Total Dose Radiation Test Report

MSK5910RH
(MSK5900RH, MSK5920RH, MSK5921RH, MSK5922RH)

Ultra Low Dropout Adjustable Positive Linear Regulator

December 20,2004 (MSK5900RH - 1st Test)
May 17, 2005 (MSK5910RH - 1st Test)
December 27, 2005 (MSK5920RH - 1st Test)
January 6, 2006 (MSK5921RH - 1st Test)
Updated on July 31, 2006
February 21, 2007 – (MSK5921RH – 2nd Test)
March 29, 2007 (MSK5920RH – 2nd Test)
June 14, 2007 (MSK5920RH – 3rd Test)
Updated on January 21, 2008 (MSK5910RH - 2nd Test)
November 06, 2009 (MSK5910RH 3rd Test)
May 14, 2010 (MSK5910RH 4th Test)
September 21, 2011 (MSK5910RH – 5th Test)

April 18, 2014 (MSK5910RH – 6th Test,	IC Wafer Lot: W10607254.1 WF#8 Transistor Wafer Lot: CJ302831 wf#20)
June 29, 2017 (MSK5910RH – 7th Test,	IC Wafer Lot: W10607254.1 WF#8 Transistor Wafer Lot: PF01F1005 WF# 6)
March 20, 2018 (MSK5910RH – 8th Test,	IC Wafer Lot: W10607254.1 WF#8 Transistor Wafer Lot: DL153631 WF# 3)
August 22, 2018 (MSK5910RH – 9th Test,	IC Wafer Lot: W10607254.1 WF#8 Transistor Wafer Lot: P741F1002 Wf#21)

N. Kresse
J. Joy

Anaren, Inc. – MSK Products

I. Introduction:

The total dose radiation test plan for the MSK5910RH was developed to qualify the device as a radiation tolerant device to 100 Krad(Si). The testing was performed up to 150 Krad(Si) to show trends in device performance as a function of total dose. The MSK5900RH, MSK5910RH, MSK5920RH, MSK5921RH, and MSK5922RH all use the same active components. The data in this report is from direct measurement of the MSK5910RH response to irradiation, but it is indicative of the response of all five device types and is applicable to all five 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 MSK5910RH.

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 117.4 rad (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 160 hours of burn-in per MIL-STD-883 Method 1015. For test platform verification, two control devices were tested at 25°C. Eight 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. Four devices were biased during irradiation. Maximum recommended operating voltage of +7.5V was used for the bias condition. Four devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted and the devices were 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 devices, at each total dose level. Electrical tests were completed within one hour of irradiation. Each subsequent dose was performed within two hours of the previous irradiation.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing, the MSK5910RH qualified as a 100 Krad(Si) Radiation Hardened device.

Based on the test data recorded during radiation testing and statistical analysis, Feedback Voltage, Shutdown Threshold, Shutdown Hysteresis and Output Current Limit exhibited shift due to irradiation, however all performance curves stayed within specification beyond 100 Krad(Si) TID.

MSK5910RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin #0162

Irradiation Date
8/22/18

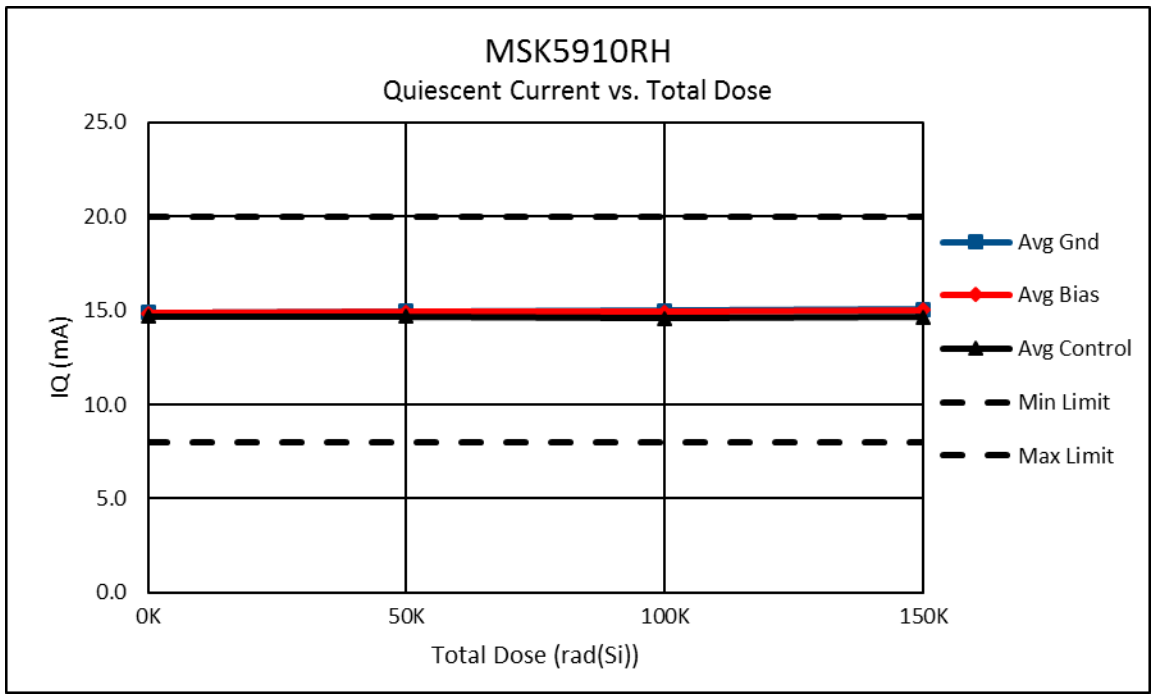
Exposure Length (min:sec)	Incremental Dose rad(Si)	Cumulative Dose rad(Si)
7:19	51,500	51,500
7:19	51,500	130,000
7:19	51,500	154,500

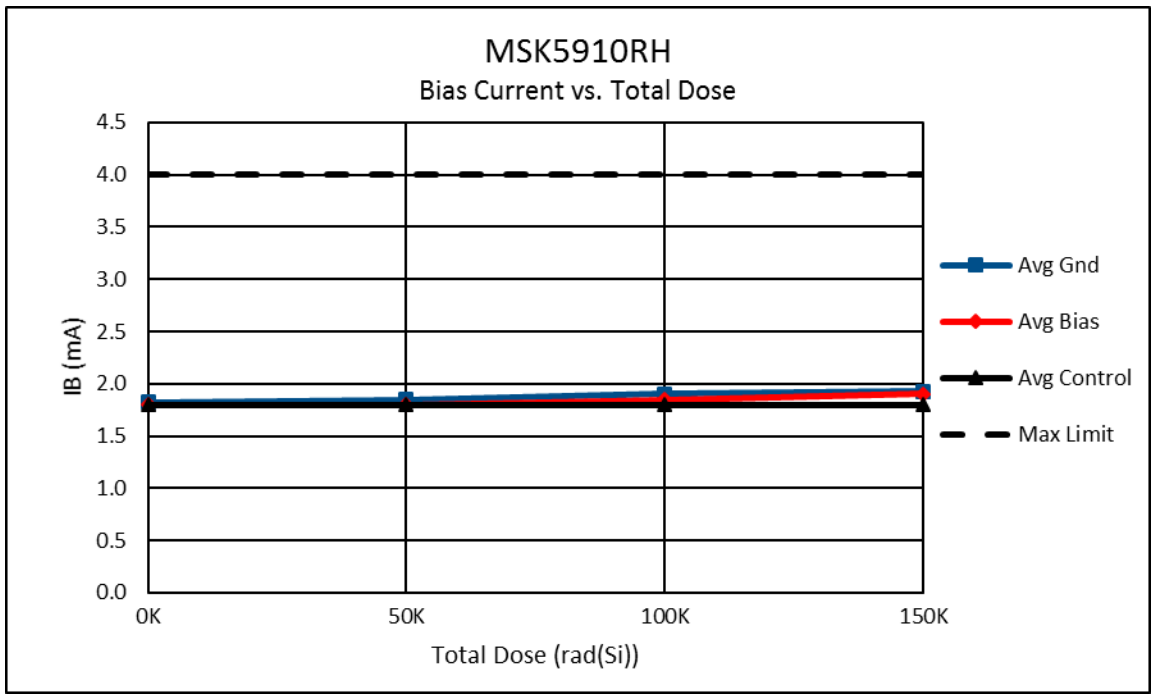
Biased S/N – 0013, 0014, 0015, 0016

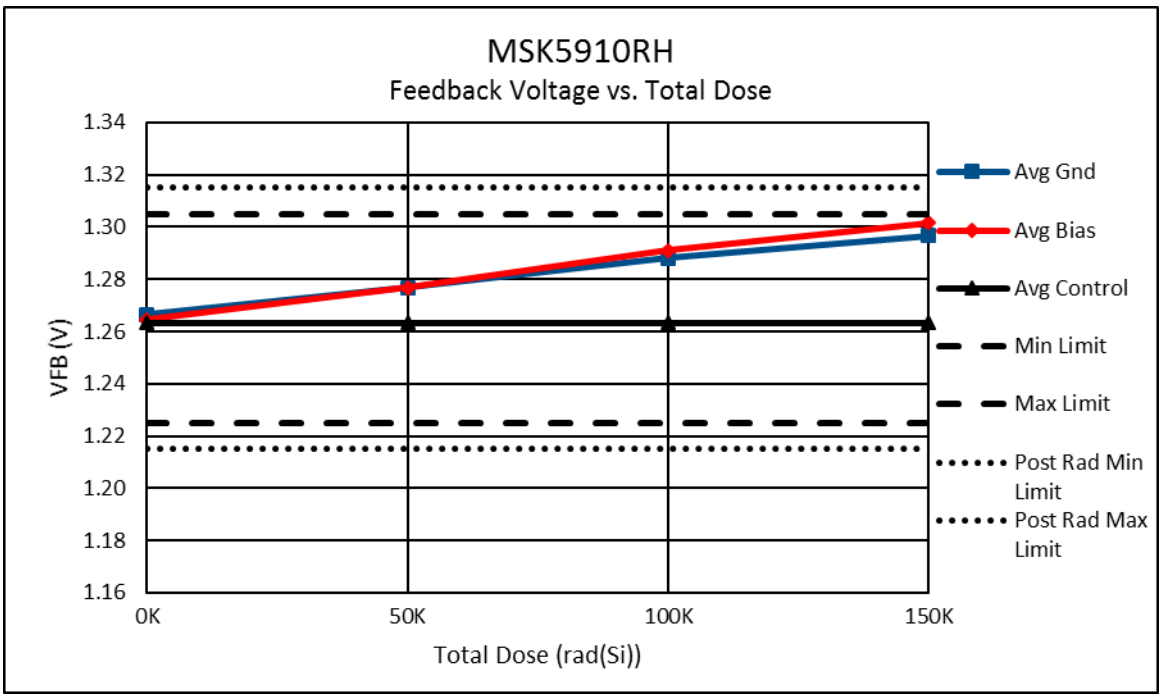
Unbiased S/N – 0017, 0018, 0023, 0024

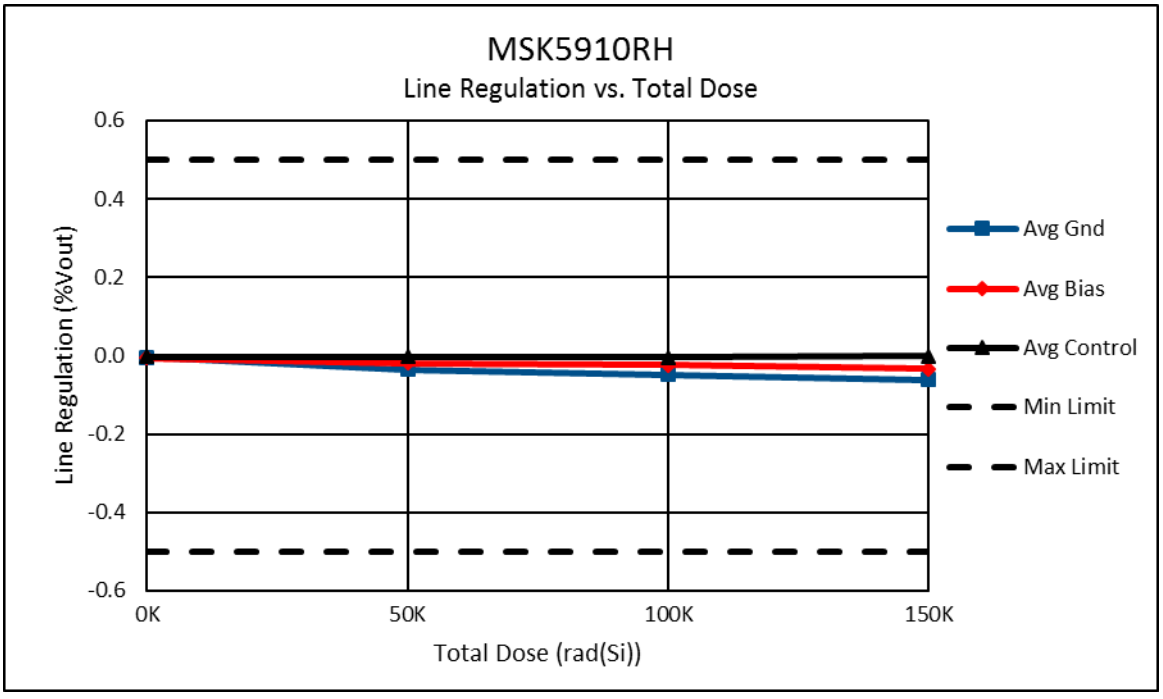
Table I

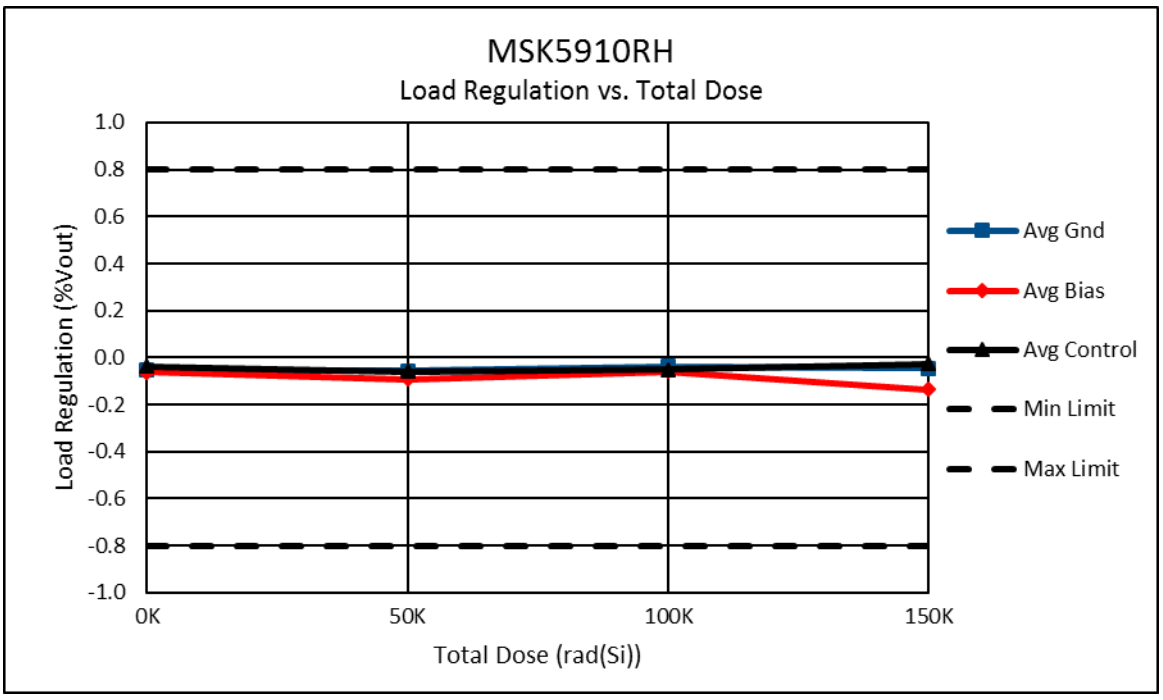
Dose Time, Incremental Dose and Total Cumulative Dose

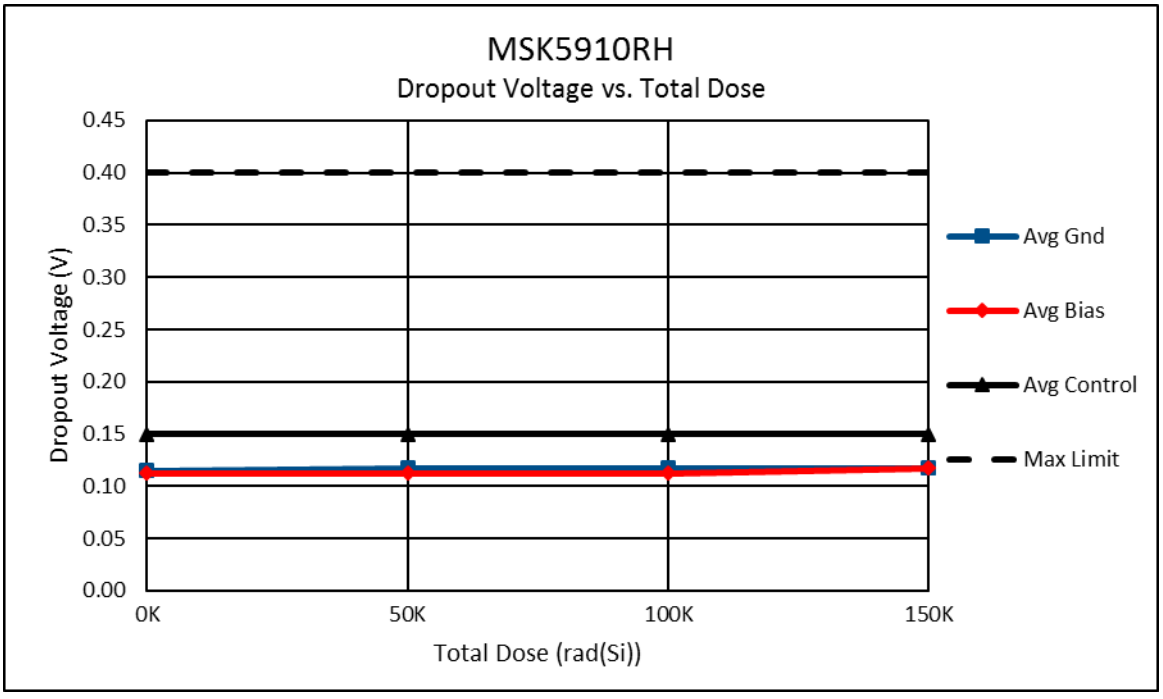

MSK5910RH
Quiescent Current vs. Total Dose
25.0
20.0
15.0
10.0
5.0
0.0
IQ (mA)
0K
50K
100K
150K
Total Dose (rad(Si))
Avg Gnd
Avg Bias
Avg Control
Min Limit
Max Limit

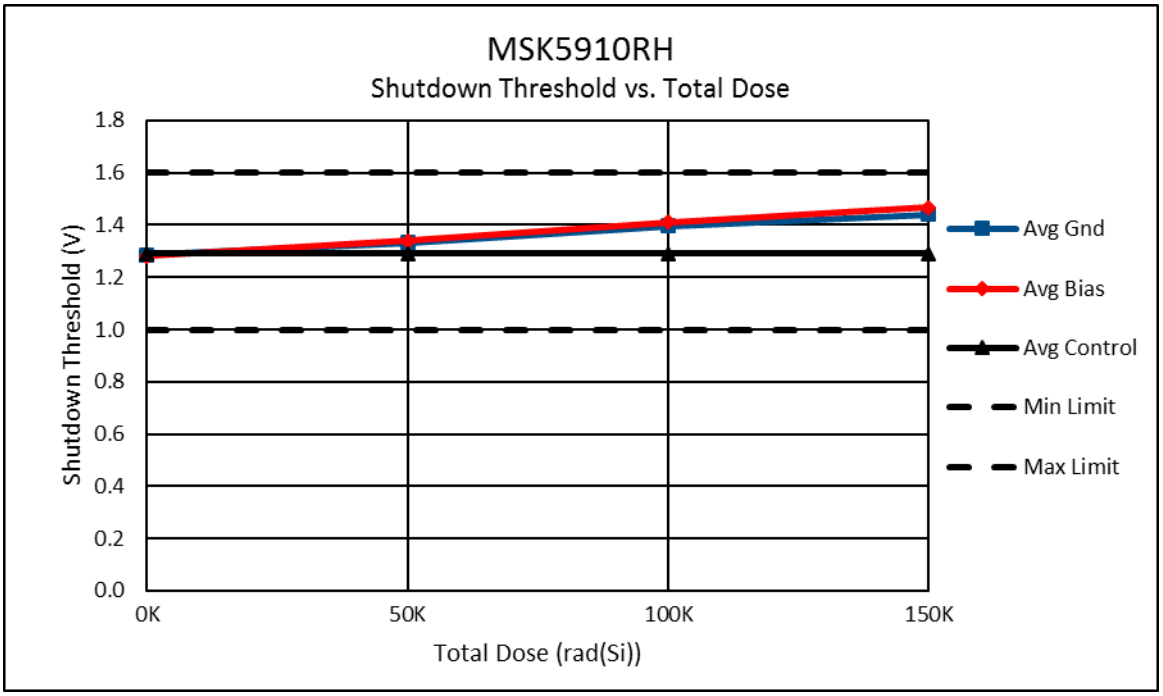

MSK5910RH
Bias Current vs. Total Dose
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
IB (mA)
0K
50K
100K
150K
Total Dose (rad(Si))
Avg Gnd
Avg Bias
Avg Control
Max Limit

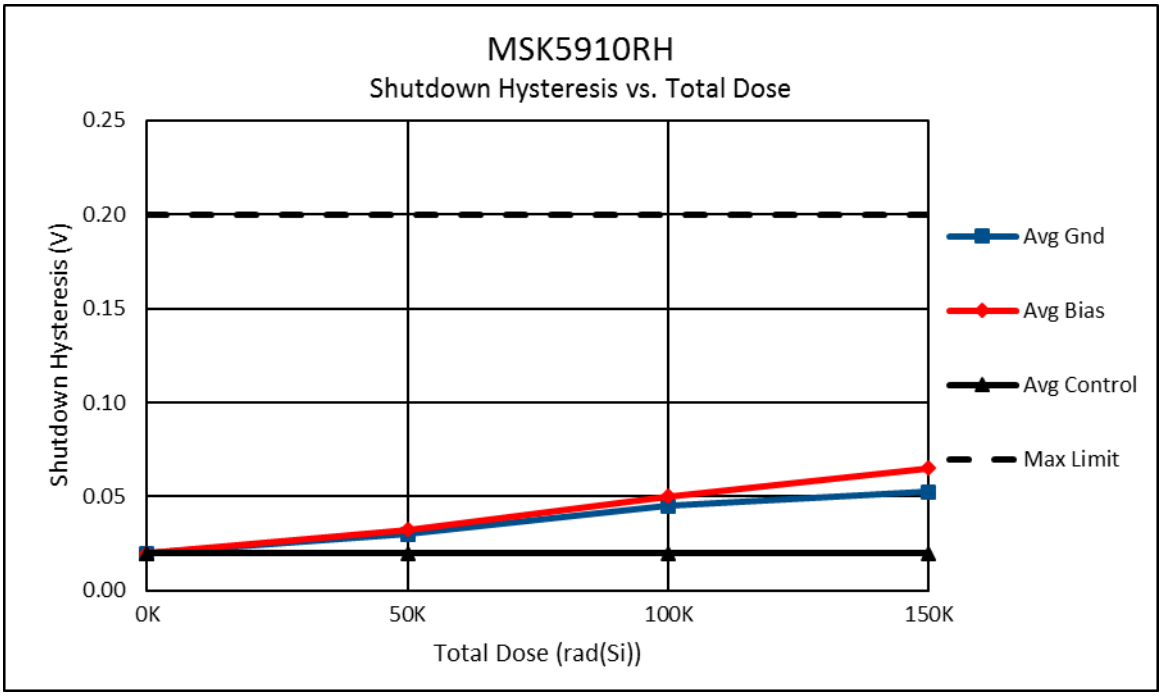

MSK5910RH
Feedback Voltage vs. Total Dose
1.34
1.32
1.30
1.28
1.26
1.24
1.22
1.20
1.18
1.16
VFB (V)
0K
50K
100K
150K
Total Dose (rad(Si))
Avg Gnd
Avg Bias
Avg Control
Min Limit
Max Limit
Post Rad Min Limit
Post Rad Max Limit

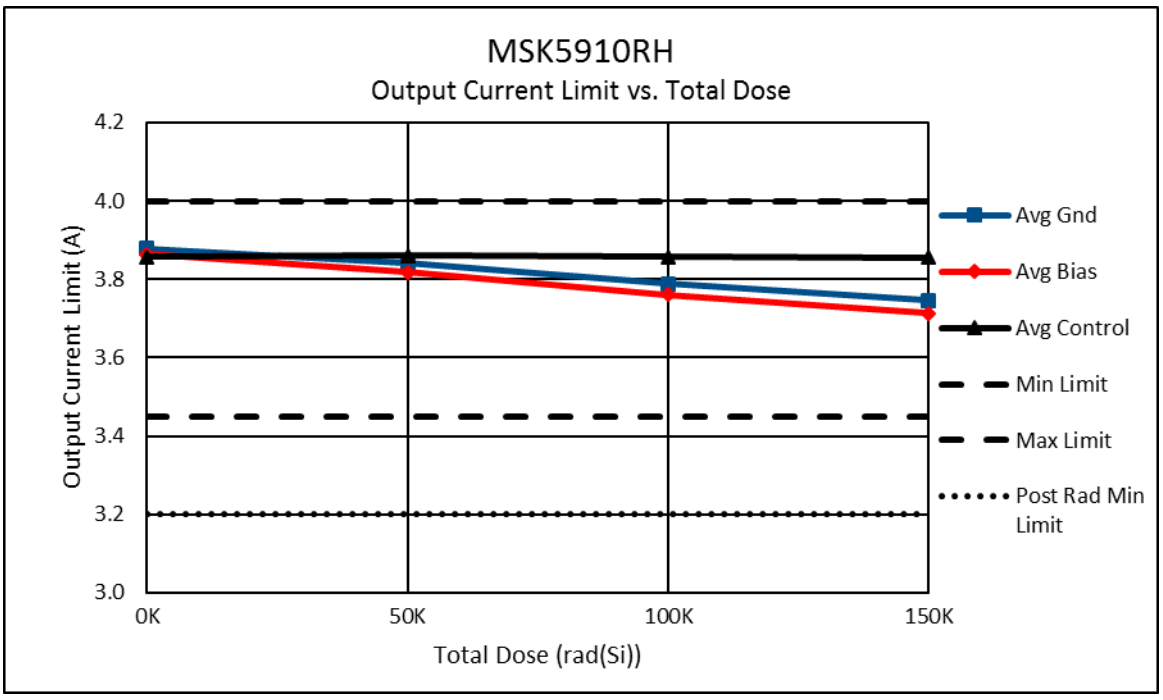

MSK5910RH
Line Regulation vs. Total Dose
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
Line Regulation (%Vout)
0K
50K
100K
150K
Total Dose (rad(Si))
Avg Gnd
Avg Bias
Avg Control
Min Limit
Max Limit


MSK5910RH
Load Regulation vs. Total Dose
Load Regulation (%Vout)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0K
50K
100K
150K
Total Dose (rad(Si))
Avg Gnd
Avg Bias
Avg Control
Min Limit
Max Limit


MSK5910RH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0K
50K
100K
150K
Total Dose (rad(Si))
Avg Gnd
Avg Bias
Avg Control
Max Limit


MSK5910RH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0K
50K
100K
150K
Total Dose (rad(Si))
Avg Gnd
Avg Bias
Avg Control
Min Limit
Max Limit


MSK5910RH
Shutdown Hysteresis vs. Total Dose
Shutdown Hysteresis (V)
0.25
0.20
0.15
0.10
0.05
0.00
0K
50K
100K
150K
Total Dose (rad(Si))
Avg Gnd
Avg Bias
Avg Control
Max Limit


MSK5910RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
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
Avg Control
Min Limit
Max Limit
Post Rad Min Limit

Total Dose Radiation Test Report

MSK 5910RH
(MSK 5900RH, MSK 5920RH, MSK 5921RH, MSK 5922RH)

Ultra Low Dropout Adjustable Positive Linear Regulator

December 20,2004 (MSK 5900RH - 1st Test)
May 17, 2005 (MSK 5910RH - 1st Test)
December 27, 2005 (MSK5920RH - 1st Test)
January 6, 2006 (MSK 5921RH - 1st Test)
Updated on July 31, 2006
February 21, 2007 – (MSK 5921RH – 2nd Test)
March 29, 2007 (MSK5920RH – 2nd Test)
June 14, 2007 (MSK5920RH – 3rd Test)
Updated on January 21, 2008 (MSK 5910RH - 2nd Test)
November 06, 2009 (MSK 5910RH 3rd Test)
May 14, 2010 (MSK 5910RH 4th Test)
September 21, 2011 (MSK 5910RH – 5th Test)
April 18, 2014 (MSK 5910RH – 6th Test, IC Wafer Lot: W10607254.1 WF#8
Transistor Wafer Lot: CJ302831 wf#20)
June 29, 2017 (MSK 5910RH – 7th Test, IC Wafer Lot: W10607254.1 WF#8
Transistor Wafer Lot: PF01F1005 WF# 6)
March 20, 2018 (MSK 5910RH – 8th Test, IC Wafer Lot: W10607254.1 WF#8
Transistor Wafer Lot: DL153631 WF# 3)

B. Horton
J. Joy

Anaren, Inc. – MSK Products

I. Introduction:

The total dose radiation test plan for the MSK5910RH was developed to qualify the device as a radiation tolerant device to 100 Krad(Si). The testing was performed up to 150 Krad to show trends in device performance as a function of total dose. The MSK 5900RH, MSK 5910RH, MSK 5920RH, MSK 5921RH, and MSK 5922RH all use the same active components. The data in this report is from direct measurement of the MSK 5910RH response to irradiation, but it is indicative of the response of all five device types and is applicable to all five 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 5910RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo-luminescence dosimetry was performed and the dose rate was determined to be 124 rad (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 biased during irradiation. Recommended operating voltage of +7.5V 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 and the devices were transported to the MSK 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. Each subsequent dose was performed within two hours of the previous irradiation.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing, the MSK 5910RH qualified as a 100 KRAD(Si) Radiation Hardened device.

Statistical analysis of Feedback Voltage showed that there was a positive shift from 0 KRADS(Si) to 150 KRAD(Si), however all performance curves stayed within post-irradiation specs beyond 100 KRAD(Si).

All other test parameters stayed within pre-irradiation test limits throughout the irradiation process.

MSK 5910RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0371

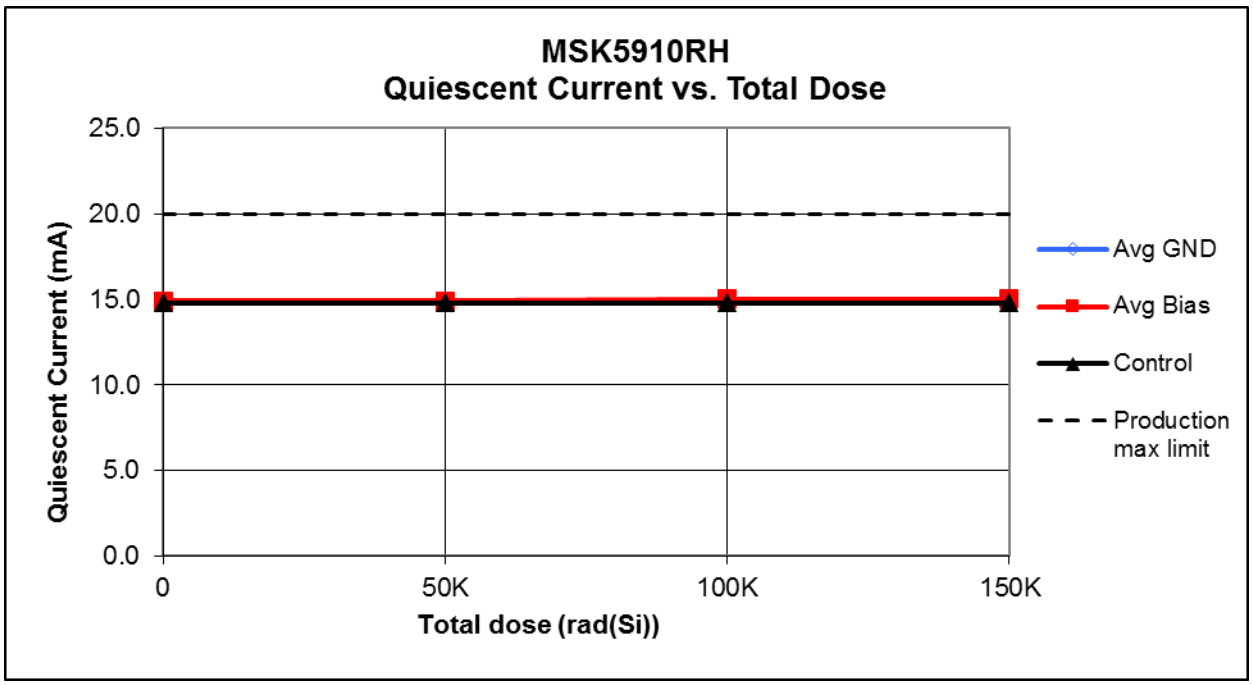
Irradiation Date 3-20-18

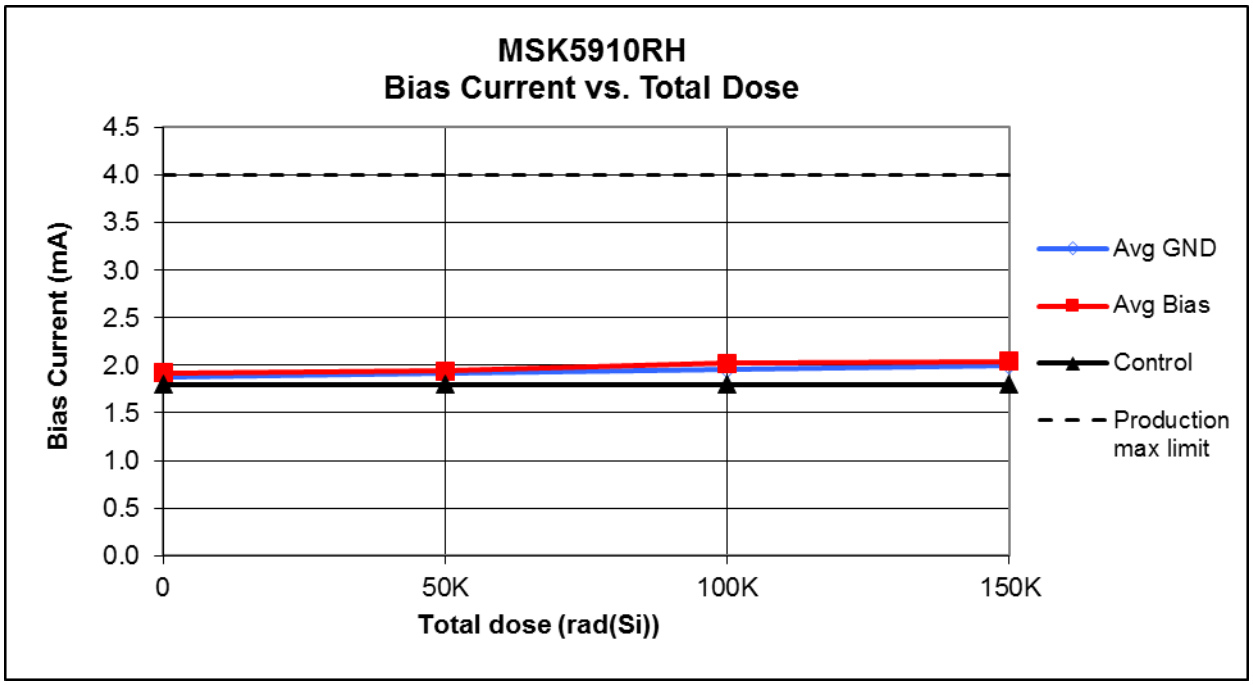
Exposure Length (min:sec)	Incremental Dose rad(Si)	Cumulative Dose rad(Si)
6:55	51,500	51,500
6:55	51,500	130,000
6:55	51,500	154,500

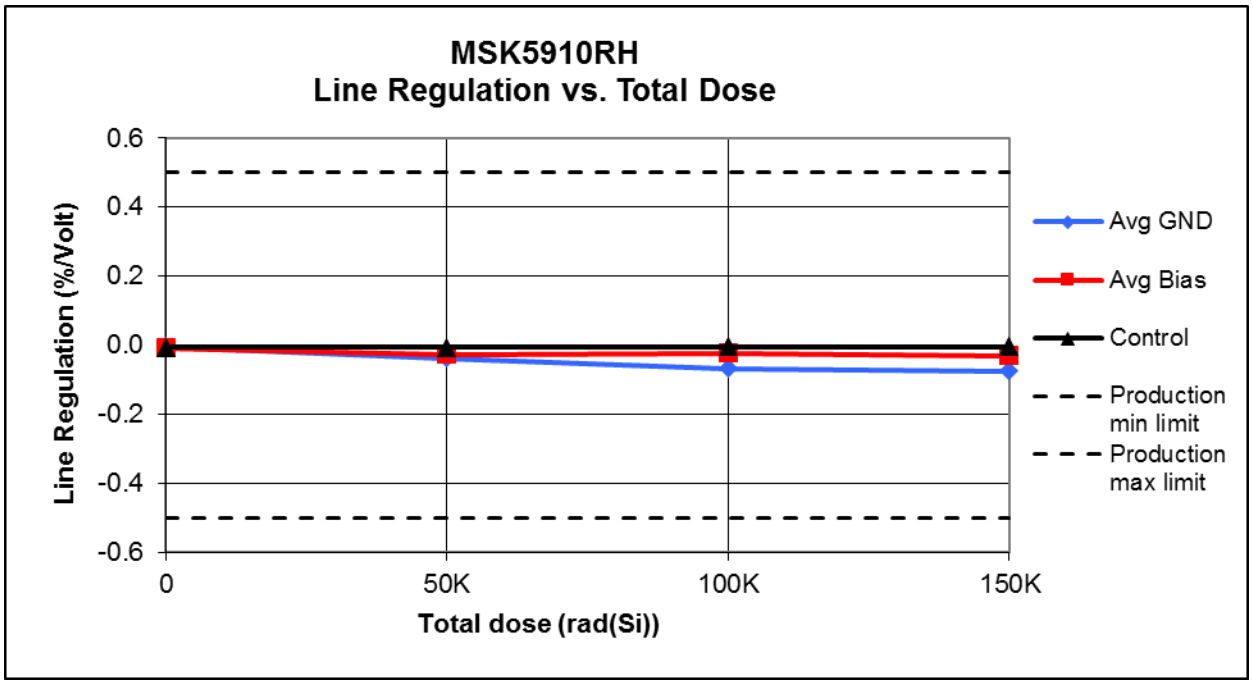
Biased S/N – 0001, 0002, 0003, 0004, 0005

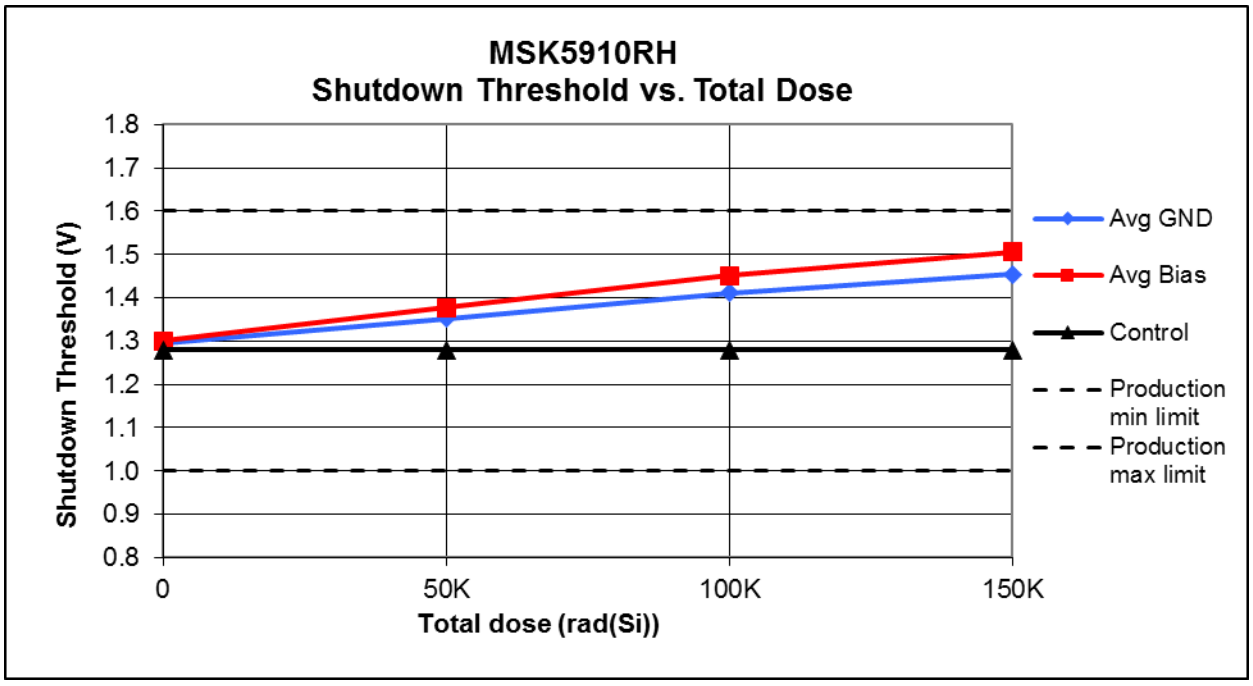
Unbiased S/N – 0006, 0007, 0008, 0009, 0010

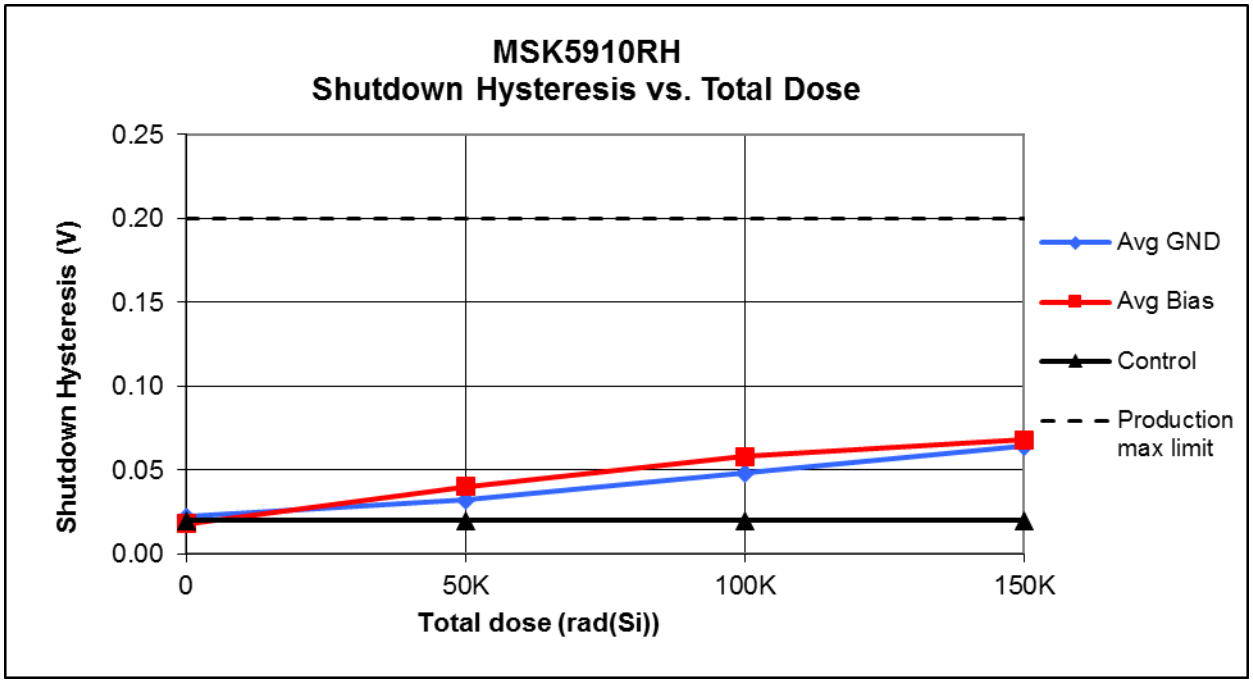
Table I
Dose Time, Incremental Dose and Total Cumulative Dose

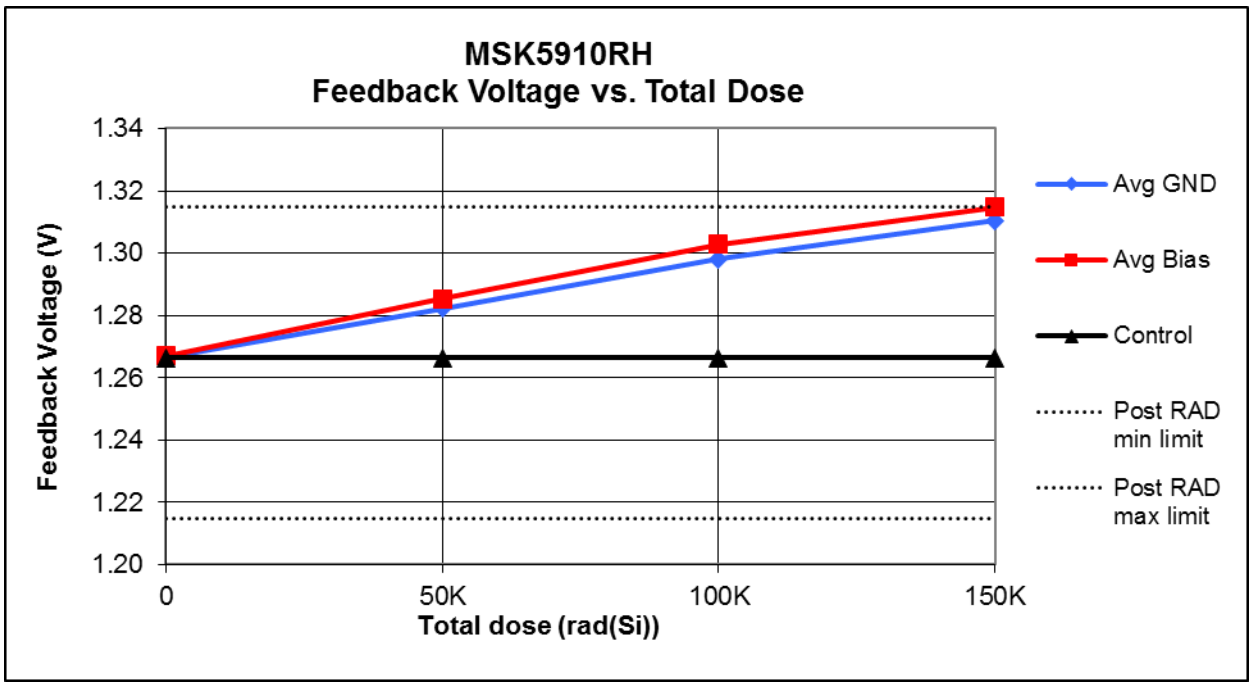

MSK5910RH
Quiescent Current vs. Total Dose
Quiescent Current (mA)
25.0
20.0
15.0
10.0
5.0
0.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production max limit

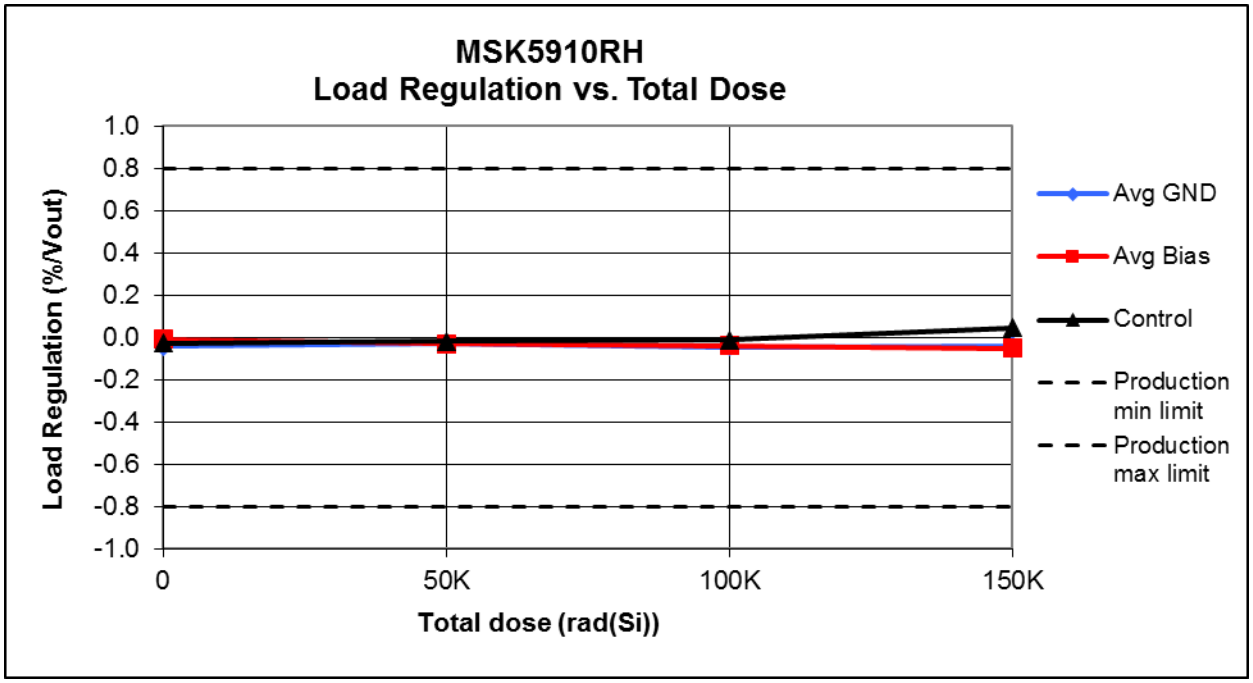

MSK5910RH
Bias Current vs. Total Dose
Bias Current (mA)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production max limit

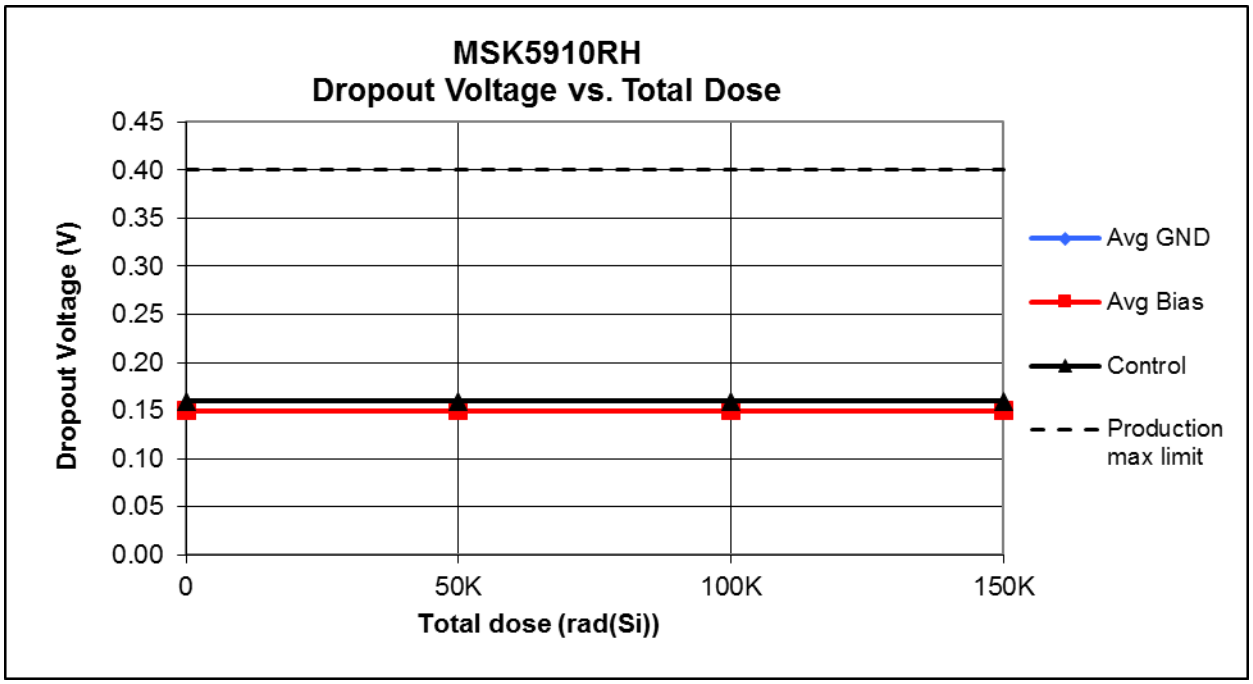

MSK5910RH
Line Regulation vs. Total Dose
Line Regulation (%/Volt)
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production min limit
Production max limit

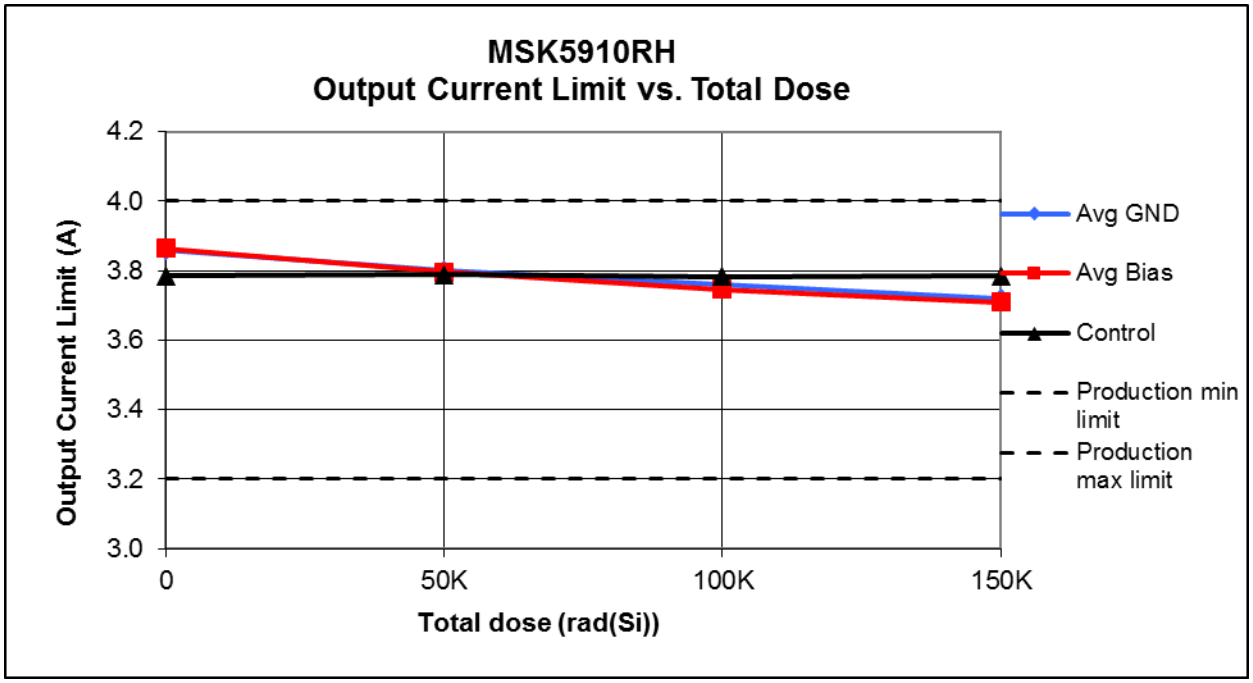

MSK5910RH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production min limit
Production max limit


MSK5910RH
Shutdown Hysteresis vs. Total Dose
Shutdown Hysteresis (V)
0.25
0.20
0.15
0.10
0.05
0.00
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production max limit


MSK5910RH
Feedback Voltage vs. Total Dose
Feedback Voltage (V)
1.34
1.32
1.30
1.28
1.26
1.24
1.22
1.20
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Post RAD min limit
Post RAD max limit


MSK5910RH
Load Regulation vs. Total Dose
Load Regulation (%/Vout)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production min limit
Production max limit


MSK5910RH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production max limit


MSK5910RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
4.2
4.0
3.8
3.6
3.4
3.2
3.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production min limit
Production max limit

Total Dose Radiation Test Report

MSK 5910RH
(MSK 5900RH, MSK 5920RH, MSK 5921RH, MSK 5922RH)

Ultra Low Dropout Adjustable Positive Linear Regulator

December 20,2004 (MSK 5900RH - 1st Test)
May 17, 2005 (MSK 5910RH - 1st Test)
December 27, 2005 (MSK5920RH - 1st Test)
January 6, 2006 (MSK 5921RH - 1st Test)
Updated on July 31, 2006
February 21, 2007 – (MSK 5921RH – 2nd Test)
March 29, 2007 (MSK5920RH – 2nd Test)
June 14, 2007 (MSK5920RH – 3rd Test)
Updated on January 21, 2008 (MSK 5910RH - 2nd Test)
November 06, 2009 (MSK 5910RH 3rd Test)
May 14, 2010 (MSK 5910RH 4th Test)
September 21, 2011 (MSK 5910RH – 5th Test)
April 18, 2014 (MSK 5910RH – 6th Test, IC Wafer Lot: W10607254.1 WF#8
Transistor Wafer Lot: CJ302831 wf#20)
June 29, 2017 (MSK 5910RH – 7th Test, IC Wafer Lot: W10607254.1 WF#8
Transistor Wafer Lot: PF01F1005 WF# 6)

B. Horton
F. Freytag
N. Kresse

Anaren, Inc. – MSK Products

I. Introduction:

The total dose radiation test plan for the MSK 5910RH was developed to qualify the device as a radiation tolerant device to 100 KRADS(Si). The testing was performed up to 150 KRAD to show trends in device performance as a function of total dose. The MSK 5900RH, MSK 5910RH, MSK 5920RH, MSK 5921RH, and MSK 5922RH all use the same active components. The data in this report is from direct measurement of the MSK 5910RH response to irradiation, but it is indicative of the response of all five device types and is applicable to all five 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 5910RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and the dose rate was determined to be 144 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 biased during irradiation. Recommended operating voltage of +7.5V 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 and the devices were transported to the MSK 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. Each subsequent dose was performed within two hours of the previous irradiation.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing, the MSK 5910RH qualified as a 100 KRAD(Si) Radiation Hardened device.

