Neutron, TID and ELDRS Radiation Test Report

MSK 5826RH
(MSK5823RH, MSK5824RH, MSK5825RH)

Radiation Hardened
Ultra Low Dropout
Positive Adjustable Linear Regulator

December 26, 2008 (TID - First Test)
June 18, 2009 (ELDRS Test)
September 03, 2009 (TID - Second Test)
November 06, 2009 (TID - Third Test)
May 14, 2010 (TID – Fourth Test)
August 24, 2010 (Neutron Fluence)
September 17, 2010 (TID – Fifth Test)
July 8, 2011 (TID – Sixth Test)
August 16, 2013 (TID – Seventh Test, IC Wafer Lot: WD0051441#9
Transistor Wafer Lot: CJ302831#21)

B. Horton
C. Salce

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5826RH series 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 MSK5823RH, MSK5824RH, MSK5825RH and MSK5826RH all use the same active components. The data in this report is from the direct measurement of the MSK5826RH response to irradiation but it is indicative of the response of all four device types and is applicable to all four 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 5826RH.

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 91Rads(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 at 25°C in accordance with the device data sheet. In addition, all devices received 320 hours of burn-in per MIL-STD-883 Method 1015. 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 +6.5V 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 transported to the MSK automatic electrical test platform and tested IAW 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:

Based on the test data recorded during radiation testing and statistical analysis, the MSK5826RH qualified as a 300 Krad(Si) radiation hardened device. Load Regulation, Shutdown Threshold and Output Current Limit exhibited the most significant shift due to irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5826RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0162

Irradiation Date
8/16/13

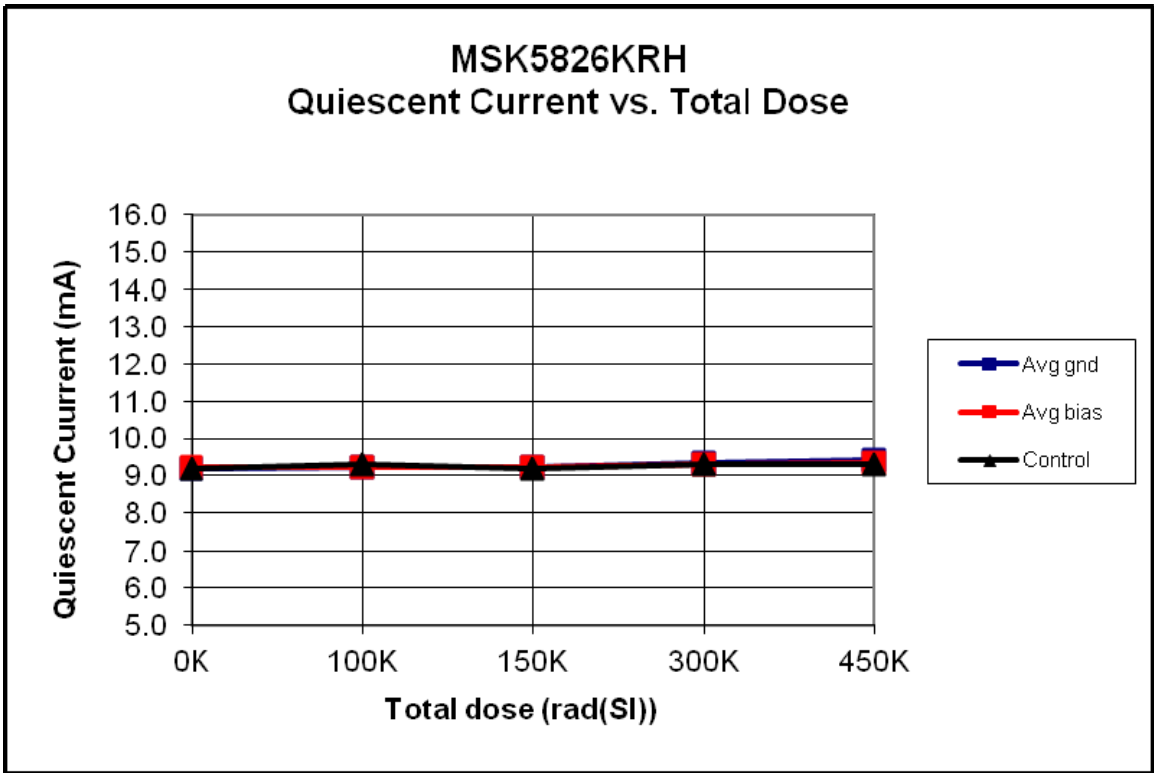
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
18:52	103,012	103,012
9:26	51,506	154,518
28:18	154,518	309,036
28:18	154,518	463,554

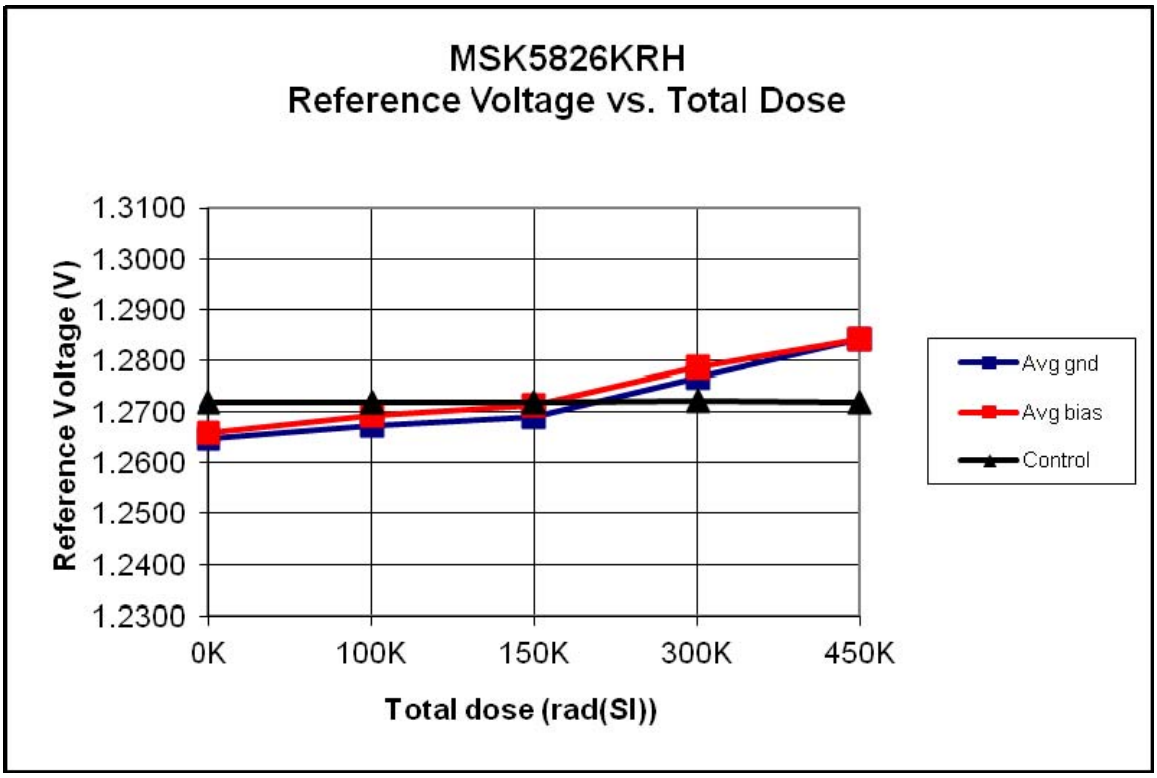
Biased S/N – 1551, 1552, 1553, 1554, 155

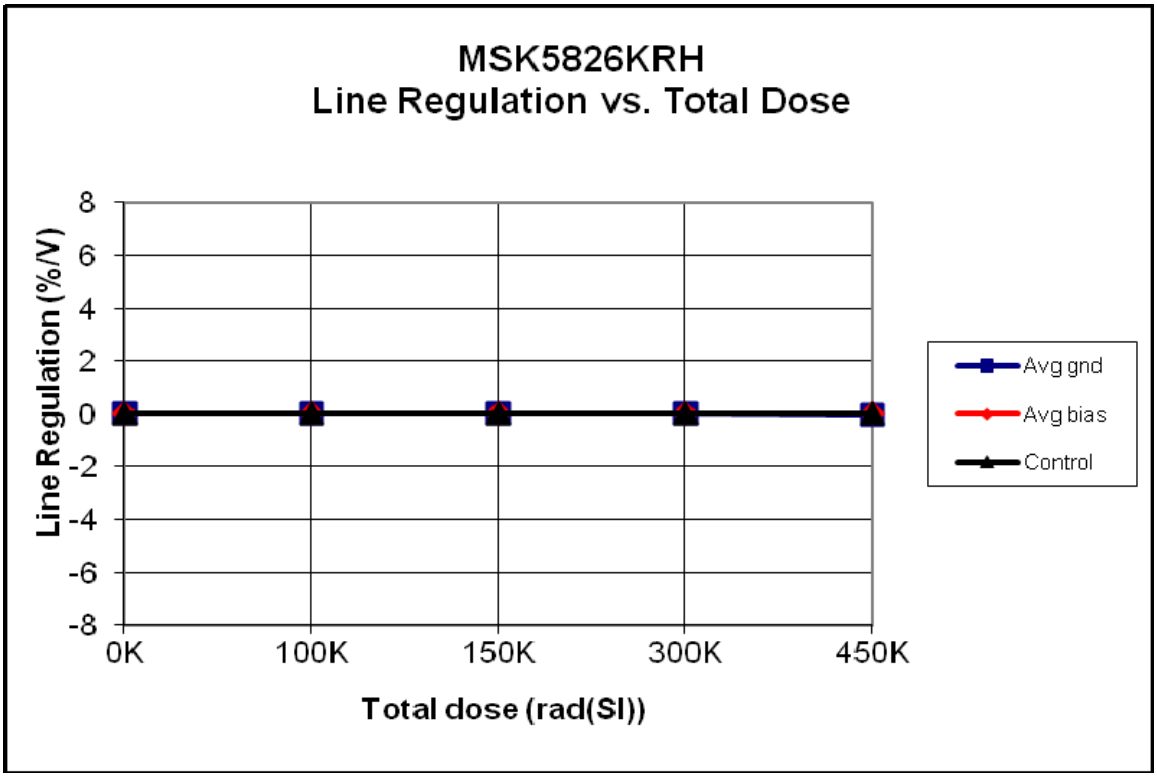
Unbiased S/N – 1556, 1557, 1558, 1559, 1560

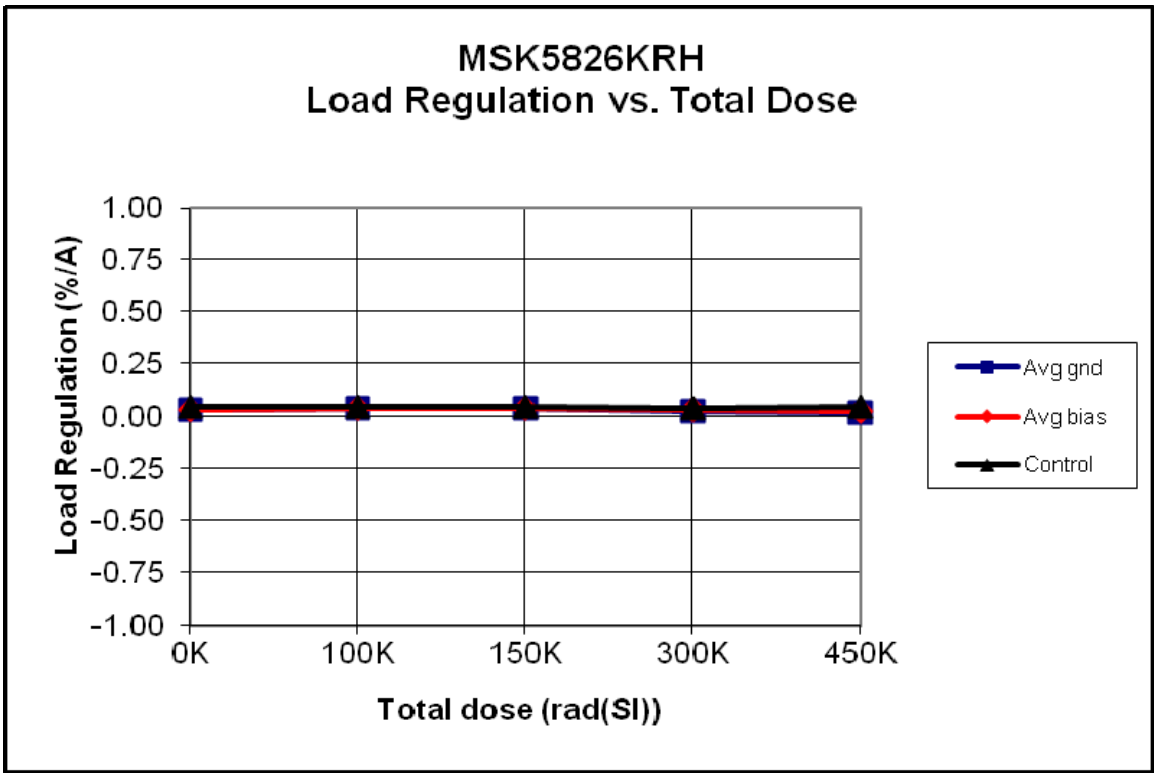
Table 1

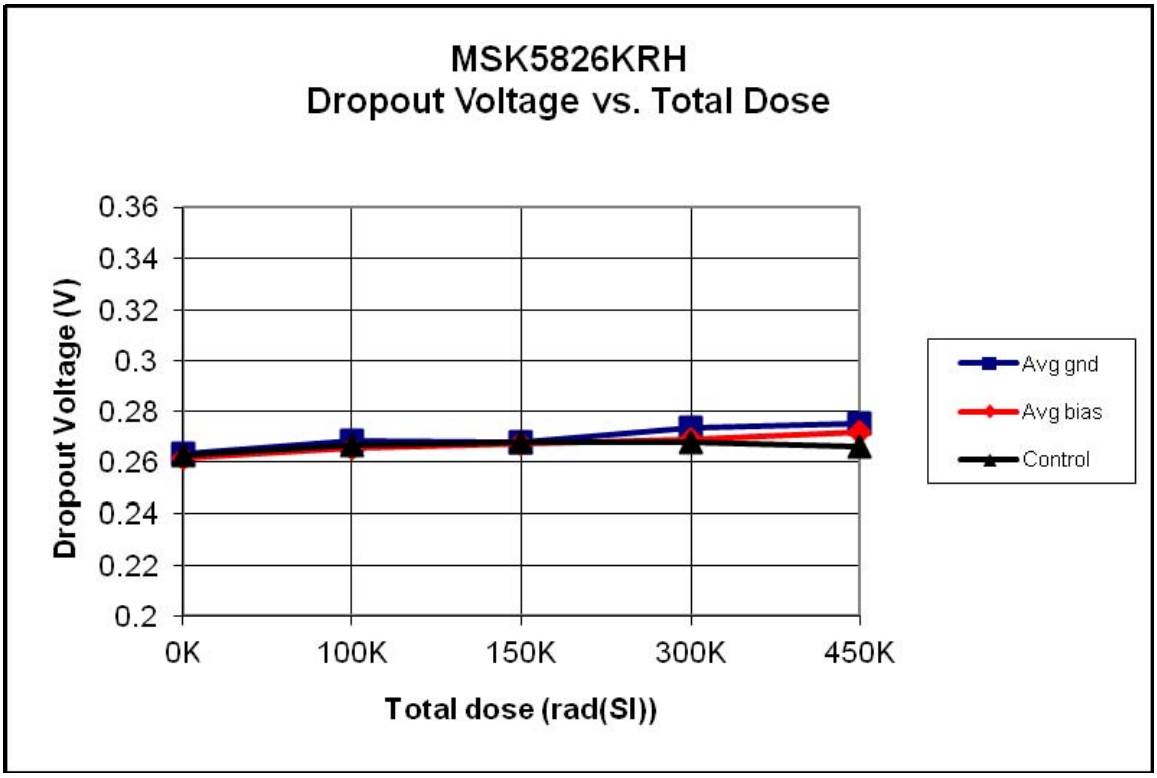
Dose Time, Incremental Dose and Total Cumulative Dose

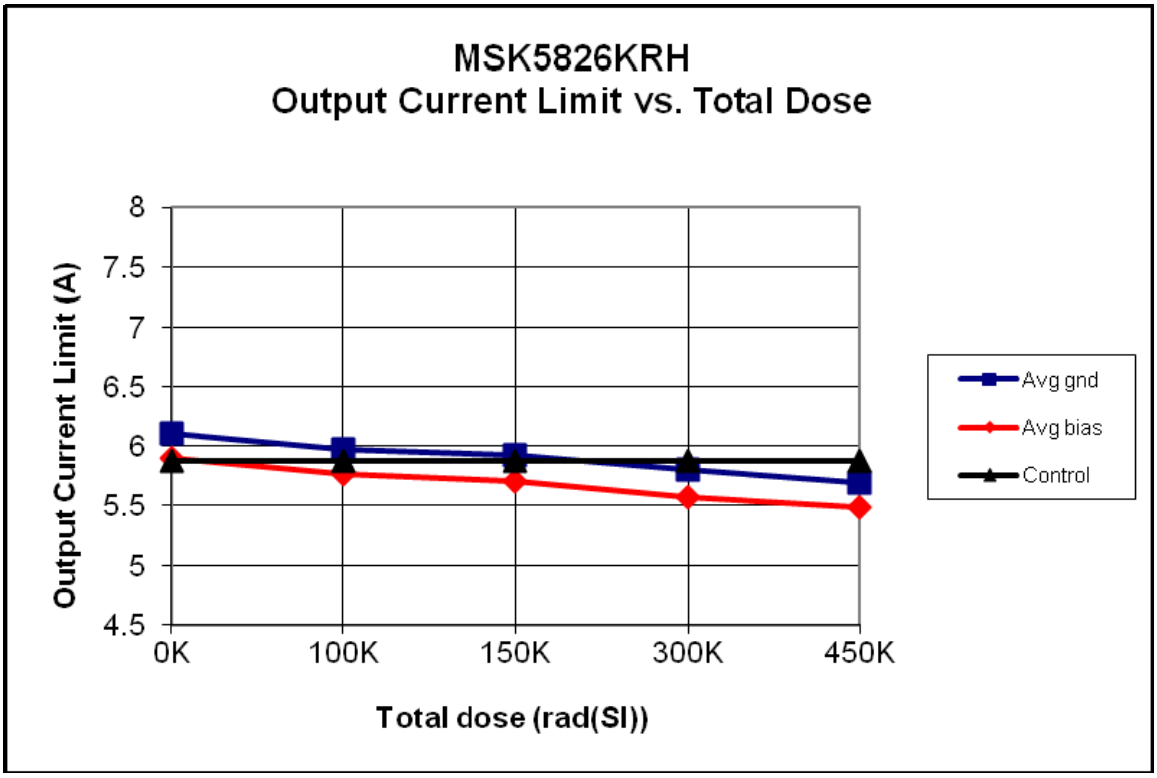

MSK5826KRH
Quiescent Current vs. Total Dose
Quiescent Cuurrent (mA)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

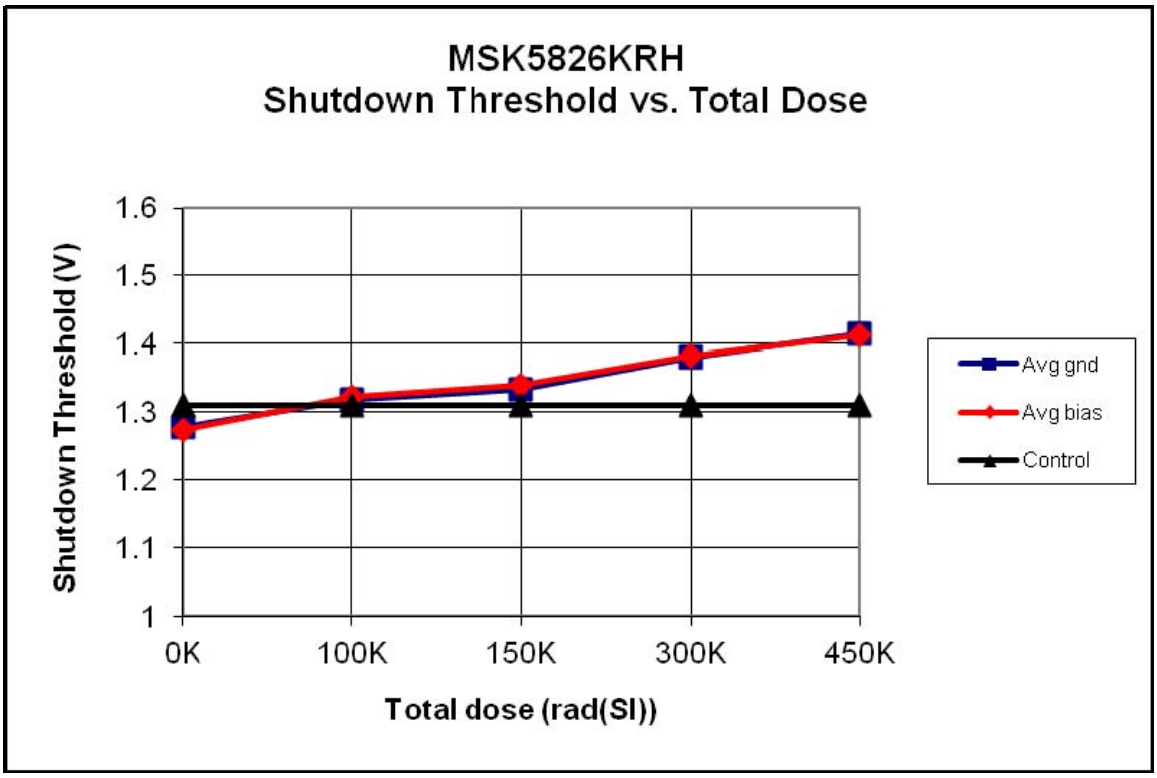

MSK5826KRH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.3100
1.3000
1.2900
1.2800
1.2700
1.2600
1.2500
1.2400
1.2300
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

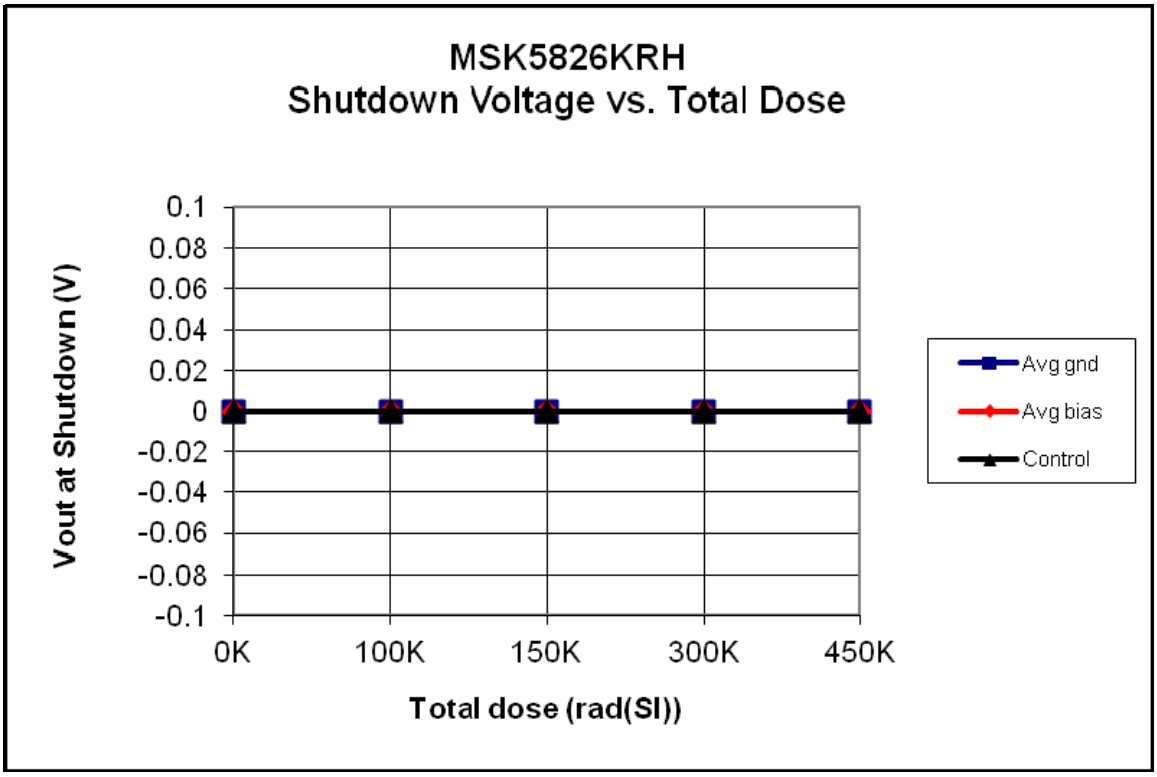

MSK5826KRH
Line Regulation vs. Total Dose
Line Regulation (%/V)
8
6
4
2
0
-2
-4
-6
-8
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Load Regulation vs. Total Dose
Load Regulation (%/A)
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Output Current Limit vs. Total Dose
Output Current Limit (A)
8
7.5
7
6.5
6
5.5
5
4.5
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.6
1.5
1.4
1.3
1.2
1.1
1
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Shutdown Voltage vs. Total Dose
Vout at Shutdown (V)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

Neutron, TID and ELDRS Radiation Test Report

MSK 5826RH
(MSK5823RH, MSK5824RH, MSK5825RH)

Radiation Hardened
Ultra Low Dropout
Positive Adjustable Linear Regulator

December 26, 2008 (TID - First Test)
June 18, 2009 (ELDRS Test)
September 03, 2009 (TID - Second Test)
November 06, 2009 (TID - Third Test)
May 14, 2010 (TID – Fourth Test)
August 24, 2010 (Neutron Fluence)
September 17, 2010 (TID – Fifth Test)
July 8, 2011 (TID – Sixth Test)

B. Horton
C. Salce

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5826RH series 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 MSK5823RH, MSK5824RH, MSK5825RH and MSK5826RH all use the same active components. The data in this report is from the direct measurement of the MSK5826RH response to irradiation but it is indicative of the response of all four device types and is applicable to all four 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 5826RH.

