test plan for the MSK5978RH and MSK5980RH.

**II. Radiation Source:**

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. The dose rate was determined to be 151 rads(Si)/sec. The total dose schedule can be found in Table I.

**III. Test Setup:**

All test samples were subjected to Group A Electrical Test in accordance with the device data sheet. In addition, all devices received 240 hours minimum of burn-in per MIL-STD-883 Method 1015 and were fully screened IAW MIL-PRF-38535 Class V. For test platform verification, two control devices were tested at 25°C. Ten devices were then tested at 25°C, prior to irradiation, and were found to be within acceptable test limits.

The devices were vertically aligned with the radiation source and enclosed in a lead/aluminum container during irradiation. Five devices were kept under bias during irradiation. An operating voltage of +26 Volts was used for the bias condition. Five devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation, the device leads were shorted together and the devices were transported to the MSK automatic electrical test platform. Testing was performed in accordance with the MSK device data sheet. Testing was performed on irradiated devices, as well as the control device, at each total dose level. Electrical tests were completed within one hour of irradiation. Devices were subjected to subsequent radiation doses within two hours of removal from the radiation field.

**IV. Data:**

All performance curves are averaged from the test results of the biased and unbiased devices respectively. If required, full test data can be obtained by contacting MSK Products – Anaren Inc.

**V. Summary:**

Based on the test data recorded during radiation testing and statistical analysis, the MSK5978RH and MSK5980RH qualified as a 300 Krad(Si) radiation hardened device. The Set Pin Currents exhibited the most significant change with irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK5978VRH Biased/Unbiased Dose Rate Schedule
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Dosimetry Equipment
Bruker Biospin # 0162

Irradiation Date
10/28/15

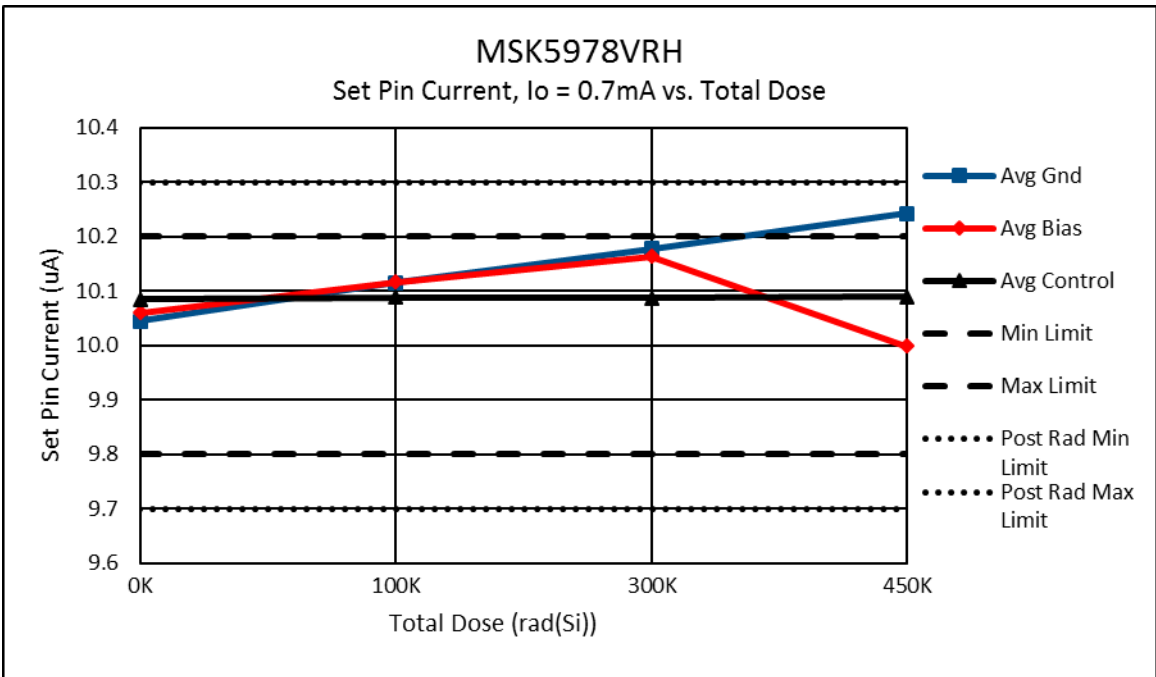
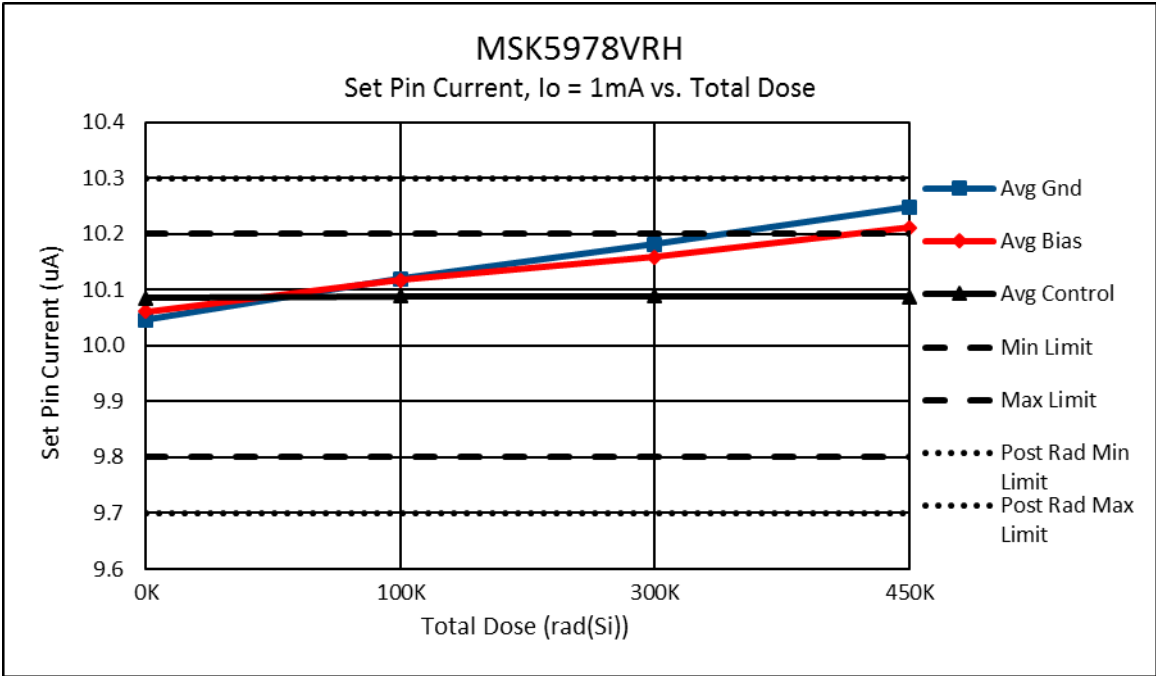
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22:46	206,000	309,000
17:05	154,500	463,500

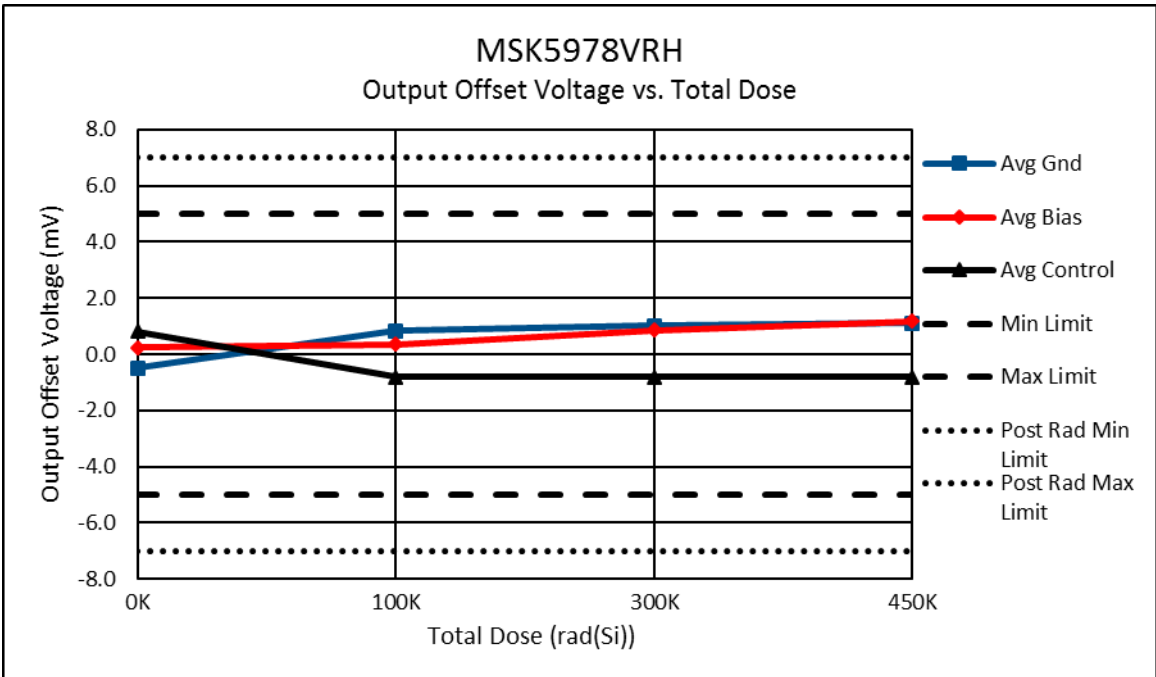
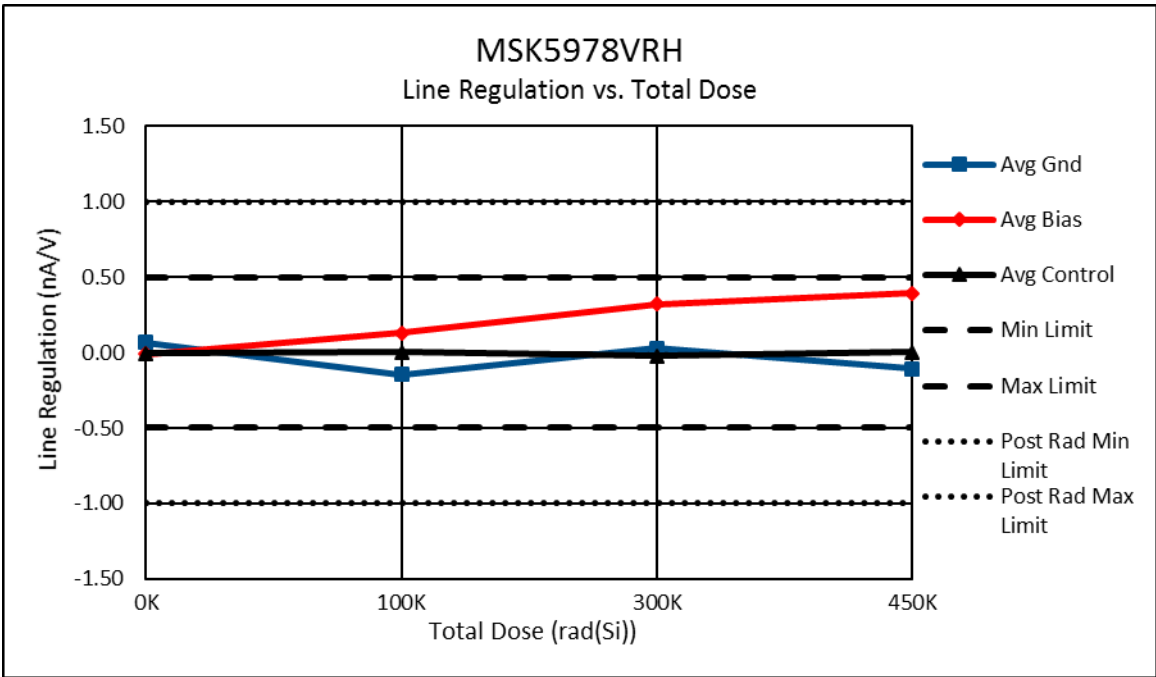
Biased S/N – 4330, 4331, 4332, 4333, 4334
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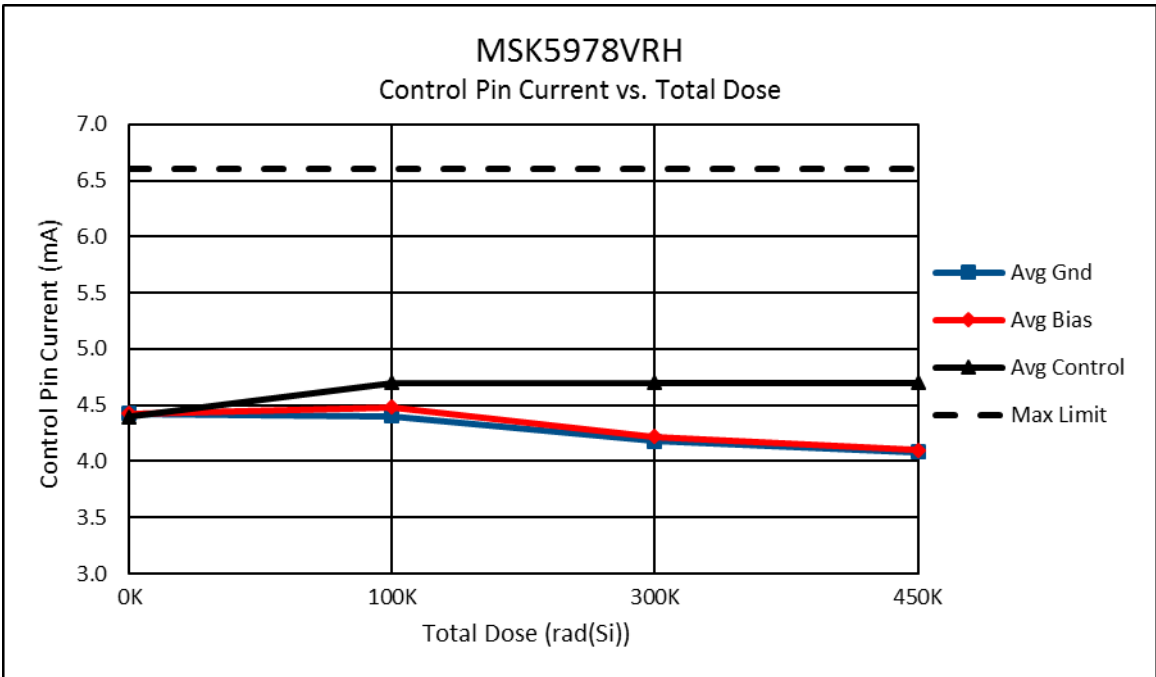
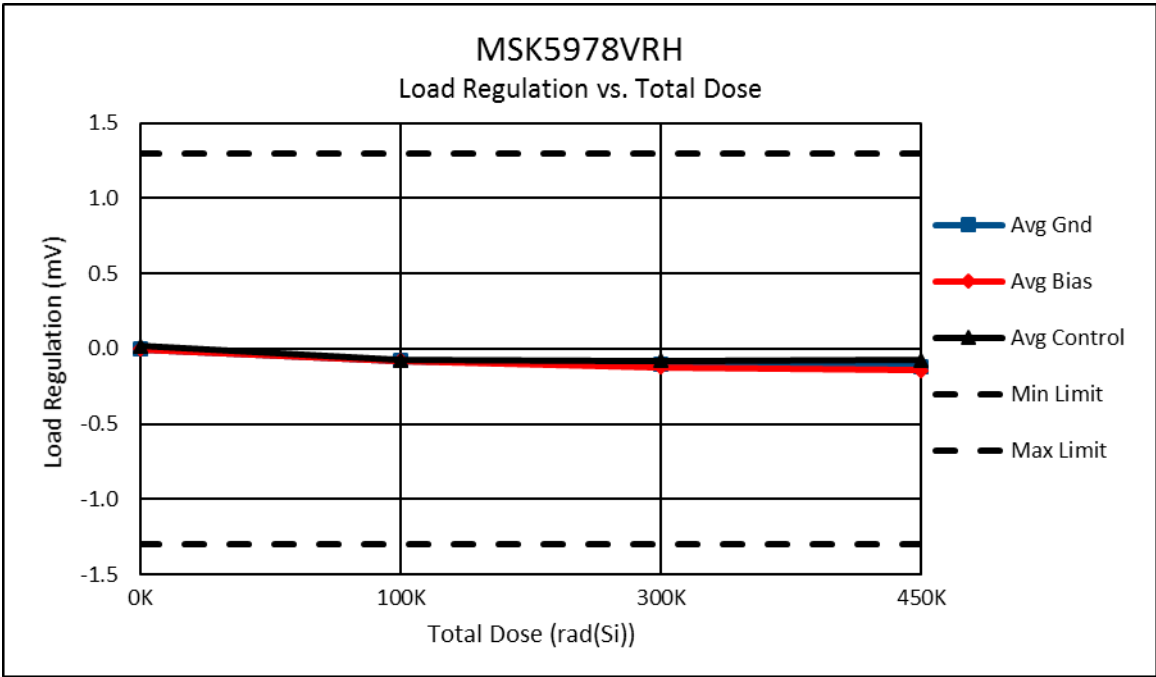
Unbiased S/N – 4335, 4336, 4337, 4338, 4339
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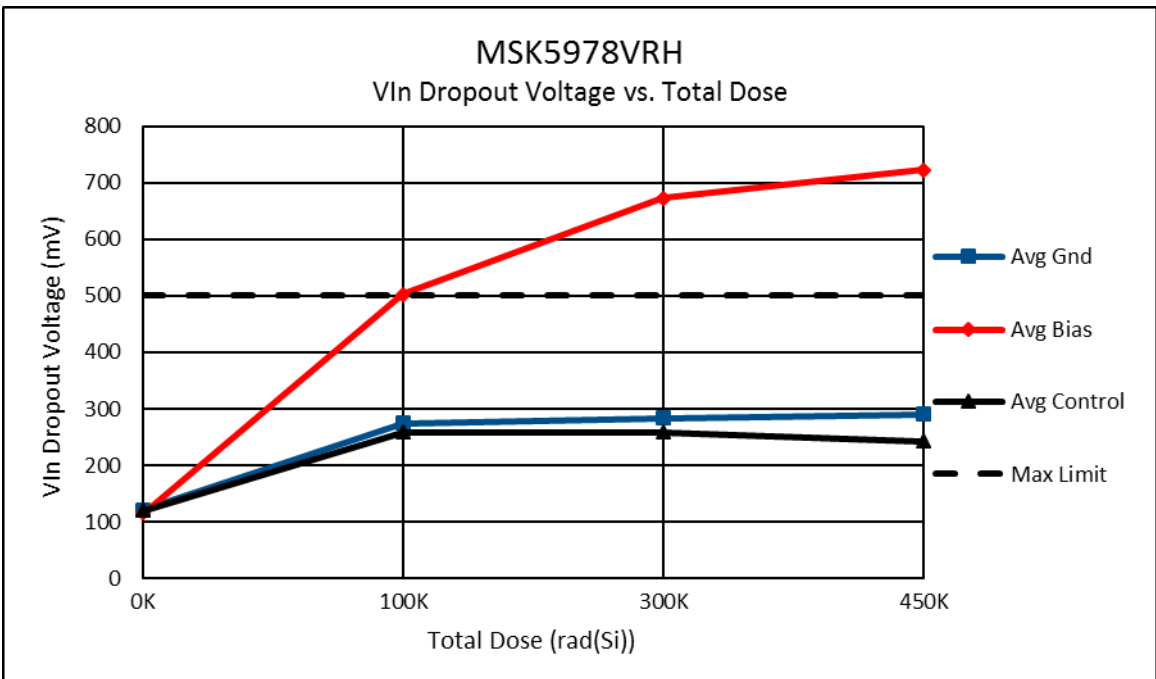
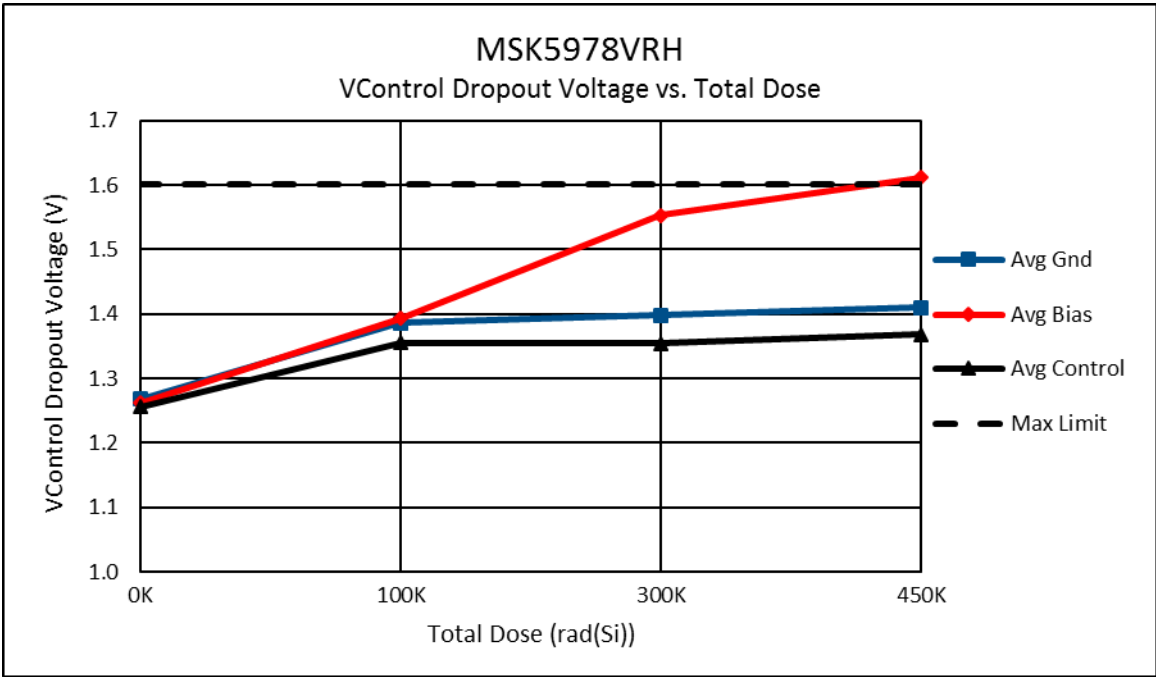
Table 1

