Total Dose Radiation Test Report

MSK5970KRH

RAD Hard Positive Voltage Regulator

May 14, 2009 (TID - First Test, WAFER LOT: 46233.3W#8)
Updated July 10, 2010
July 16, 2010 (TID – Second Test, WAFER LOT: 550635.2W#4)
June 14, 2013 (TID – Third Test, WAFER LOT: W10913024.1W#19)

B. Horton
C. Salce
P. Dinneen

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK5970KRH 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.

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 MSK5970KRH 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 93 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 +25 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:

The reference voltage decreased an average of -0.8% up to the maximum specified dose but remained well with specification.

All other parameters exhibited slight shifts with irradiation and remained well within specification through 150Krad(Si) TID.

MSK5970RH Dose Rate Schedule
Dosimetry Equipment
Bruker Biospin # 0141
Irradiation Date
6/13/13

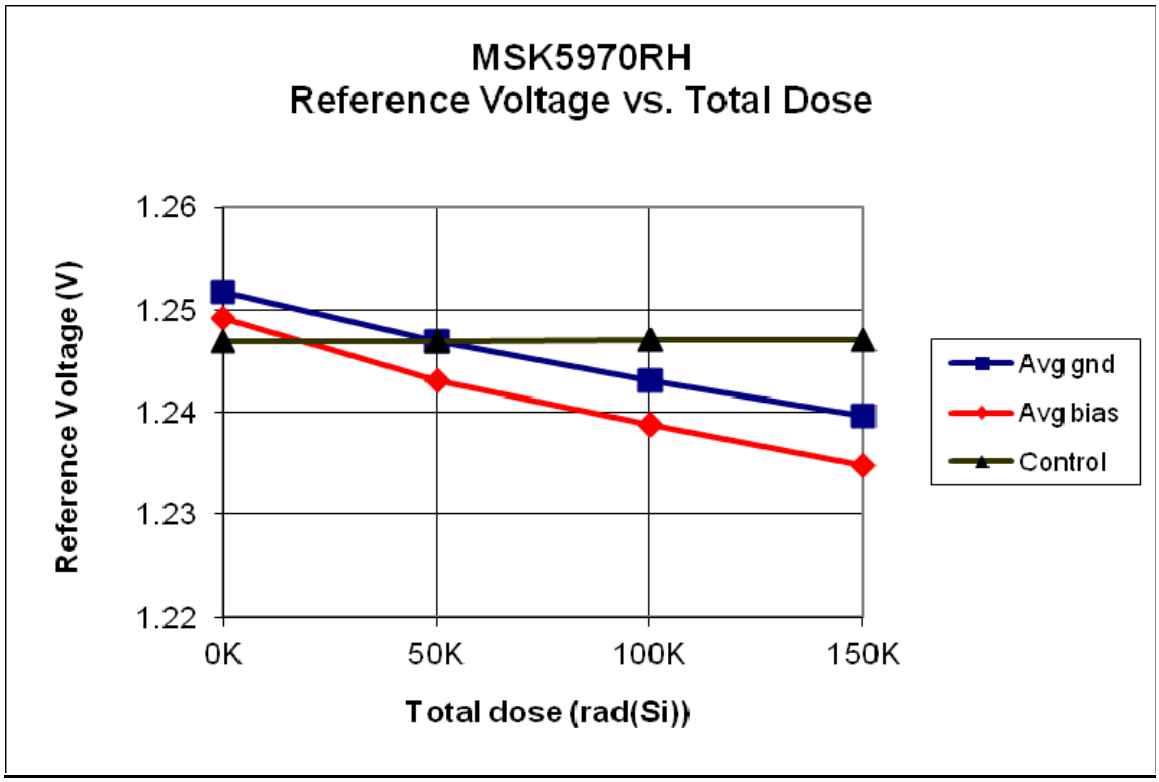
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
9:14	51,522	51,522
9:14	51,522	103,044
9:14	51,522	154,566

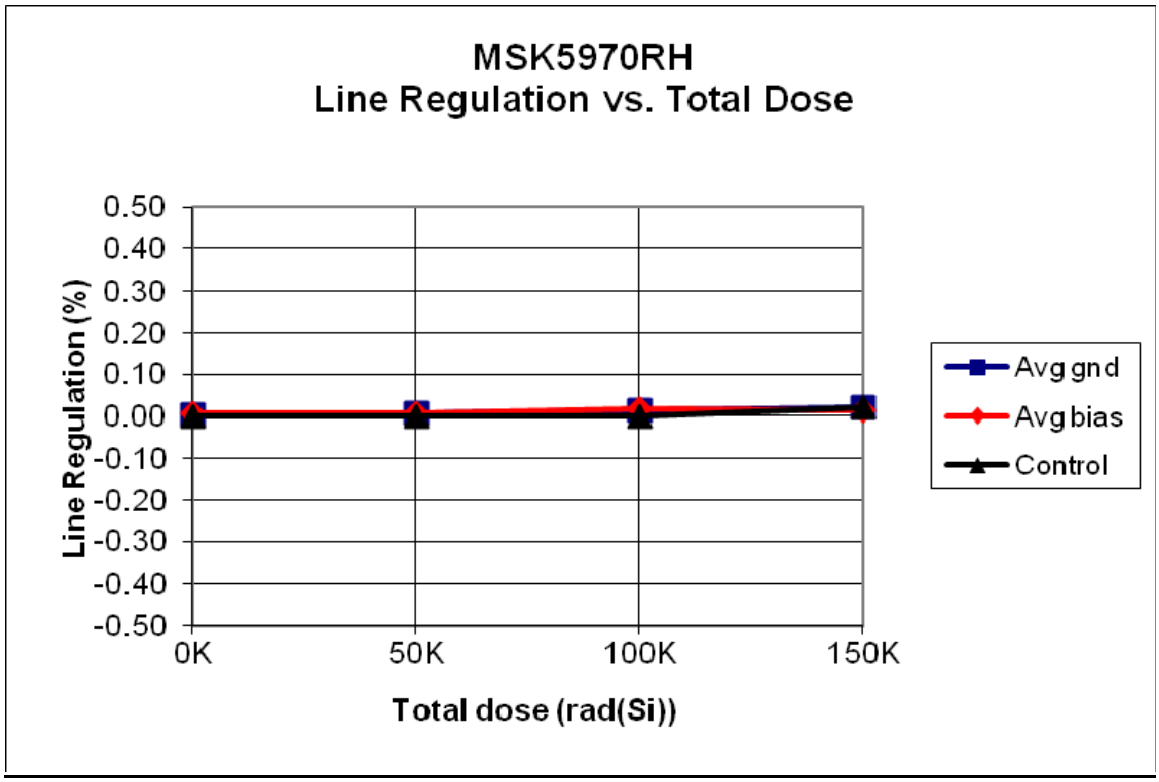
Biased S/N – 1656, 1657, 1658, 1659, 1660