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 122 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 at 25°C in accordance with the device data sheet. In addition, all devices received 320 hours of burn-in per MIL-STD-883 Method 1015. 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 +6.5V 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 transported to the MSK automatic electrical test platform and tested IAW 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:

Based on the test data recorded during radiation testing and statistical analysis, the MSK5826RH qualified as a 300 Krad(Si) radiation hardened device. Load Regulation, Shutdown Threshold and Output Current Limit exhibited the most significant shift due to irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5826RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0162

Irradiation Date
7/8/11

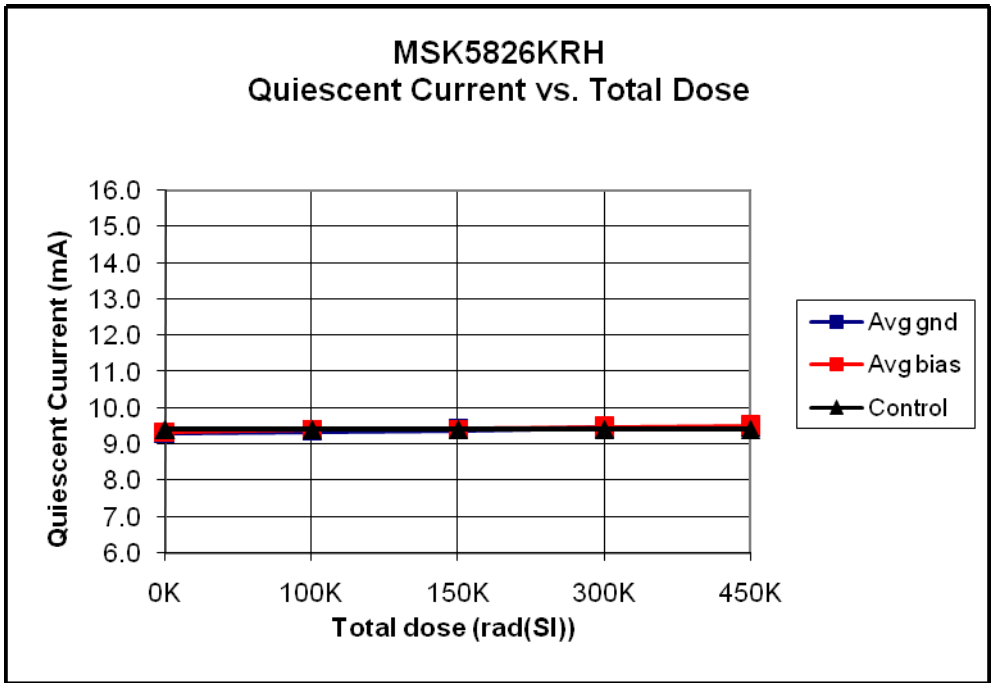
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
14:05	103,090	103,090
7:02	51,484	154,574
21:06	154,452	309,012
21:06	154,452	463,478

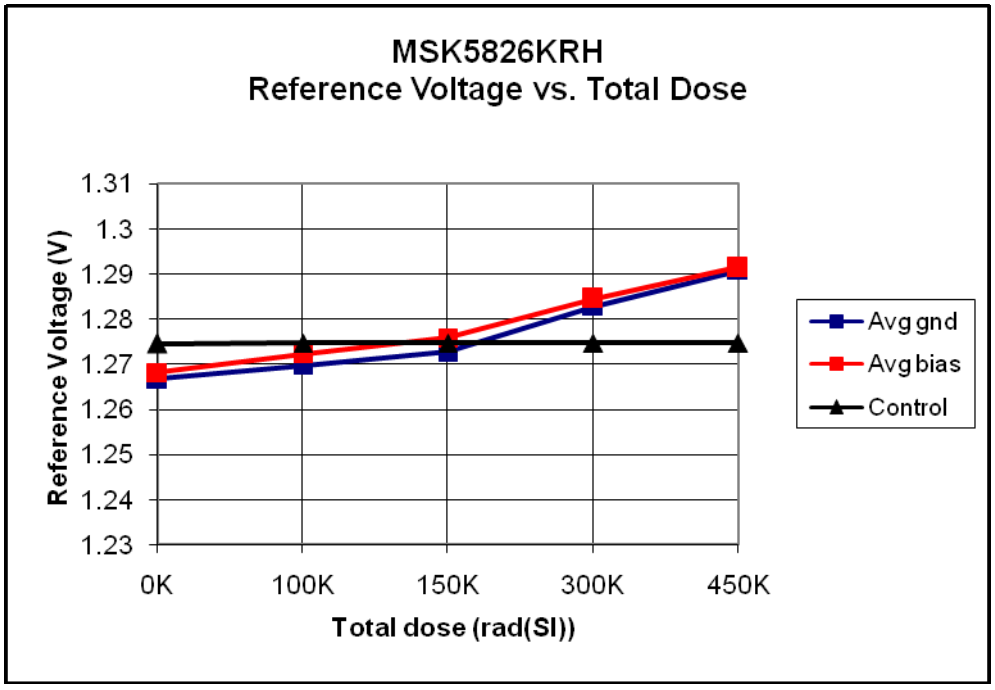
Biased S/N – 1077, 1079, 1080,1081,1082

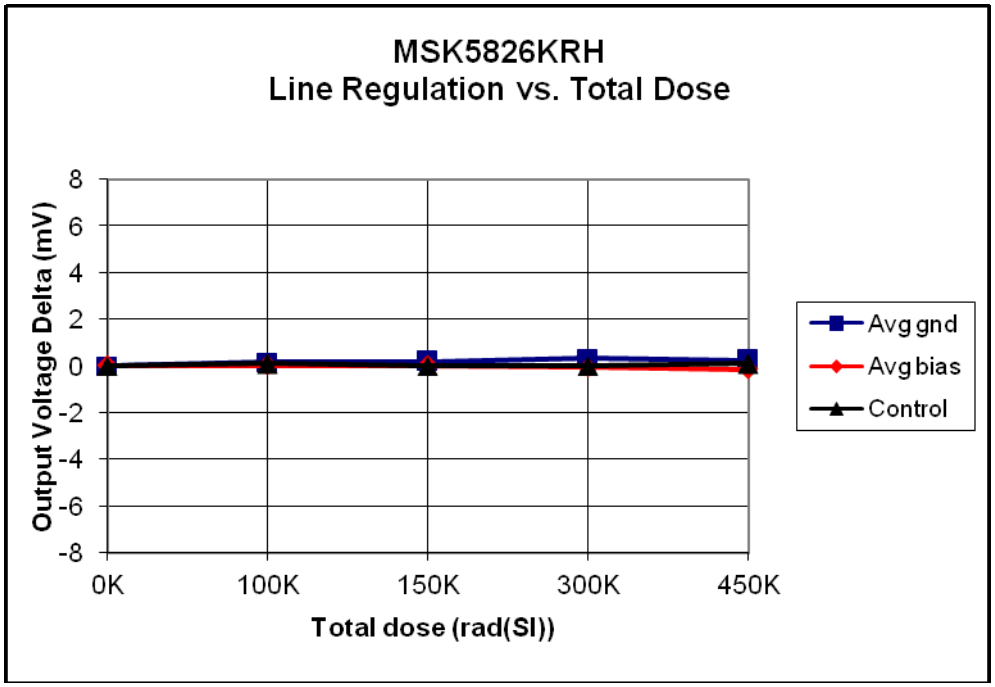
Unbiased S/N – 1083, 1084, 1085, 1086, 1088

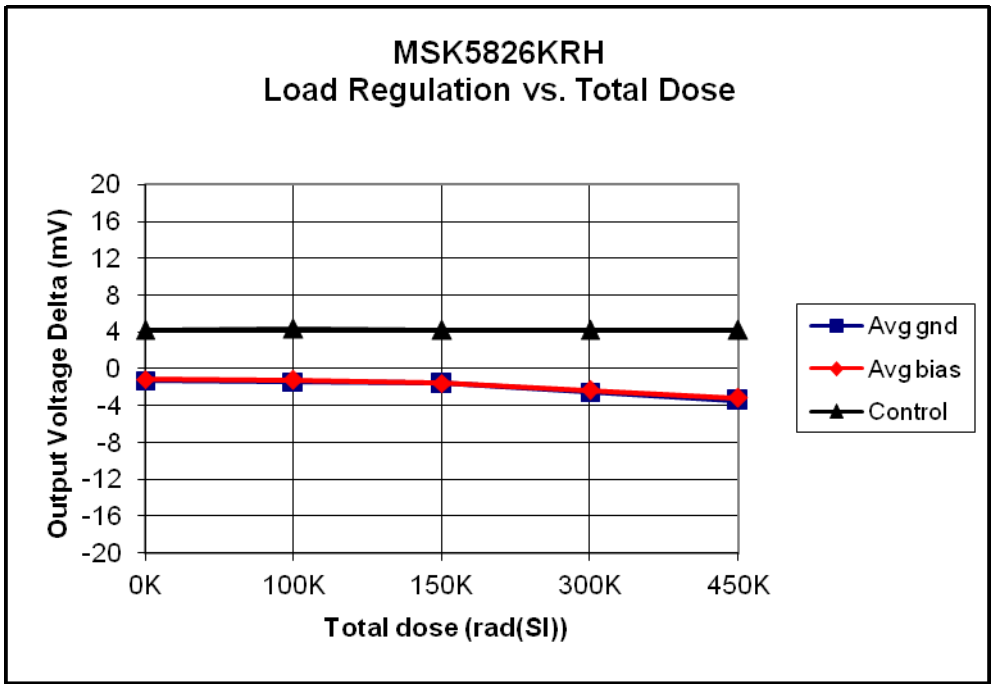
Table 1

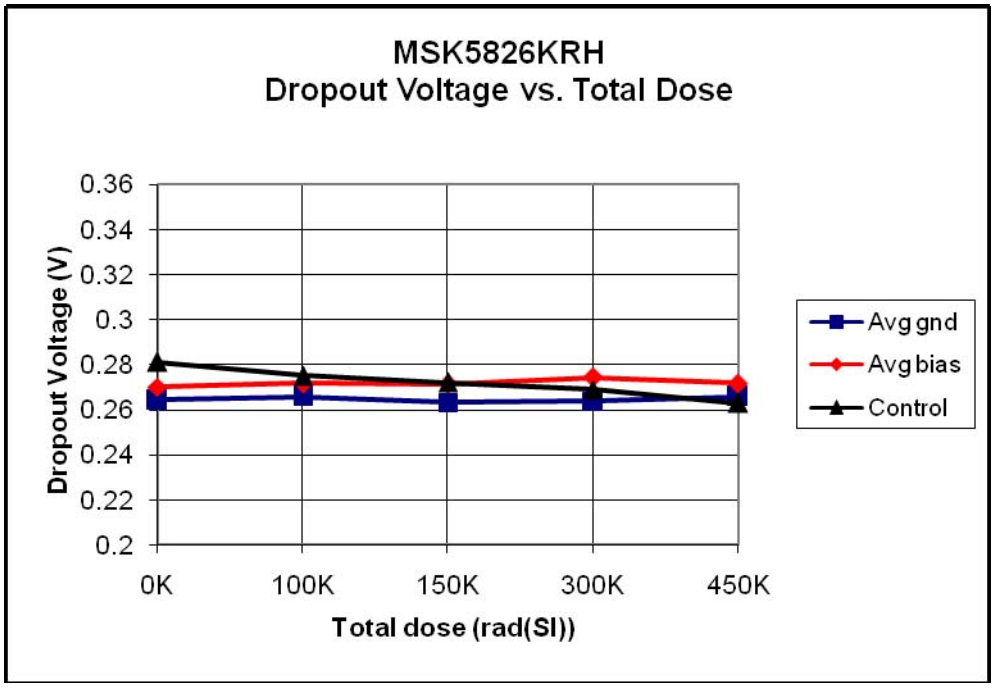
Dose Time, Incremental Dose and Total Cumulative Dose

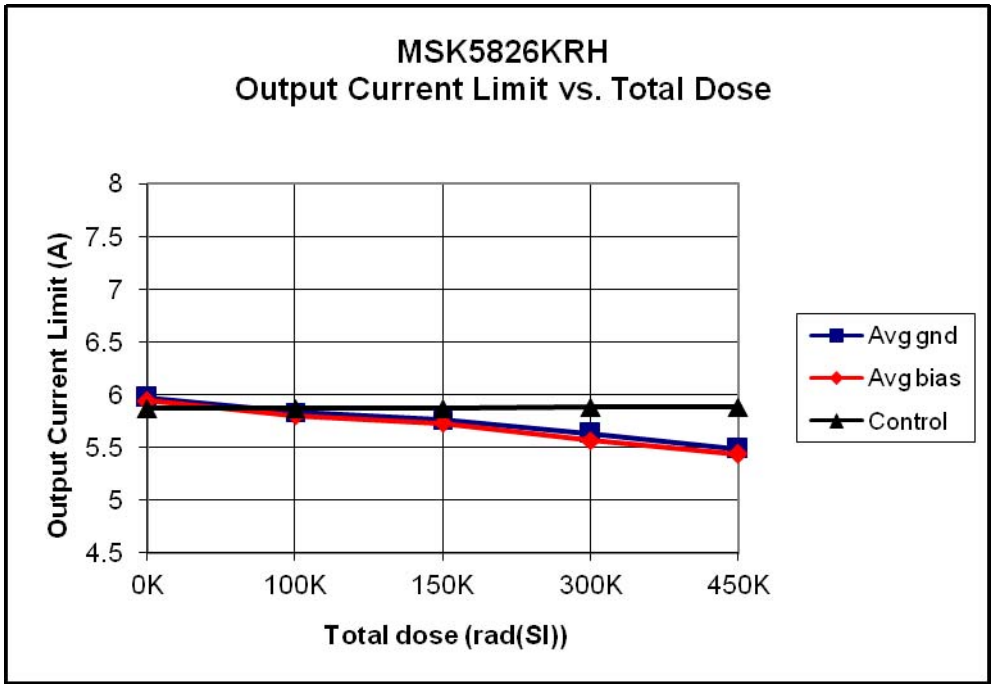

MSK5826KRH
Quiescent Current vs. Total Dose
Quiescent Cuurrent (mA)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

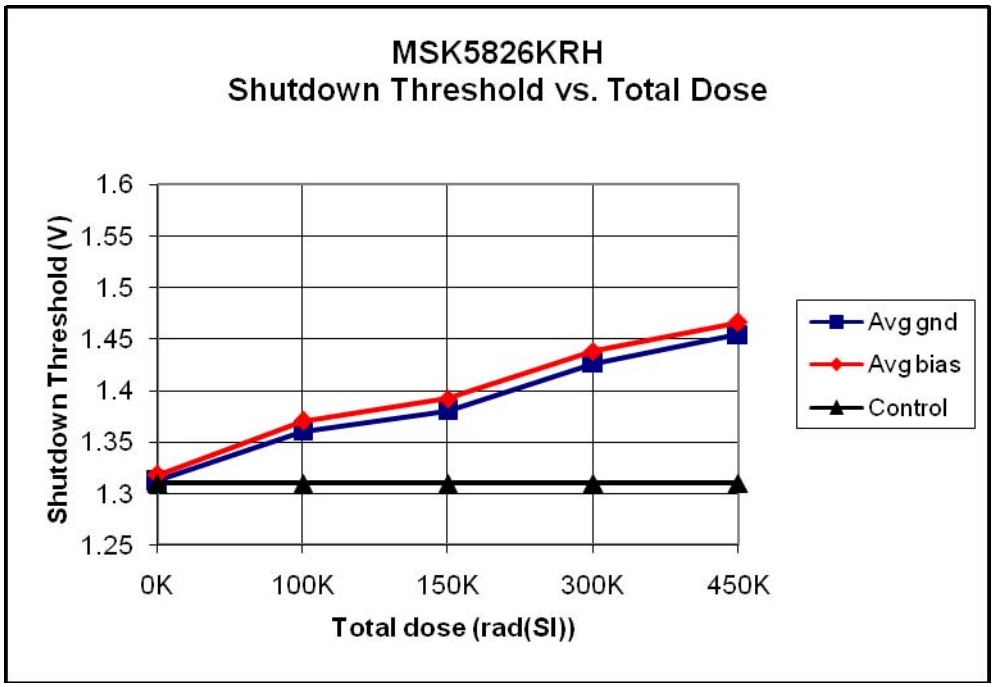

MSK5826KRH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.31
1.3
1.29
1.28
1.27
1.26
1.25
1.24
1.23
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

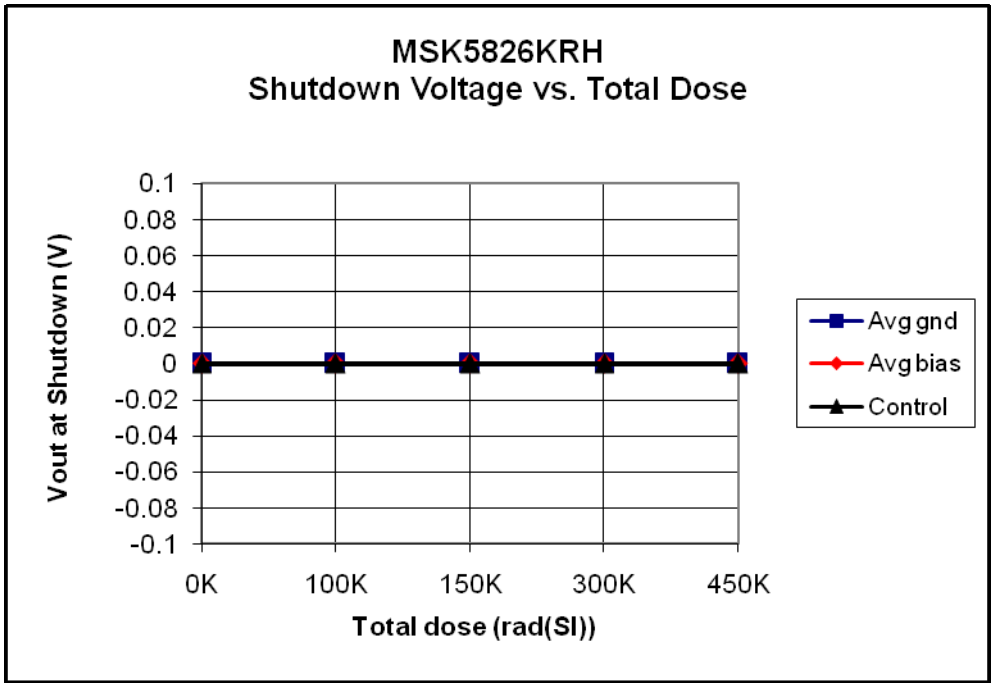

MSK5826KRH
Line Regulation vs. Total Dose
Output Voltage Delta (mV)
8
6
4
2
0
-2
-4
-6
-8
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Load Regulation vs. Total Dose
Output Voltage Delta (mV)
20
16
12
8
4
0
-4
-8
-12
-16
-20
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Output Current Limit vs. Total Dose
Output Current Limit (A)
8
7.5
7
6.5
6
5.5
5
4.5
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.6
1.55
1.5
1.45
1.4
1.35
1.3
1.25
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Shutdown Voltage vs. Total Dose
Vout at Shutdown (V)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

Neutron, TID and ELDRS Radiation Test Report

MSK 5826RH
(MSK5823RH, MSK5824RH, MSK5825RH)

Radiation Hardened
Ultra Low Dropout
Positive Adjustable Linear Regulator

December 26, 2008 (TID - First Test)
June 18, 2009 (ELDRS Test)
September 03, 2009 (TID - Second Test)
November 06, 2009 (TID - Third Test)
May 14, 2010 (TID – Fourth Test)
August 24, 2010 (Neutron Fluence)
September 17, 2010 (TID – Fifth Test)

B. Horton
R. Wakeman

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5826RH series 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 MSK5823RH, MSK5824RH, MSK5825RH and MSK5826RH all use the same active components. The data in this report is from the direct measurement of the MSK5826RH response to irradiation but it is indicative of the response of all four device types and is applicable to all four 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 5826RH.