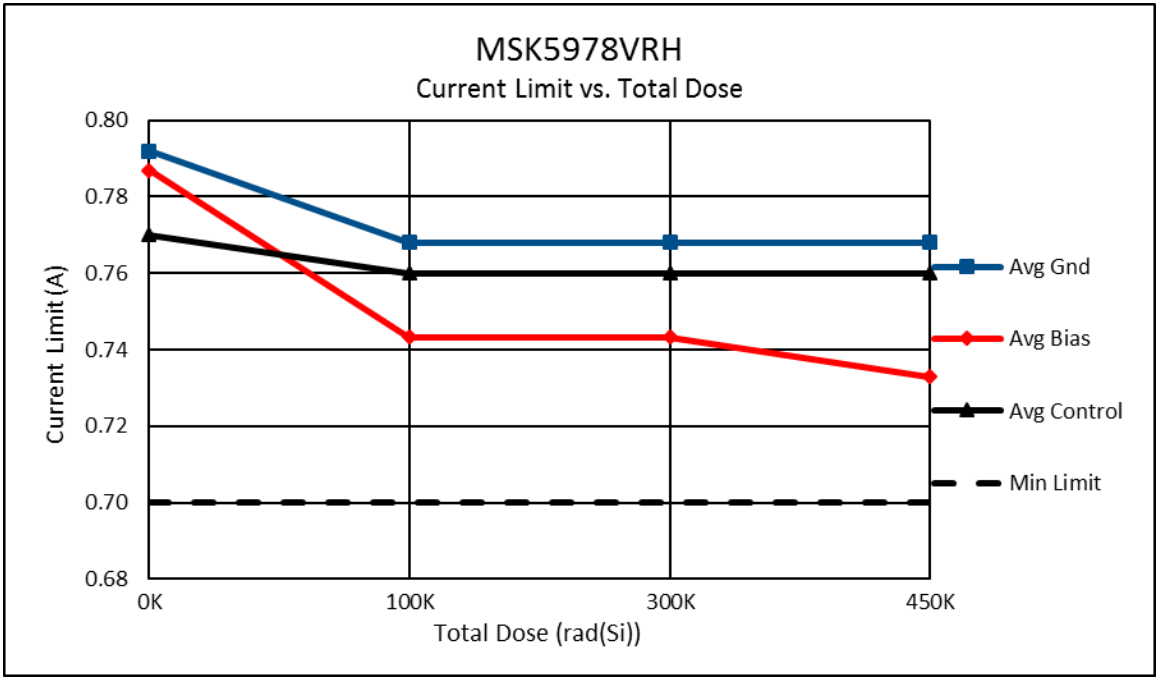
**Dose Time, Incremental Dose and Total Cumulative Dose**













## **Total Dose Radiation Test Report**

**MSK 5978RH,  
MSK 5980RH**

### **RAD Hard Positive Adjustable Voltage Regulator**

Sept 24, 2010 (TID, First Test)  
May 11, 2012 (TID, Second Test, LOT H0923840.4 WF#3)  
Jan 29, 2014 (TID, Third Test, LOT H0923840.4 WF#5)  
October 28, 2015 (TID, Fourth Test, LOT h0852403.1 WF#10)  
Revised May 23, 2017

B. Horton  
P. Dinneen

Anaren, Inc. – MSK Products

**I. Introduction:**

The total dose radiation test plan for the MSK 5978RH was developed to qualify the devices as RAD Hard to 300 KRADS(Si). The testing was performed beyond 300 KRADS(Si) to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the device, but simply offers designers insight to the critical parameter-shifts up to the specified total dose level. The MSK 5980RH uses the same active components and package material.

The data herein is from direct measurement of the MSK5978RH response to total dose irradiation, but is indicative of the response of both device types.

MIL-STD-883 Method 1019.7 and ASTM F1892-06 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5978RH and MSK 5980RH..

**II. Radiation Source:**

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. The dose rate was determined to be 106 rads(Si)/sec. The total dose schedule can be found in Table I.

**III. Test Setup:**

All test samples were subjected to Group A Electrical Test in accordance with the device data sheet. In addition, all devices received burn-in per MIL-STD-883 Method 1015 and were fully screened IAW MIL-PRF 38534 Class K or MIL-PRF-38535 Class V. For test platform verification, one control device was tested at 25°C. Ten devices were then tested at 25°C, prior to irradiation, and were found to be within acceptable test limits.

The devices were vertically aligned with the radiation source and enclosed in a lead/aluminum container during irradiation. Five devices were kept under bias during irradiation. An operating voltage of +26 Volts was used for the bias condition. Five devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation, the device leads were shorted together and the devices were transported to the MSK automatic electrical test platform. Testing was performed in accordance with the MSK device data sheet. Testing was performed on irradiated devices, as well as the control device, at each total dose level. Electrical tests were completed within one hour of irradiation. Devices were subjected to subsequent radiation doses within two hours of removal from the radiation field.

**IV. Data:**

All performance curves are averaged from the test results of the biased and unbiased devices respectively. If required, full test data can be obtained by contacting Anaren, Inc.- MSK Products.

**V. Summary:**

Based on the test data recorded during radiation testing and statistical analysis, the MSK5978RH and MSK5980RH qualified as a 300 Krad(Si) radiation hardened device. Output Offset Voltage and Load Regulation exhibited the most significant change with irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5978 RH Biased/Unbiased Dose Rate  
Schedule

Dosimetry Equipment  
Bruker Biospin # 0162

Irradiation Date  
10/28/15

Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
8:06	51,516	51,516
8:06	51,516	103,032
8:06	51,516	154,548
24:17	154,442	308,990
24:17	154,442	463,432

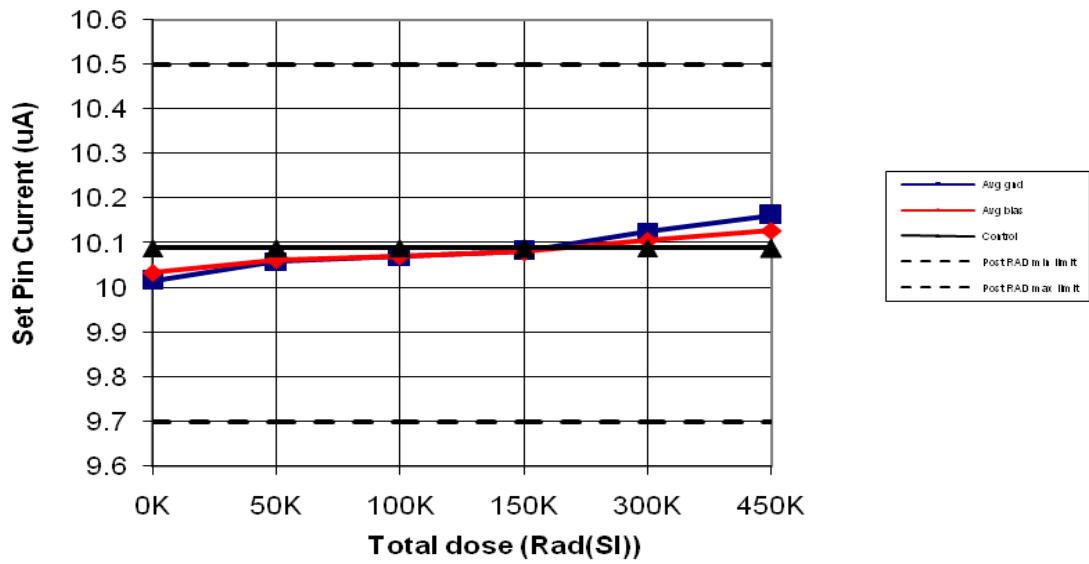
Biased S/N – 3570, 3571, 3572, 3573, 3574

