Total Dose Radiation Test Report

MSK5971KRH and MSK5971KRHL

RAD Hard Positive Voltage Regulator

May 14, 2009 (TID – First Test)
June 16, 2010 (Neutron Fluence)
Updated July 10, 2010
July 16, 2010 (TID – Second Test)

M. Bilecki
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I. Introduction:

The total dose radiation test plan for the MSK5971KRH series was developed to qualify the devices as RAD Hard to 100 KRADS(Si). The testing was performed beyond 100 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 MSK5971KRH and the MSK5971KRHL use the same active component. The data in this report is from direct measurement of the MSK5971KRH response to 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 MSK5971KRH series.

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 135 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 320 hours of burn-in per MIL-STD-883 Method 1015 and were fully screened IAW MIL-PRF-38534 Class K. 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. Maximum recommended operating voltage of +30 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 M.S. Kennedy Corporation.

V. Summary:

Reference voltage exhibited the most significant shifts due to irradiation. The reference voltage decreased with each successive dose. It is important to note however, that all devices maintained post irradiation output tolerance levels up to 150 Krad(Si).

Line and load regulation shifts were very small and stayed within pre-irradiation limits throughout testing.

Dropout voltage showed a slight increase, but also stayed within pre-irradiation limits up to 150 Krad(Si).

Current Limit decreased by approximately 2.5 percent at 100 Krad(Si). .

MSK5971KRH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

Irradiation Date
7/16/10

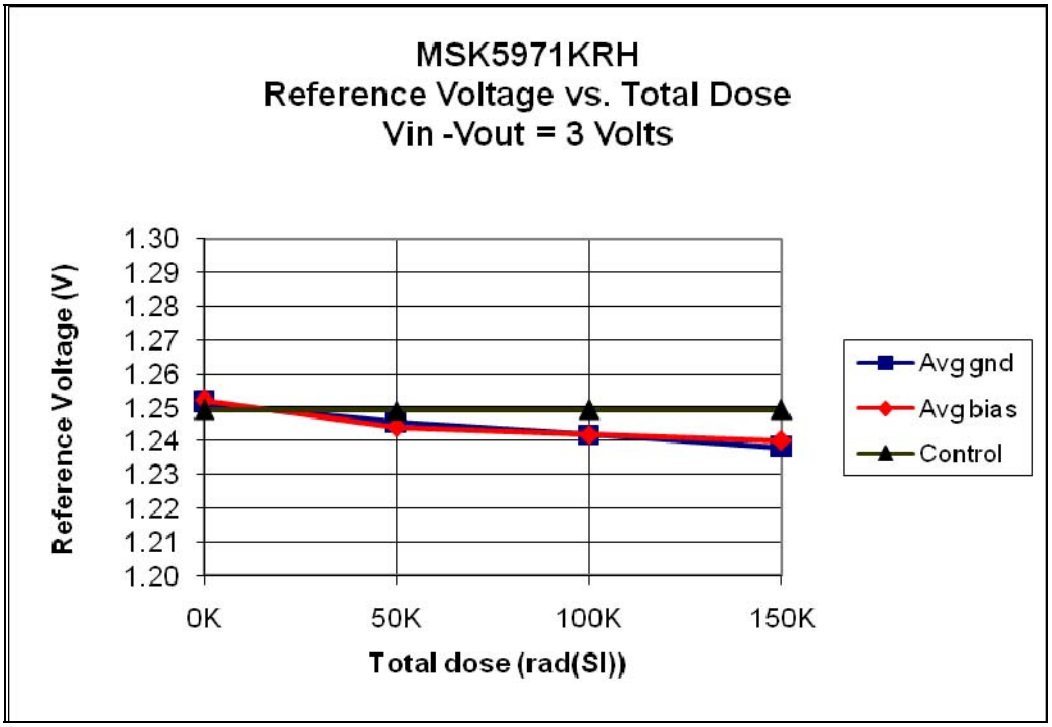
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
6:22	51,570	51,570
6:22	51,570	103,140
6:22	51,570	154,710

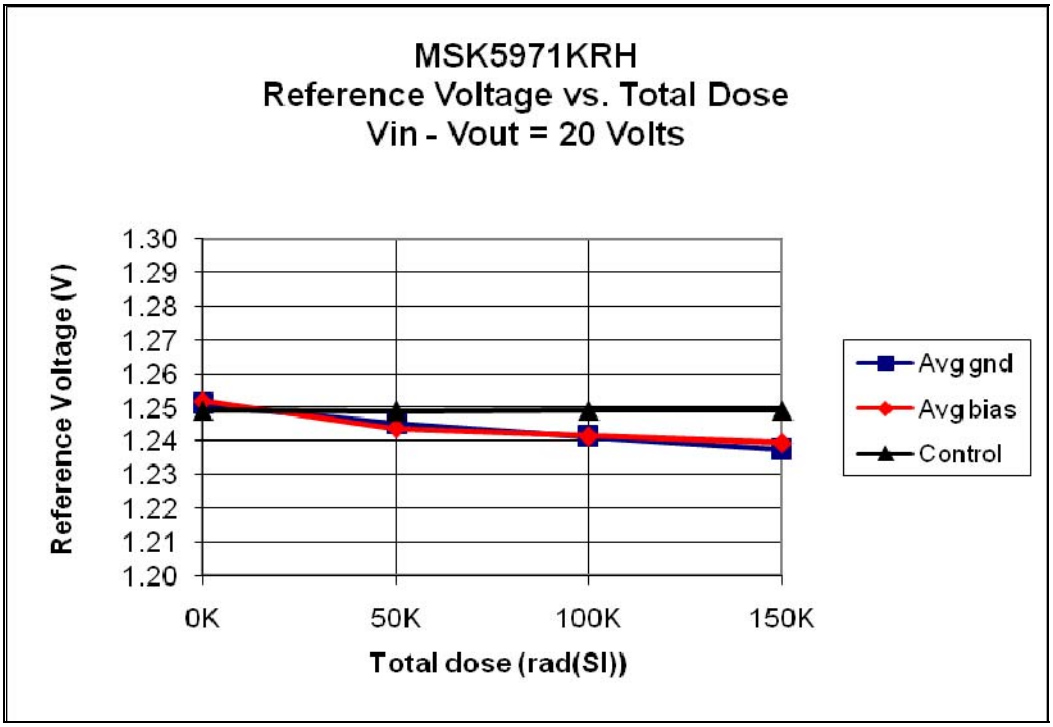
Biased S/N – 0209, 0210, 0211, 0212, 0213