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 at 25°C in accordance with the device data sheet. In addition, all devices received 320 hours of burn-in per MIL-STD-883 Method 1015. 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 +6.5V 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 transported to the MSK automatic electrical test platform and tested IAW 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:

Based on the test data recorded during radiation testing and statistical analysis, the MSK5826RH qualified as a 300 Krad(Si) radiation hardened device. Reference Voltage, Shutdown Threshold and Output Current Limit exhibited the most significant shift due to irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5826RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0162

Irradiation Date
09/17/10

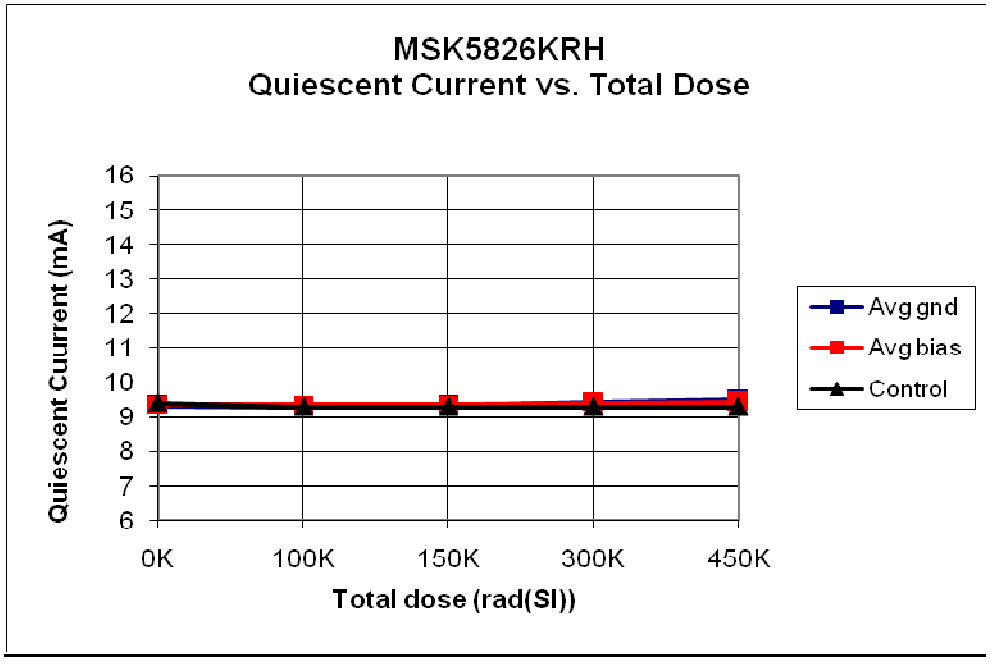
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
13:00	102,960	102,960
6:30	51,480	154,440
19:31	154,572	309,012
19:31	154,572	463,584

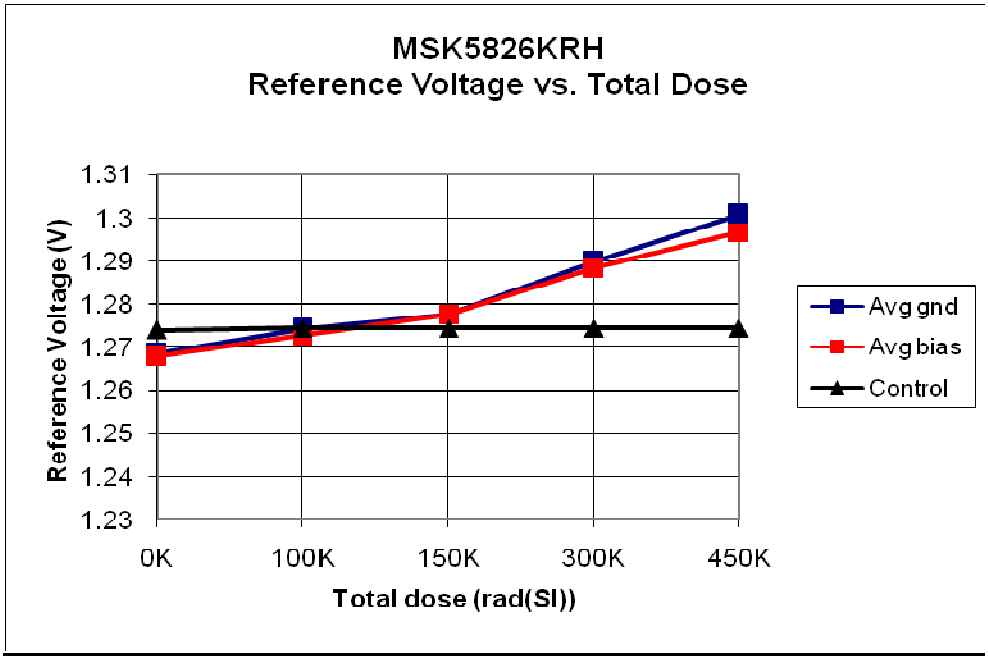
Biased S/N – 0954, 0955, 0956, 0957, 0958

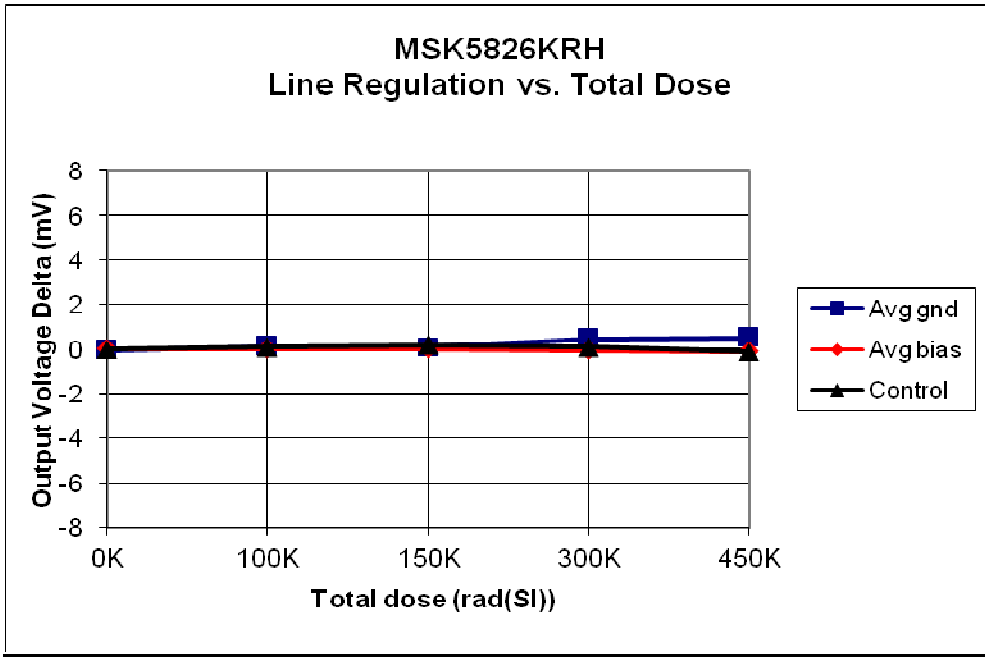
Unbiased S/N – 0959, 0960, 0961, 0962, 0963

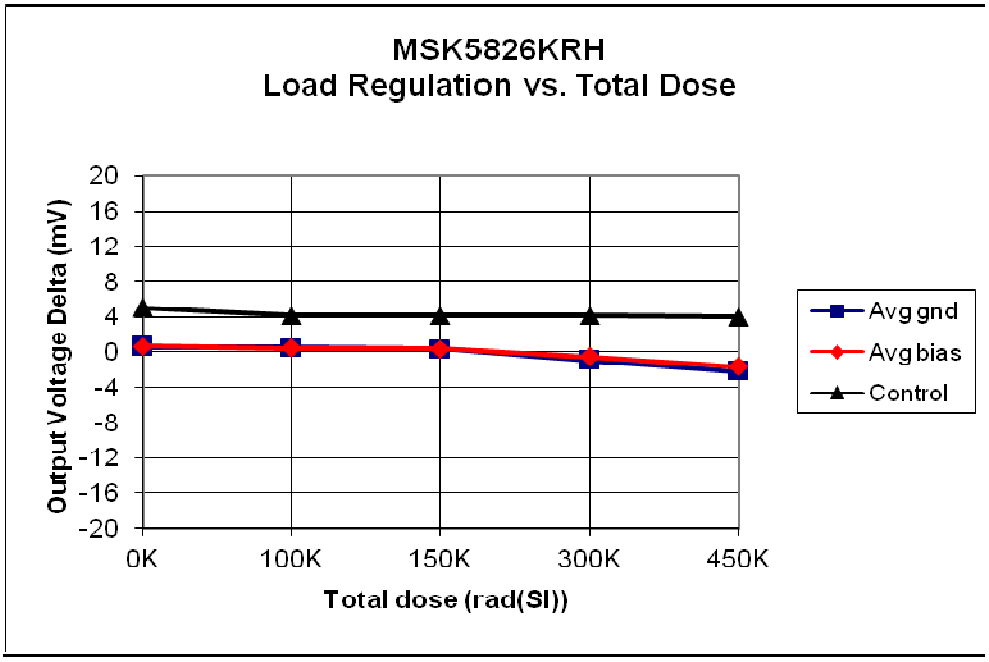
Table 1

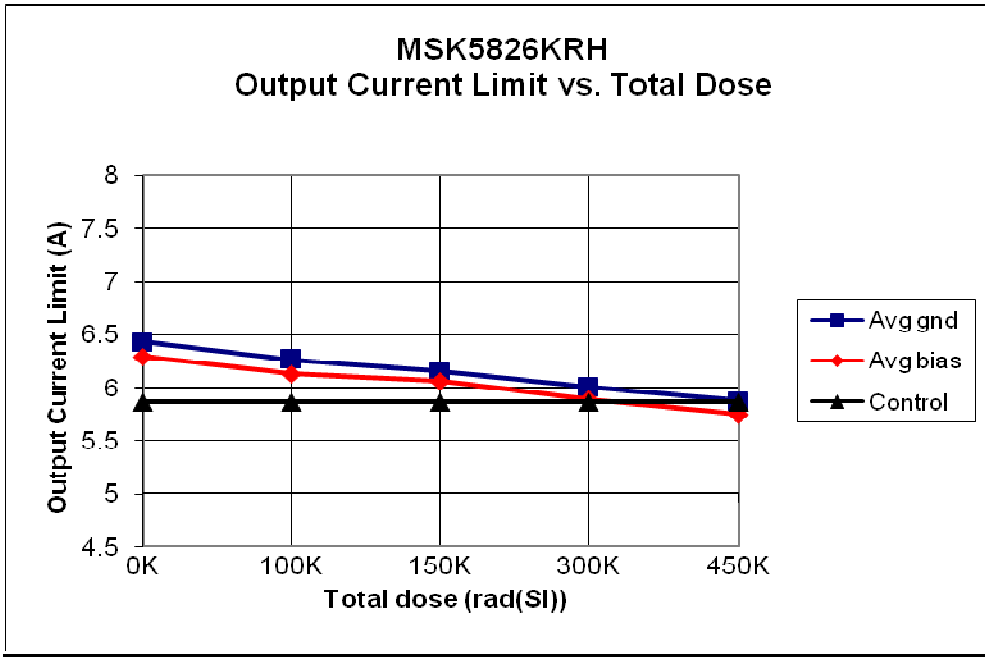
Dose Time, Incremental Dose and Total Cumulative Dose

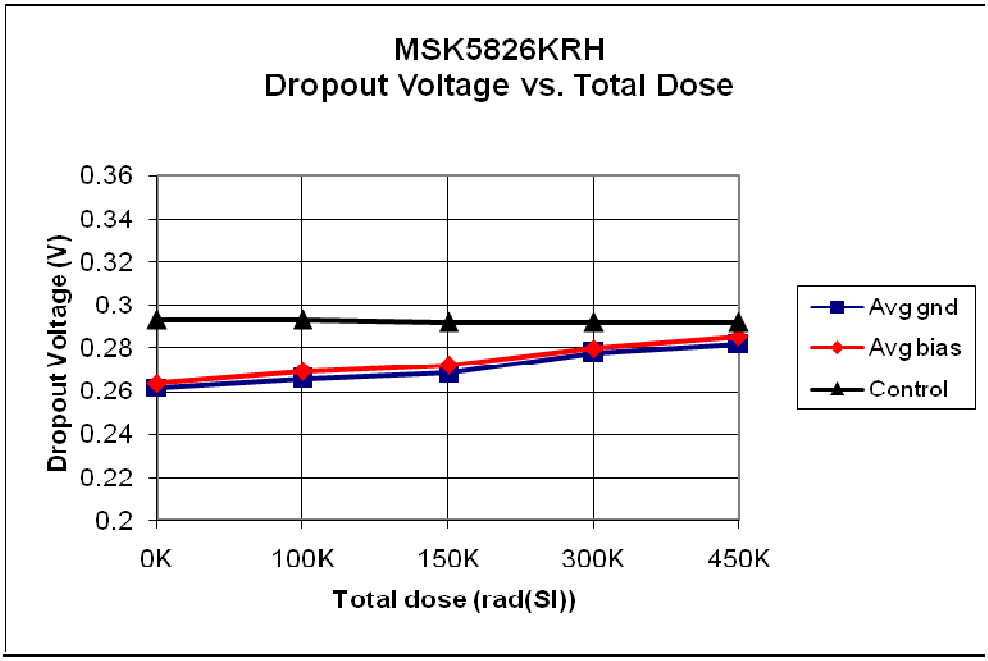

MSK5826KRH
Quiescent Current vs. Total Dose
Quiescent Current (mA)
16
15
14
13
12
11
10
9
8
7
6
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

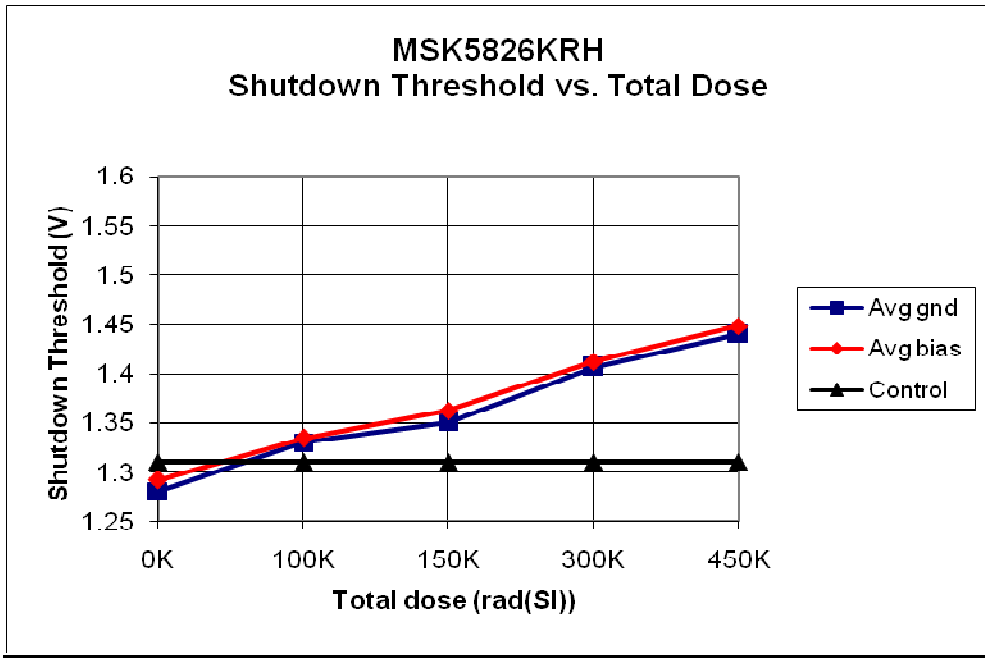

MSK5826KRH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.31
1.3
1.29
1.28
1.27
1.26
1.25
1.24
1.23
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

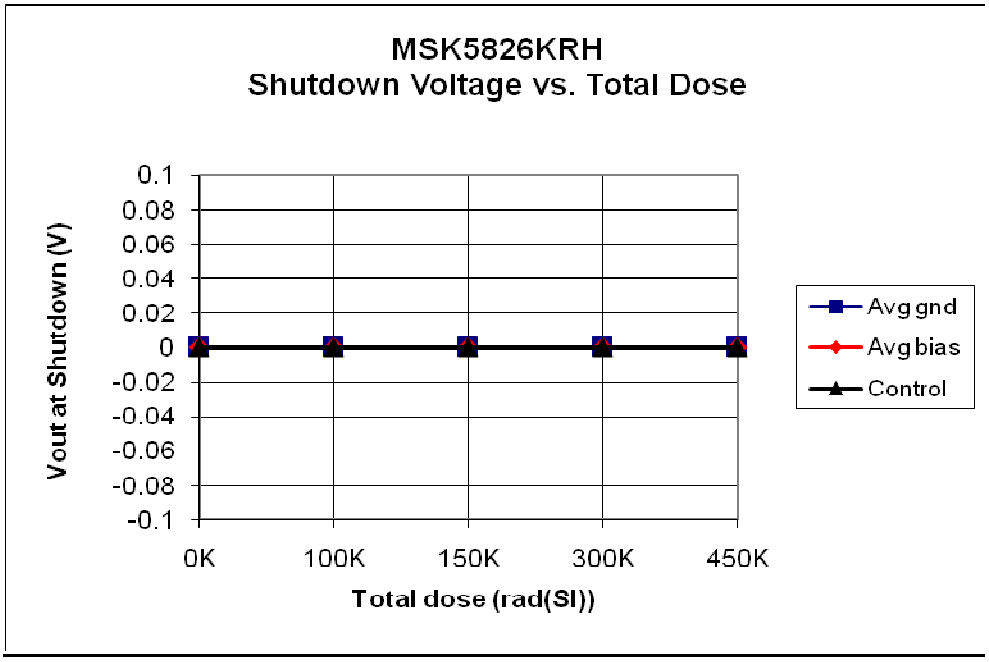

MSK5826KRH
Line Regulation vs. Total Dose
Output Voltage Delta (mV)
8
6
4
2
0
-2
-4
-6
-8
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Load Regulation vs. Total Dose
Output Voltage Delta (mV)
20
16
12
8
4
0
-4
-8
-12
-16
-20
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Output Current Limit vs. Total Dose
Output Current Limit (A)
8
7.5
7
6.5
6
5.5
5
4.5
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.6
1.55
1.5
1.45
1.4
1.35
1.3
1.25
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826KRH
Shutdown Voltage vs. Total Dose
Vout at Shutdown (V)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

Neutron, TID and ELDRS Radiation Test Report

MSK 5826RH
(MSK5823RH, MSK5824RH, MSK5825RH)

Radiation Hardened
Ultra Low Dropout
Positive Adjustable Linear Regulator

December 26, 2008 (TID - First Test)
June 18, 2009 (ELDRS Test)
September 03, 2009 (TID - Second Test)
November 06, 2009 (TID - Third Test)
May 14, 2010 (TID – Fourth Test)
August 24, 2010 (Neutron Fluence)

C. Salce
M. Bilecki

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The neutron irradiation test for the MSK 5826RH was performed to determine the change in device performance as a function of neutron fluence. The neutron irradiation test plan for the MSK 5826RH was developed to characterize neutron fluence sensitivity for devices incorporating active components including the Linear Tech RH1573 die and a PNP pass transistor. These devices include, but are not limited to, MSK5800RH, MSK5810RH, MSK5820RH, MSK5821RH, MSK5822RH, MSK5823RH, MSK5824RH, MSK5825RH, MSK5826RH, MSK5951RH, MSK1832RH and MSK1835RH. Neutron irradiation testing was performed to 1.08E+12 n/cm² total neutron fluence.

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 neutron fluence level. The data in this report is from direct measurement of the MSK 5826RH response to neutron irradiation.

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 5826RH.

II. Radiation Source:

Neutron irradiation was performed at the University of Massachusetts, Lowell, using the Reactor Facility-FNI. Neutron flux was determined by the dosimetry system S/P-32, ASTM E-265 to be 5.03×10^{8} n/cm^2-s, 1MeV equivalent for step 1. The flux was increased to 1.01×10^{9} n/cm^2-s for steps 2 and 3.

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:

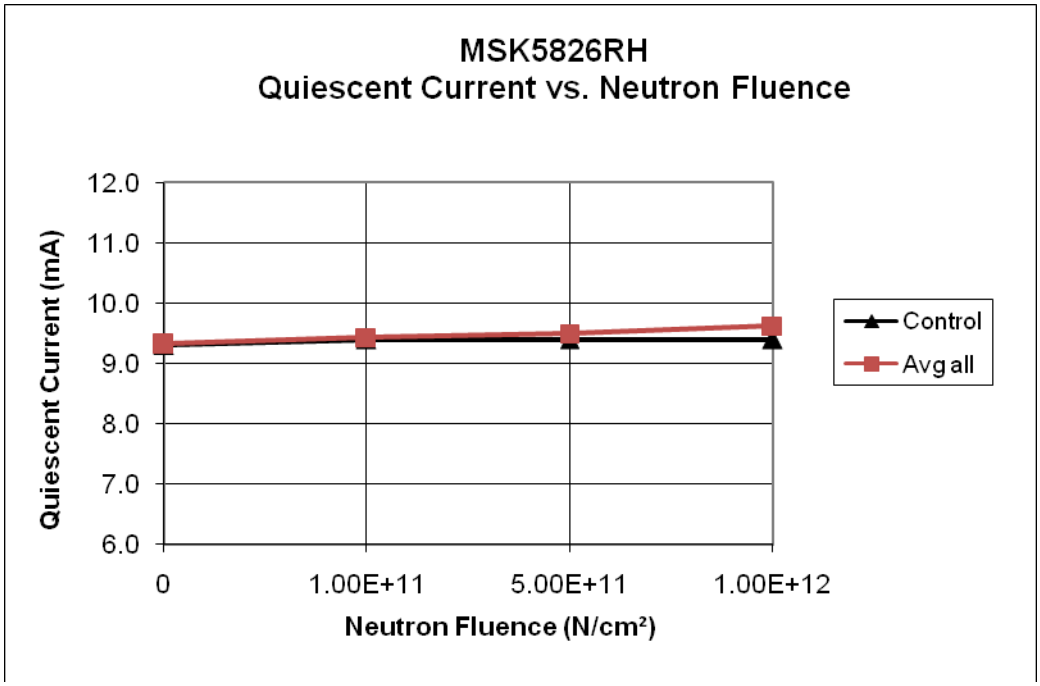
Based on the test data recorded during neutron irradiation testing and statistical analysis, the MSK5826RH shows immunity to displacement damage. Dropout voltage and Output Current Limit exhibited the most significant shift due to irradiation, however all performance curves stayed well within specification.

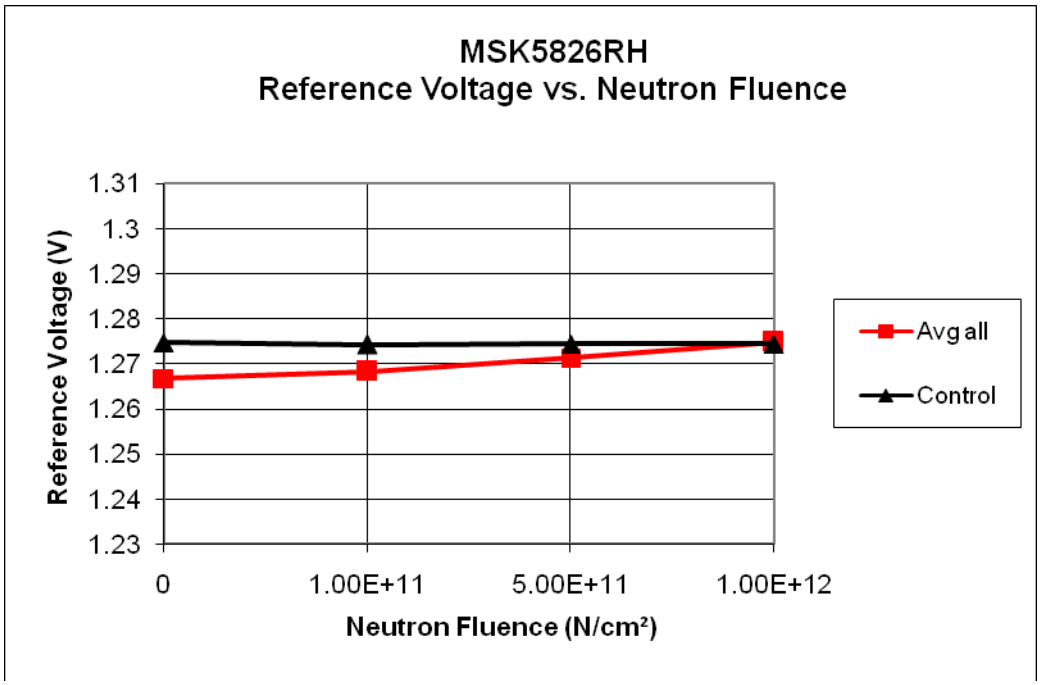
MSK5826RH Neutron Irradiation

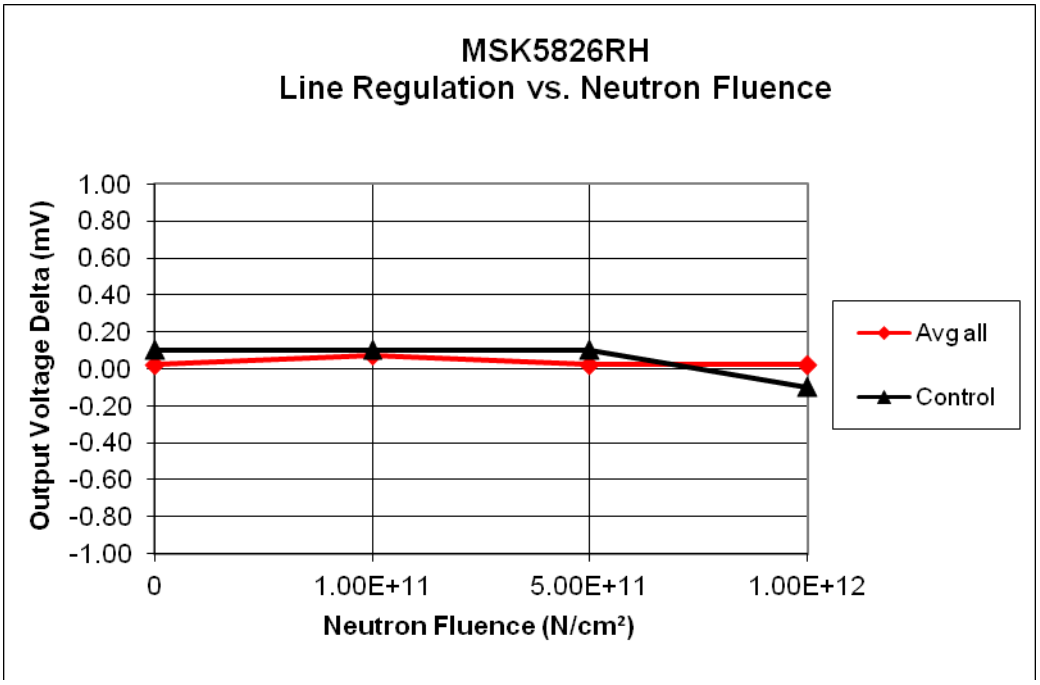
Reactor Facility – Fast Neutron Irradiation (FNI)
Dosimetry System: S/P-32 (ASTM E-265)