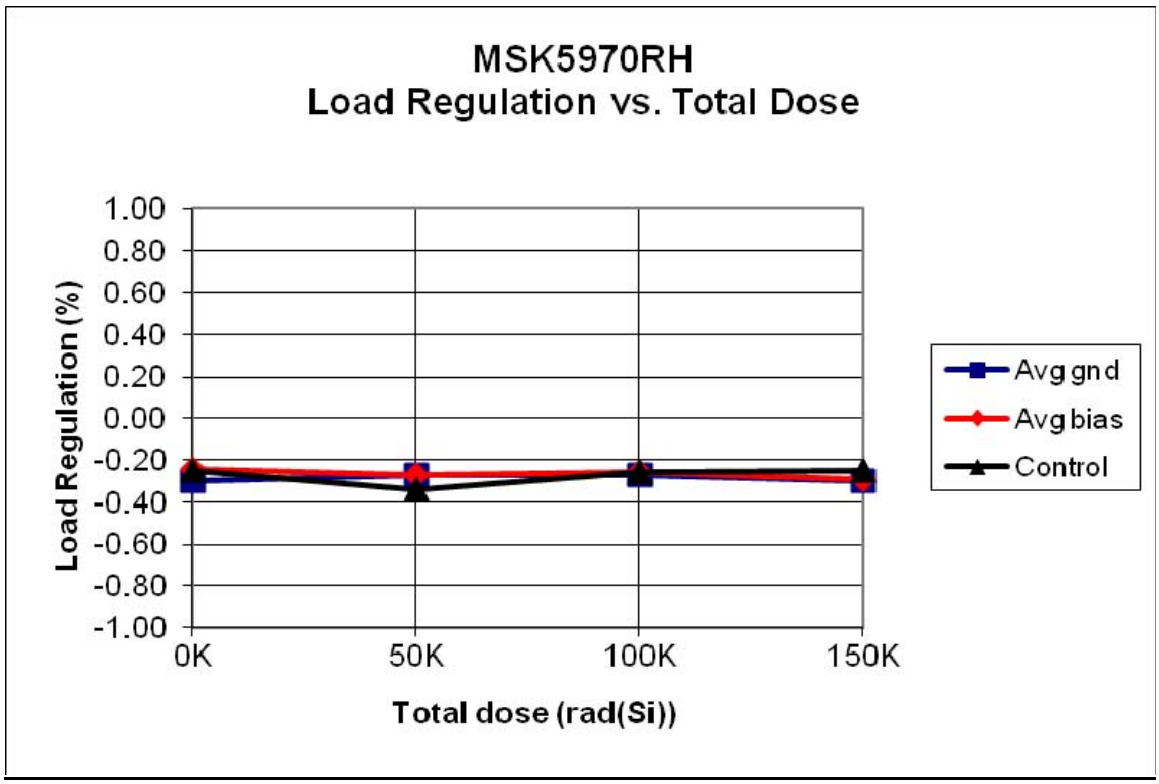
Unbiased S/N – 1661, 1662, 1663, 1664, 1665

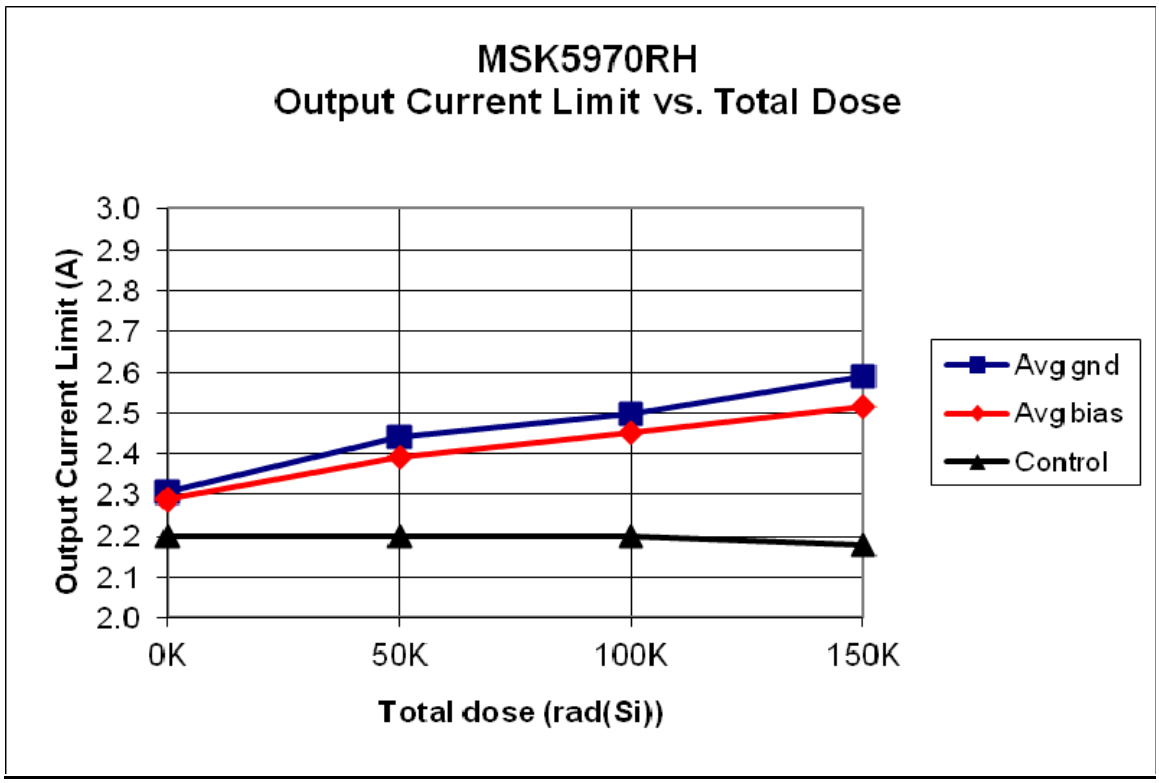
Table 1

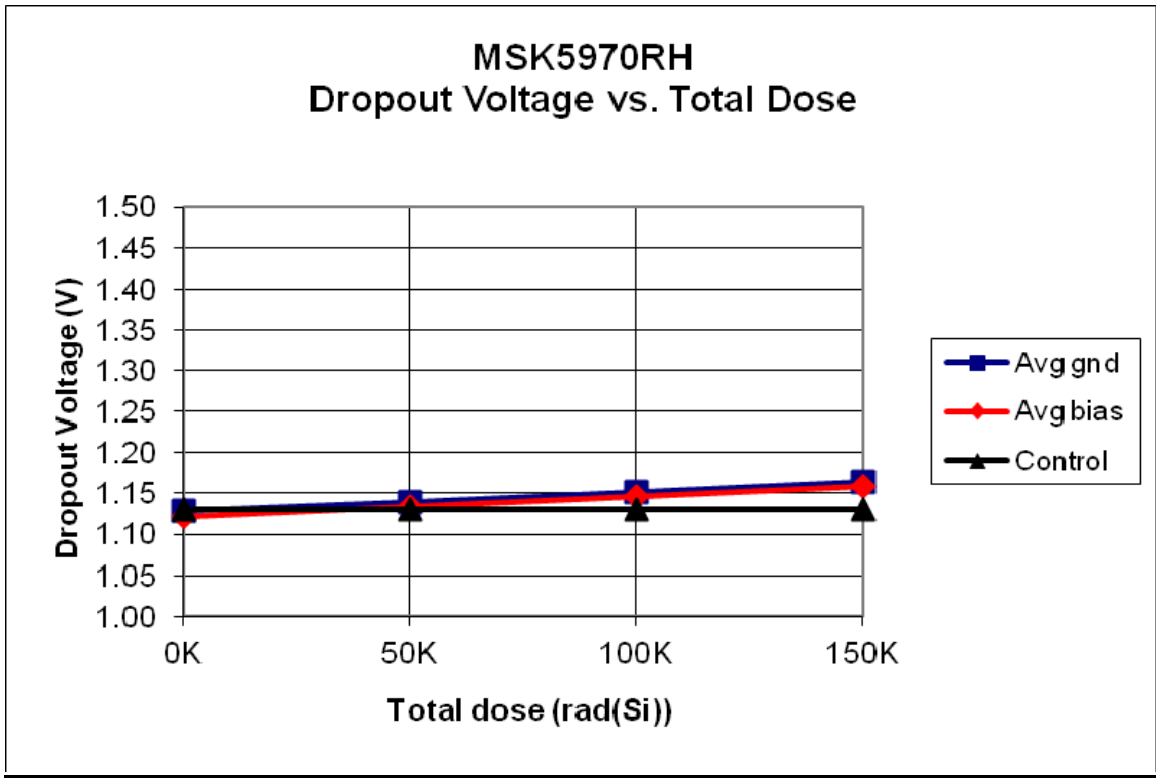
Dose Time, Incremental Dose and Total Cumulative Dose