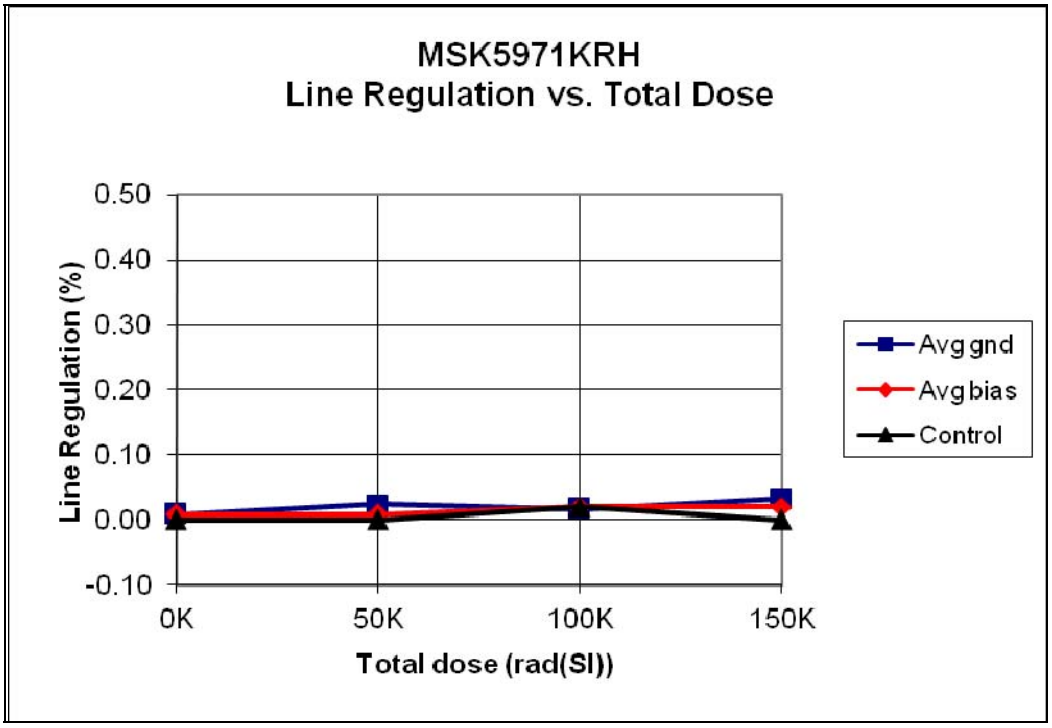
Unbiased S/N – 0214, 0215, 0216, 0217, 0218

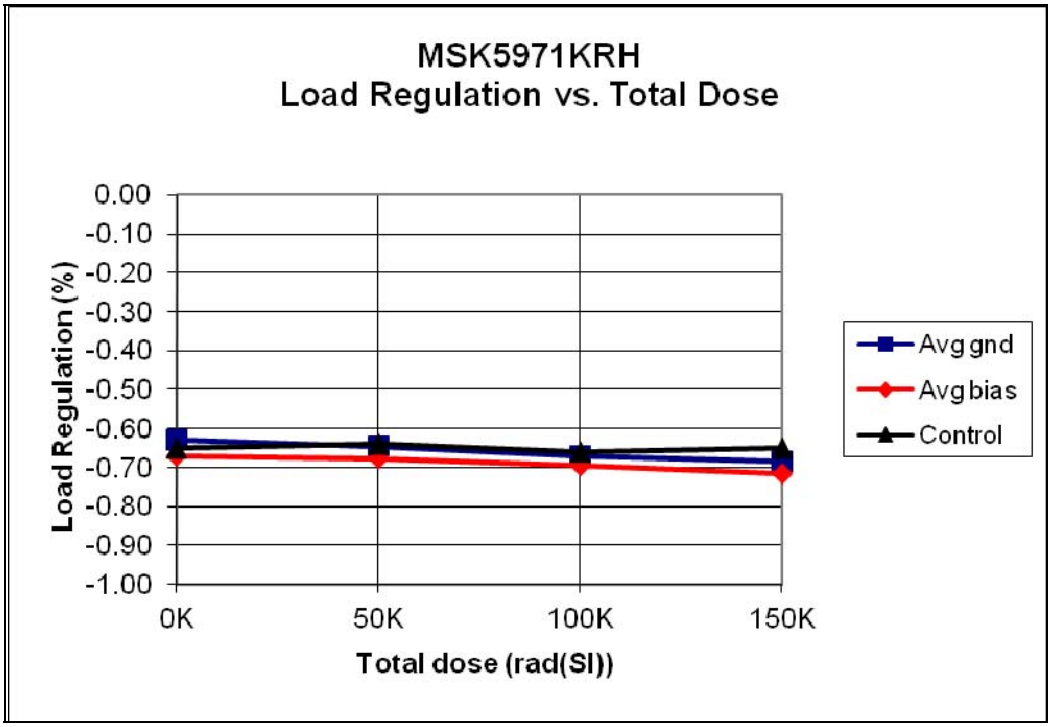
Table 1

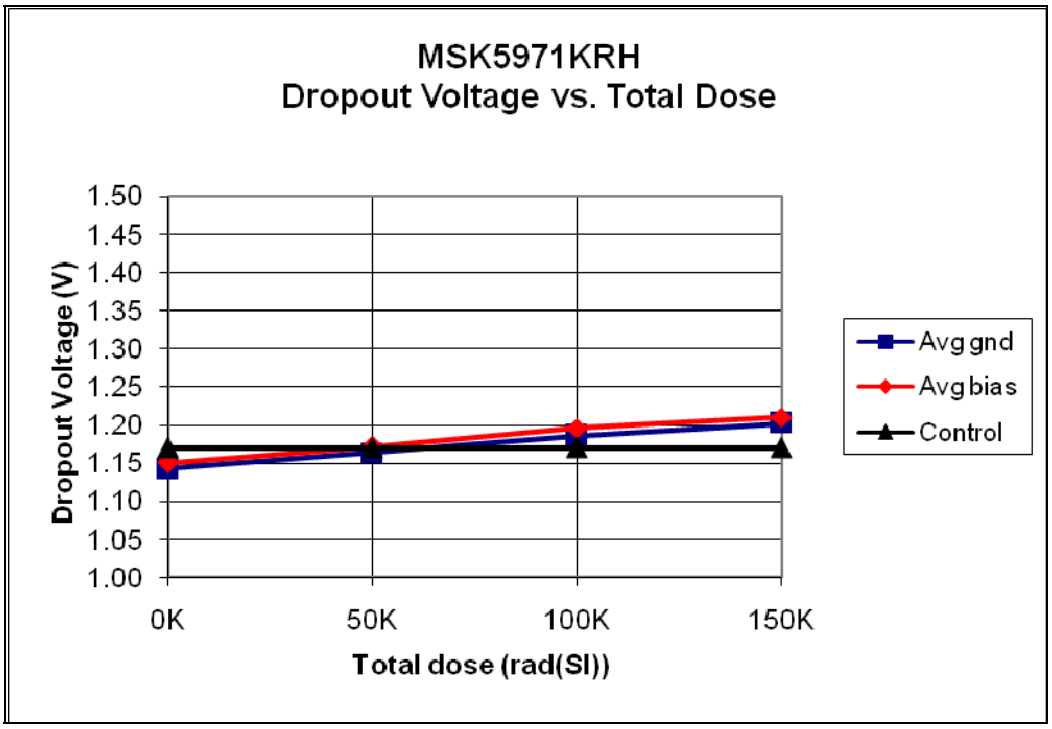
Dose Time, Incremental Dose and Total Cumulative Dose