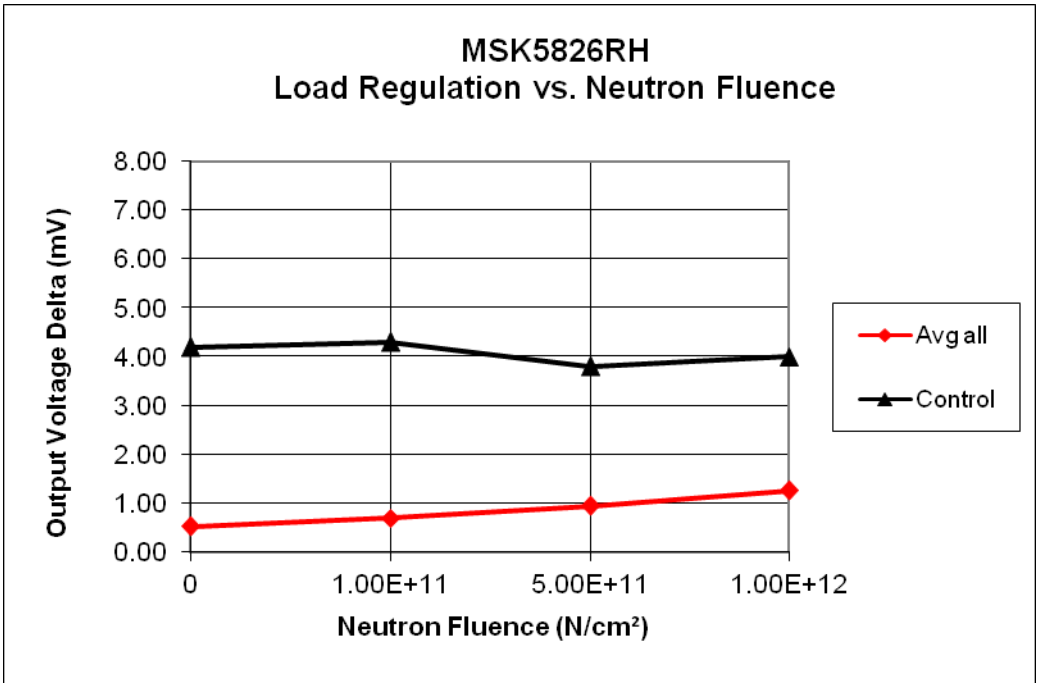
Exposure Date: 8/20/10

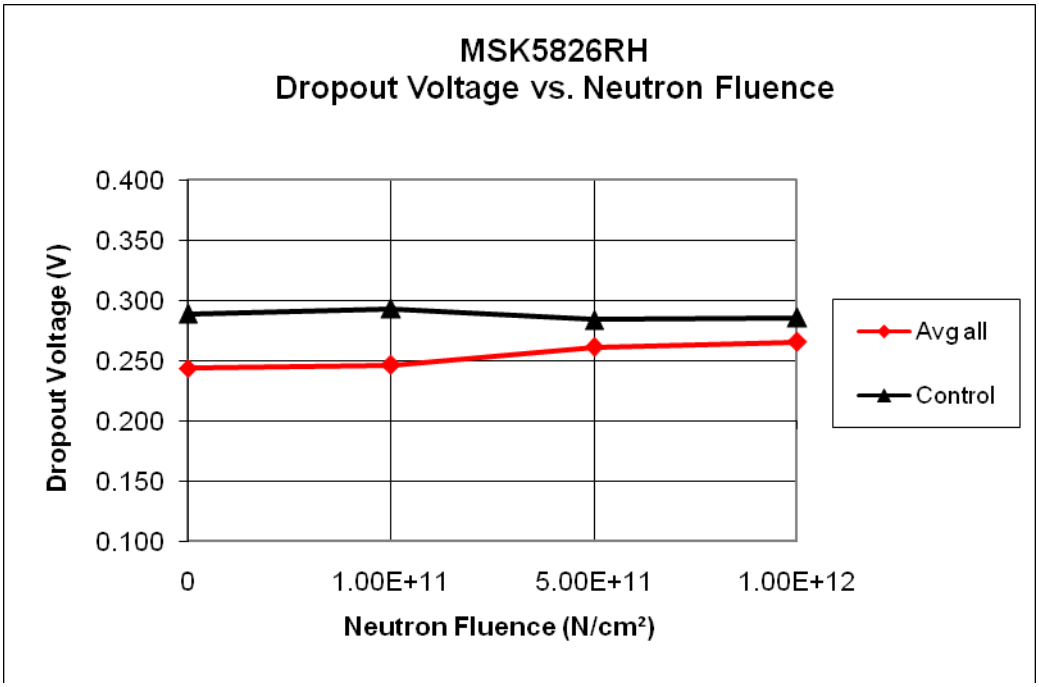
Irradiation	Reactor Power (kW)	Gamma Dose Rad(Si)	Flux (n/cm^2-s)	Time (s)	Fluence (n/cm^2)	Total Fluence (n/cm^2)
Step 1	4.5	17	5.30E+08	330	1.75E+11	1.75E+11
Step 2	9.5	43	1.01E+09	398	4.02E+11	5.77E+11
Step 3	9.5	54	1.01E+09	498	5.03E+11	1.08E+12

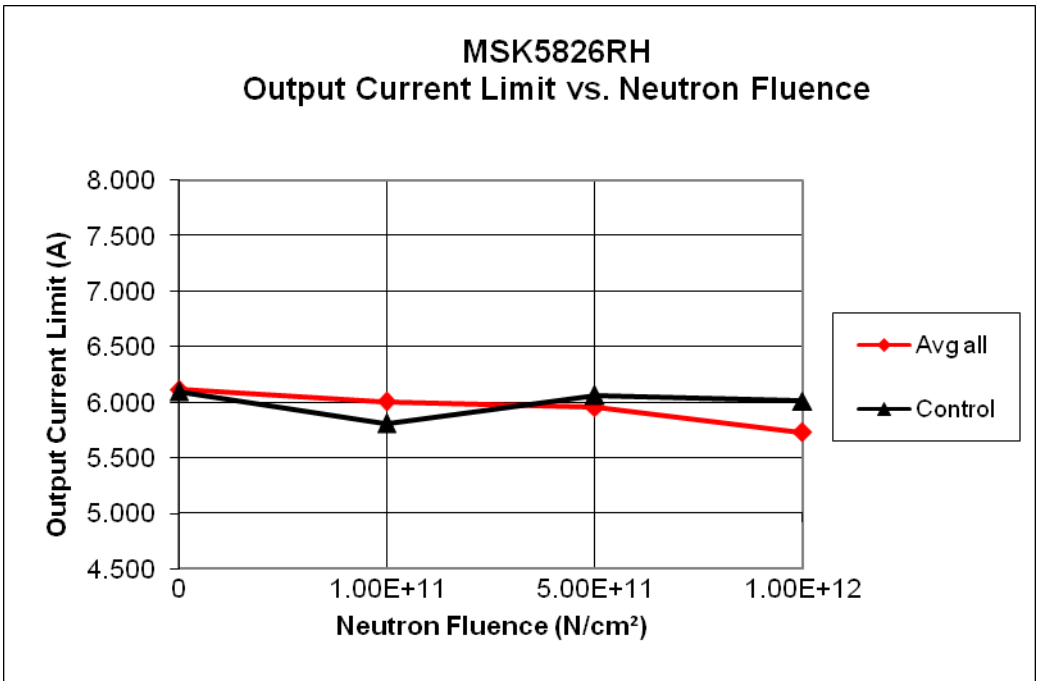

MSK5826RH
Quiescent Current vs. Neutron Fluence
Quiescent Current (mA)
12.0
11.0
10.0
9.0
8.0
7.0
6.0
0
1.00E+11
5.00E+11
1.00E+12
Neutron Fluence (N/cm²)
Control
Avg all

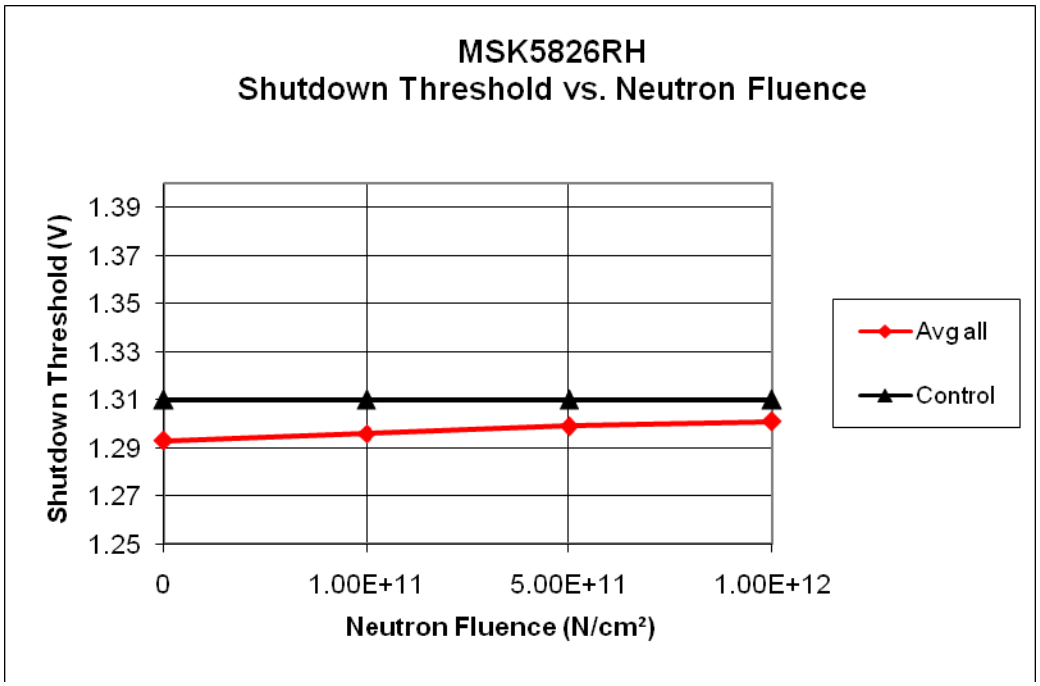

MSK5826RH
Reference Voltage vs. Neutron Fluence
Reference Voltage (V)
1.31
1.3
1.29
1.28
1.27
1.26
1.25
1.24
1.23
0
1.00E+11
5.00E+11
1.00E+12
Neutron Fluence (N/cm²)
Avg all
Control

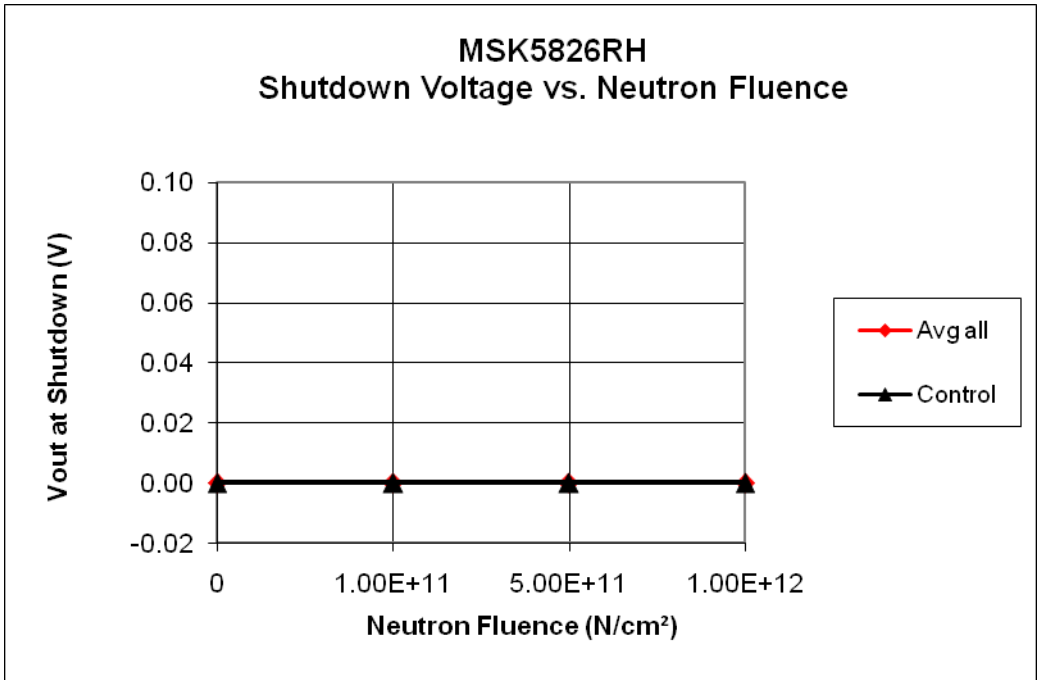

MSK5826RH
Line Regulation vs. Neutron Fluence
Output Voltage Delta (mV)
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
0
1.00E+11
5.00E+11
1.00E+12
Neutron Fluence (N/cm²)
Avg all
Control


MSK5826RH
Load Regulation vs. Neutron Fluence
Output Voltage Delta (mV)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
1.00E+11
5.00E+11
1.00E+12
Neutron Fluence (N/cm²)
Avg all
Control


MSK5826RH
Dropout Voltage vs. Neutron Fluence
Dropout Voltage (V)
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0
1.00E+11
5.00E+11
1.00E+12
Neutron Fluence (N/cm²)
Avg all
Control


MSK5826RH
Output Current Limit vs. Neutron Fluence
Output Current Limit (A)
8.000
7.500
7.000
6.500
6.000
5.500
5.000
4.500
0
1.00E+11
5.00E+11
1.00E+12
Neutron Fluence (N/cm²)
Avg all
Control


MSK5826RH
Shutdown Threshold vs. Neutron Fluence
Shutdown Threshold (V)
1.39
1.37
1.35
1.33
1.31
1.29
1.27
1.25
0
1.00E+11
5.00E+11
1.00E+12
Neutron Fluence (N/cm²)
Avg all
Control


MSK5826RH
Shutdown Voltage vs. Neutron Fluence
Vout at Shutdown (V)
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
0
1.00E+11
5.00E+11
1.00E+12
Neutron Fluence (N/cm²)
Avg all
Control

TID and ELDRS Radiation Test Report

MSK 5826RH
(MSK 5823RH, MSK 5824RH, MSK 5825RH)

Radiation Hardened
Ultra Low Dropout
Positive Adjustable Linear Regulator

December 26, 2008 (TID - First Test)
June 18, 2009 (ELDRS Test)
September 03, 2009 (TID - Second Test)
November 06, 2009 (TID - Third Test)
May 14, 2010 (TID – Fourth Test)

M. Bilecki
B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5826RH series 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 MSK5823RH, MSK5824RH, MSK5825RH and MSK5826RH all use the same active components. The data in this report is from the direct measurement of the MSK5826RH response to irradiation but it is indicative of the response of all four device types and is applicable to all four 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 5826RH.

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 138 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 at 25°C in accordance with the device data sheet. In addition, all devices received 320 hours of burn-in per MIL-STD-883 Method 1015. 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 +6.5V 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 transported to the MSK automatic electrical test platform and tested IAW 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:

Based on the test data recorded during radiation testing and statistical analysis, the MSK5826RH qualified as a 300 Krad(Si) radiation hardened device. Reference Voltage, Shutdown Threshold and Output Current Limit exhibited the most significant shift due to irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5826RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

Irradiation Date
05/14/10

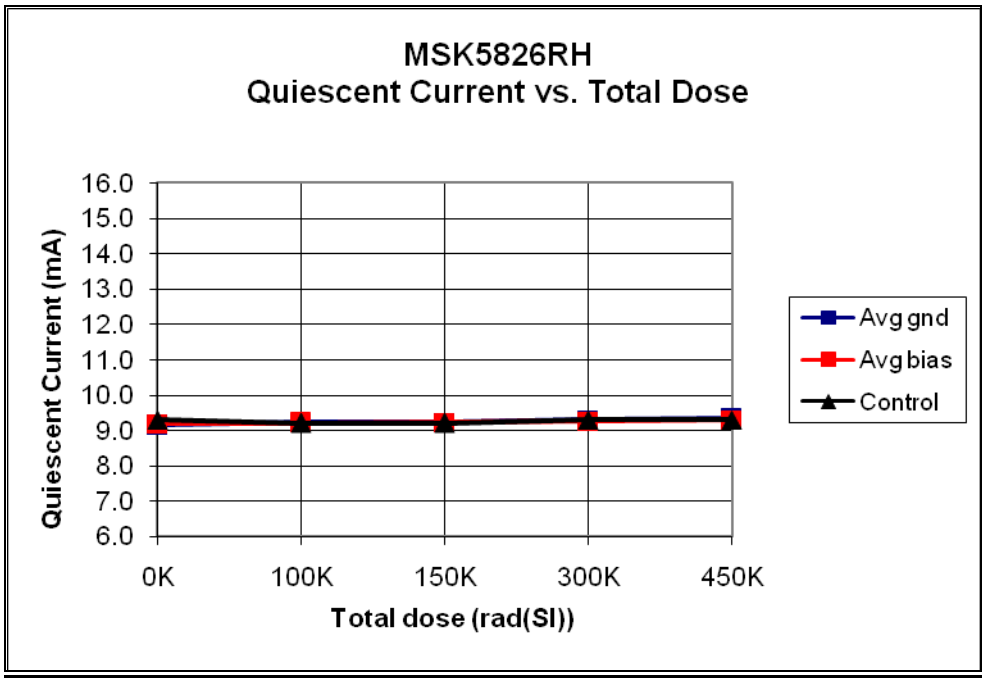
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
12:27	106,086	106,086
6:14	51,612	154,698
18:40	154,560	309,258
18:40	154,560	463,818

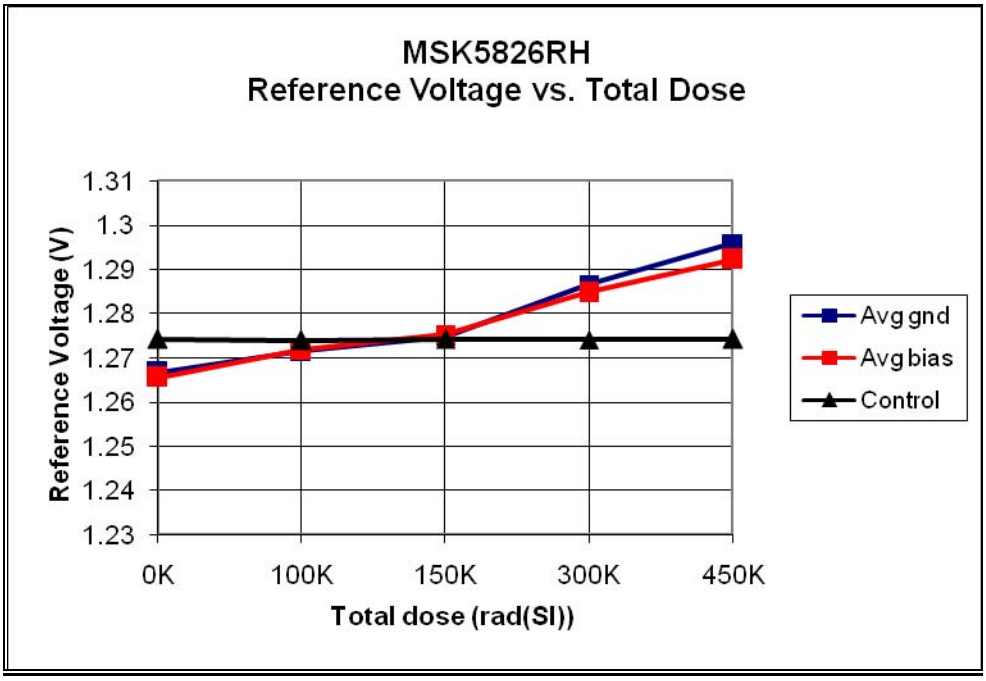
Biased S/N – 0827, 0828, 0829, 0830, 0831

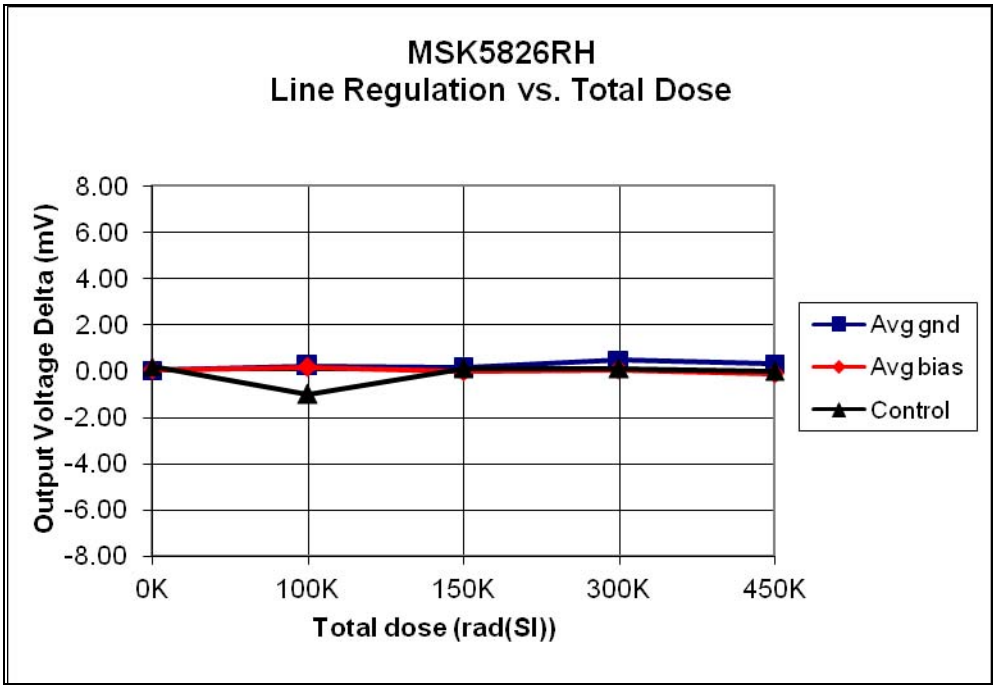
Unbiased S/N – 0832, 0833, 0834, 0835, 0836