MSK5970RH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.26
1.25
1.24
1.23
1.22
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970RH
Line Regulation vs. Total Dose
Line Regulation (%)
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970RH
Load Regulation vs. Total Dose
Load Regulation (%)
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970RH
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

Total Dose Radiation Test Report

MSK5970KRH and MSK5970KRHL

RAD Hard Positive Voltage Regulator

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

M. Bilecki
B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK5970KRH 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 MSK5970KRH and the MSK5970KRHL use the same active component. The data in this report is from direct measurement of both the MSK5970KRH and MSK5970KRHL and indicates the similarity 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 MSK5970KRH 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 of both device types were kept under bias during irradiation. Maximum recommended operating voltage of +25 Volts was used for the bias condition. For the MSK5970KRH, five devices had all leads grounded during irradiation for the unbiased condition. For the MSK5970KRHL, four devices had leads grounded 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. Reference voltage shift for both device types was typically less than 1% at 100Krad(Si) and less than 2% at 200Krad(Si).

Dropout voltage showed a slight increase, but also stayed within pre-irradiation limits up to 200 Krad(Si).

Output Current Limit increased slightly throughout all test points up to 200Krad(Si) .

MSK5970KRH 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
6:22	51,570	206,280

Biased S/N – 0249, 0250, 0251, 0252, 0253

Unbiased S/N – 0254, 0255, 0256, 0258, 0259

MSK5970KRHL Biased/Unbiased Dose Rate Schedule
Dosimetry Equipment
Bruker Biospin # 0141
Irradiation Date
7/16/10

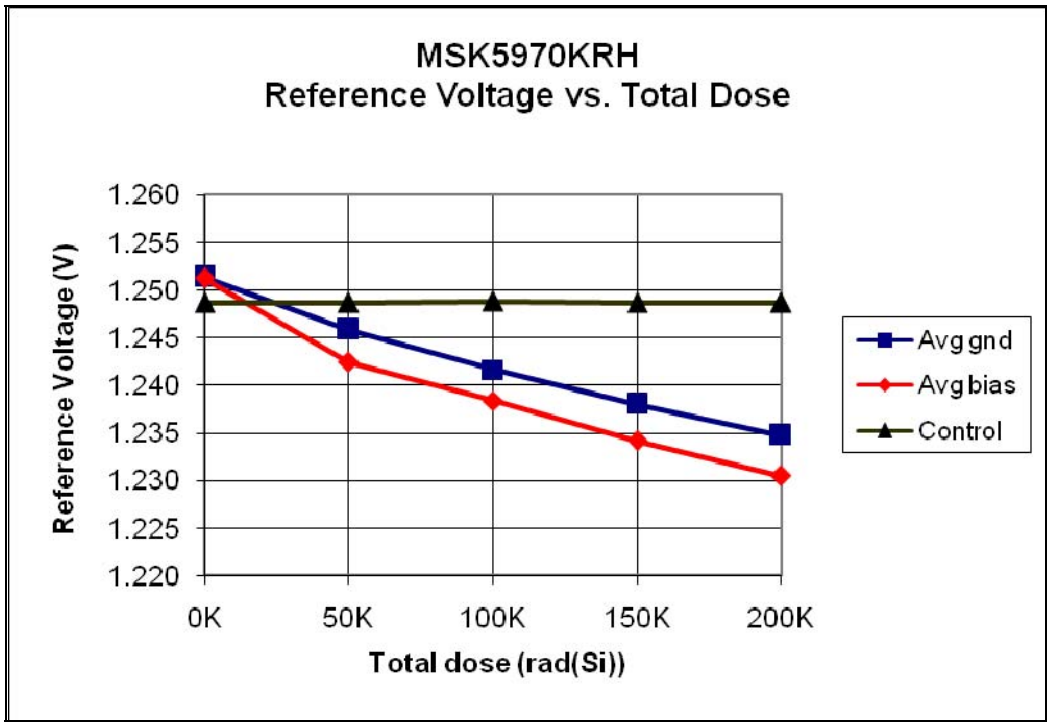
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
6:22	51,570	51,570
6:22	51,570	103,140
6:22	51,570	154,710
6:22	51,570	206,280

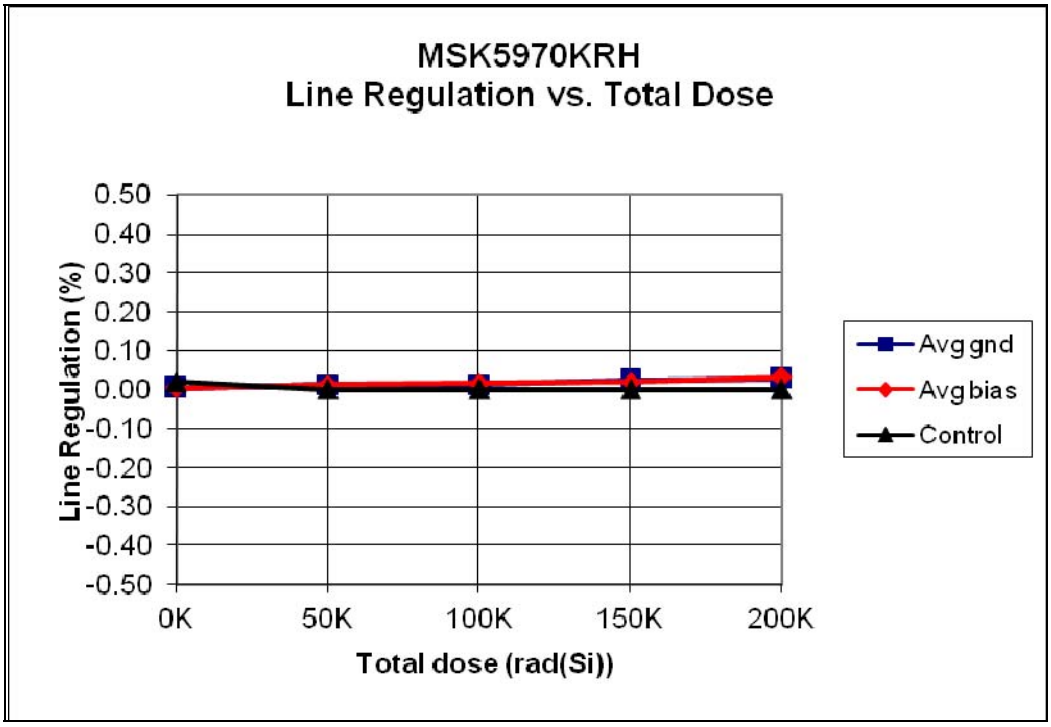
Biased S/N – 0194, 0195, 0196, 0197, 0198