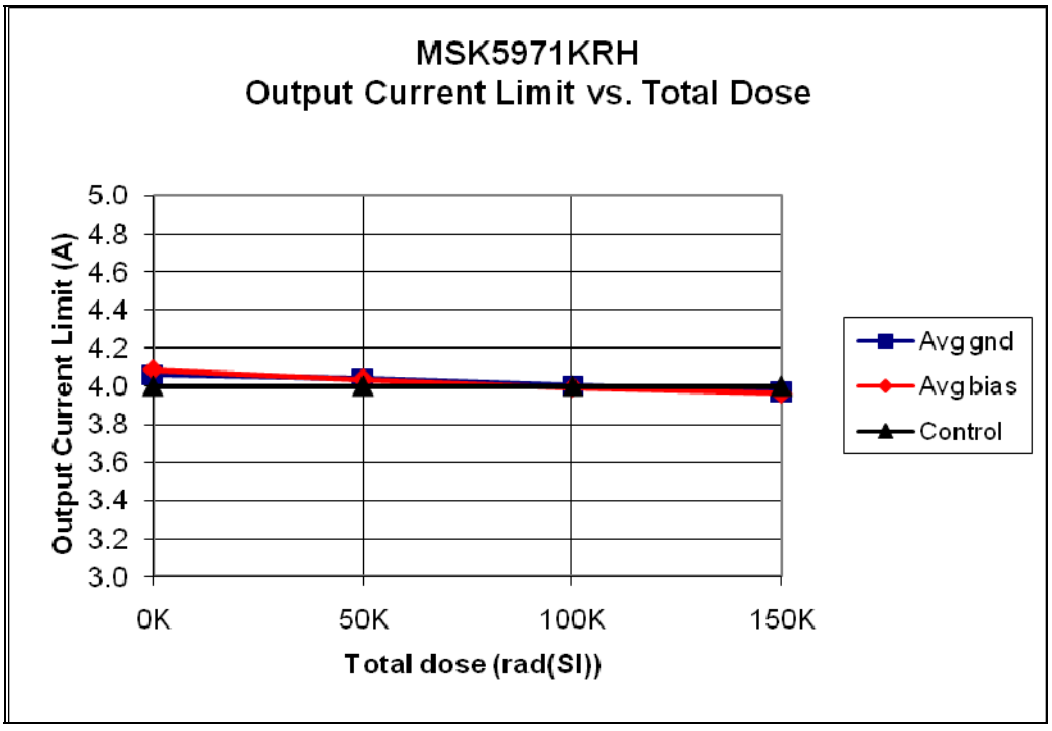

MSK5971KRH
Reference Voltage vs. Total Dose
Vin -Vout = 3 Volts
Reference Voltage (V)
1.30
1.29
1.28
1.27
1.26
1.25
1.24
1.23
1.22
1.21
1.20
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5971KRH
Reference Voltage vs. Total Dose
Vin - Vout = 20 Volts
Reference Voltage (V)
1.30
1.29
1.28
1.27
1.26
1.25
1.24
1.23
1.22
1.21
1.20
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5971KRH
Line Regulation vs. Total Dose
Line Regulation (%)
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5971KRH
Load Regulation vs. Total Dose
Load Regulation (%)
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5971KRH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5971KRH
Output Current Limit vs. Total Dose
Output Current Limit (A)
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

Neutron and TID Test Report

MSK 5971 RH and MSK 5971 RHL

RAD Hard Positive Voltage Regulator

May 14,2009 (TID – First Test)
June 16, 2010 (Neutron Fluence)

B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The neutron irradiation test for the MSK 5971RH series was performed to determine the change in device performance as a function of neutron fluence. The testing was performed to 6.65 x 10^{11} n/cm^2. 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 fluence level. The MSK 5971RH and the MSK5971 RHL use the same active component. The data in this report is from direct measurement of the MSK 5971RH response to neutron irradiation, but is indicative of the response of both device types.

MIL-STD-883 Method 1017.2 was used as a guideline in the development and implementation of the neutron irradiation test plan for the MSK 5971RH series.

II. Radiation Source:

Neutron irradiation was performed at the University of Massachusetts, Lowell, using the Reactor Facility-FNI. The neutron flux was determined by dosimetry system S/P-32, ASTM E-265 to be 1.01 x 10^8 n/cm^2-S, 1 MeV equivalent, for step 1 and step 2. The flux was increased to 1.01 x 10^9 1.02 n/cm^2-S for the third irradiation.

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 320 hours of burn-in per MIL-STD-883 Method 1015 and were fully screened IAW MIL-PRF-38534 Class K. 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.
During irradiation, devices leads were shorted together using antistatic foam and then devices were placed into an anti-static bag. Devices were vertically aligned with the radiation source.

After each irradiation, 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 the irradiated devices, as well as the control device, at each fluence level. Electrical tests were completed within two hours of irradiation.

IV. Data:

All performance curves are averaged from the test results of the irradiated devices. If required, full test data can be obtained by contacting M.S. Kennedy Corporation.

V. Summary:

Irradiated devices stayed within data sheet post radiation limits throughout testing.

Reference voltage exhibited an approximately 1.2 % percent decrease at a neutron fluence of 6.65 x 10^{11} n/cm^2.

Devices had a 0.1 % decrease in line regulation and a 0.15 % increase in load regulation.