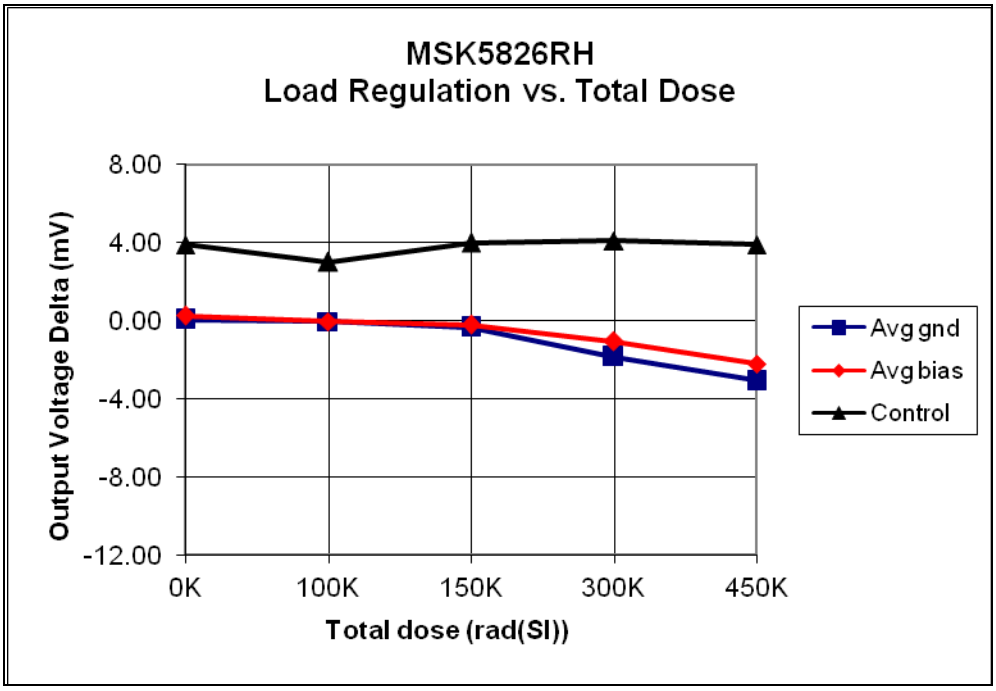
Table 1

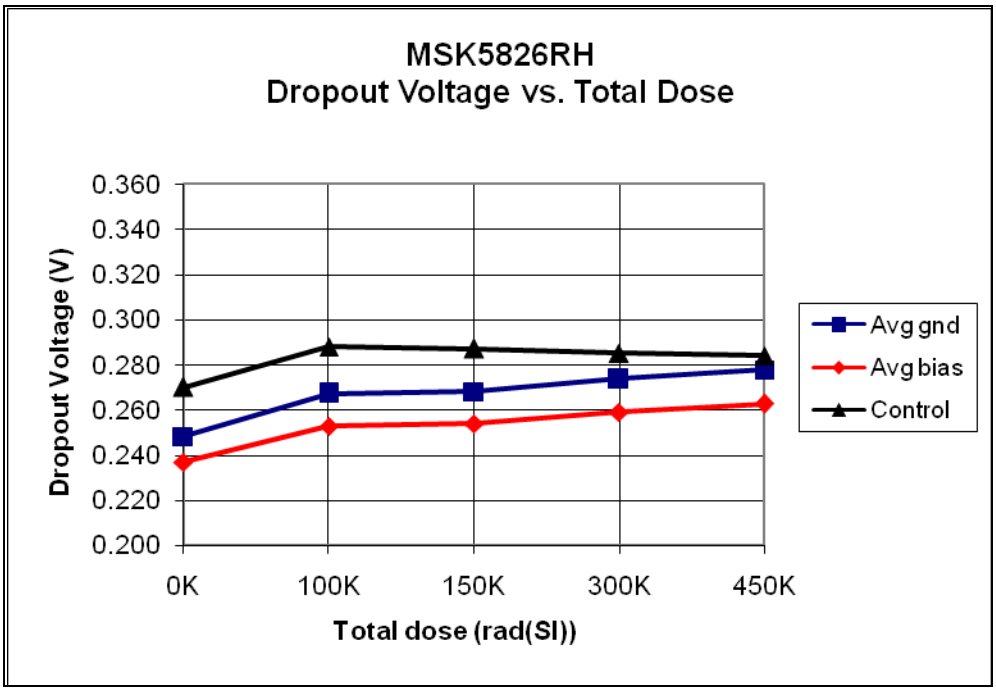
Dose Time, Incremental Dose and Total Cumulative Dose

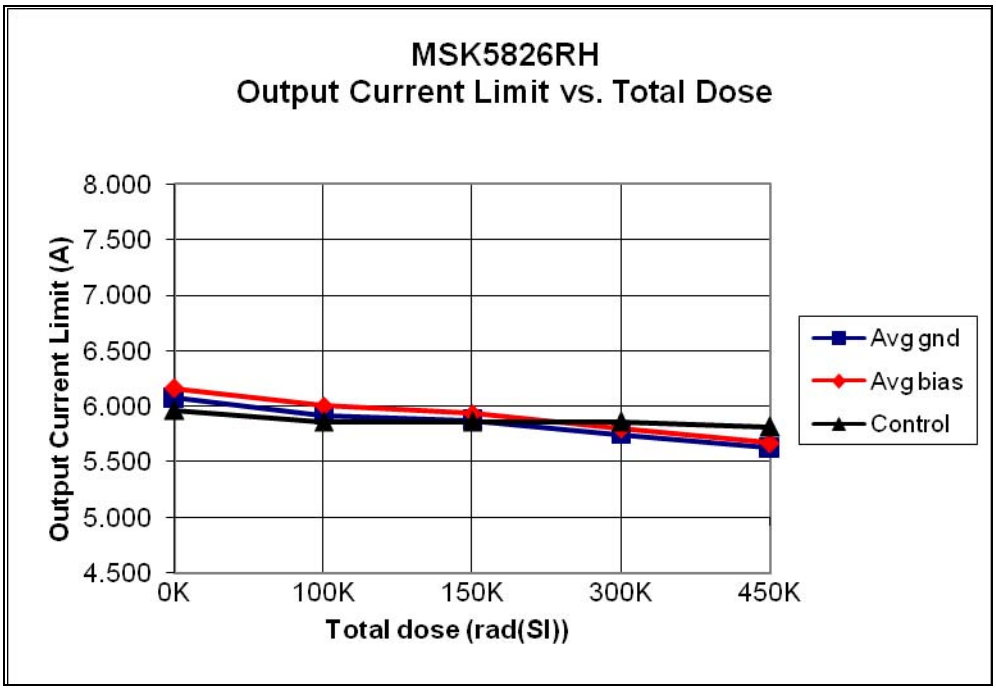

MSK5826RH
Quiescent Current vs. Total Dose
Quiescent Current (mA)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

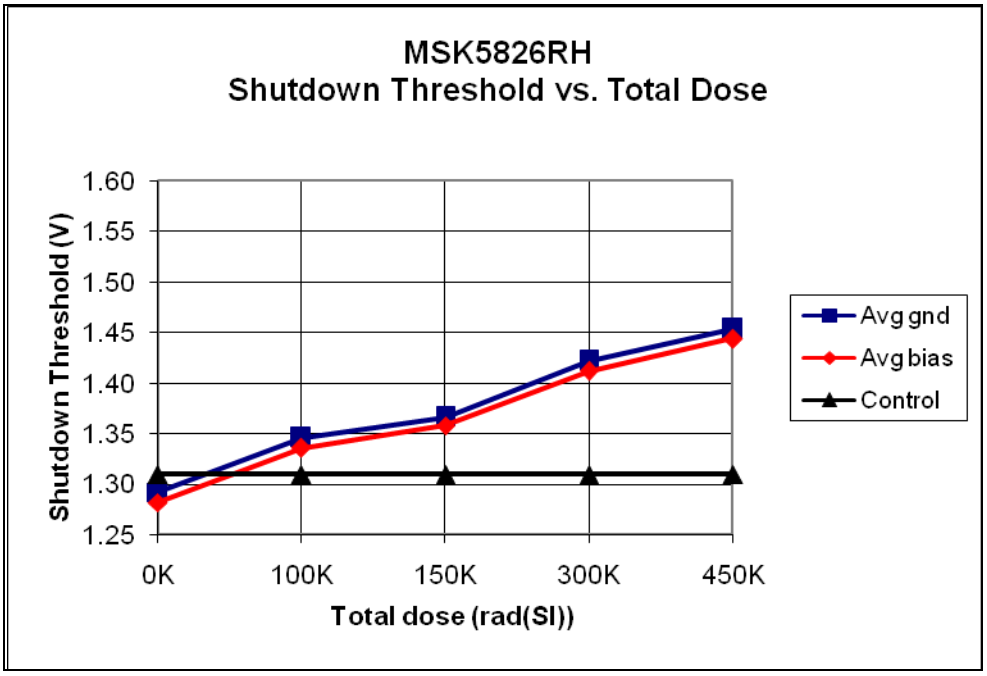

MSK5826RH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.31
1.3
1.29
1.28
1.27
1.26
1.25
1.24
1.23
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

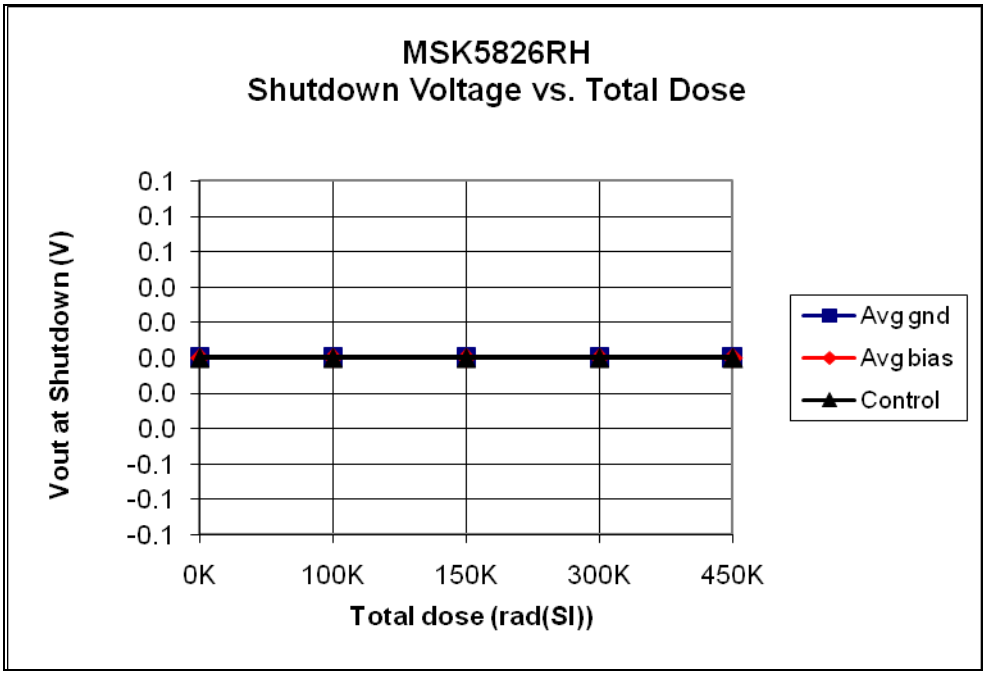

MSK5826RH
Line Regulation vs. Total Dose
Output Voltage Delta (mV)
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826RH
Load Regulation vs. Total Dose
Output Voltage Delta (mV)
8.00
4.00
0.00
-4.00
-8.00
-12.00
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826RH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.360
0.340
0.320
0.300
0.280
0.260
0.240
0.220
0.200
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
8.000
7.500
7.000
6.500
6.000
5.500
5.000
4.500
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826RH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826RH
Shutdown Voltage vs. Total Dose
Vout at Shutdown (V)
0.1
0.1
0.1
0.0
0.0
0.0
0.0
0.0
-0.1
-0.1
-0.1
0K
100K
150K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

TID and ELDRS Radiation Test Report

MSK 5826RH
(MSK 5823RH, MSK 5824RH, MSK 5825RH)

Radiation Hardened
Ultra Low Dropout
Positive Adjustable Linear Regulator

December 26, 2008 (TID - First Test)
June 18, 2009 (ELDRS Test)
September 03, 2009 (TID - Second Test)
November 06, 2009 (TID - Third Test)

M. Bilecki
B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5826RH series 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 MSK5823RH, MSK5824RH, MSK5825RH and MSK5826RH all use the same active components. The data in this report is from the direct measurement of the MSK5826RH response to irradiation but it is indicative of the response of all four device types and is applicable to all four 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 5826RH.

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 156 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 at 25°C in accordance with the device data sheet. In addition, all devices received 320 hours of burn-in per MIL-STD-883 Method 1015. 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 +6.5V 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 transported to the MSK automatic electrical test platform and tested IAW 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:

Based on the test data recorded during radiation testing and statistical analysis, the MSK5826RH qualified as a 300 Krad(Si) radiation hardened device. Reference Voltage, Shutdown Threshold and Output Current Limit exhibited the most significant shift due to irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5826RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

Irradiation Date
11/06/09

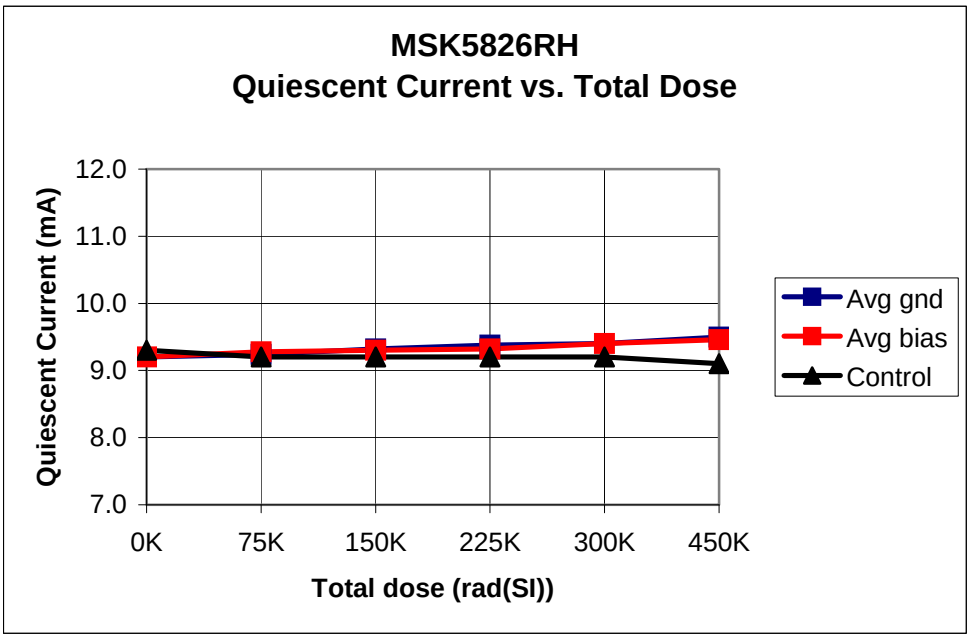
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
8:16	77,376	77376
8:16	77,376	154,752
8:16	77,376	232,128
8:16	77,376	309,504
16:35	154,752	464,256

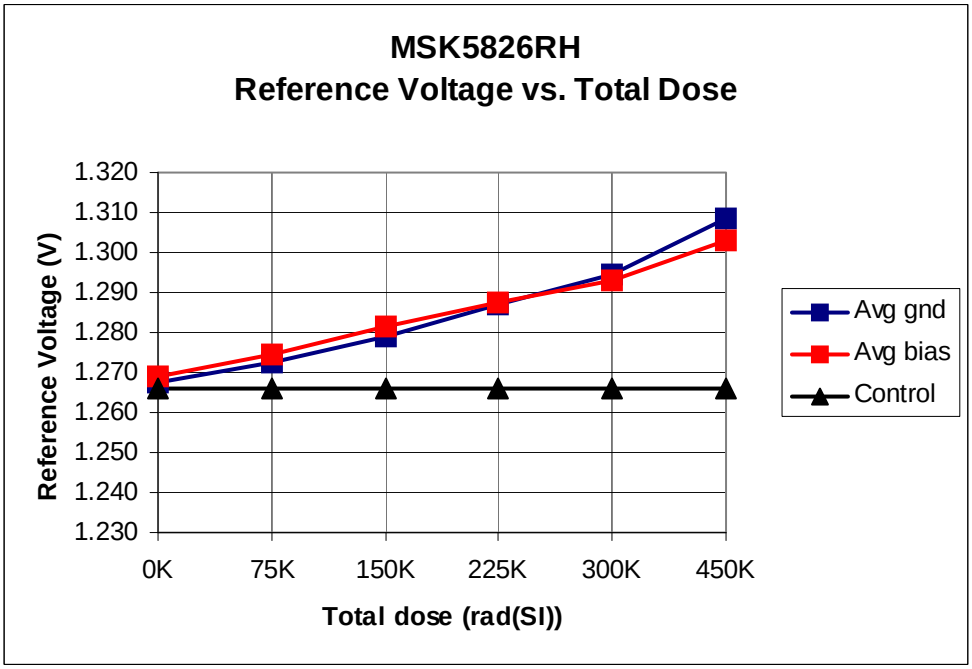
Biased S/N – 0541, 0542, 0543, 0544, 0545

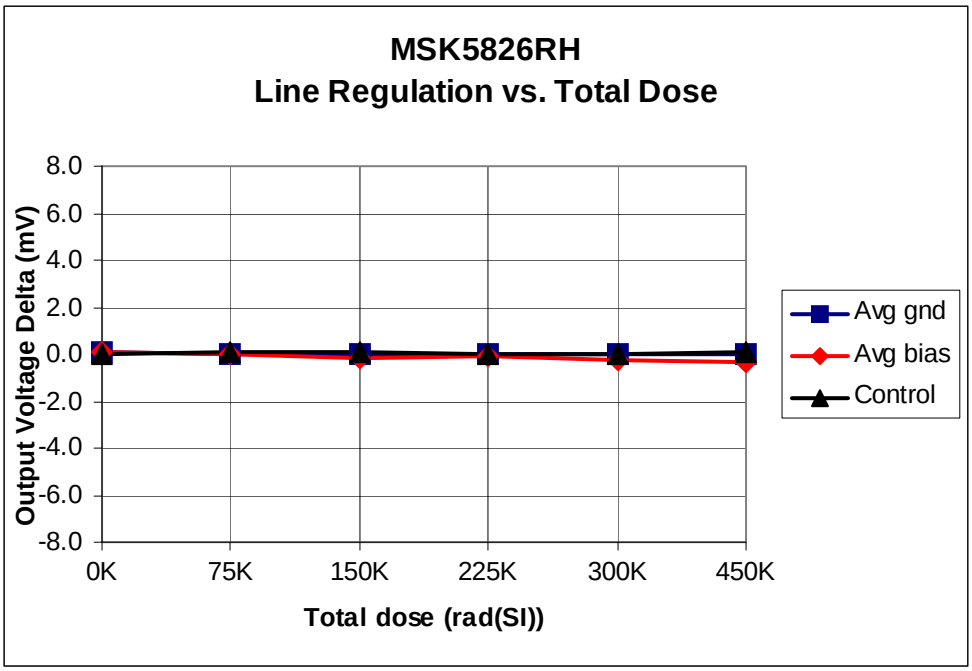
Unbiased S/N – 0546, 0547, 0548, 0549, 0550

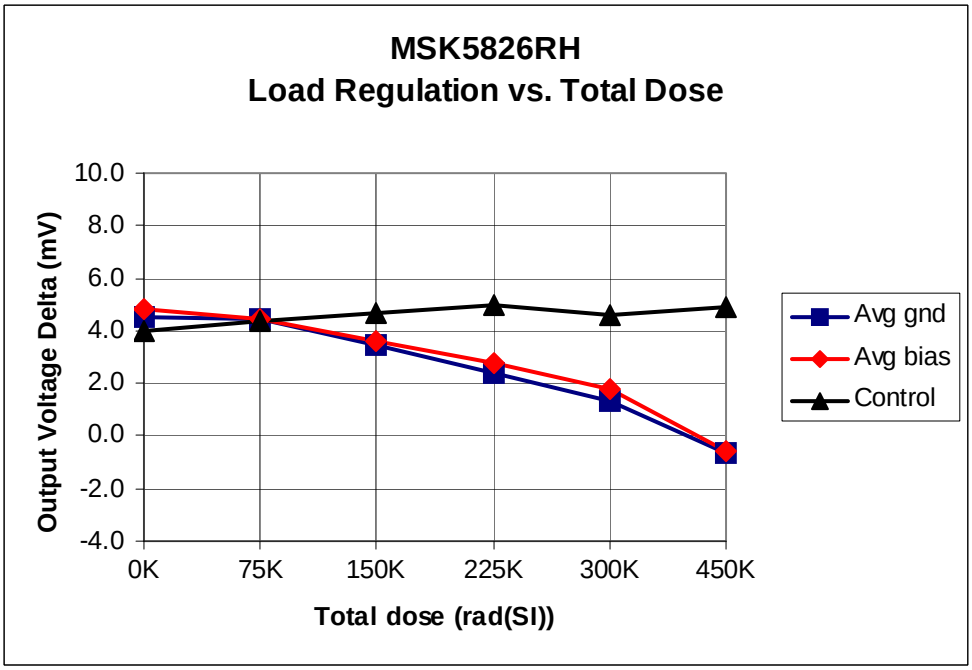
Table 1

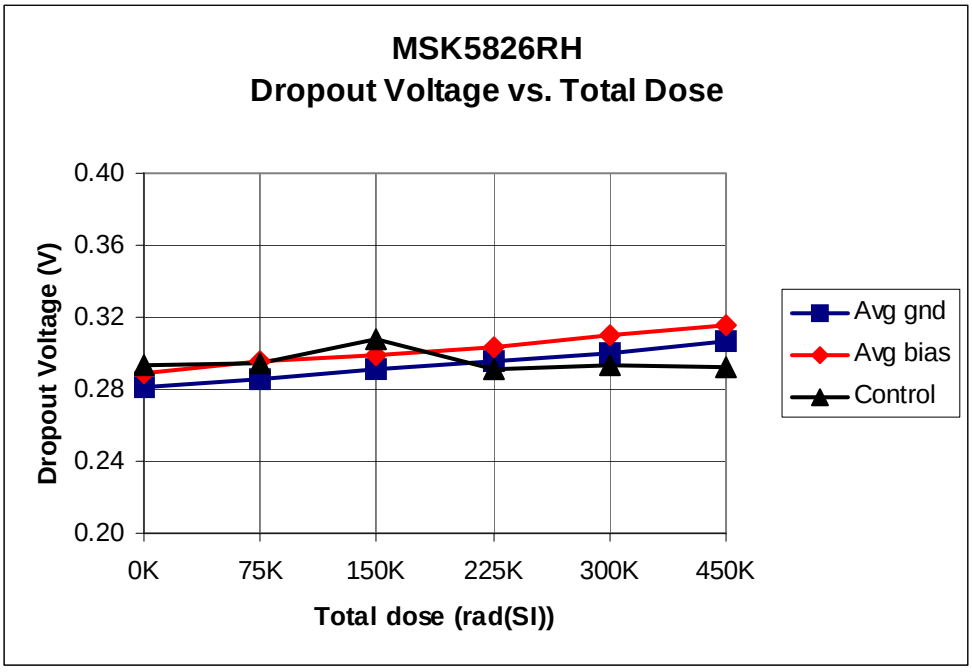
Dose Time, Incremental Dose and Total Cumulative Dose

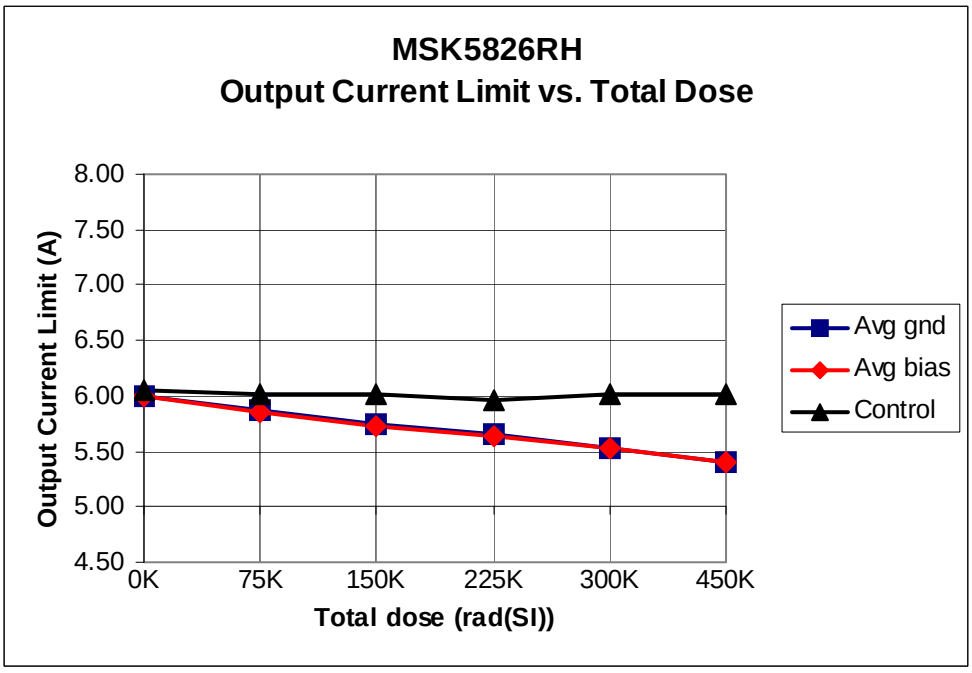

MSK5826RH
Quiescent Current vs. Total Dose
Quiescent Current (mA)
12.0
11.0
10.0
9.0
8.0
7.0
0K
75K
150K
225K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