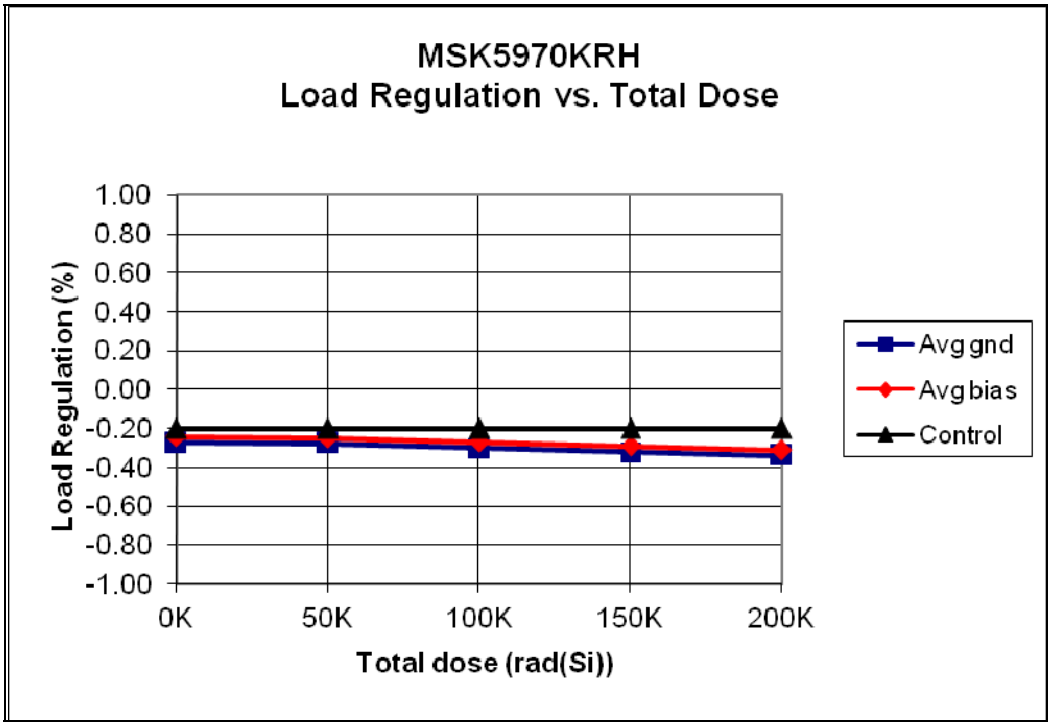
Unbiased S/N – 0199, 0200, 0201, 0202

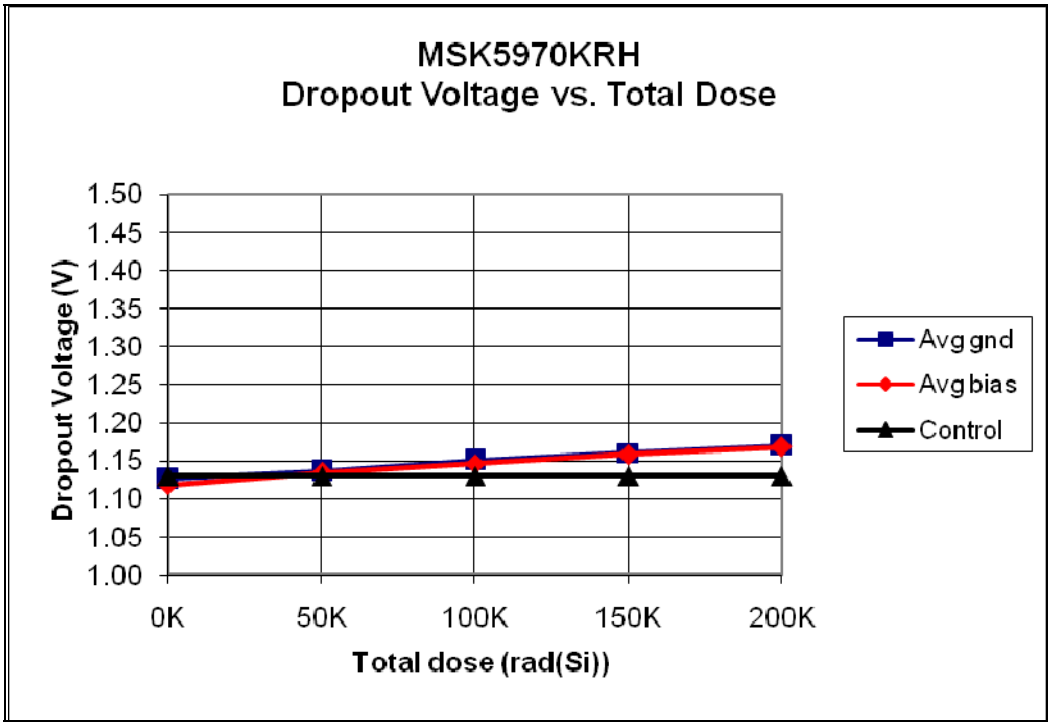
Table 1

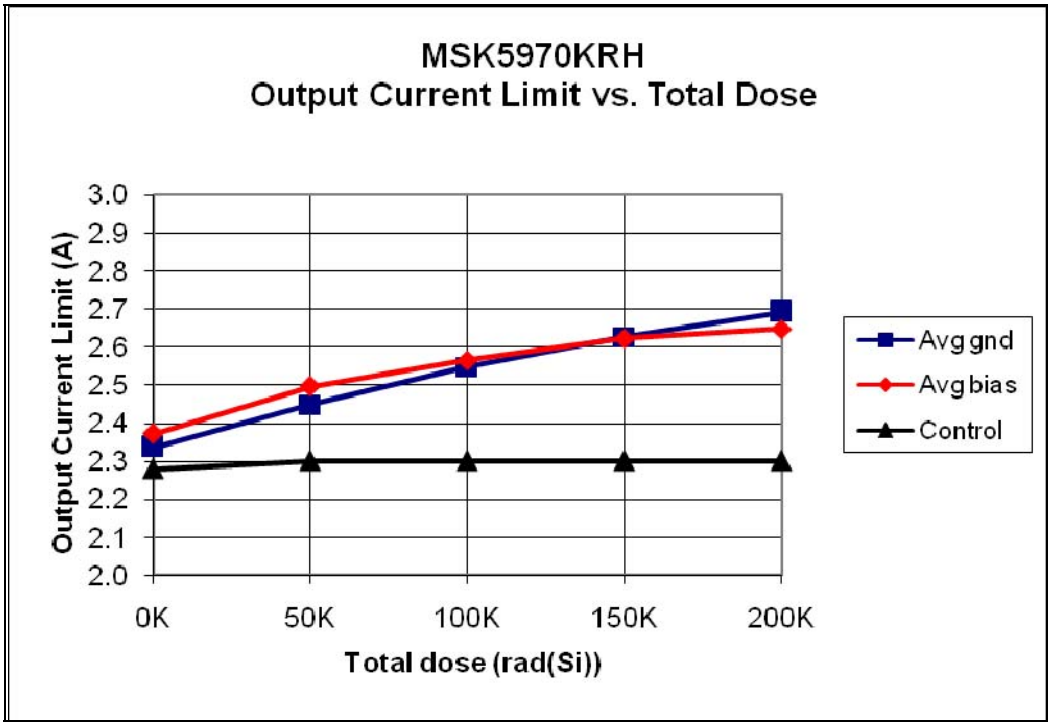
Dose Time, Incremental Dose and Total Cumulative Dose