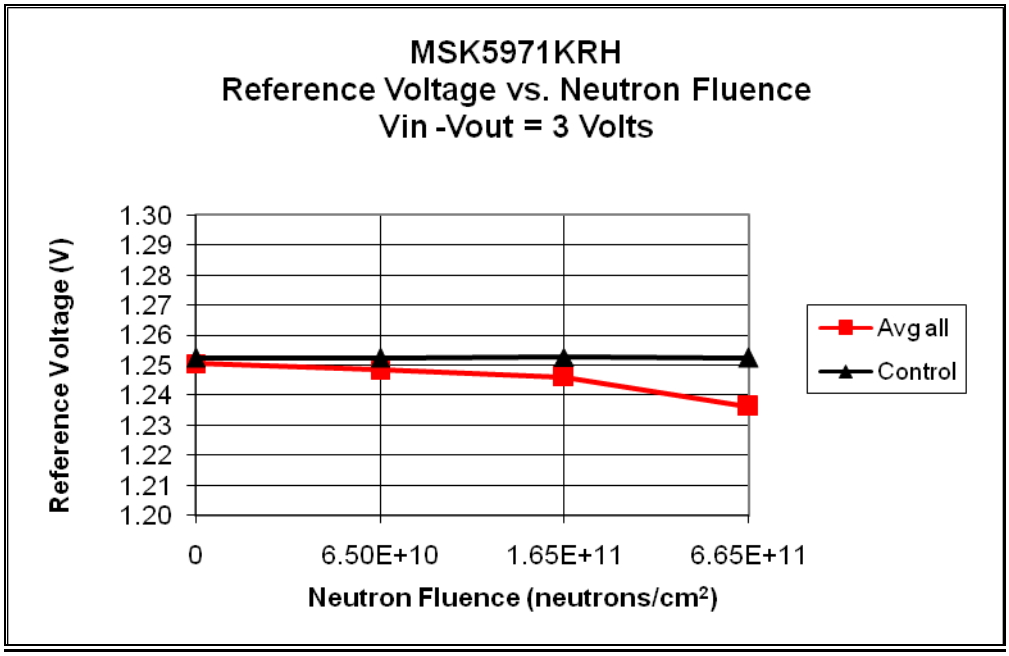
The changes seen in dropout voltage and current limit were less than 2.0 %.

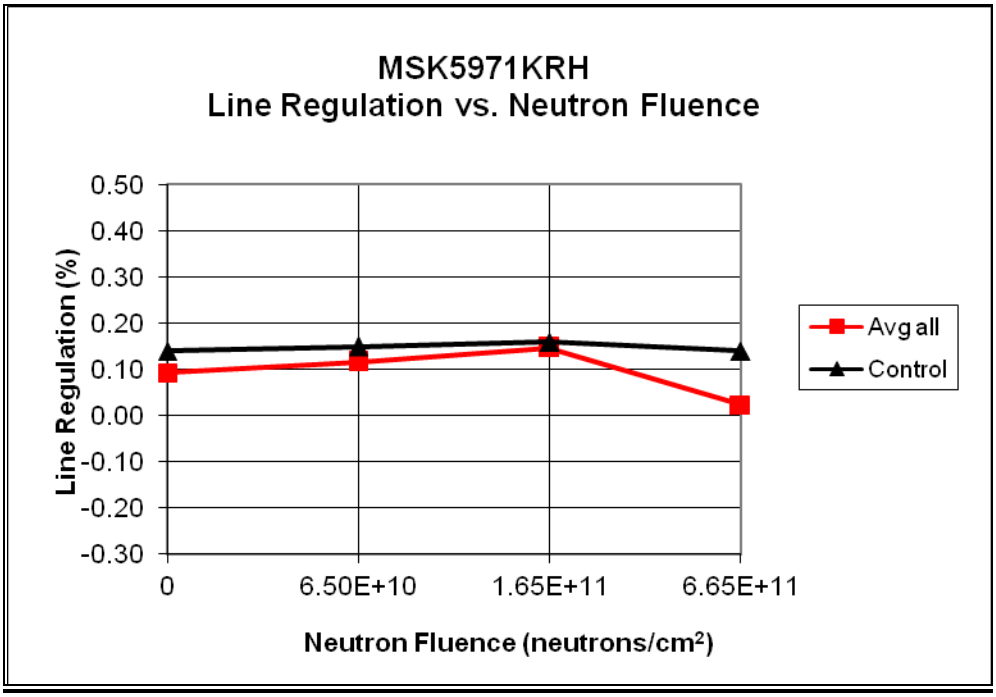
It should be noted that the 0 n/cm^2 current limit, control device data was inaccurate and therefore removed and replaced with an approximation value based on additional device testing.

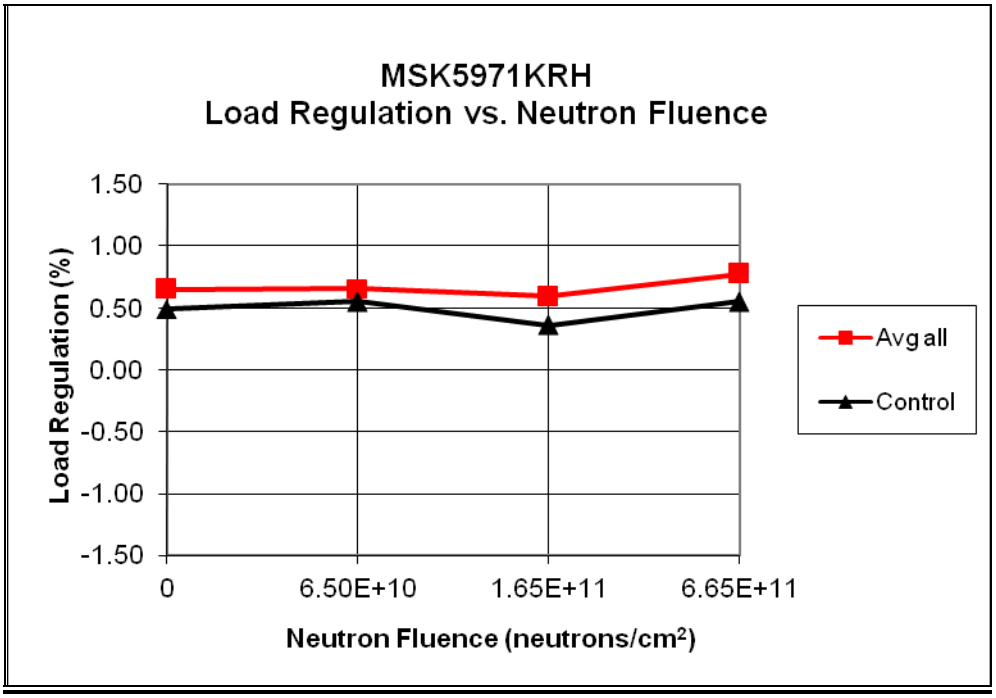
MSK5971RH Neutron Irradiation						
Reactor Facility – Fast Neutron Irradiation (FNI) Dosimetry System: S/P-32 (ASTM E-265)						
Exposure Date: 6/16/10						
Irradiation	Reactor Power (kW)	Gamma Dose Rad (Si)	Flux (n/cm^2-S)	Time(s)	Fluence (n/cm^2)	Total Fluence (n/cm^2)
Step 1	0.95	7	1.01×10^{8}	650	6.55×10^{10}	6.55×10^{10}
Step 2	0.95	11	1.01×10^{8}	995	1.00×10^{11}	1.66×10^{11}
Step 3	9.5	54	1.01×10^{9}	497	5.00×10^{11}	6.66×10^{11}