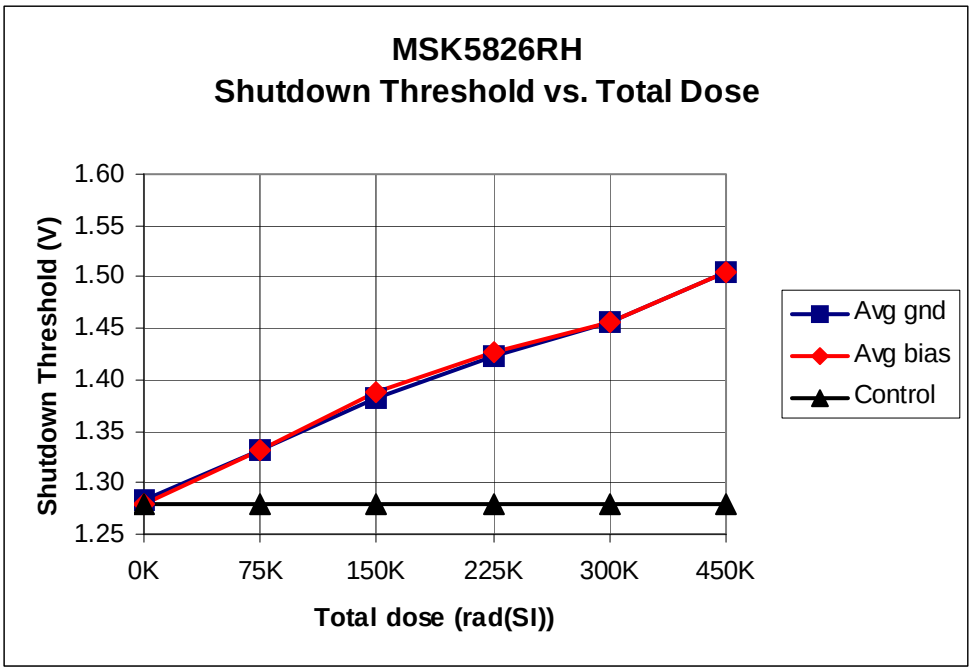

MSK5826RH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.320
1.310
1.300
1.290
1.280
1.270
1.260
1.250
1.240
1.230
0K
75K
150K
225K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

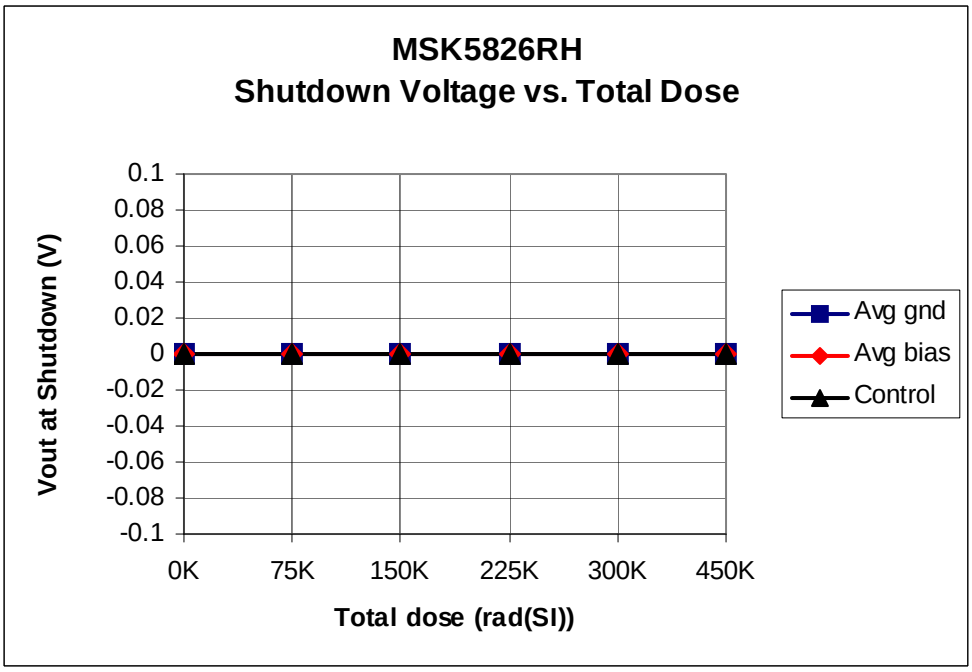

MSK5826RH
Line Regulation vs. Total Dose
Output Voltage Delta (mV)
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
0K
75K
150K
225K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5826RH
Load Regulation vs. Total Dose
Output Voltage Delta (mV)
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
0K
75K
150K
225K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5826RH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.40
0.36
0.32
0.28
0.24
0.20
0K
75K
150K
225K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5826RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
0K
75K
150K
225K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5826RH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
0K
75K
150K
225K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5826RH
Shutdown Voltage vs. Total Dose
Vout at Shutdown (V)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0K
75K
150K
225K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control

TID and ELDRS Radiation Test Report

MSK 5826RH

Radiation Hardened
Ultra Low Dropout
Positive Adjustable Linear Regulator

December 26, 2008 (TID - First Test)
June 18, 2009 (ELDRS Test)
September 03, 2009 (TID - Second Test)

M. Bilecki
B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5826RH series 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 MSK5823RH, MSK5824RH, MSK5825RH and MSK5826RH all use the same active components. The data in this report is from the direct measurement of the MSK5826RH response to irradiation but it is indicative of the response of all four device types and is applicable to all four 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 5826RH.

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 168 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 at 25°C in accordance with the device data sheet. In addition, all devices received 320 hours of burn-in per MIL-STD-883 Method 1015. 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 +6.5V 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 transported to the MSK automatic electrical test platform and tested IAW 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:

Based on the test data recorded during radiation testing and statistical analysis, the MSK5826RH qualified as a 300 Krad(Si) radiation hardened device. Reference Voltage, Shutdown Threshold and Output Current Limit exhibited the most significant shift due to irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5826RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

Irradiation Date
09/03/09

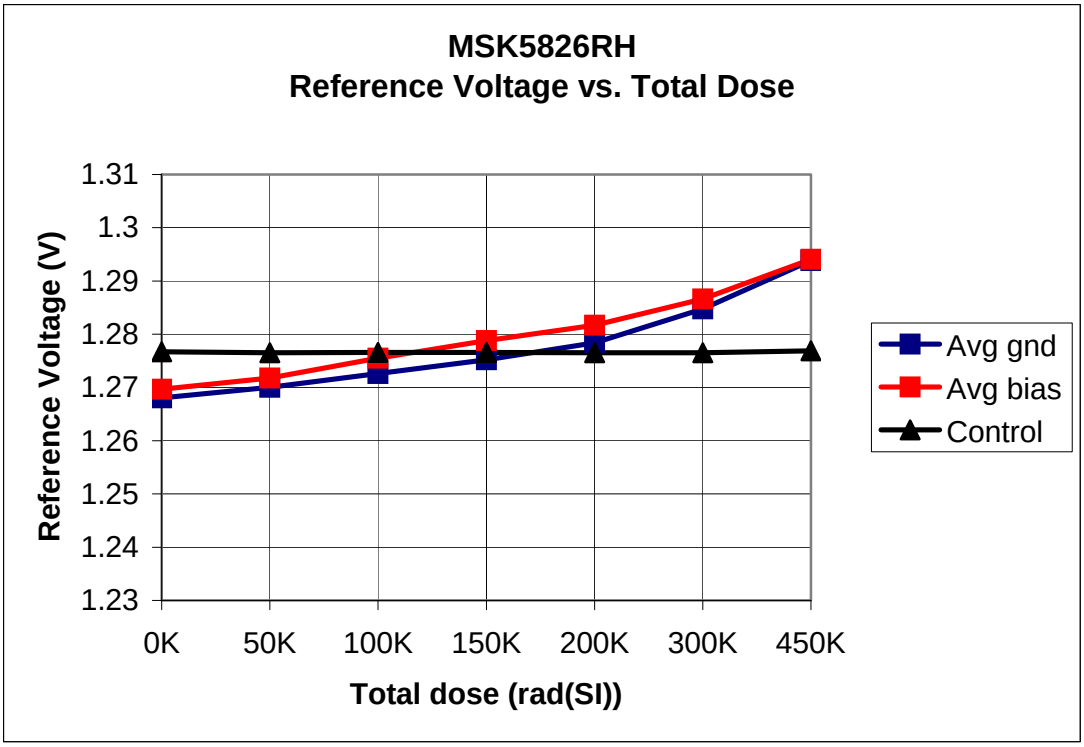
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
5:07	51,576	51,576
5:07	51,576	103,152
5:07	51,576	154,728
5:07	51,576	206,304
10:13	102,984	309,288
15:20	154,560	463,848

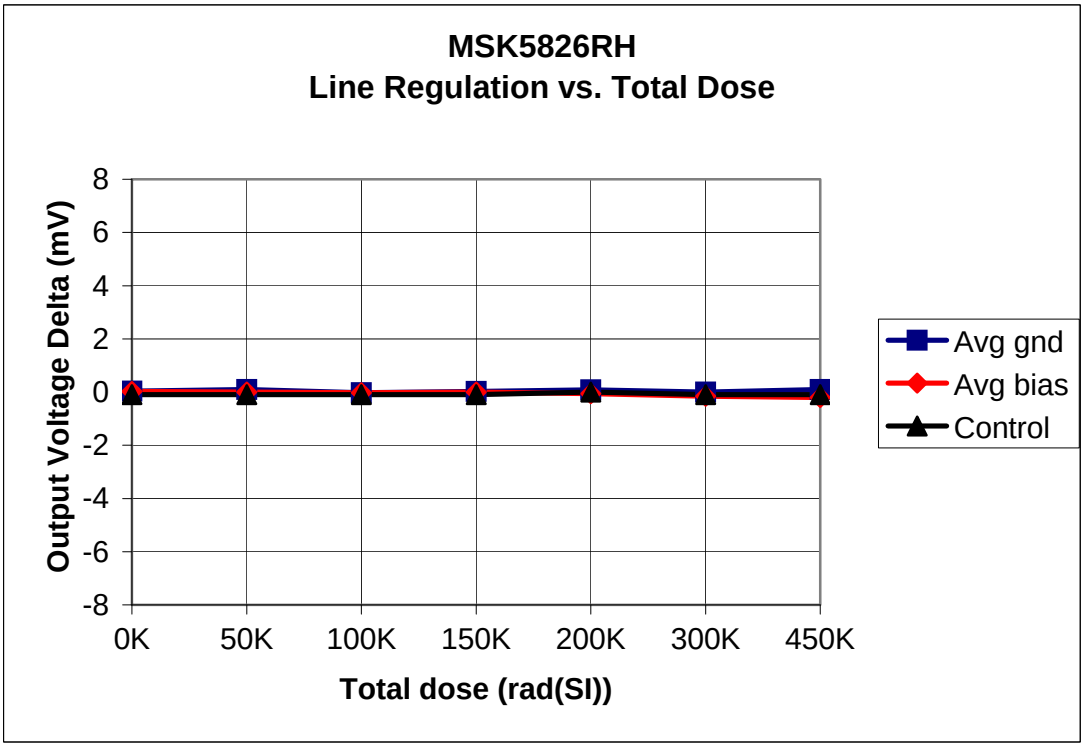
Biased S/N – 0507, 0508, 0509, 0510, 0511

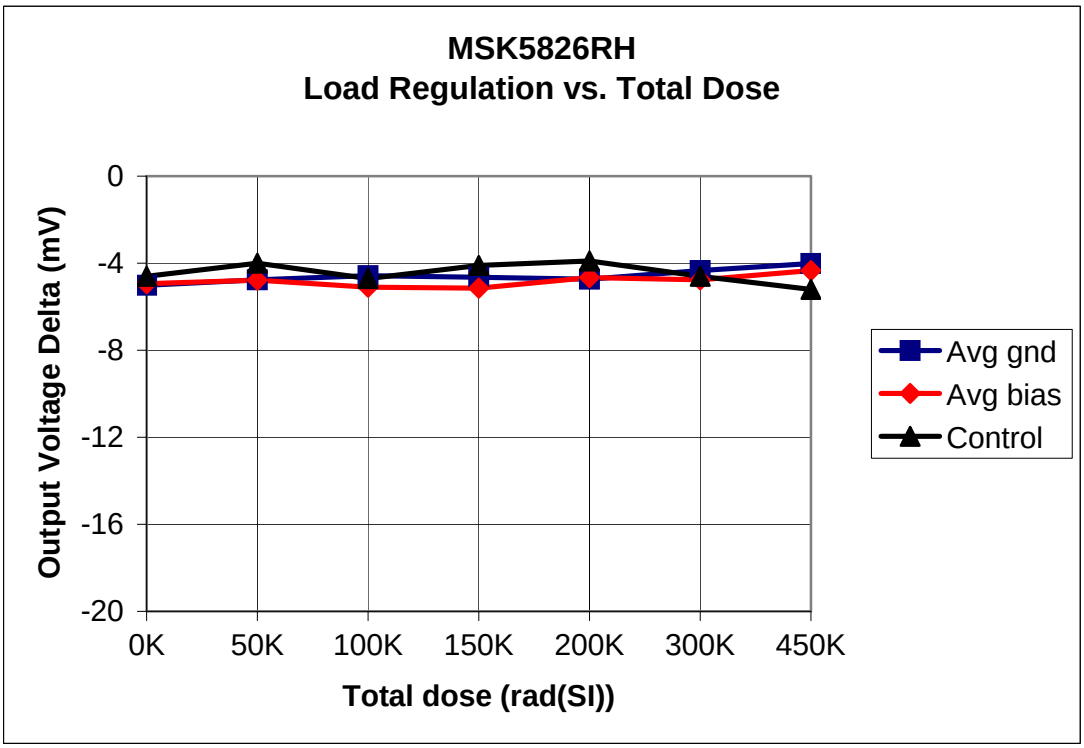
Unbiased S/N – 0512, 0513, 0514, 0515, 0516

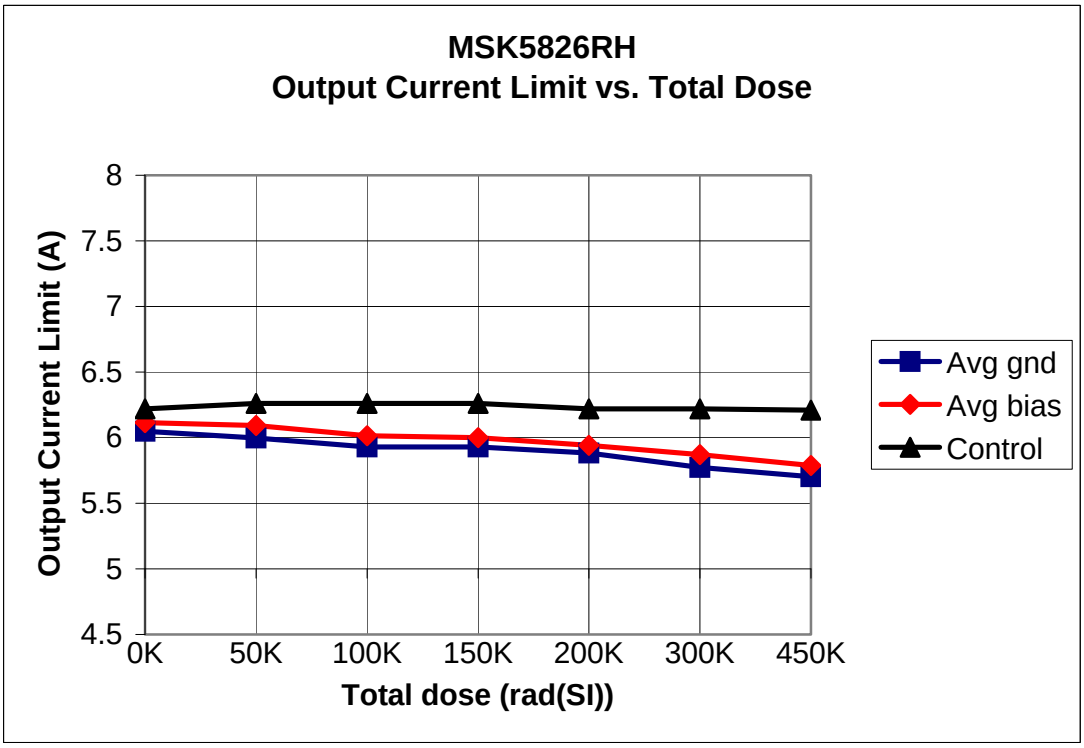
Table 1

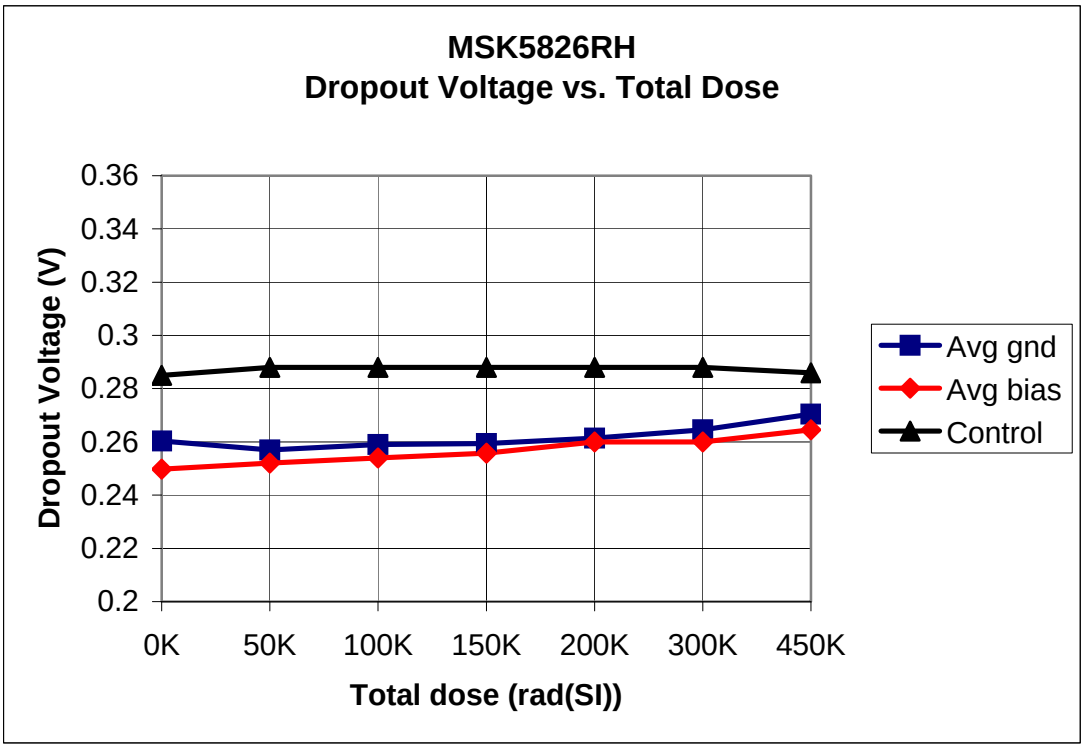
Dose Time, Incremental Dose and Total Cumulative Dose

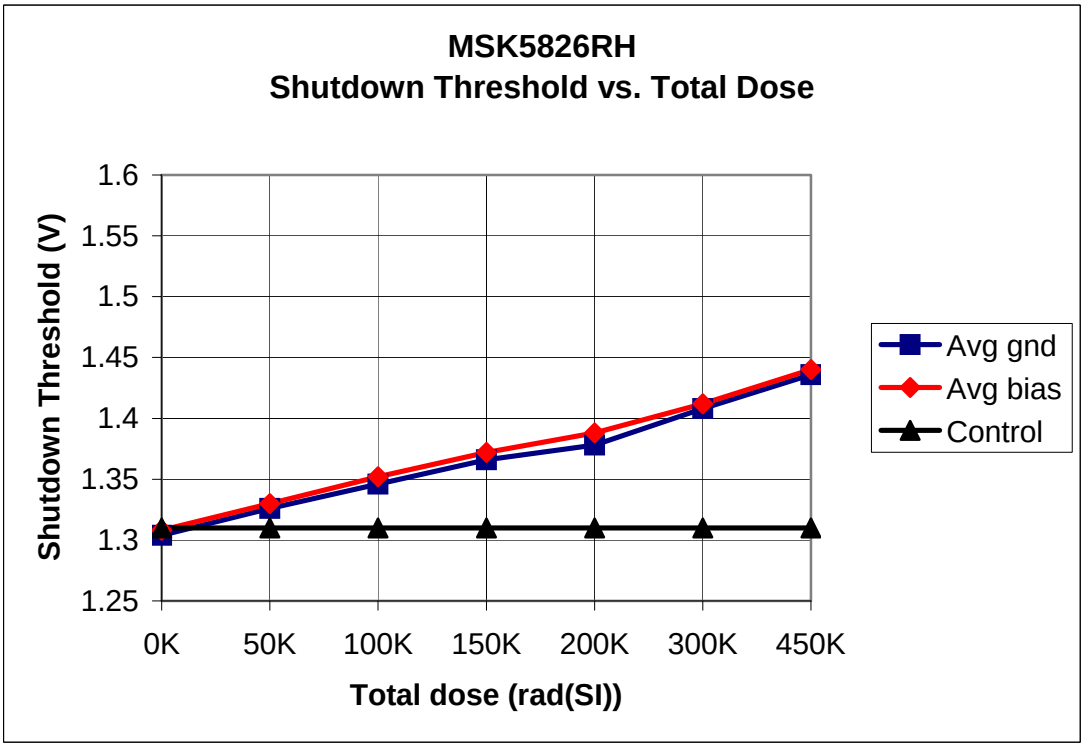

MSK5826RH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.31
1.3
1.29
1.28
1.27
1.26
1.25
1.24
1.23
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control

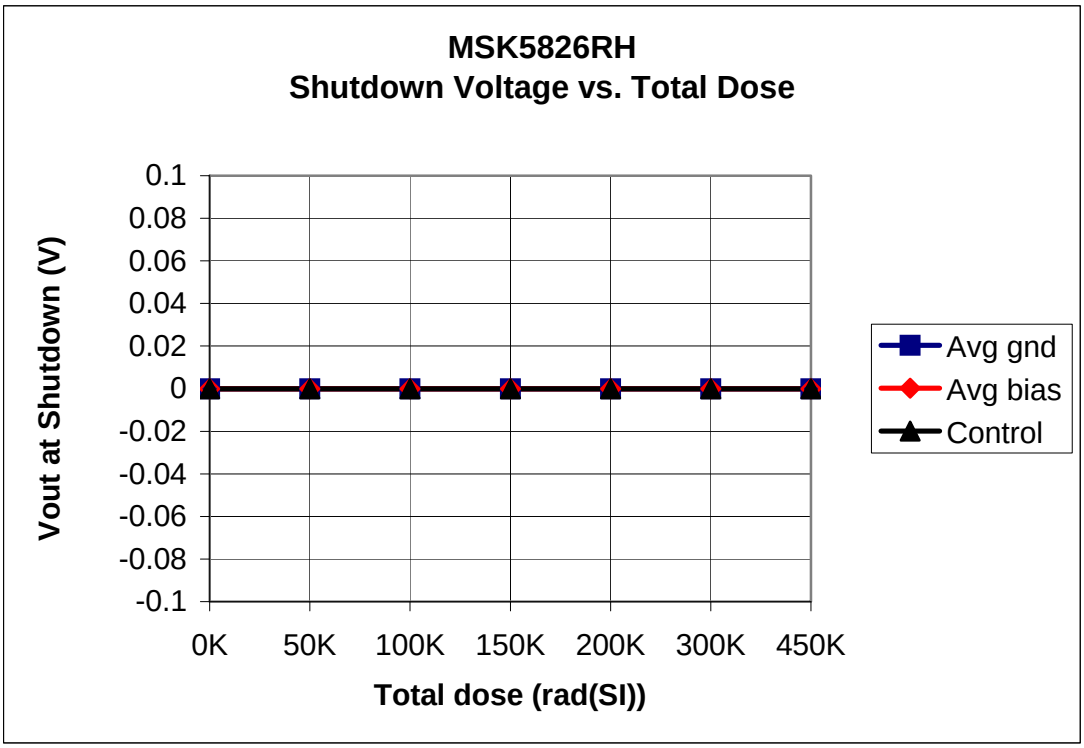

MSK5826RH
Line Regulation vs. Total Dose
Output Voltage Delta (mV)
8
6
4
2
0
-2
-4
-6
-8
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5826RH
Load Regulation vs. Total Dose
Output Voltage Delta (mV)
0
-4
-8
-12
-16
-20
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5826RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
8
7.5
7
6.5
6
5.5
5
4.5
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5826RH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5826RH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.6
1.55
1.5
1.45
1.4
1.35
1.3
1.25
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(SI))
Avg gnd
Avg bias
Control


MSK5826RH
Shutdown Voltage vs. Total Dose
Vout at Shutdown (V)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

ELDRS Radiation Test Report

MSK 5826RH

Radiation Hardened
Ultra Low Dropout
Positive Adjustable Linear Regulator

December 26, 2008 (First Test)
June 18, 2009 (Second Test)

B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The ELDRS radiation test plan for the MSK 5826RH was developed to characterize ELDRS sensitivity for devices incorporating active components including the Linear Tech RH1573 die and a PNP pass transistor. These devices include, but are not limited to, MSK5800RH, MSK5810RH, MSK5820RH, MSK5821RH, MSK5822RH, MSK5823RH, MSK5824RH, MSK5826RH, and MSK5826RH. ELDRS testing was performed to 100Krad(Si) accumulated dose.