One device exhibited higher load regulation at all test points and was excluded as an outlier from the statistical analysis for this parameter only.

Statistical analysis of Feedback Voltage showed that there was a positive shift from 0 KRADS(Si) to 150 KRAD(Si), however all performance curves stayed within post-irradiation specs beyond 100 KRAD(Si).

All other test parameters stayed within pre-irradiation test limits throughout the irradiation process.

MSK 5910RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0371

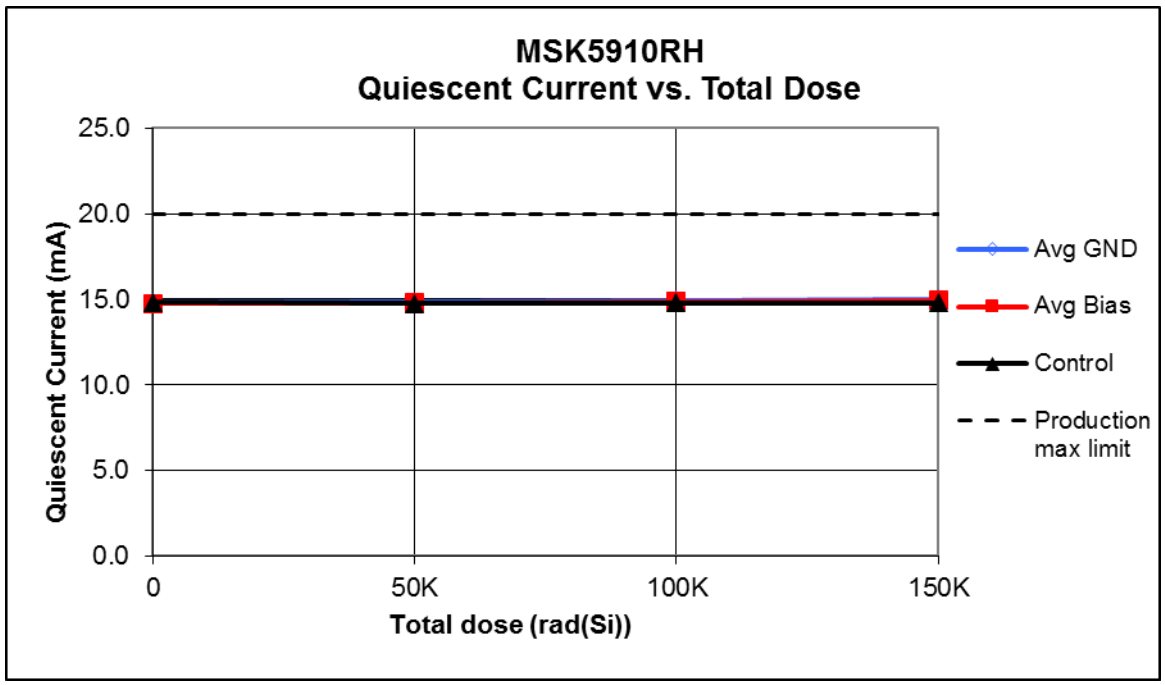
Irradiation Date
04/18/14

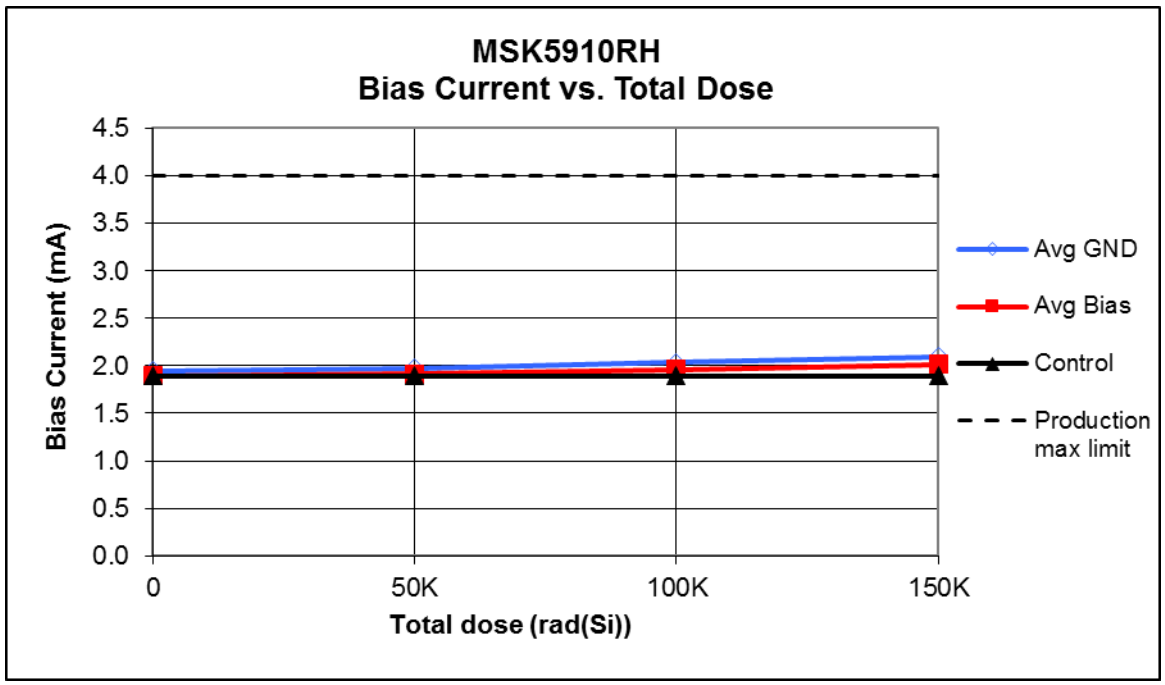
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
5:57	51,500	51,500
5:57	51,500	103,000
5:57	51,500	154,500

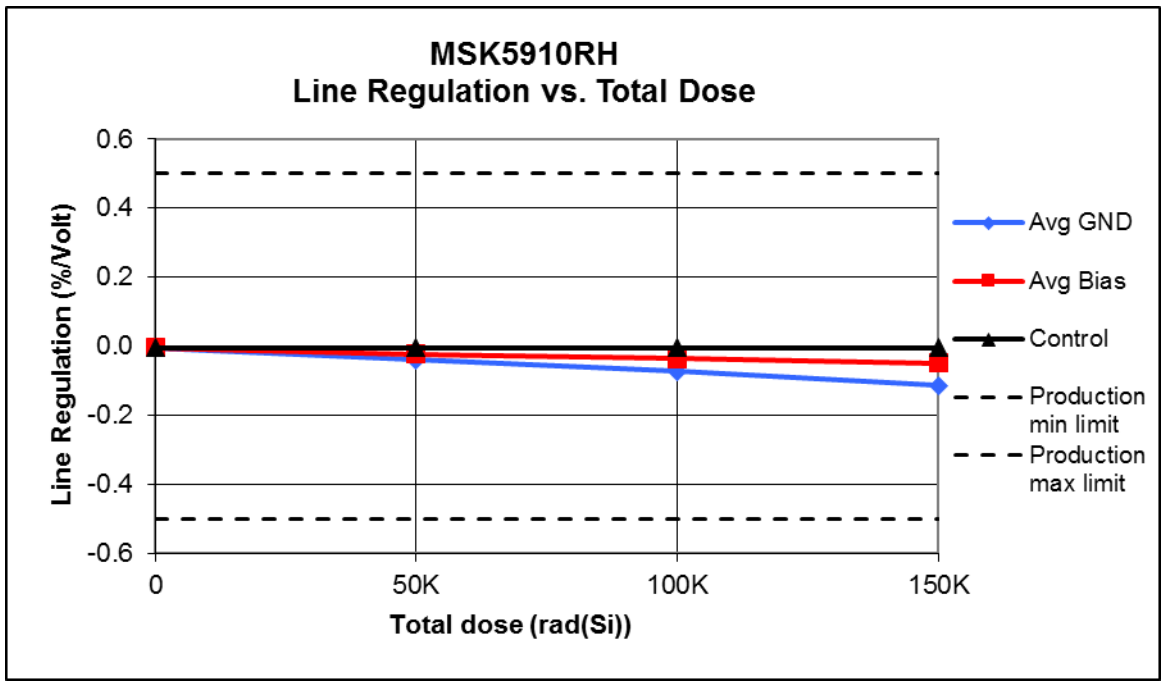
Biased S/N – 1379, 1381, 1384, 1386, 1387

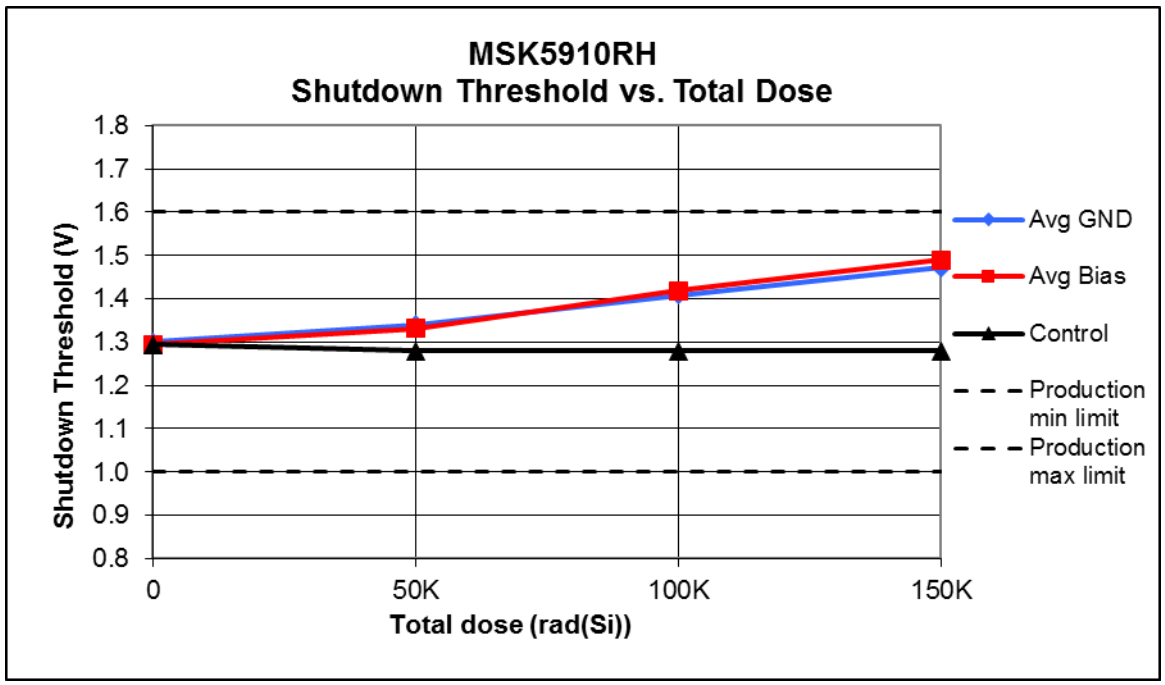
Unbiased S/N – 1388, 1389, 1391, 1394, 1395

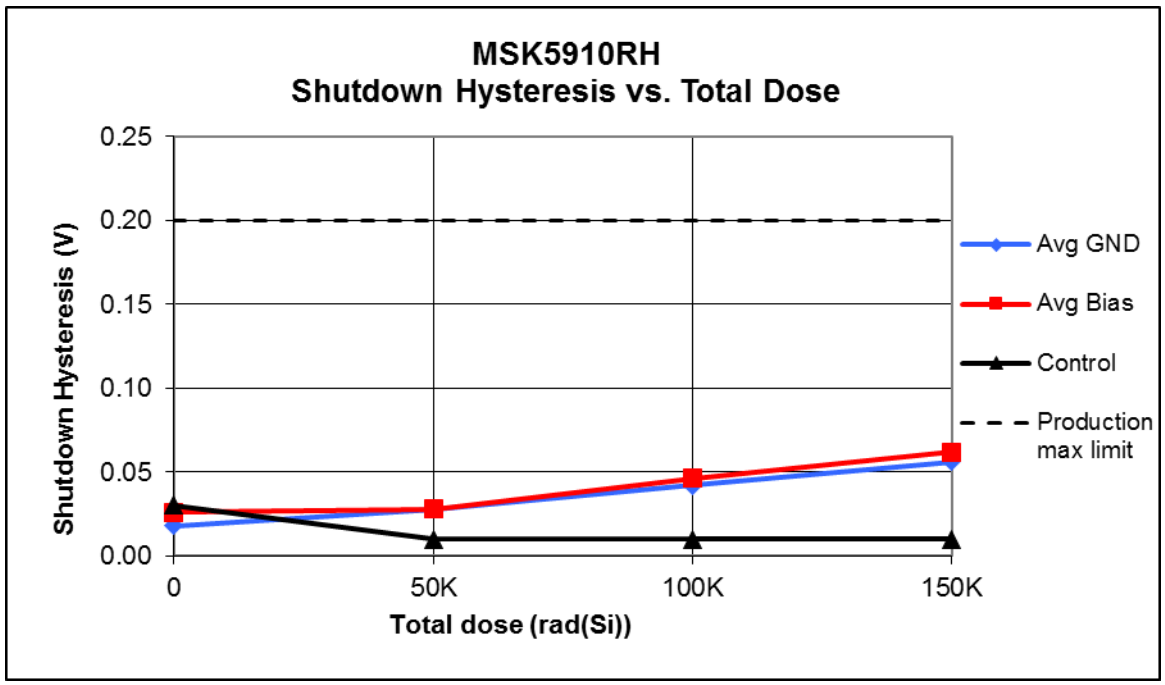
Table I
Dose Time, Incremental Dose and Total Cumulative Dose

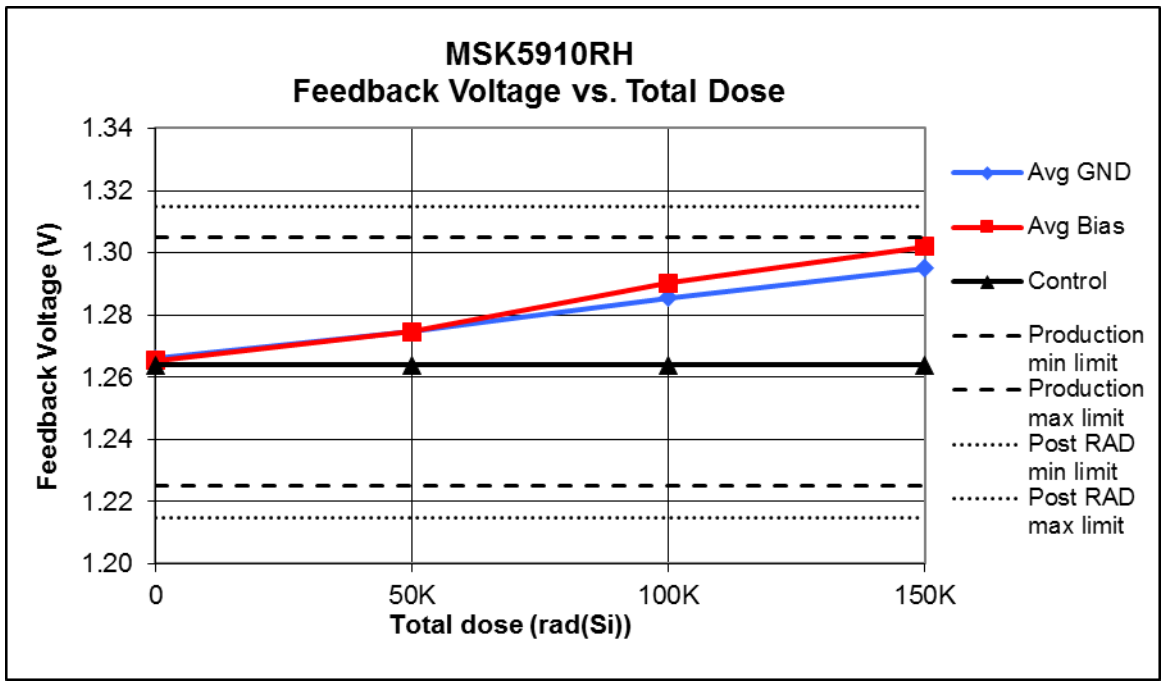

MSK5910RH
Quiescent Current vs. Total Dose
Quiescent Current (mA)
25.0
20.0
15.0
10.0
5.0
0.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production max limit

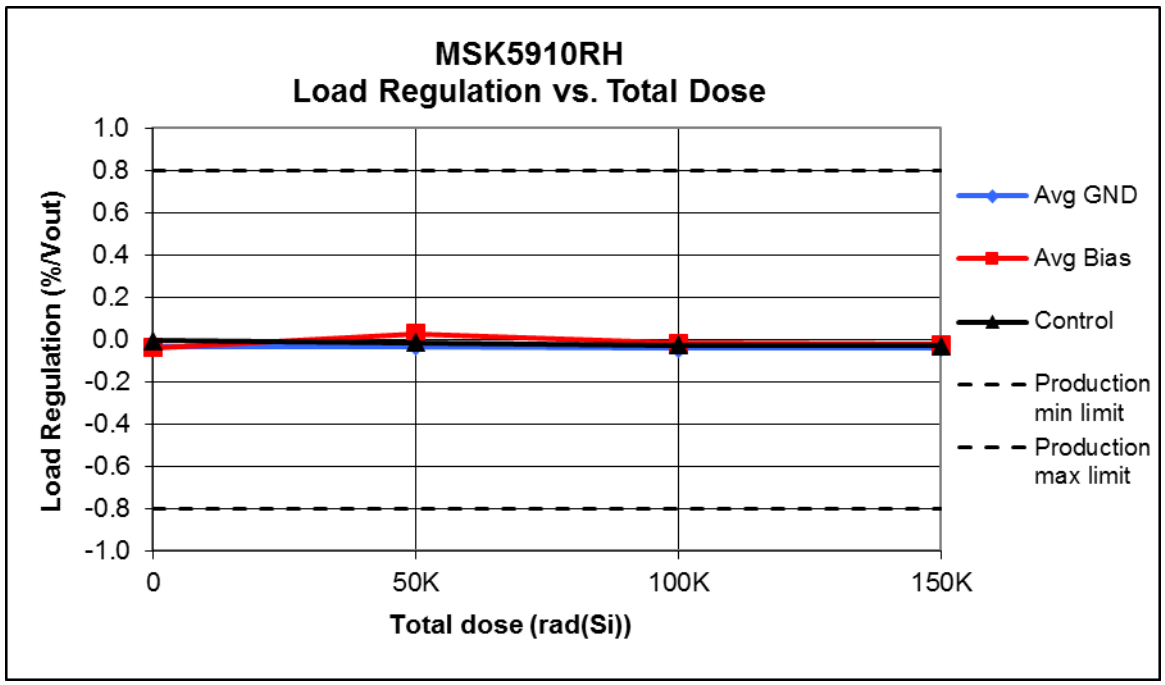

MSK5910RH
Bias Current vs. Total Dose
Bias Current (mA)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production max limit

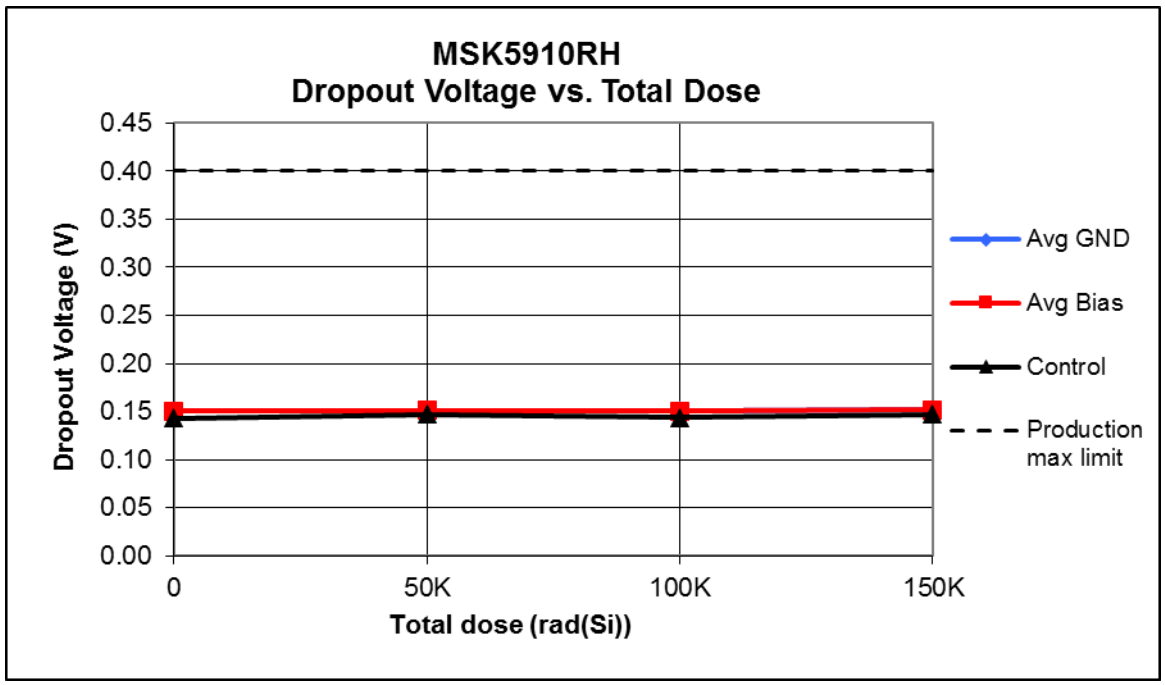

MSK5910RH
Line Regulation vs. Total Dose
Line Regulation (%/Volt)
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production min limit
Production max limit

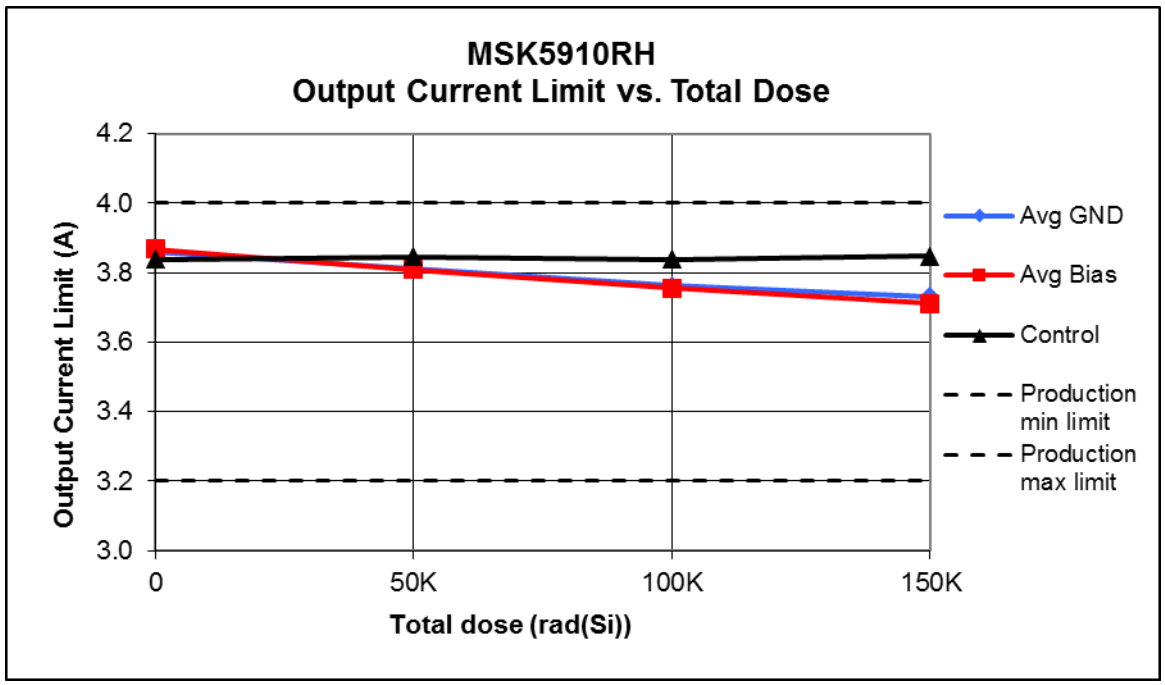

MSK5910RH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production min limit
Production max limit


MSK5910RH
Shutdown Hysteresis vs. Total Dose
Shutdown Hysteresis (V)
0.25
0.20
0.15
0.10
0.05
0.00
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production max limit


MSK5910RH
Feedback Voltage vs. Total Dose
Feedback Voltage (V)
1.34
1.32
1.30
1.28
1.26
1.24
1.22
1.20
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production min limit
Production max limit
Post RAD min limit
Post RAD max limit


MSK5910RH
Load Regulation vs. Total Dose
Load Regulation (%/Vout)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production min limit
Production max limit


MSK5910RH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production max limit


MSK5910RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
4.2
4.0
3.8
3.6
3.4
3.2
3.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control
Production min limit
Production max limit

Total Dose Radiation Test Report

MSK 5910RH
(MSK 5900RH, MSK 5920RH, MSK 5921RH, MSK 5922RH)

Ultra Low Dropout Adjustable Positive Linear Regulator

December 20,2004 (MSK 5900RH - 1st Test)
May 17, 2005 (MSK 5910RH - 1st Test)
December 27, 2005 (MSK5920RH - 1st Test)
January 6, 2006 (MSK 5921RH - 1st Test)
Updated on July 31, 2006
February 21, 2007 – (MSK 5921RH – 2nd Test)
March 29, 2007 (MSK5920RH – 2nd Test)
June 14, 2007 (MSK5920RH – 3rd Test)
Updated on January 21, 2008 (MSK 5910RH - 2nd Test)
November 06, 2009 (MSK 5910RH 3rd Test)
May 14, 2010 (MSK 5910RH 4th Test)
September 21, 2011 (MSK 5910RH – 5th Test)
April 18, 2014 (MSK 5910RH – 6th Test, IC Wafer Lot: w10607254.1 WF#8
Transistor Wafer Lot:CJ302831 wf#20)

B. Horton
F. Freytag

M.S. Kennedy Corporation

I. Introduction:

The total dose radiation test plan for the MSK 5910RH was developed to qualify the device as a radiation tolerant device to 100 KRADS(Si). The testing was performed up to 150 KRAD to show trends in device performance as a function of total dose. The MSK 5900RH, MSK 5910RH, MSK 5920RH, MSK 5921RH, and MSK 5922RH all use the same active components. The data in this report is from direct measurement of the MSK 5910RH response to irradiation, but it is indicative of the response of all five device types and is applicable to all five 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 5910RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and the dose rate was determined to be 123 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 biased during irradiation. Recommended operating voltage of +7.5V 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 and the devices were transported to the MSK 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. Each subsequent dose was performed within two hours of the previous irradiation.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing, the MSK 5910RH qualified as a 100 KRADS(Si) radiation Hardened device.

It should be noted that there was a positive shift in feedback voltage from 0 KRADS(Si) to 150 KRADS(Si).

All other test parameters stayed within pre-irradiation test limits throughout the irradiation process.

MSK 5910RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0371

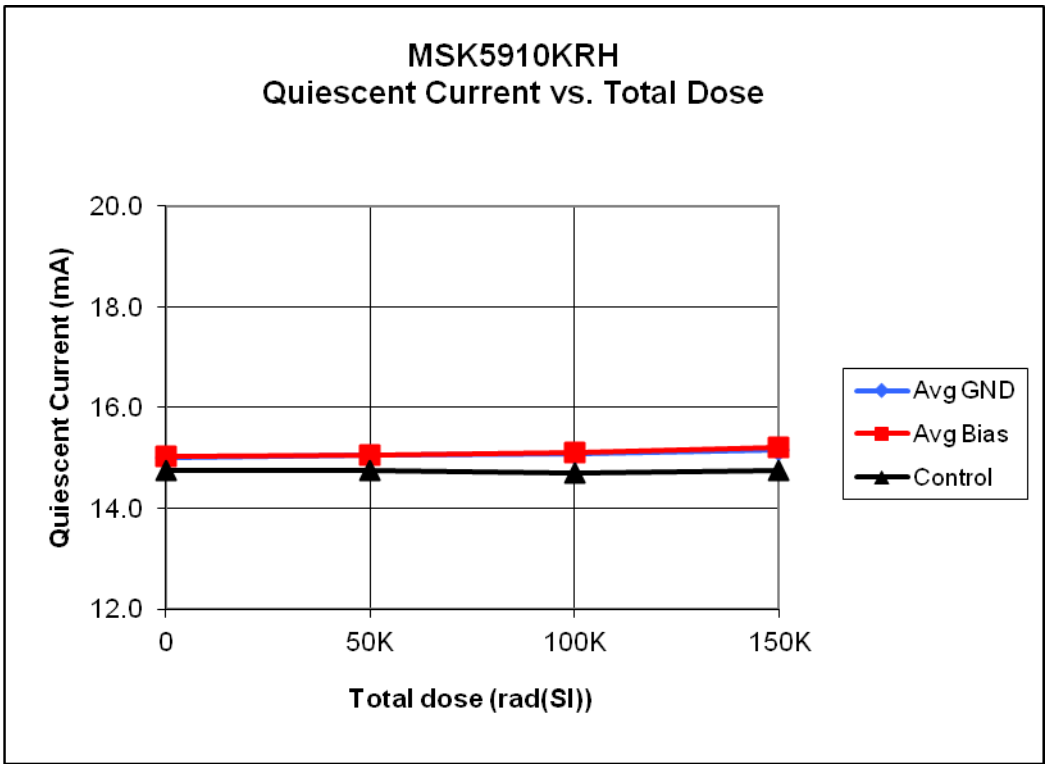
Irradiation Date
04/18/14

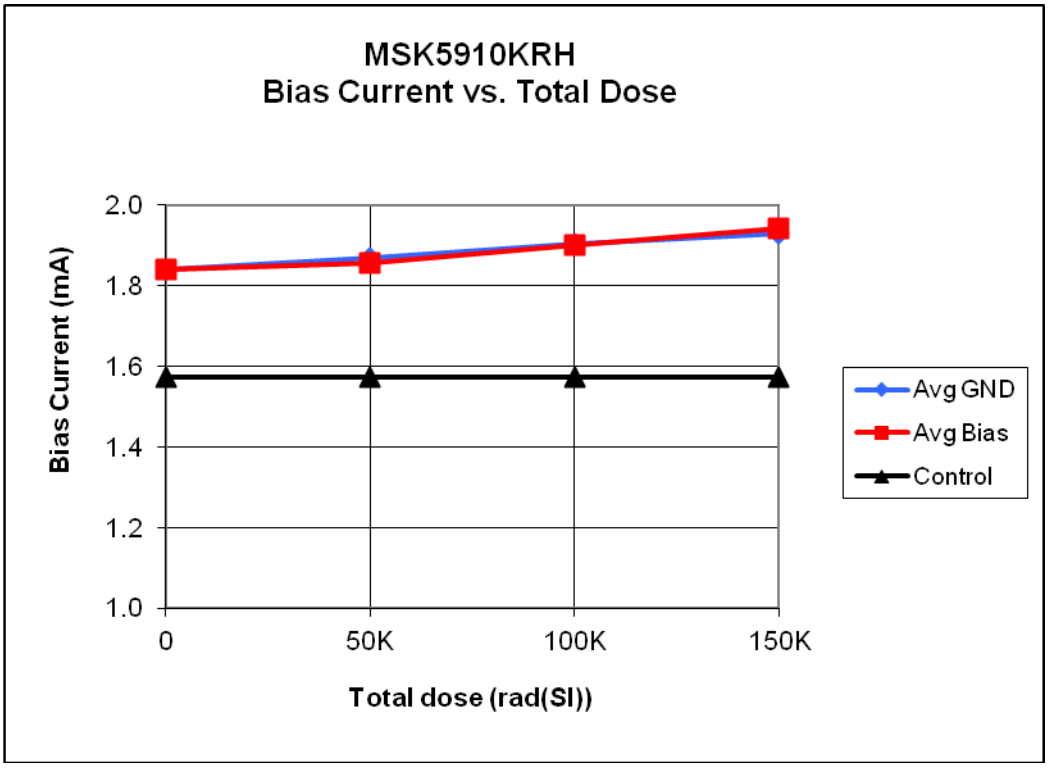
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
7:00	51,660	51,60
7:00	51,660	103,320
7:00	51,660	154,980

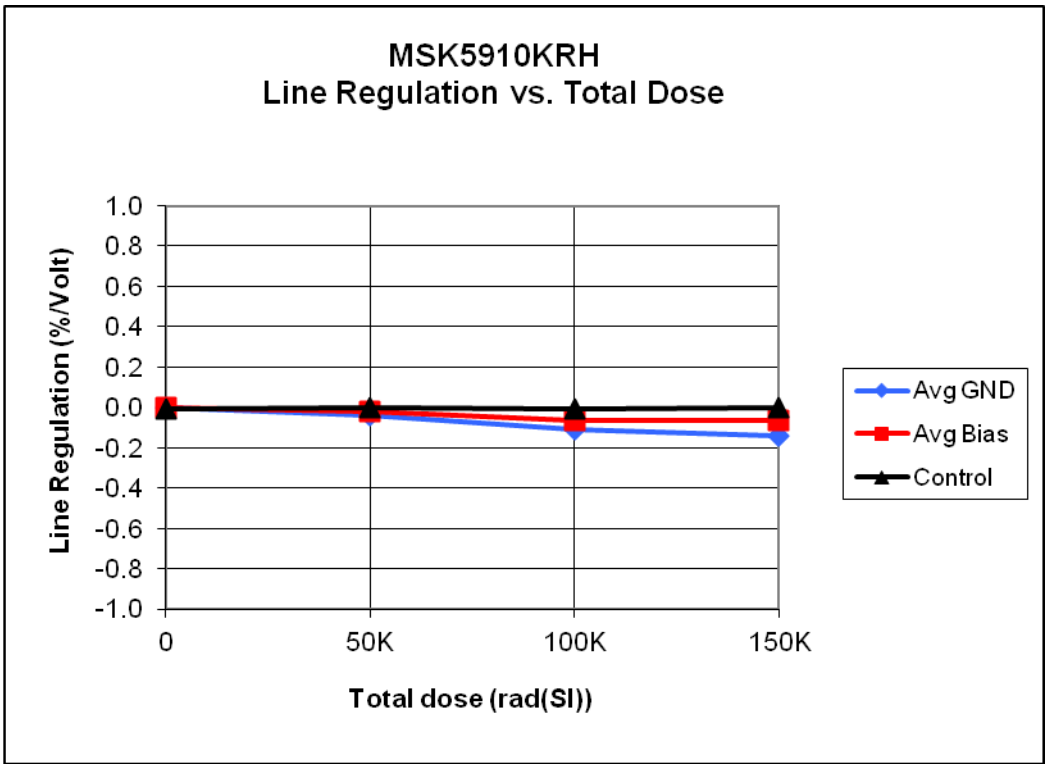
Biased S/N – 0942, 0943, 1083, 1084, 1085

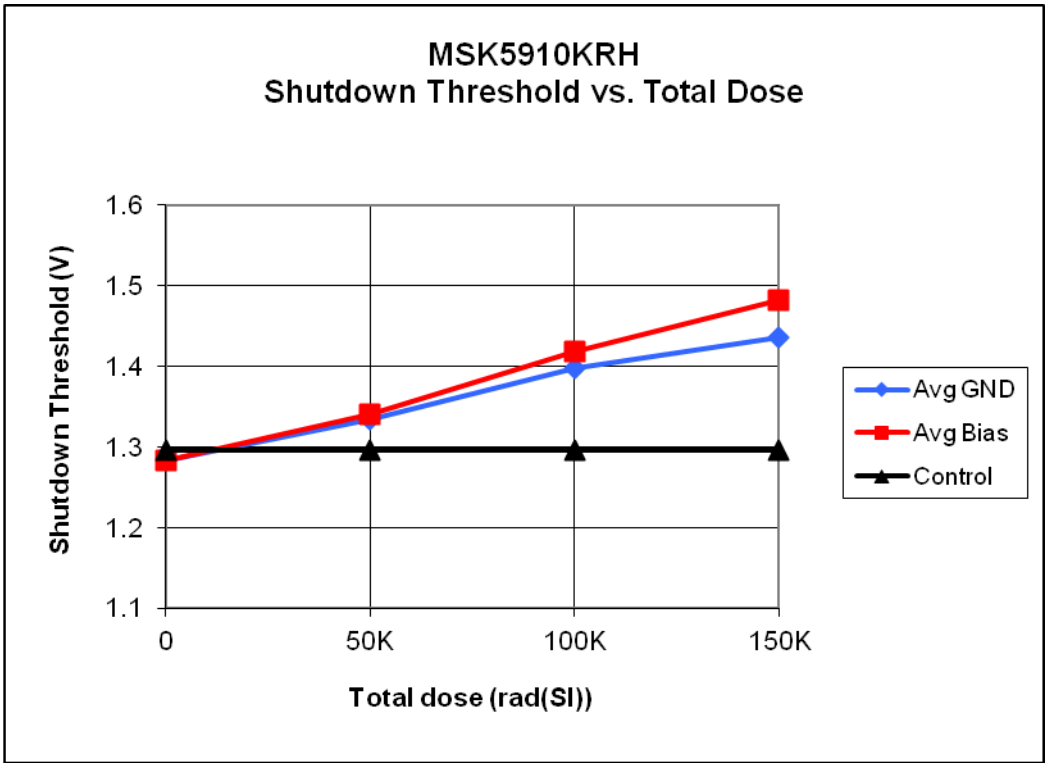
Unbiased S/N – 1086, 1087, 1088, 1089, 1090

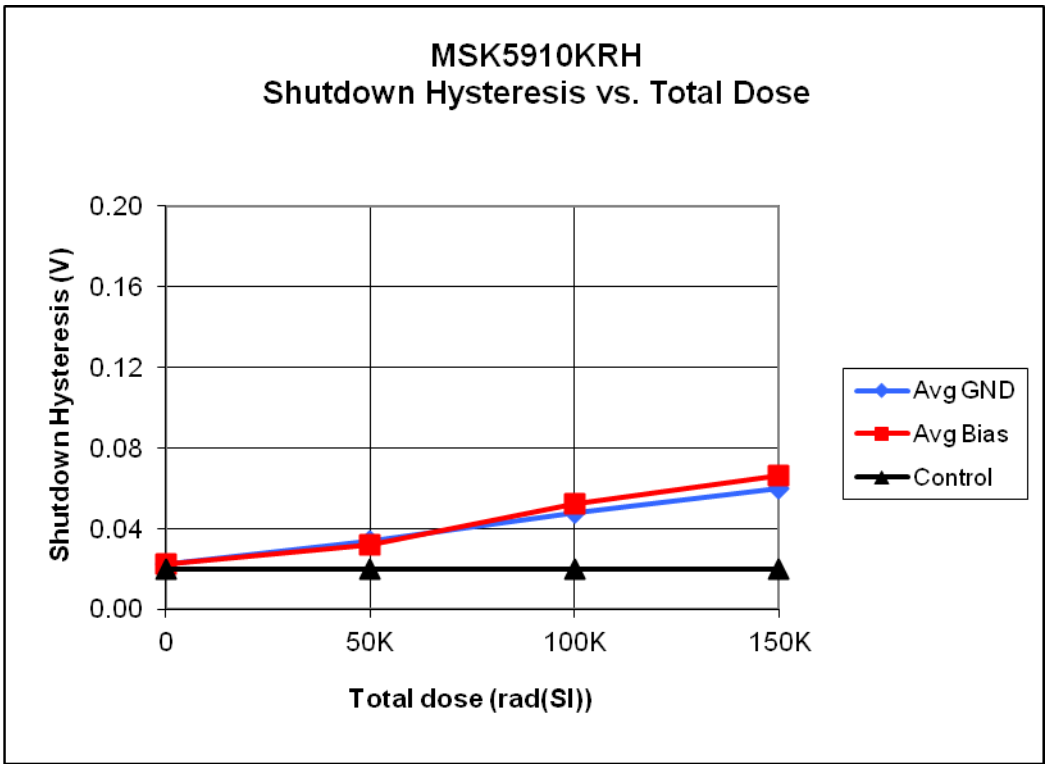
Table I
Dose Time, Incremental Dose and Total Cumulative Dose

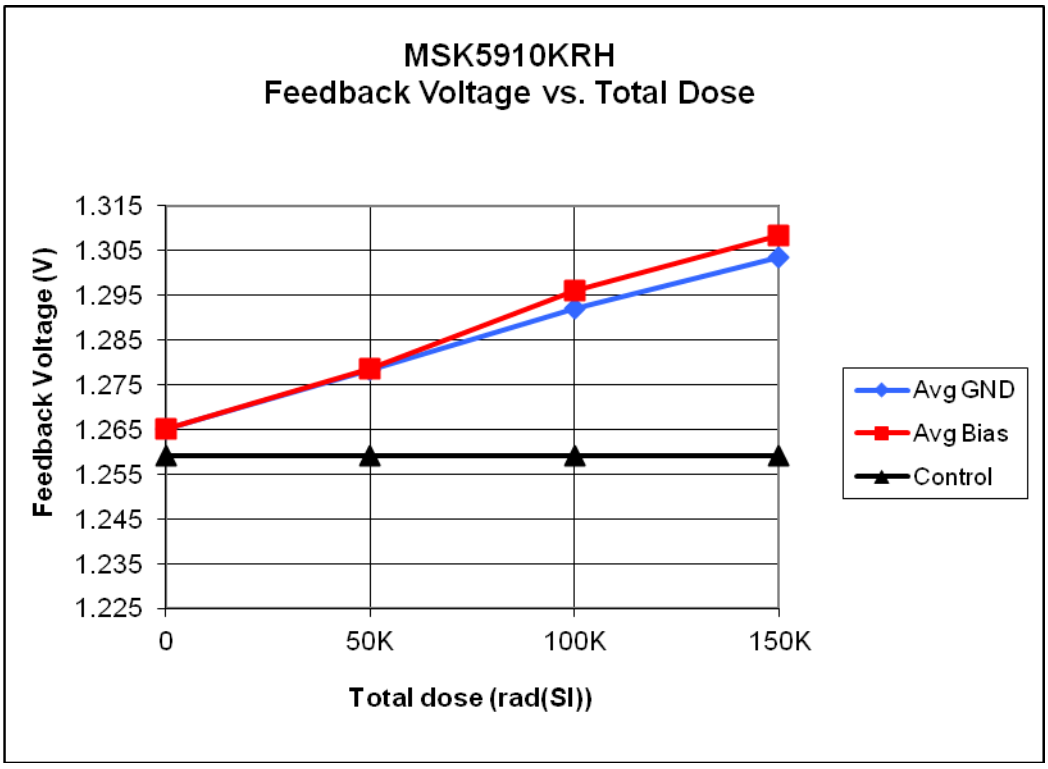

MSK5910KRH
Quiescent Current vs. Total Dose
Quiescent Current (mA)
20.0
18.0
16.0
14.0
12.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control

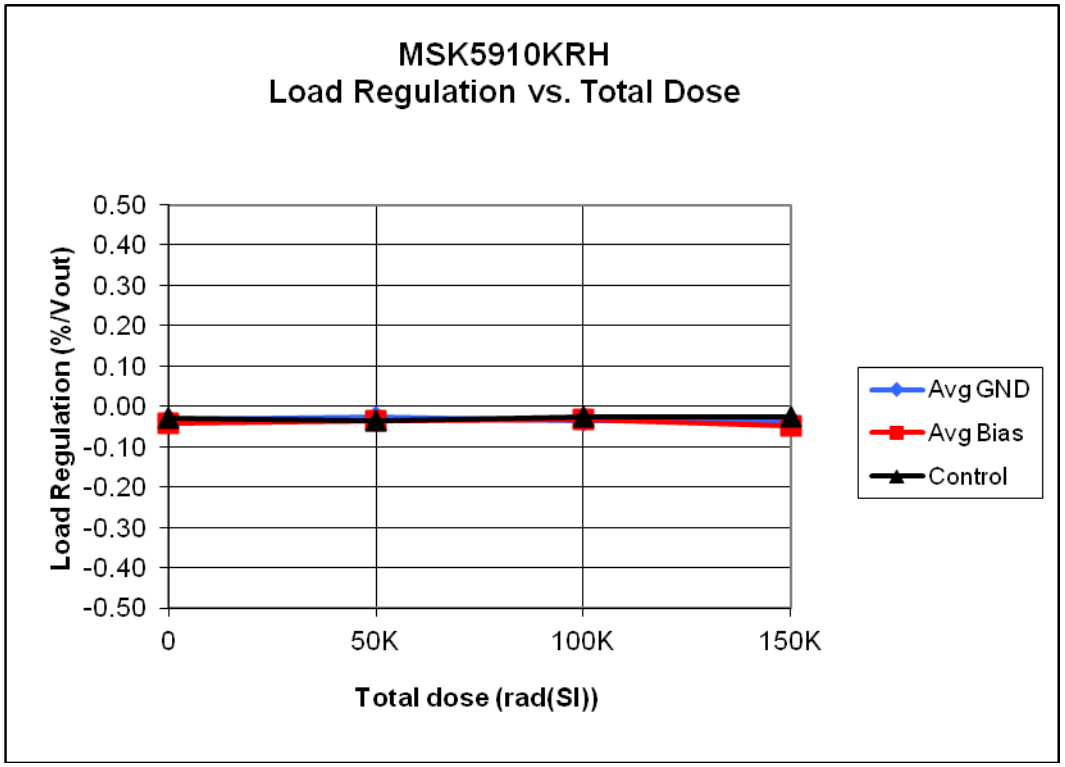

MSK5910KRH
Bias Current vs. Total Dose
Bias Current (mA)
2.0
1.8
1.6
1.4
1.2
1.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control

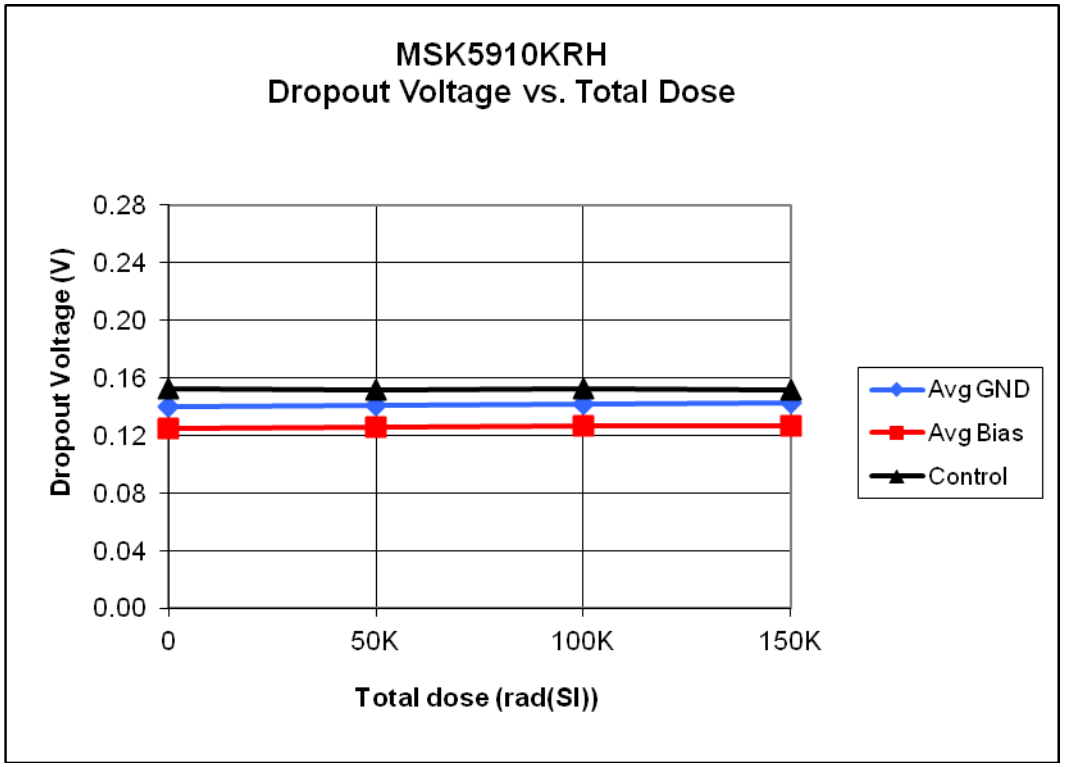

MSK5910KRH
Line Regulation vs. Total Dose
Line Regulation (%/Volt)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control

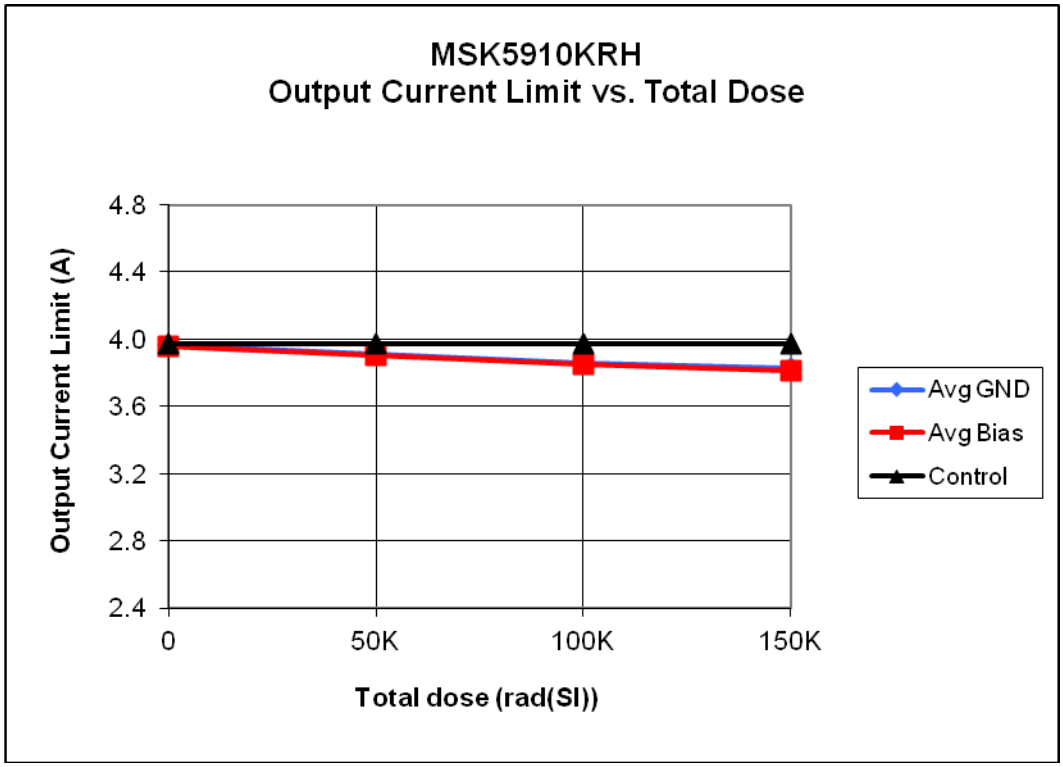

MSK5910KRH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.6
1.5
1.4
1.3
1.2
1.1
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control


MSK5910KRH
Shutdown Hysteresis vs. Total Dose
Shutdown Hysteresis (V)
0.20
0.16
0.12
0.08
0.04
0.00
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control


MSK5910KRH
Feedback Voltage vs. Total Dose
Feedback Voltage (V)
1.315
1.305
1.295
1.285
1.275
1.265
1.255
1.245
1.235
1.225
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control


MSK5910KRH
Load Regulation vs. Total Dose
Load Regulation (%/Vout)
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control


MSK5910KRH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.28
0.24
0.20
0.16
0.12
0.08
0.04
0.00
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control


MSK5910KRH
Output Current Limit vs. Total Dose
Output Current Limit (A)
4.8
4.4
4.0
3.6
3.2
2.8
2.4
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control

Total Dose Radiation Test Report

MSK 5910RH
(MSK 5900RH, MSK 5920RH, MSK 5921RH, MSK 5922RH)

Ultra Low Dropout Adjustable Positive Linear Regulator

December 20,2004 (MSK 5900RH - 1st Test)
May 17, 2005 (MSK 5910RH - 1st Test)
December 27, 2005 (MSK5920RH - 1st Test)
January 6, 2006 (MSK 5921RH - 1st Test)
Updated on July 31, 2006
February 21, 2007 – (MSK 5921RH – 2nd Test)
March 29, 2007 (MSK5920RH – 2nd Test)
June 14, 2007 (MSK5920RH – 3rd Test)
Updated on January 21, 2008 (MSK 5910RH - 2nd Test)
November 06, 2009 (MSK 5910RH 3rd Test)
May 14, 2010 (MSK 5910RH 4th Test)
September 21, 2011 (MSK 5910RH – 5th Test)

B. Erwin
R. Wakeman

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5910RH was developed to qualify the device as a radiation tolerant device to 100 KRADS(Si). The testing was performed up to 300 KRAD to show trends in device performance as a function of total dose. The MSK 5900RH, MSK 5910RH, MSK 5920RH, MSK 5921RH, and MSK 5922RH all use the same active components. The data in this report is from direct measurement of the MSK 5910RH response to irradiation, but it is indicative of the response of all five device types and is applicable to all five 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 5910RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and the dose rate was determined to be 119 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 biased during irradiation. Recommended operating voltage of +7.5V 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 and the devices were transported to the MSK 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. Each subsequent dose was performed within two hours of the previous irradiation.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing, the MSK 5910RH qualified as a 100 KRADS(Si) radiation tolerant device.