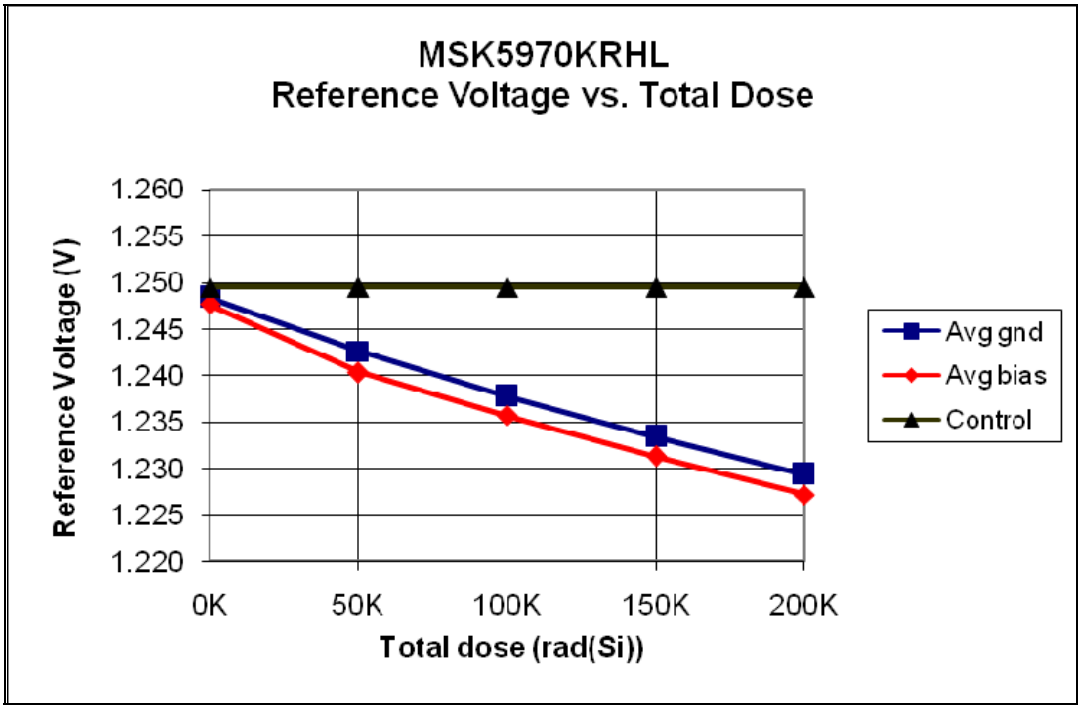

MSK5970KRH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.260
1.255
1.250
1.245
1.240
1.235
1.230
1.225
1.220
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

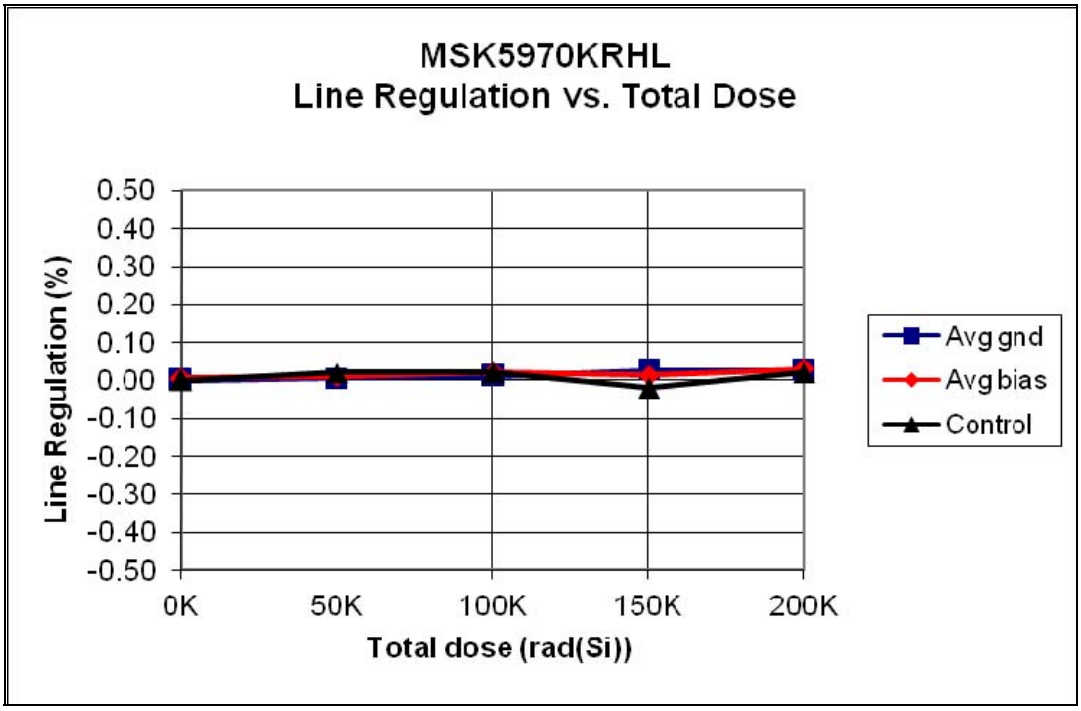

MSK5970KRH
Line Regulation vs. Total Dose
Line Regulation (%)
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