MIL-STD-883 Method 1019.7 Condition C and ASTM F1892-06 were used as guidelines in the development and implementation of the ELDRS test plan for the MSK 5826RH.

II. Radiation Source:

ELDRS test was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Dosimetry was performed prior to device irradiation and the dose rate was determined to be 0.01 rads(Si)/sec. The ELDRS 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 electrically tested prior to irradiation. For test platform verification, one control device was tested at 25°C.
The devices were vertically aligned with the radiation source in the University of Massachusetts ELDRS facility, chamber #2. Five devices were kept under bias during irradiation. Maximum recommended operating voltages of + 6.5Volts was used for bias. Five devices had all leads grounded during irradiation for the unbiased condition.
After each irradiation, the device leads were shorted together then the devices were packaged with dry ice for shipment, and shipped overnight to the MSK facility. Electrical testing to the MSK device data sheet was performed within 72 hours from the removal of the radiation source. Testing was performed on irradiated devices, as well as the control device, at each total dose level. Devices were then repackaged with dry ice for shipment and returned to the UMass facility overnight for subsequent dose level. Devices were returned to the irradiation field within 120 hours of removal from the radiation source per MIL-STD-883 Method 1019.7 Condition C. To prove that the device temperature did not exceed the irradiation chamber temperature it was verified that dry ice remained in the shipping container at each point during the shipping process

IV. Data:

All performance curves are averaged from the test results of the biased and unbiased devices respectively.

V. Summary:

The devices stayed within the pre irradiation test limits for all specifications.

A change was noted in reference voltage. An increase of approximately 0.8 % occurred between 0 Krad(Si) and 100 Krad(si). However the devices still remained within pre irradiation limits.

Line regulation, load regulation, and dropout voltage remained virtually unchanged throughout irradiation.

Shutdown threshold did exhibit a 6% increase, but still stayed within all test limits.

The output current limit of the devices decreased by approximately 7 %. The final current limit after irradiation remained nearly double the production limit minimum of 3 Amps however.

MSK 5826RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

Irradiation Date
1/21/2009 – 6/10/2009

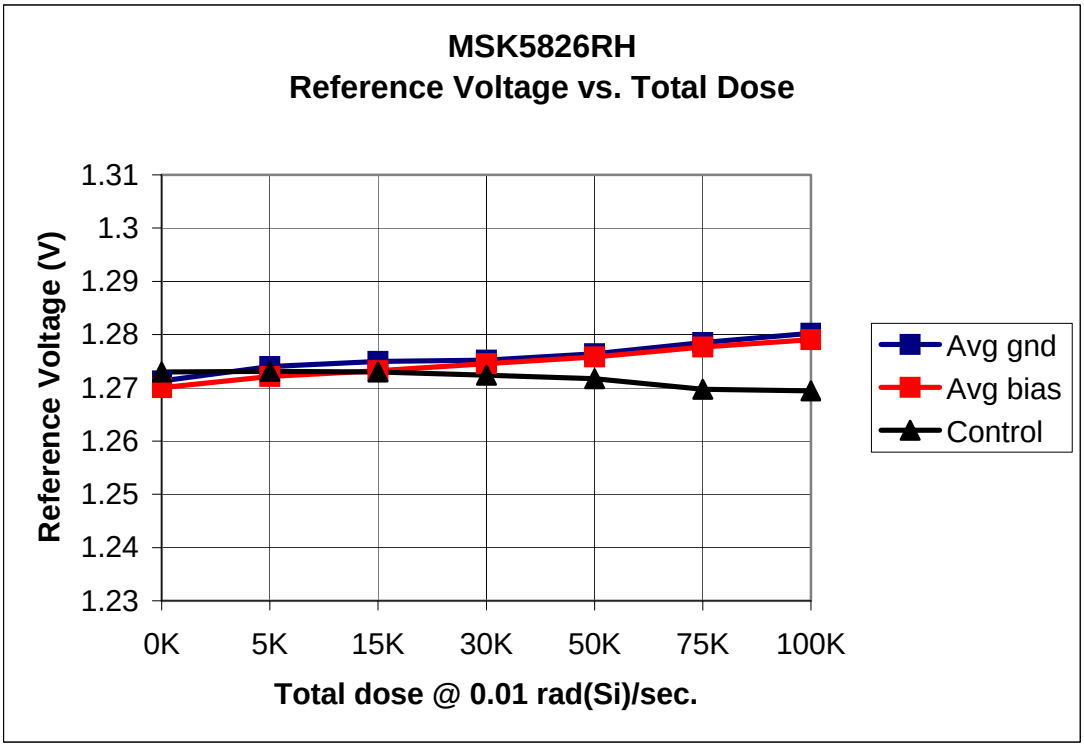
Exposure Length (hr:min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
142:28:00	4.96E3	4,960
260:42:00	9.05E3	14,000
431:44:00	1.49E4	28,900
617:35:00	2.12E4	50,100
758:48:00	2.57E4	75,800
815:07:07	2.73E4	103,000

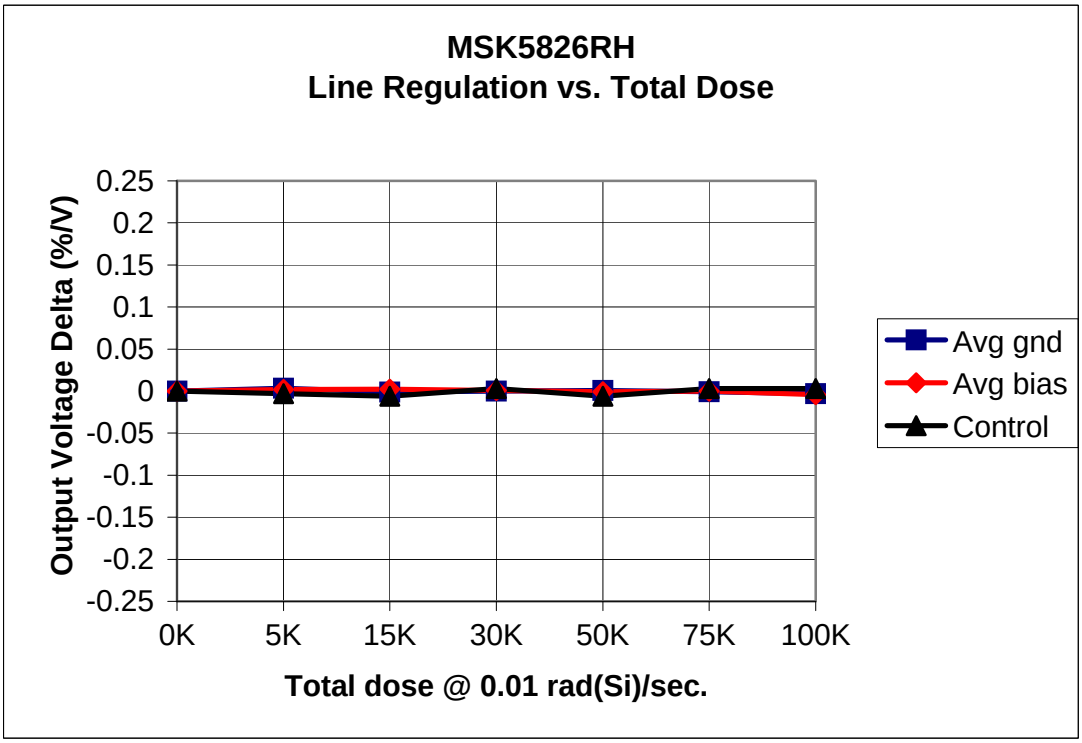
Biased S/N – 0001, 0002, 0003, 0004, 0005

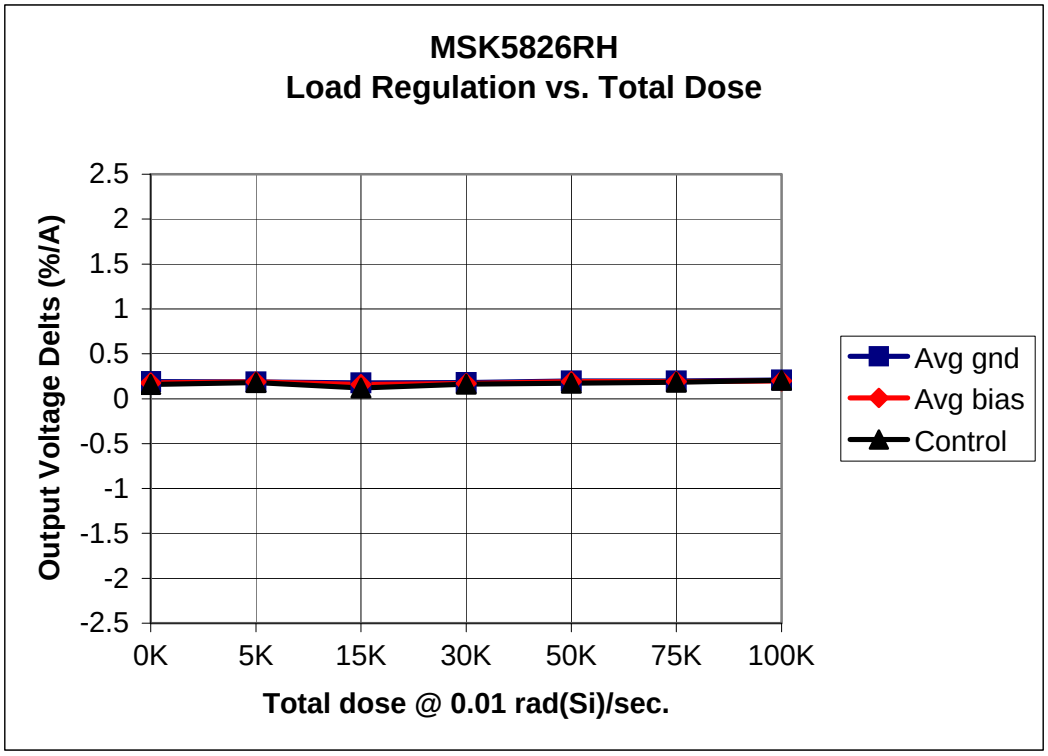
Unbiased S/N – 0006, 0007, 0008, 0009, 0010

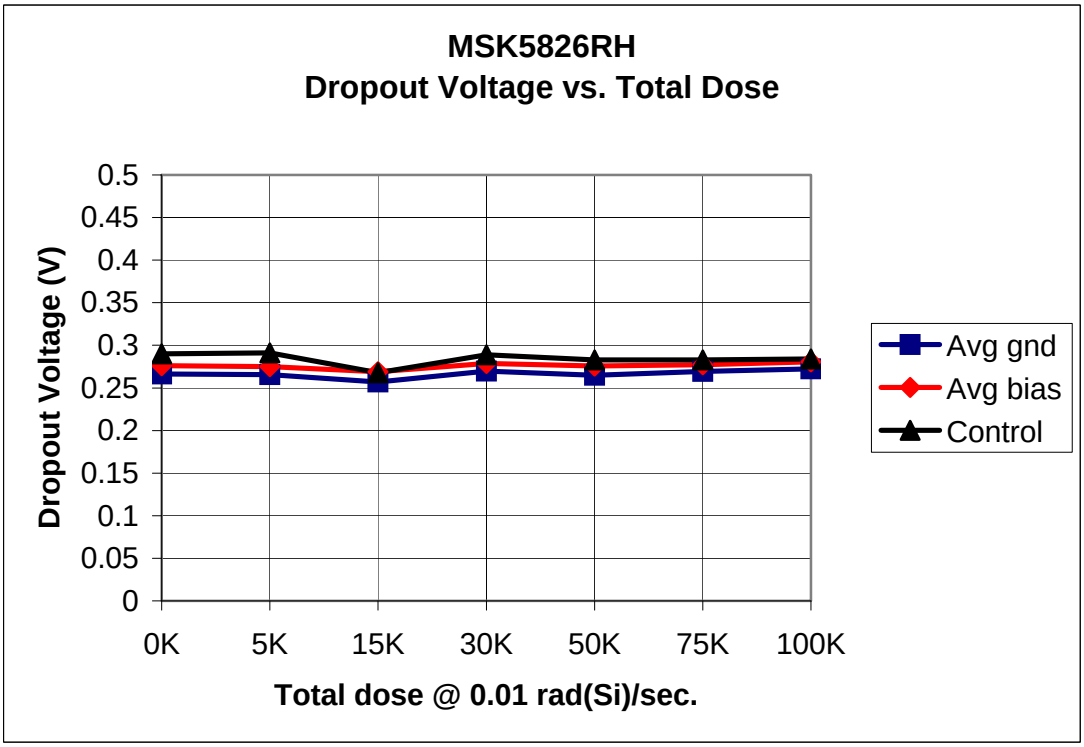
Table 1

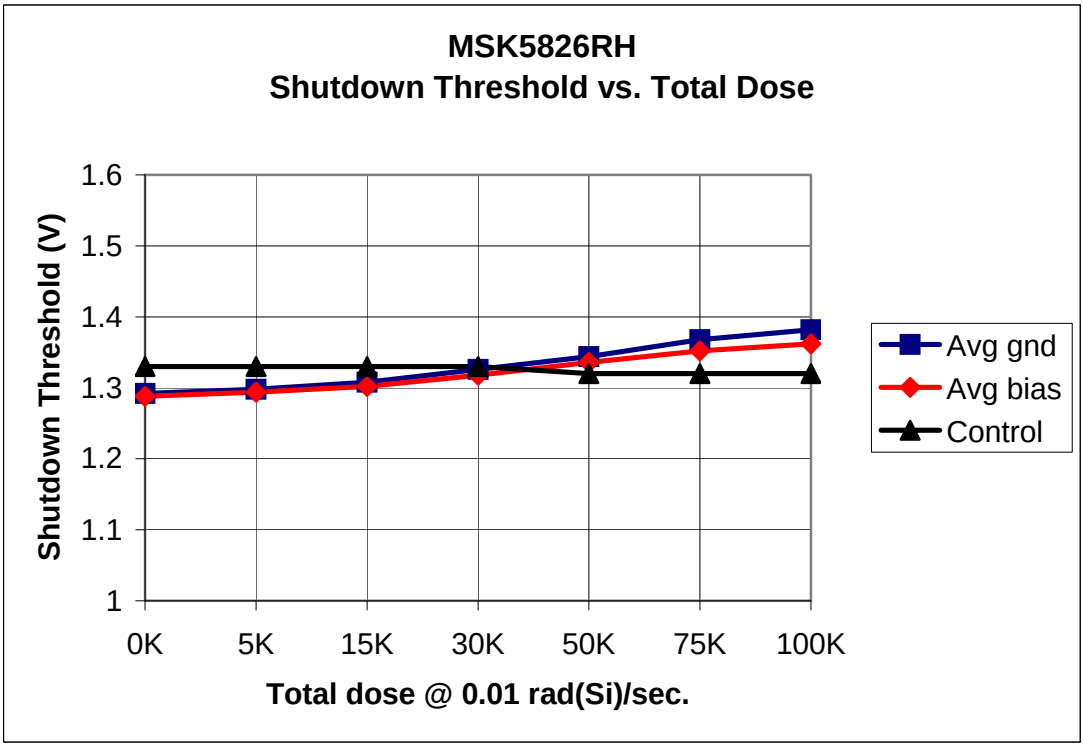
Dose Time, Incremental Dose and Total Cumulative Dose

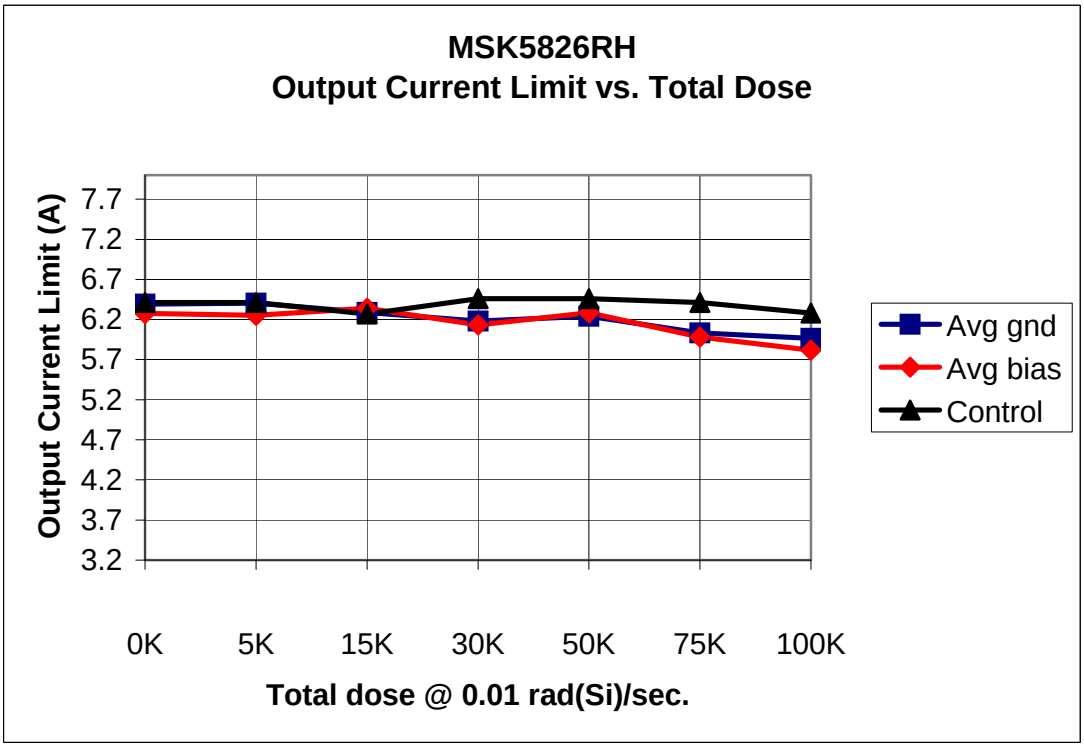

MSK5826RH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.31
1.3
1.29
1.28
1.27
1.26
1.25
1.24
1.23
0K
5K
15K
30K
50K
75K
100K
Total dose @ 0.01 rad(Si)/sec.
Avg gnd
Avg bias
Control

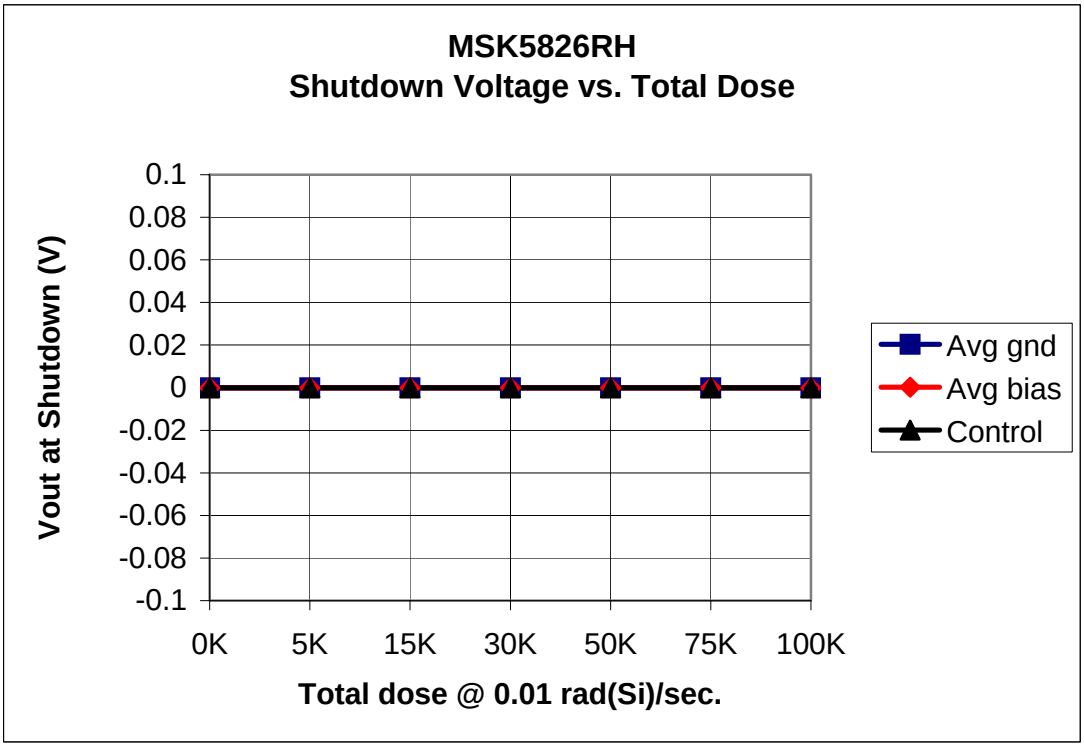

MSK5826RH
Line Regulation vs. Total Dose
Output Voltage Delta (%/V)
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
0K
5K
15K
30K
50K
75K
100K
Total dose @ 0.01 rad(Si)/sec.
Avg gnd
Avg bias
Control


MSK5826RH
Load Regulation vs. Total Dose
Output Voltage Delts (%/A)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
0K
5K
15K
30K
50K
75K
100K
Total dose @ 0.01 rad(Si)/sec.
Avg gnd
Avg bias
Control


MSK5826RH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0K
5K
15K
30K
50K
75K
100K
Total dose @ 0.01 rad(Si)/sec.
Avg gnd
Avg bias
Control


MSK5826RH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.6
1.5
1.4
1.3
1.2
1.1
1
0K
5K
15K
30K
50K
75K
100K
Total dose @ 0.01 rad(Si)/sec.
Avg gnd
Avg bias
Control


MSK5826RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
7.7
7.2
6.7
6.2
5.7
5.2
4.7
4.2
3.7
3.2
0K
5K
15K
30K
50K
75K
100K
Total dose @ 0.01 rad(Si)/sec.
Avg gnd
Avg bias
Control


MSK5826RH
Shutdown Voltage vs. Total Dose
Vout at Shutdown (V)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0K
5K
15K
30K
50K
75K
100K
Total dose @ 0.01 rad(Si)/sec.
Avg gnd
Avg bias
Control

Total Dose Radiation Test Report

MSK 5826RH
(MSK5823RH, MSK5824RH, MSK5825RH)

RAD Hard Ultra Low Dropout
Adjustable Positive Linear Regulator

December 26, 2008

J. Douglas
B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5826RH series 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 MSK5823RH, MSK5824RH, MSK5825RH and MSK5826RH all use the same active components. The data in this report is from the direct measurement of the MSK5826RH response to irradiation but it is indicative of the response of all four device types and is applicable to all four 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 5826RH.

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 185 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 at 25°C in accordance with the device data sheet. In addition, all devices received 320 hours of burn-in per MIL-STD-883 Method 1015. 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 +6.5V 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 transported to the MSK automatic electrical test platform and tested IAW 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:

Based on the test data recorded during radiation testing and statistical analysis, the MSK5826RH qualified as a 300 Krad(Si) radiation hardened device. Reference Voltage, Shutdown Threshold and Output Current Limit exhibited the most significant shift due to irradiation, however all performance curves stayed within specification up to 450 Krad(Si) TID.