It should be noted that there was a positive shift in feedback voltage from 0 KRADS(Si) to 150 KRADS(Si).

All other test parameters stayed within pre-irradiation test limits throughout the irradiation process.

MSK 5910RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

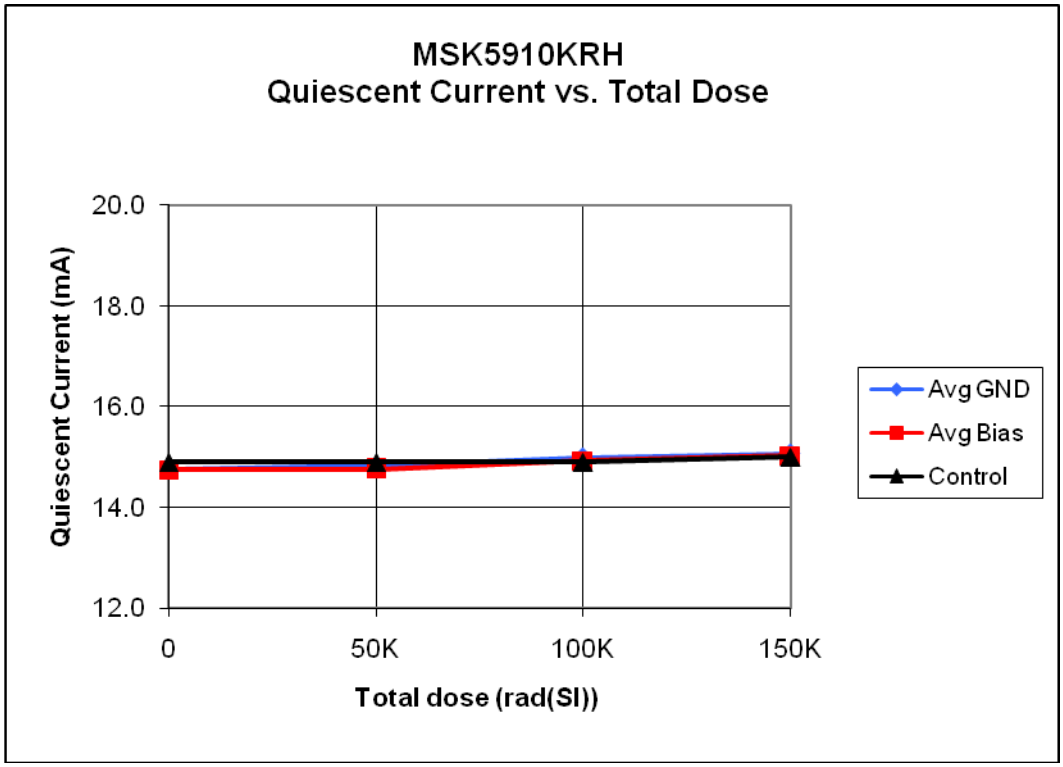
Irradiation Date
09/21/11

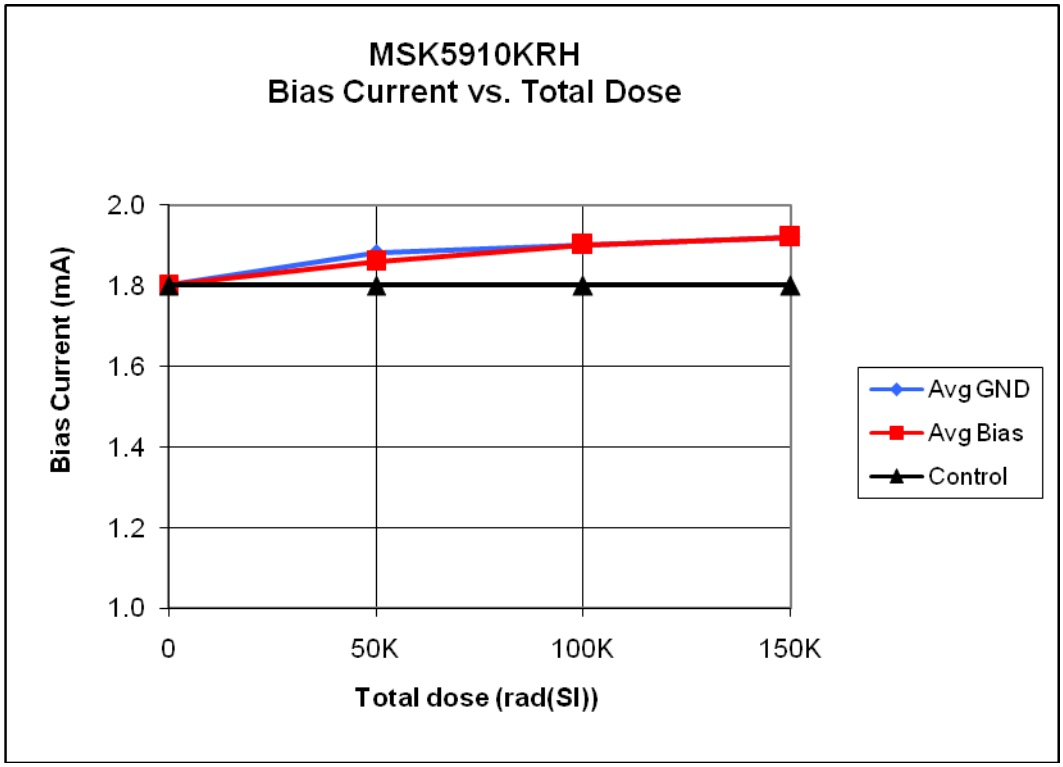
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
7:13	51,527	51,527
7:13	51,527	103,054
7:13	51,527	154,581

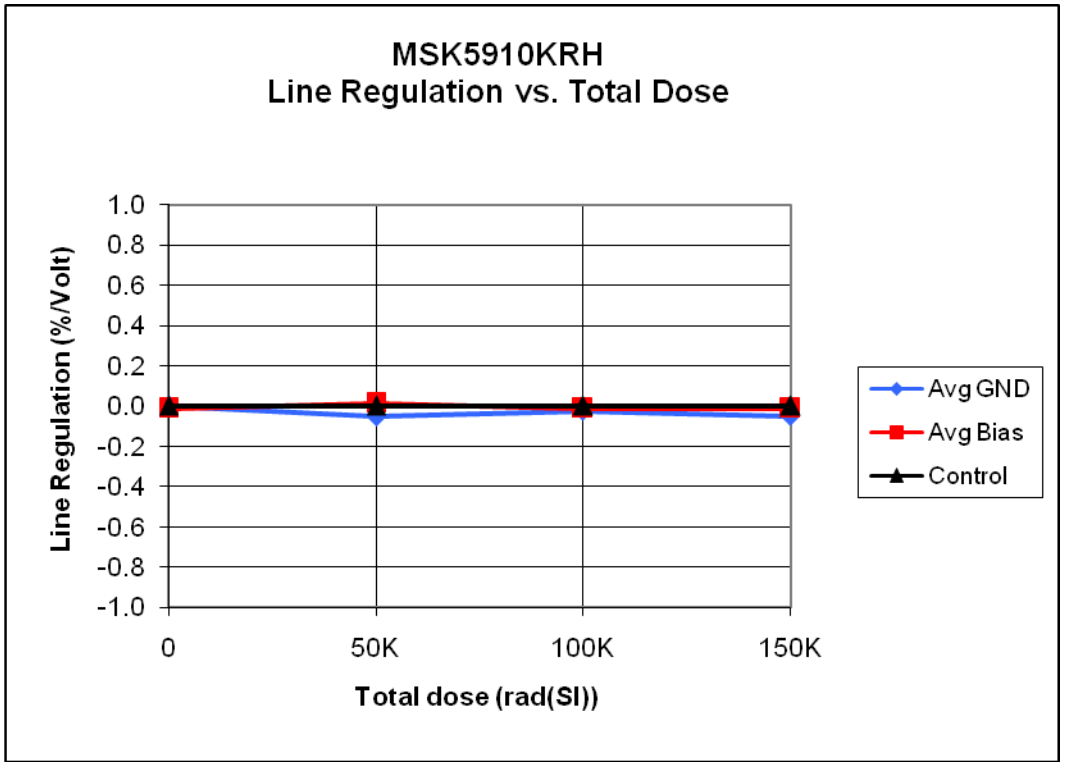
Biased S/N – 0778, 0779, 0780, 0781, 0782

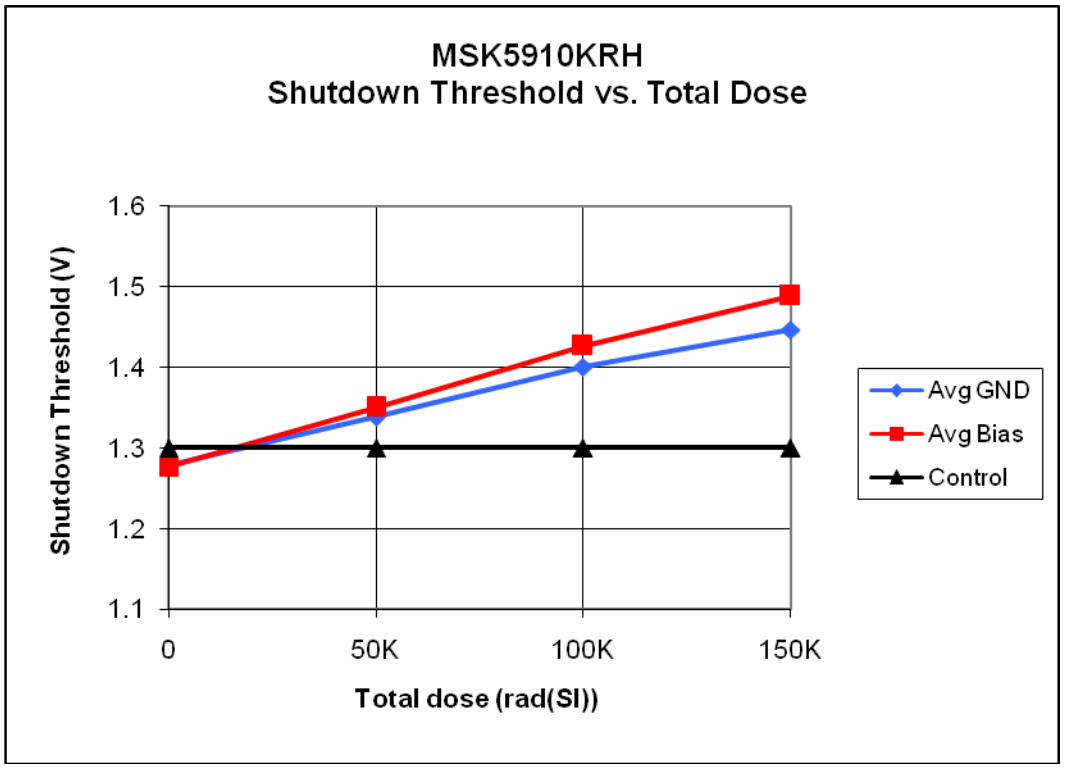
Unbiased S/N – 0783, 0784, 0785, 0786, 0787

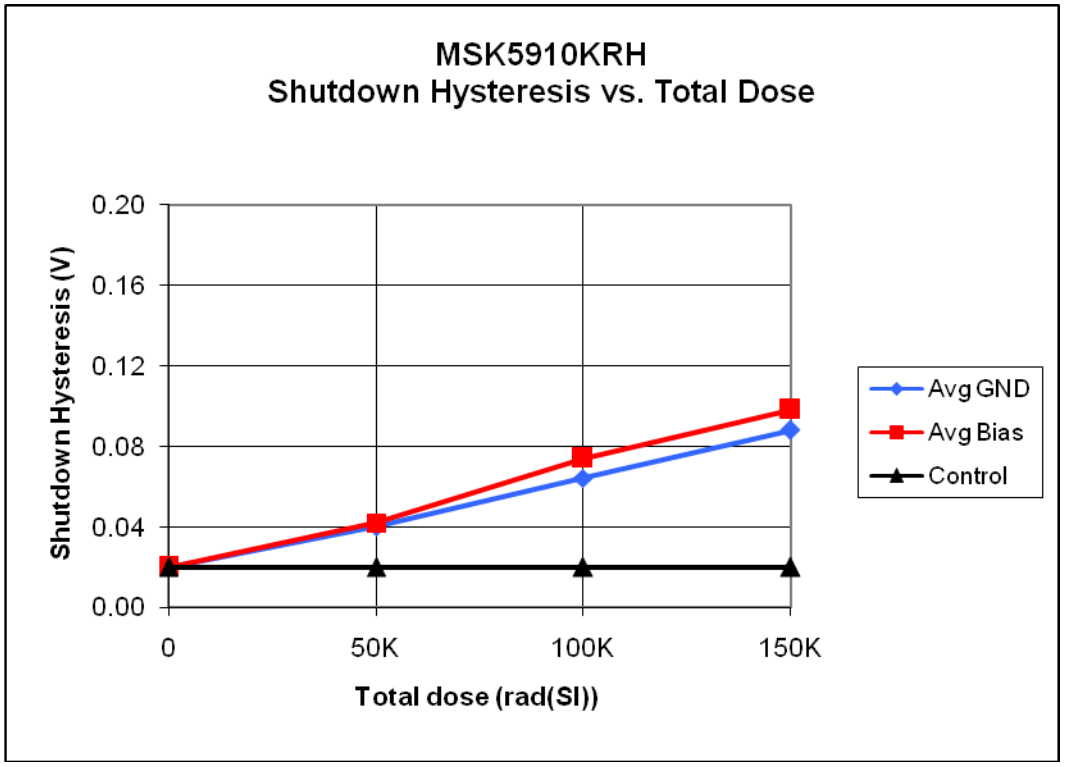
Table I
Dose Time, Incremental Dose and Total Cumulative Dose

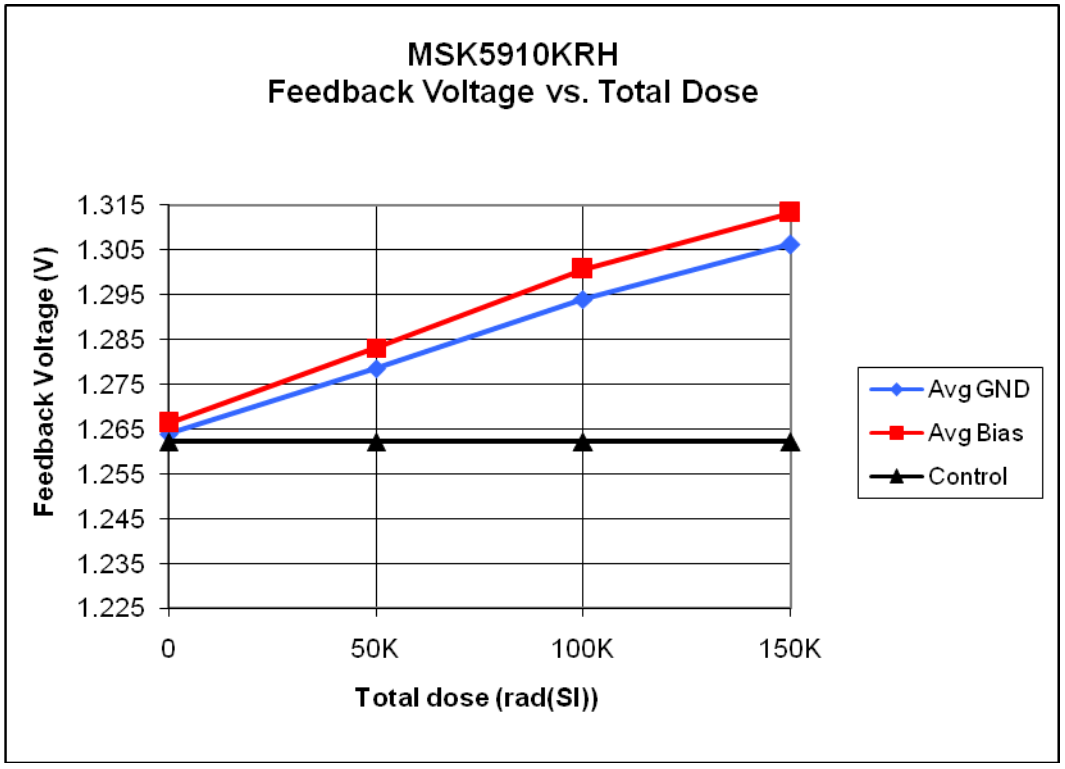

MSK5910KRH
Quiescent Current vs. Total Dose
Quiescent Current (mA)
20.0
18.0
16.0
14.0
12.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control

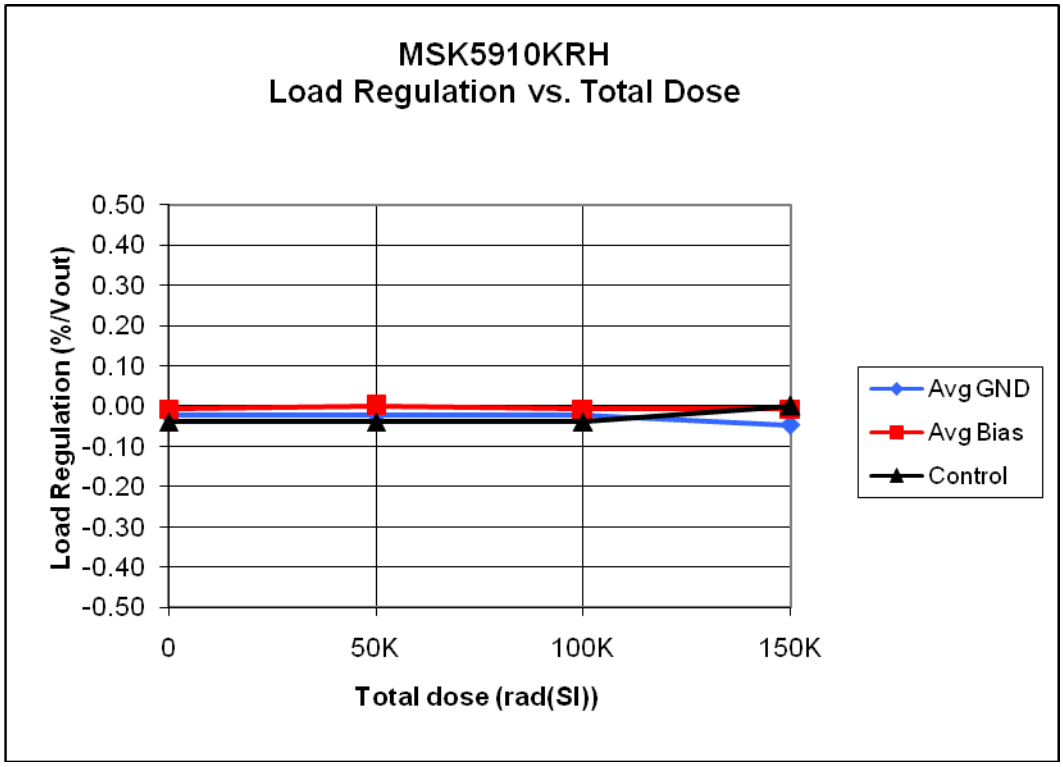

MSK5910KRH
Bias Current vs. Total Dose
Bias Current (mA)
2.0
1.8
1.6
1.4
1.2
1.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control

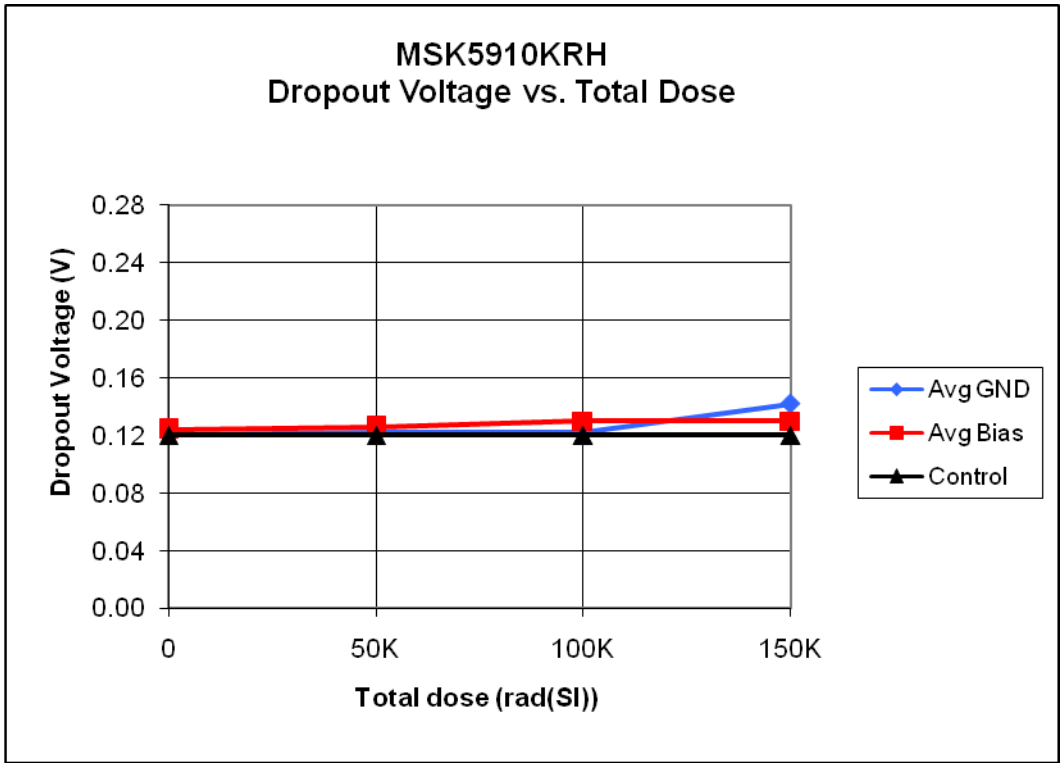

MSK5910KRH
Line Regulation vs. Total Dose
Line Regulation (%/Volt)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control

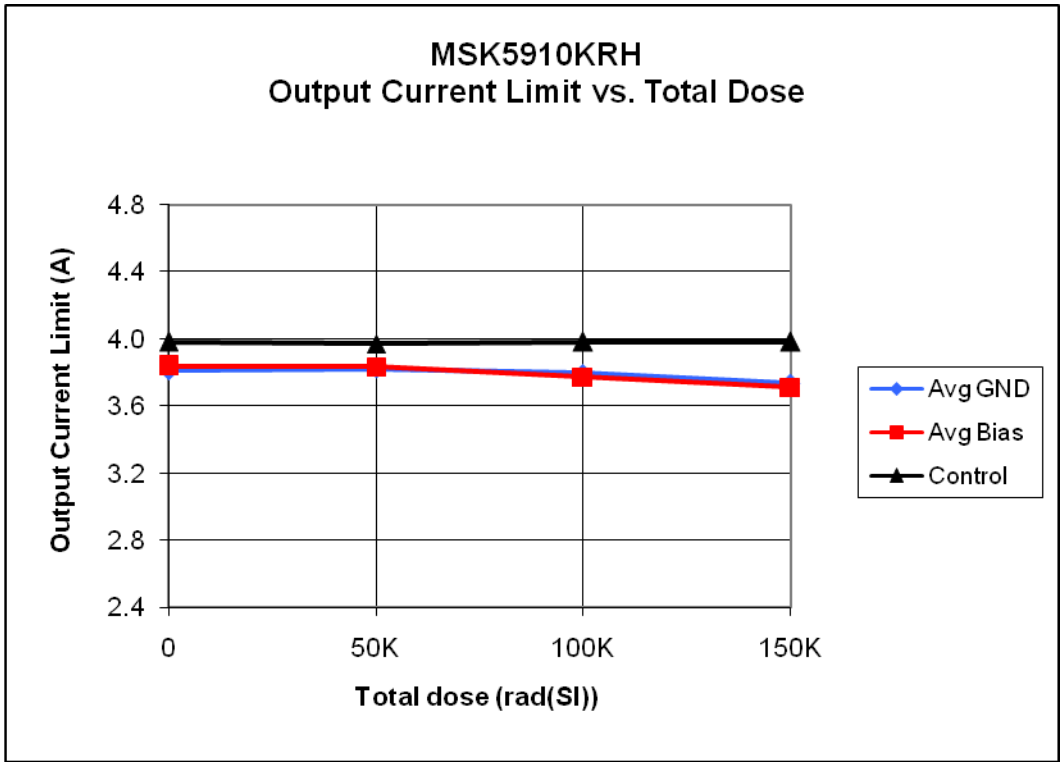

MSK5910KRH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.6
1.5
1.4
1.3
1.2
1.1
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control


MSK5910KRH
Shutdown Hysteresis vs. Total Dose
Shutdown Hysteresis (V)
0.20
0.16
0.12
0.08
0.04
0.00
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control


MSK5910KRH
Feedback Voltage vs. Total Dose
Feedback Voltage (V)
1.315
1.305
1.295
1.285
1.275
1.265
1.255
1.245
1.235
1.225
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control


MSK5910KRH
Load Regulation vs. Total Dose
Load Regulation (%/Vout)
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control


MSK5910KRH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.28
0.24
0.20
0.16
0.12
0.08
0.04
0.00
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control


MSK5910KRH
Output Current Limit vs. Total Dose
Output Current Limit (A)
4.8
4.4
4.0
3.6
3.2
2.8
2.4
0
50K
100K
150K
Total dose (rad(Si))
Avg GND
Avg Bias
Control

Total Dose Radiation Test Report

MSK 5910RH
(MSK 5900RH, MSK 5920RH, MSK 5921RH, MSK 5922RH)

Ultra Low Dropout Adjustable Positive Linear Regulator

December 20,2004 (MSK 5900RH - 1st Test)
May 17, 2005 (MSK 5910RH - 1st Test)
December 27, 2005 (MSK5920RH - 1st Test)
January 6, 2006 (MSK 5921RH - 1st Test)
Updated on July 31, 2006
February 21, 2007 – (MSK 5921RH – 2nd Test)
March 29, 2007 (MSK5920RH – 2nd Test)
June 14, 2007 (MSK5920RH – 3rd Test)
Updated on January 21, 2008 (MSK 5910RH - 2nd Test)
November 06, 2009 (MSK 5910RH 3rd Test)
May 14, 2010 (MSK 5910RH 4th Test)

M. Bilecki
B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5910RH was developed to qualify the device as a radiation tolerant device to 100 KRADS(Si). The testing was performed up to 300 KRAD to show trends in device performance as a function of total dose. The MSK 5900RH, MSK 5910RH, MSK 5920RH, MSK 5921RH, and MSK 5922RH all use the same active components. The data in this report is from direct measurement of the MSK 5910RH response to irradiation, but it is indicative of the response of all five device types and is applicable to all five types.

MIL-STD-883 Method 1019.7 and ASTM F1892-98 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5910RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and 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 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 biased during irradiation. Five devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted and the devices were transported to the MSK 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.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing, the MSK 5910RH qualified as a 100 KRADS(Si) radiation tolerant device.

It should be noted that there was a positive shift in feedback voltage from 0 KRADS(Si) to 150 KRADS(Si).

In addition, the shutdown voltage increased slightly, but stayed within pre-irradiation limits.

All other test parameters stayed within pre-irradiation test limits throughout the irradiation process.

MSK 5910RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

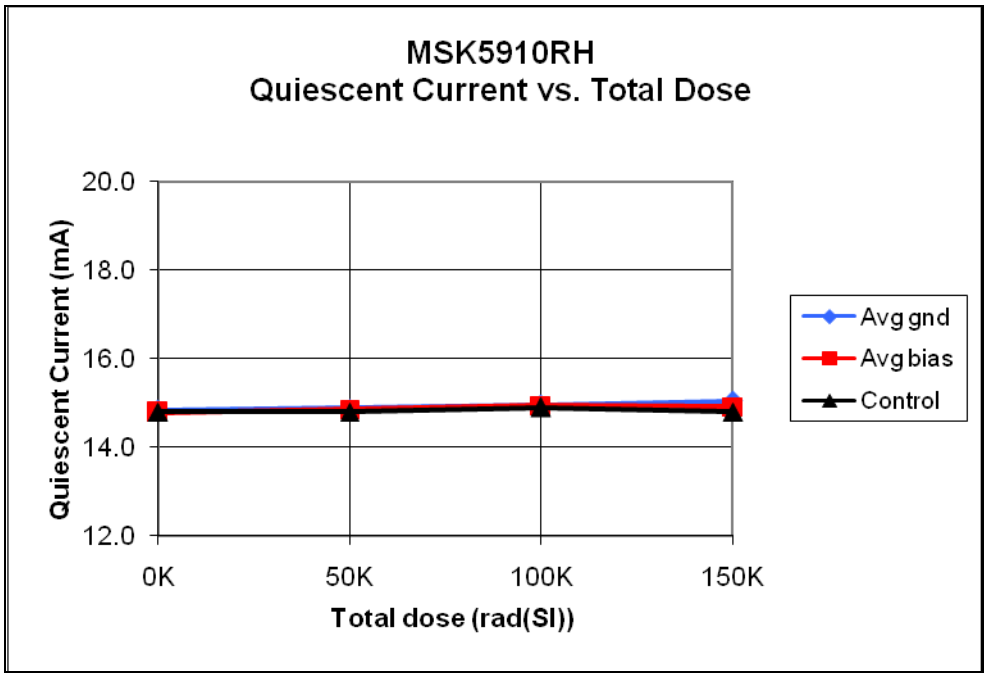
Irradiation Date
05/14/10

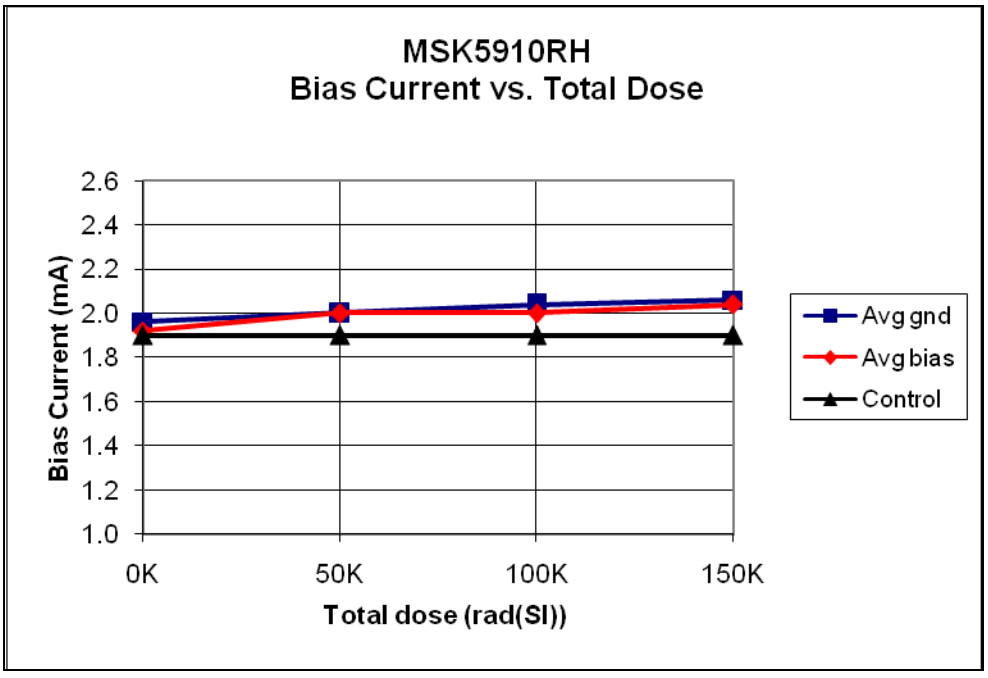
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
6:14	51,612	51,612
6:14	51,612	103,224
6:14	51,612	154,836

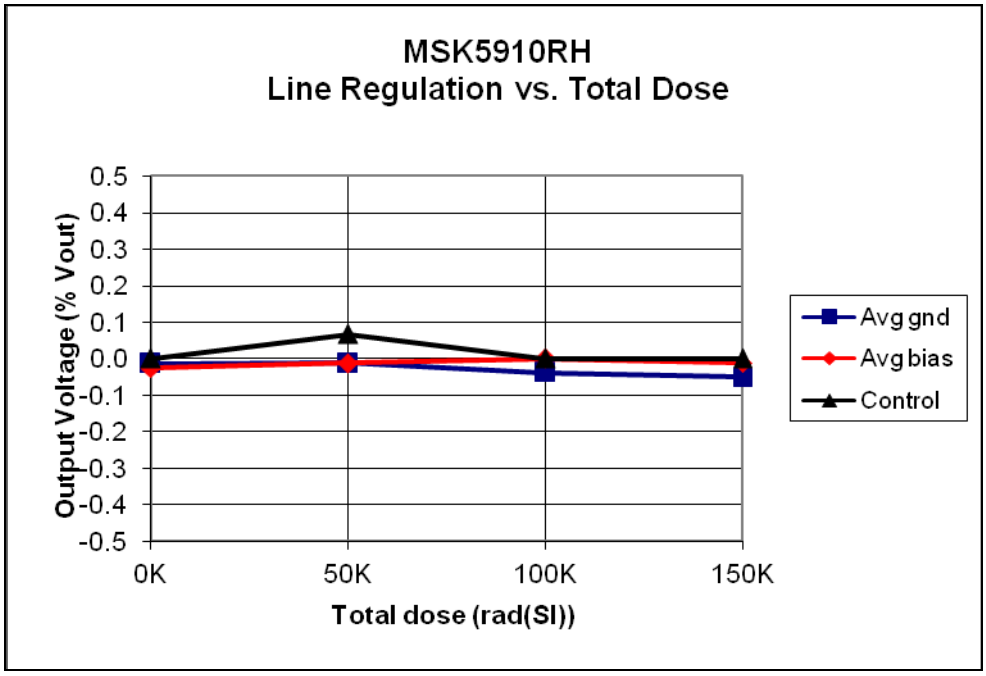
Biased S/N – 0411, 0412, 0413, 0414, 0415

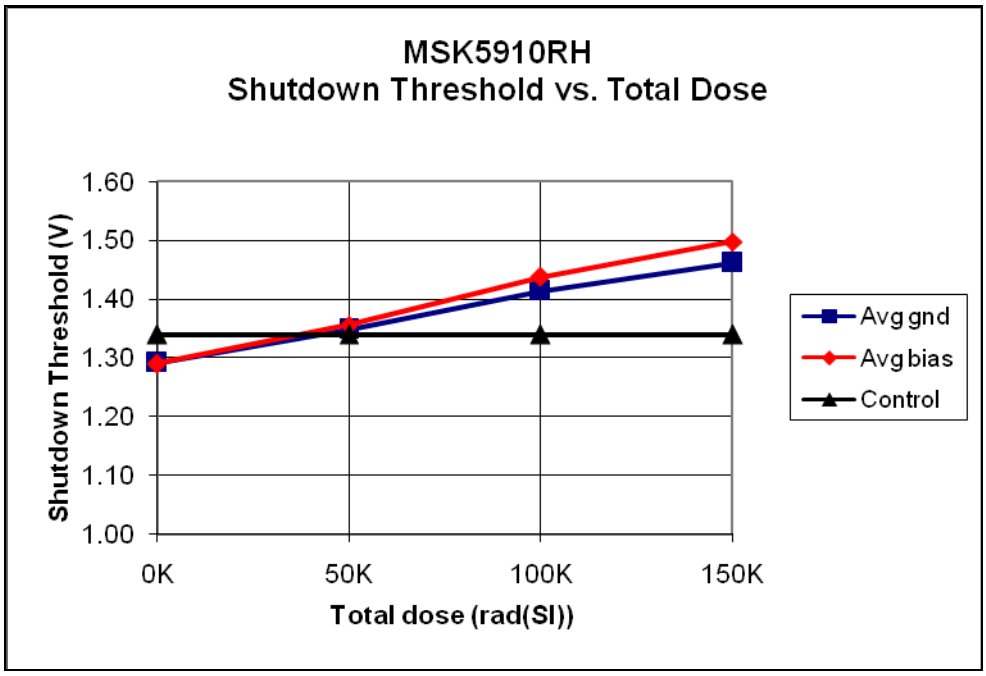
Unbiased S/N – 0416, 0417, 0418, 0419, 0420

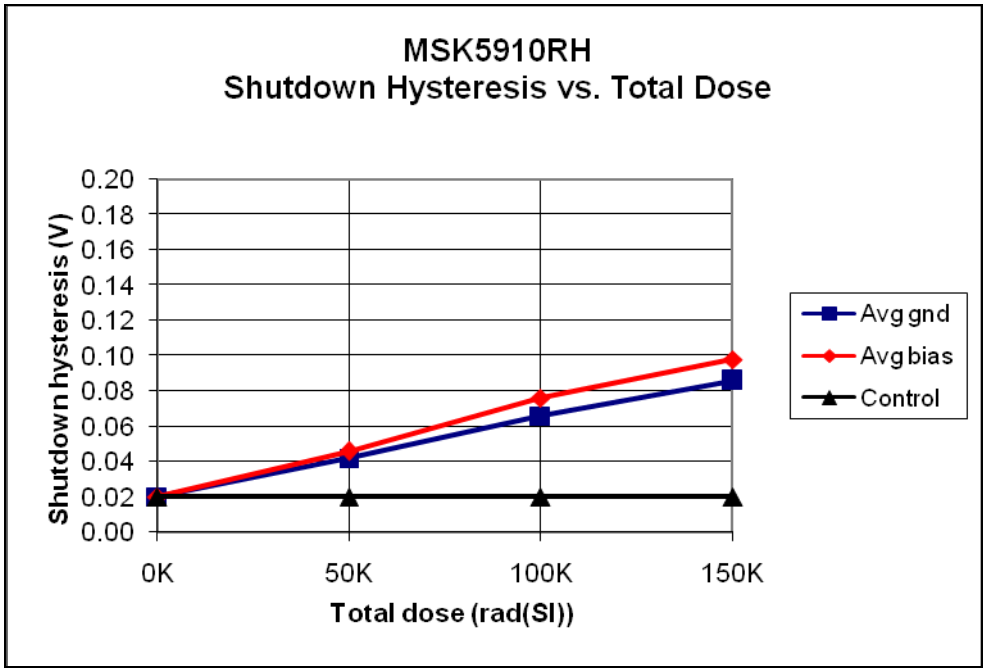
Table I
Dose Time, Incremental Dose and Total Cumulative Dose

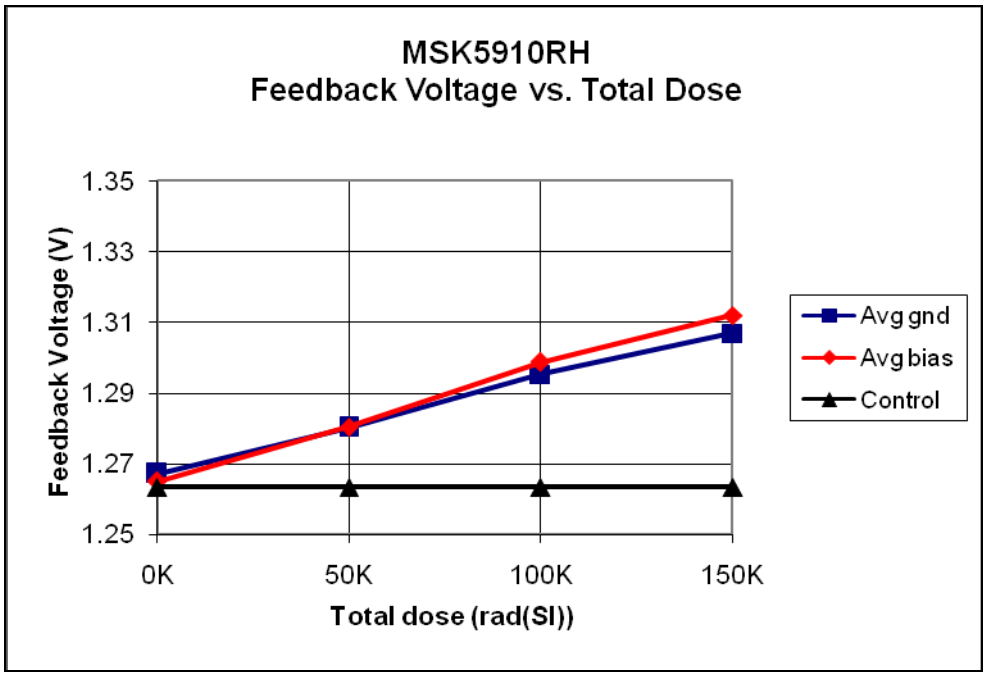

MSK5910RH
Quiescent Current vs. Total Dose
Quiescent Current (mA)
20.0
18.0
16.0
14.0
12.0
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

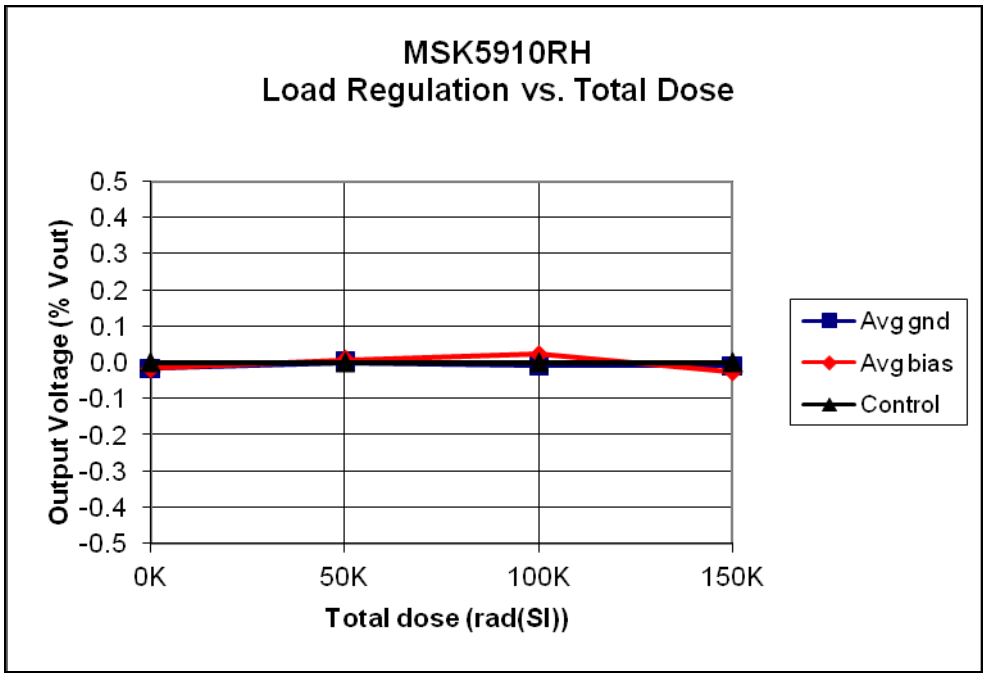

MSK5910RH
Bias Current vs. Total Dose
Bias Current (mA)
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

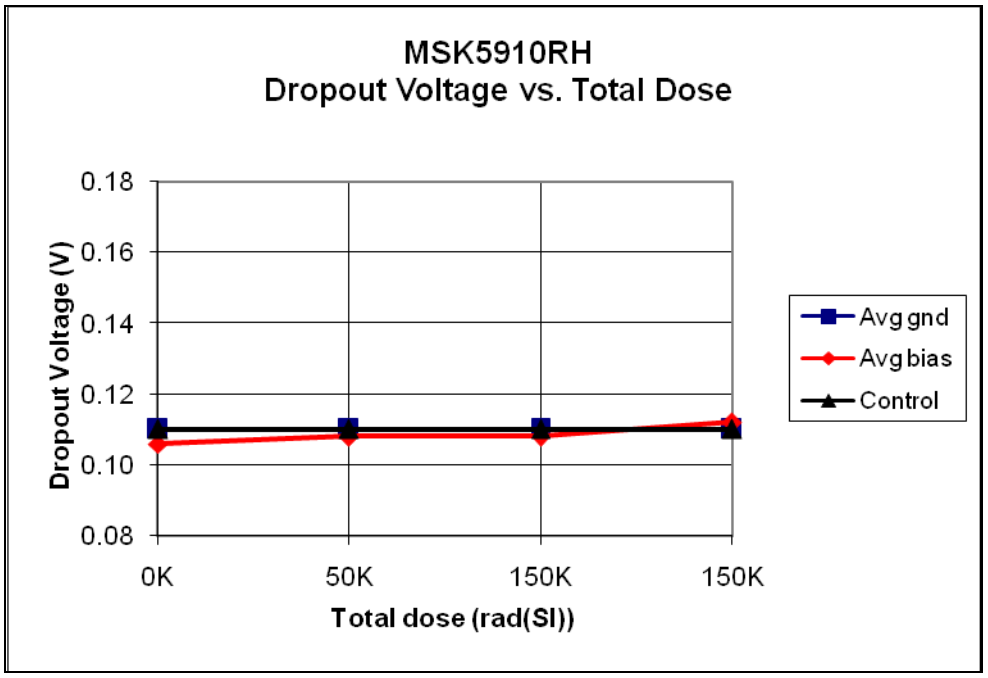

MSK5910RH
Line Regulation vs. Total Dose
Output Voltage (% Vout)
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

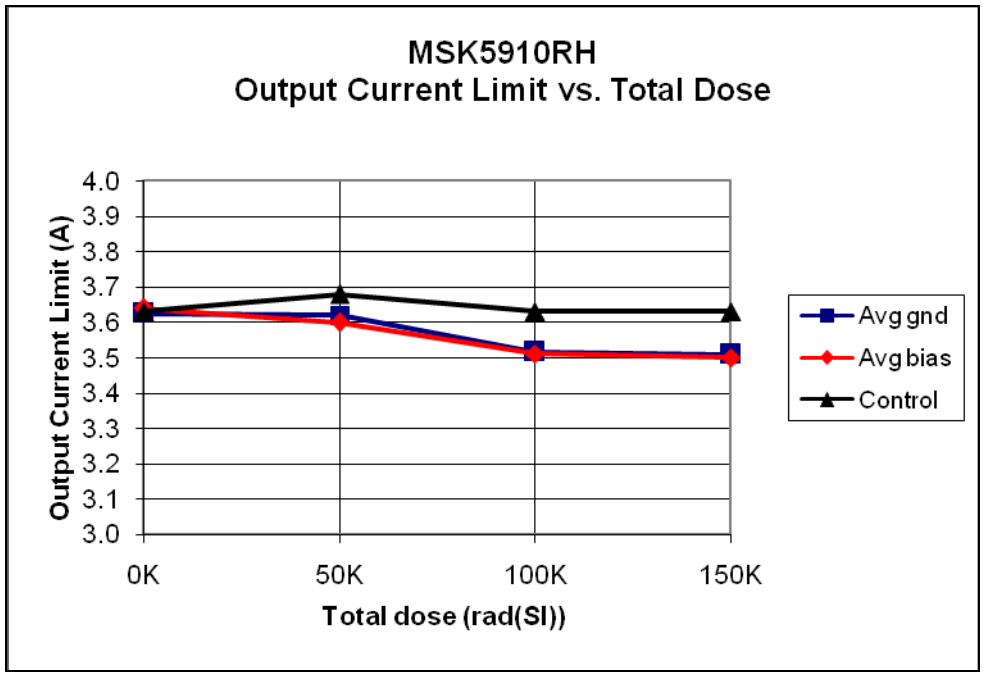

MSK5910RH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5910RH
Shutdown Hysteresis vs. Total Dose
Shutdown hysteresis (V)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5910RH
Feedback Voltage vs. Total Dose
Feedback Voltage (V)
1.35
1.33
1.31
1.29
1.27
1.25
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5910RH
Load Regulation vs. Total Dose
Output Voltage (% Vout)
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5910RH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.18
0.16
0.14
0.12
0.10
0.08
0K
50K
150K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5910RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
4.0
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3.0
0K
50K
100K
150K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

Total Dose Radiation Test Report

MSK 5910RH
(MSK 5900RH, MSK 5920RH, MSK 5921RH, MSK 5922RH)

Ultra Low Dropout Adjustable Positive Linear Regulator

December 20,2004 (MSK 5900RH - 1st Test)
May 17, 2005 (MSK 5910RH - 1st Test)
December 27, 2005 (MSK5920RH - 1st Test)
January 6, 2006 (MSK 5921RH - 1st Test)
Updated on July 31, 2006
February 21, 2007 – (MSK 5921RH – 2nd Test)
March 29, 2007 (MSK5920RH – 2nd Test)
June 14, 2007 (MSK5920RH – 3rd Test)
Updated on January 21, 2008 (MSK 5910RH - 2nd Test)
November 06, 2009 (MSK 5910RH 3rd Test)

M. Bilecki
B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5910RH was developed to qualify the device as a radiation tolerant device to 100 KRADS(Si). The testing was performed up to 300 KRAD to show trends in device performance as a function of total dose. The MSK 5900RH, MSK 5910RH, MSK 5920RH, MSK 5921RH, and MSK 5922RH all use the same active components. The data in this report is from direct measurement of the MSK 5910RH response to irradiation, but it is indicative of the response of all five device types and is applicable to all five types.

MIL-STD-883 Method 1019.7 and ASTM F1892-98 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5910RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and 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 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 biased during irradiation. Five devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted and the devices were transported to the MSK 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.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing, the MSK 5910RH qualified as a 100 KRADS(Si) radiation tolerant device.

It should be noted that there was a positive shift in feedback voltage from 0 KRADS(Si) to 200 KRADS(Si).

All other test parameters stayed within pre-irradiation test limits throughout the irradiation process.