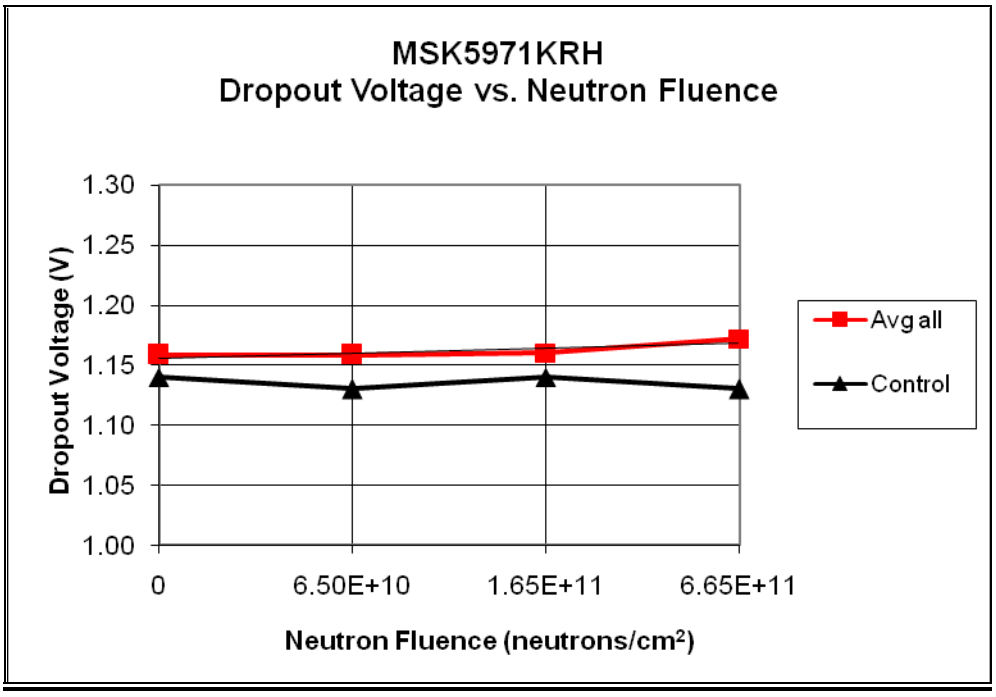
Table 1

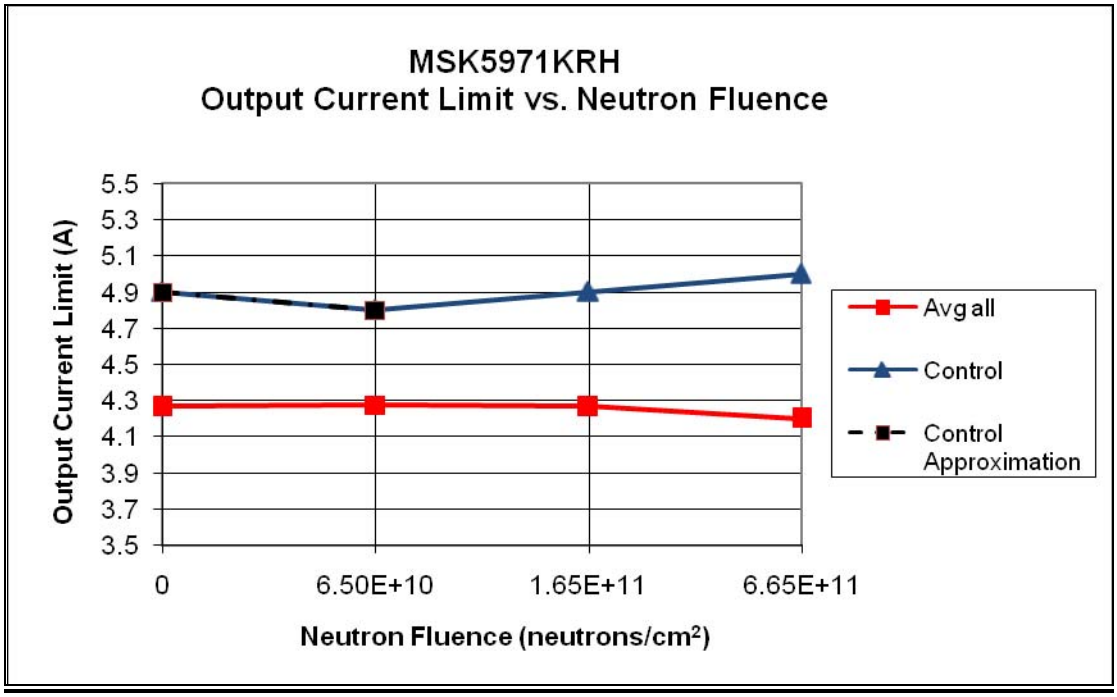
Gamma Dose, Neutron Flux and Total Fluence


MSK5971KRH
Reference Voltage vs. Neutron Fluence
Vin -Vout = 3 Volts
Reference Voltage (V)
1.30
1.29
1.28
1.27
1.26
1.25
1.24
1.23
1.22
1.21
1.20
0
6.50E+10
1.65E+11
6.65E+11
Neutron Fluence (neutrons/cm²)
Avg all
Control


MSK5971KRH
Line Regulation vs. Neutron Fluence
Line Regulation (%)
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
0
6.50E+10
1.65E+11
6.65E+11
Neutron Fluence (neutrons/cm²)
Avg all
Control