Unbiased S/N – 3575, 3576, 3577, 3579, 3580

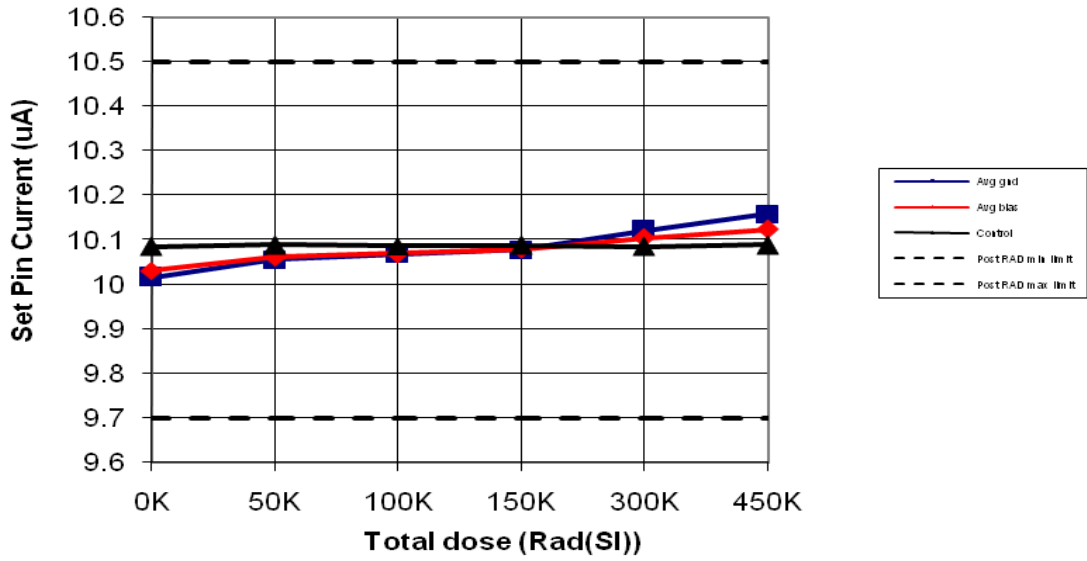
Table 1

**Dose Time, Incremental Dose and Total Cumulative Dose**

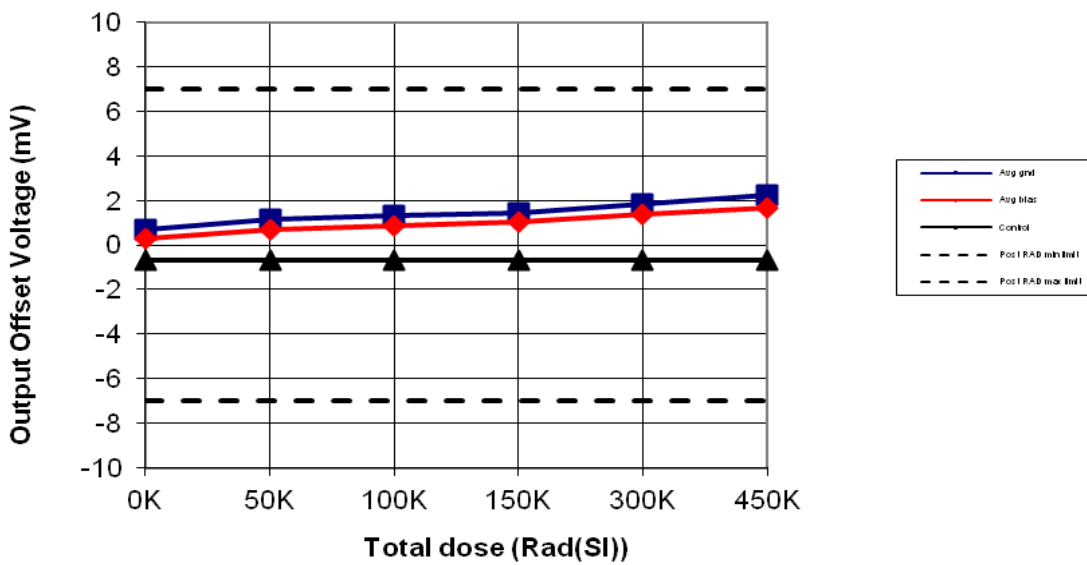
MSK5978VRH  
Set Pin Current (Io=1mA) vs. Total Dose

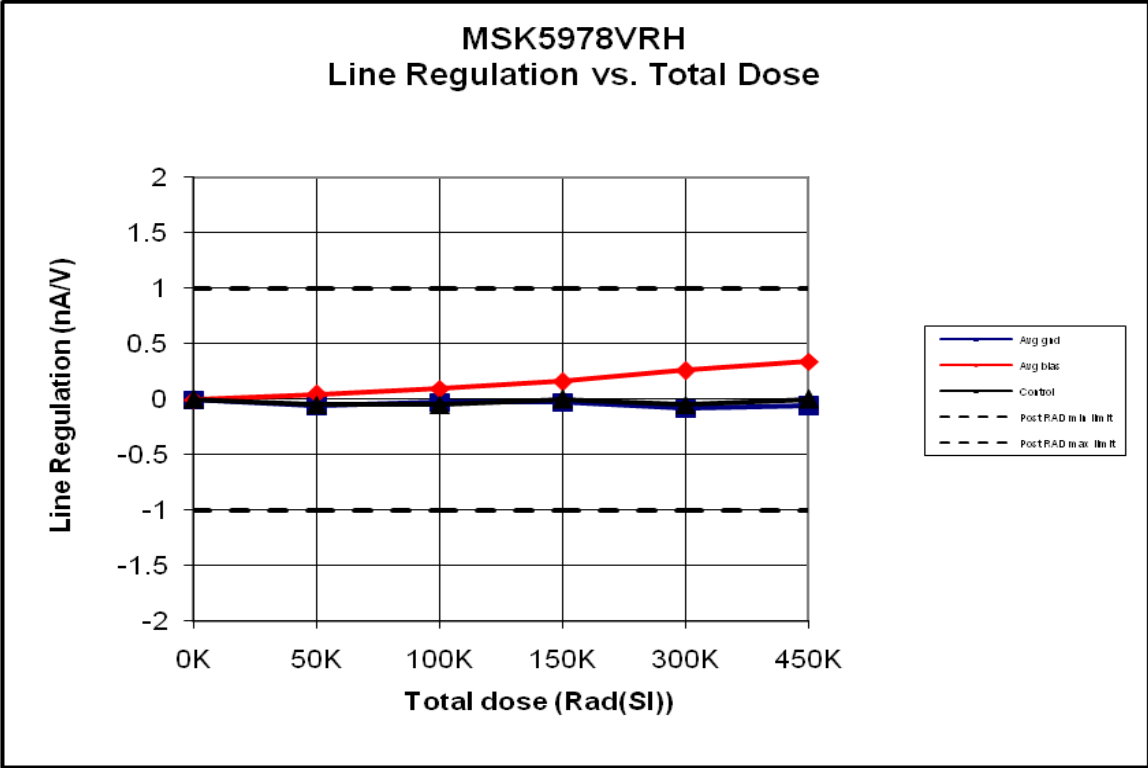
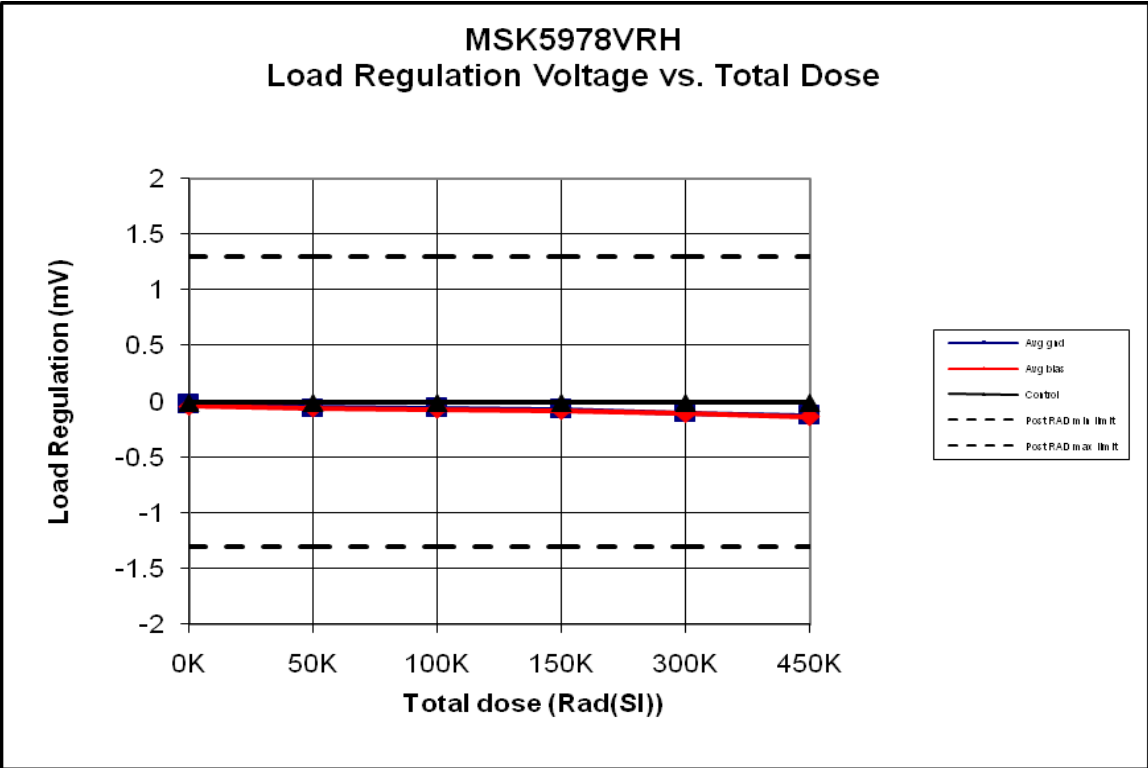


**MSK5978VRH**  
Set Pin Current (I<sub>o</sub>= 0.7A) vs. Total Dose

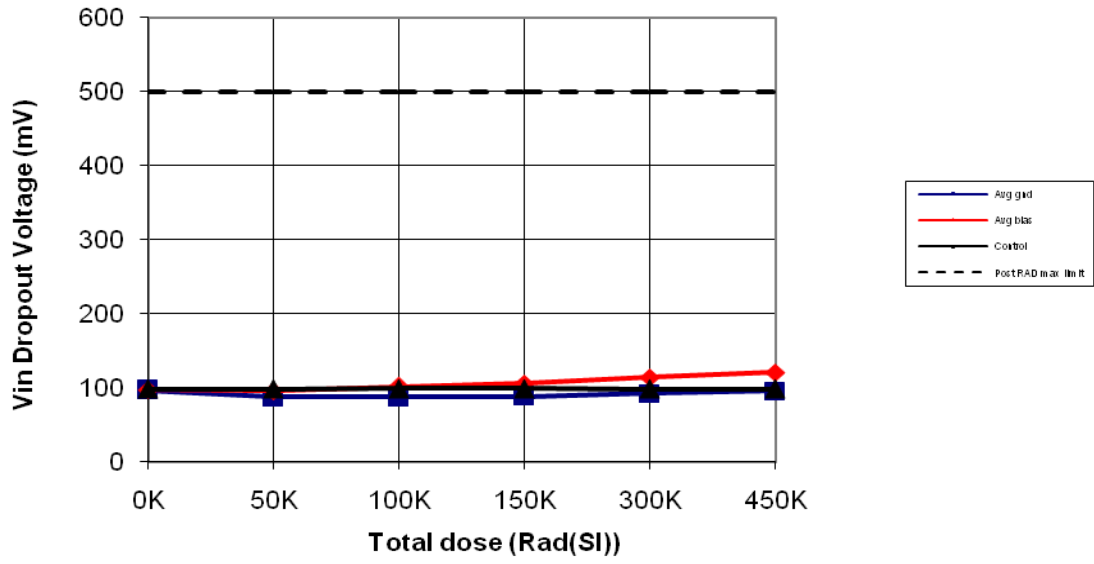


**MSK5978VRH**  
Output Offset Voltage vs. Total Dose

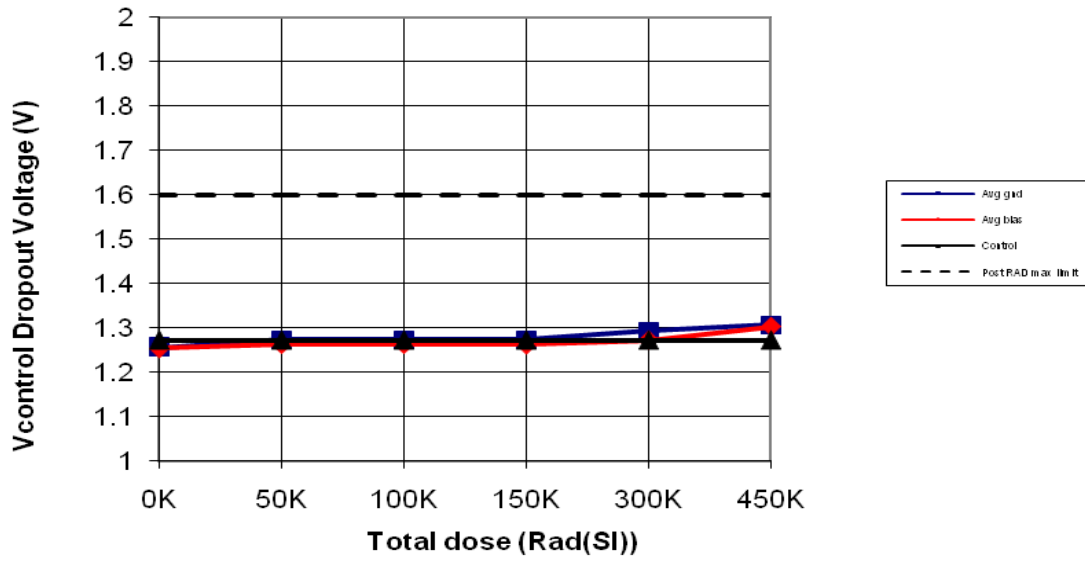




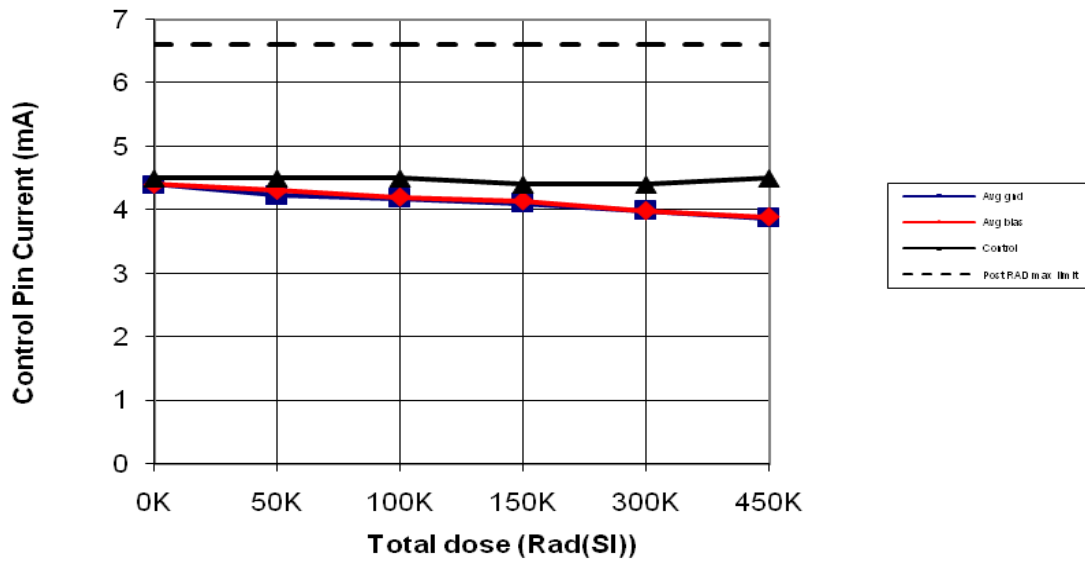
MSK5978VRH  
Vin Dropout Voltage vs. Total Dose