MSK 5910RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
Bruker Biospin # 0141

Irradiation Date
11/06/09

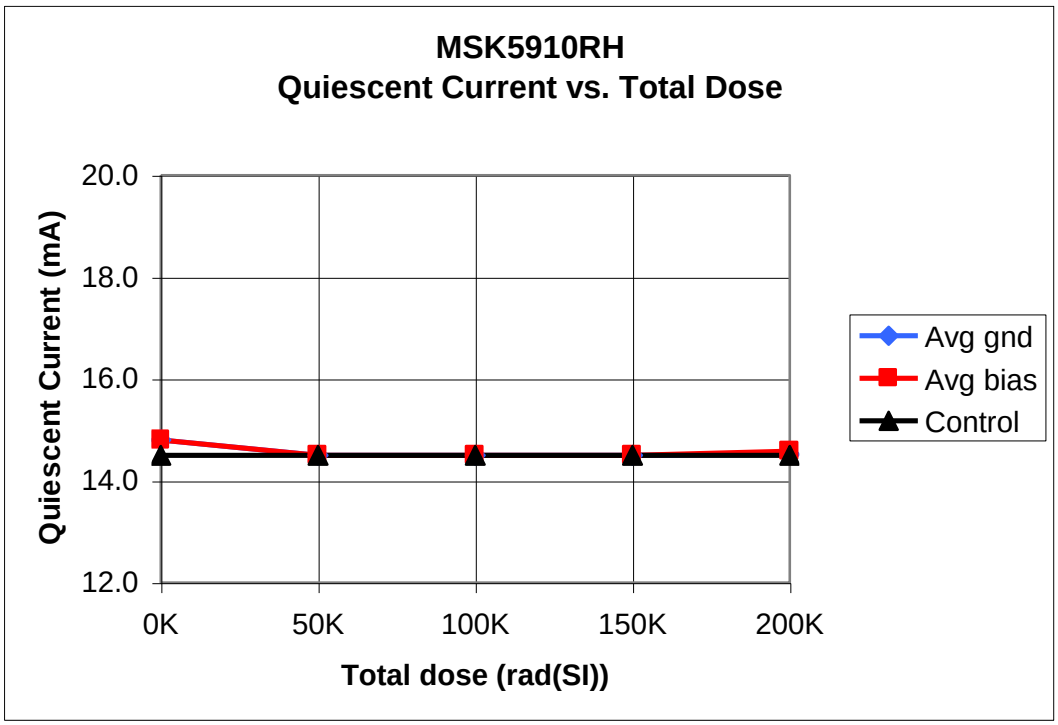
Exposure Length (min:sec)	Incremental Dose rads(Si)	Cumulative Dose rads(Si)
5:30	51,480	51,480
5:30	51,480	102,960
5:30	51,480	154,440
5:30	51,480	205,920

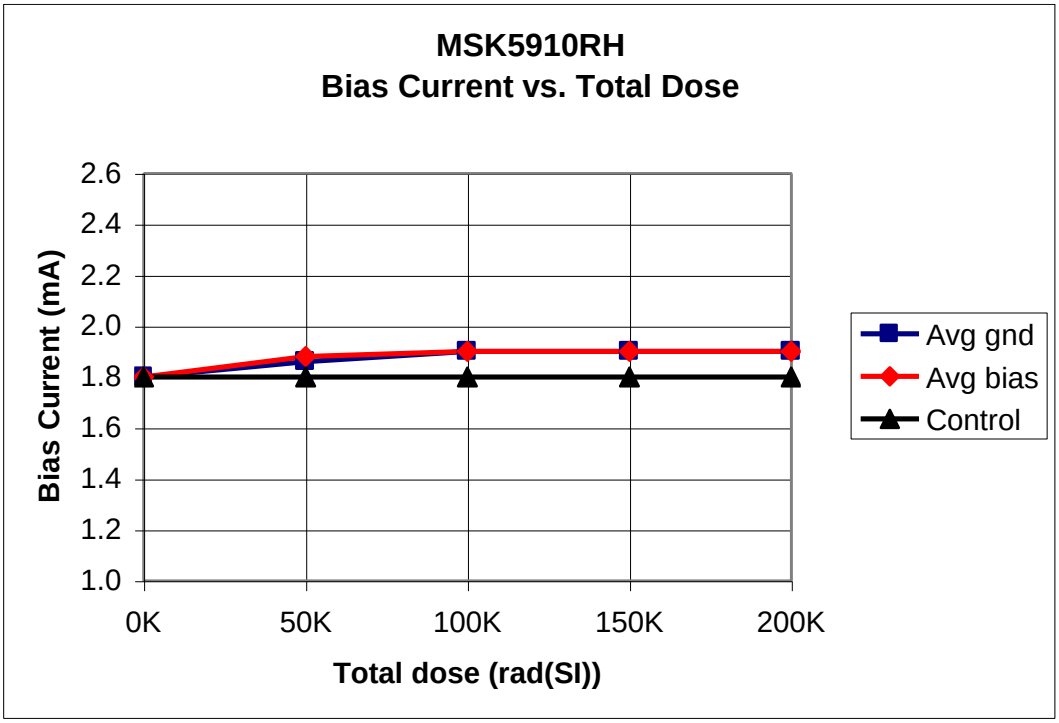
Biased S/N – 0399, 0400, 0401, 0402, 0403

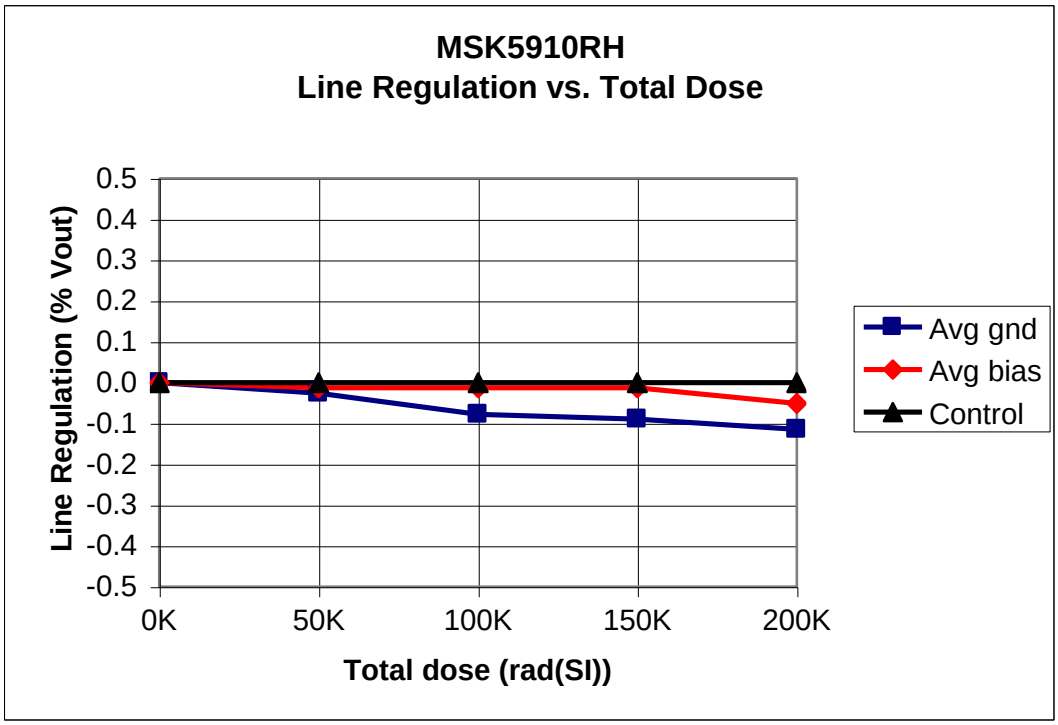
Unbiased S/N – 0404, 0405, 0406, 0407, 0408

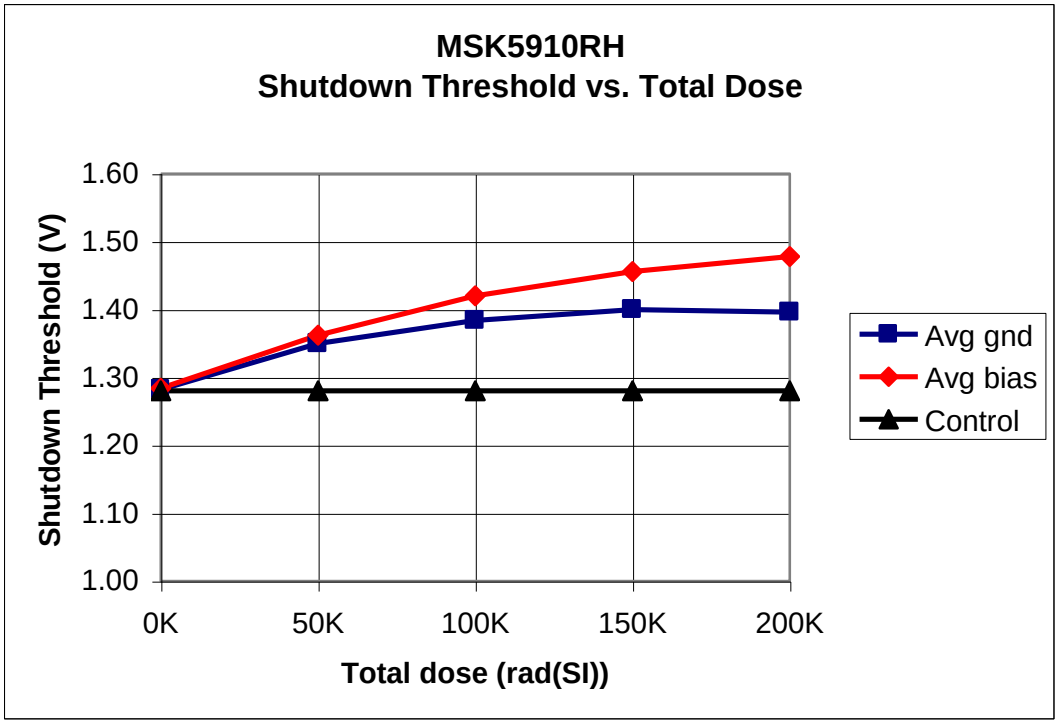
Table I

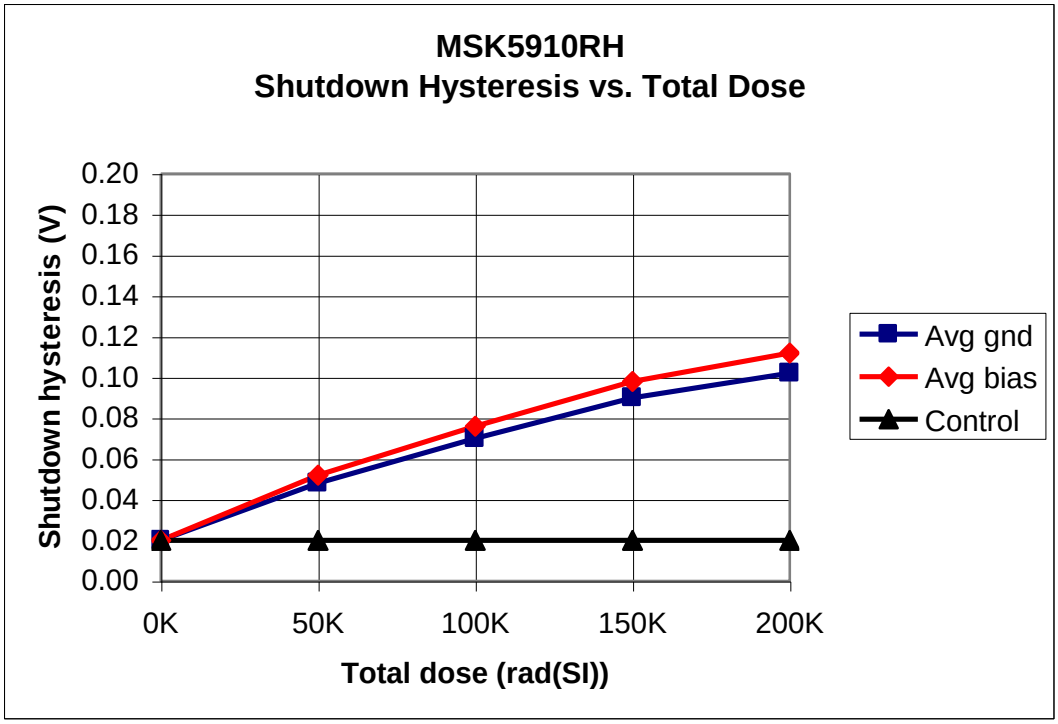
Dose Time, Incremental Dose and Total Cumulative Dose

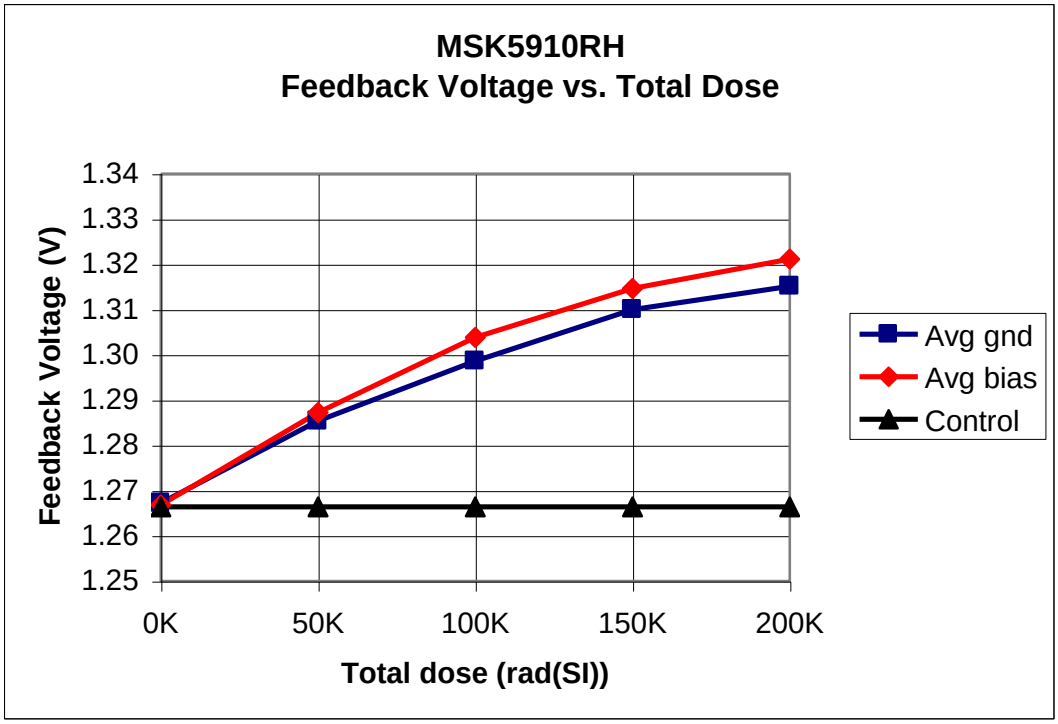

MSK5910RH
Quiescent Current vs. Total Dose
Quiescent Current (mA)
20.0
18.0
16.0
14.0
12.0
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

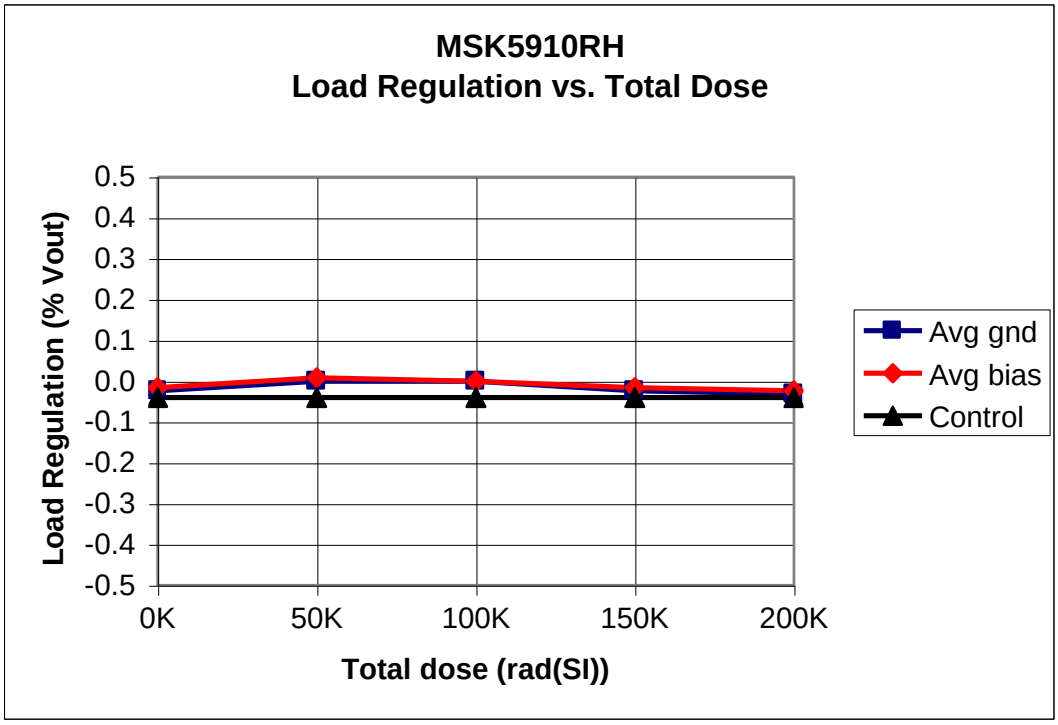

MSK5910RH
Bias Current vs. Total Dose
Bias Current (mA)
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

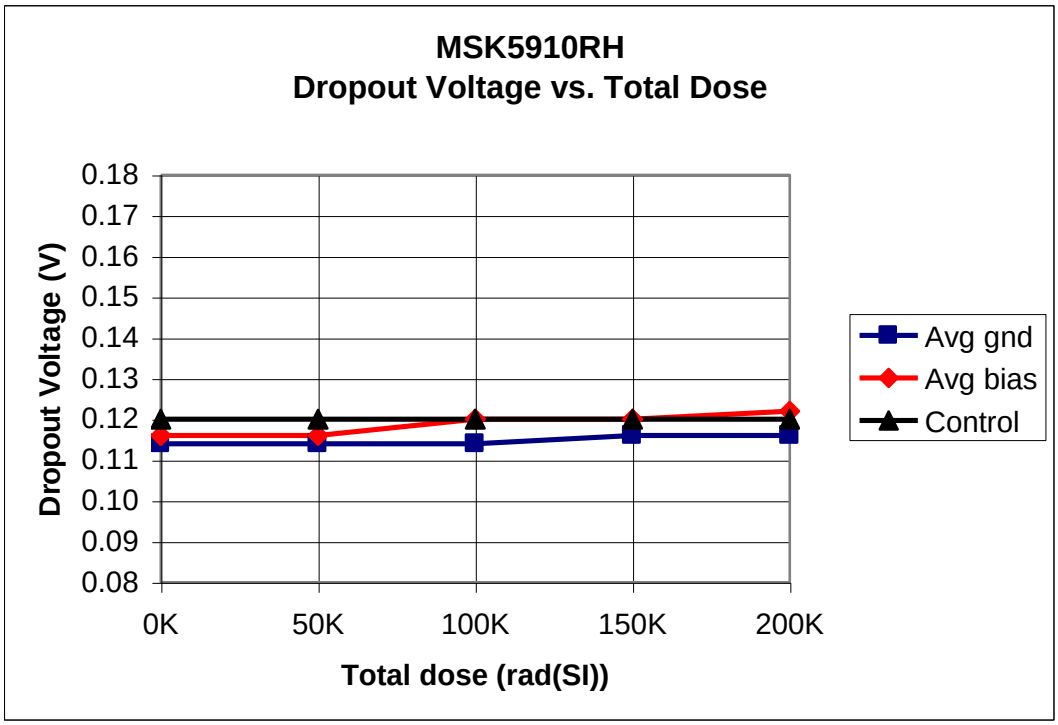

MSK5910RH
Line Regulation vs. Total Dose
Line Regulation (% Vout)
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

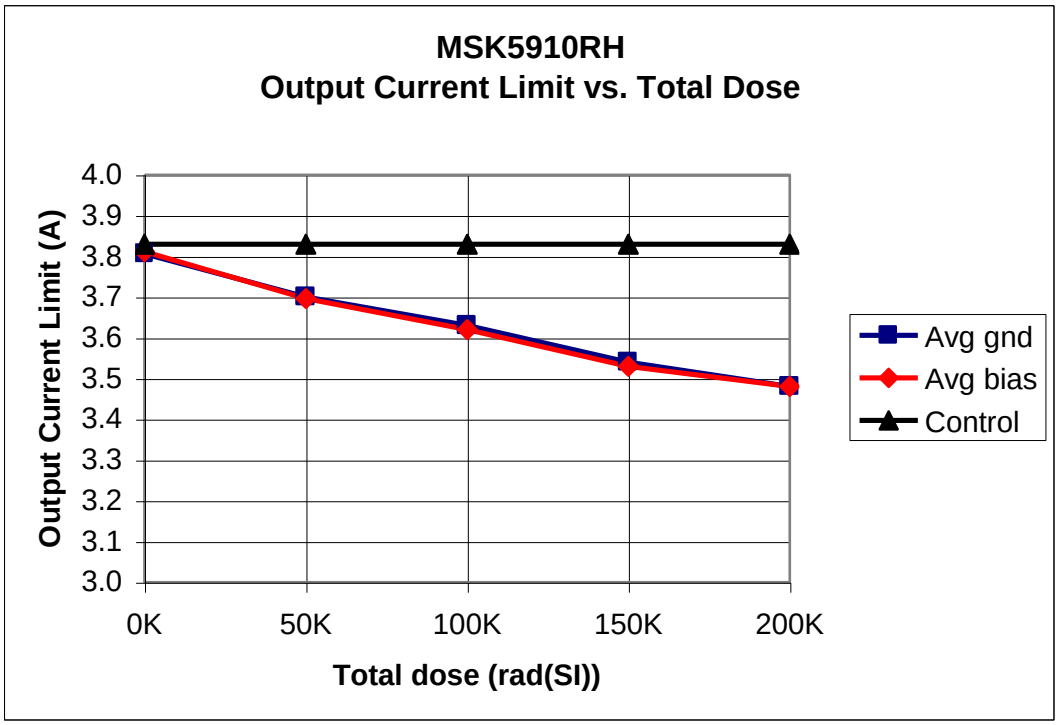

MSK5910RH
Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5910RH
Shutdown Hysteresis vs. Total Dose
Shutdown hysteresis (V)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5910RH
Feedback Voltage vs. Total Dose
Feedback Voltage (V)
1.34
1.33
1.32
1.31
1.30
1.29
1.28
1.27
1.26
1.25
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5910RH
Load Regulation vs. Total Dose
Load Regulation (% Vout)
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5910RH
Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control


MSK5910RH
Output Current Limit vs. Total Dose
Output Current Limit (A)
4.0
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3.0
0K
50K
100K
150K
200K
Total dose (rad(Si))
Avg gnd
Avg bias
Control

Total Dose Radiation Test Report

MSK 5910RH

Ultra Low Dropout Adjustable Positive Linear Regulator

Updated on January 21, 2008 (Second Test)

P. Musil
J. Douglas

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK5910RH was developed to qualify the device as a radiation tolerant device to 100 KRADS(Si). The testing was performed up to 300 KRAD to show trends in device performance as a function of total dose.

MIL-STD-883 Method 1019.7 and ASTM F1892-98 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5910RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and the dose rate was determined to be 105 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. Five devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted and the devices were transported to the MSK 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.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing, the MSK 5910RH easily qualified as a 100 KRADS(Si) radiation tolerant device.

It should be noted that there was a slight positive shift in feedback voltage from 0 KRADS(Si) to 300 KRADS(Si).

All other test parameters stayed within pre-irradiation test limits throughout the irradiation process.

An ELDRS test is planned for the future to determine the effects of Low Dose Rate Exposure.

Dosimetry Equipment: Bruker Biospin #0141

Dose Rate = 105 Rads(Si)/Sec

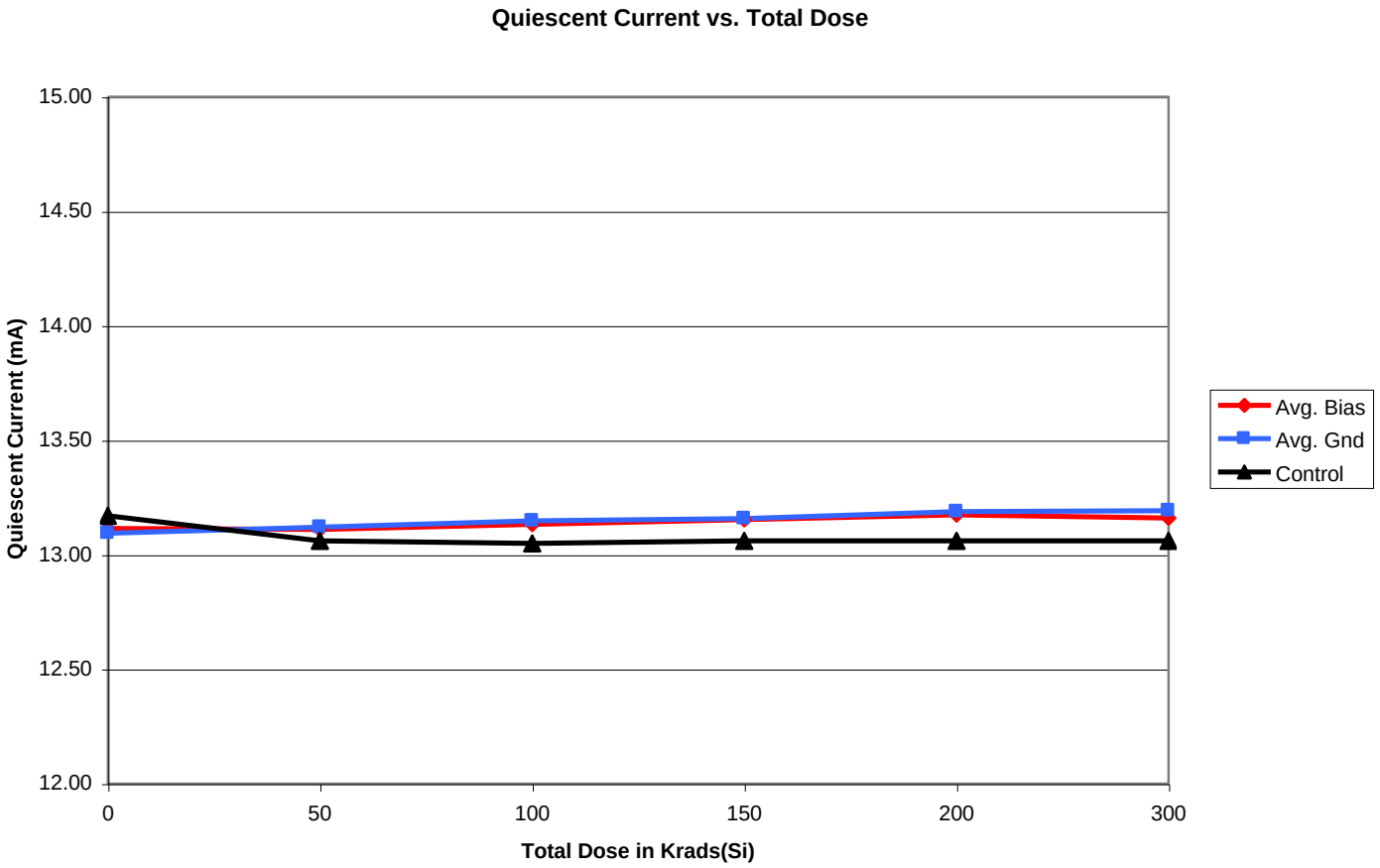
Testing Performed: 01/10/2008

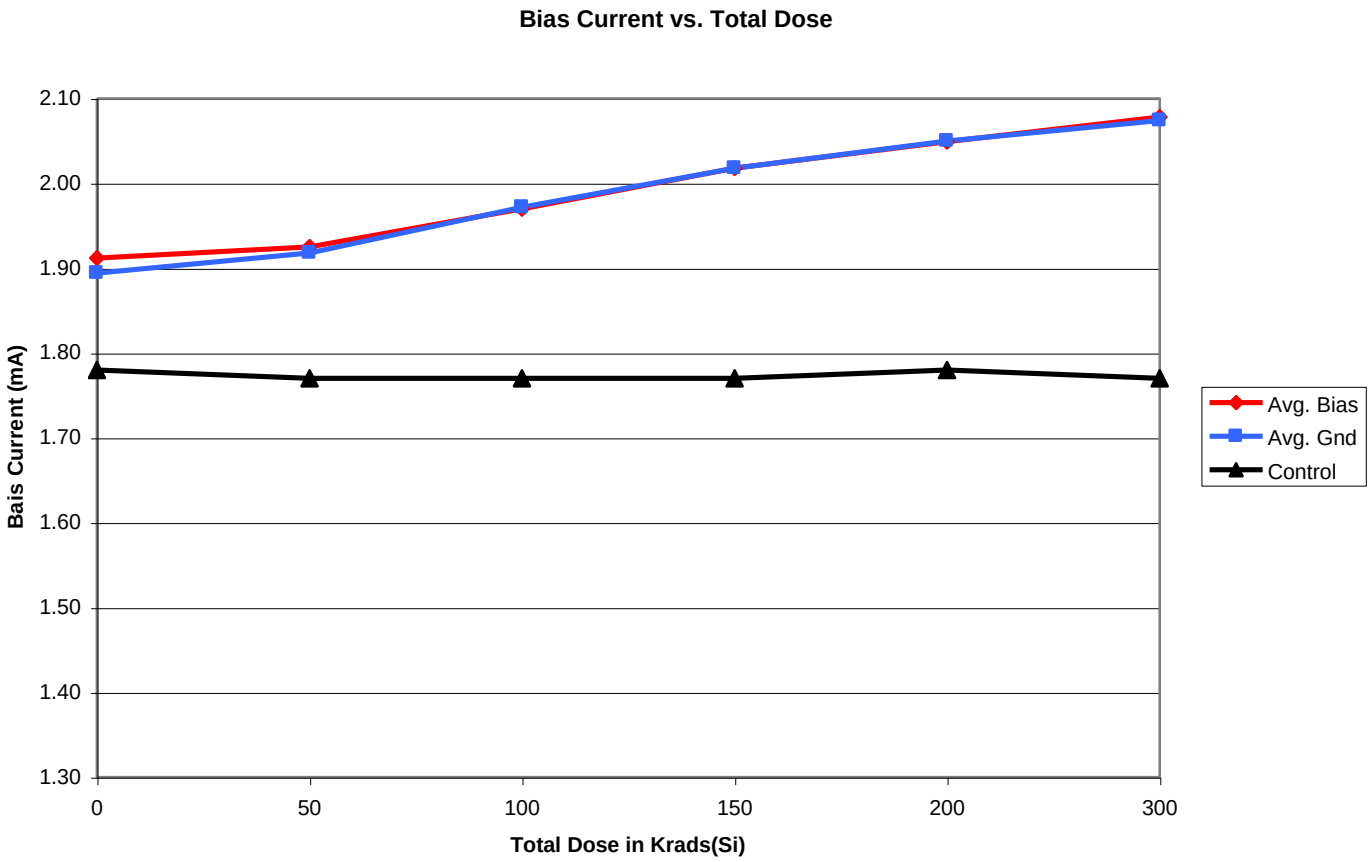
Biased MSK 5910RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
8.10	51,450	51, 450
8.10	51,450	102,900
8.10	51,450	154,350
8.10	51,450	205,800
16.21	103,005	308,805
SERIAL NUMBERS 0202, 0203, 0204, 0205, 0206		

Unbiased MSK 5910RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
8.10	51,450	51, 450
8.10	51,450	102,900
8.10	51,450	154,350
8.10	51,450	205,800
16.21	103,005	308,805
SERIAL NUMBERS 0207, 0208, 0209, 0210, 0211		

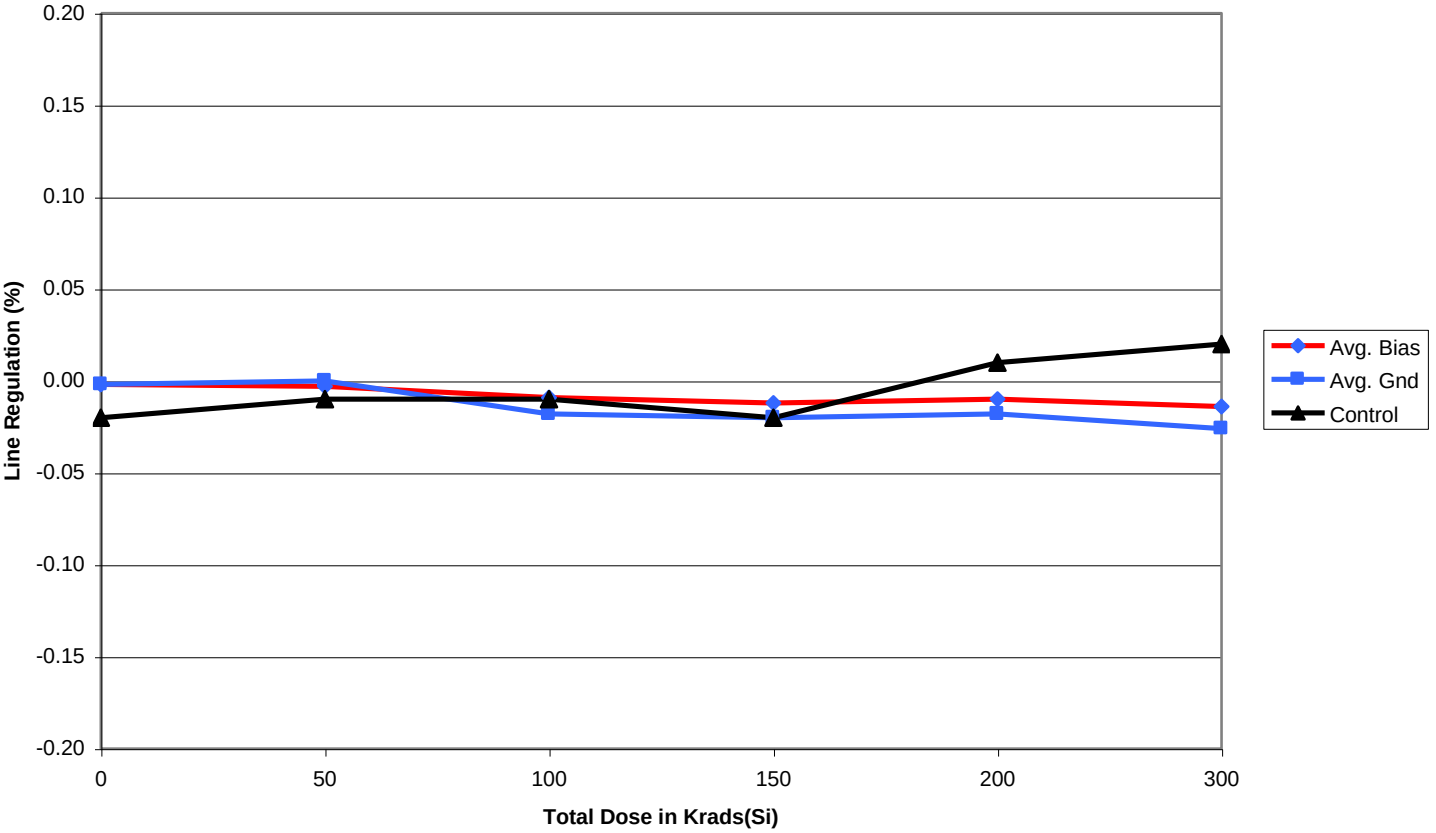
Table I

Dose Time, Incremental Dose and Total Cumulative Dose

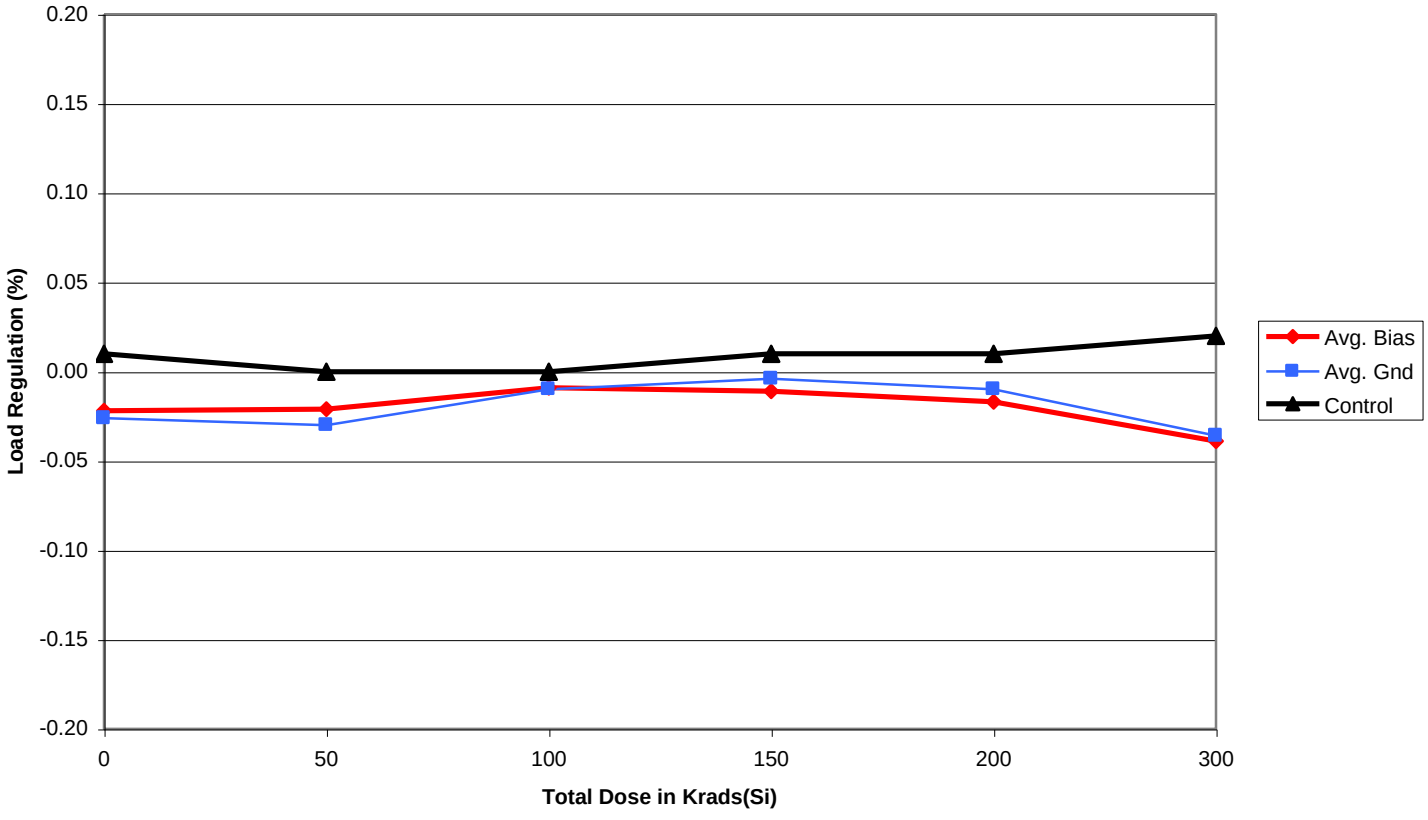

Quiescent Current vs. Total Dose
15.00
14.50
14.00
13.50
13.00
12.50
12.00
Quiescent Current (mA)
0
50
100
150
200
300
Total Dose in Krads(Si)
Avg. Bias
Avg. Gnd
Control


Bias Current vs. Total Dose
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
Bais Current (mA)
0
50
100
150
200
300
Total Dose in Krads(Si)
Avg. Bias
Avg. Gnd
Control

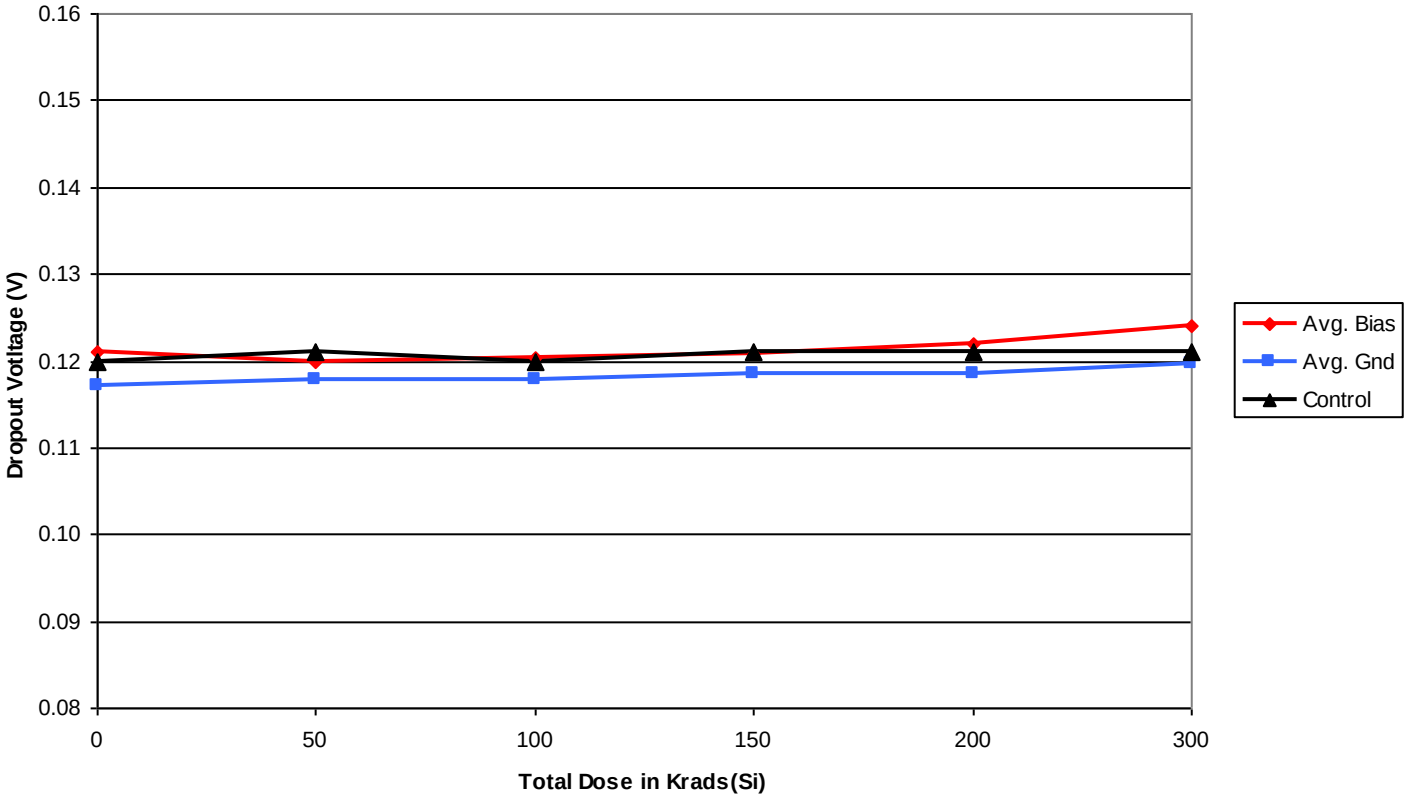
Line Regulation vs. Total Dose



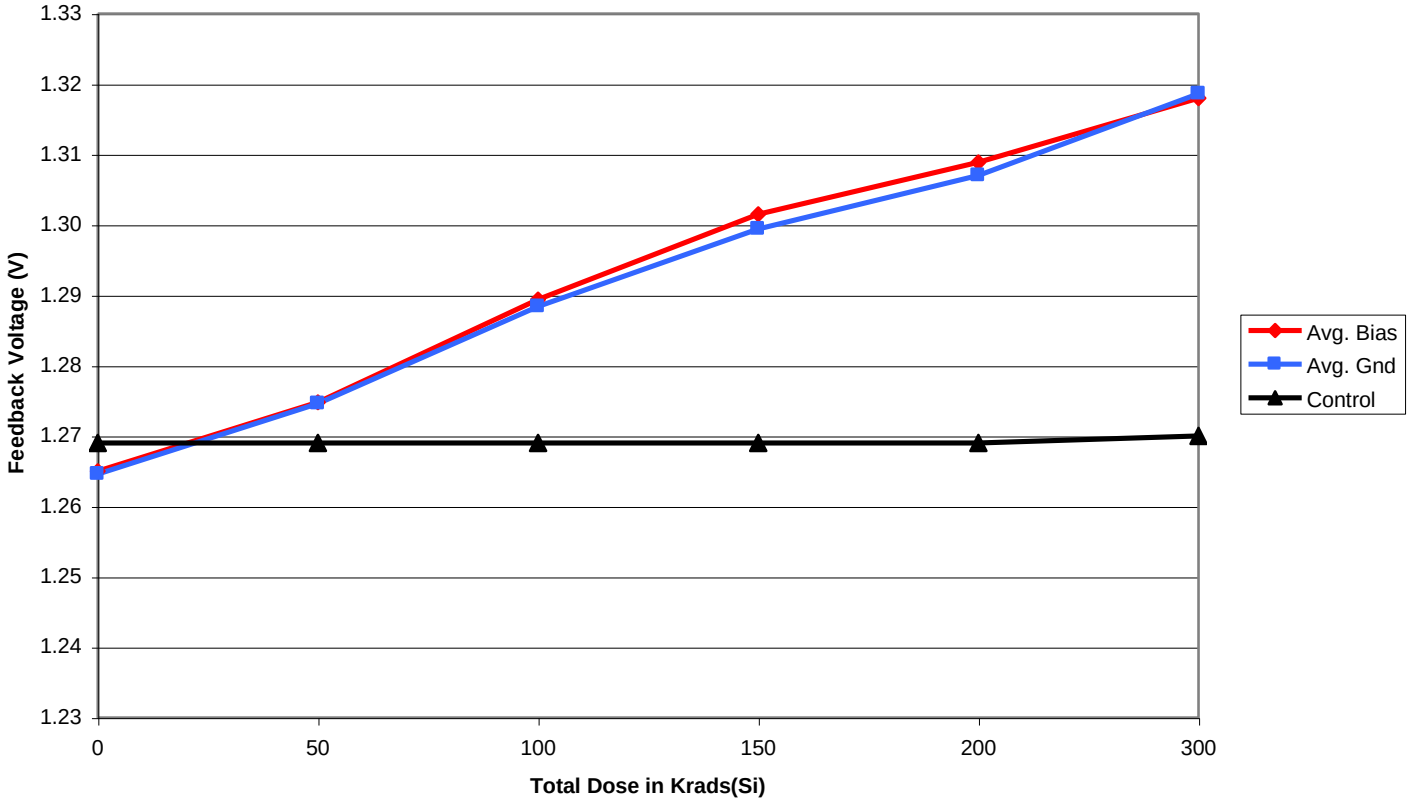
Load Regulation vs. Total Dose



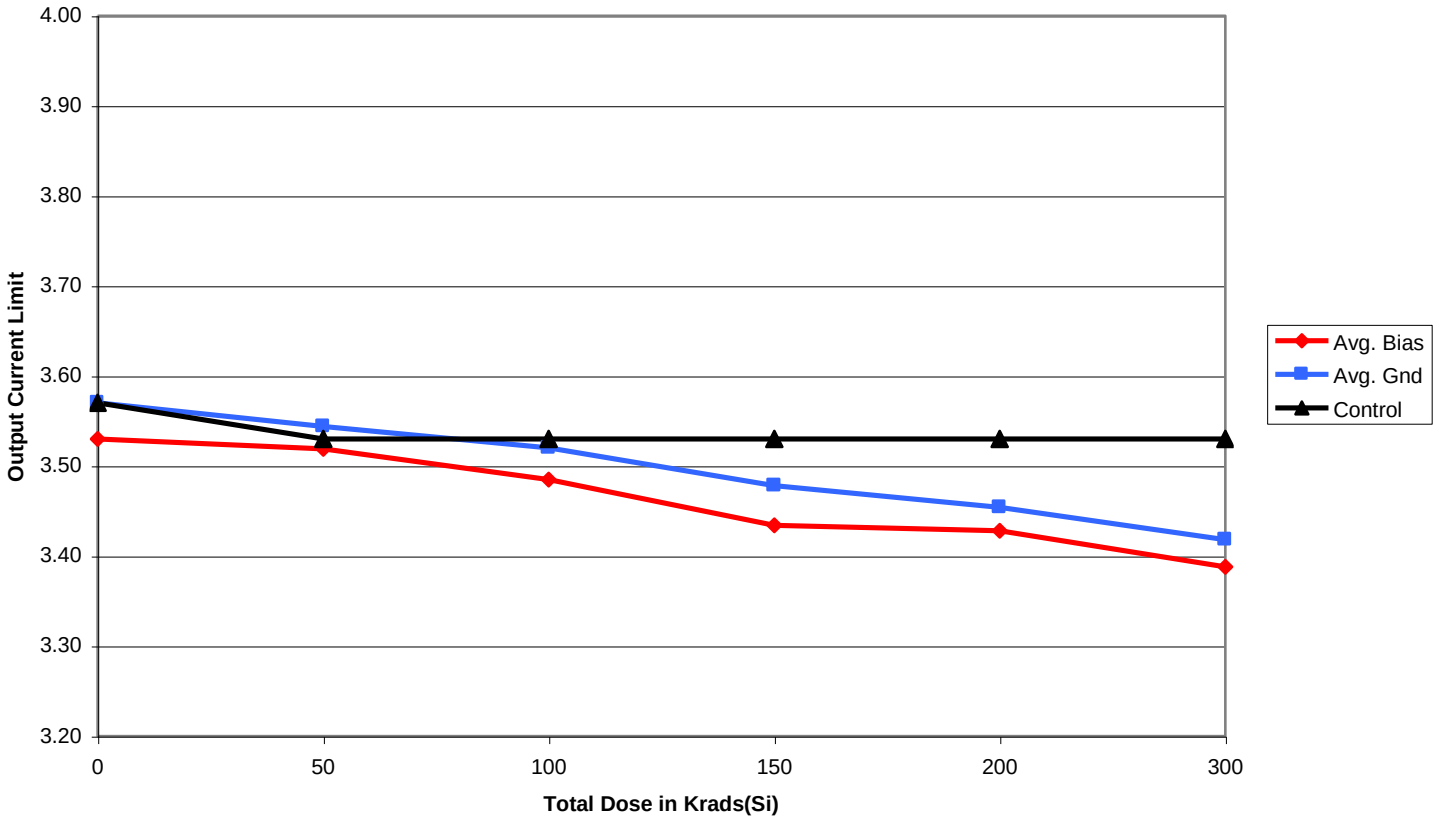
Dropout Voltage vs. Total Dose



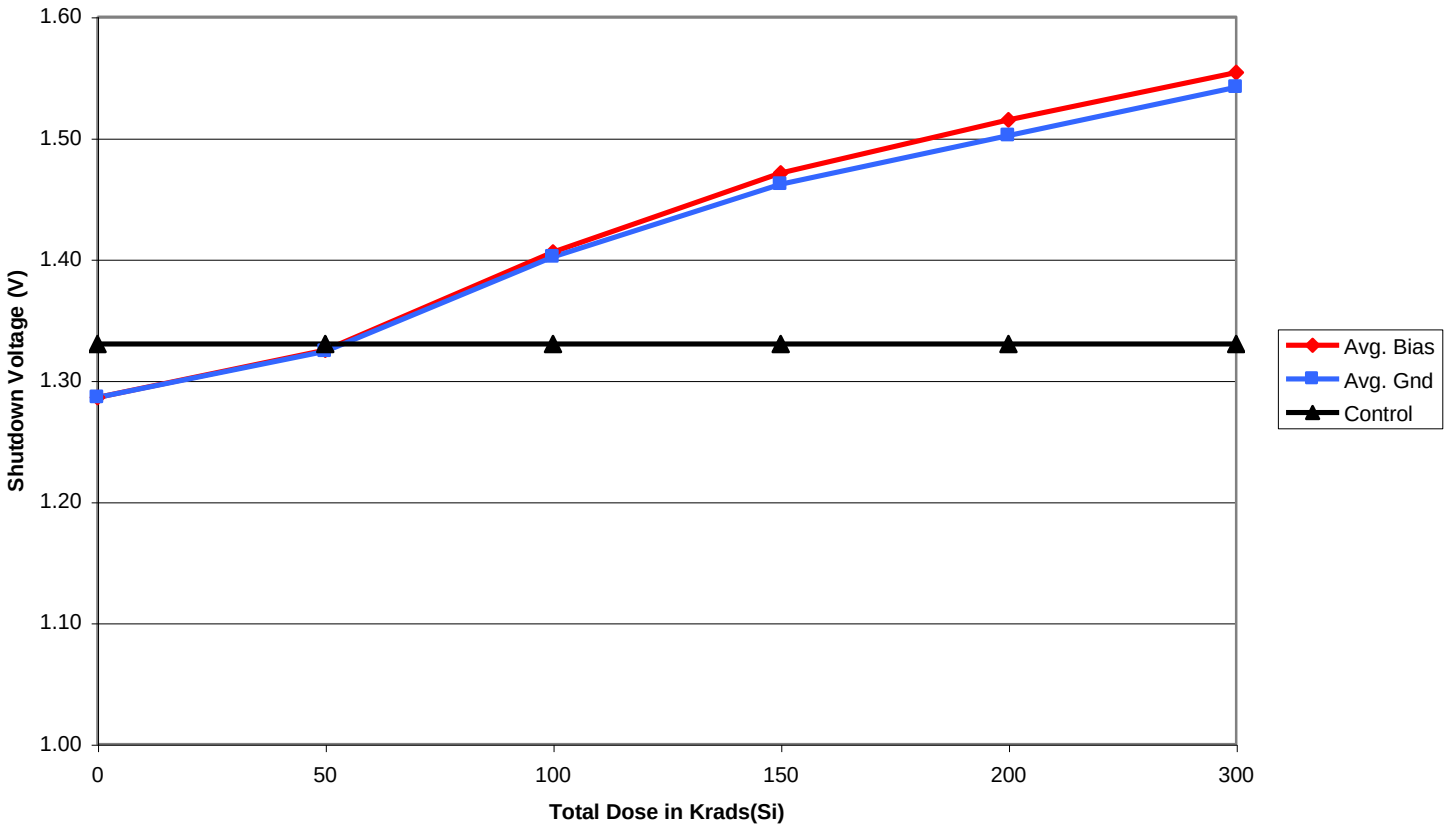
Feedback Voltage vs. Total Dose



Output Current Limit vs. Total Dose



Shutdown Threshold vs. Total Dose



Total Dose Radiation Test Report

MSK 5920RH SERIES

Ultra Low Dropout Positive Linear Regulator

Updated June 14, 2007 (Third Test)

J. Douglas
B. Erwin

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5920RH was developed to qualify the device as a radiation tolerant device to 100 Krad(Si). The testing was performed to 300 Krad to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the hybrid, 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 5920RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Alanine dosimetry was performed and the dose rate was determined to be 104 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 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 and enclosed in a Pb/Al container during irradiation to minimize dose enhancement effects. Four devices were kept under bias during irradiation. Four devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted together and were 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. Each subsequent dose was performed within 2 hours.

IV. Data:

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

V. Summary:

Based on statistical analysis of the test data recorded during radiation testing the MSK 5920RH qualified as a 100 Krad(Si) radiation tolerant device. Further analysis of the data shows the hybrid to offer radiation tolerance to dose levels of 300 Krad(Si).

The only test parameter that exceeded pre-irradiation test limits was output voltage tolerance. All biased devices exhibited output voltage tolerances between 4.5 and 4.85 percent at 300 Krads(Si). The unbiased devices had slightly higher output voltage tolerances at 5.3 to 5.5 percent. Post irradiation output voltage tolerance specification is $\pm$ 4 percent at 100 Krad(Si). The devices did not exceed this limit at 100 Krad(Si).

All other test parameters stayed within pre irradiation test limits throughout the irradiation process to 300 Krad(Si).

An ELDRS test is planned for the future to determine the effects of low dose exposure.