MSK 5826RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

Irradiation Date
12/16/08

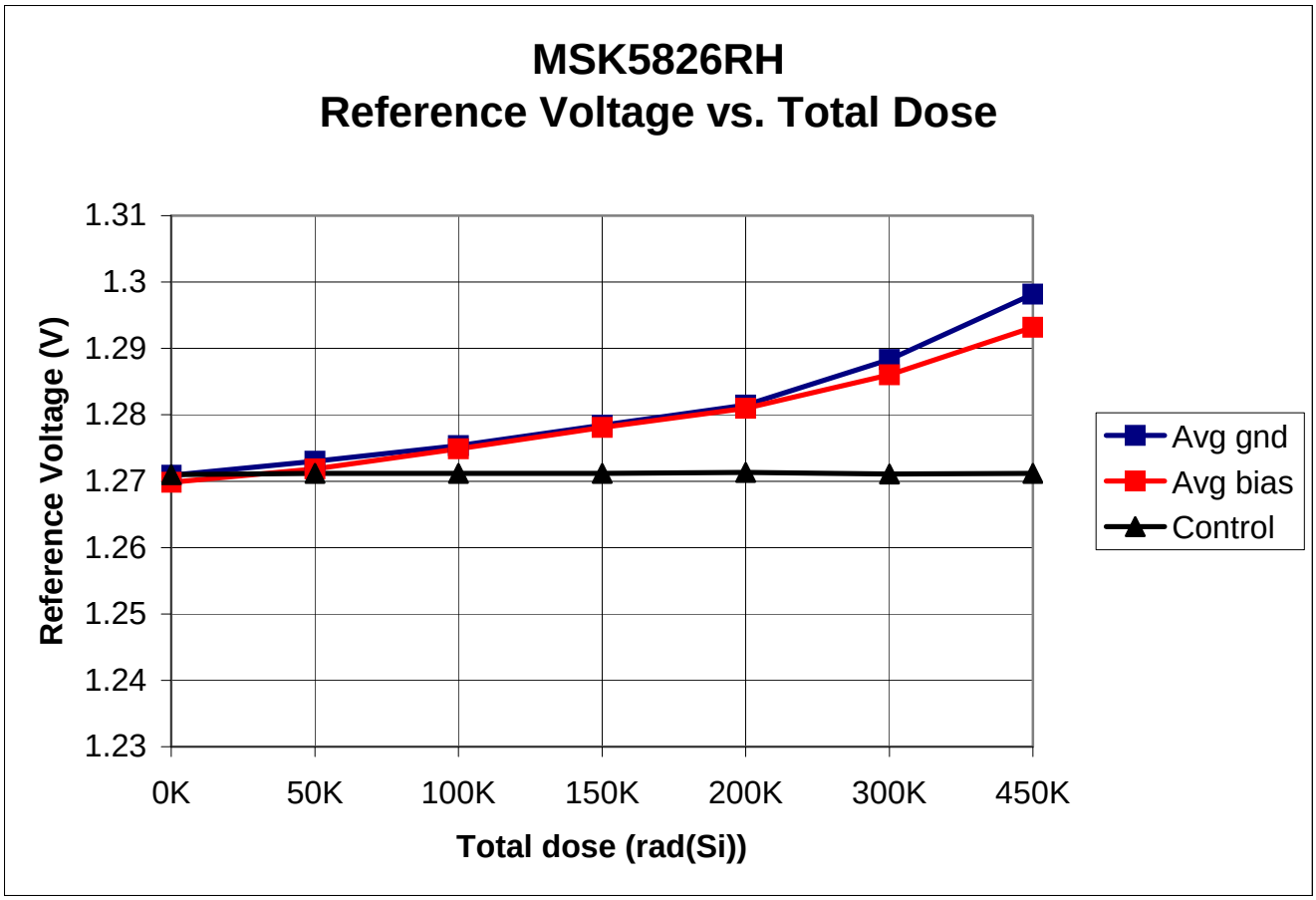
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
4:38	51,430	51,430
4:38	51,430	102,860
4:38	51,430	154,290
4:38	51,430	205,720
9:17	103,045	308,765
13:55	154,475	463,240

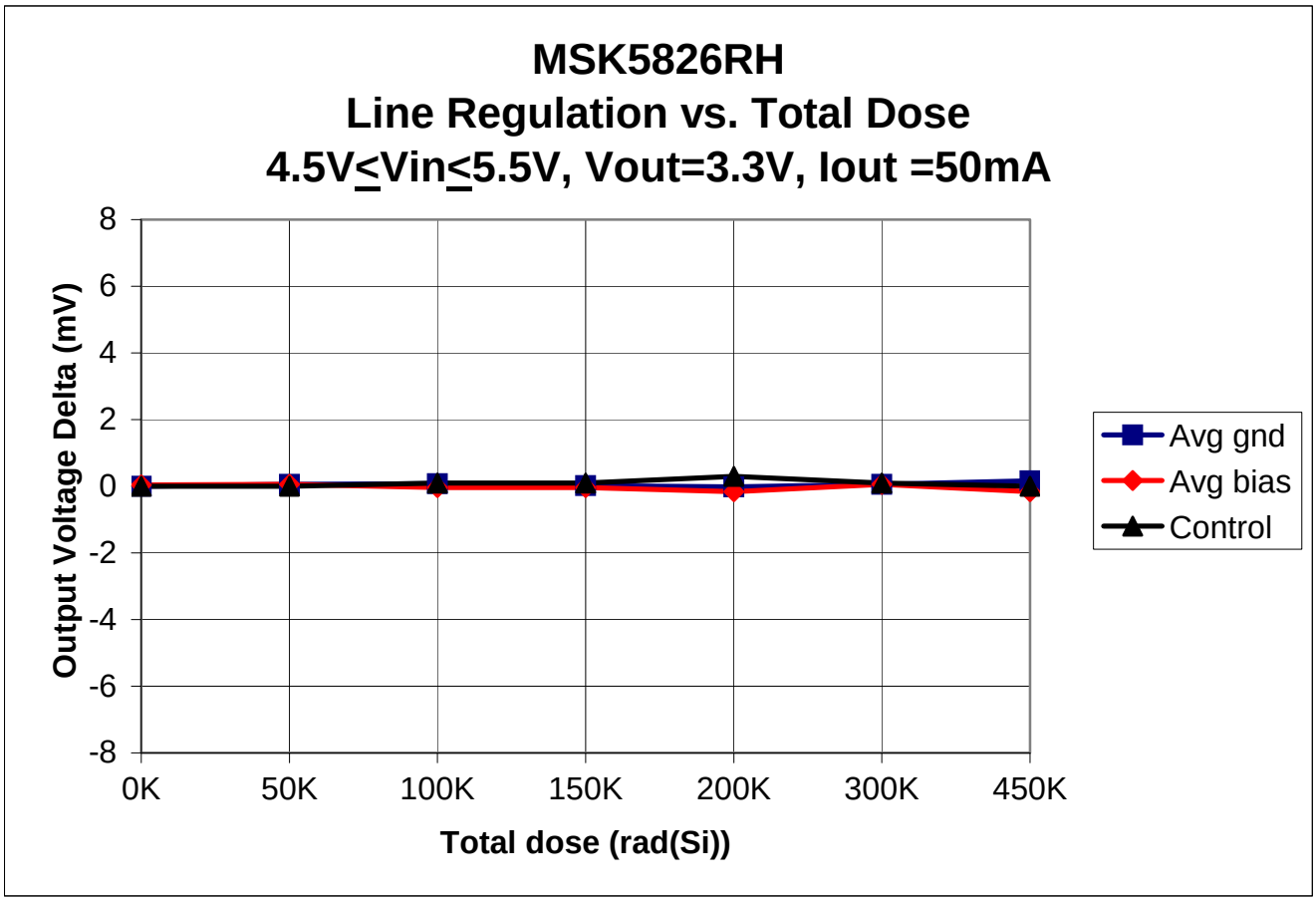
Biased S/N – 0021, 0022, 0023, 0024, 0025

Unbiased S/N – 0026, 0027, 0028, 0029, 0030

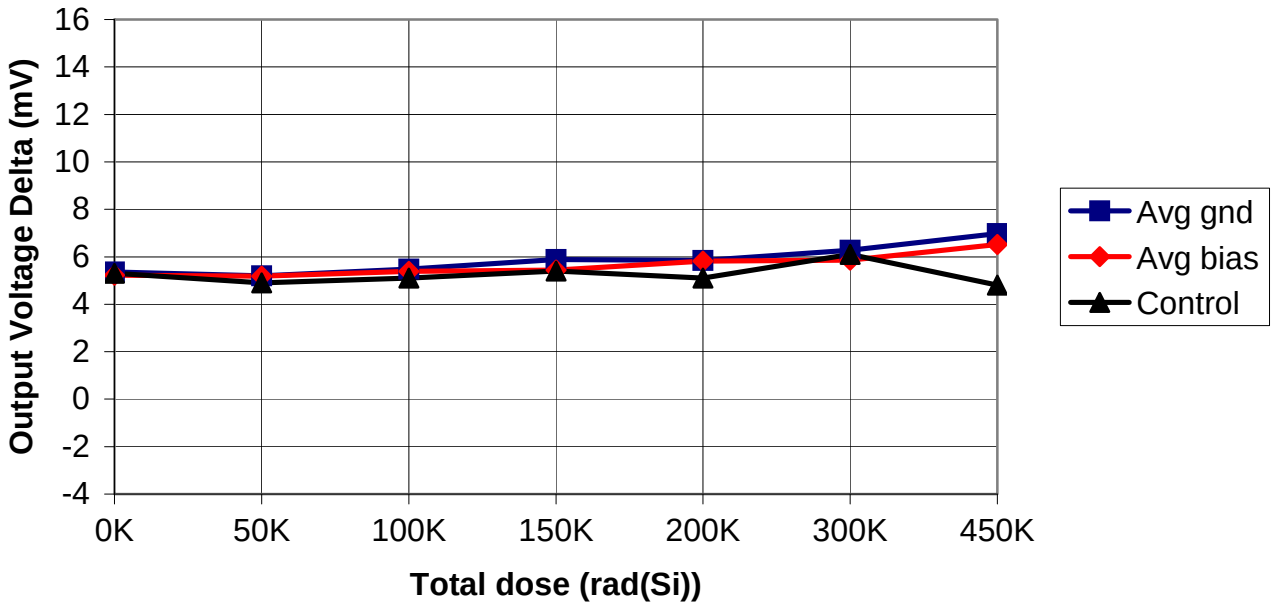
Table 1

Dose Time, Incremental Dose and Total Cumulative Dose

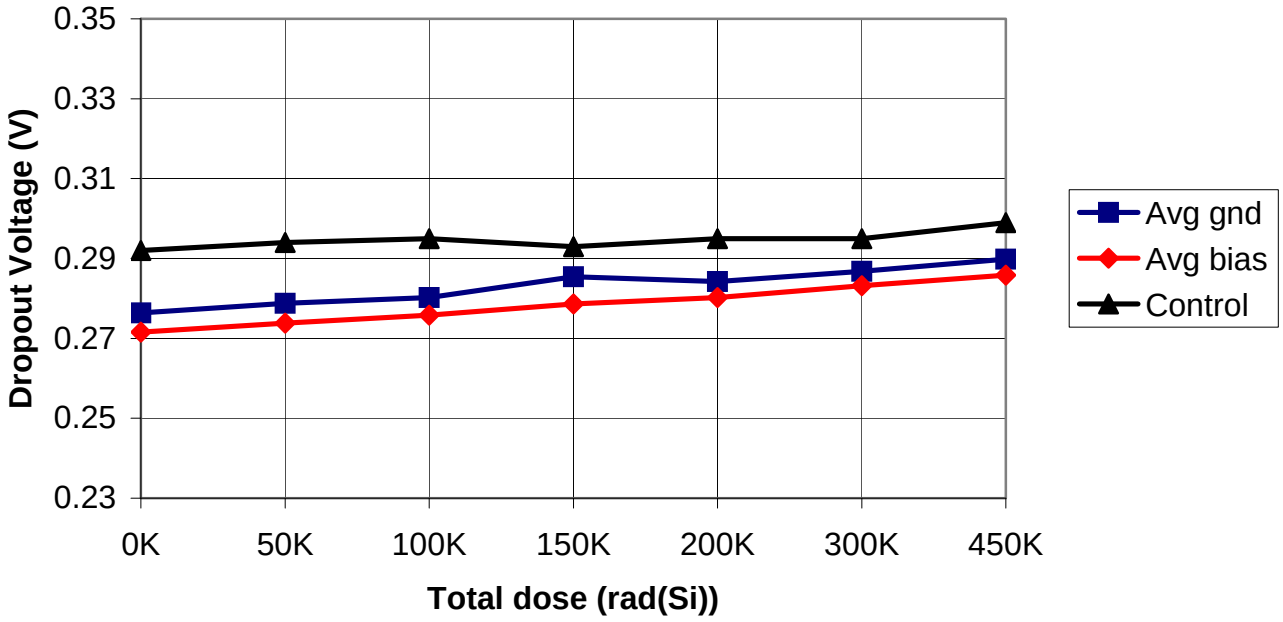

MSK5826RH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.31
1.3
1.29
1.28
1.27
1.26
1.25
1.24
1.23
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

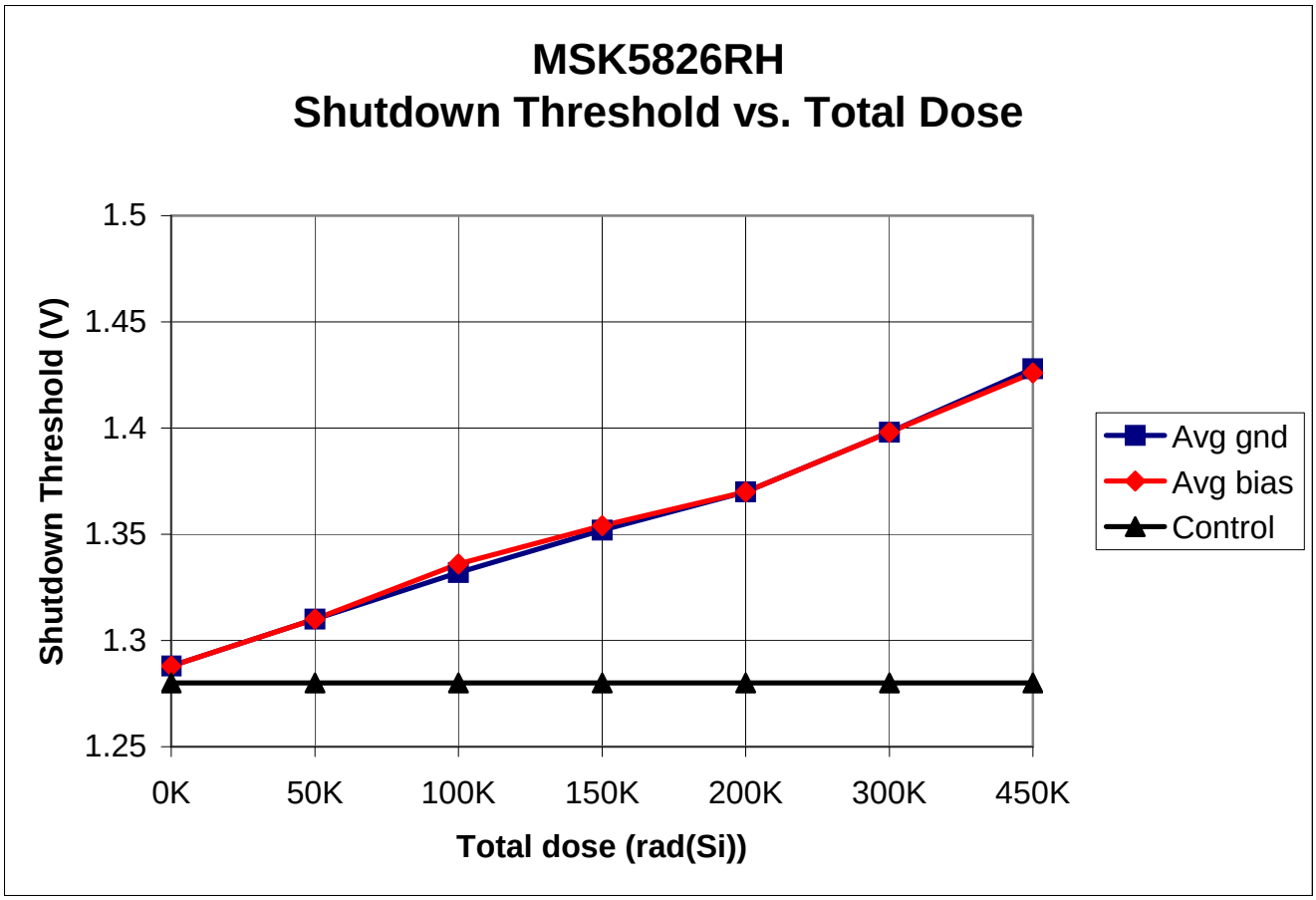

MSK5826RH
Line Regulation vs. Total Dose
4.5V≤Vin≤5.5V, Vout=3.3V, Iout =50mA
Output Voltage Delta (mV)
8
6
4
2
0
-2
-4
-6
-8
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

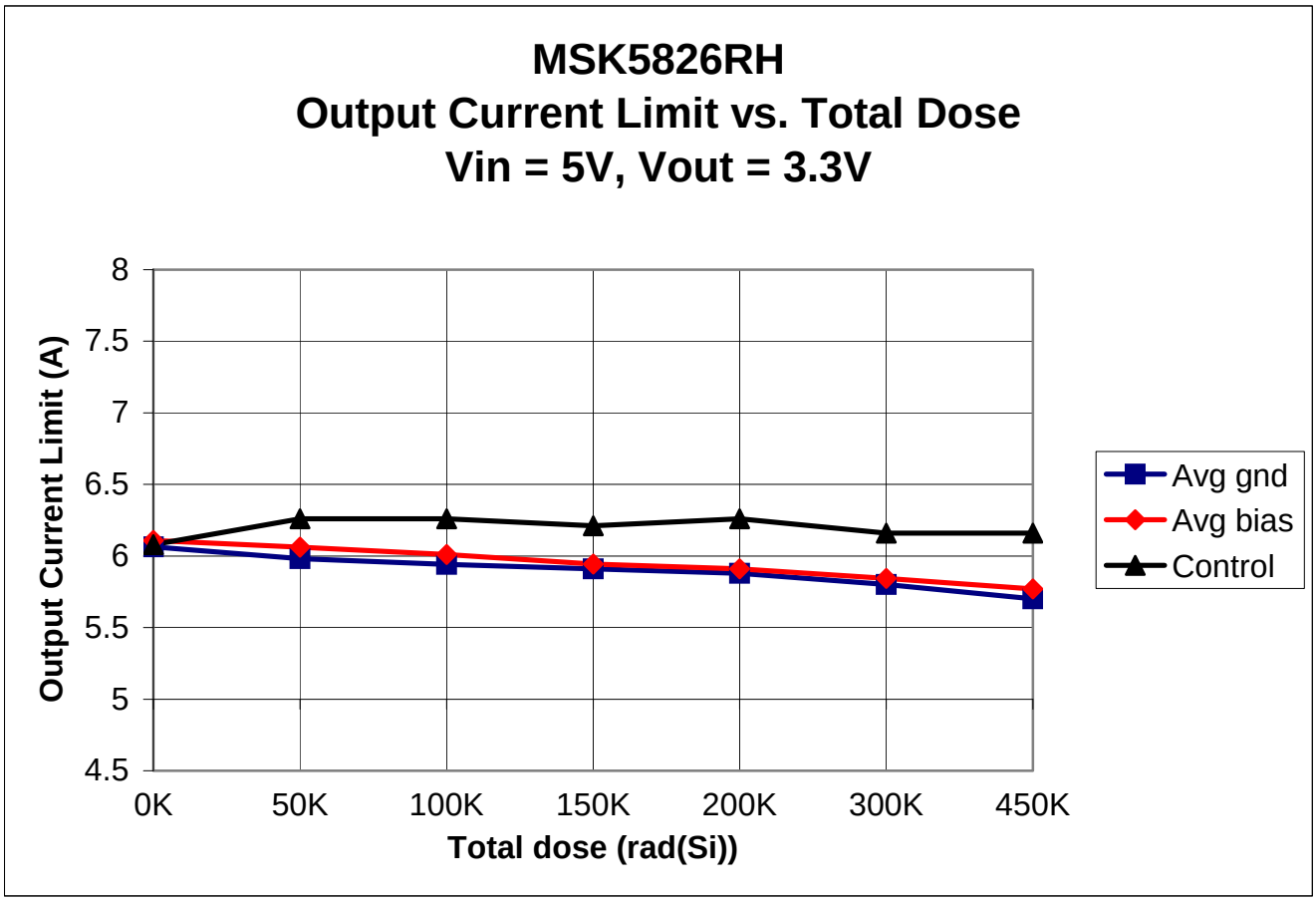
MSK5826RH
Load Regulation vs. Total Dose
Vin=5.0V, Vout=3.3V, 50mA≤Iout≤3.0A

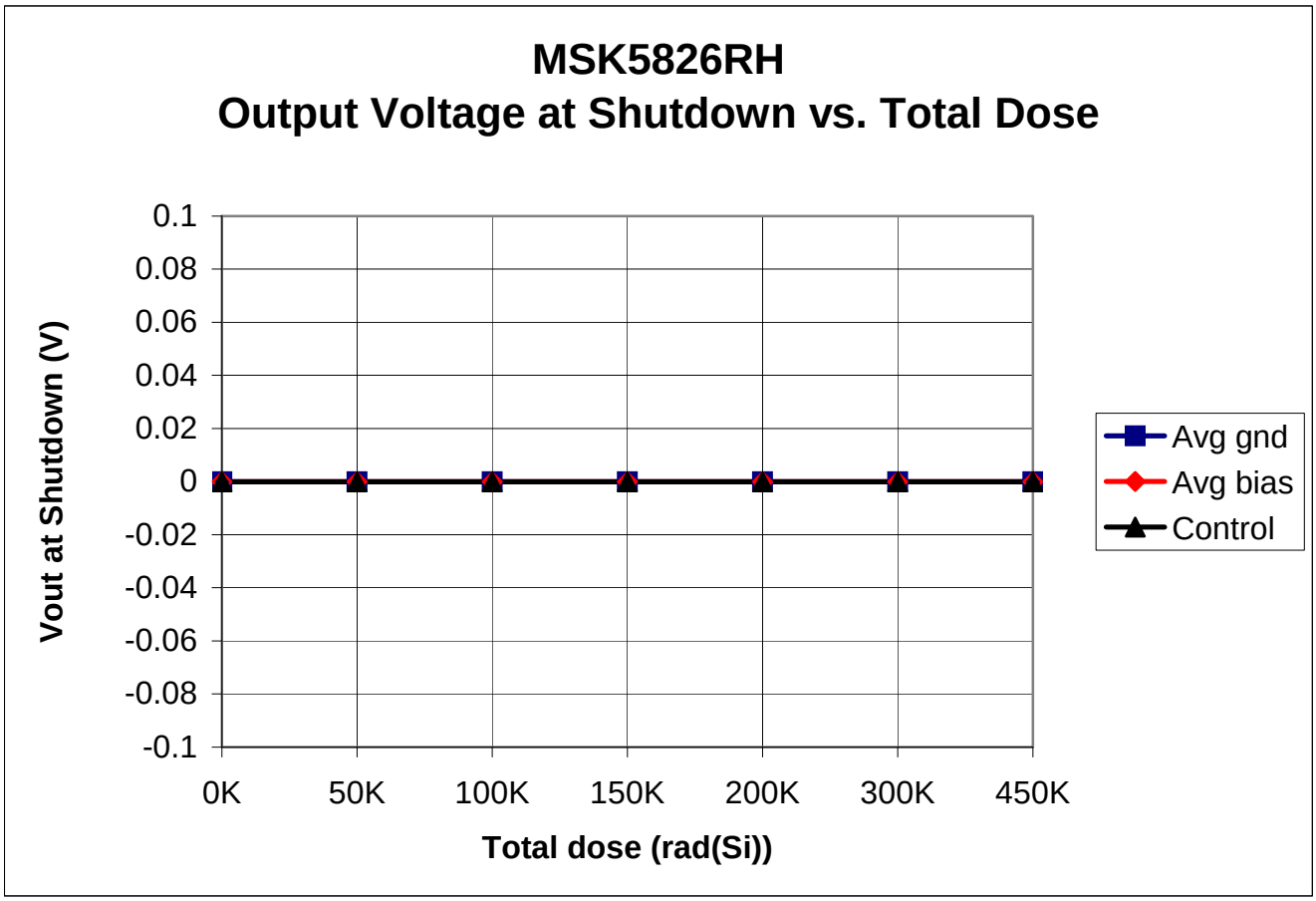


MSK5826RH
Dropout Voltage vs. Total Dose
Iout = 3A




MSK5826RH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.5
1.45
1.4
1.35
1.3
1.25
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826RH
Output Current Limit vs. Total Dose
Vin = 5V, Vout = 3.3V
Output Current Limit (A)
8
7.5
7
6.5
6
5.5
5
4.5
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5826RH
Output Voltage at Shutdown vs. Total Dose
Vout at Shutdown (V)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0K
50K
100K
150K
200K
300K
450K
Total dose (rad(Si))
Avg gnd
Avg bias
Control