MSK5978VRH  
Vcontrol Dropout Voltage vs. Total Dose

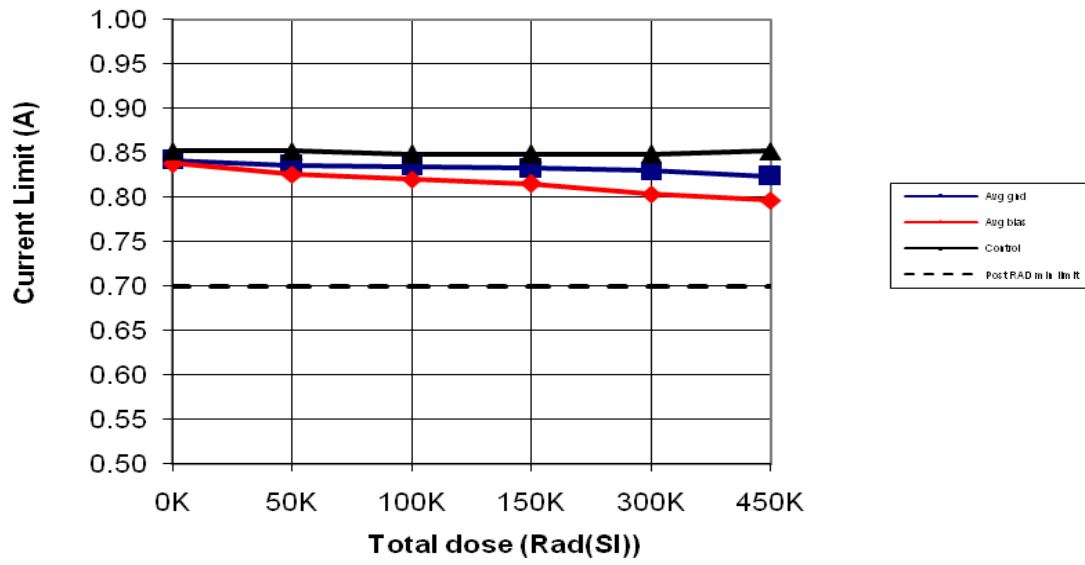


MSK5978VRH  
Control Pin Current vs. Total Dose





### MSK5978VRH Current Limit vs. Total Dose



## **Total Dose Radiation Test Report**

**MSK 5978RH**

**MSK 5980RH**

### **RAD Hard Positive Adjustable Voltage Regulator**

Sept 24, 2010 (TID, First Test)

May 11, 2012 (TID, Second Test, LOT H0923840.4 WF#3)

Jan 29, 2014 (TID, Third Test, LOT H0923840.4 WF#5)

B. Horton  
P. Dinneen

Anaren, Inc – MSK Products

**I. Introduction:**

The total dose radiation test plan for the MSK 5978RH was developed to qualify the devices as RAD Hard to 300 KRADS(Si). The testing was performed beyond 300 KRADS(Si) to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the device, but simply offers designers insight to the critical parameter-shifts up to the specified total dose level.

The data herein is from direct measurement of the MSK5978RH response to total dose irradiation, but is indicative of the response of both device types.

MIL-STD-883 Method 1019.7 and ASTM F1892-06 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5978RH

**II. Radiation Source:**

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. The dose rate was determined to be 85 rads(Si)/sec. The total dose schedule can be found in Table I.

**III. Test Setup:**

All test samples were subjected to Group A Electrical Test in accordance with the device data sheet. In addition, all devices received burn-in per MIL-STD-883 Method 1015 and were fully screened IAW MIL-PRF 38534 Class K or MIL-PRF-38535 Class V. For test platform verification, one control device was tested at 25°C. Ten devices were then tested at 25°C, prior to irradiation, and were found to be within acceptable test limits.

The devices were vertically aligned with the radiation source and enclosed in a lead/aluminum container during irradiation. Five devices were kept under bias during irradiation. An operating voltage of +26 Volts was used for the bias condition. Five devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation, the device leads were shorted together and the devices were transported to the MSK automatic electrical test platform. Testing was performed in accordance with the MSK device data sheet. Testing was performed on irradiated devices, as well as the control device, at each total dose level. Electrical tests were completed within one hour of irradiation. Devices were subjected to subsequent radiation doses within two hours of removal from the radiation field.

**IV. Data:**

All performance curves are averaged from the test results of the biased and unbiased devices respectively. If required, full test data can be obtained by contacting Anaren, Inc.- MSK Products.

**V. Summary:**

Based on the test data recorded during radiation testing and statistical analysis, the MSK5978RH and MSK 5980RH qualified as a 300 Krad(Si) radiation hardened device. Set Control Pin Current and Load Regulation exhibited the most significant shift due to irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5978 RH Biased/Unbiased Dose Rate  
Schedule

Dosimetry Equipment  
Bruker Biospin # 0162

Irradiation Date  
1/29/14

Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
10:06	51,510	51,510
10:06	51,510	103,020
10:06	51,510	154,530
30:18	154,530	309,060
30:18	154,530	463,590

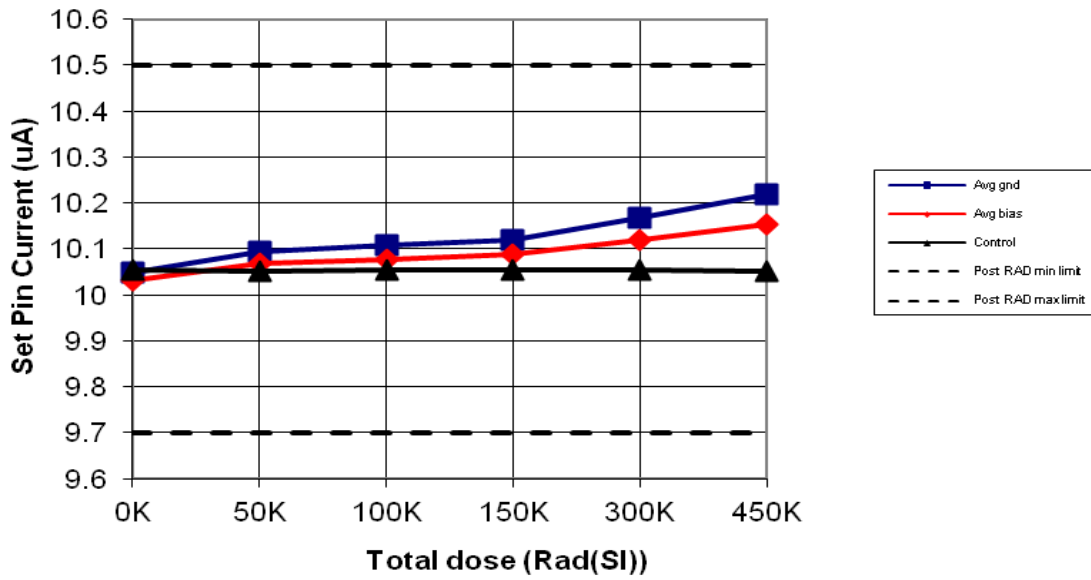
Biased S/N – 1930, 1931, 1932, 1933, 1936

Unbiased S/N – 1937, 1938, 1939, 1943, 1944

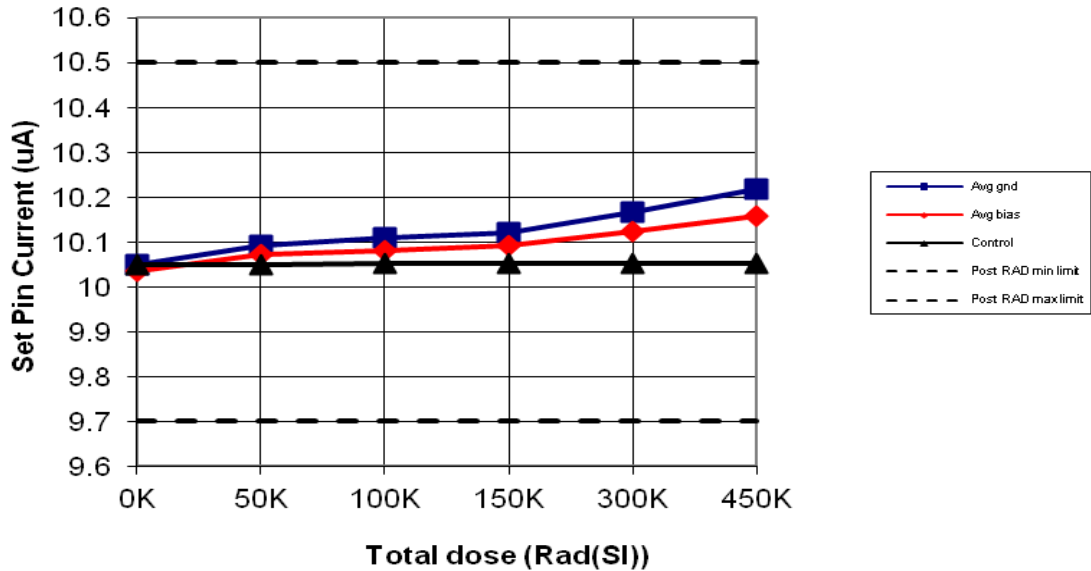
Table 1

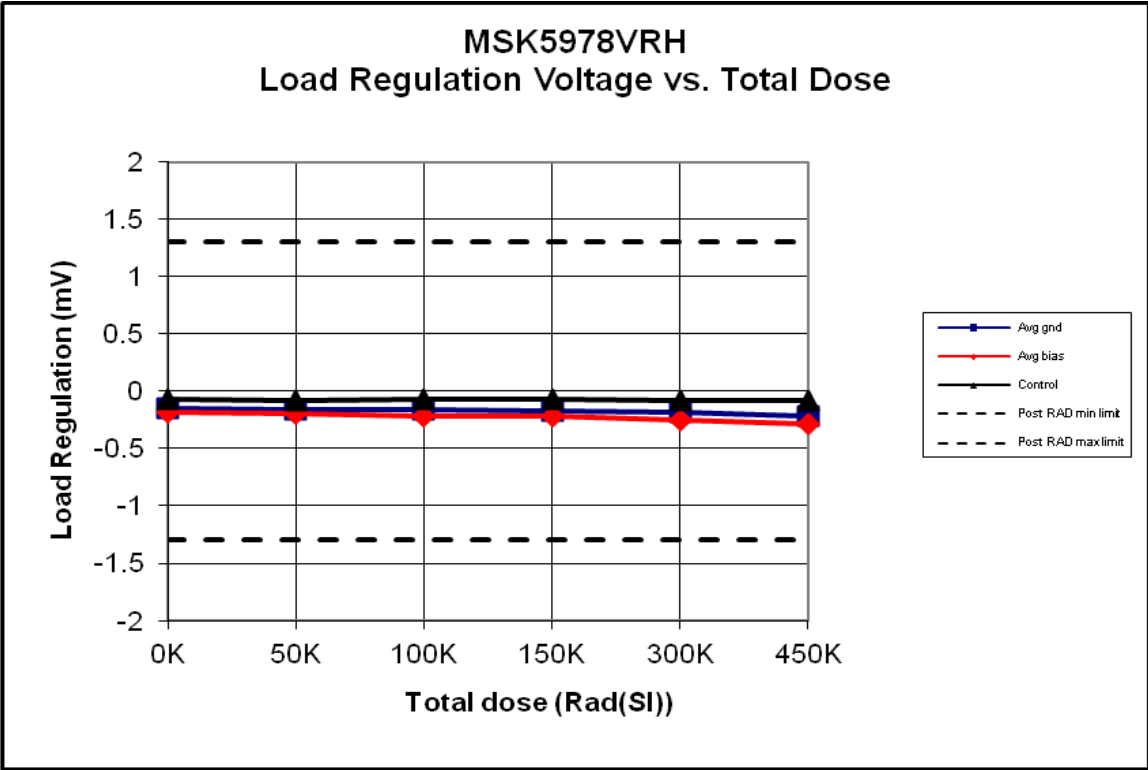
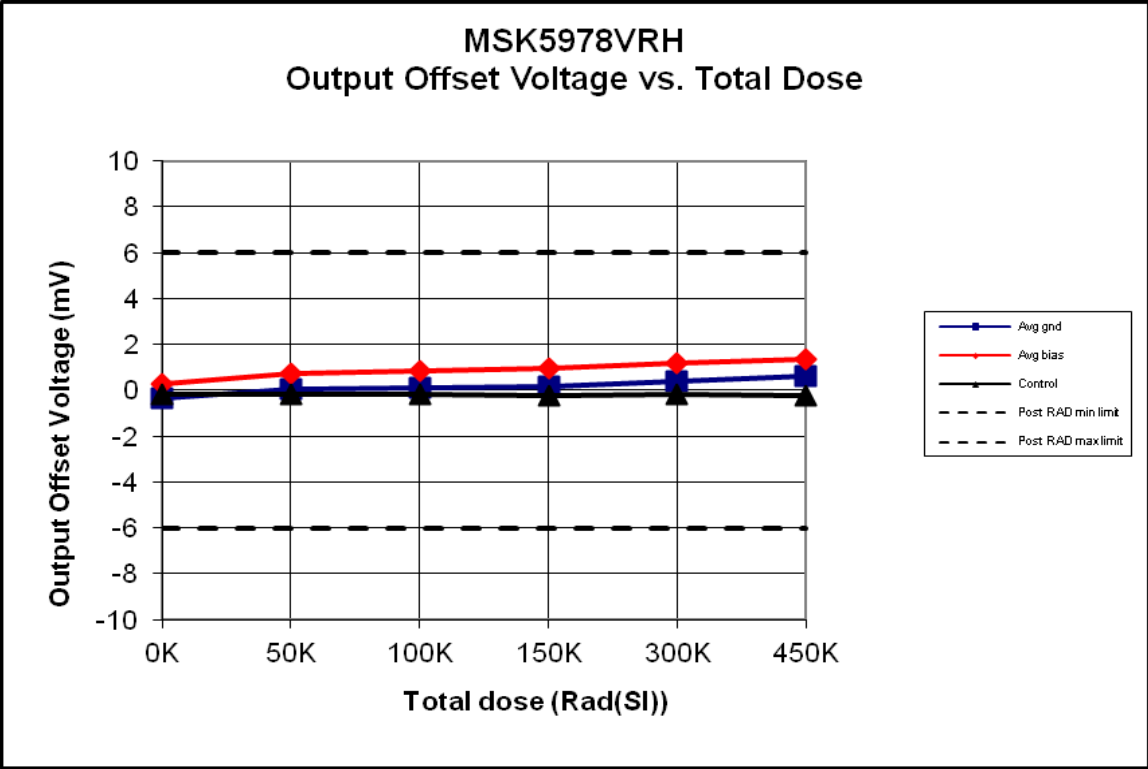
**Dose Time, Incremental Dose and Total Cumulative Dose**