Dosimetry Equipment: Bruker Biospin #0141

Dose Rate = 104 Rads(Si)/Sec

Testing Performed: 06/13/2007

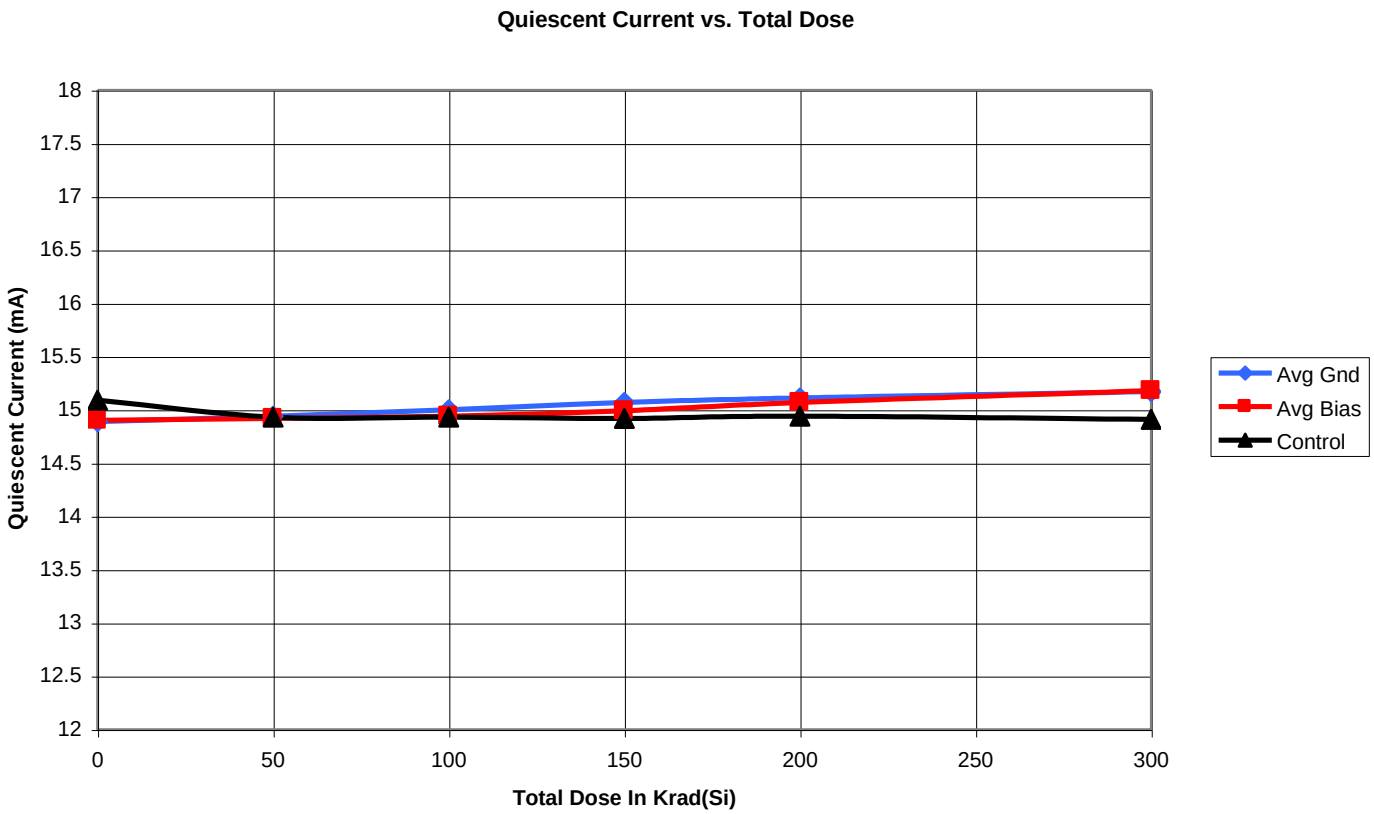
Device Date Code: 0721

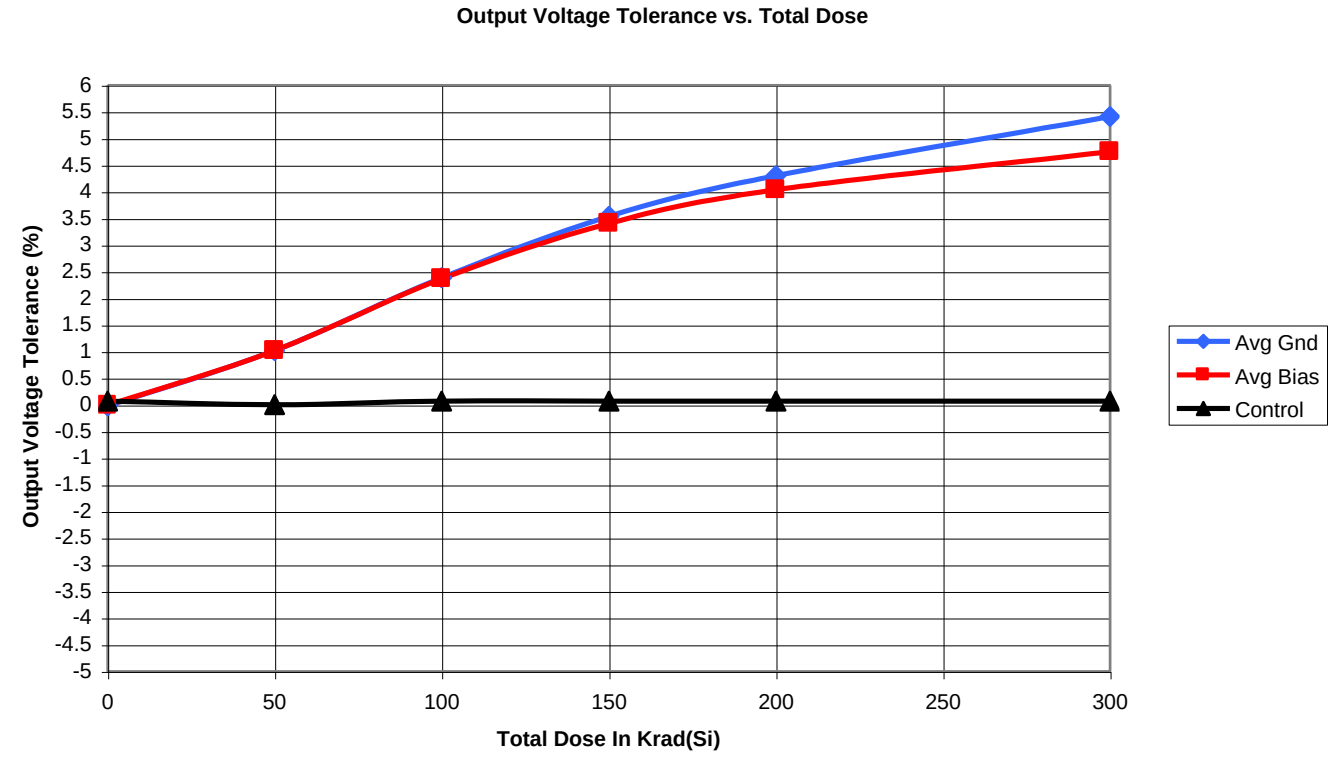
Biased MSK 5920RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
8:15	51,480	51,480
8:15	51,480	102,960
8:15	51,480	154,440
8:15	51,480	205,920
16:32	103,168	309,088
Serial Numbers: 9678, 9680, 9681, 9682		

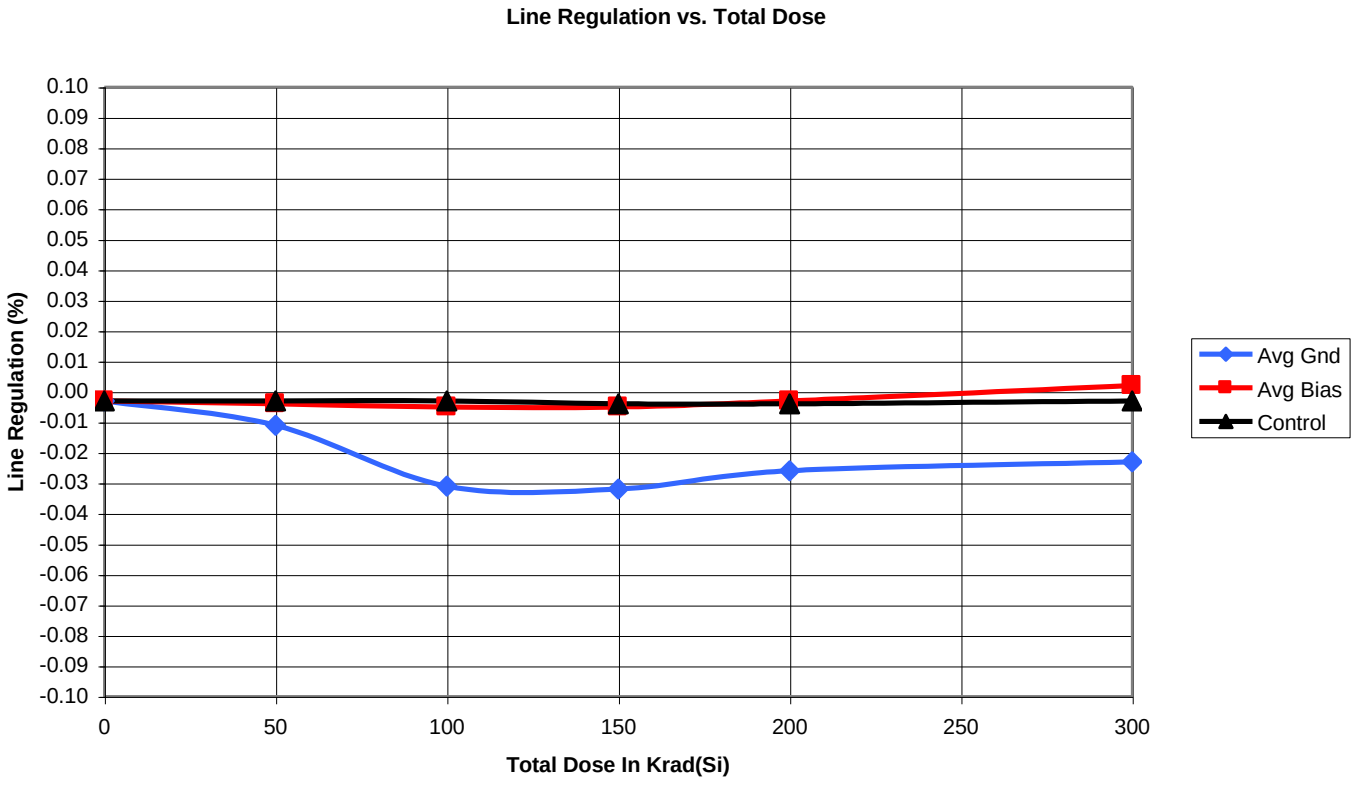
Unbiased MSK 5920RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
8:15	51,480	51,480
8:15	51,480	102,960
8:15	51,480	154,440
8:15	51,480	205,920
16:32	103,168	309,088
Serial Numbers: 9683, 9685, 9686, 9687		

Table I

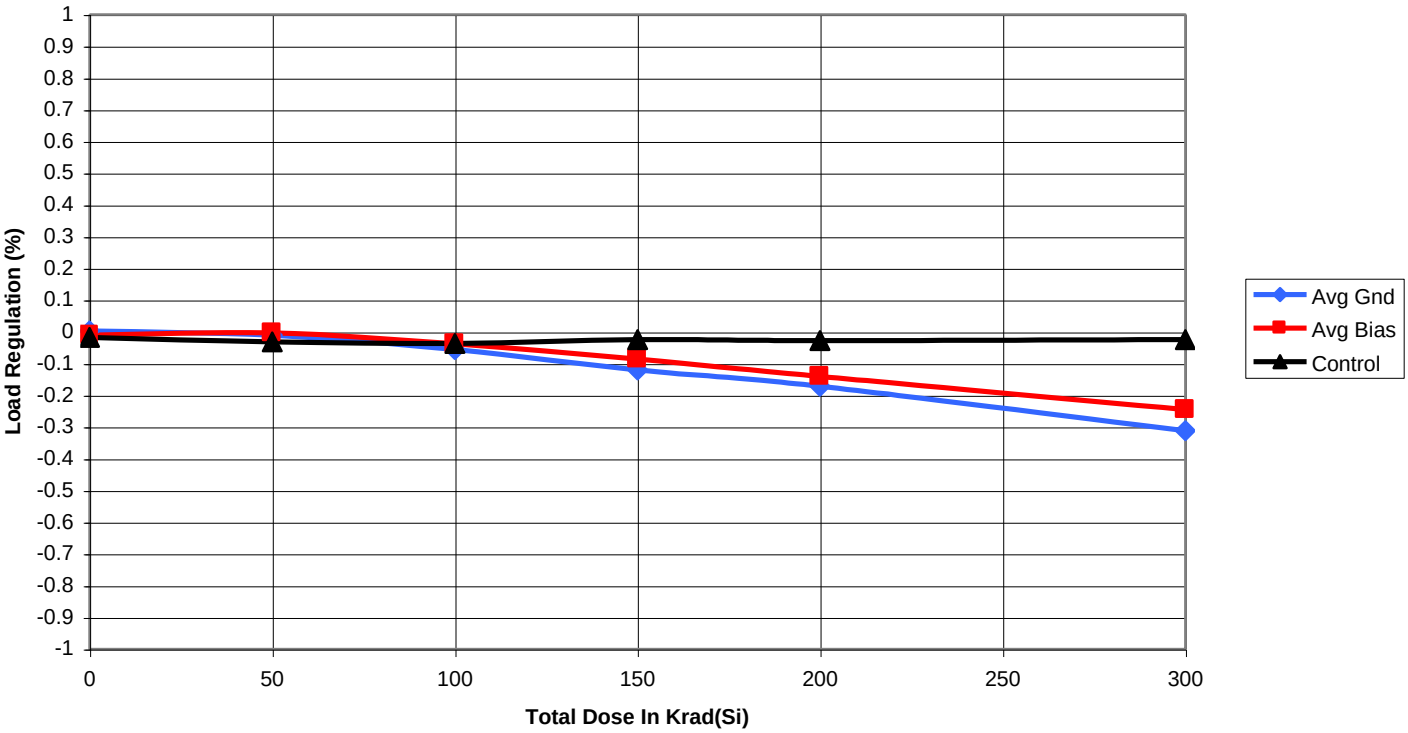
Dose Time, Incremental Dose and Total Cumulative Dose



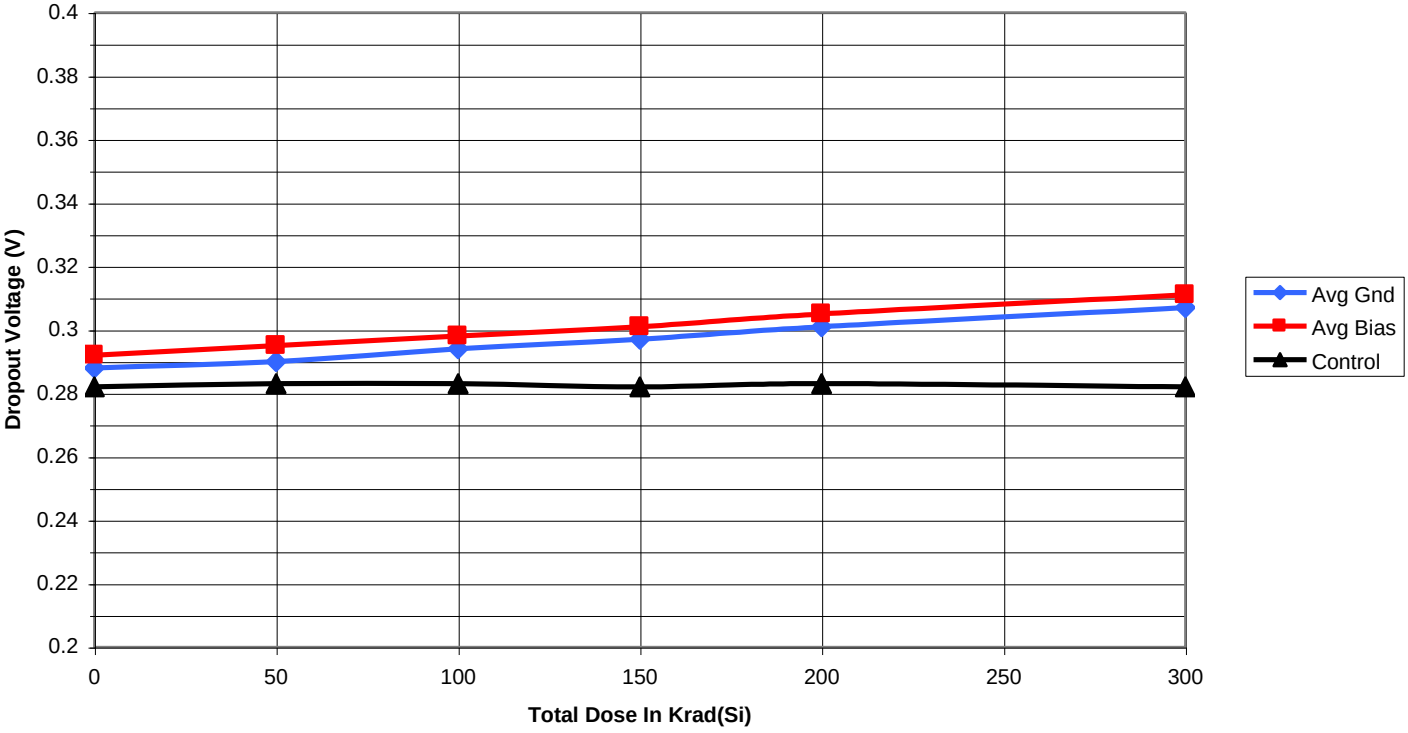

Output Voltage Tolerance vs. Total Dose
Output Voltage Tolerance (%)
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
-5
0
50
100
150
200
250
300
Total Dose In Krad(Si)
Avg Gnd
Avg Bias
Control


Line Regulation vs. Total Dose
Line Regulation (%)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
0
50
100
150
200
250
300
Total Dose In Krad(Si)
Avg Gnd
Avg Bias
Control

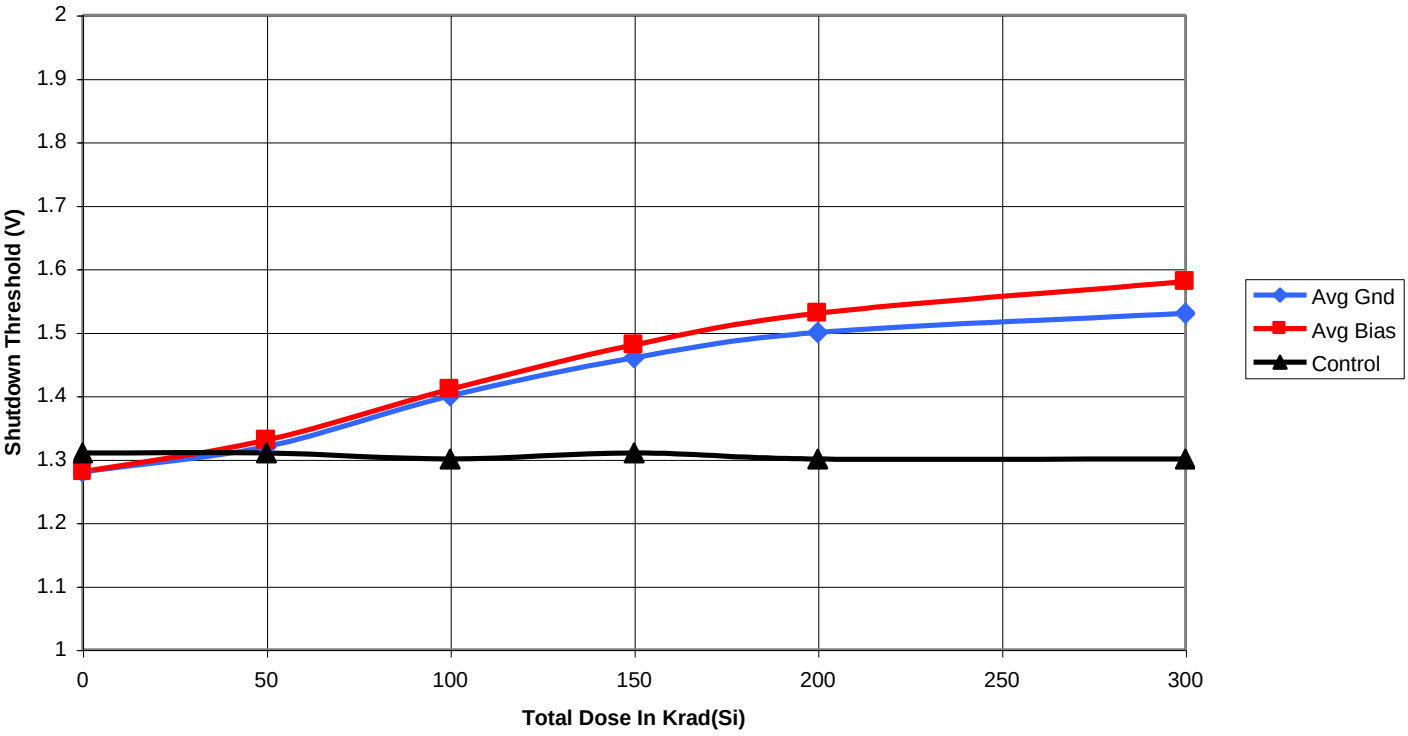
Load Regulation vs. Total Dose



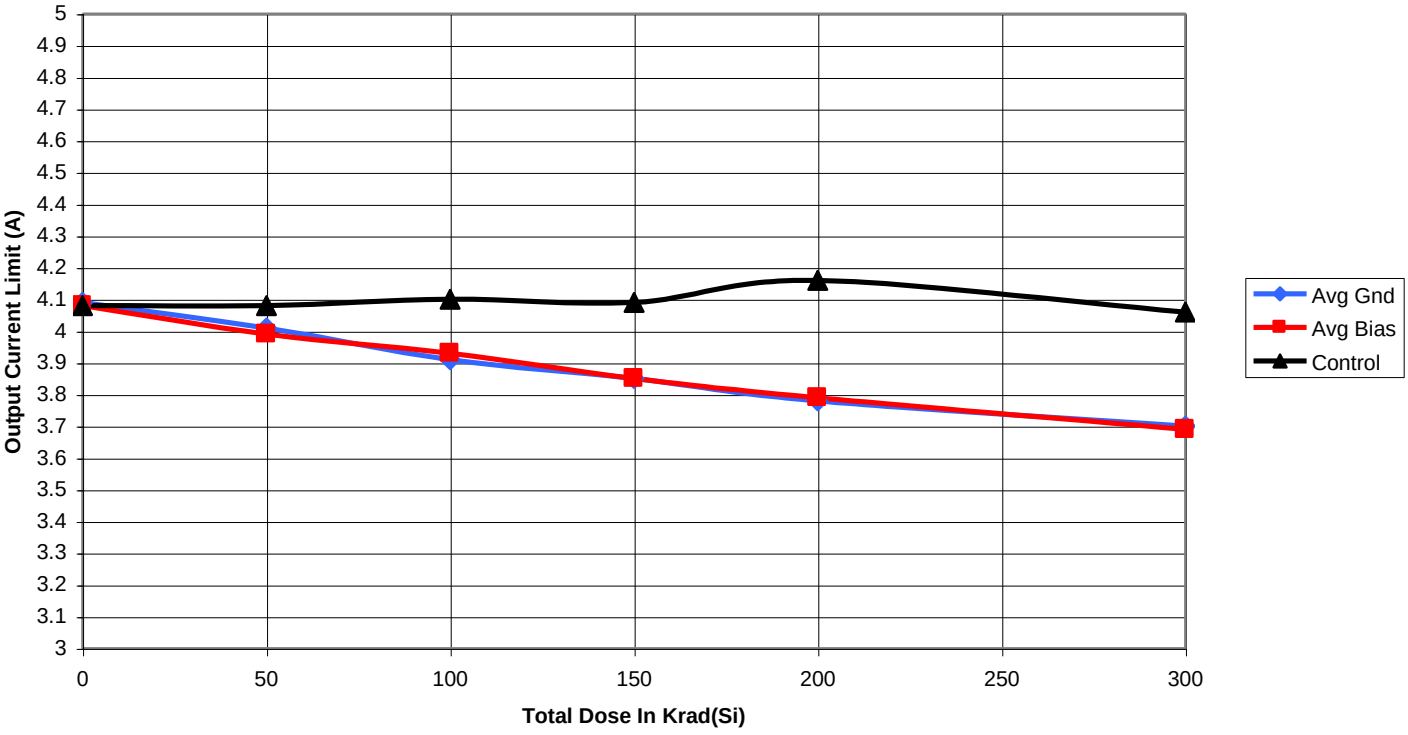
Dropout Voltage vs. Total Dose



Shutdown Threshold vs. Total Dose



Output Current Limit vs. Total Dose



Total Dose Radiation Test Report

MSK 5921RH

Ultra Low Dropout Adjustable Positive Linear Regulator

February 21, 2007
(SECOND TEST)

P. Musil
J. Douglas

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5921 RH was developed to qualify the device as a radiation tolerant device to 100 KRADS(Si). The testing was performed to 500 KRAD to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the hybrid, 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 F1892-98 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5921RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and the dose rate was determined to be 115 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 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 and enclosed in a Pb/Al container during irradiation to minimize dose enhancement effects. Three devices were kept under bias during irradiation. Three devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted using conductive foam and were 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.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing the MSK 5921RH qualified as a 100 KRADS(Si) radiation tolerant device. Further analysis of the data shows the hybrid to offer tolerance to total dose radiation levels of 300 KRADS(Si).

Feedback voltage measurements shifted beyond pre irradiation test limits above 200 KRADS(Si). This trend resulted in a + 3.870% shift in the feedback voltage at 300 KRADS(Si). Shutdown threshold measurements shifted beyond pre-irradiation test limits above 300 KRADS(Si) on the biased units only.

All other test parameters stayed within pre irradiation test limits throughout the irradiation process.

An ELDRS test is planned for the future to determine the effects of low dose rate exposure.

VI. Notes:

This is the second time that this device has been tested. Results from the first test were very similar and can be obtained from the factory.

Dosimetry Equipment: Bruker Biospin #0141

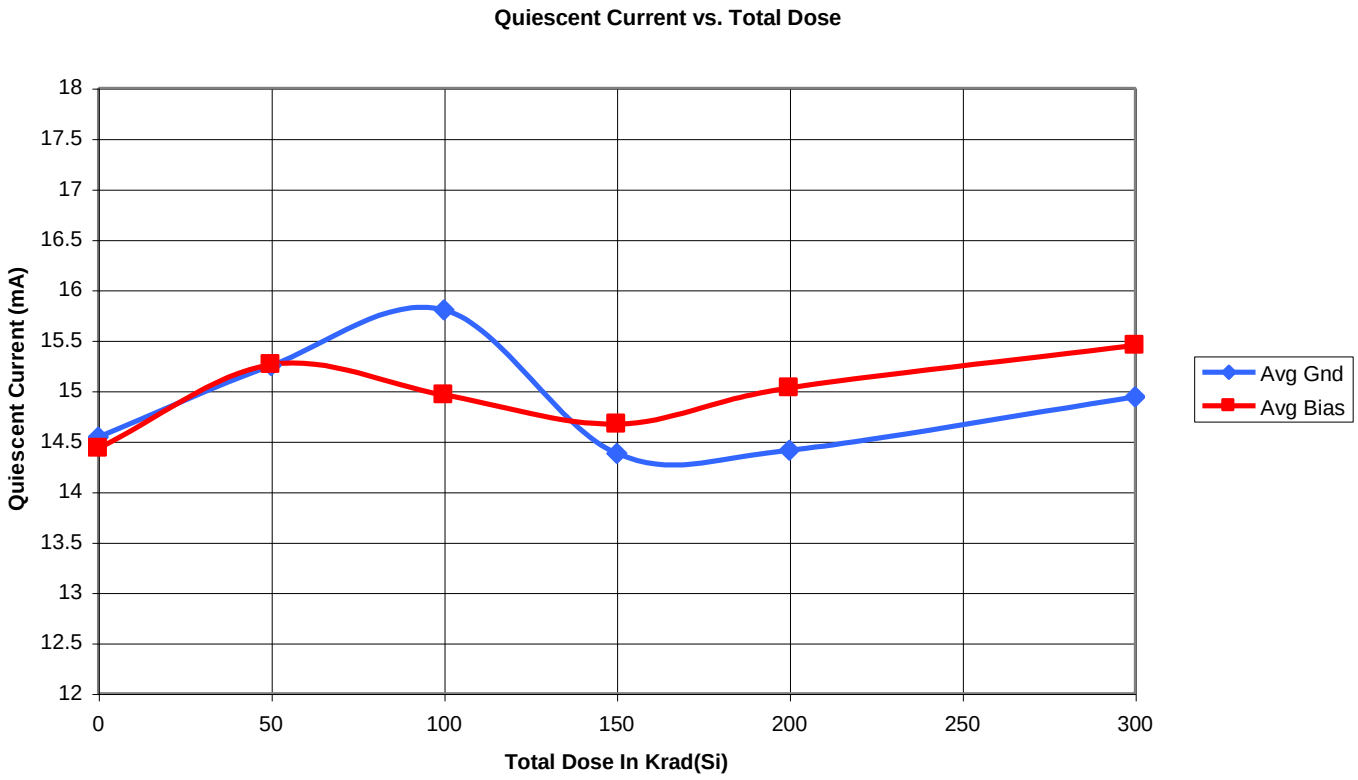
Dose Rate = 115 Rads(Si)/Sec

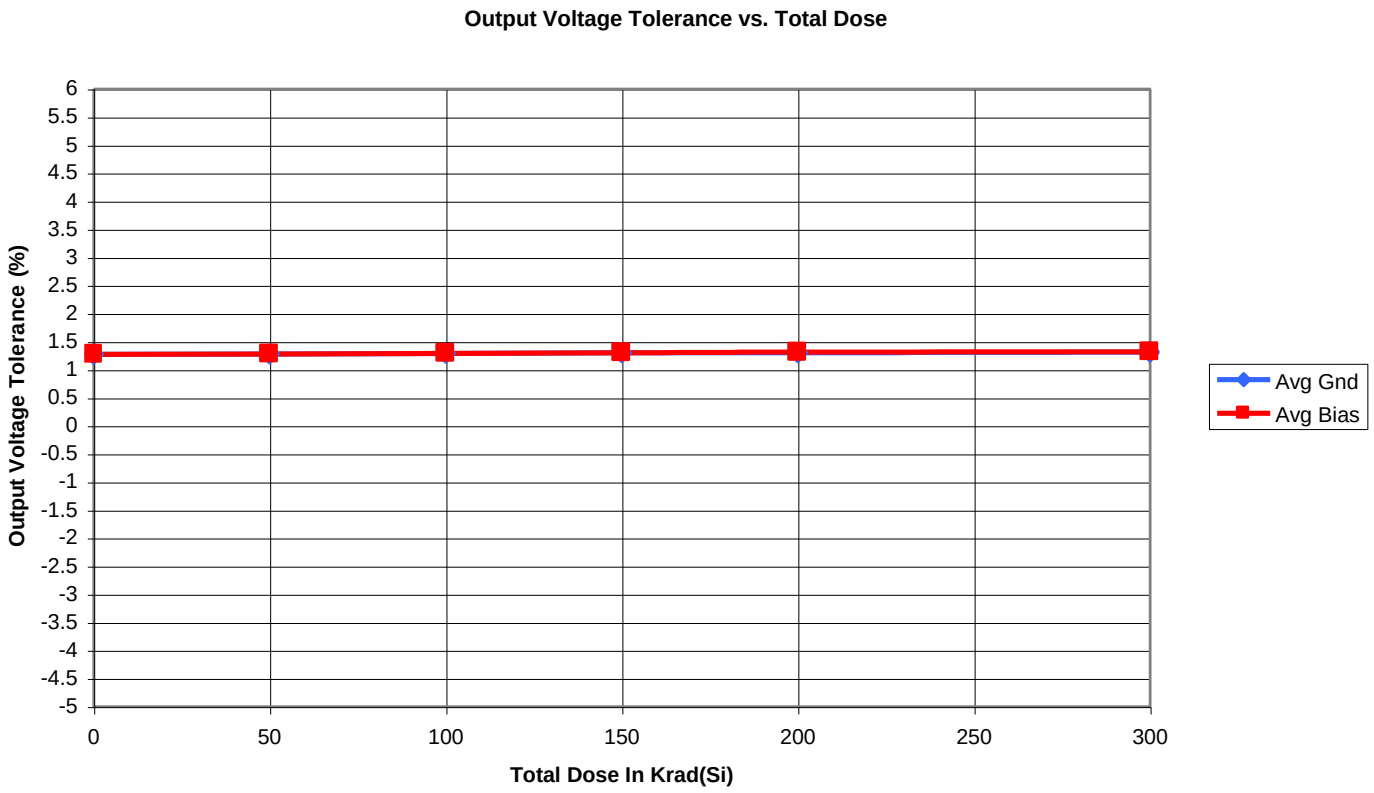
Testing Performed: 02/20/2007

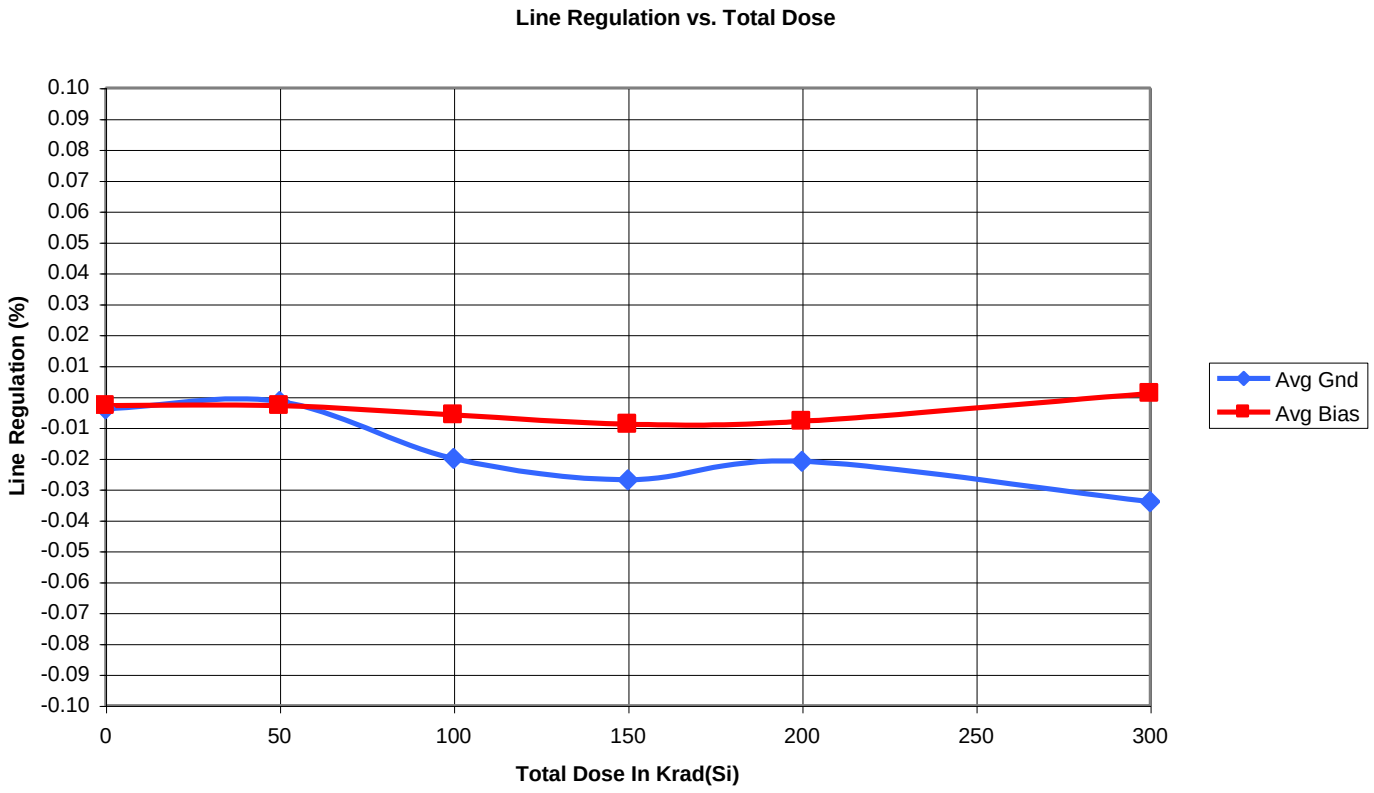
Biased MSK 5921RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
0:07:28	51,520	51,520
0:07:28	51,520	103,040
0:07:28	51,520	154,560
0:07:28	51,520	206,080
0:14:56	103,040	309,120
0:14:56	103,040	412,160
0:14:56	103,040	515,200

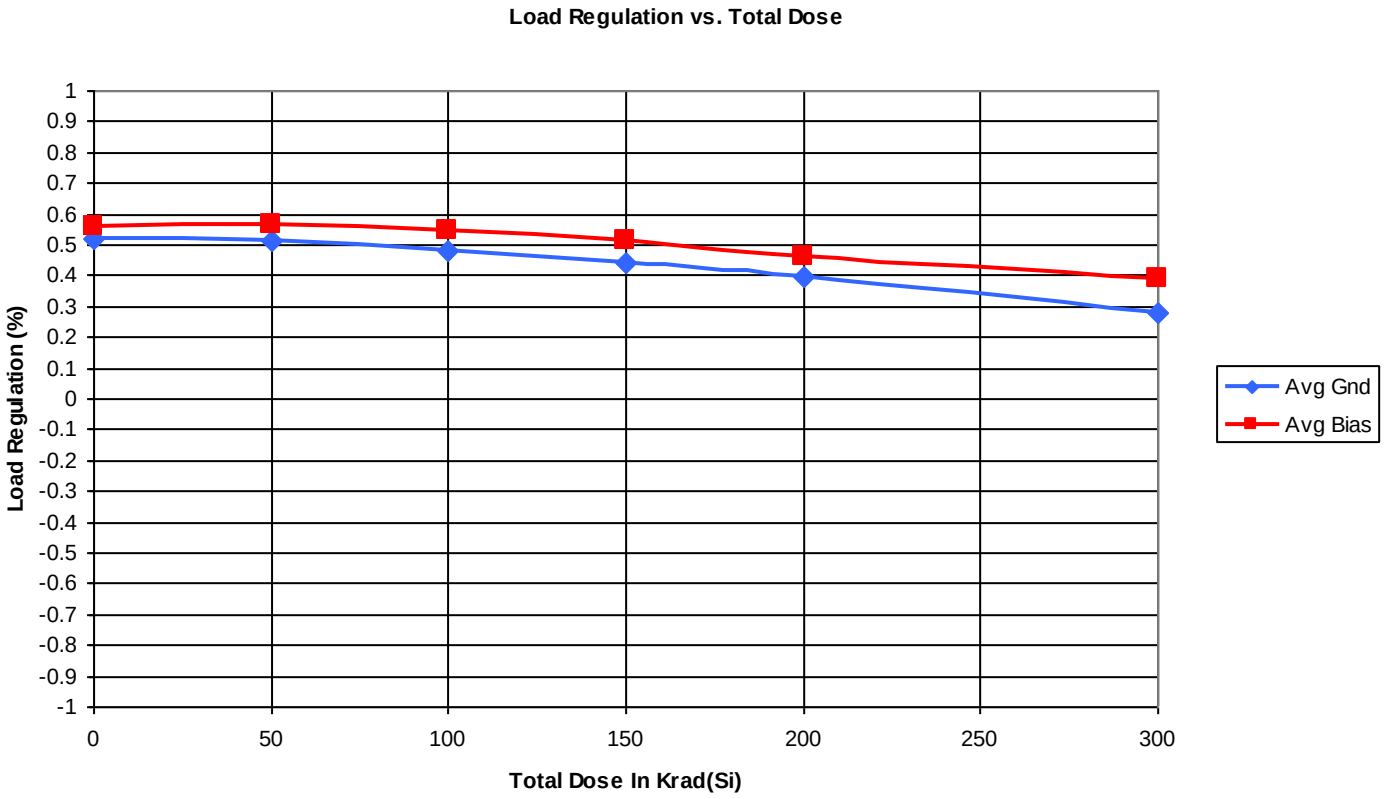
Unbiased MSK 5921RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
0:07:28	51,520	51,520
0:07:28	51,520	103,040
0:07:28	51,520	154,560
0:07:28	51,520	206,080
0:14:56	103,040	309,120
0:14:56	103,040	412,160
0:14:56	103,040	515,200

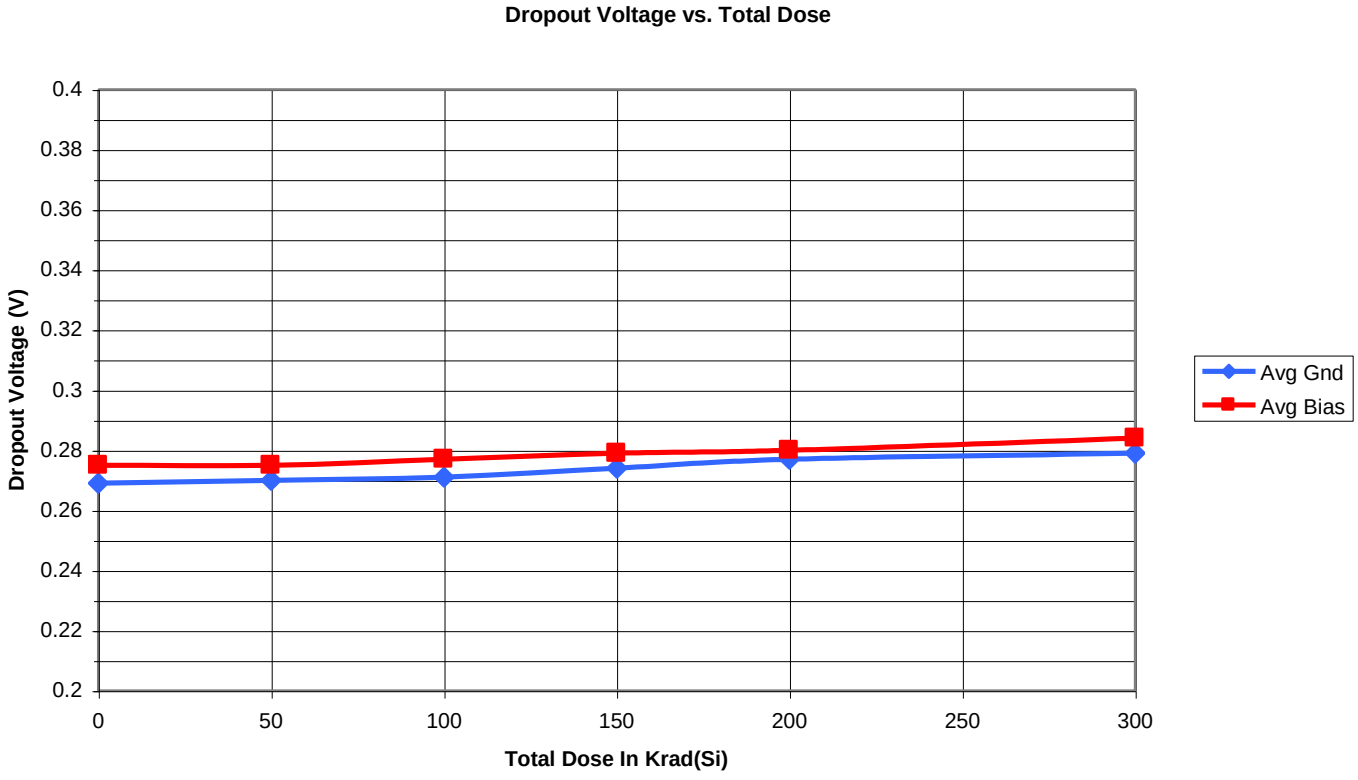
Table I
Dose Time, Incremental Dose and Total Cumulative Dose



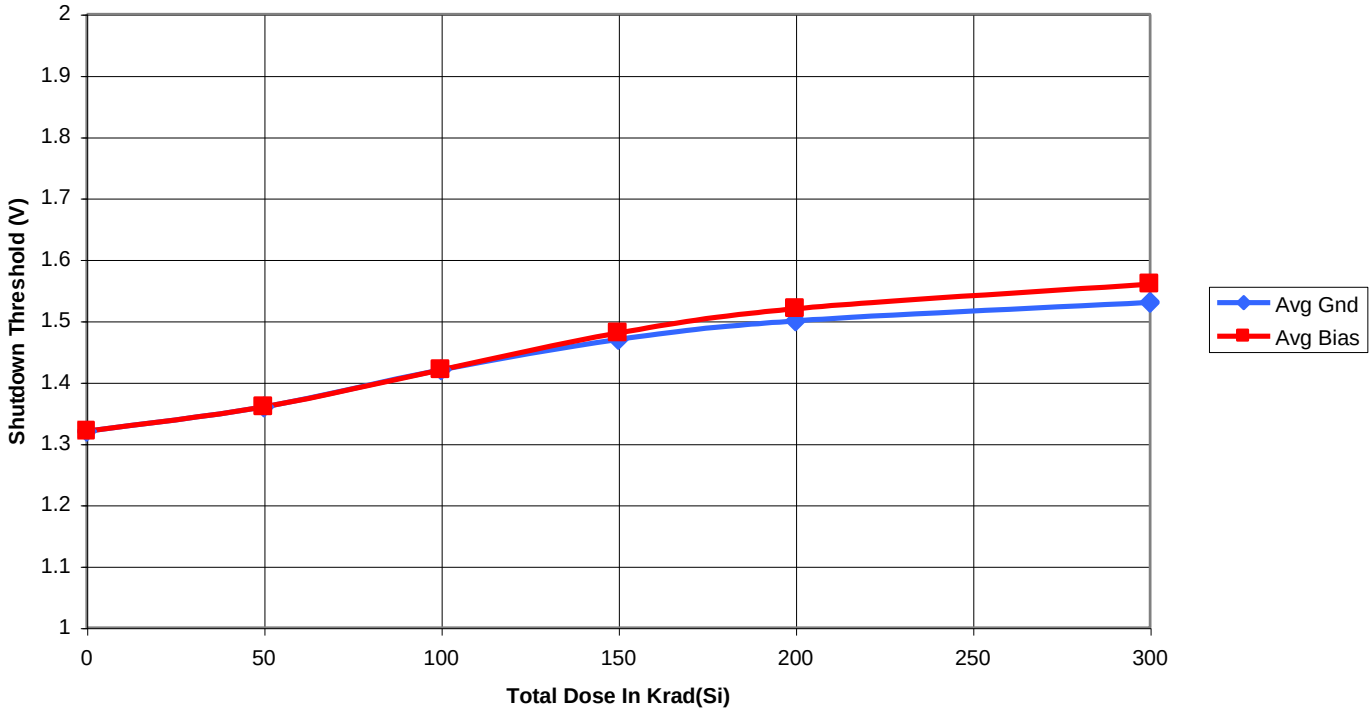

Output Voltage Tolerance vs. Total Dose
Output Voltage Tolerance (%)
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
-5
0
50
100
150
200
250
300
Total Dose In Krad(Si)
Avg Gnd
Avg Bias


Line Regulation vs. Total Dose
Line Regulation (%)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
0
50
100
150
200
250
300
Total Dose In Krad(Si)
Avg Gnd
Avg Bias

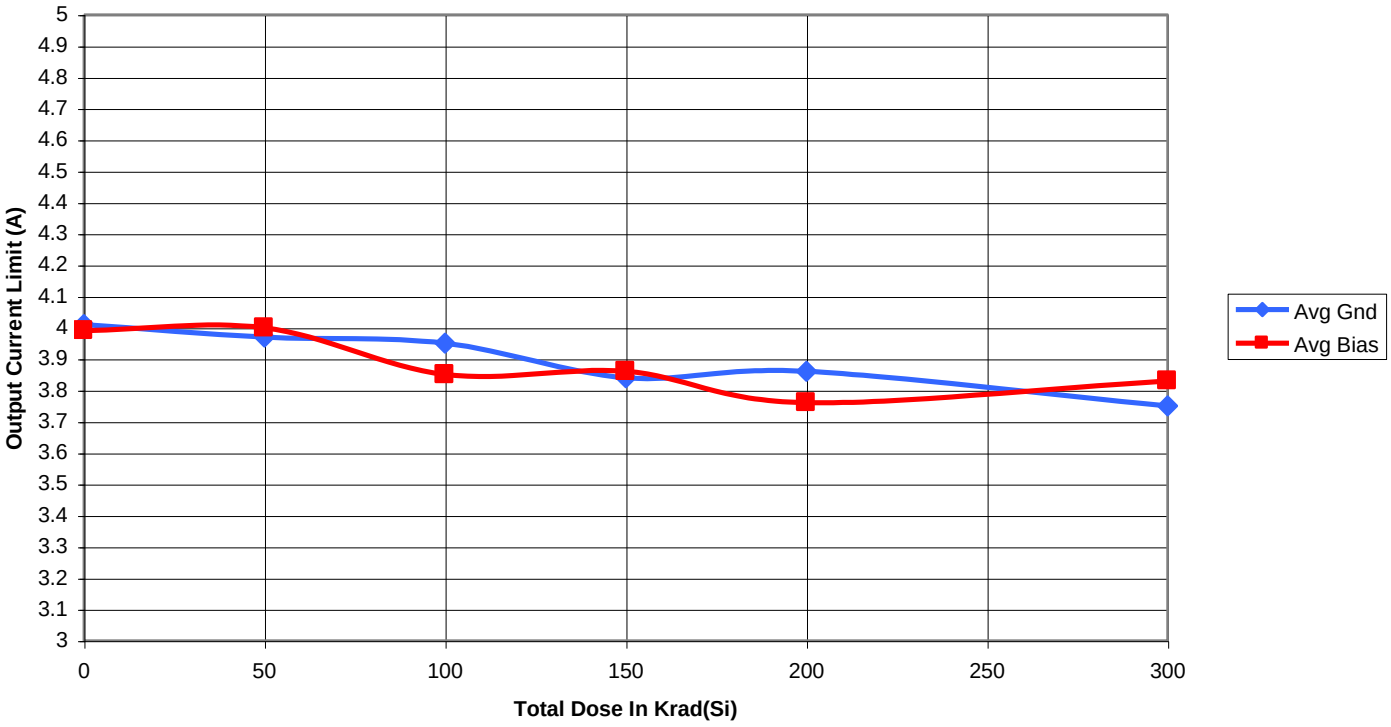

Load Regulation vs. Total Dose
Load Regulation (%)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
0
50
100
150
200
250
300
Total Dose In Krad(Si)
Avg Gnd
Avg Bias


Dropout Voltage vs. Total Dose
Dropout Voltage (V)
0.4
0.38
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0
50
100
150
200
250
300
Total Dose In Krad(Si)
Avg Gnd
Avg Bias

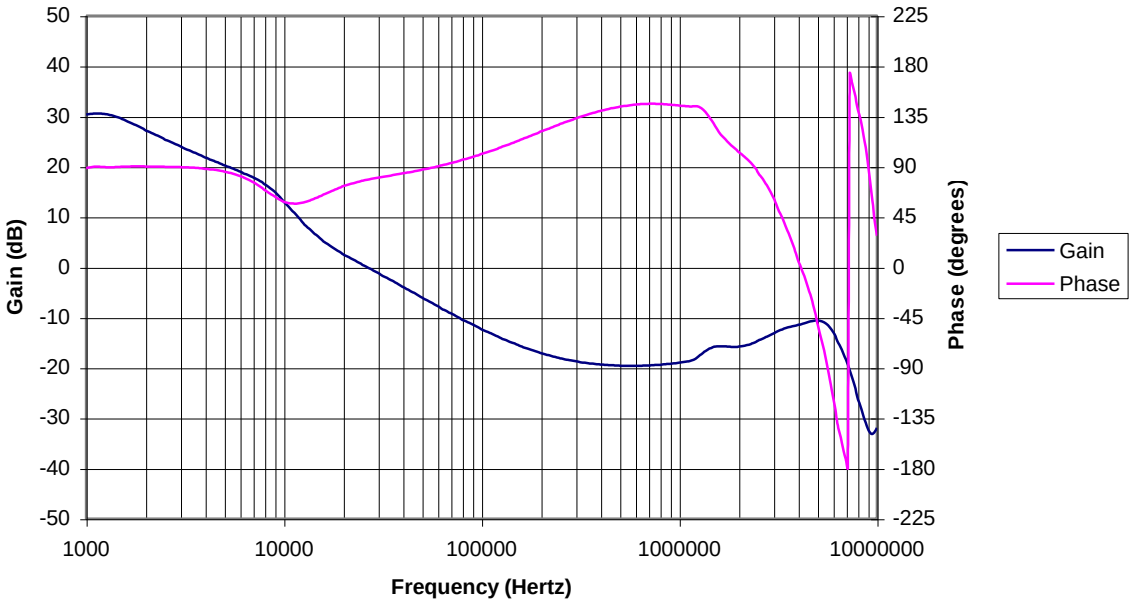
Shutdown Threshold vs. Total Dose



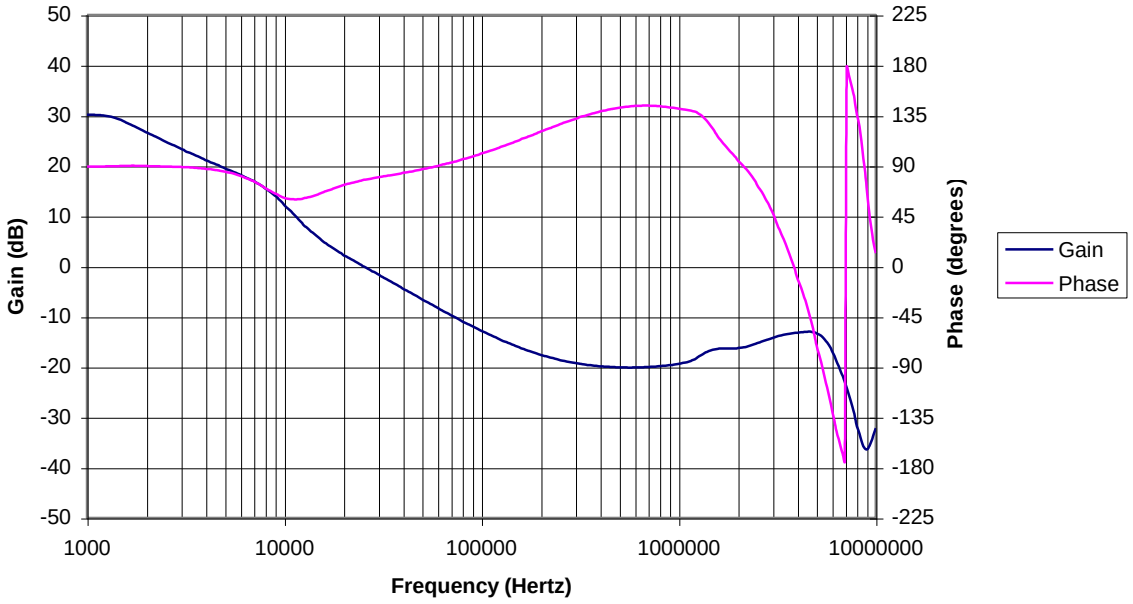
Output Current Limit vs. Total Dose



MSK5921 RH Frequency Response
SN5816 (Biased) 0Krad(Si)