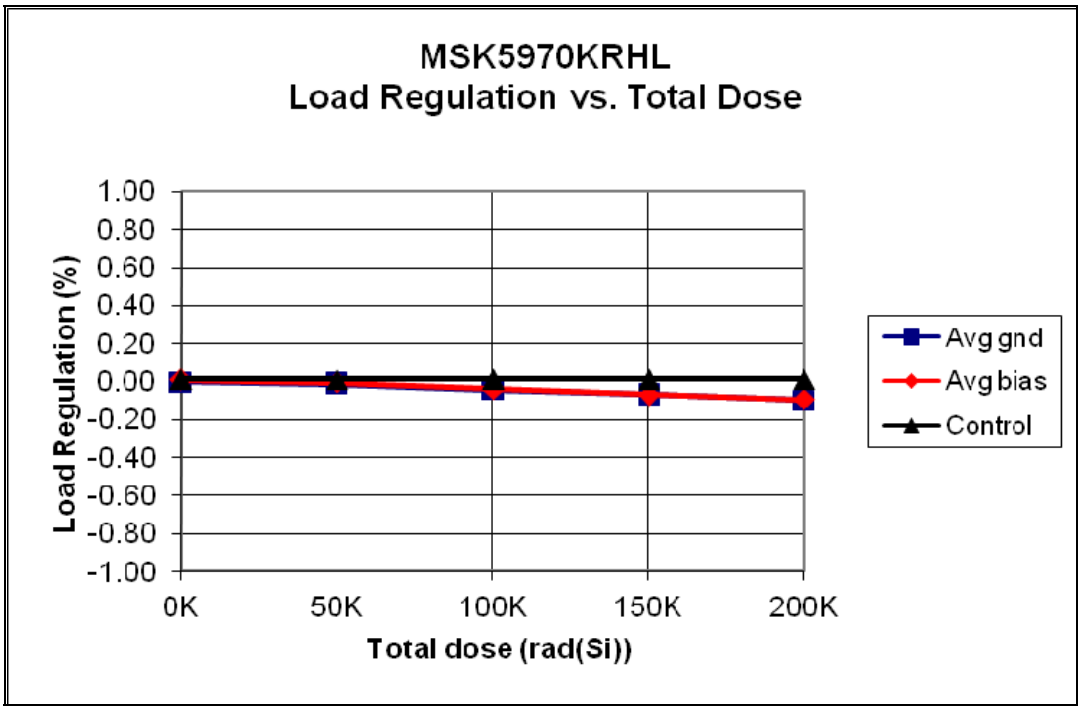

MSK5970KRH
Load Regulation vs. Total Dose
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
Load Regulation (%)
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

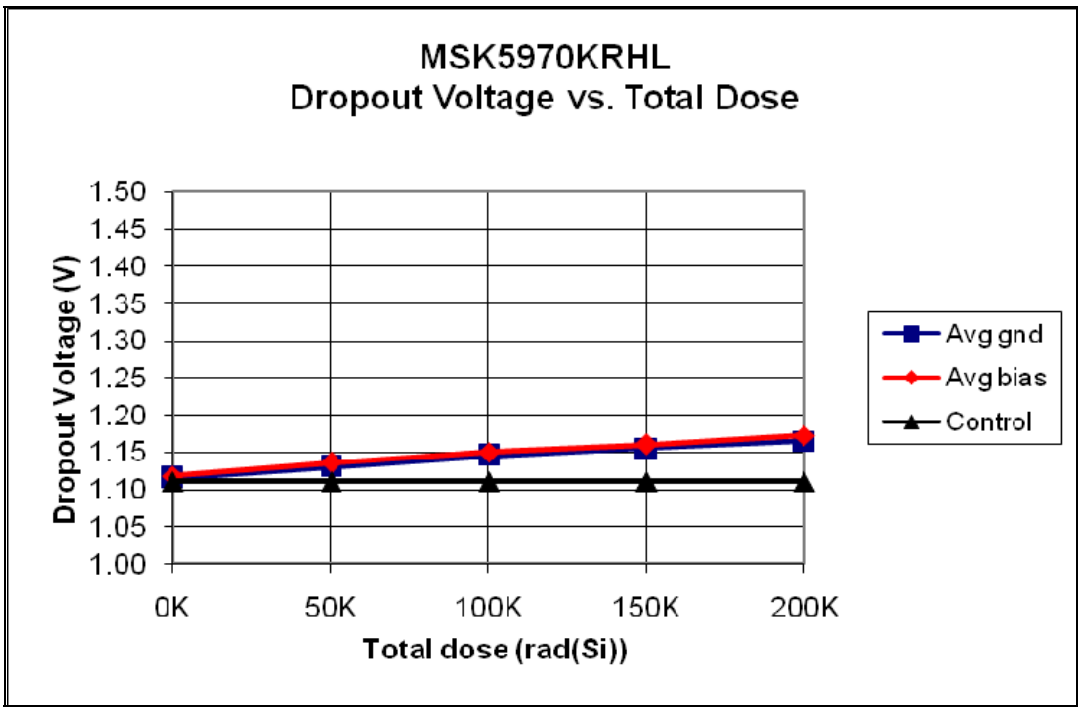

MSK5970KRH
Dropout Voltage vs. Total Dose
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
Dropout Voltage (V)
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

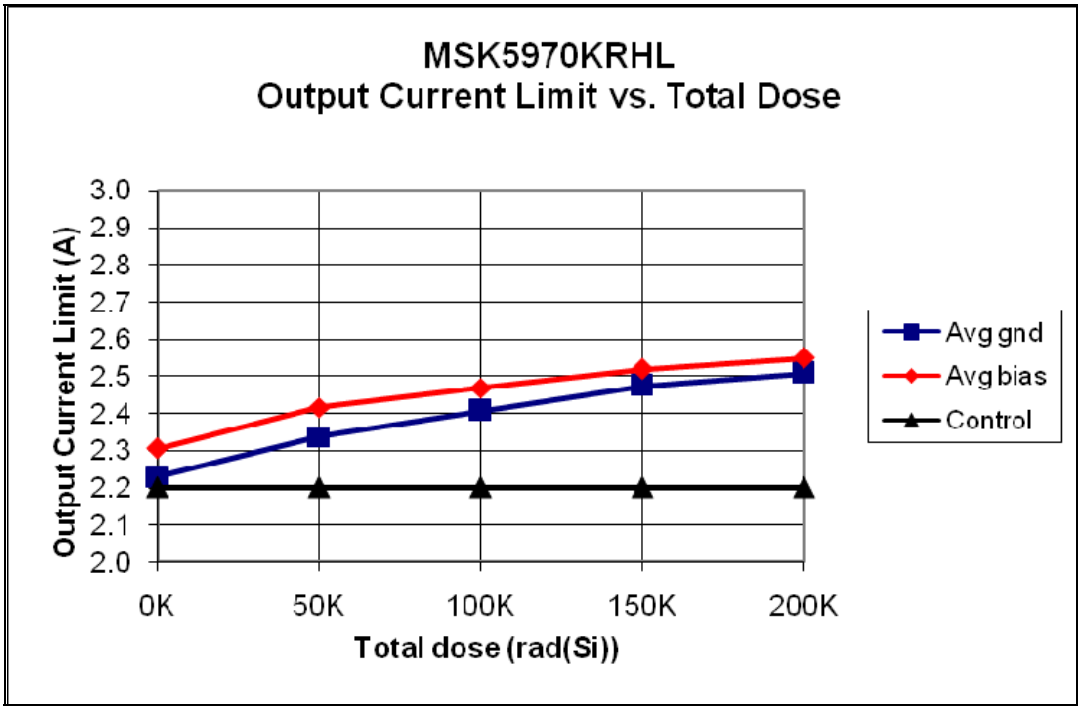

MSK5970KRH
Output Current Limit vs. Total Dose
Output Current Limit (A)
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970KRHL
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.260
1.255
1.250
1.245
1.240
1.235
1.230
1.225
1.220
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970KRHL
Line Regulation vs. Total Dose
Line Regulation (%)
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970KRHL
Load Regulation vs. Total Dose
Load Regulation (%)
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970KRHL
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
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970KRHL
Output Current Limit vs. Total Dose
Output Current Limit (A)
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

Total Dose Radiation Test Report

MSK 5970 RH Series

RAD Hard Positive Voltage Regulator

April 7, 2009
April 28, 2009 (Updated)

B. Erwin
R. Wakeman

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5970RH 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.