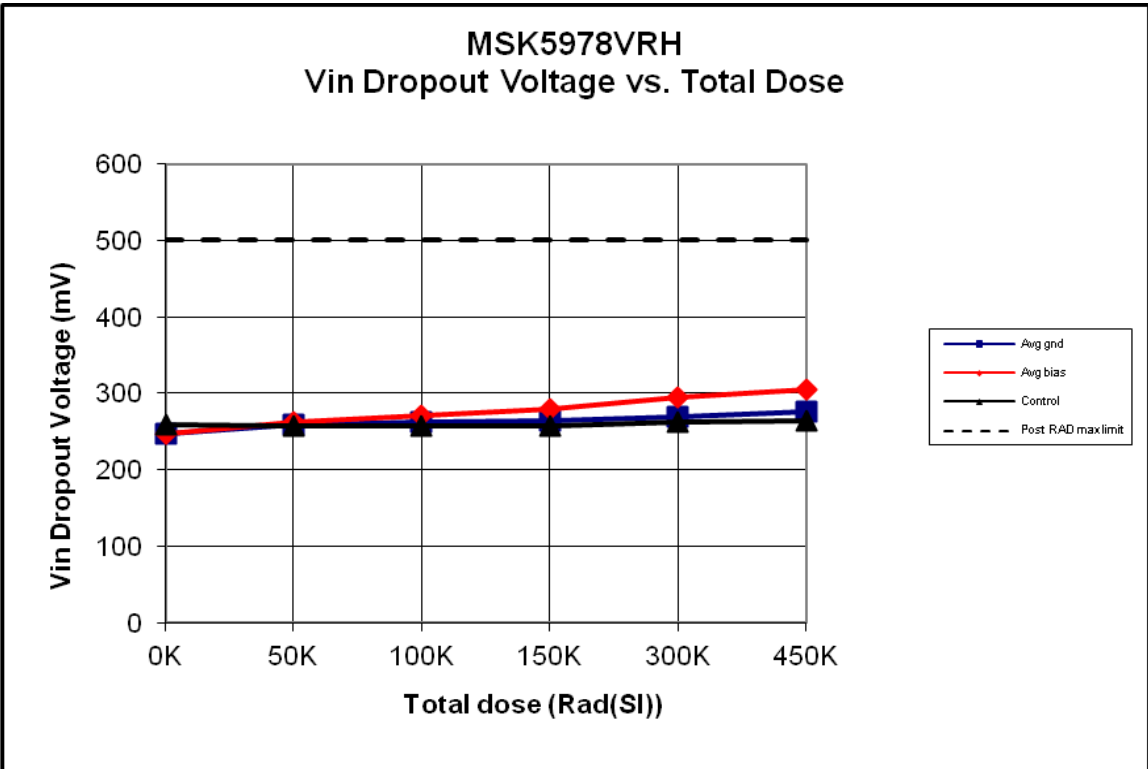
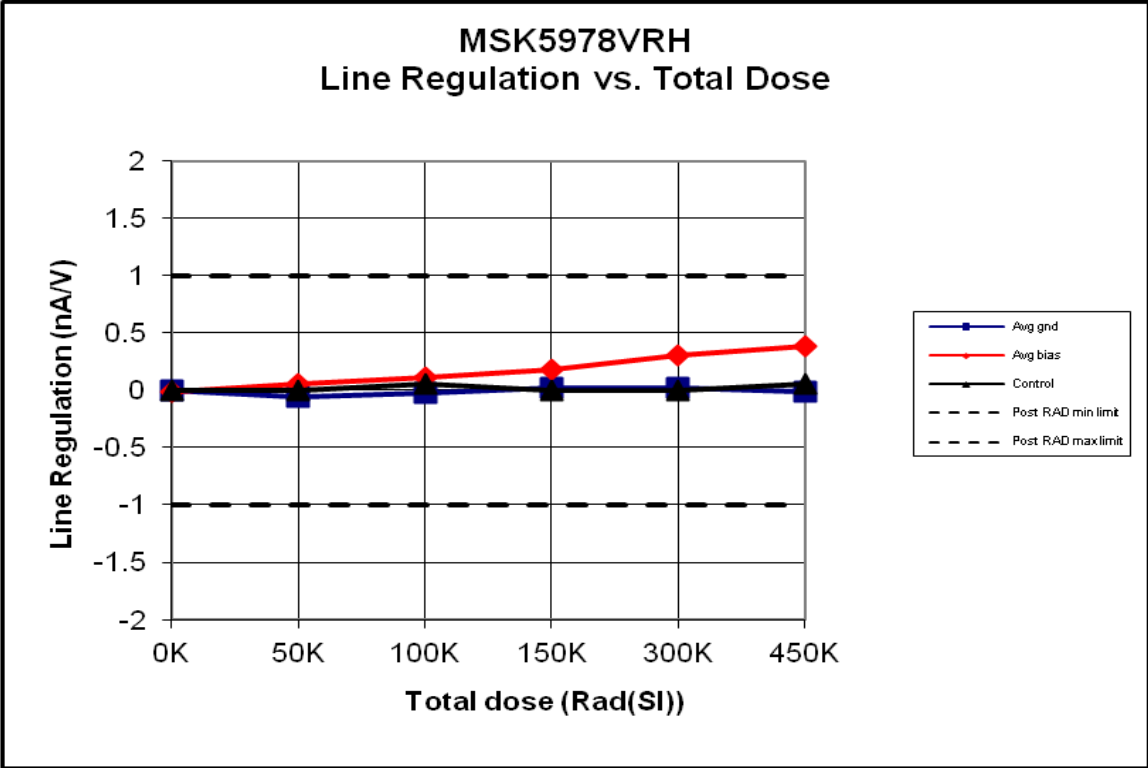
**MSK5978VRH**  
**Set Pin Current (I<sub>o</sub>=1mA) vs. Total Dose**

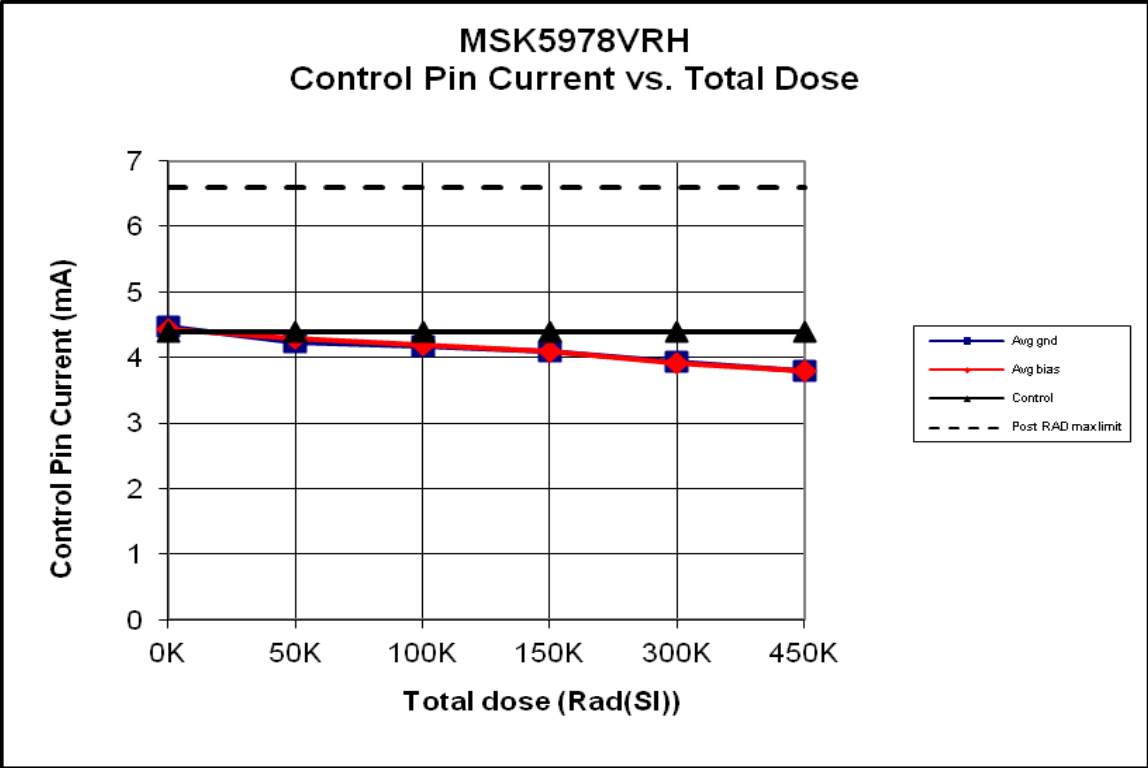
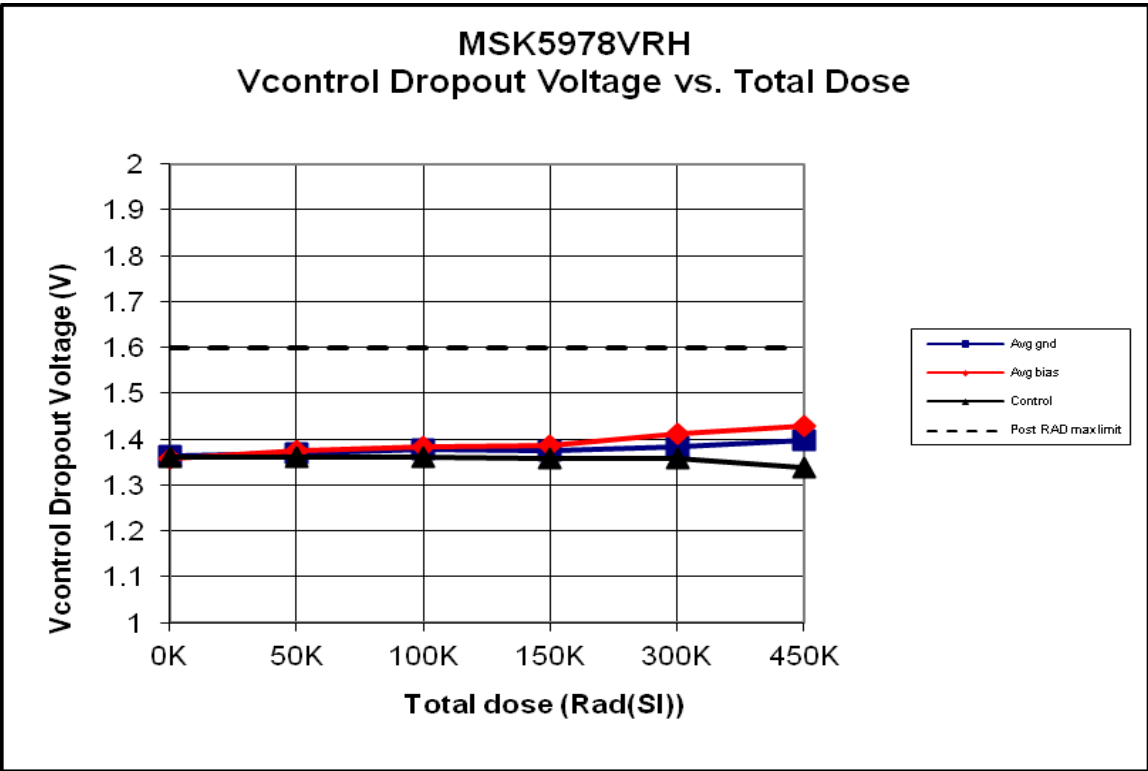


**MSK5978VRH**  
**Set Pin Current (I<sub>o</sub>= 0.7A) vs. Total Dose**



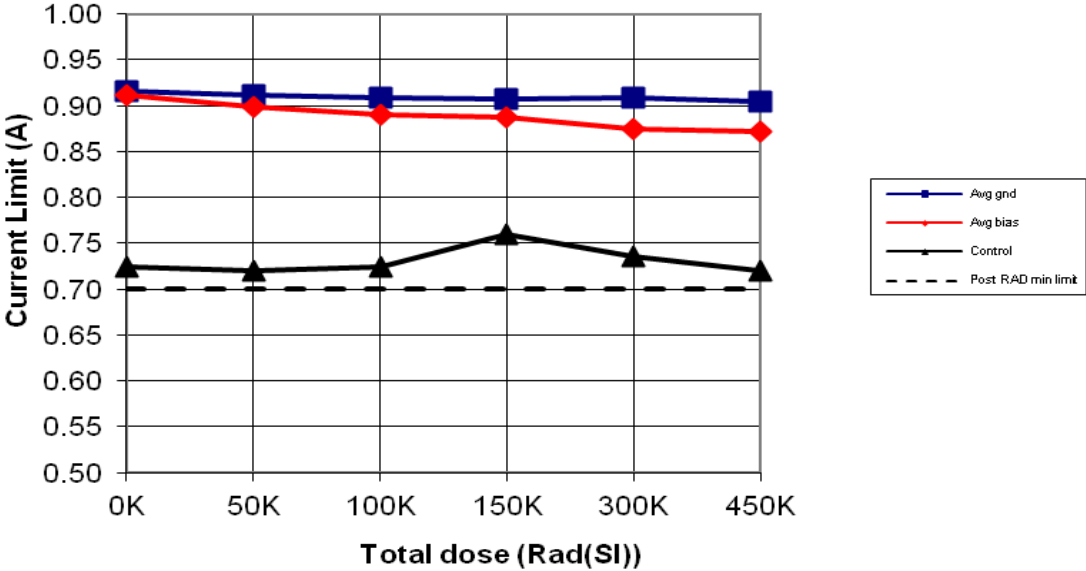








### MSK5978VRH Current Limit vs. Total Dose



## **Total Dose Radiation Test Report**

**MSK 5978RH  
MSK 5980RH**

### **RAD Hard Positive Adjustable Voltage Regulator**

Sept 24, 2010 (TID, First Test)  
May 11, 2012 (TID, Second Test, H09238404.4 WF#3)

B. Horton  
K. Conroy  
R. Wakeman

Anaren, Inc.- MSK Products

**I. Introduction:**

The total dose radiation test plan for the MSK 5978RH was developed to qualify the devices as RAD Hard to 300 KRADS(Si). The testing was performed beyond 300 KRADS(Si) to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the device, but simply offers designers insight to the critical parameter-shifts up to the specified total dose level.

The data herein is from direct measurement of the MSK5978RH response to total dose irradiation, but is indicative of the response of both device types.

MIL-STD-883 Method 1019.7 and ASTM F1892-06 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5978RH.

**II. Radiation Source:**

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. The dose rate was determined to be 109 Rads(Si)/sec. The total dose schedule can be found in Table I.