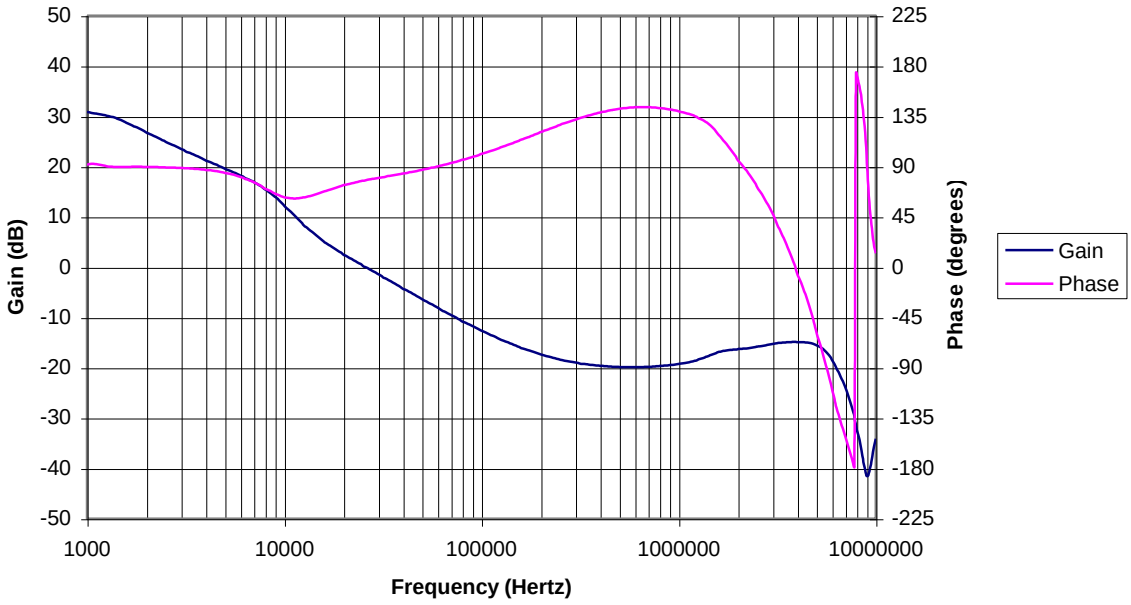


MSK5921 RH Frequency Response
SN5816 (Biased) 100Krad(Si)

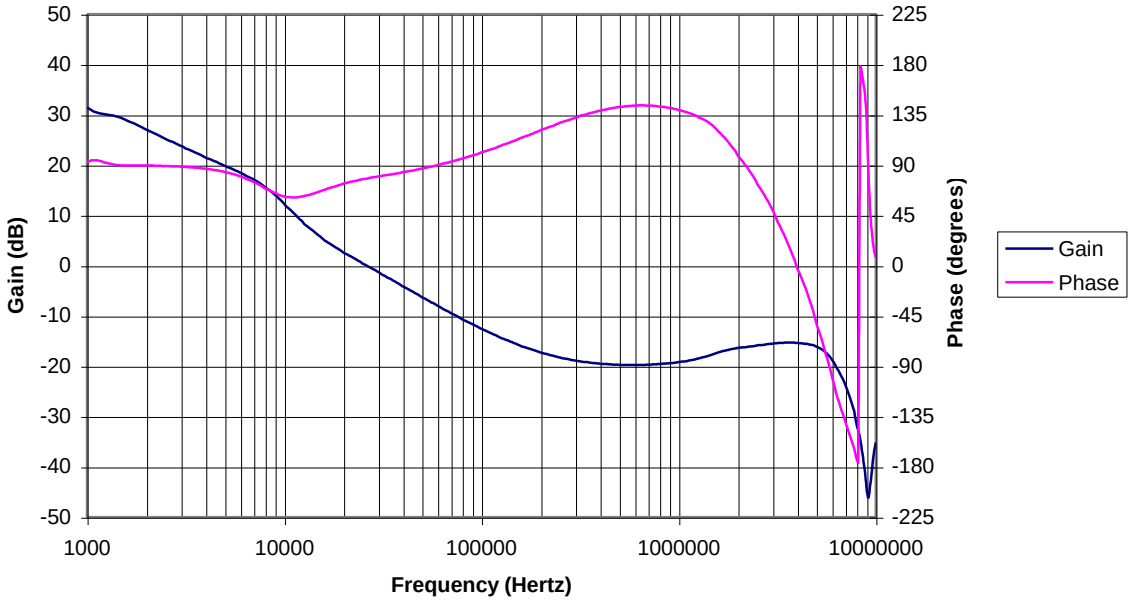


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5816 (Biased) 300Krad(Si)

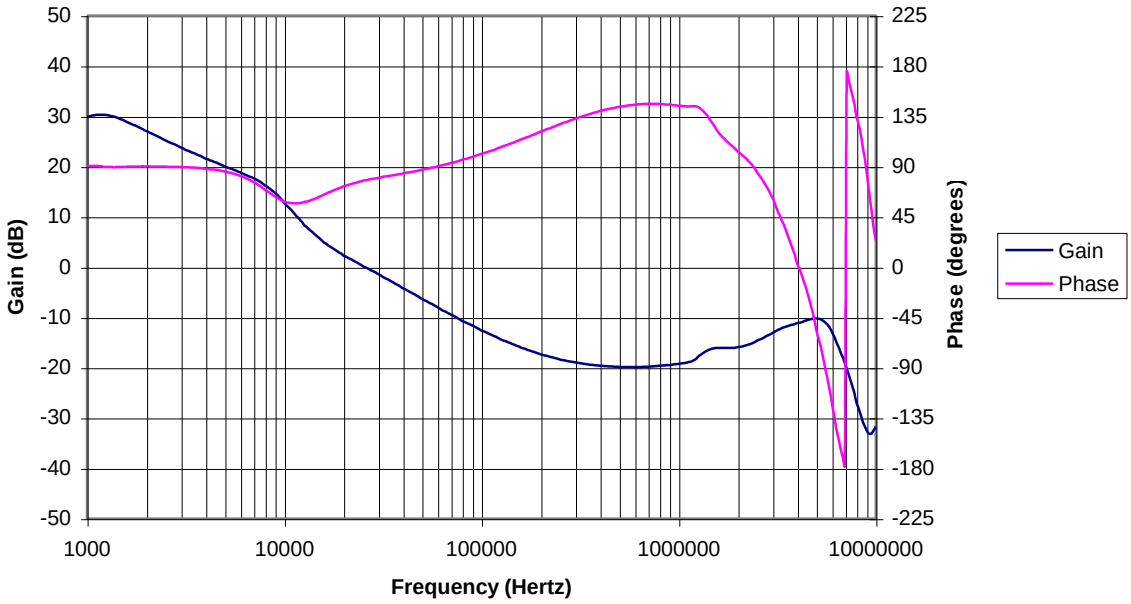


MSK5921 RH Frequency Response
SN5816 (Biased) 500Krad(Si)

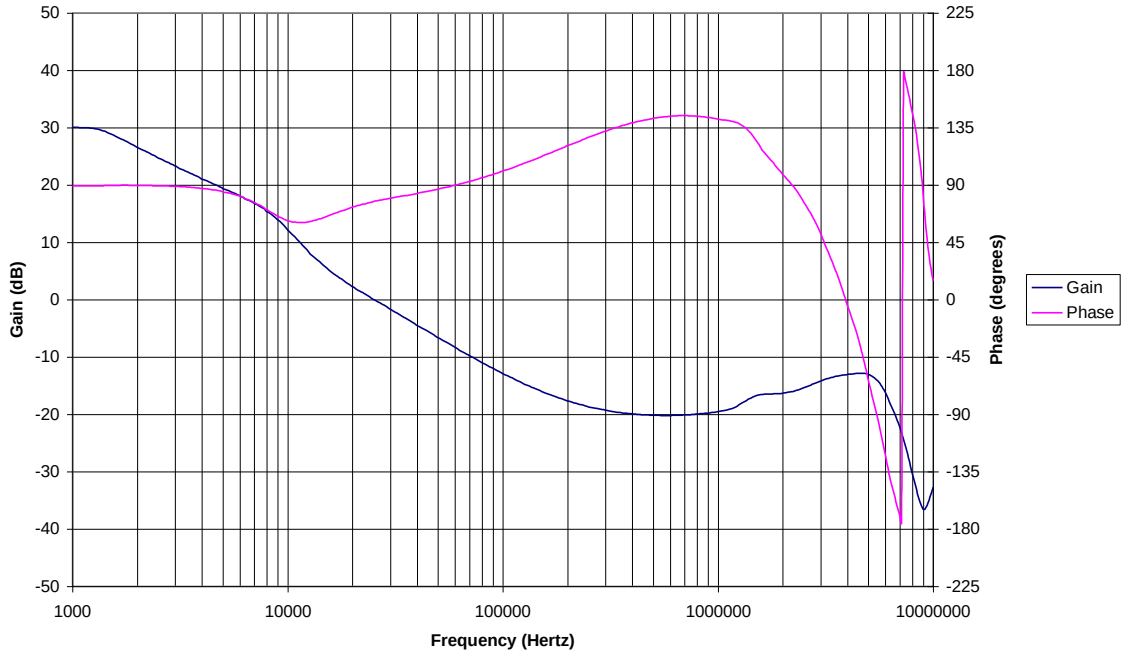


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5817 (Biased) 0Krad(Si)

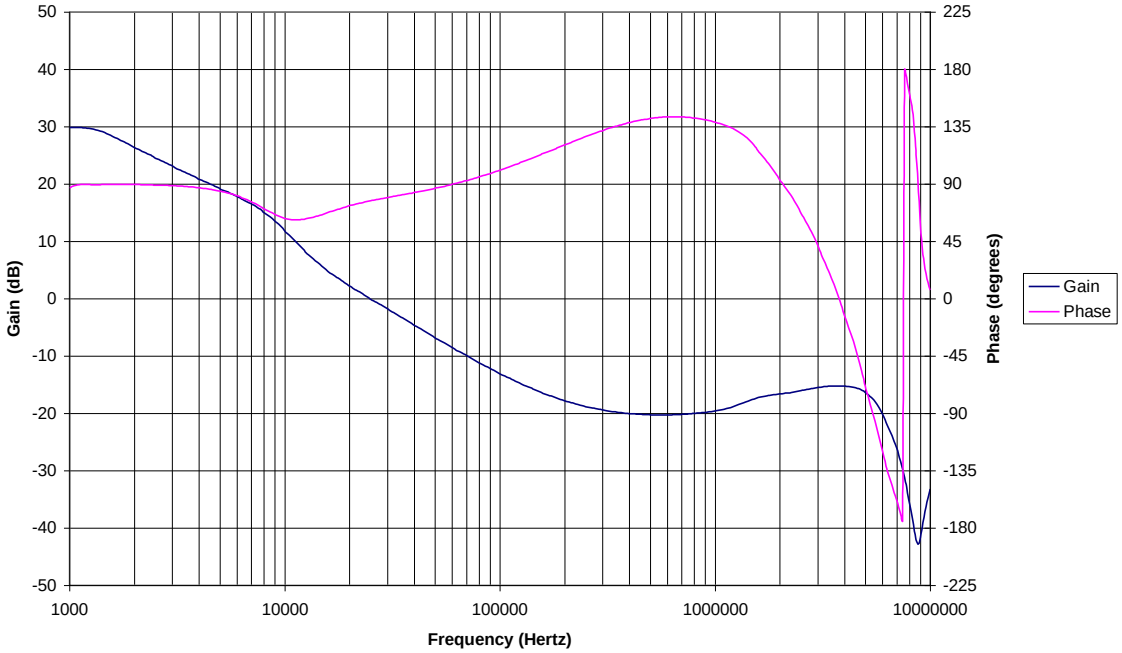


MSK5921 RH Frequency Response
SN5817 (Biased) 100Krad(Si)

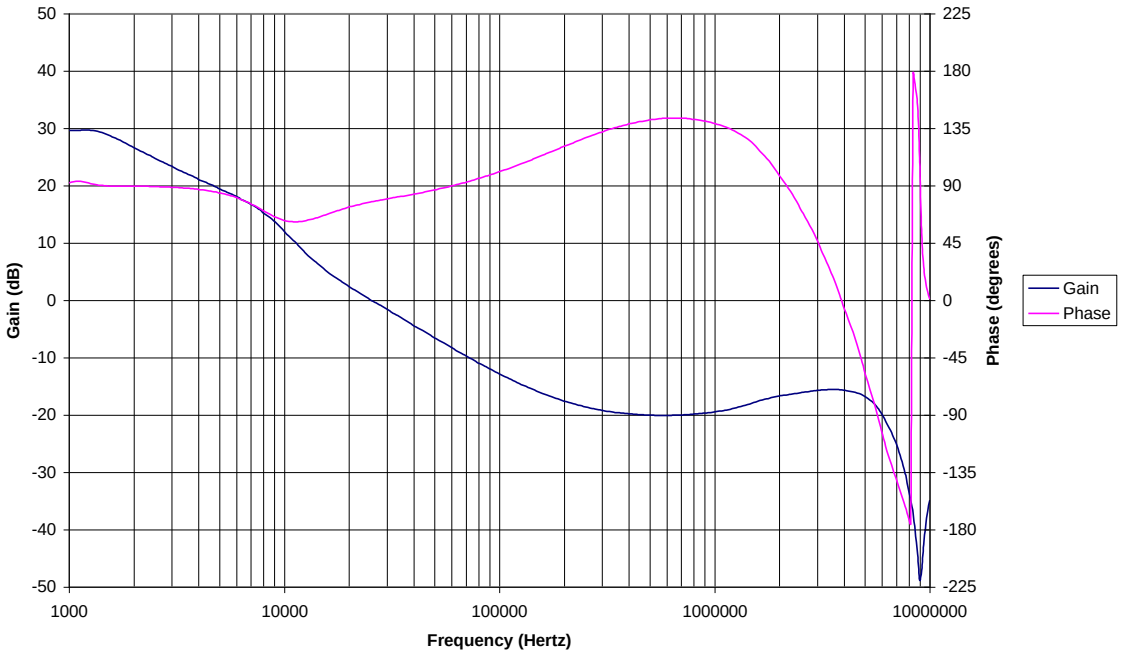


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5817 (Biased) 300Krad(Si)

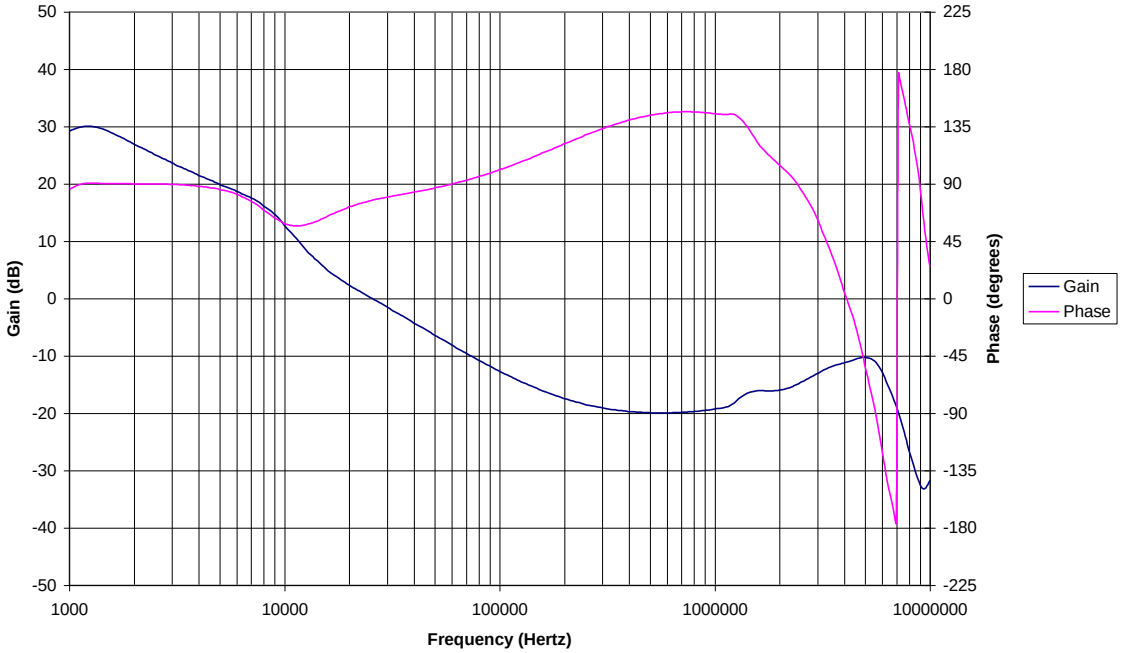


MSK5921 RH Frequency Response
SN5817 (Biased) 500Krad(Si)

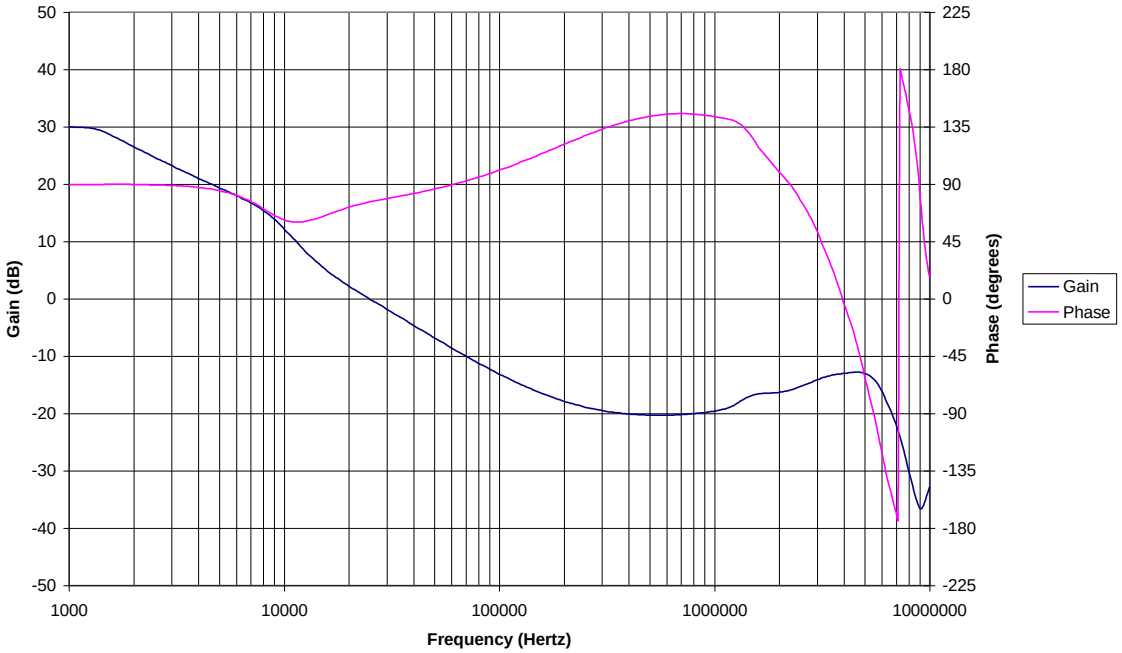


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5818 (Biased) 0Krad(Si)

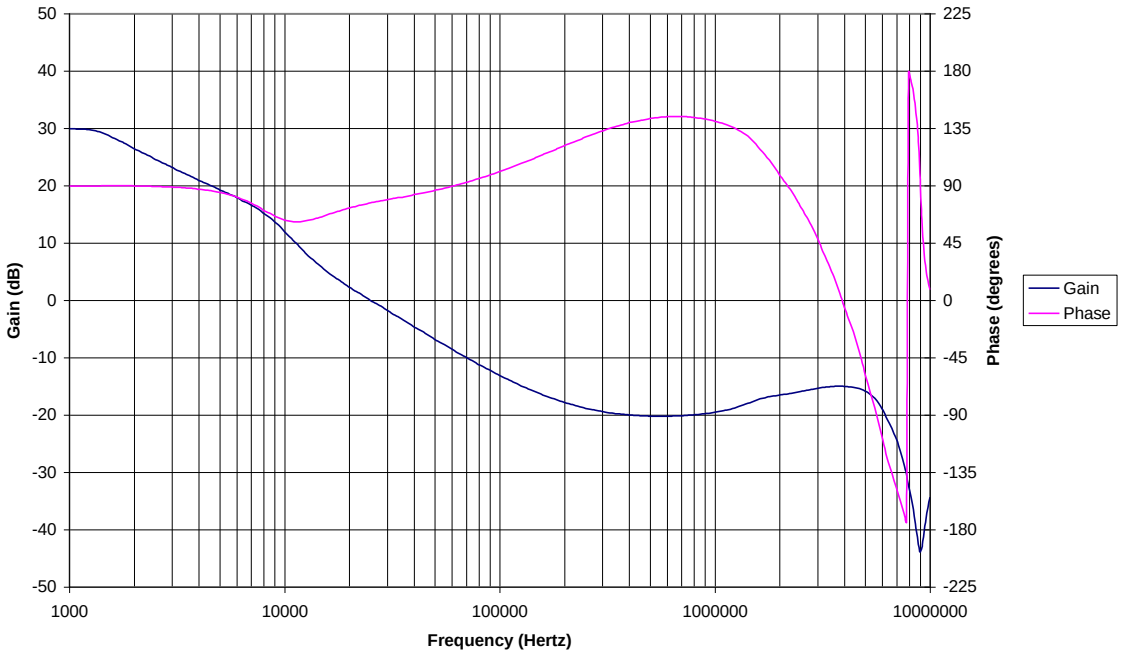


MSK5921 RH Frequency Response
SN5818 (Biased) 100Krad(Si)

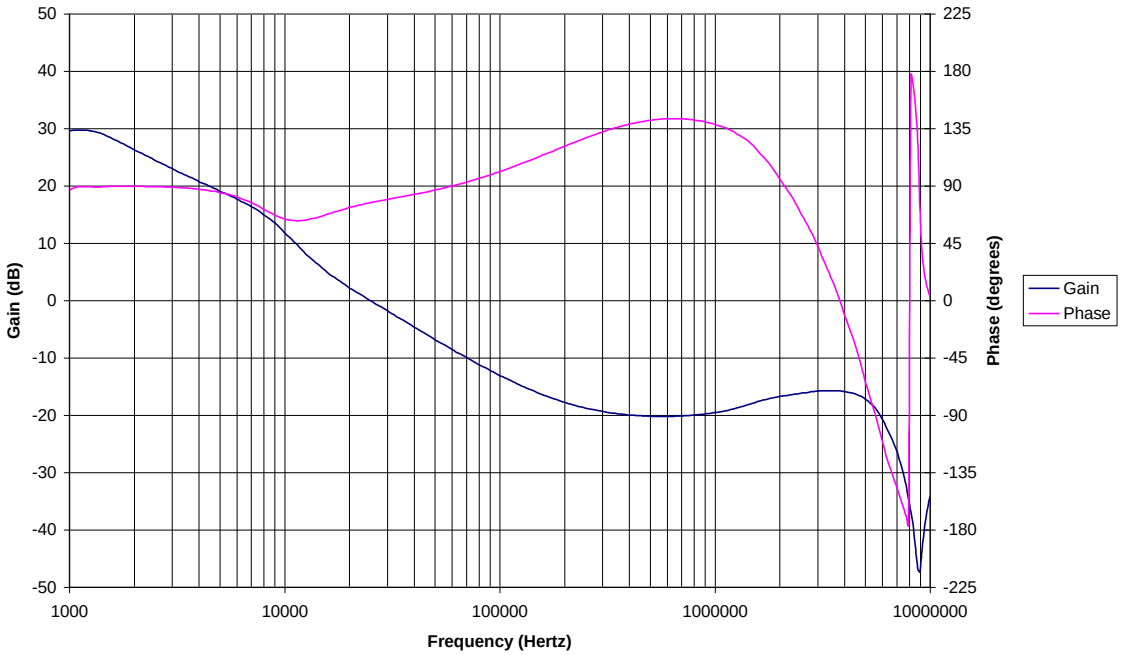


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5818 (Biased) 300Krad(Si)

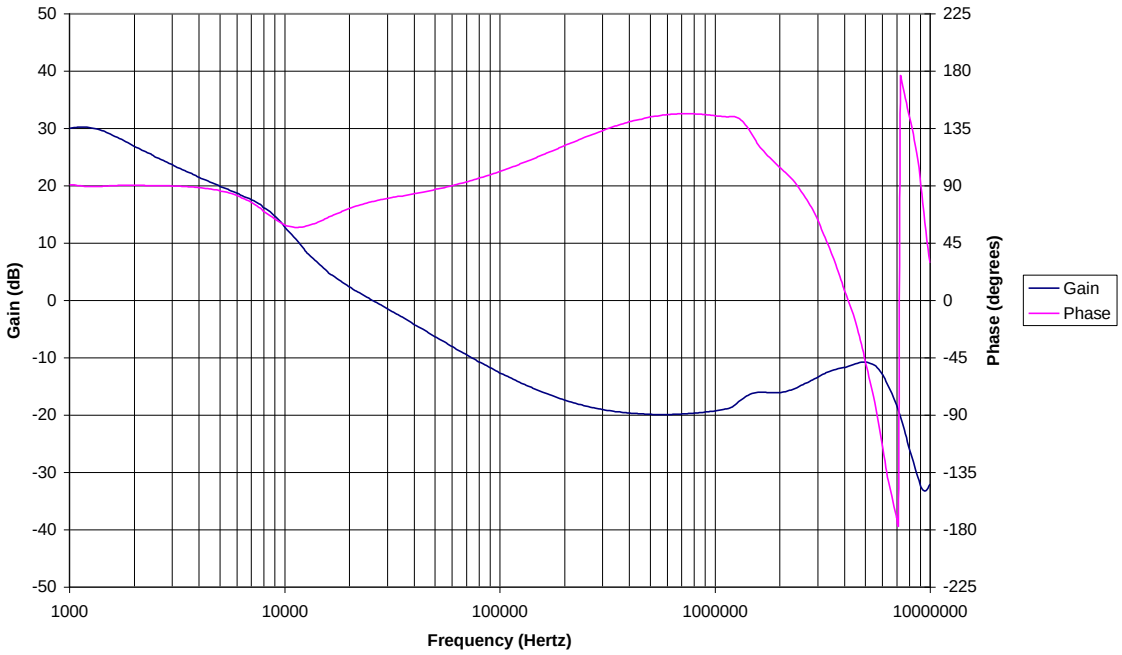


MSK5921 RH Frequency Response
SN5818 (Biased) 500Krad(Si)

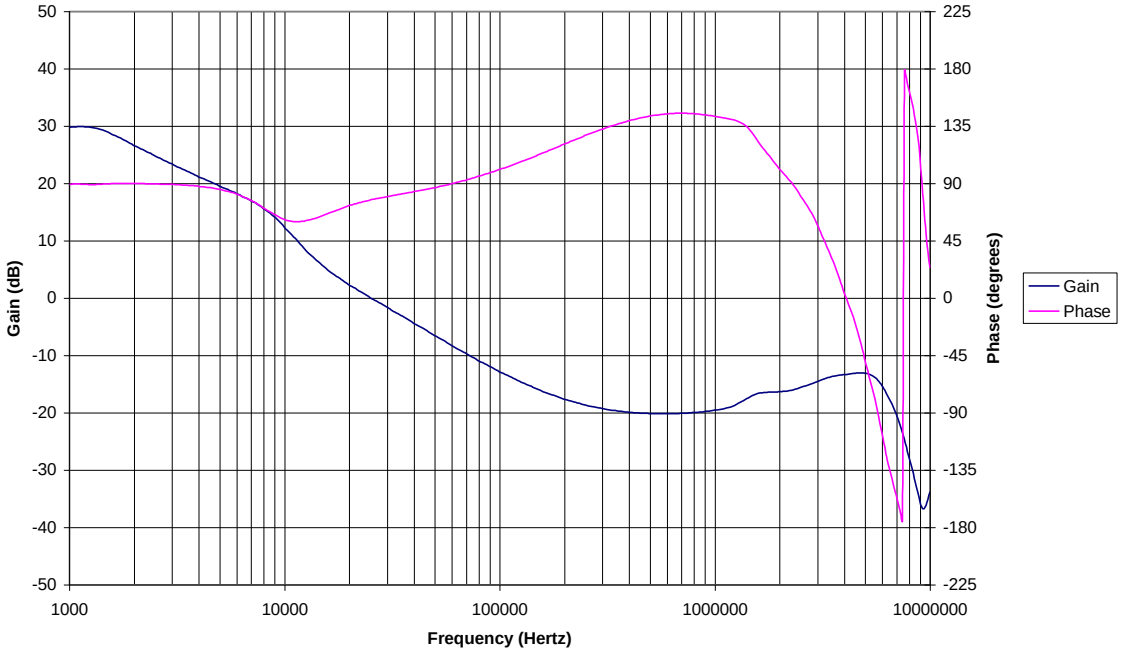


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5819 (Un-Biased) 0Krad(Si)

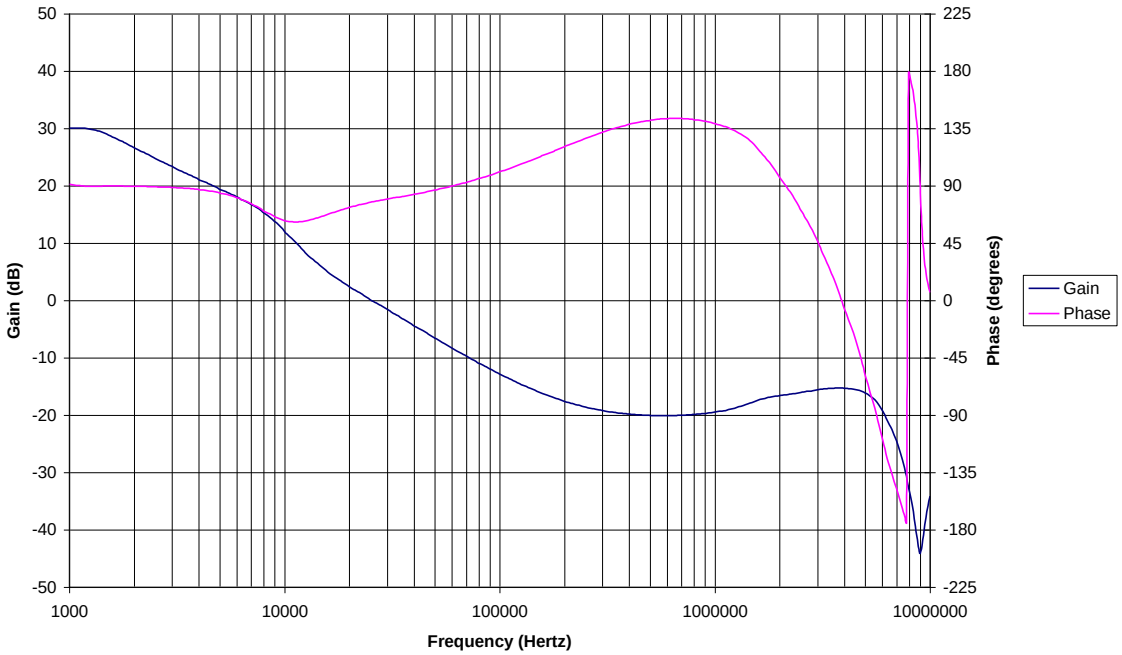


MSK5921 RH Frequency Response
SN5819 (Un-Biased) 100Krad(Si)

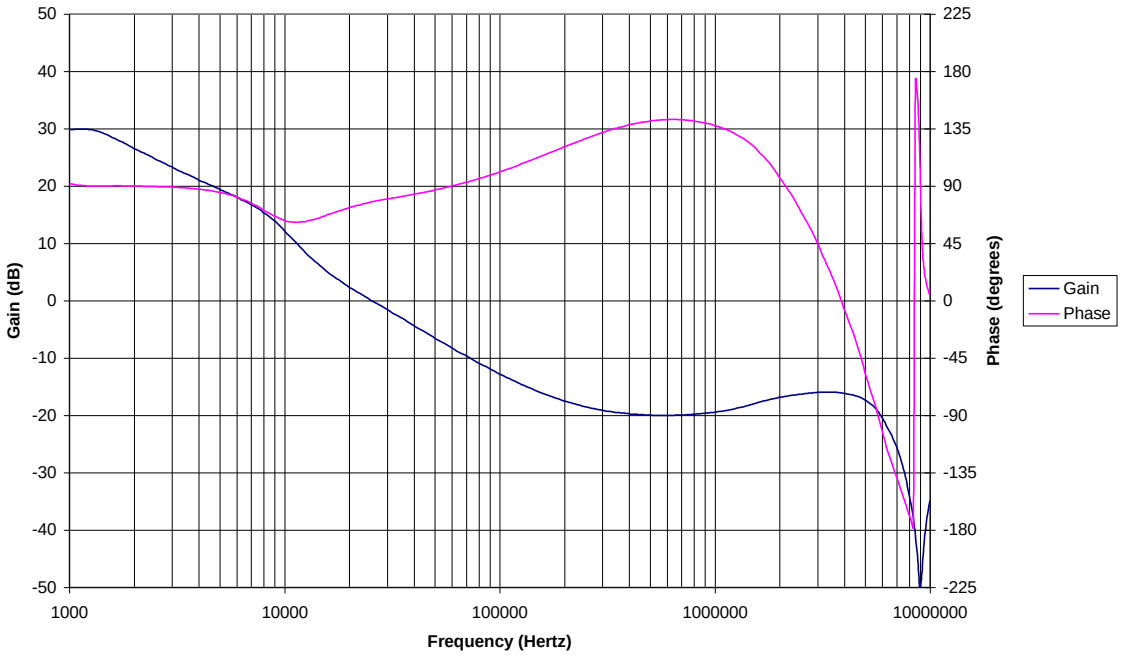


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5819 (Un-Biased) 300Krad(Si)

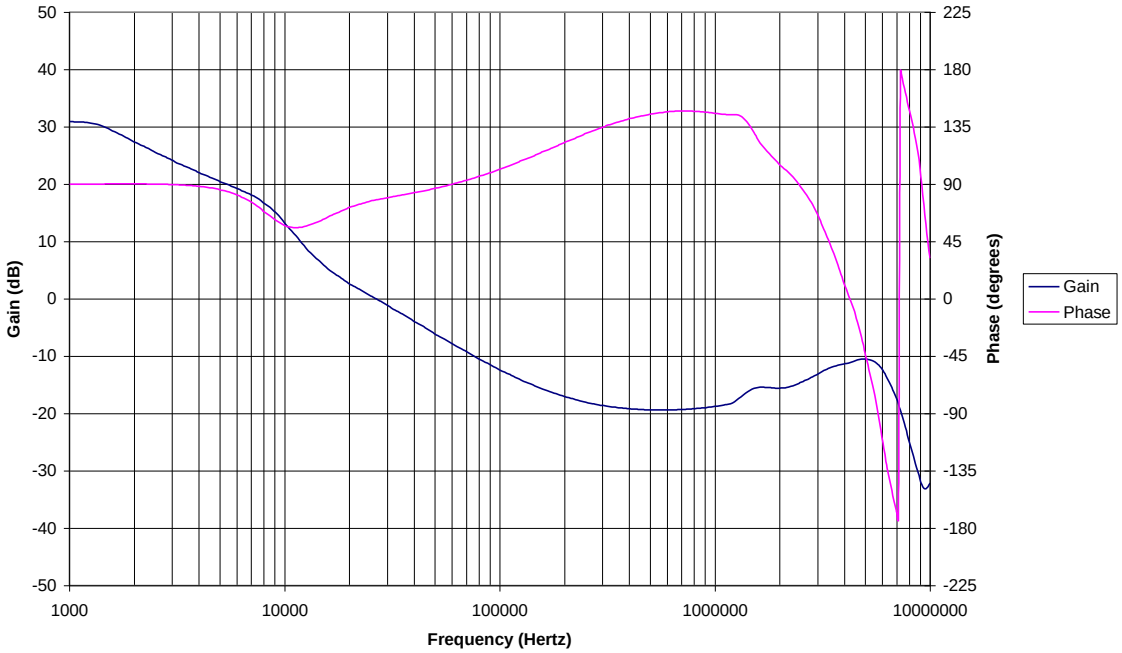


MSK5921 RH Frequency Response
SN5819 (Un-Biased) 500Krad(Si)

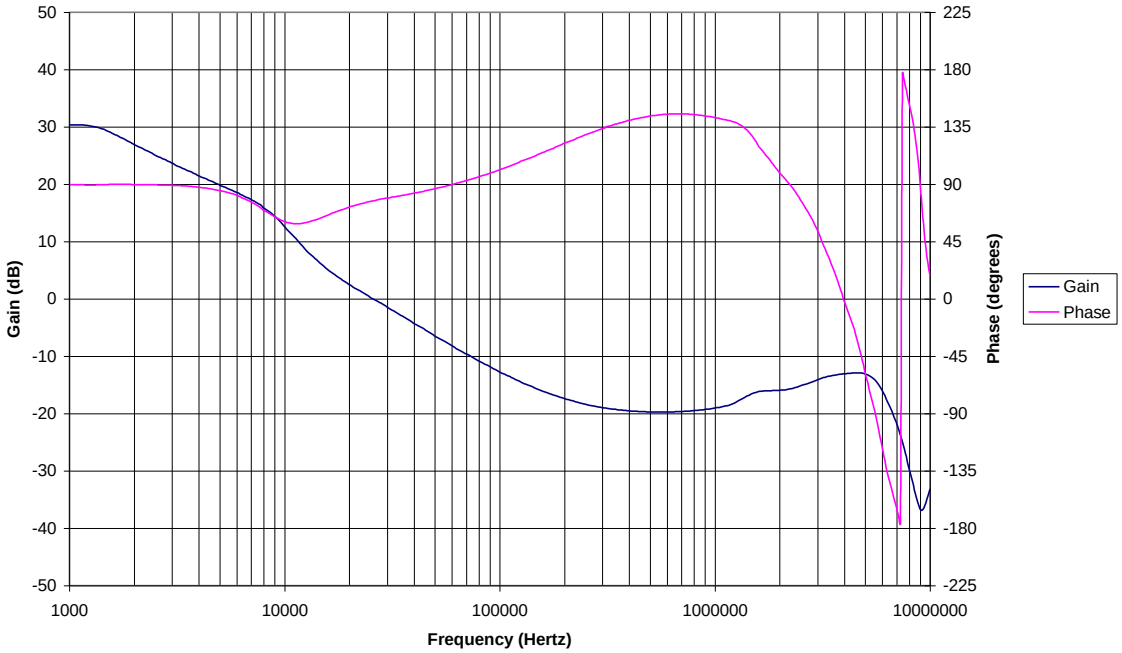


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5820 (Un-Biased) 0Krad(Si)

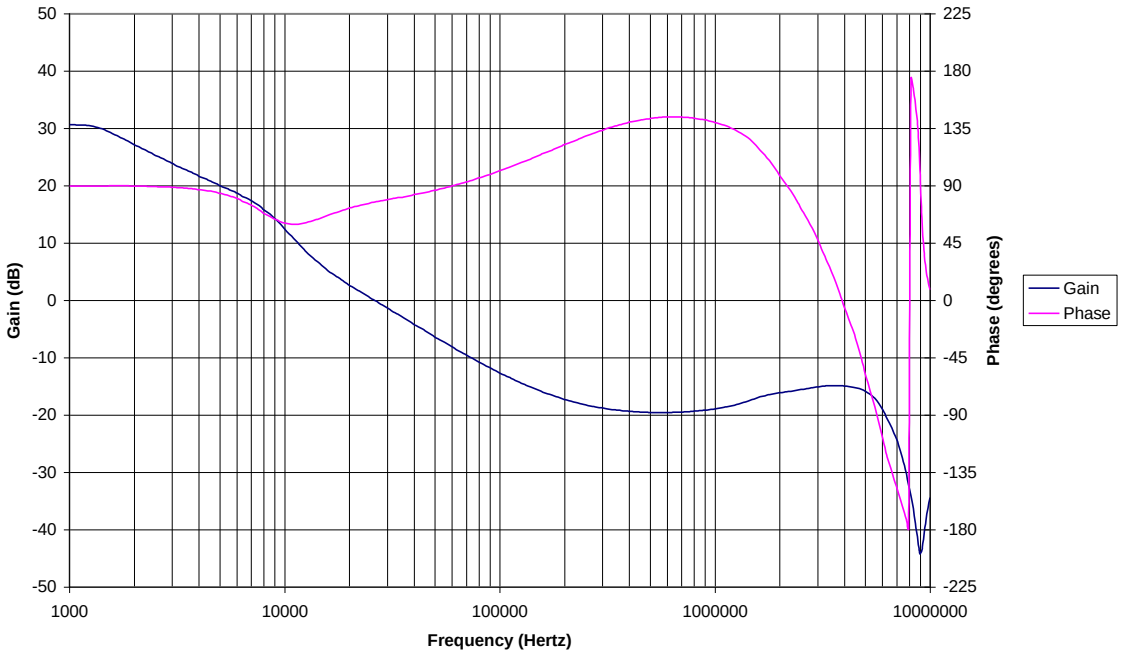


MSK5921 RH Frequency Response
SN5820 (Un-Biased) 100Krad(Si)

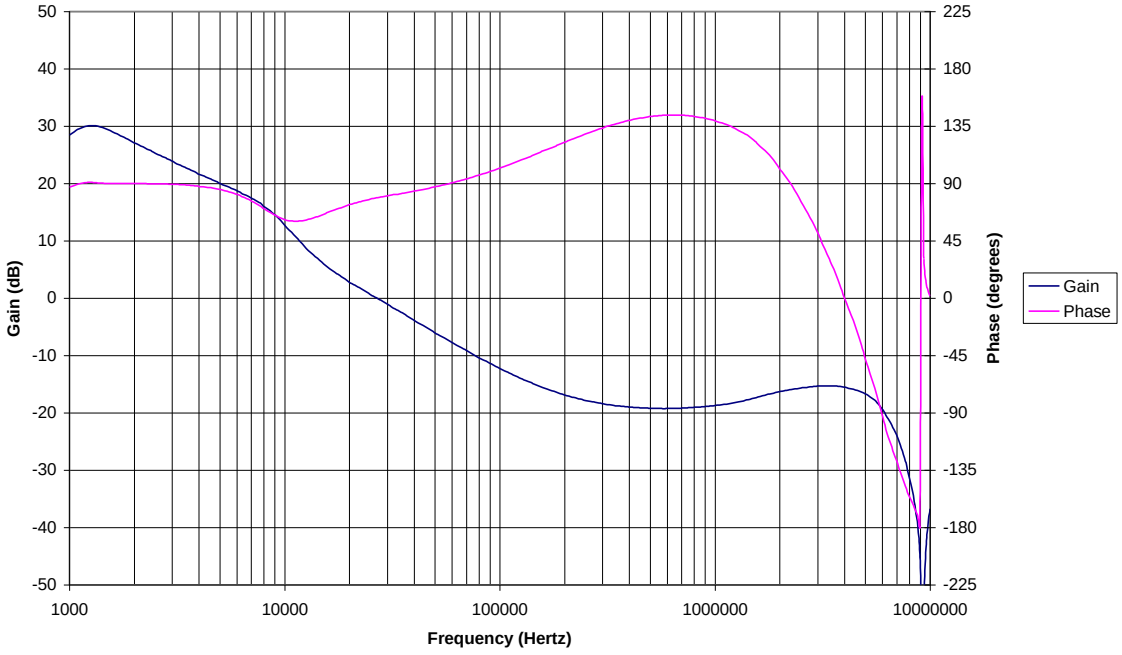


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5820 (Un-Biased) 300Krad(Si)

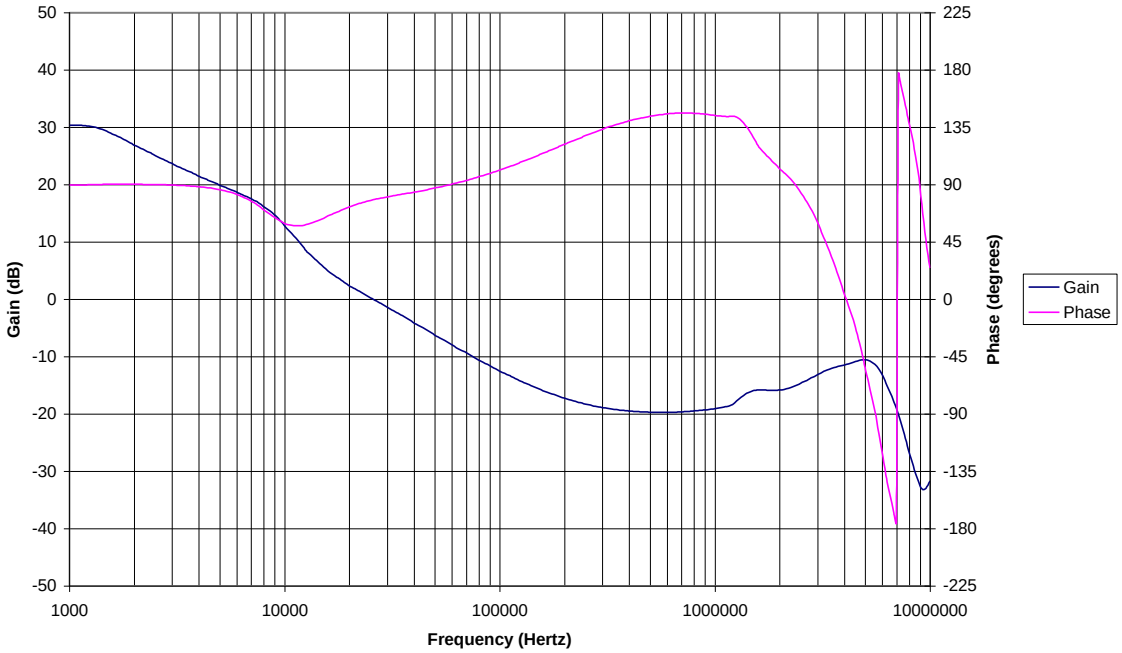


MSK5921 RH Frequency Response
SN5820 (Un-Biased) 500Krad(Si)

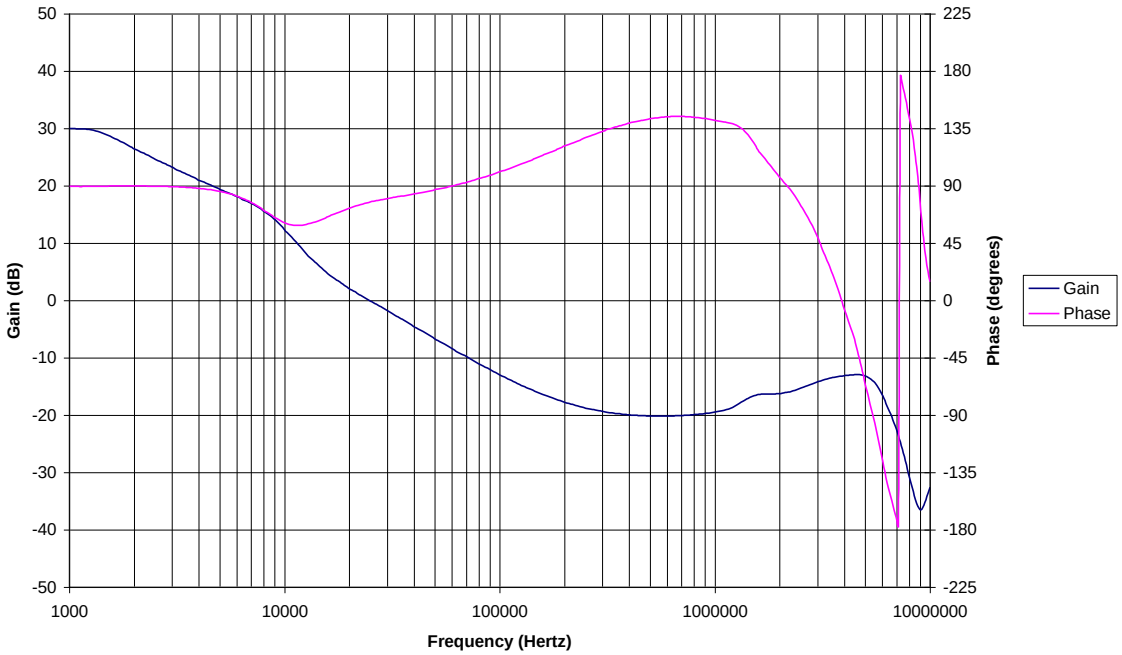


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5822 (Un-Biased) 0Krad(Si)

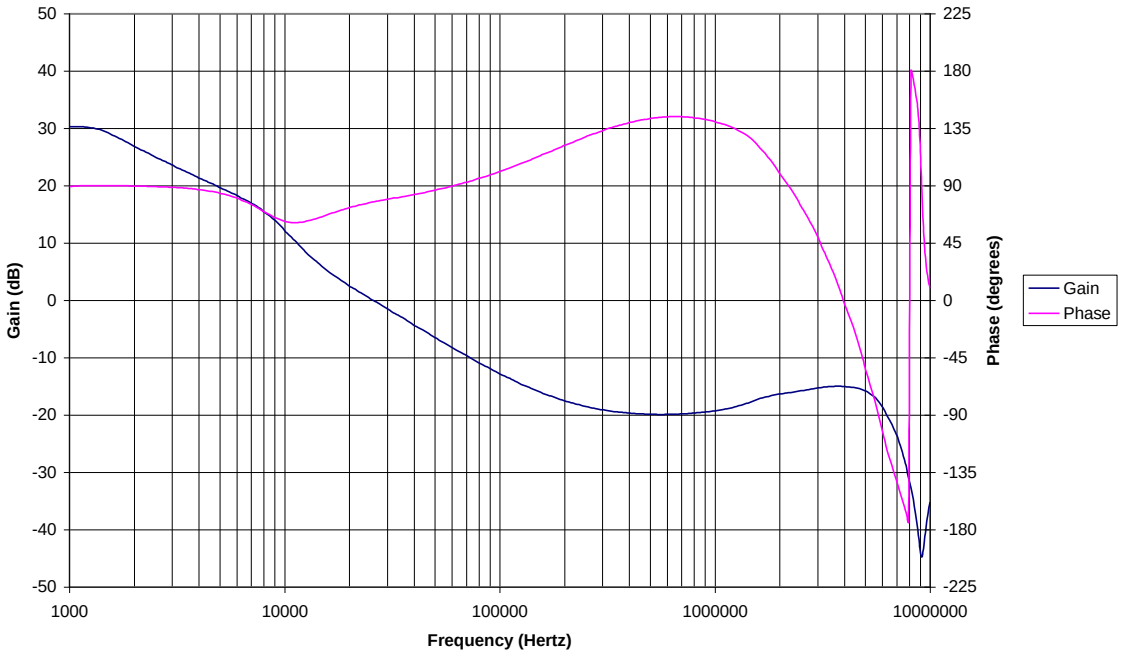


MSK5921 RH Frequency Response
SN5822 (Un-Biased) 100Krad(Si)

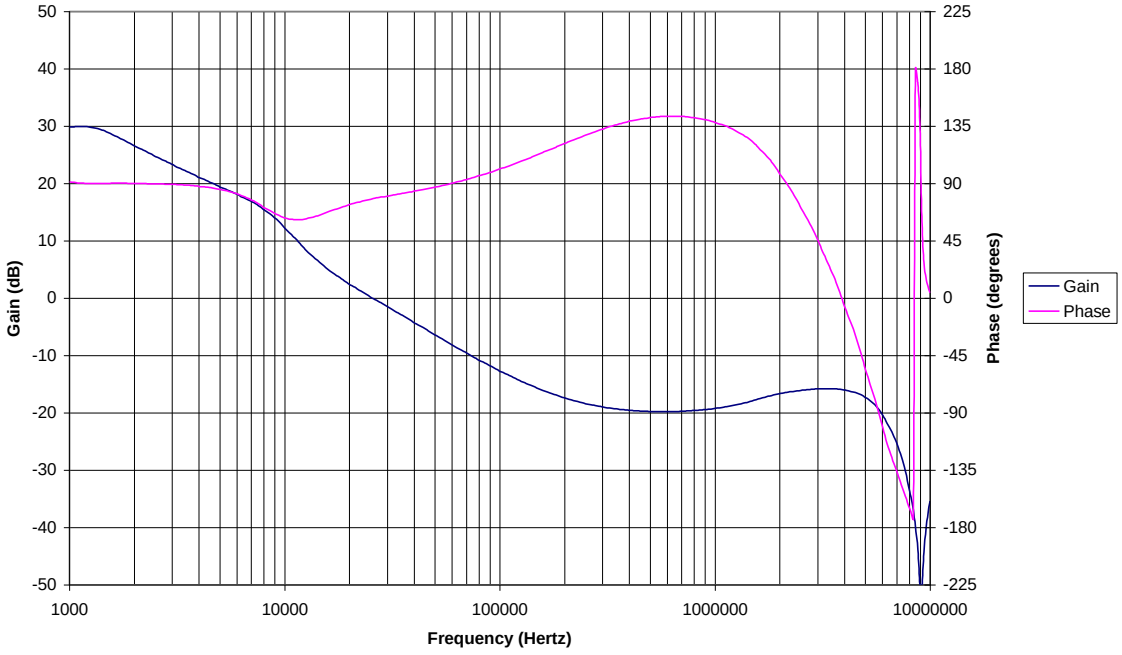


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN5822 (Un-Biased) 300Krad(Si)

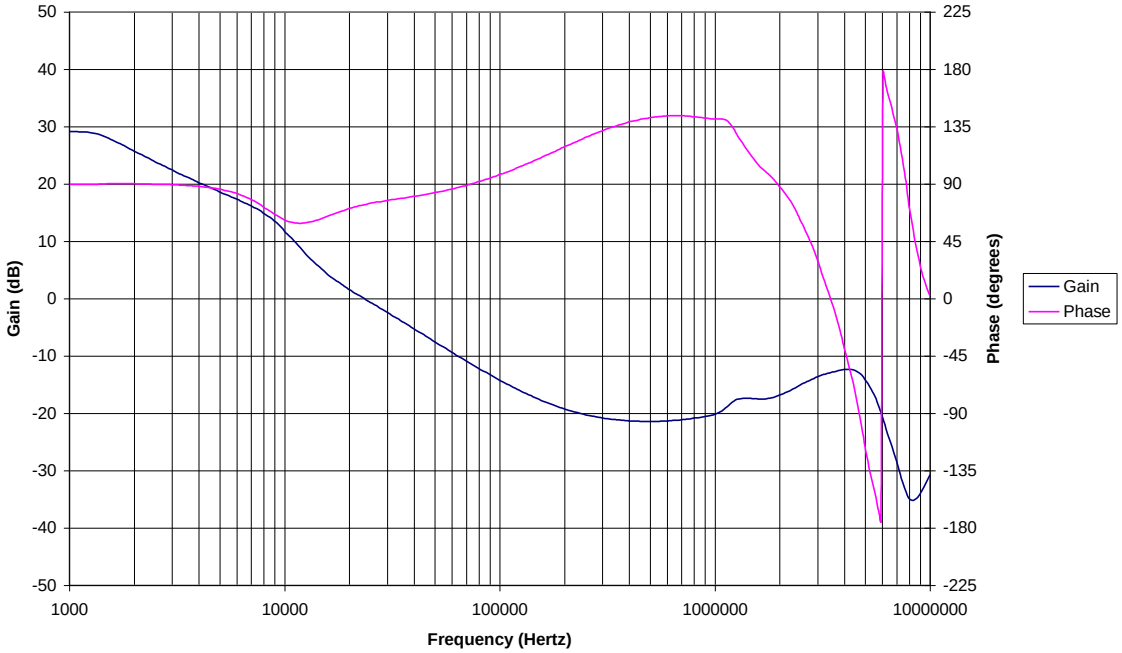


MSK5921 RH Frequency Response
SN5822 (Un-Biased) 500Krad(Si)