MSK5971KRH
Load Regulation vs. Neutron Fluence
Load Regulation (%)
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
0
6.50E+10
1.65E+11
6.65E+11
Neutron Fluence (neutrons/cm²)
Avg all
Control


MSK5971KRH
Dropout Voltage vs. Neutron Fluence
Dropout Voltage (V)
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0
6.50E+10
1.65E+11
6.65E+11
Neutron Fluence (neutrons/cm²)
Avg all
Control


MSK5971KRH
Output Current Limit vs. Neutron Fluence
Output Current Limit (A)
5.5
5.3
5.1
4.9
4.7
4.5
4.3
4.1
3.9
3.7
3.5
0
6.50E+10
1.65E+11
6.65E+11
Neutron Fluence (neutrons/cm²)
Avg all
Control
Control Approximation

Total Dose Radiation Test Report

MSK5971KRH and MSK5971KRHL

RAD Hard Positive Voltage Regulator

May 14, 2009
Updated July 10, 2010

M. Bilecki
B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK5971KRH series was developed to qualify the devices as RAD Hard to 100 KRADS(Si). The testing was performed beyond 100 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 MSK5971KRH and the MSK5971KRHL use the same active component. The data in this report is from direct measurement of the MSK5971KRH response to 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 MSK5971KRH series.

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 176 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 320 hours of burn-in per MIL-STD-883 Method 1015 and were fully screened IAW MIL-PRF-38534 Class K. 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 MSK5971KRH and the MSK5971KRHL use the same active component

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. Maximum recommended operating voltage of +30 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 M.S. Kennedy Corporation.

V. Summary:

Reference voltage exhibited the most significant shifts due to irradiation. The reference voltage decreased with each successive dose. It is important to note however, that all devices maintained post irradiation output tolerance levels up to 300 Krad(Si).

Line and load regulation shifts were very small and stayed within pre-irradiation limits throughout testing.

Dropout voltage showed a slight increase, but also stayed within pre-irradiation limits up to 300 Krad(Si).

Current Limit decreased by approximately 2.5 percent at 100 Krad(Si). Decrease in current limit was linear to 5 percent at 300 Krad(Si).

MSK5971KRH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

Irradiation Date
5/14/09

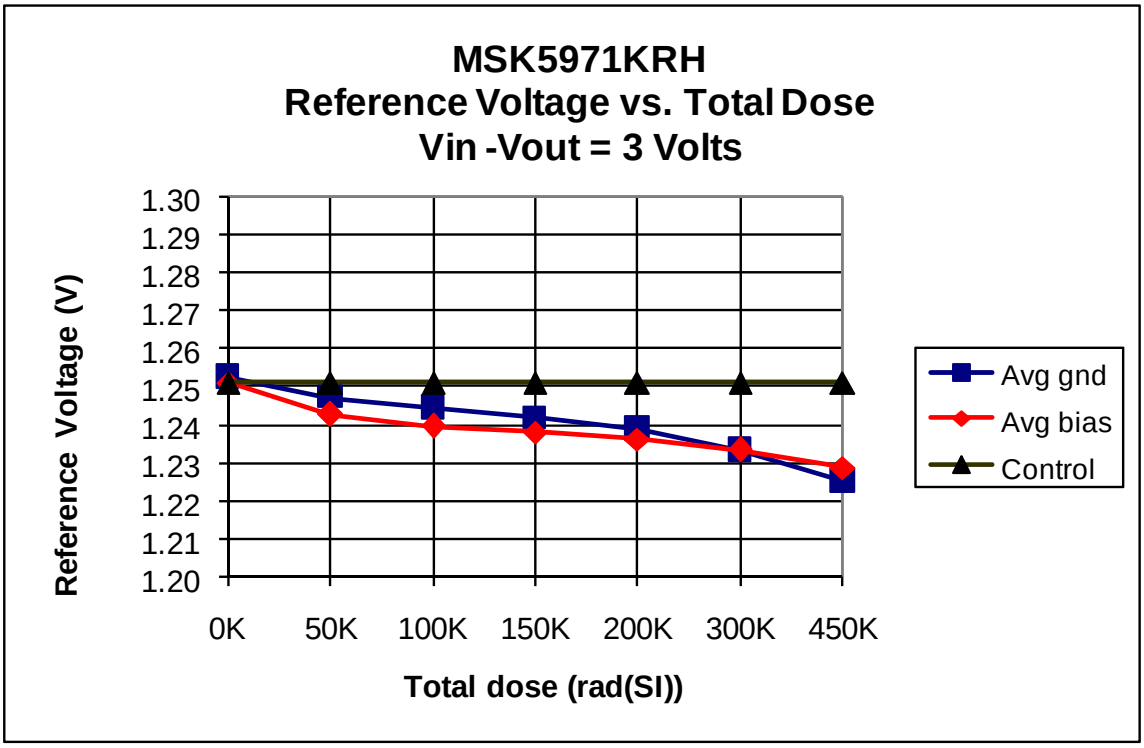
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
4:53	51,568	51,568
4:53	51,568	103,136
4:53	51,568	154,704
4:53	51,568	206,272
9:46	103,136	309,408
14:39	154,704	464,112