**III. Test Setup:**

All test samples were subjected to Group A Electrical Test in accordance with the device data sheet. In addition, all devices received burn-in per MIL-STD-883 Method 1015 and were fully screened IAW MIL-PRF-38534 Class K or MIL-PRF-38535 Class V. For test platform verification, one control device was tested at 25°C. Ten devices were then tested at 25°C, prior to irradiation, and were found to be within acceptable test limits.

The devices were vertically aligned with the radiation source and enclosed in a lead/aluminum container during irradiation. Five devices were kept under bias during irradiation. An operating voltage of +26 Volts was used for the bias condition. Five devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation, the device leads were shorted together and the devices were transported to the MSK automatic electrical test platform. Testing was performed in accordance with the MSK device data sheet. Testing was performed on irradiated devices, as well as the control device, at each total dose level. Electrical tests were completed within one hour of irradiation. Devices were subjected to subsequent radiation doses within two hours of removal from the radiation field.

**IV. Data:**

All performance curves are averaged from the test results of the biased and unbiased devices, respectively. If required, full test data can be obtained by contacting Anaren, Inc.- MSK Products.

**V. Summary:**

Based on the test data recorded during radiation testing and statistical analysis, the MSK5978RH and MSK 5980RH qualified as a 300 Krad(Si) radiation hardened device. Set Control Pin Current and Load Regulation exhibited the most significant shift due to irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5978 RH Biased/Unbiased Dose Rate  
Schedule

Dosimetry Equipment  
Bruker Biospin # 0162

Irradiation Date  
5/11/12

Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
08:00	51,840	51,480
08:00	51,840	103,680
08:00	51,840	155,520
23:50	154,440	309,960
23:50	154,440	464,400
08:00	51,840	51,480

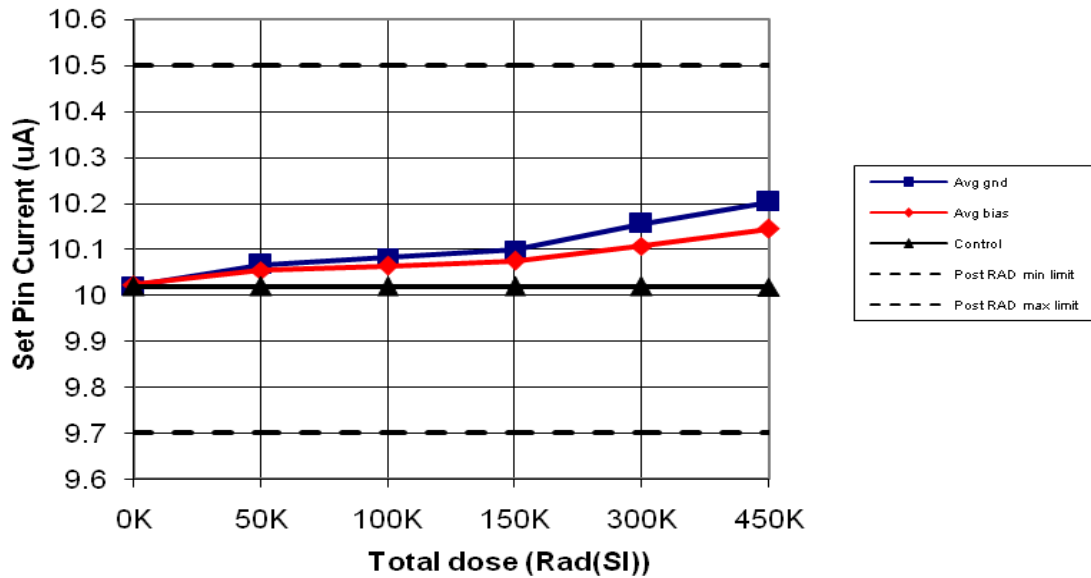
Biased S/N – 0487, 0488, 0489, 0490, 0491

Unbiased S/N – 0492, 0493, 0494, 0495, 0496

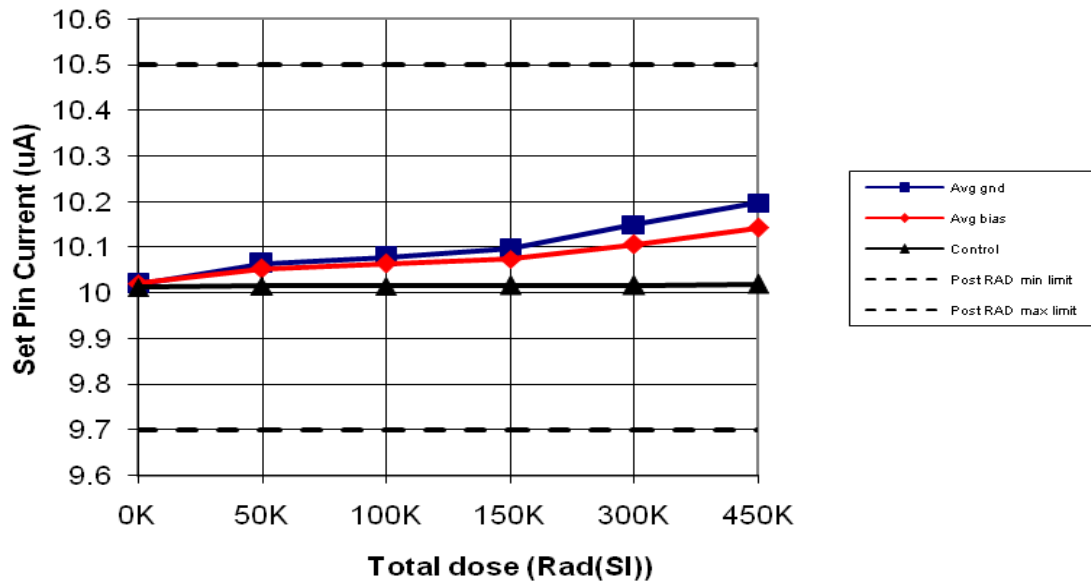
Table 1

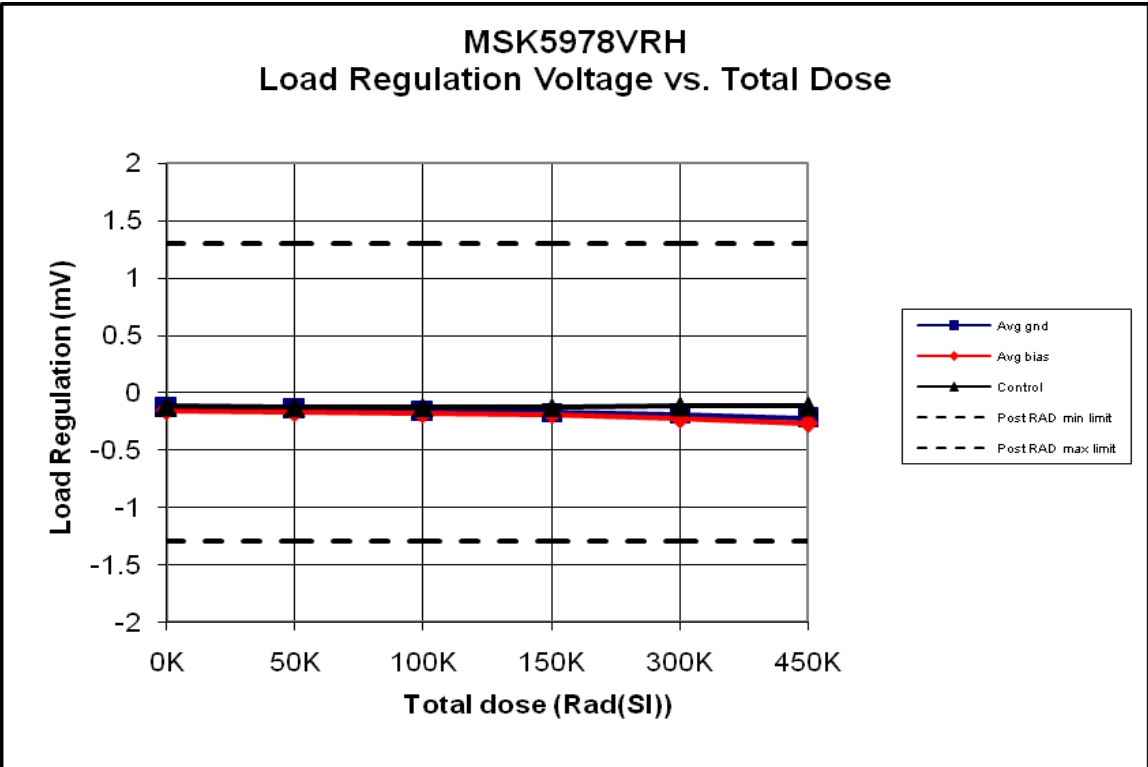
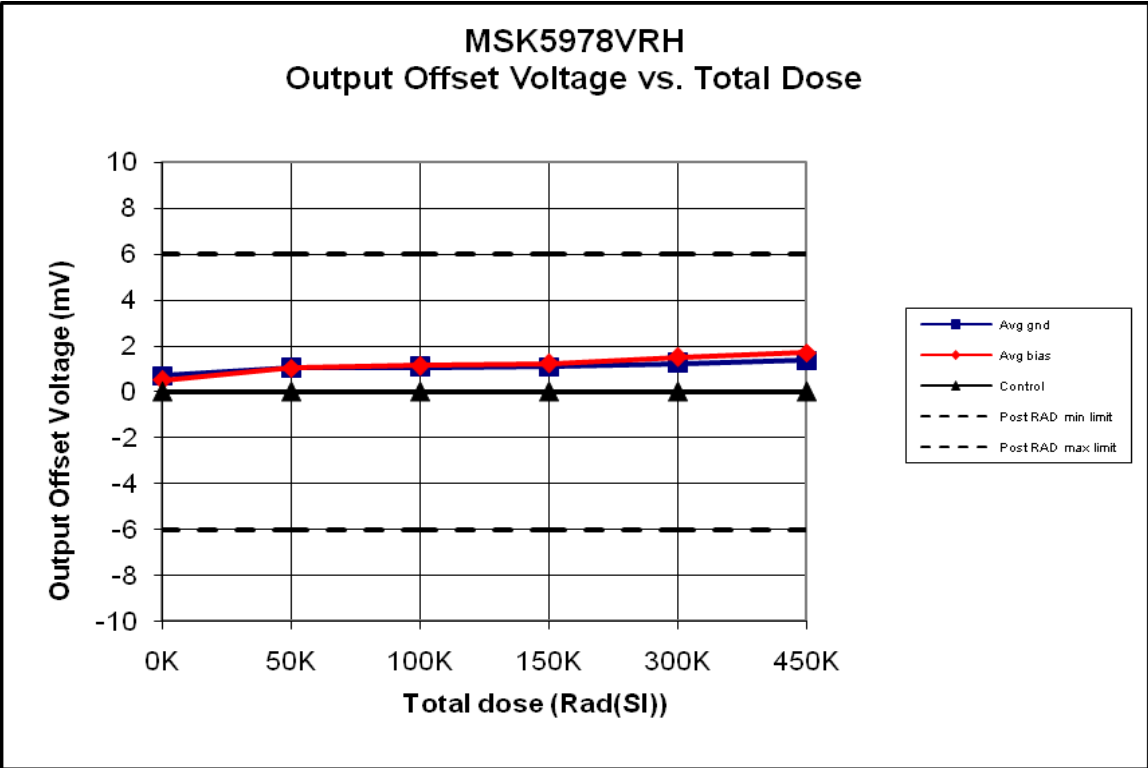
**Dose Time, Incremental Dose and Total Cumulative Dose**

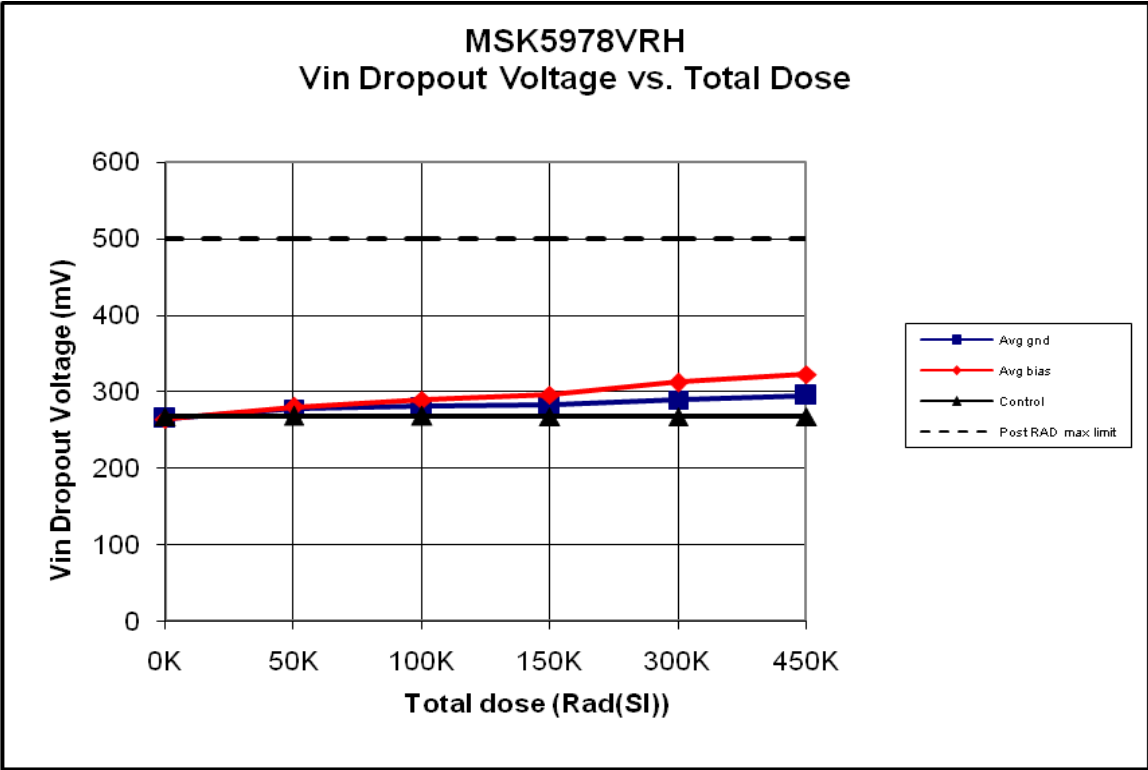
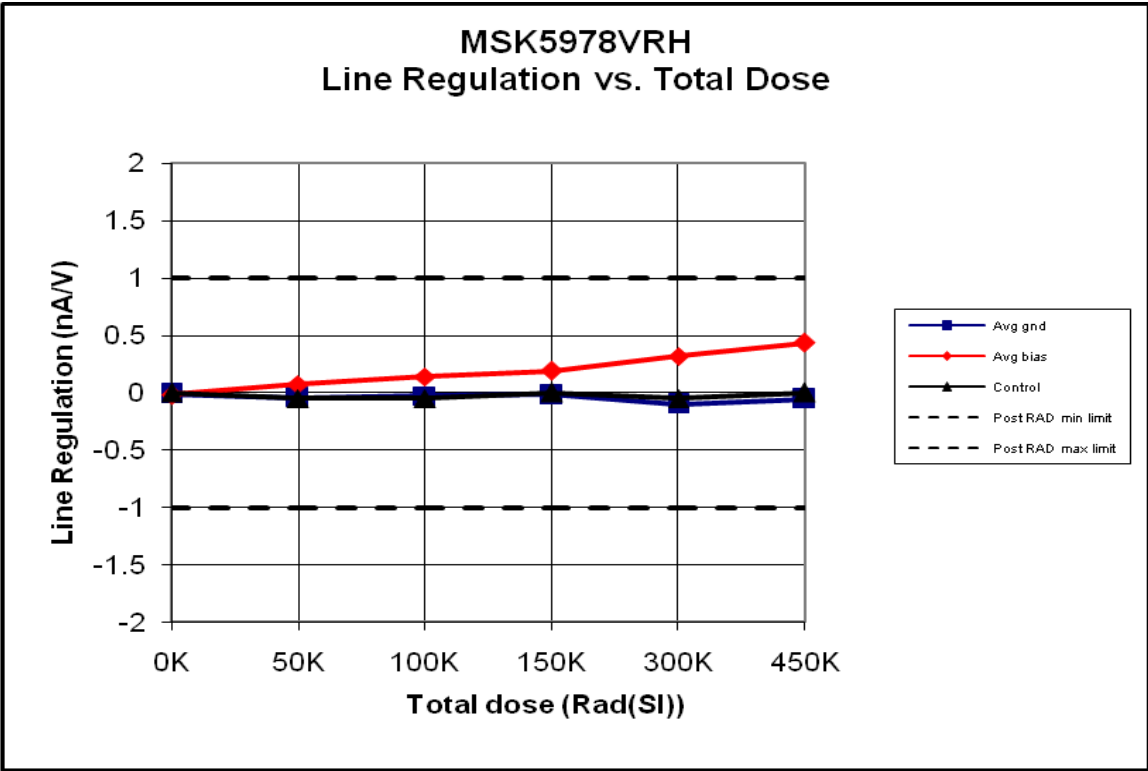
**MSK5978VRH**  
**Set Pin Current ( $I_o=1\text{mA}$ ) vs. Total Dose**