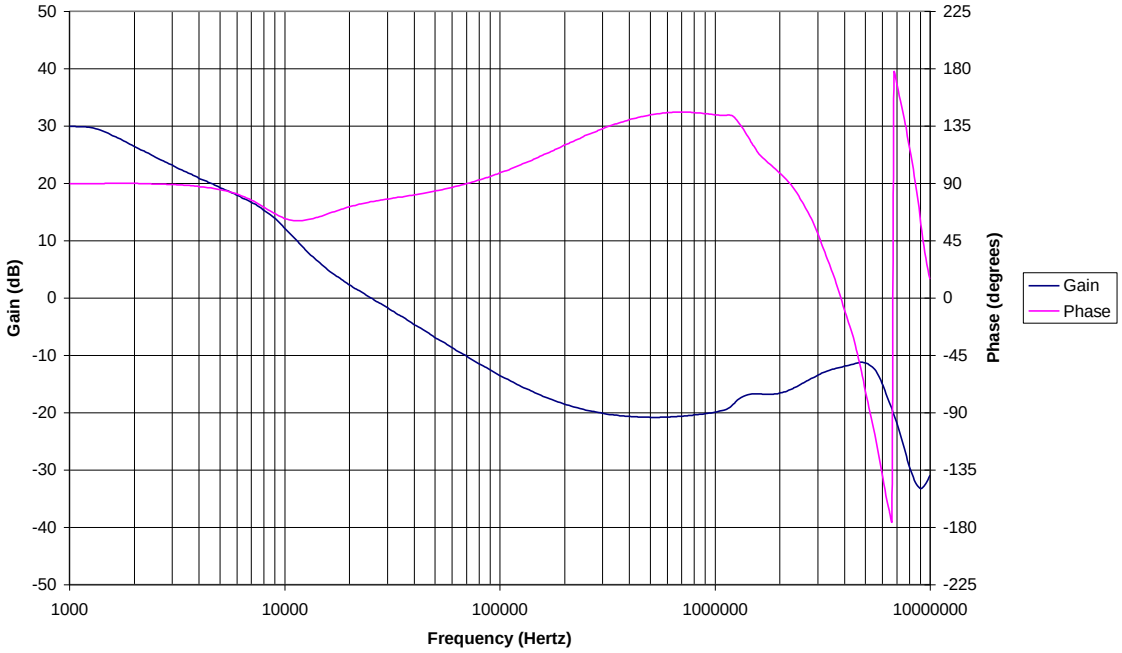


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN8004 (Control) 0Krad(Si)

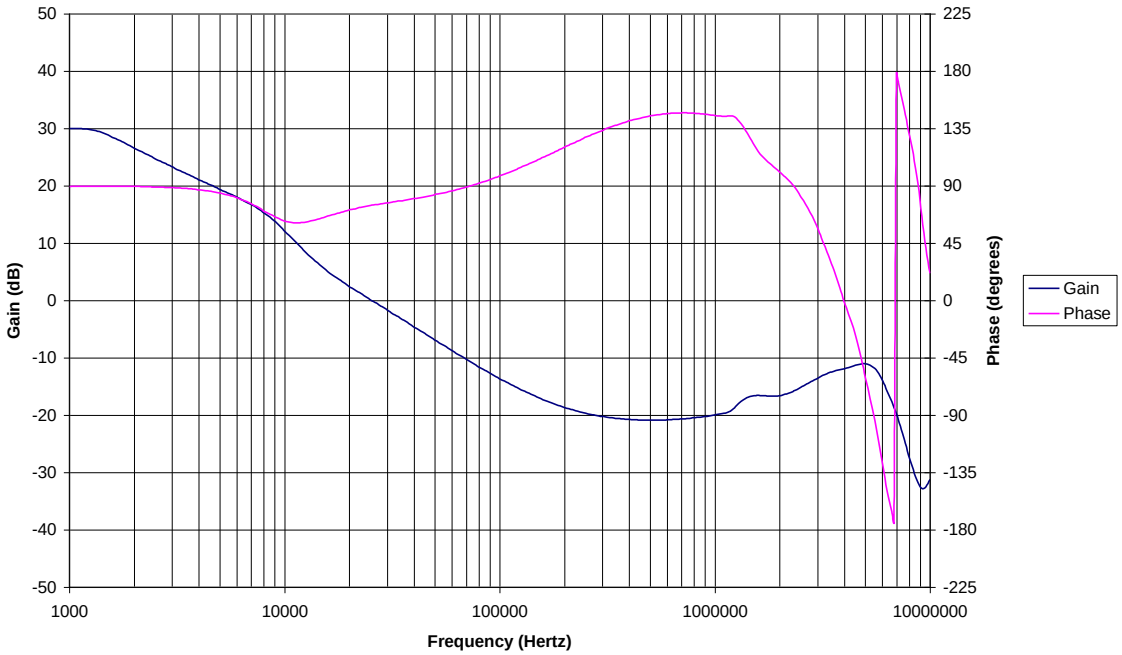


MSK5921 RH Frequency Response
SN8004 (Control) 100Krad(Si)

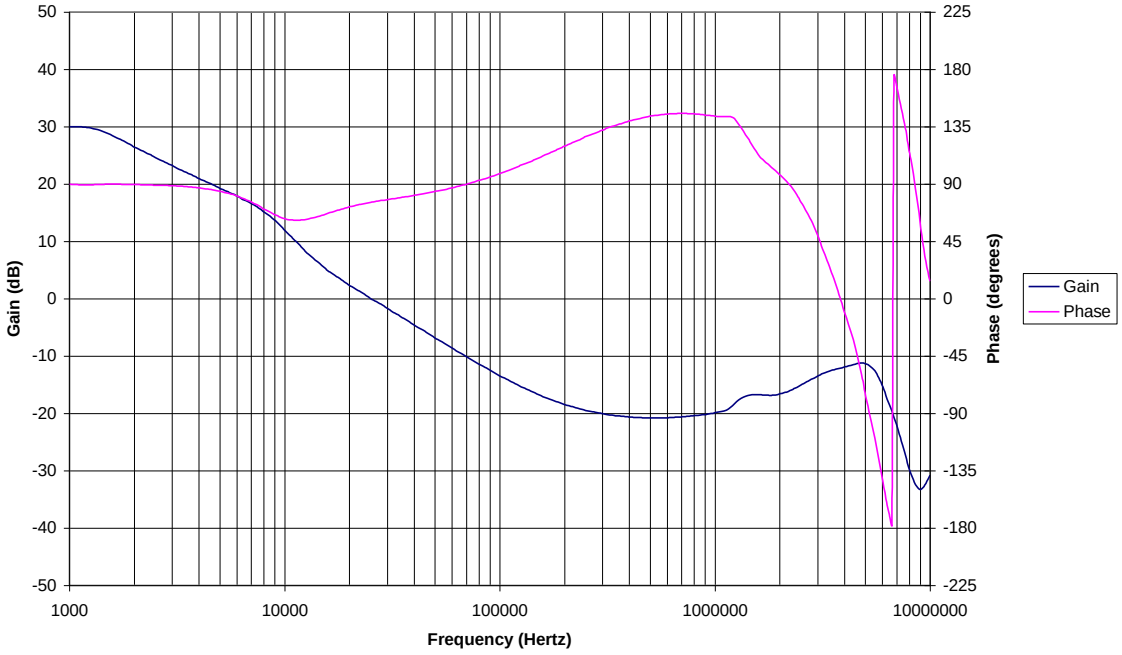


Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

MSK5921 RH Frequency Response
SN8004 (Control) 300Krad(Si)



MSK5921 RH Frequency Response
SN8004 (Control) 500Krad(Si)



Conditions: VIN = 6V VOUT = 3.3V IOUT = 0.5A

Total Dose Radiation Test Report

MSK 5920RH SERIES

Ultra Low Dropout Positive Linear Regulator

Updated March 29, 2007 (Second Test)

J. Douglas
B. Erwin
P. Musil

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5920RH was developed to qualify the device as a radiation tolerant device to 100 Krad(Si). The testing was performed to 500 Krad to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the hybrid, 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 5920RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and the dose rate was determined to be 108 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 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 and enclosed in a Pb/Al container during irradiation to minimize dose enhancement effects. Four devices were kept under bias during irradiation. Four devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted together and were 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.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing the MSK 5920RH easily qualified as a 100 Krad(Si) radiation tolerant device. Further analysis of the data shows the hybrid to offer good radiation tolerance to dose levels of 300 Krad(Si).

The only test parameter that exceeded pre-irradiation test limits was output voltage tolerance. Two ground devices and one biased device slightly exceeded 4.0 percent at 300 Krad(Si). However, the average of the devices was below 4.0 percent. Post irradiation output voltage tolerance level is ±4.0 percent at 100 Krad(Si). The devices did not exceed this limit at 100 Krad(Si).

All other test parameters stayed within pre irradiation test limits throughout the irradiation process to 300 Krad(Si). It should be noted that 3 grounded devices were functional failures at 400 Krad(Si). The fourth ground device failed functionally at 500 Krads(Si). The four devices exhibited no output voltage.

Please contact the factory for additional data beyond 300 Krad(Si) if necessary.

An ELDRS test is planned for the future to determine the effects of low dose exposure.

Dosimetry Equipment:
Bruker Biospin #0141

Dose Rate = 108 Rads(Si)/Sec

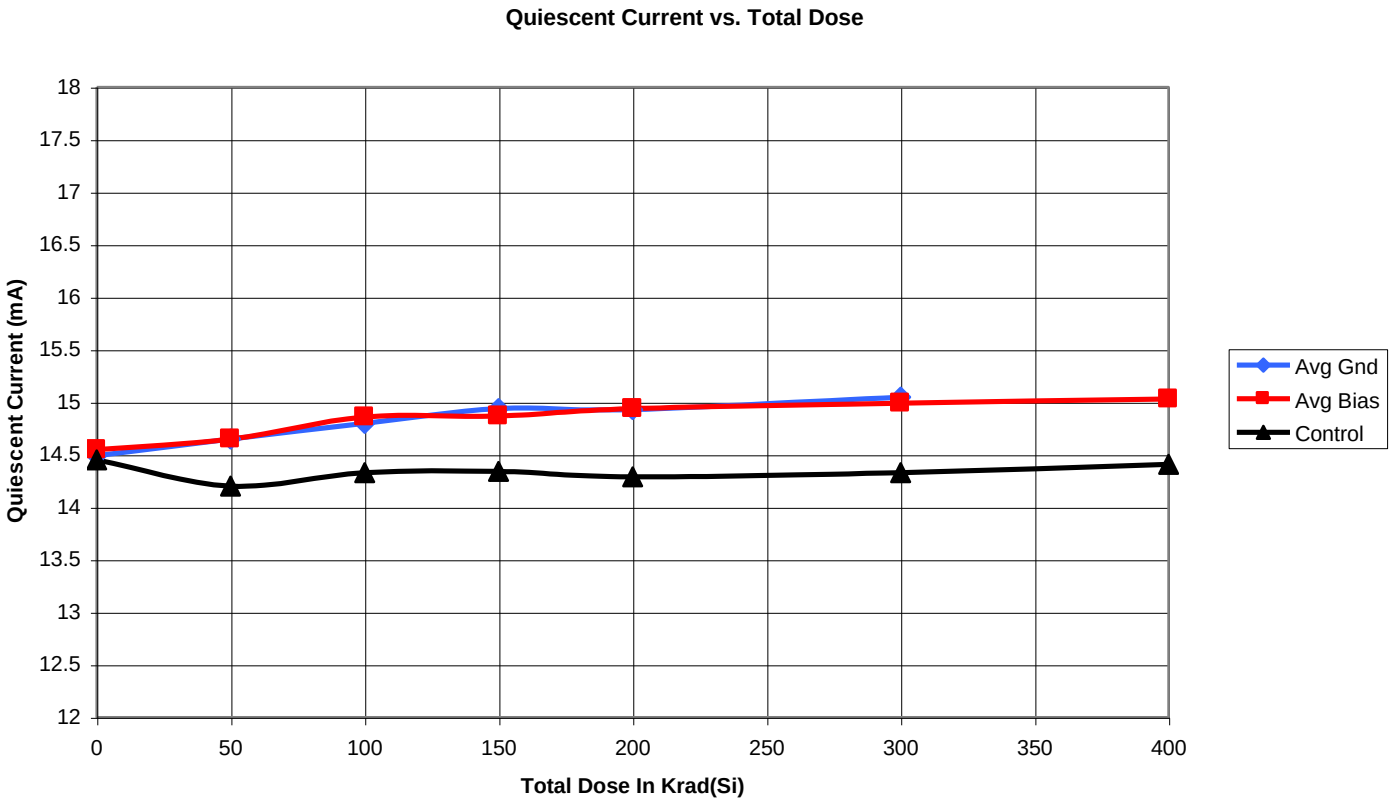
Testing Performed:
03/29/2007

Biased MSK 5920RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
7:57	51,516	51,516
7:57	51,516	103,032
7:57	51,516	154,548
7:57	51,516	206,064
15:54	103,046	309,096
15:54	103,032	412,128
15:54	103,032	515,160

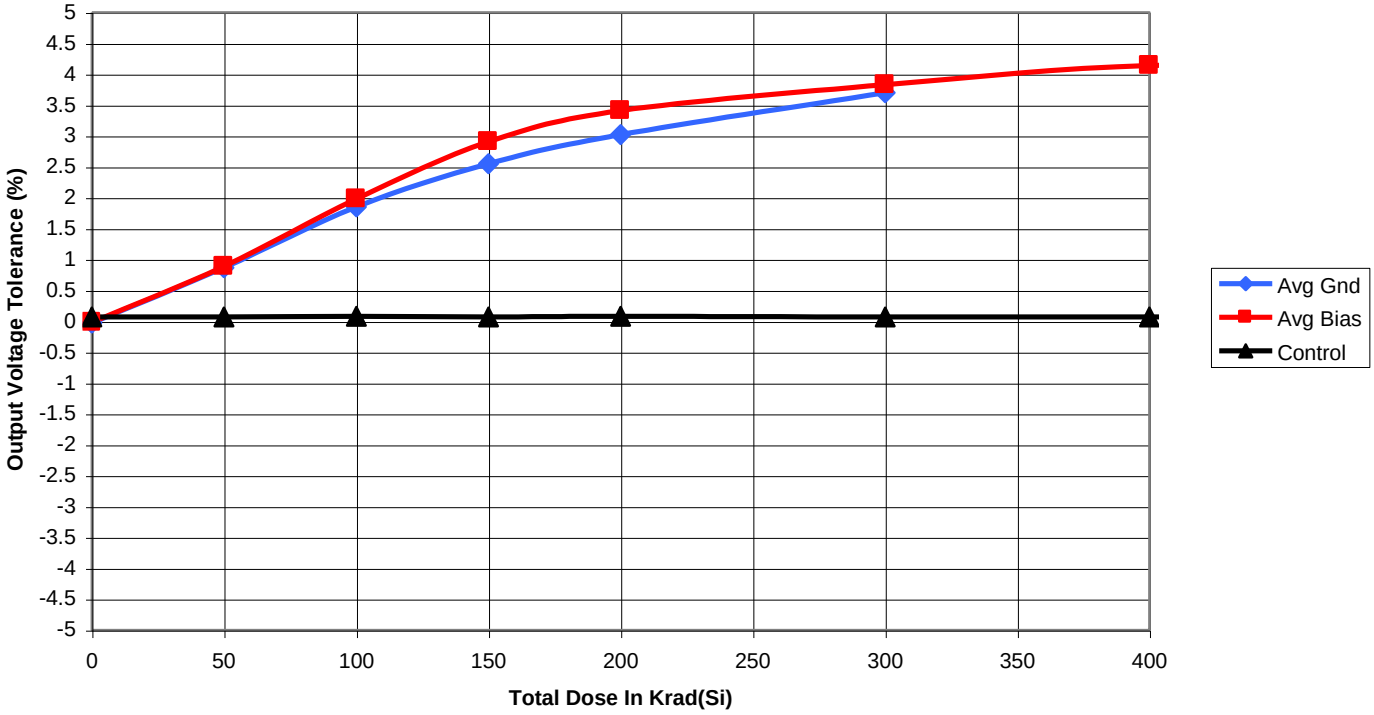
Unbiased MSK 5920RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
7:57	51,516	51,516
7:57	51,516	103,032
7:57	51,516	154,548
7:57	51,516	206,064
15:54	103,046	309,096
15:54	103,032	412,128
15:54	103,032	515,160

Table I

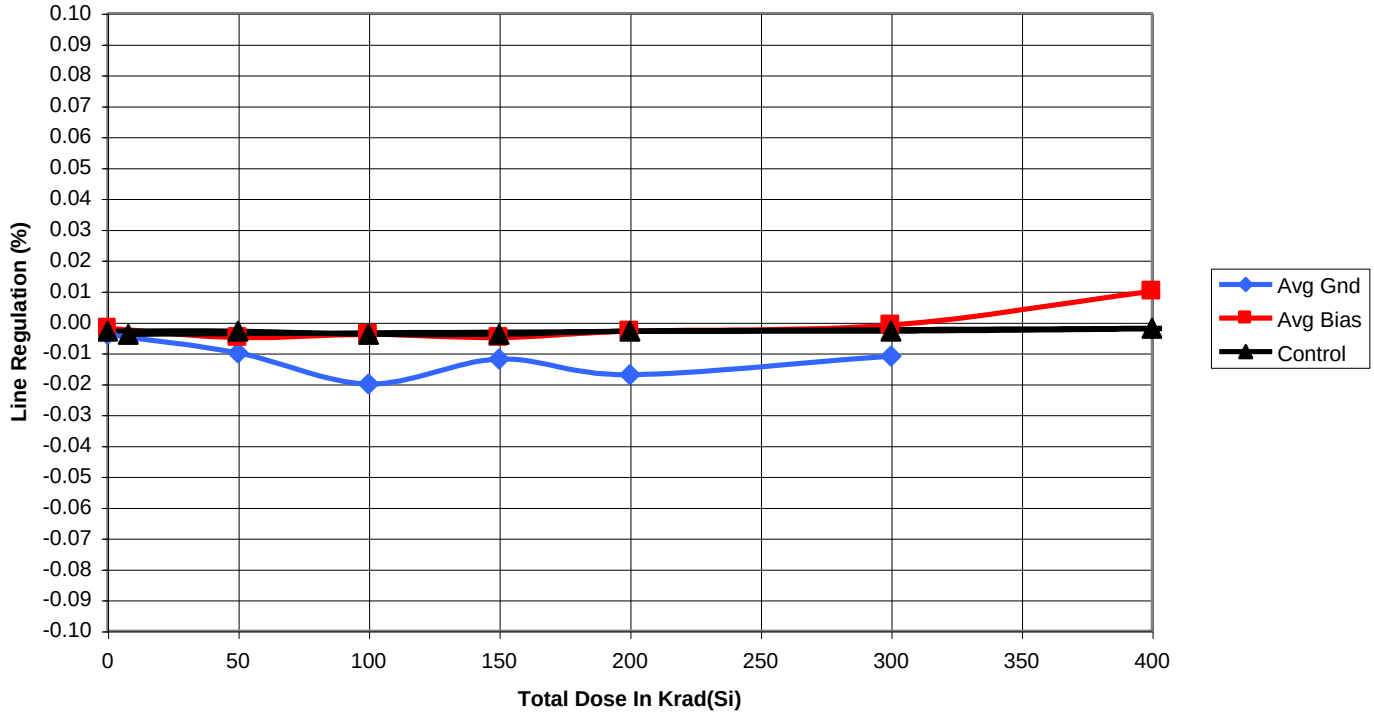
Dose Time, Incremental Dose and Total Cumulative Dose



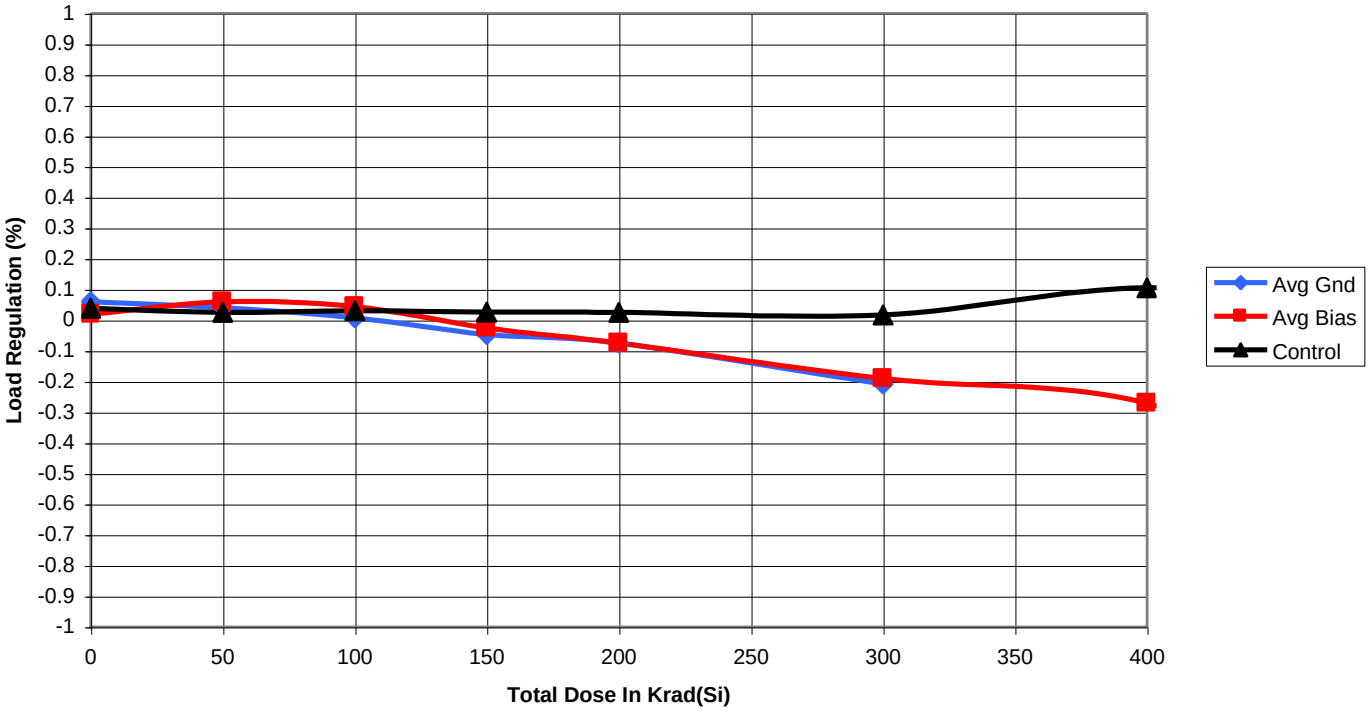
Output Voltage Tolerance vs. Total Dose



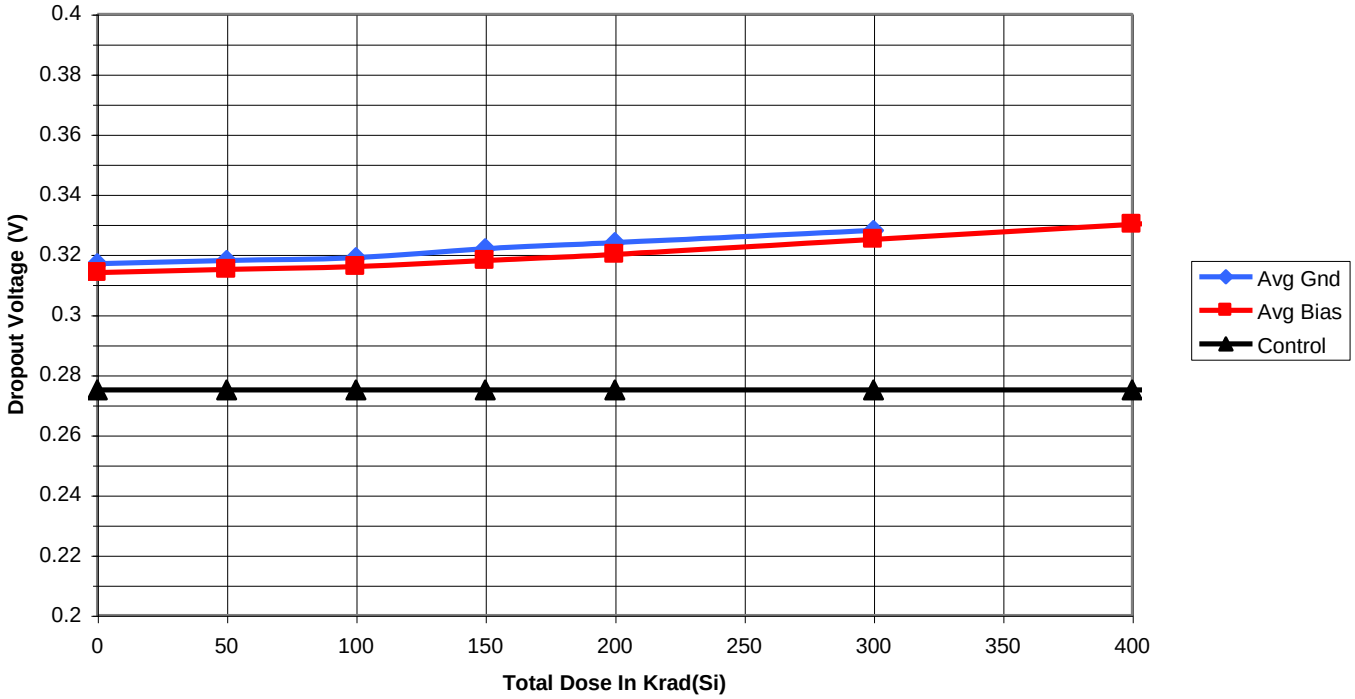
Line Regulation vs. Total Dose

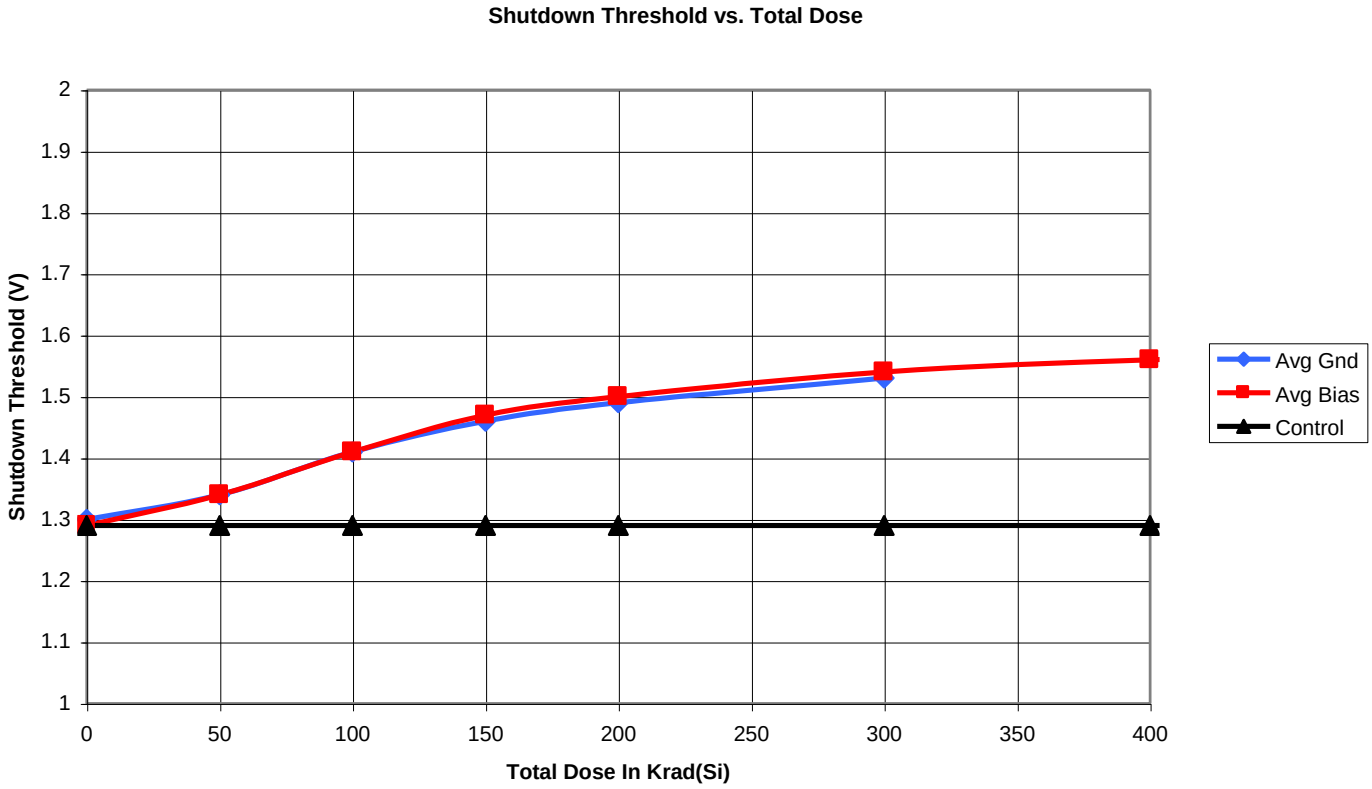


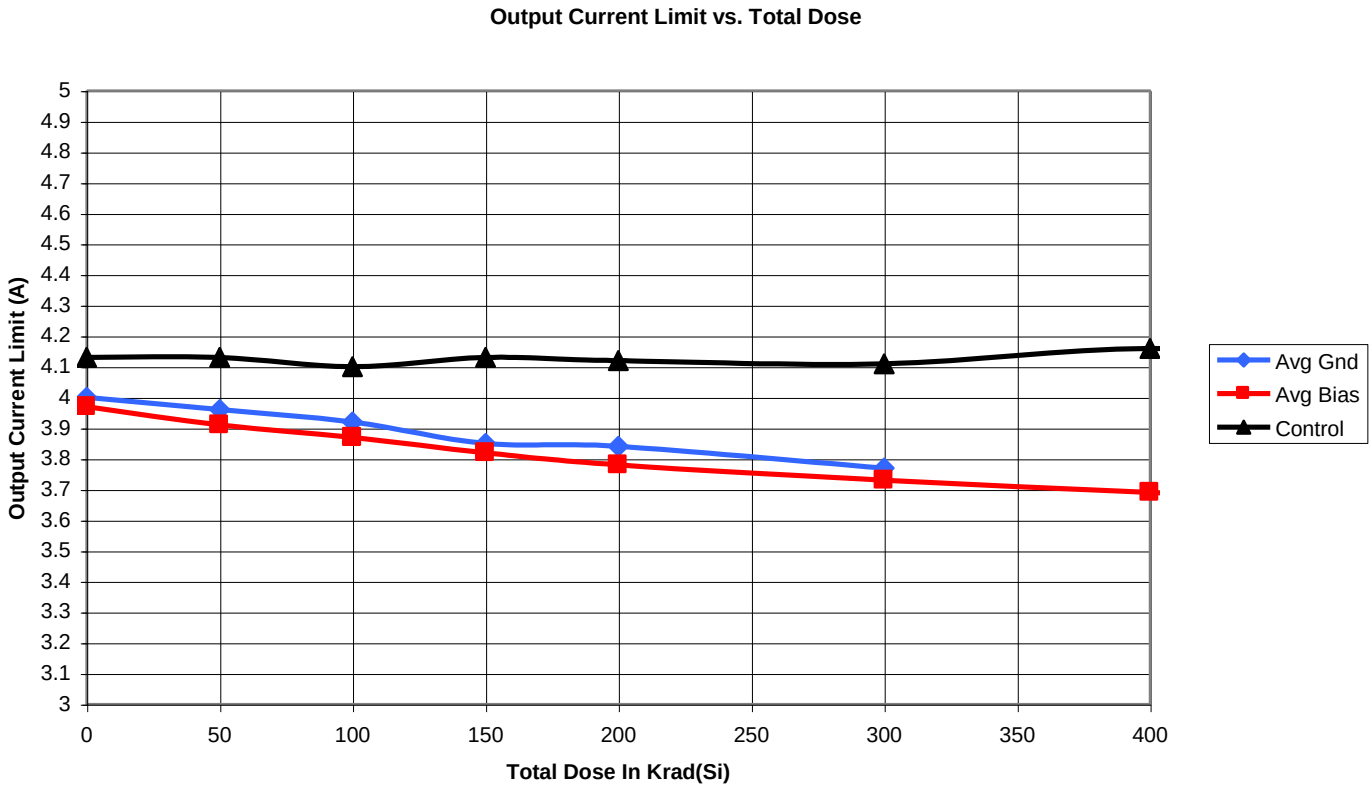
Load Regulation vs. Total Dose



Dropout Voltage vs. Total Dose




Shutdown Threshold vs. Total Dose
Shutdown Threshold (V)
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0
50
100
150
200
250
300
350
400
Total Dose In Krad(Si)
Avg Gnd
Avg Bias
Control


Output Current Limit vs. Total Dose
Output Current Limit (A)
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
0
50
100
150
200
250
300
350
400
Total Dose In Krad(Si)
Avg Gnd
Avg Bias
Control

Total Dose Radiation Test Report

MSK 5921RH

Ultra Low Dropout Adjustable Positive Linear Regulator

January 10, 2006 (First Test)

B. Erwin
J. Swistak

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5921 RH was developed to qualify the device as a radiation tolerant device to 300 KRADS(Si). The testing was performed to 300 KRAD to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the hybrid, but simply offers designers insight to the critical parameter-shifts up to the specified total dose level.

MIL-STD-883 Method 1019 and ASTM F1892-98 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5921RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and the dose rate was determined to be 134 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.

The devices were vertically aligned with the radiation source and enclosed in a Pb/Al container during irradiation to minimize dose enhancement effects. Four devices were kept under bias during irradiation. Four devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted using Conductive foam and were 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. At the conclusion of irradiation and testing all devices were subjected to a 160 hour anneal at 100°C. Electrical tests were then performed to determine the effects of annealing.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing the MSK 5921RH qualified as a 100 KRADS(Si) radiation hardened device. Further analysis of the data shows the hybrid to offer tolerance to total dose radiation levels of 300 KRADS(Si).

Feedback voltage measurements shifted beyond pre irradiation test limits above 150 KRADS(Si). This trend resulted in a + 3.5 % shift in the feedback voltage at 300 KRADS(Si).

All other test parameters stayed within pre irradiation test limits throughout the irradiation process.

Annealing the devices resulted in a shift towards pre-irradiation test results. Feedback voltage measurements returned to within data sheet test limits.

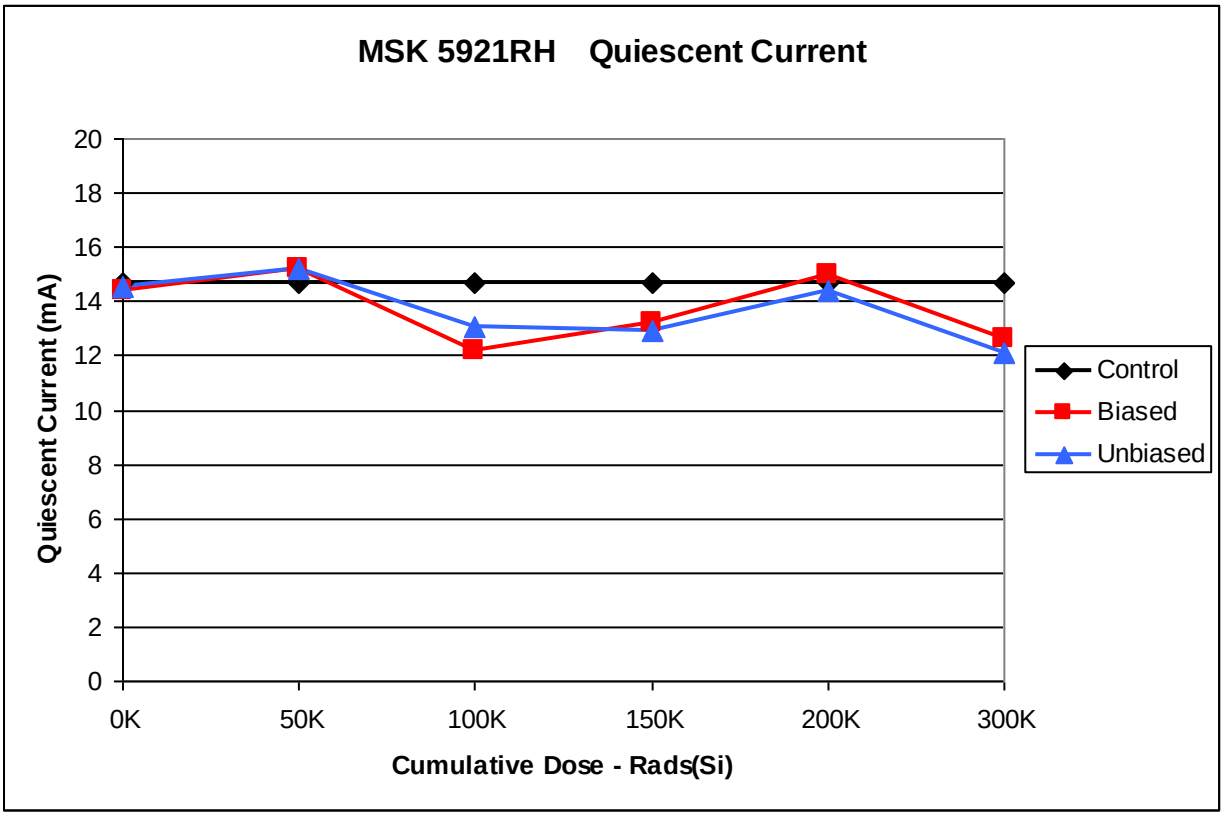
Dosimetry Equipment: Dose Rate = 134 Rads(Si)/Sec Testing Performed:

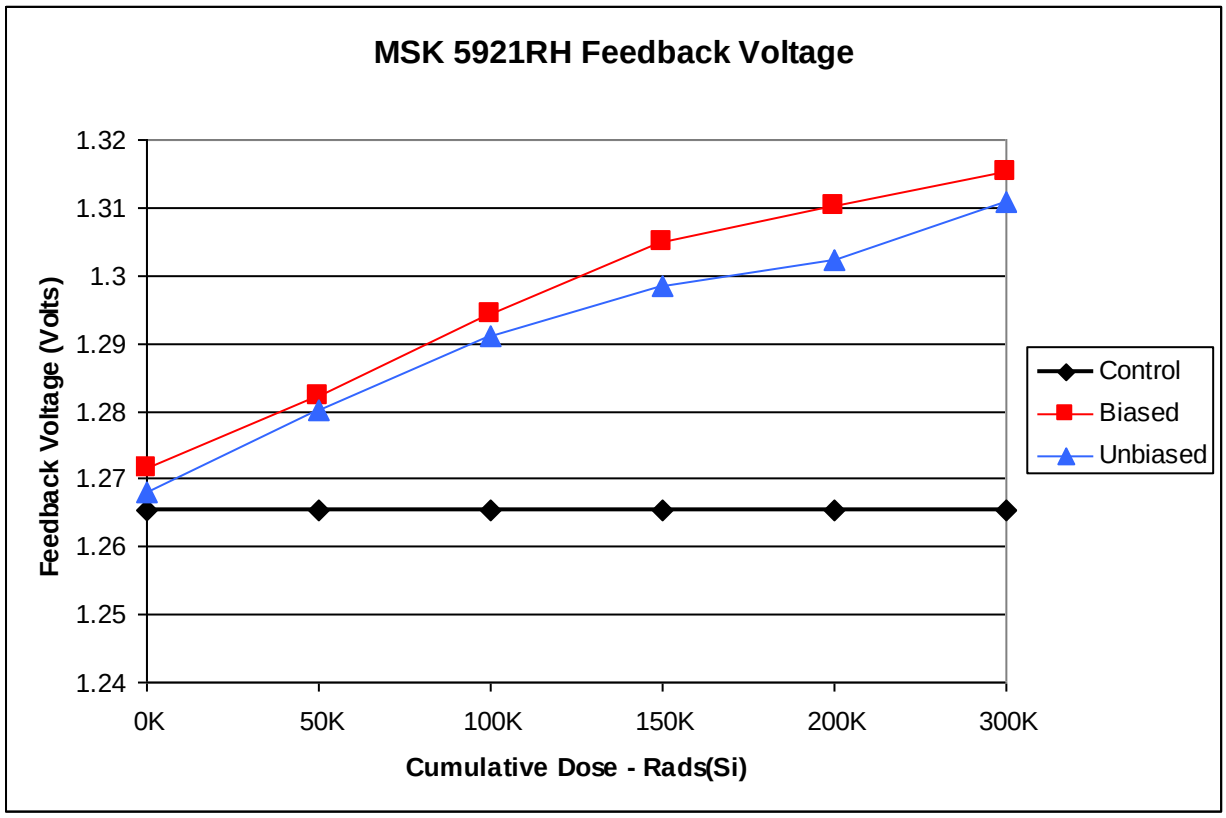
Bruker Biospin #0141 11/30/2006

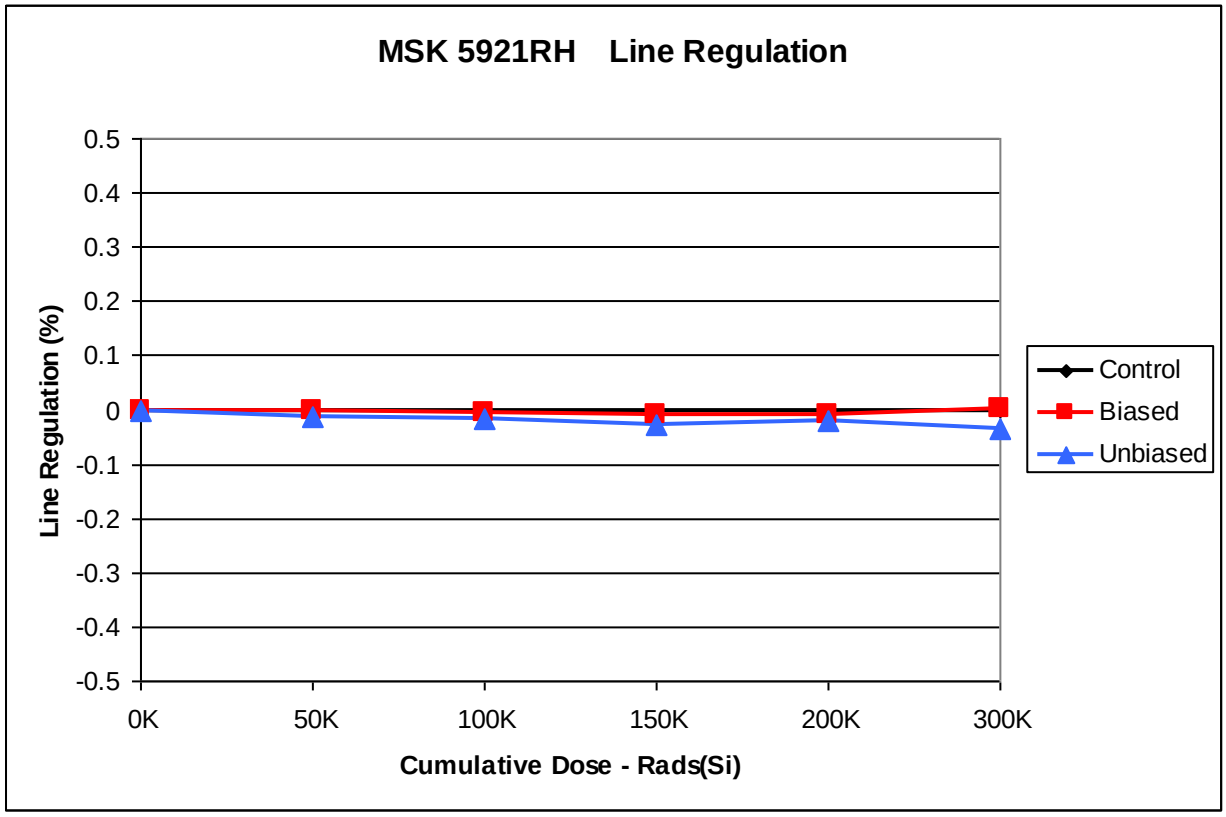
Biased MSK 5921RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
6:24	51,456	51,456
6:24	51,456	102,912
6:24	51,456	154,368
6:24	51,456	205,824
12:49	103,046	308,870

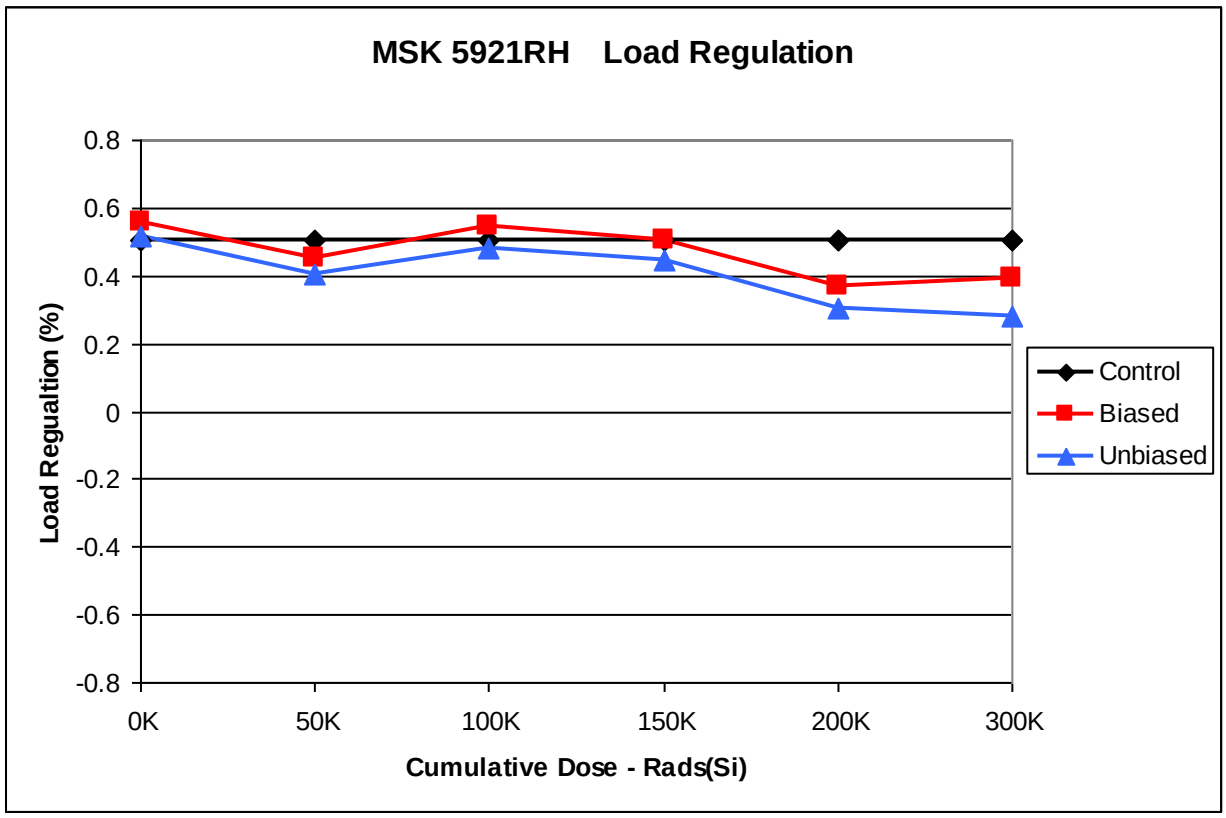
Unbiased MSK 5921RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
6:24	51,456	51,456
6:24	51,456	102,912
6:24	51,456	154,368
6:24	51,456	205,824
12:49	103,046	308,870

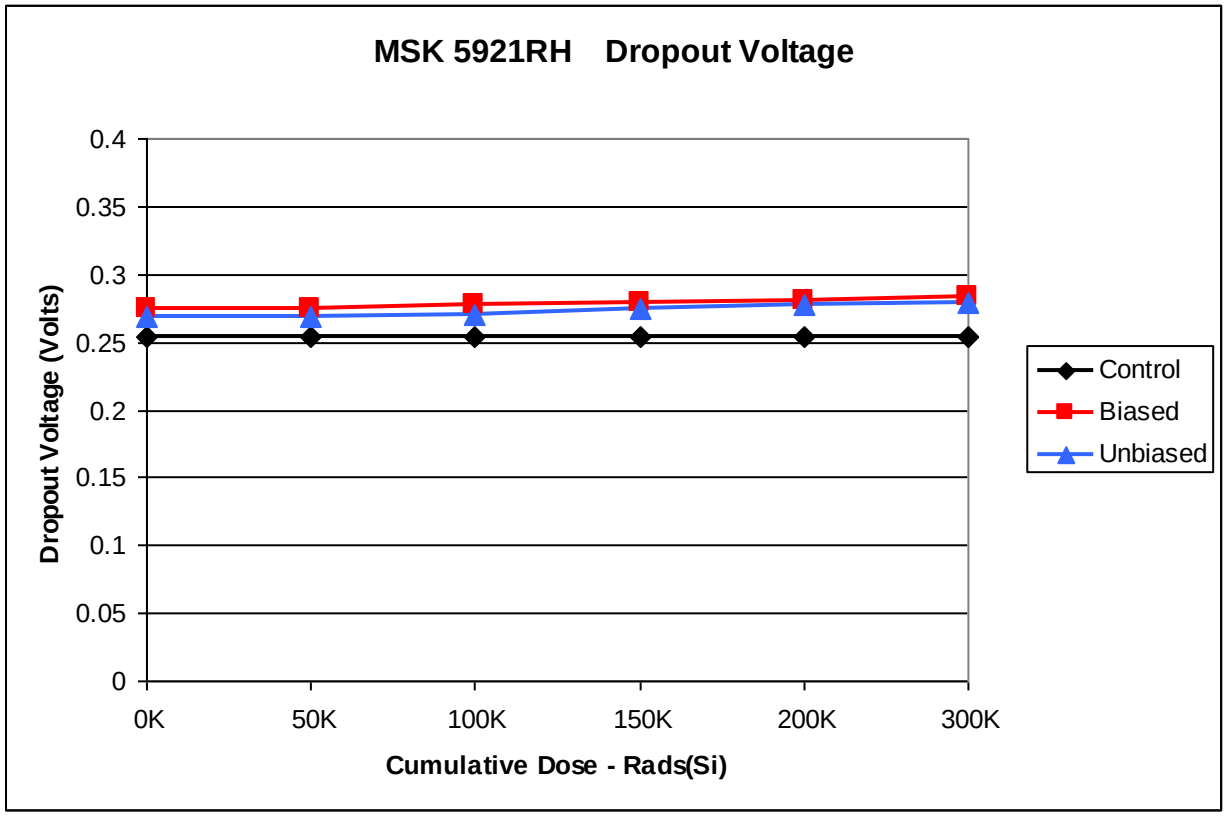
Table I
Dose Time, Incremental Dose and Total Cumulative Dose

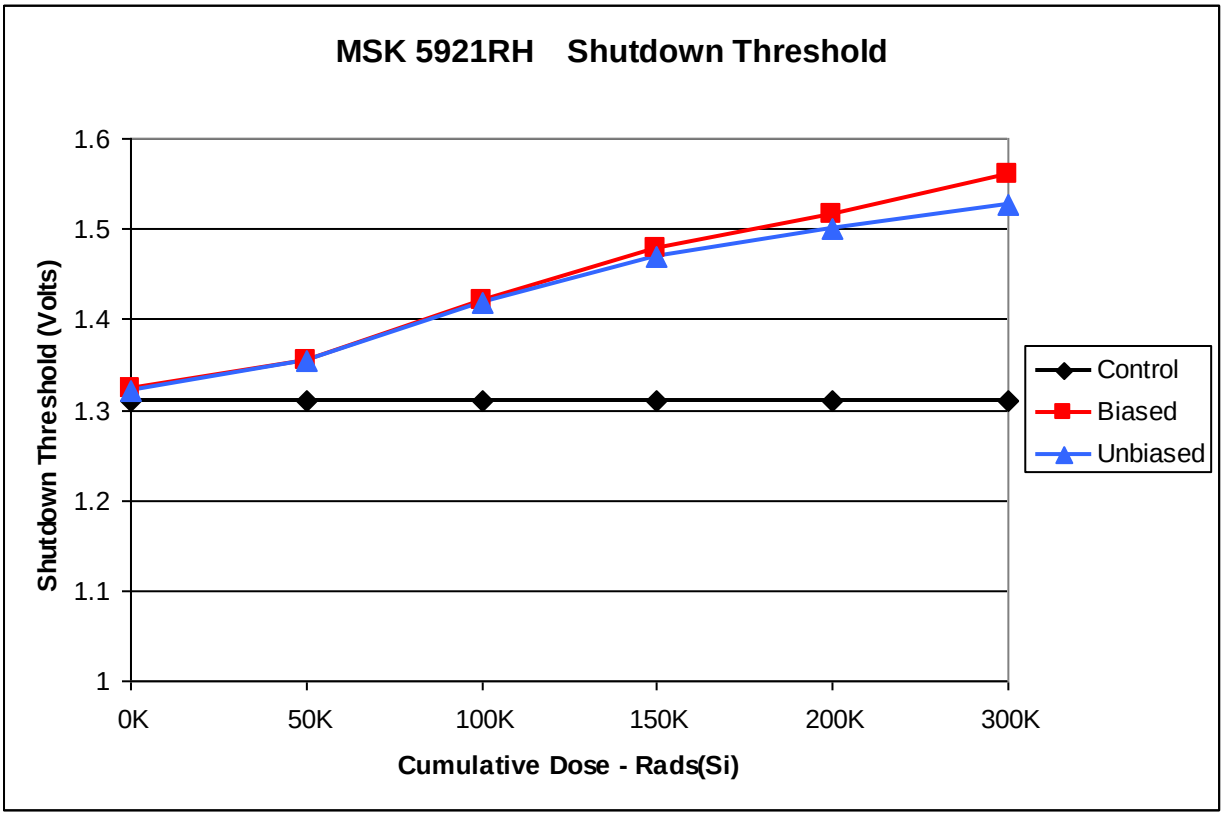


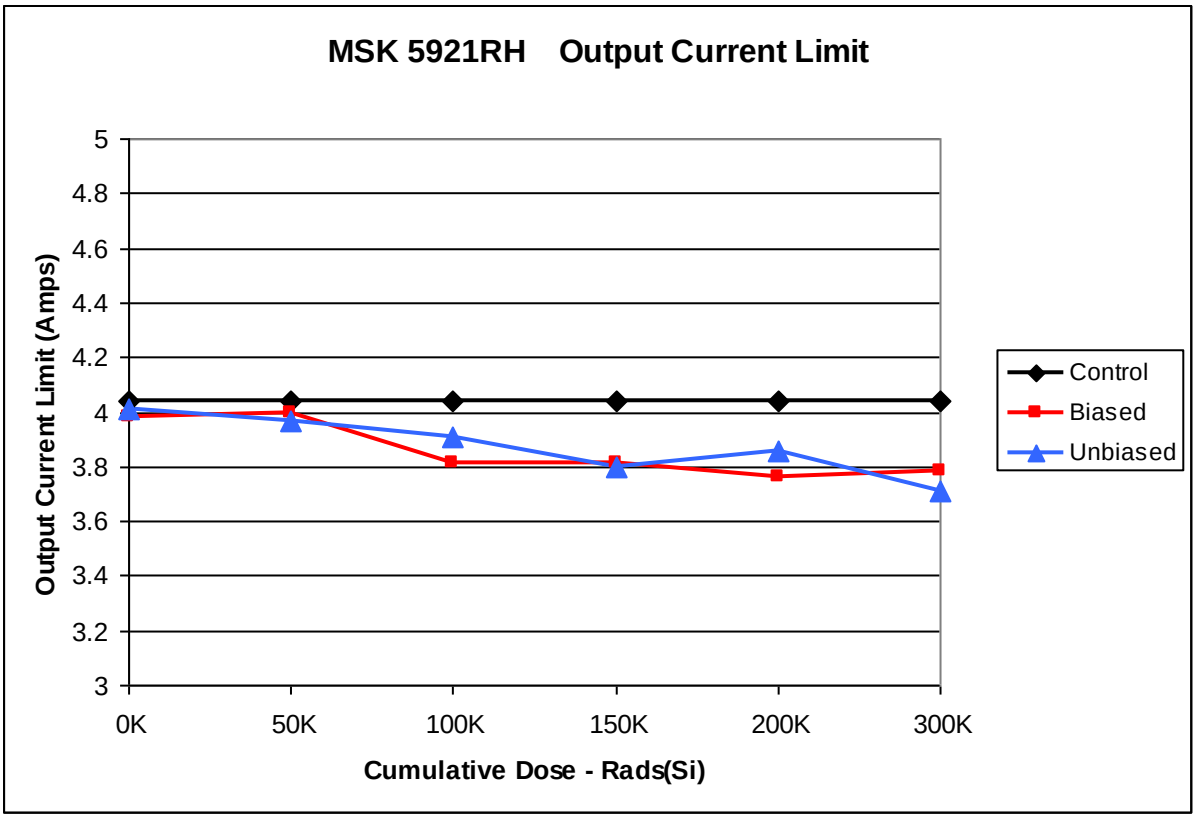

MSK 5921RH Feedback Voltage
Feedback Voltage (Volts)
1.32
1.31
1.3
1.29
1.28
1.27
1.26
1.25
1.24
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased


MSK 5921RH Line Regulation
Line Regulation (%)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased


MSK 5921RH Load Regulation
Load Regualtion (%)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased


MSK 5921RH Dropout Voltage
Dropout Voltage (Volts)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased


MSK 5921RH Shutdown Threshold
Shutdown Threshold (Volts)
1.6
1.5
1.4
1.3
1.2
1.1
1
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased


MSK 5921RH Output Current Limit
Output Current Limit (Amps)
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased

Total Dose Radiation Test Report

MSK 5920RH SERIES

Ultra Low Dropout Positive Linear Regulator

December 27, 2005 (First Test)
Updated July 31, 2006

B. Erwin
J. Swistak

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5920RH was developed to qualify the device as a radiation tolerant device to 100 KRADS(Si). The testing was performed to 300 KRAD to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the hybrid, but simply offers designers insight to the critical parameter-shifts up to the specified total dose level.