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 5970RH 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 178 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 +25 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 with the majority of the shift occurring beyond 100 Krad(Si).

Current Limit also increased by approximately 10 percent at 100 Krad(Si).

MSK 5970 RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

Irradiation Date
4/07/09

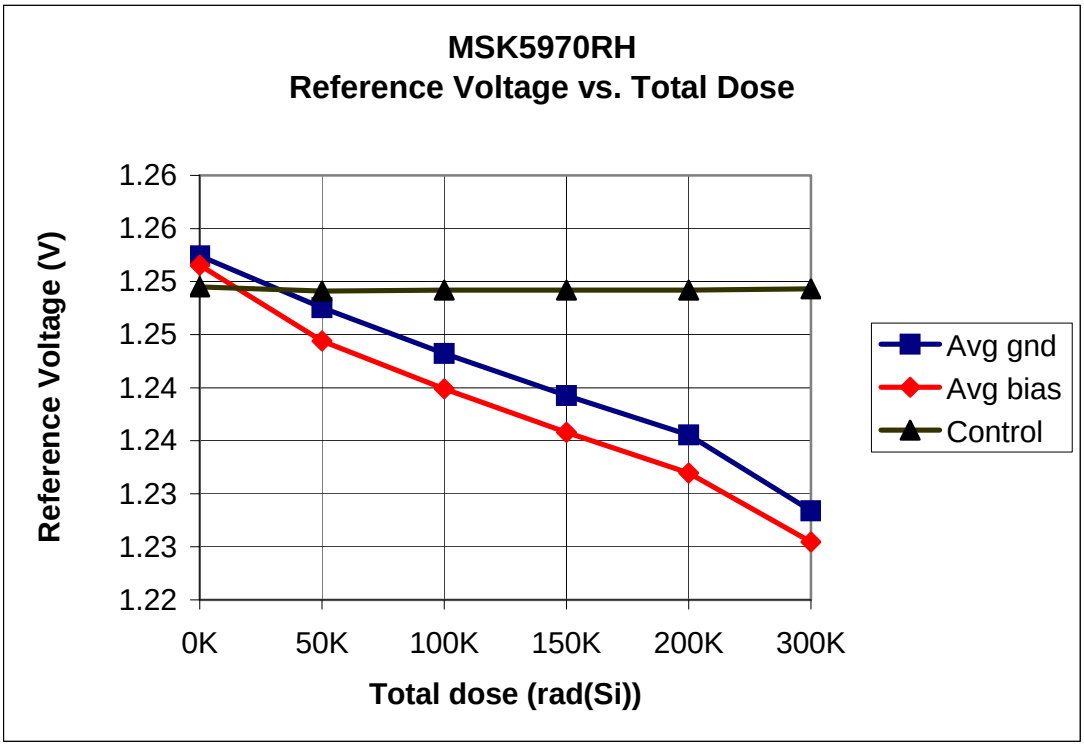
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
4:49	51,442	51,442
4:49	51,442	102,884
4:49	51,442	154,326
4:49	51,442	205,768
9:20	103,040	308,830
14:00	154,560	463,512

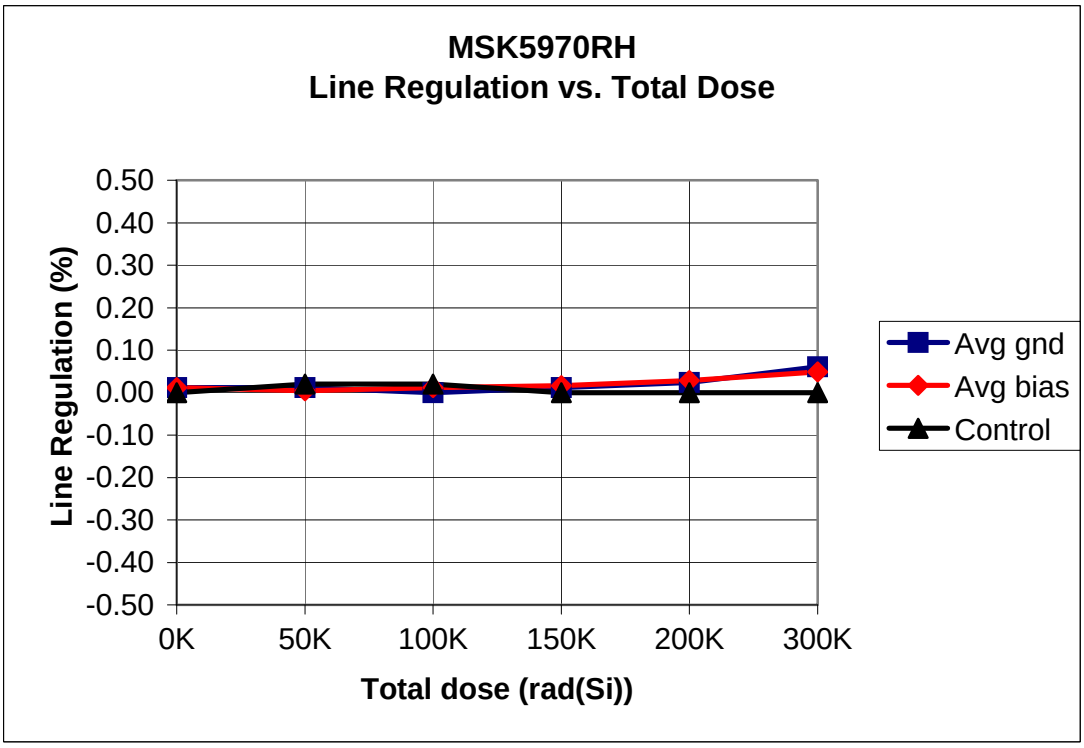
Biased S/N – 0011, 0012, 0013, 0014, 0015

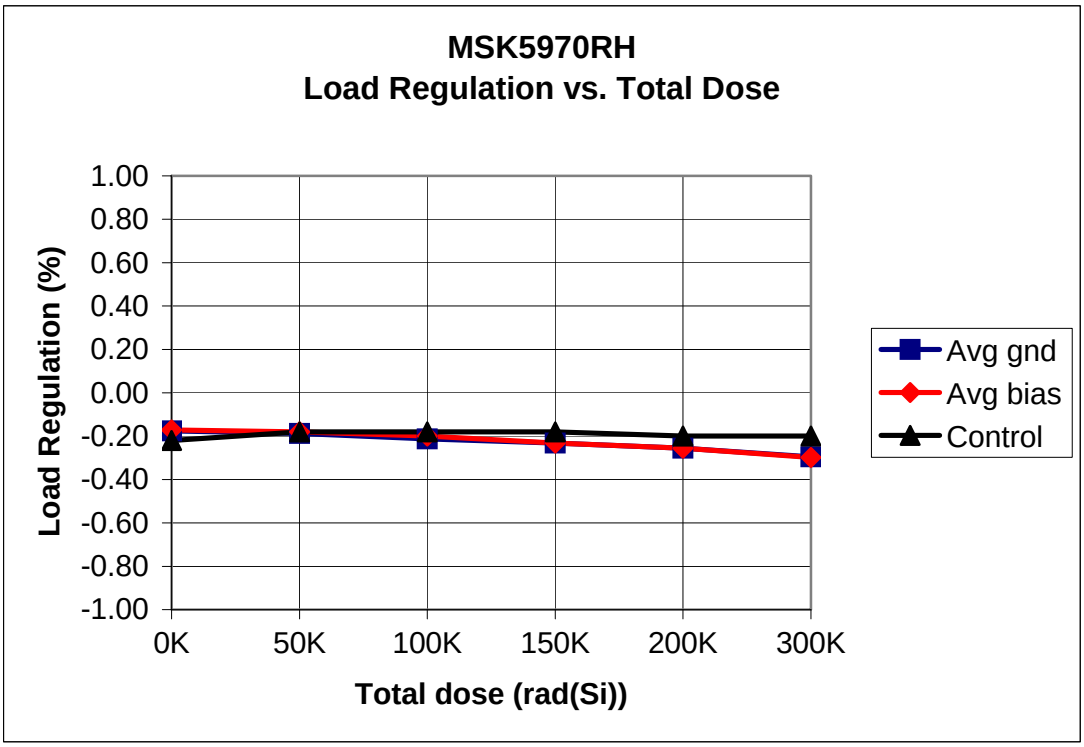
Unbiased S/N – 0017, 0018, 0019, 0020, 0021