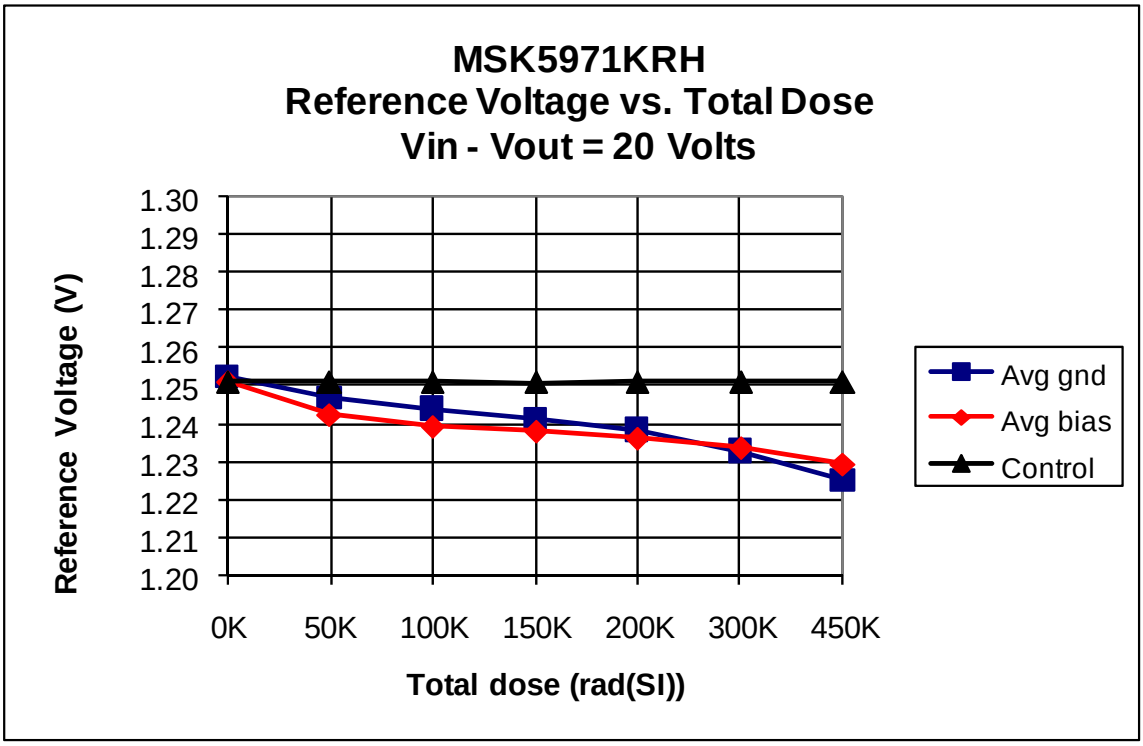
Biased S/N – 0026, 0027, 0028, 0030, 0031

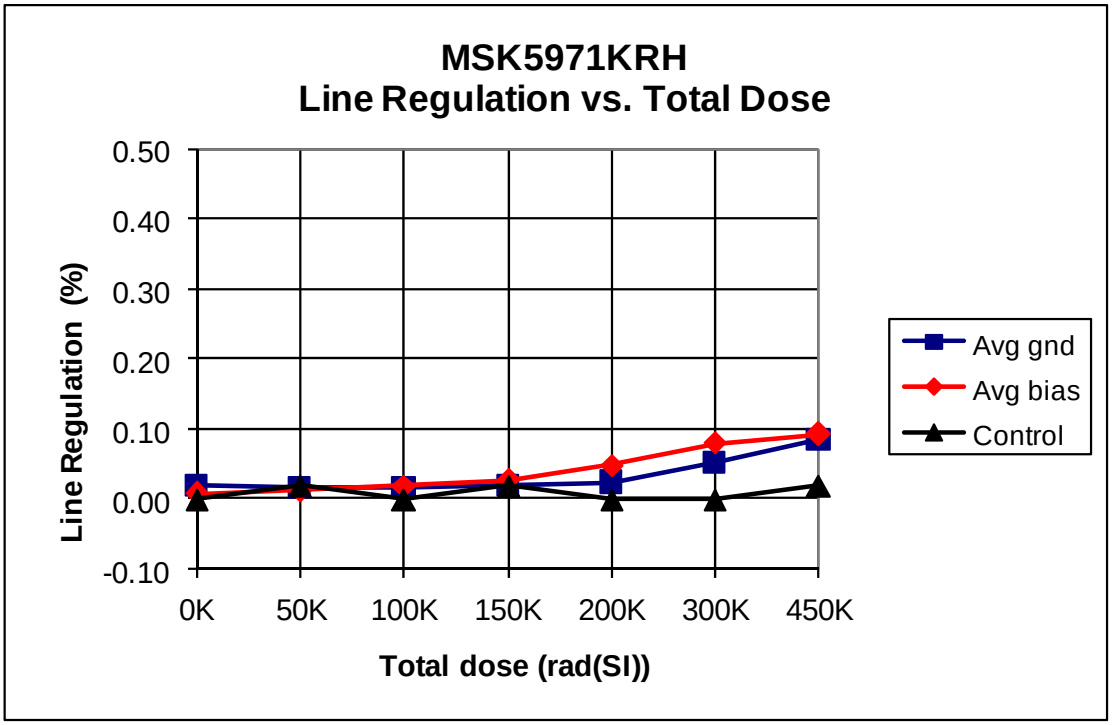
Unbiased S/N – 0032, 0033, 0034, 0039, 0042