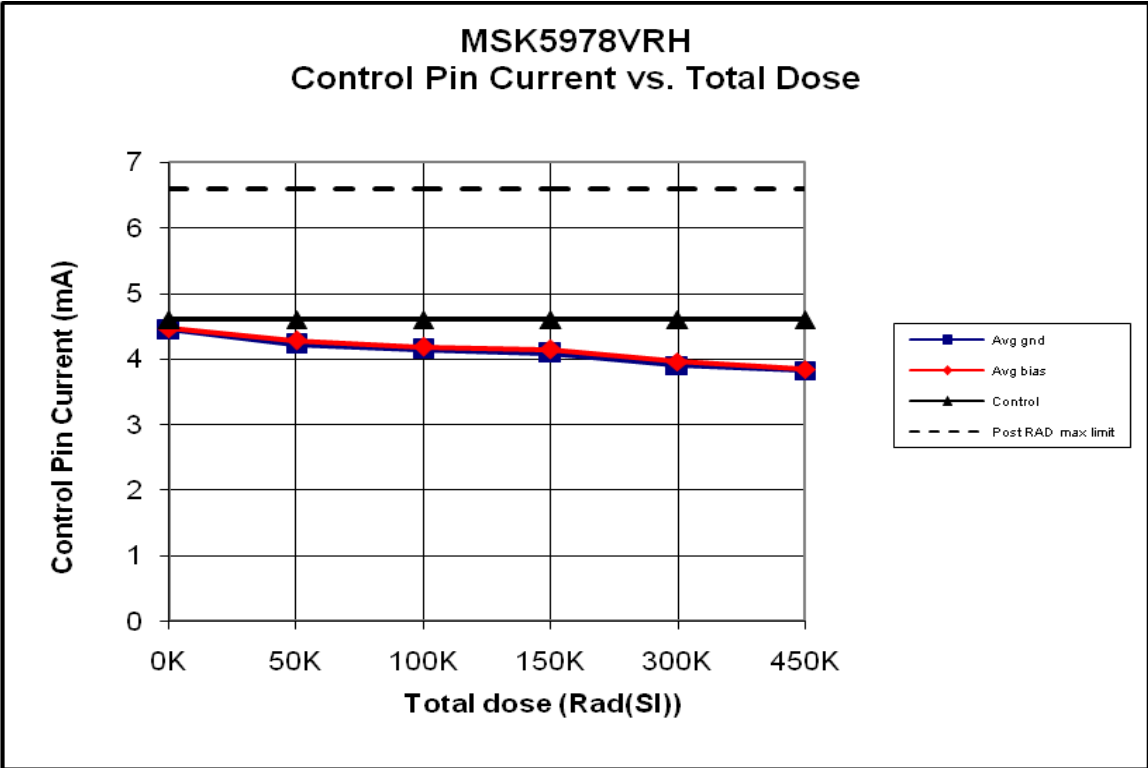
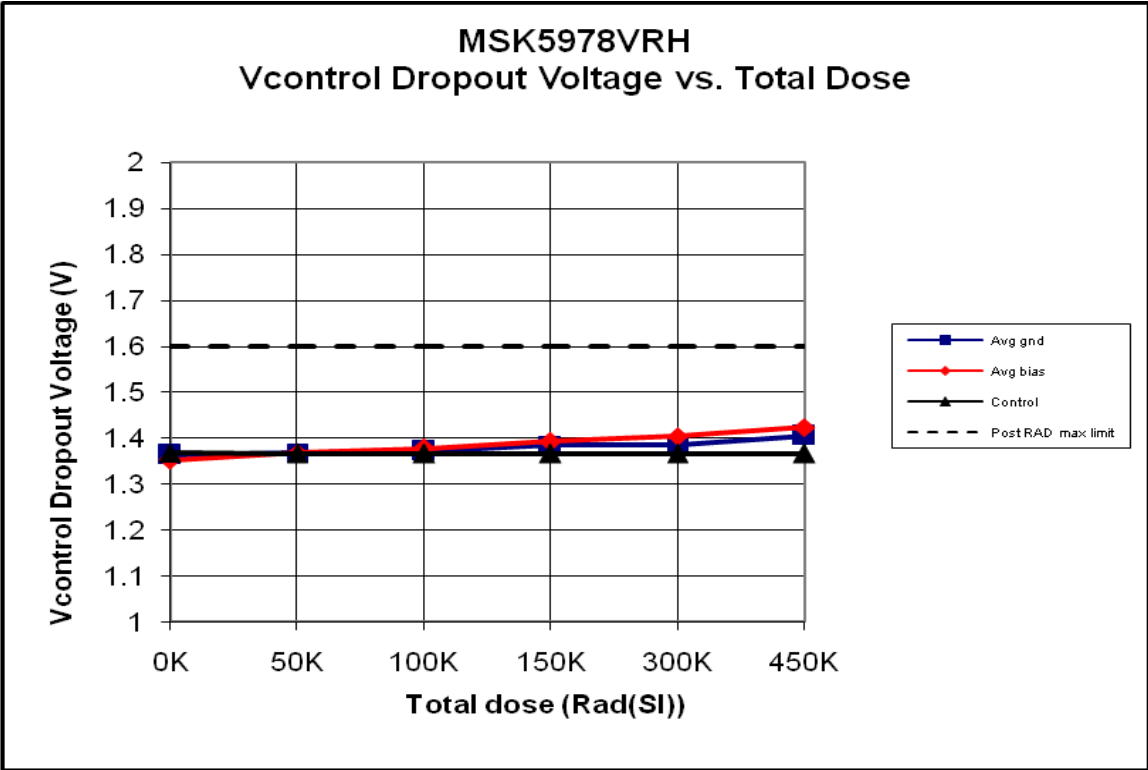


**MSK5978VRH**  
**Set Pin Current ( $I_o=0.7\text{A}$ ) vs. Total Dose**



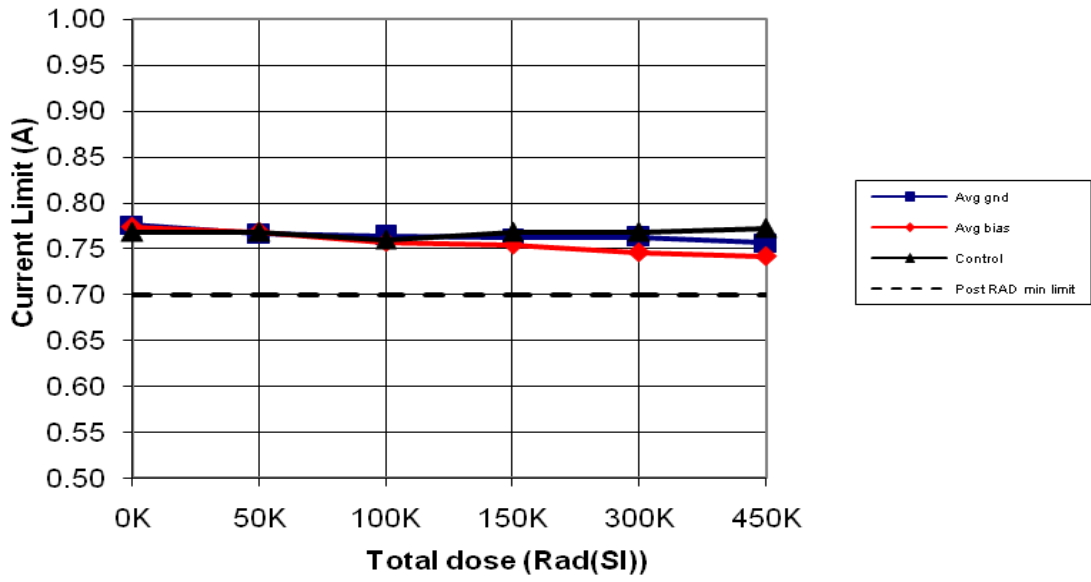








### MSK5978VRH Current Limit vs. Total Dose



**Total Dose Radiation Test Report**

**MSK 5978RH  
MSK 5980RH**

**RAD Hard Positive Adjustable Voltage Regulator**

Sept 24, 2010

C. Salce  
F. Freytag

Anaren, Inc. – MSK Products

**I. Introduction:**

The total dose radiation test plan for the MSK 5978RH was developed to qualify the devices as RAD Hard to 300 KRADS(Si). The testing was performed beyond 300 KRADS(Si) to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the device, but simply offers designers insight to the critical parameter-shifts up to the specified total dose level.

The data herein is from direct measurement of the MSK5978RH response to total dose irradiation, but is indicative of the response of both device types.

MIL-STD-883 Method 1019.7 and ASTM F1892-06 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5978RH.

**II. Radiation Source:**

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. The dose rate was determined to be 132 Rads(Si)/sec. The total dose schedule can be found in Table I.

**III. Test Setup:**

All test samples were subjected to Group A Electrical Test in accordance with the device data sheet. In addition, all devices received burn-in per MIL-STD-883 Method 1015 and were fully screened IAW MIL-PRF-38534 Class K or MIL-PRF 38535 Class V. For test platform verification, one control device was tested at 25°C. Ten devices were then tested at 25°C, prior to irradiation, and were found to be within acceptable test limits.

The devices were vertically aligned with the radiation source and enclosed in a lead/aluminum container during irradiation. Five devices were kept under bias during irradiation. An operating voltage of +26 Volts was used for the bias condition. Five devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation, the device leads were shorted together and the devices were transported to the MSK automatic electrical test platform. Testing was performed in accordance with the MSK device data sheet. Testing was performed on irradiated devices, as well as the control device, at each total dose level. Electrical tests were completed within one hour of irradiation. Devices were subjected to subsequent radiation doses within two hours of removal from the radiation field.

**IV. Data:**

All performance curves are averaged from the test results of the biased and unbiased devices, respectively. If required, full test data can be obtained by contacting Anaren, Inc. MSK Products.

**V. Summary:**

Based on the test data recorded during radiation testing and statistical analysis, the MSK5978RH and MSK 5980RH qualified as a 300 Krad(Si) radiation hardened device. Set Pin Current and Line Regulation exhibited the most significant shift due to irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5978 RH Biased/Unbiased Dose Rate  
Schedule

Dosimetry Equipment  
Bruker Biospin # 0162

Irradiation Date  
9/24/10

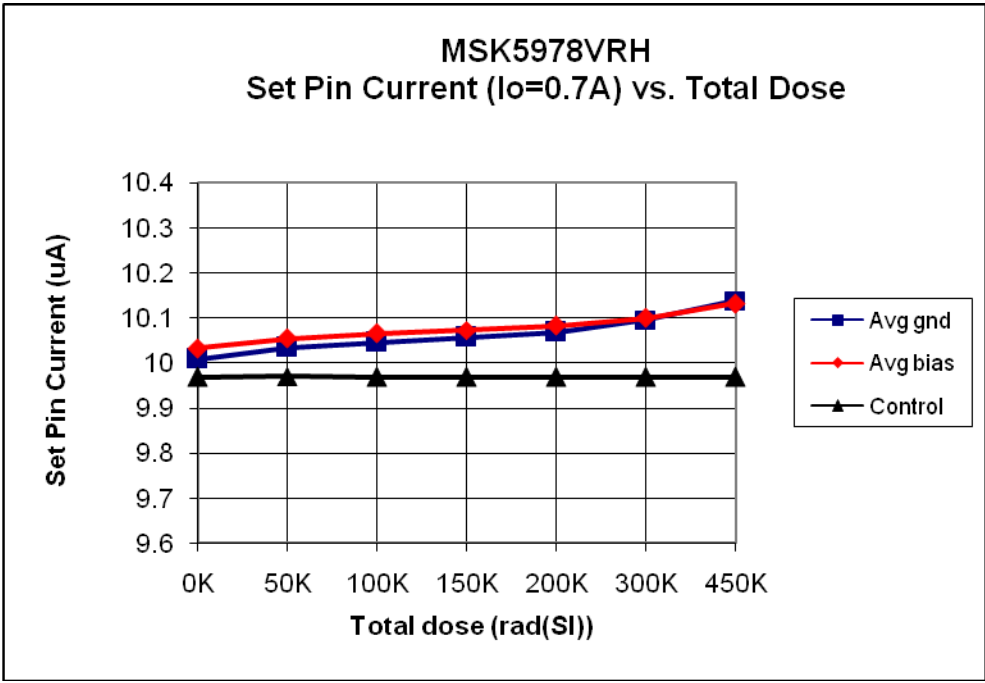
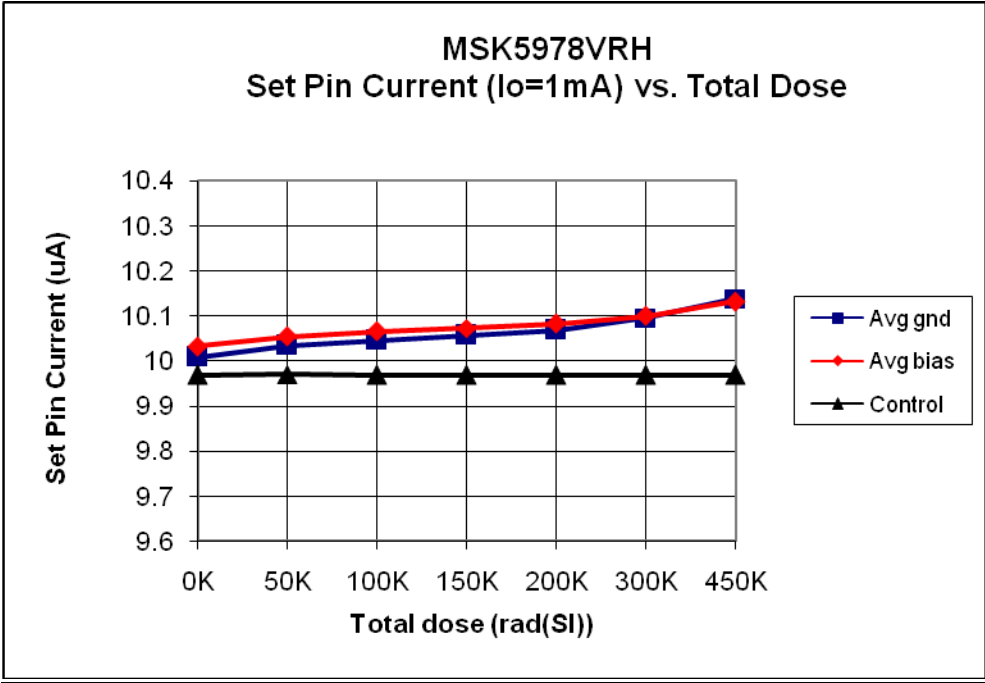
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
6:30	51,480	51,480
6:30	51,480	102,960
6:30	51,480	154,440
6:30	51,480	205,920
13:00	102,960	308,880
19:31	154,572	463,452