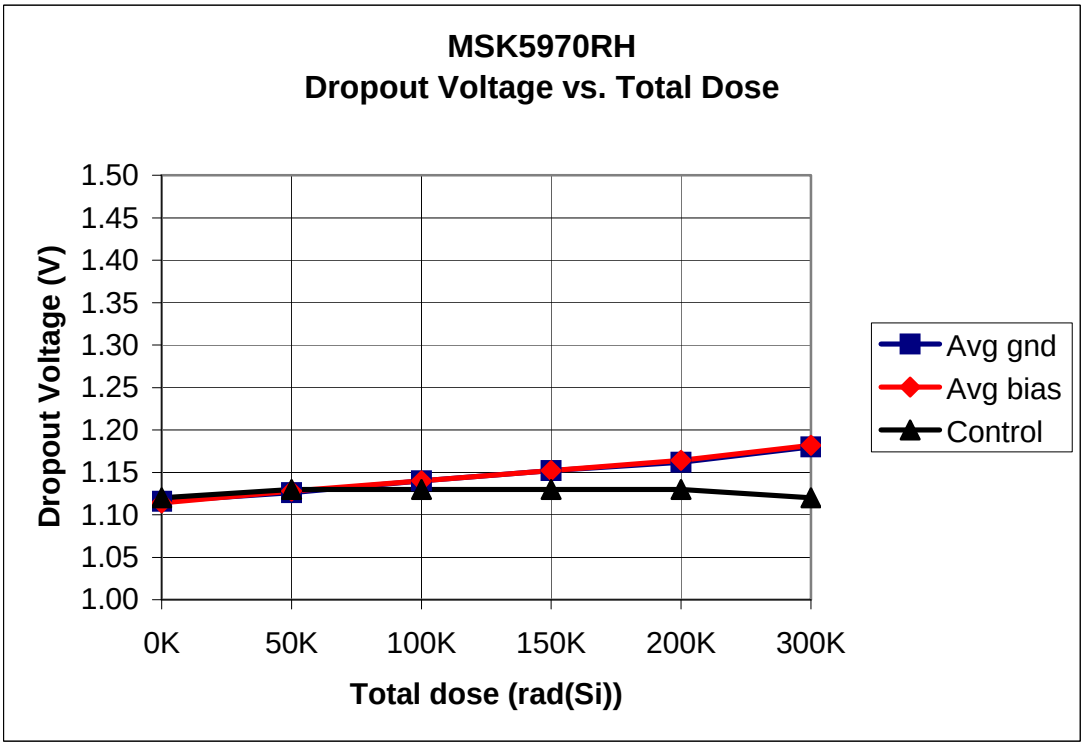
Table 1

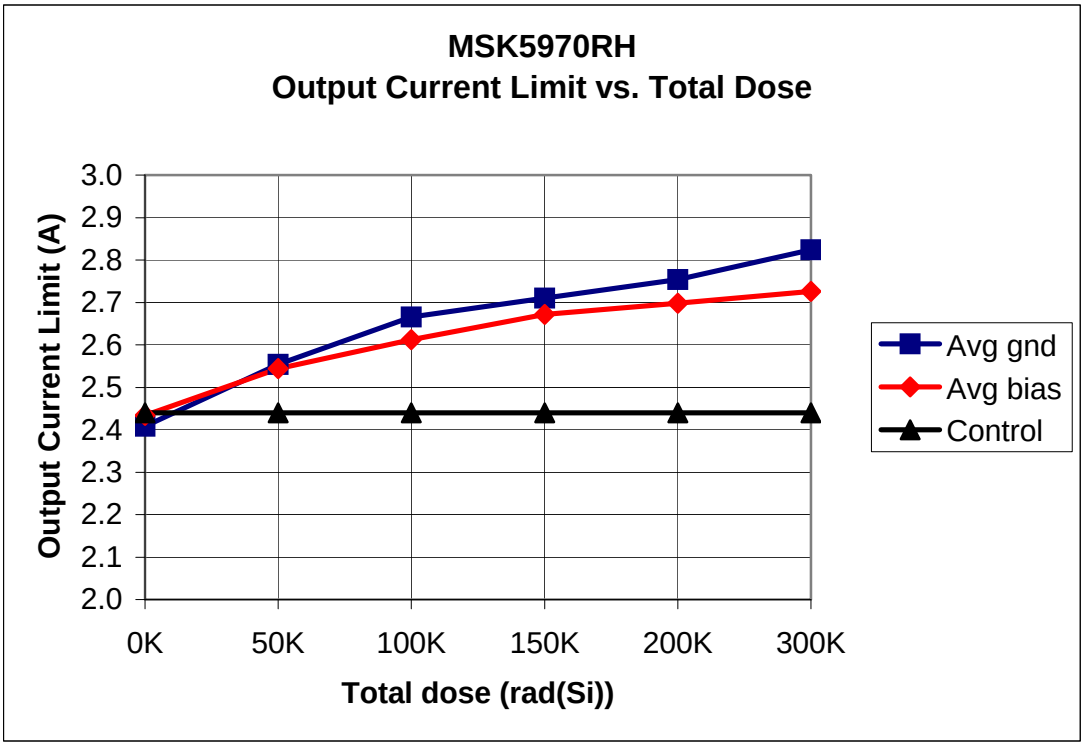
Dose Time, Incremental Dose and Total Cumulative Dose


MSK5970RH
Reference Voltage vs. Total Dose
Reference Voltage (V)
1.26
1.26
1.25
1.25
1.24
1.24
1.23
1.23
1.22
0K
50K
100K
150K
200K
300K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970RH
Line Regulation vs. Total Dose
Line Regulation (%)
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
0K
50K
100K
150K
200K
300K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970RH
Load Regulation vs. Total Dose
Load Regulation (%)
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
0K
50K
100K
150K
200K
300K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970RH
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
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5970RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
0K
50K
100K
150K
200K
300K
Total dose (rad(Si))
Avg gnd
Avg bias
Control