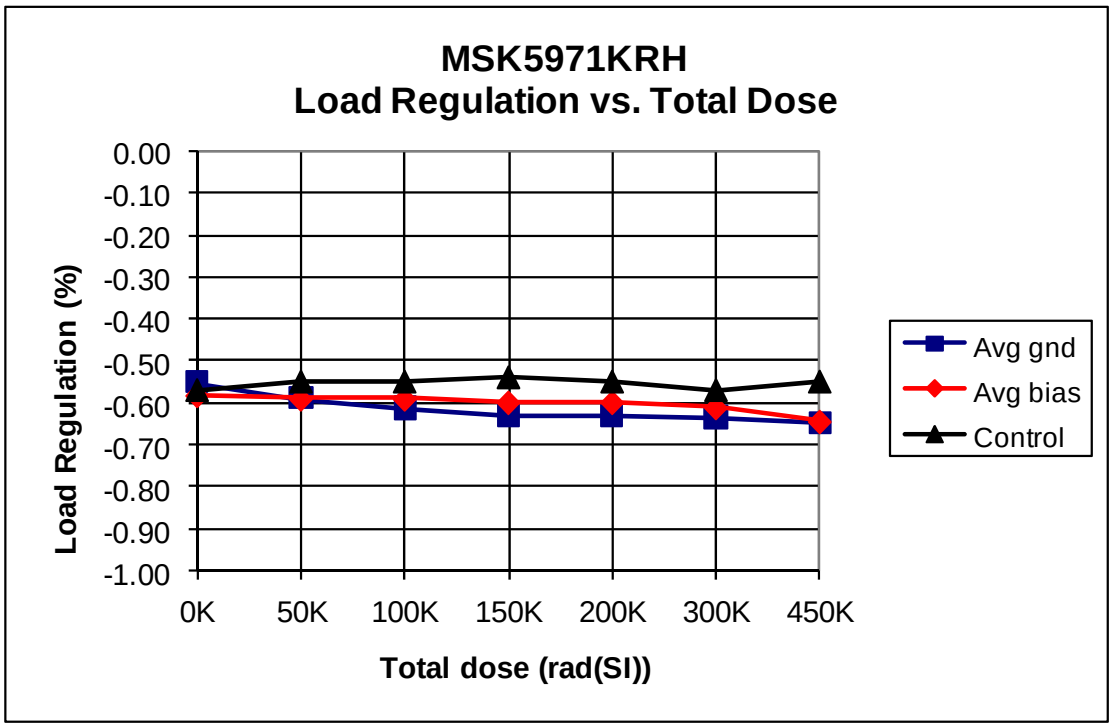
Table 1

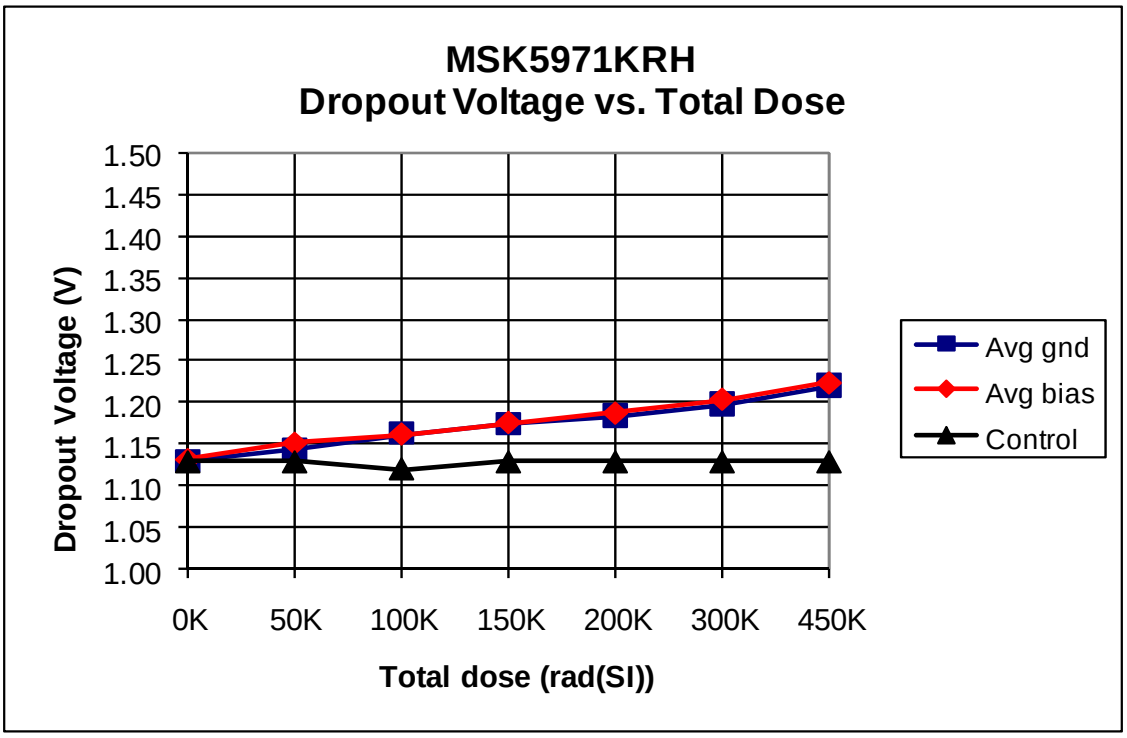
Dose Time, Incremental Dose and Total Cumulative Dose

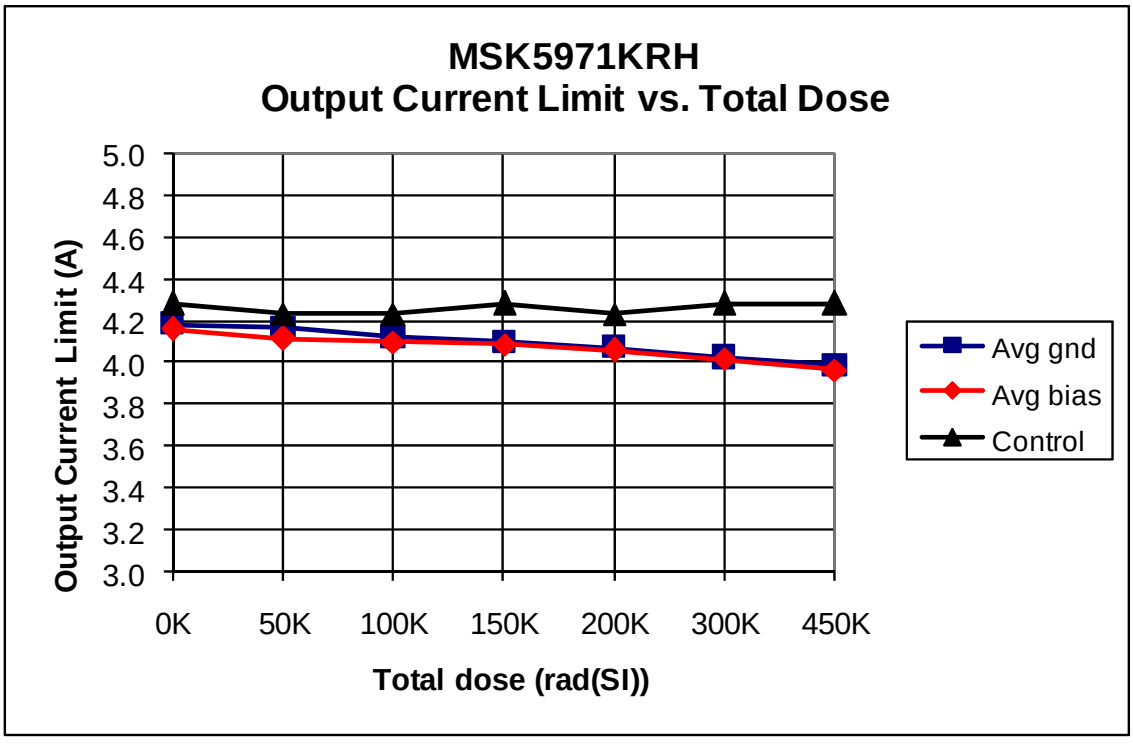

MSK5971KRH
Reference Voltage vs. Total Dose
Vin -Vout = 3 Volts
Reference Voltage (V)
1.30
1.29
1.28
1.27
1.26
1.25
1.24
1.23
1.22
1.21
1.20
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5971KRH
Reference Voltage vs. Total Dose
Vin - Vout = 20 Volts
Reference Voltage (V)
1.30
1.29
1.28
1.27
1.26
1.25
1.24
1.23
1.22
1.21
1.20
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5971KRH
Line Regulation vs. Total Dose
Line Regulation (%)
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5971KRH
Load Regulation vs. Total Dose
Load Regulation (%)
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5971KRH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5971KRH
Output Current Limit vs. Total Dose
Output Current Limit (A)
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control