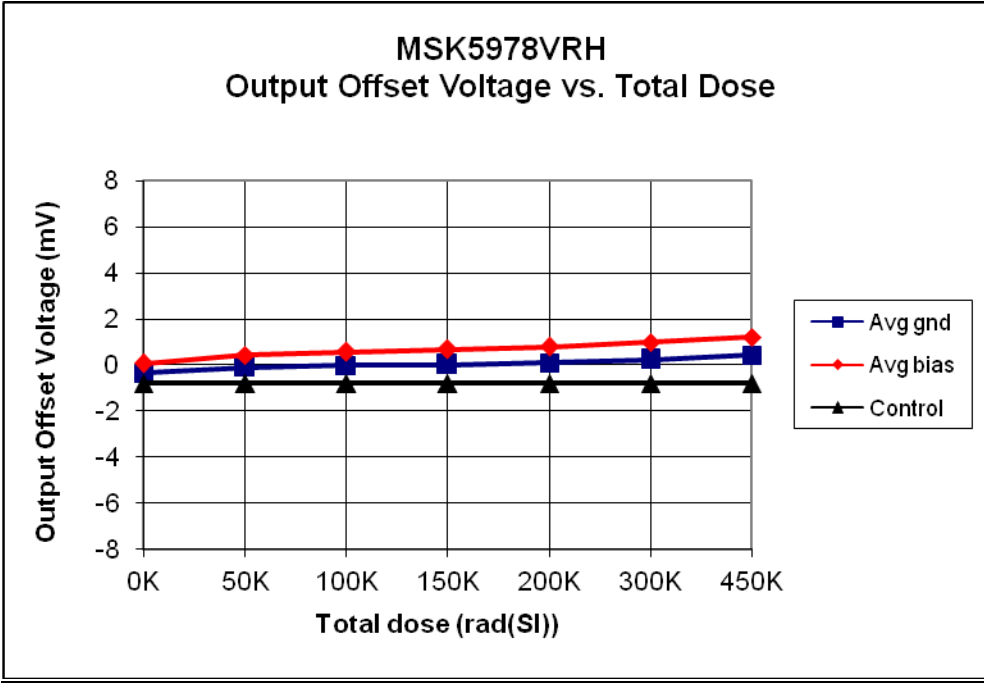
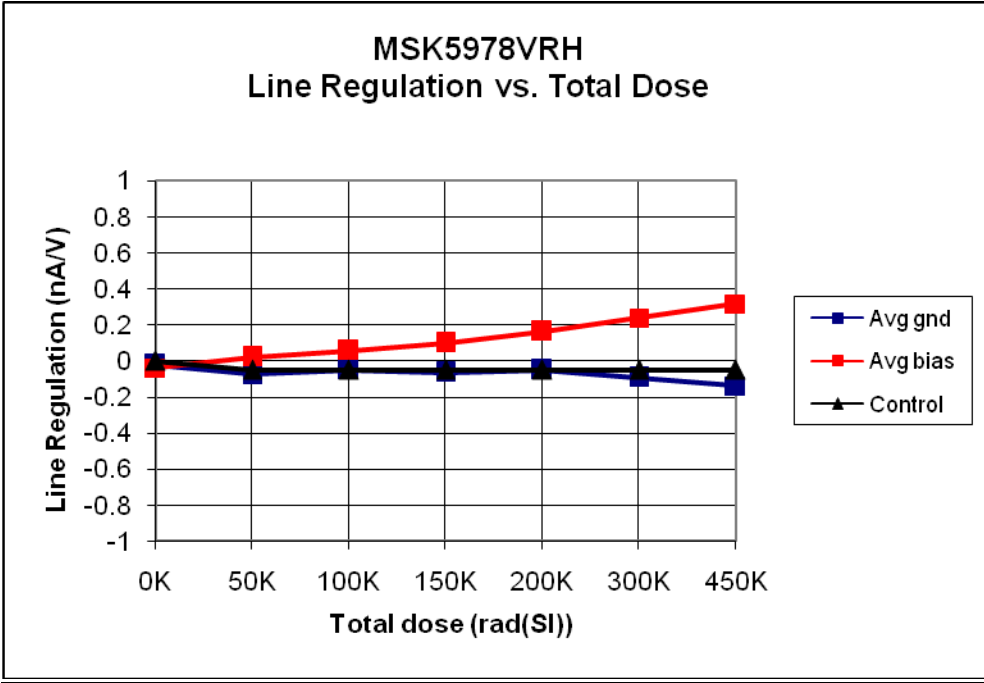
Biased S/N – 0037, 0038, 0039, 0042, 0046

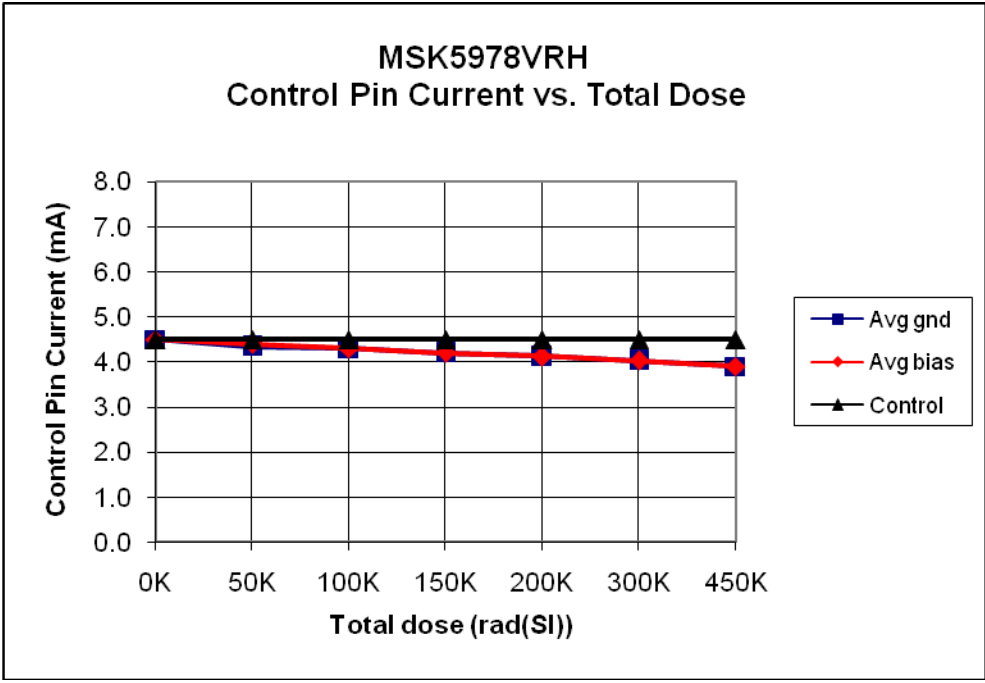
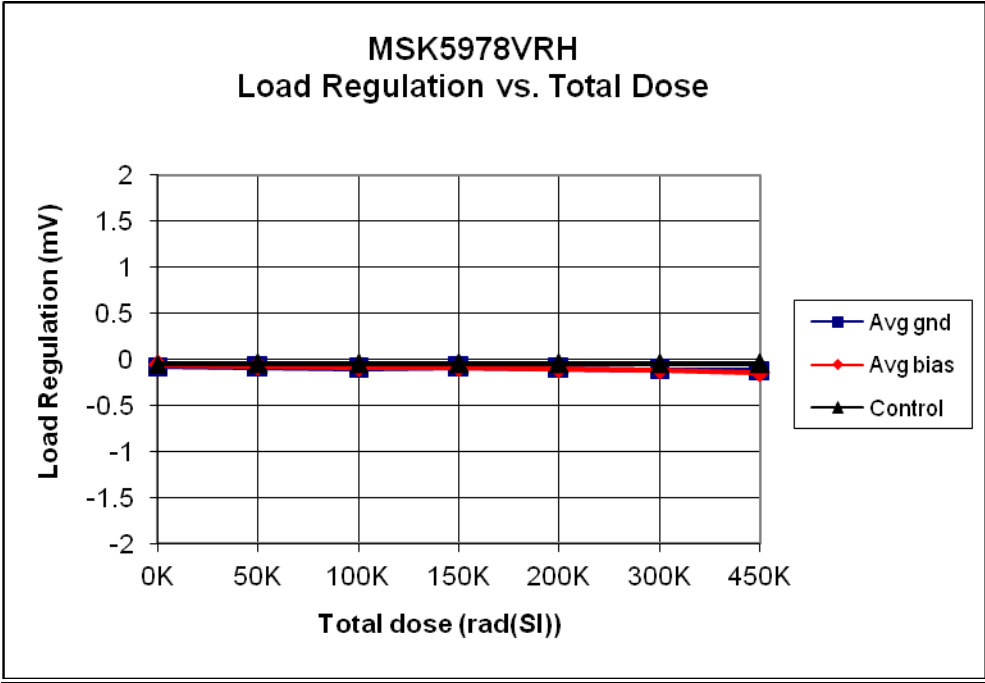
Unbiased S/N – 0049, 0053, 0055, 0059, 0060

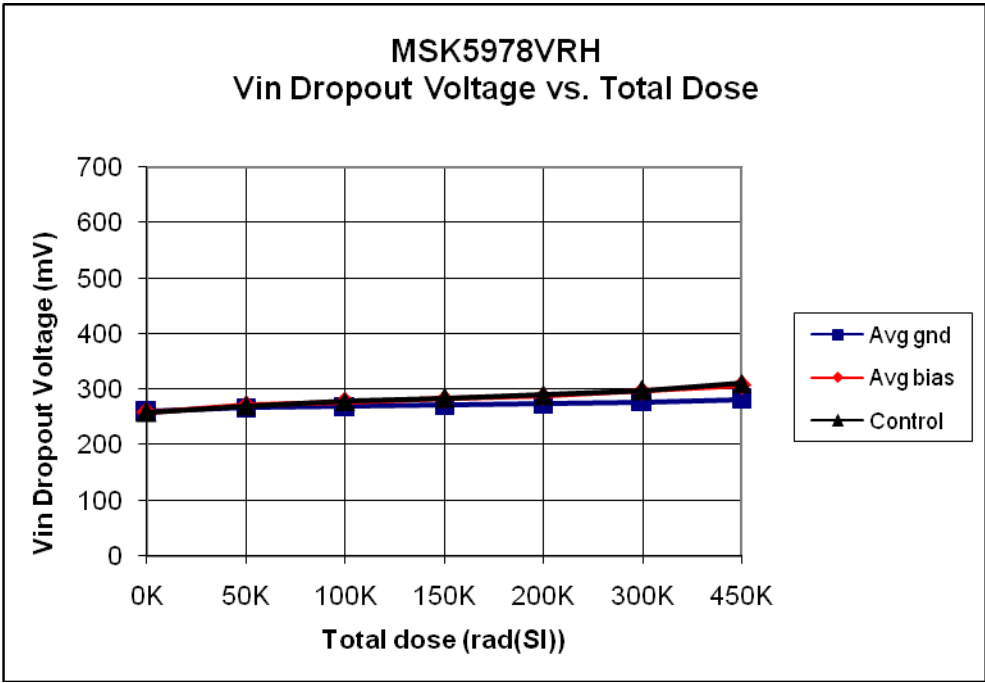
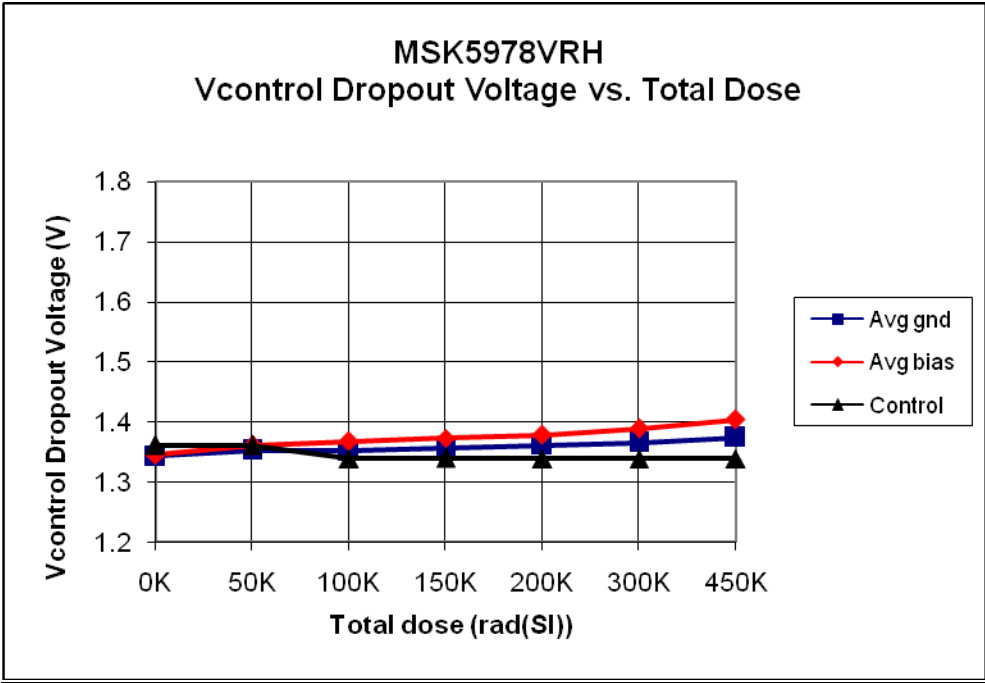
Table 1

**Dose Time, Incremental Dose and Total Cumulative Dose**











### MSK5978VRH Current Limit vs. Total Dose