MIL-STD-883 Method 1019.6 and ASTM F1892-98 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5920RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and the dose rate was determined to be 134 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.

The devices were vertically aligned with the radiation source and enclosed in a lead/aluminum container during irradiation. Four devices were kept under bias during irradiation. Four devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted using conductive foam and were 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. At the conclusion of irradiation and testing all devices were subjected to a 160 hour anneal at 100°C. Electrical tests were then performed to determine the effects of annealing.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing the MSK 5920RH easily qualified as a 100 KRADS(Si) radiation tolerant device. Further analysis of the data shows the hybrid to offer good tolerance to total dose radiation to levels of 300 KRADS(Si).

The only test parameter that exceeded pre-irradiation test limits was output voltage tolerance. The test results showed a shift of approximately 3.6 percent at 300 Krad(Si). Post irradiation output voltage tolerance level is +/- 4.0 percent.

All other test parameters stayed within pre irradiation test limits throughout the irradiation process.

Annealing the devices resulted in a shift towards pre-irradiation test results. Output voltage tolerance measurements returned to within pre irradiation data sheet test limits.

An ELDRS test is planned for the future to determine the effects of low dose exposure

Dosimetry Equipment:
Bruker Biospin #0141

Dose Rate = 134 Rads(Si)/Sec

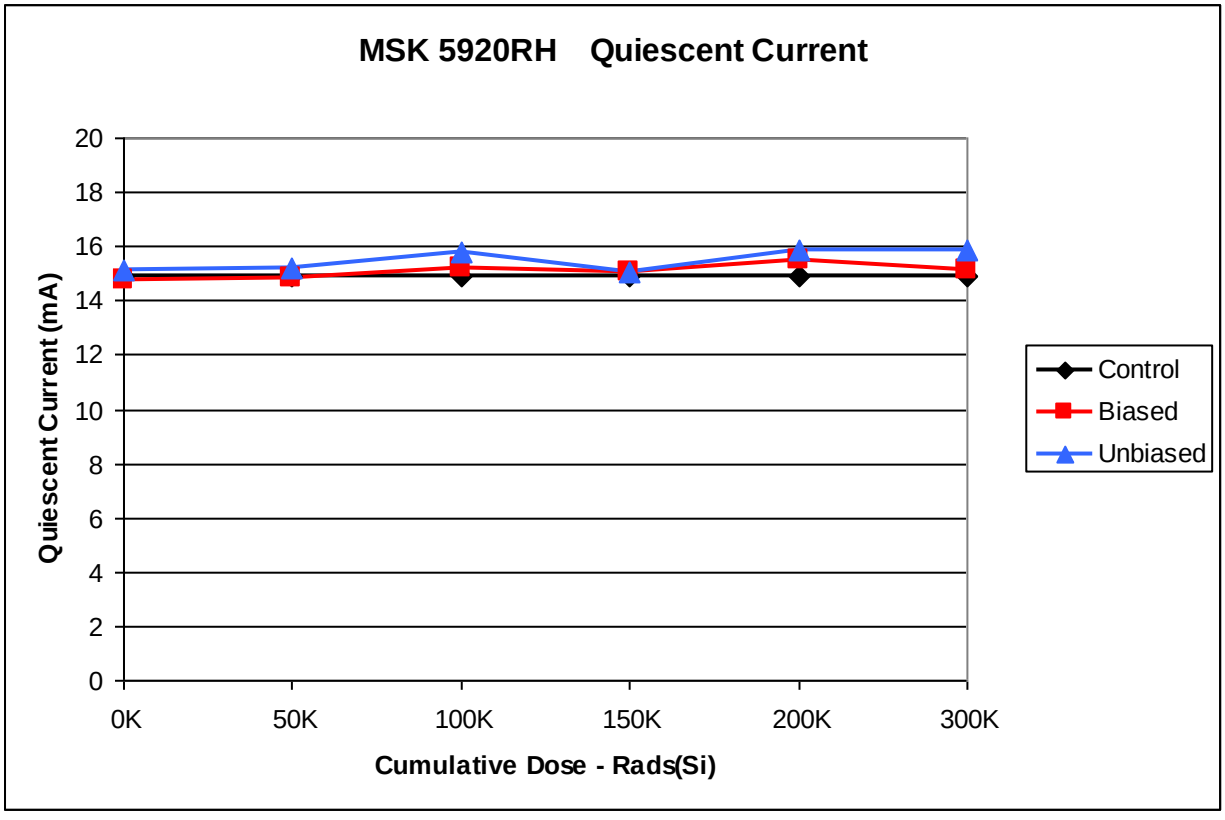
Testing Performed:
11/29/2005

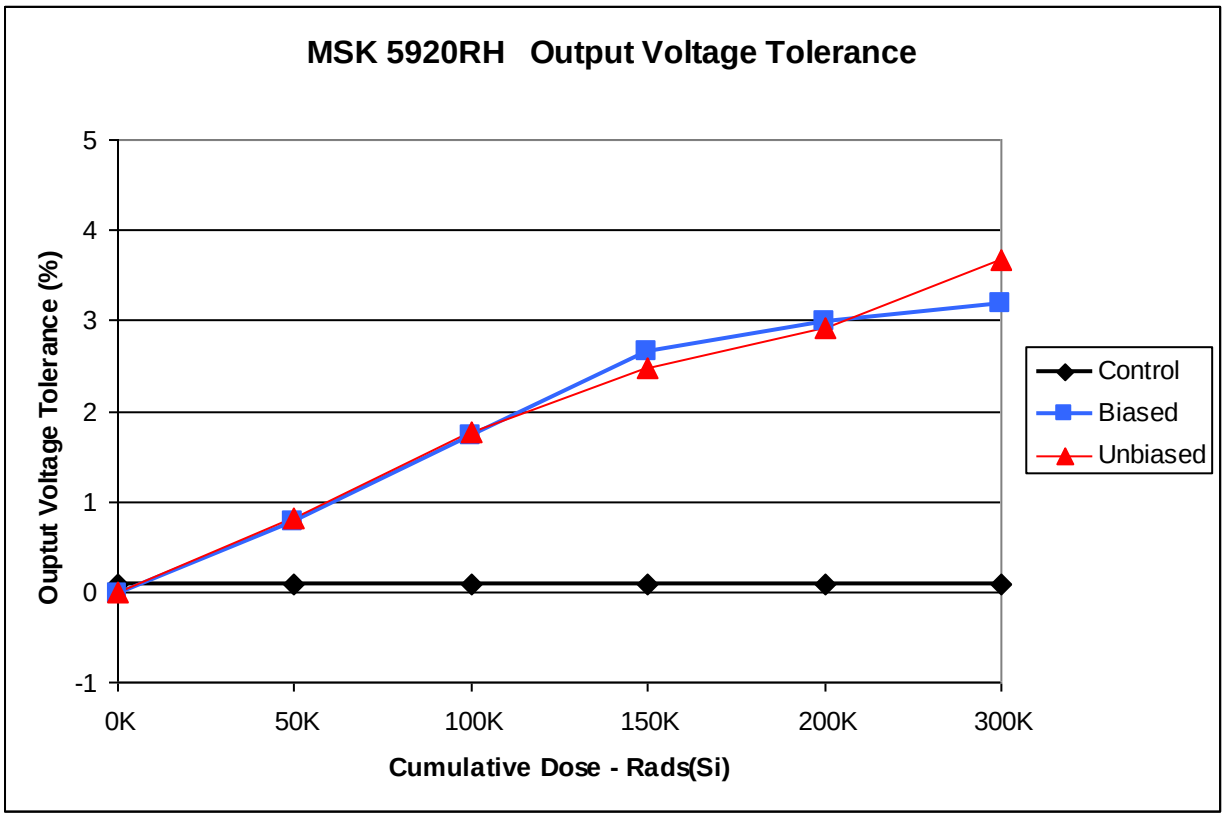
Biased MSK 5920RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
6:24	51,456	51,456
6:24	51,456	102,912
6:24	51,456	154,368
6:24	51,456	205,824
12:49	103,046	308,870

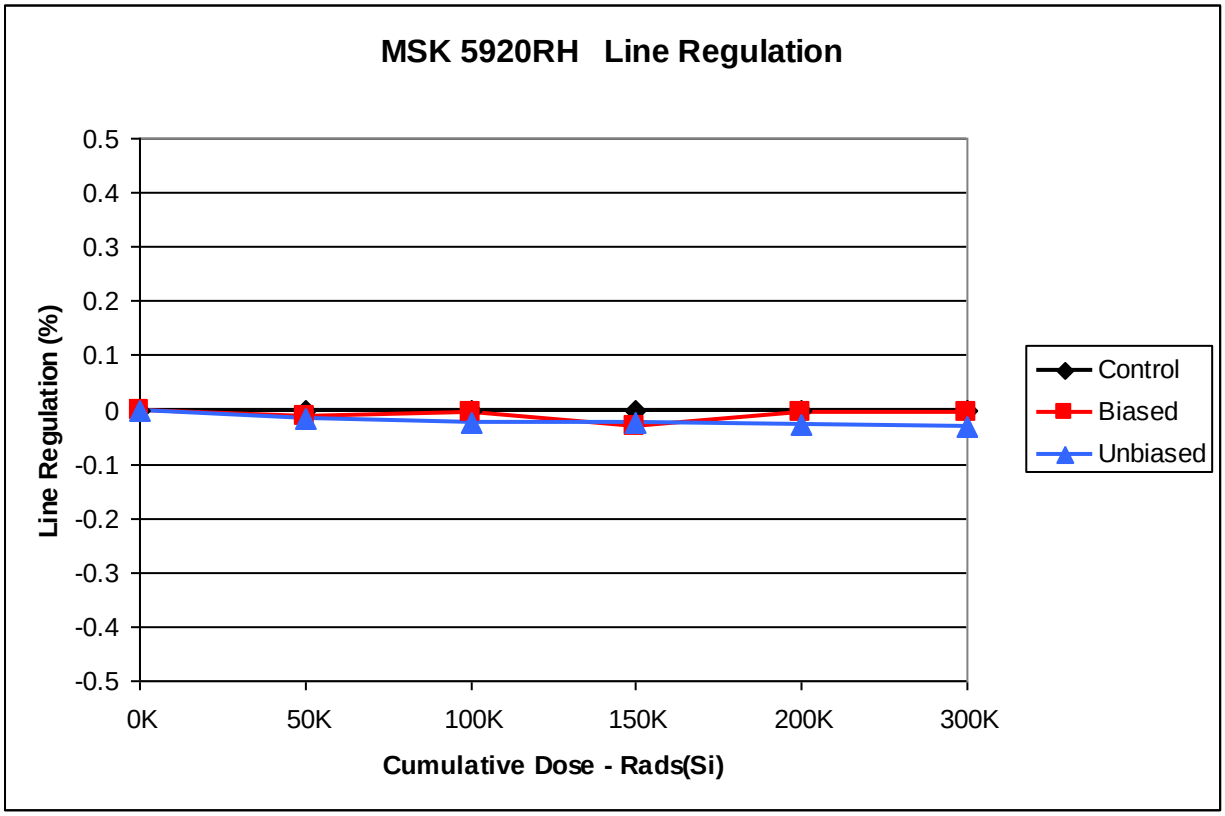
Unbiased MSK 5920RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
6:24	51,456	51,456
6:24	51,456	102,912
6:24	51,456	154,368
6:24	51,456	205,824
12:49	103,046	308,870

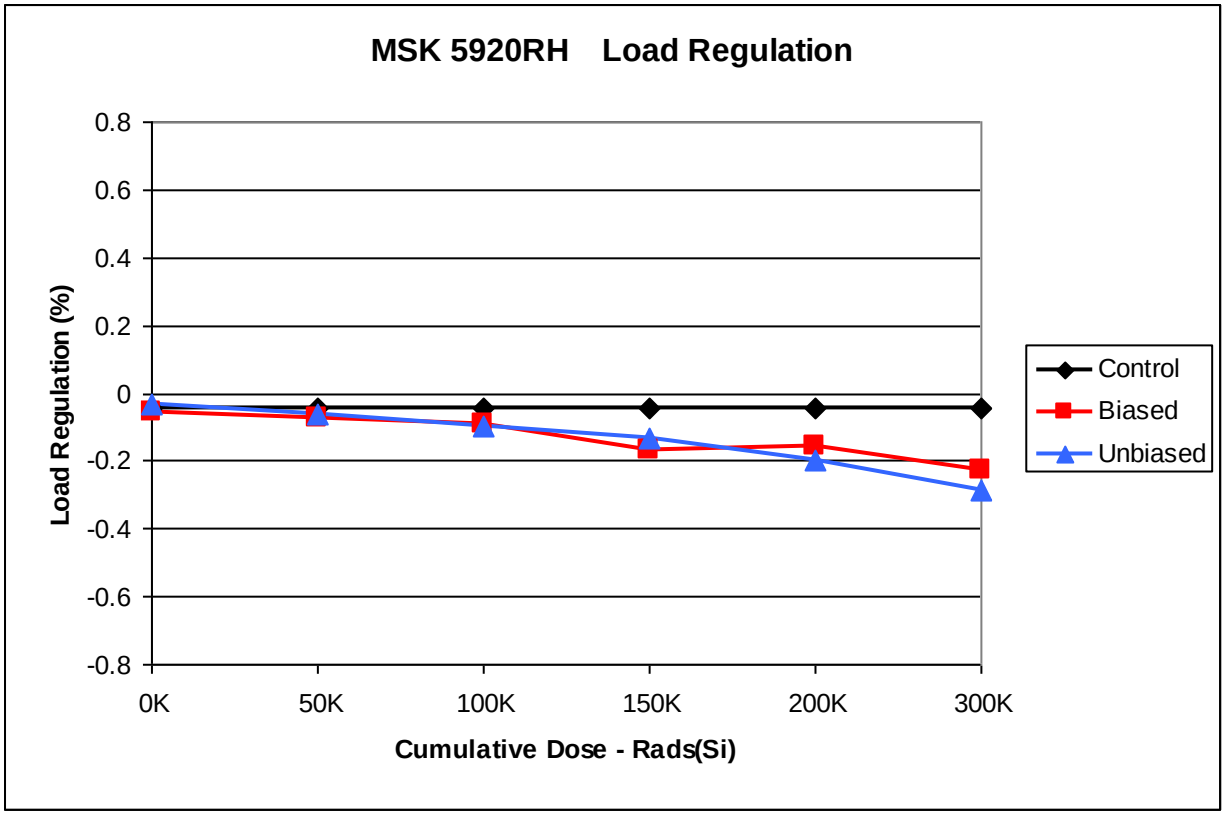
Table I

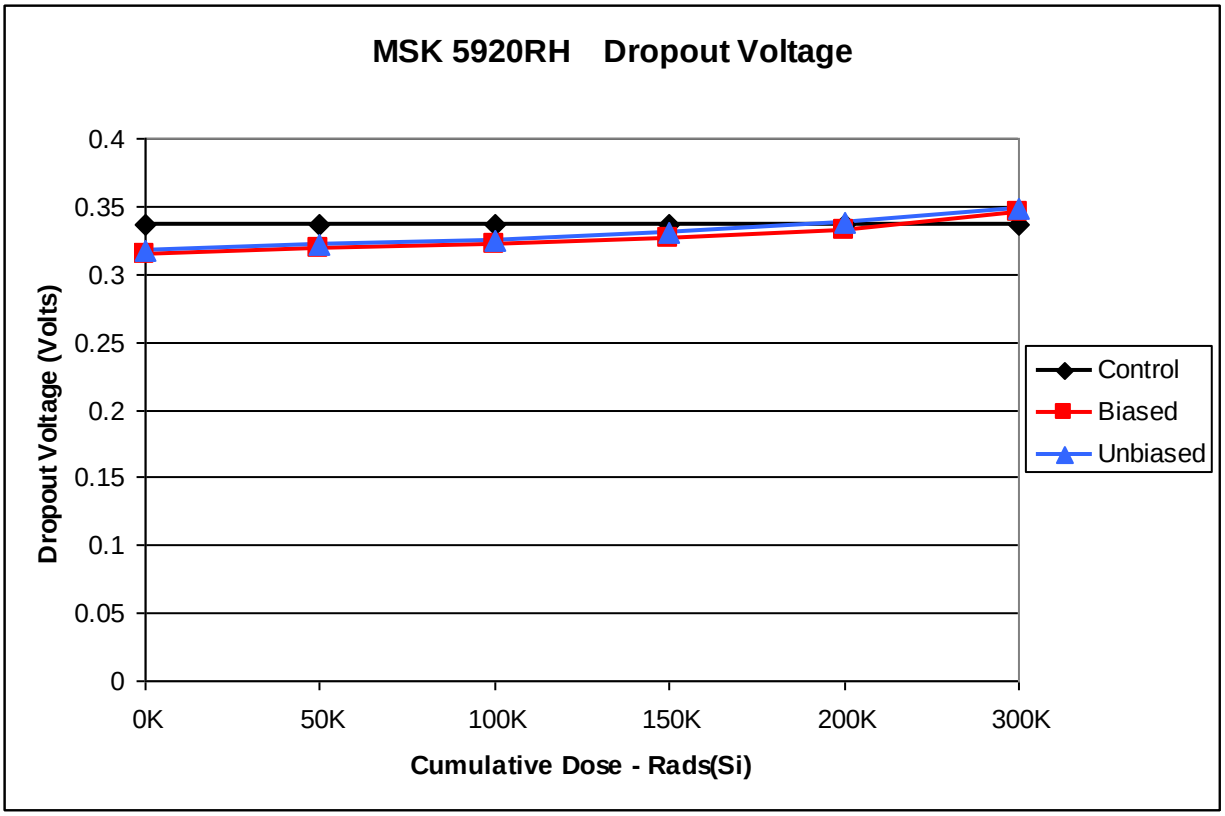
Dose Time, Incremental Dose and Total Cumulative Dose

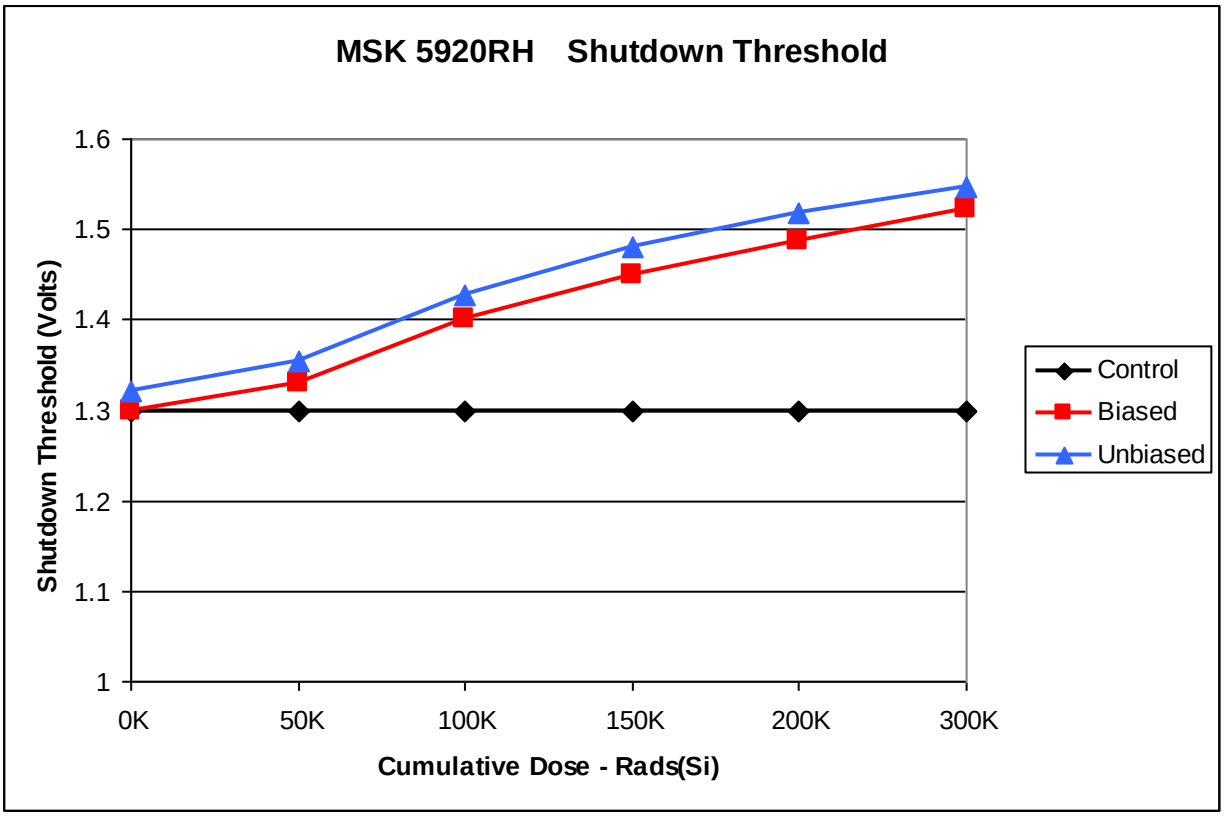


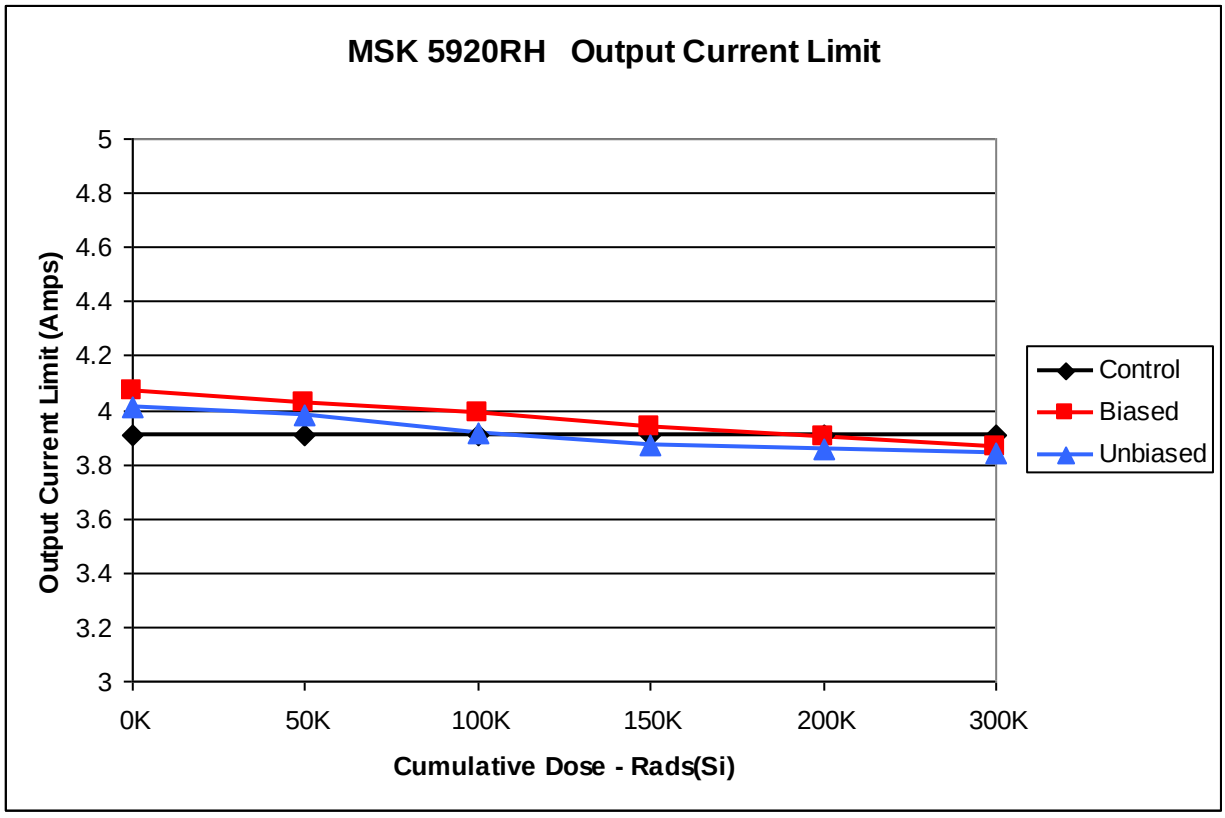

MSK 5920RH Output Voltage Tolerance
Ouptut Voltage Tolerance (%)
5
4
3
2
1
0
-1
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased


MSK 5920RH Line Regulation
Line Regulation (%)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased


MSK 5920RH Load Regulation
Load Regulation (%)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased


MSK 5920RH Dropout Voltage
Dropout Voltage (Volts)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased


MSK 5920RH Shutdown Threshold
Shutdown Threshold (Volts)
1.6
1.5
1.4
1.3
1.2
1.1
1
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased


MSK 5920RH Output Current Limit
Output Current Limit (Amps)
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
0K
50K
100K
150K
200K
300K
Cumulative Dose - Rads(Si)
Control
Biased
Unbiased

Total Dose Radiation Test Report

MSK 5910RH

Ultra Low Dropout Adjustable Positive Linear Regulator

May 17, 2005 (First Test)
Updated on July 31, 2006

B. Erwin
P. Musil

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK5910RH was developed to qualify the device as a radiation tolerant device to 100 KRADS(Si). The testing was performed up to 300 KRAD to show trends in device performance as a function of total dose.

MIL-STD-883 Method 1019.6 and ASTM F1892-98 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5910RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell, using a cobalt 60 radiation source. Thermo luminescence dosimetry was performed and the dose rate was determined to be 136 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. Eight 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. Four devices were kept under bias during irradiation. Four devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted and the devices were transported to the MSK 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. At the conclusion of irradiation and testing all devices were subjected to a 160 hour anneal at 125°C. Electrical tests were then performed to determine the effects of annealing.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing, the MSK 5910RH easily qualified as a 100 KRADS(Si) radiation tolerant device.

It should be noted that there was a slight positive shift in feedback voltage from 0 KRADS(Si) to 300 KRADS(Si).

All other test parameters stayed within pre-irradiation test limits throughout the irradiation process.

Annealing the devices resulted in a shift towards pre-irradiation test results. Feedback voltage measurements returned to within data sheet test limits.

An ELDRS test is planned for the future to determine the effects of Low Dose Rate Exposure.

Dosimetry Equipment: Bruker Biospin #0141

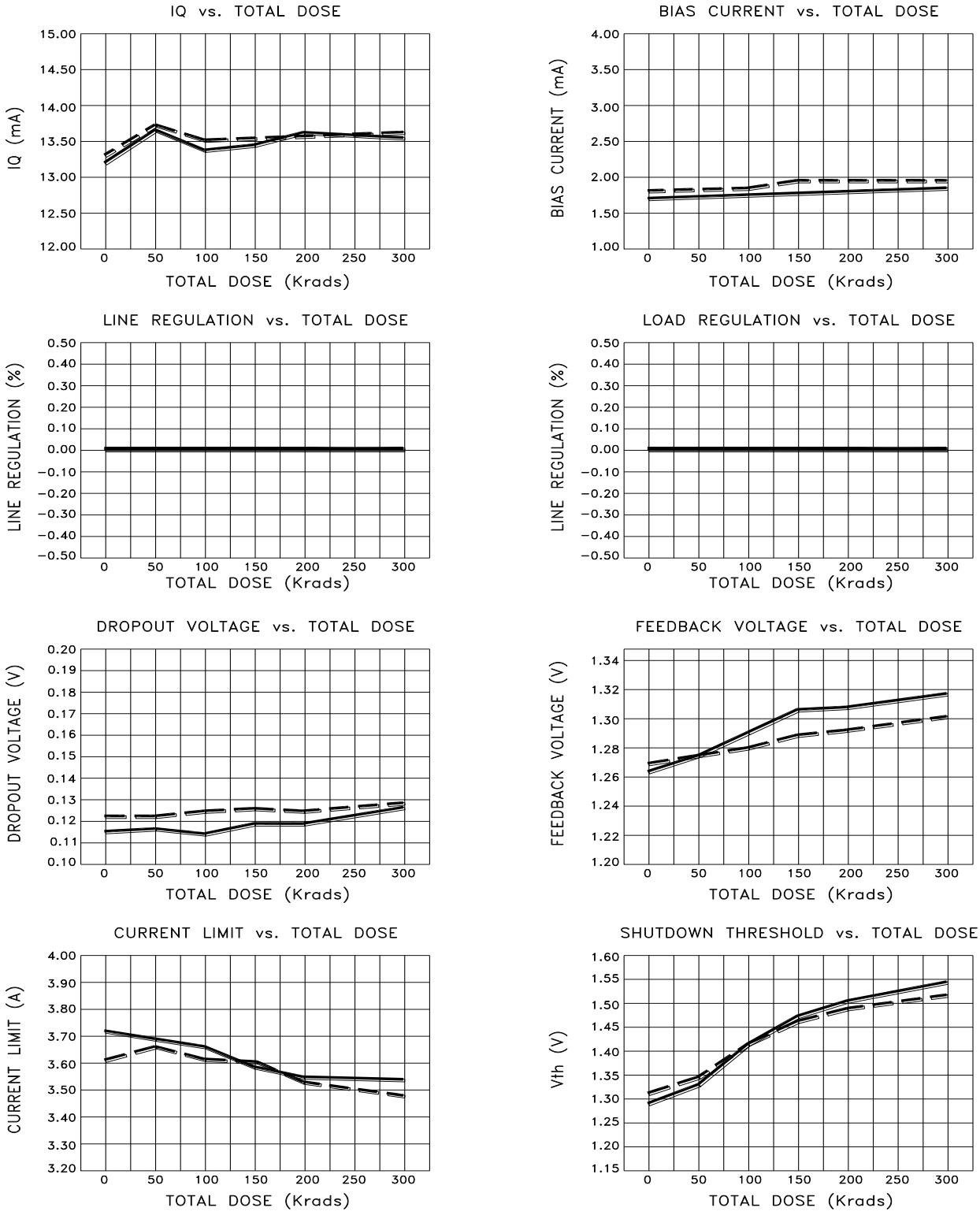
Dose Rate = 136 Rads(Si)/Sec

Testing Performed: 04/27/2005

Biased MSK 5910RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
6:19	51,430	51,430
6:19	51,430	102,860
6:19	51,430	154,290
6:19	51,430	205,720
12:38	102,861	308,581

Unbiased MSK 5910RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
6:19	51,430	51,430
6:19	51,430	102,860
6:19	51,430	154,290
6:19	51,430	205,720
12:38	102,861	308,581

Table I
Dose Time, Incremental Dose and Total Cumulative Dose


IQ vs. TOTAL DOSE
IQ (mA)
15.00
14.50
14.00
13.50
13.00
12.50
12.00
0 50 100 150 200 250 300
TOTAL DOSE (Krads)
BIAS CURRENT vs. TOTAL DOSE
BIAS CURRENT (mA)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0 50 100 150 200 250 300
TOTAL DOSE (Krads)
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
0 50 100 150 200 250 300
TOTAL DOSE (Krads)
LOAD 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
0 50 100 150 200 250 300
TOTAL DOSE (Krads)
DROPOUT VOLTAGE vs. TOTAL DOSE
DROPOUT VOLTAGE (V)
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0 50 100 150 200 250 300
TOTAL DOSE (Krads)
FEEDBACK VOLTAGE vs. TOTAL DOSE
FEEDBACK VOLTAGE (V)
1.34
1.32
1.30
1.28
1.26
1.24
1.22
1.20
0 50 100 150 200 250 300
TOTAL DOSE (Krads)
CURRENT LIMIT vs. TOTAL DOSE
CURRENT LIMIT (A)
4.00
3.90
3.80
3.70
3.60
3.50
3.40
3.30
3.20
0 50 100 150 200 250 300
TOTAL DOSE (Krads)
SHUTDOWN THRESHOLD vs. TOTAL DOSE
Vth (V)
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
0 50 100 150 200 250 300
TOTAL DOSE (Krads)
AVERAGE BIASED
AVERAGE GND

Total Dose Radiation Test Report

MSK 5900RH

Ultra Low Dropout Adjustable Positive Linear Regulator

December 20, 2004 (First Test)
Updated on July 31, 2006

B. Erwin
J. Swistak

M.S. Kennedy Corporation
Liverpool, NY

I. Introduction:

The total dose radiation test plan for the MSK 5900 RH was developed to qualify the device as a radiation tolerant device to 100 KRADS(Si). The testing was performed beyond 100 KRAD to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the hybrid, but simply offers designers insight to the critical parameter-shifts up to the specified total dose level.

MIL-STD-883 Method 1019.6 and ASTM F1892-98 were used as guidelines in the development and implementation of the total dose test plan for the MSK 5900RH.

II. Radiation Source:

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

III. Test Setup:

All test samples were subjected to Group A Electrical Test in accordance with the device data sheet. In addition, all devices received 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. Seven 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. Three devices were kept under bias during irradiation. Four devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation the device leads were shorted using foil lined carriers and were 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. At the conclusion of irradiation and testing all devices were subjected to a 160 hour anneal at 100°C. Electrical tests were then performed to determine the effects of annealing.

IV. Data:

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

V. Summary:

Based on the test data recorded during radiation testing the MSK 5900RH easily qualified as a 100 KRADS(Si) radiation hardened device. Further analysis of the data shows the hybrid to offer tolerance to total dose radiation to levels of 300 KRADS(Si).

It should be noted that there was a slight positive shift in feedback voltage from 0 KRADS(Si) to 300 KRADS(Si). The shift amounts to approximately 3.5% at 300 KRADS(Si).

All other test parameters stayed within pre-irradiation test limits throughout the irradiation process.

Annealing the devices resulted in a shift towards pre-irradiation test results. Feedback voltage measurements at all conditions returned to within data sheet test limits.

An ELDRS test is planned for the future to determine the effects of low dose rate exposure.

Dosimetry Equipment: Bruker Biospin #0141

Dose Rate = 151 Rads(Si)/Sec

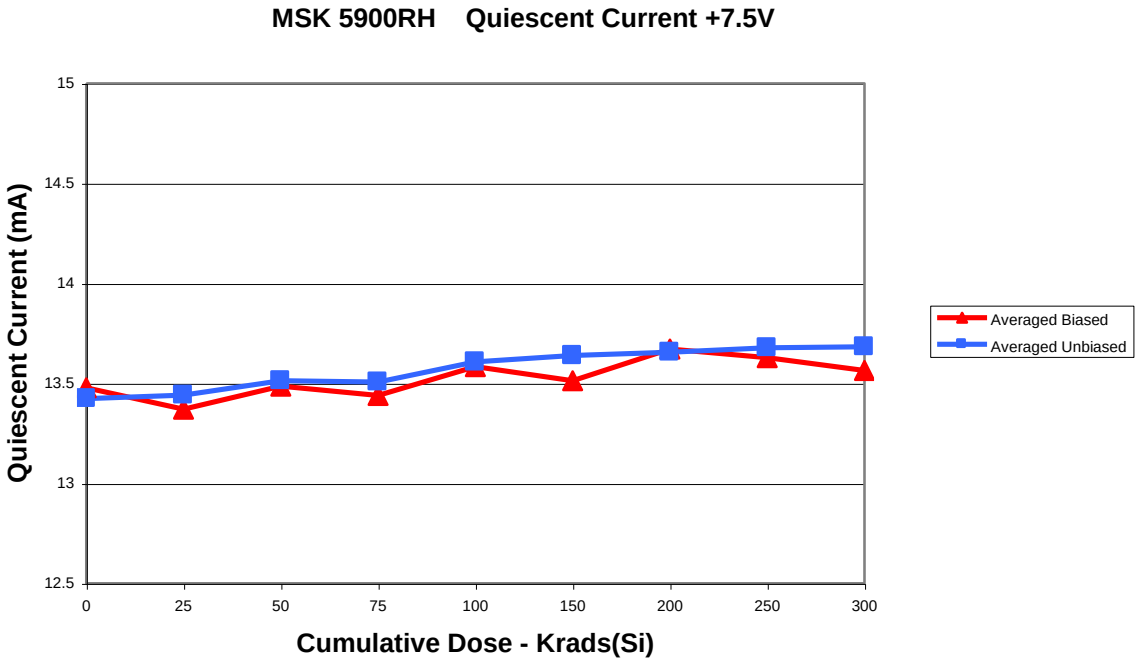
Testing Performed: 11/17/2004

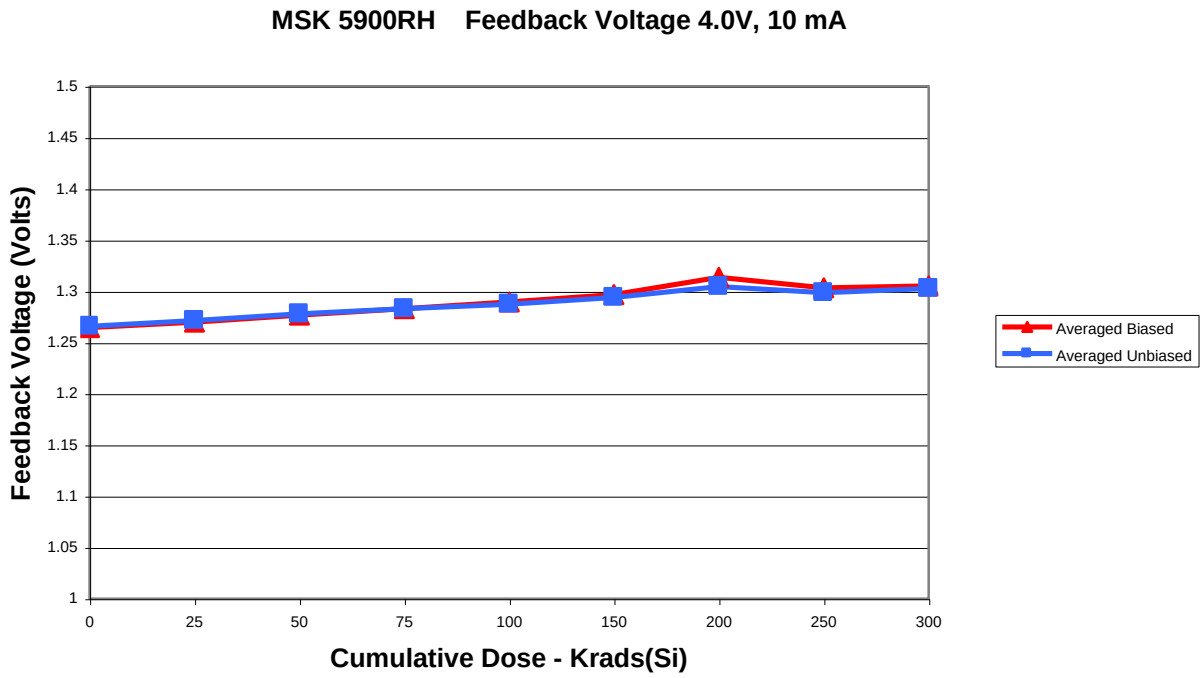
Biased MSK 5900RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
2:50	25,670	25,670
2:50	25,670	51,340
2:50	25,670	77,010
2:50	25,670	102,680
5:40	51,340	154,020
5:40	51,340	205,360
5:40	51,340	256,700
5:40	51,340	308,040

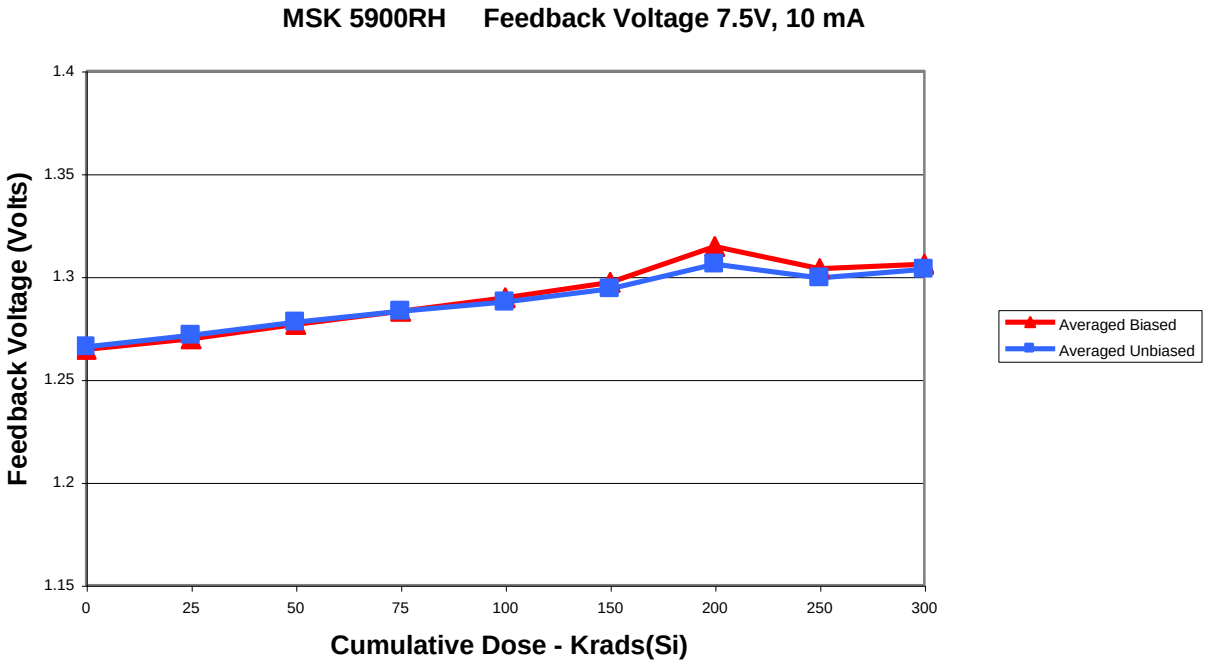
Unbiased MSK 5900RH		
Dose Time (min:sec)	Incremental Dose Rads(Si)	Cumulative Dose Rads(Si)
2:50	25,670	25,670
2:50	25,670	51,340
2:50	25,670	77,010
2:50	25,670	102,680
5:40	51,340	154,020
5:40	51,340	205,360
5:40	51,340	256,700
5:40	51,340	308,040

Table I

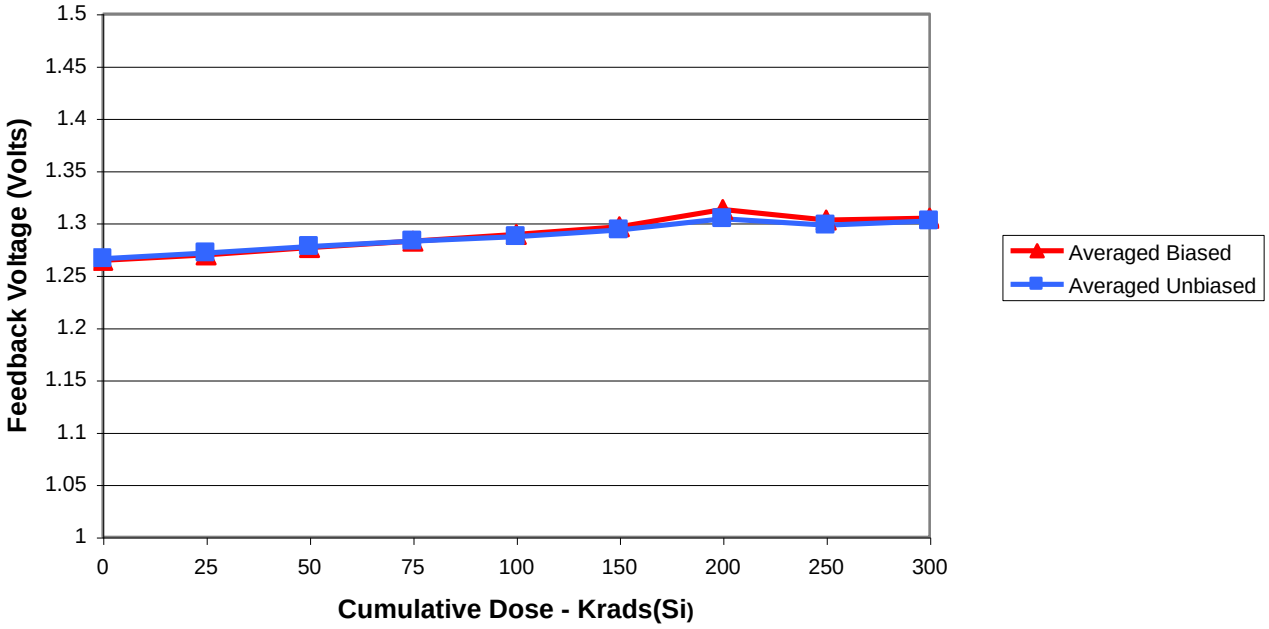
Dose Time, Incremental Dose and Total Cumulative Dose



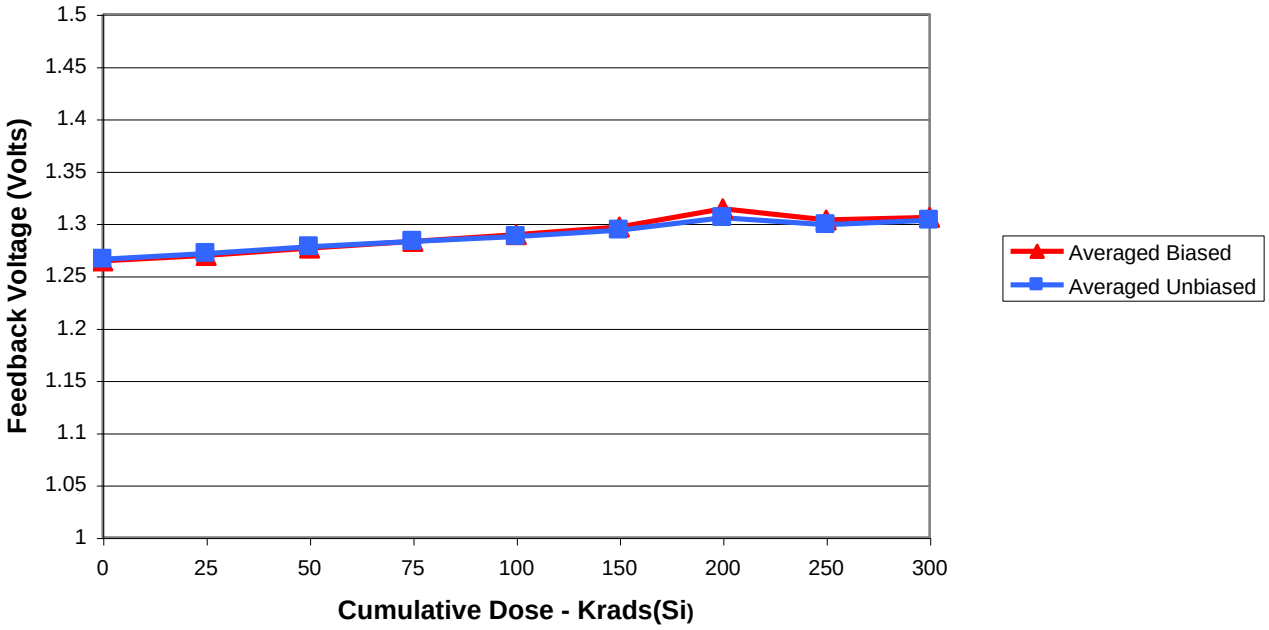

MSK 5900RH Feedback Voltage 4.0V, 10 mA
Feedback Voltage (Volts)
1.5
1.45
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
0
25
50
75
100
150
200
250
300
Cumulative Dose - Krads(Si)
Averaged Biased
Averaged Unbiased


MSK 5900RH Feedback Voltage 7.5V, 10 mA
Feedback Voltage (Volts)
1.4
1.35
1.3
1.25
1.2
1.15
0
25
50
75
100
150
200
250
300
Cumulative Dose - Krads(Si)
Averaged Biased
Averaged Unbiased

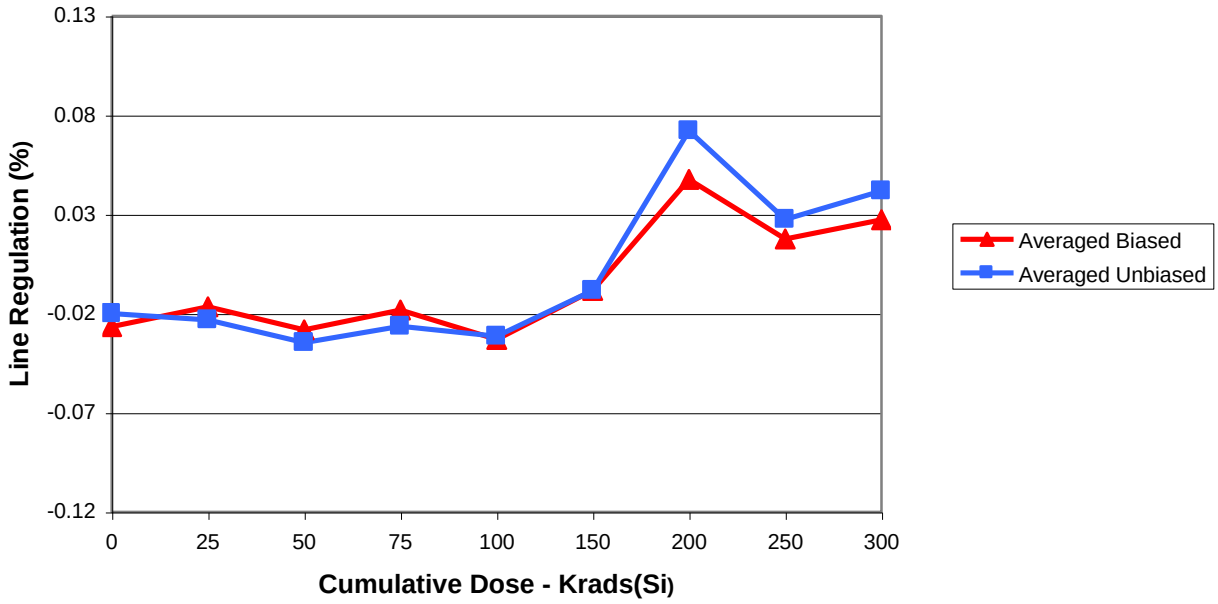
MSK 5900RH Feedback Voltage 4.0V, 1 A



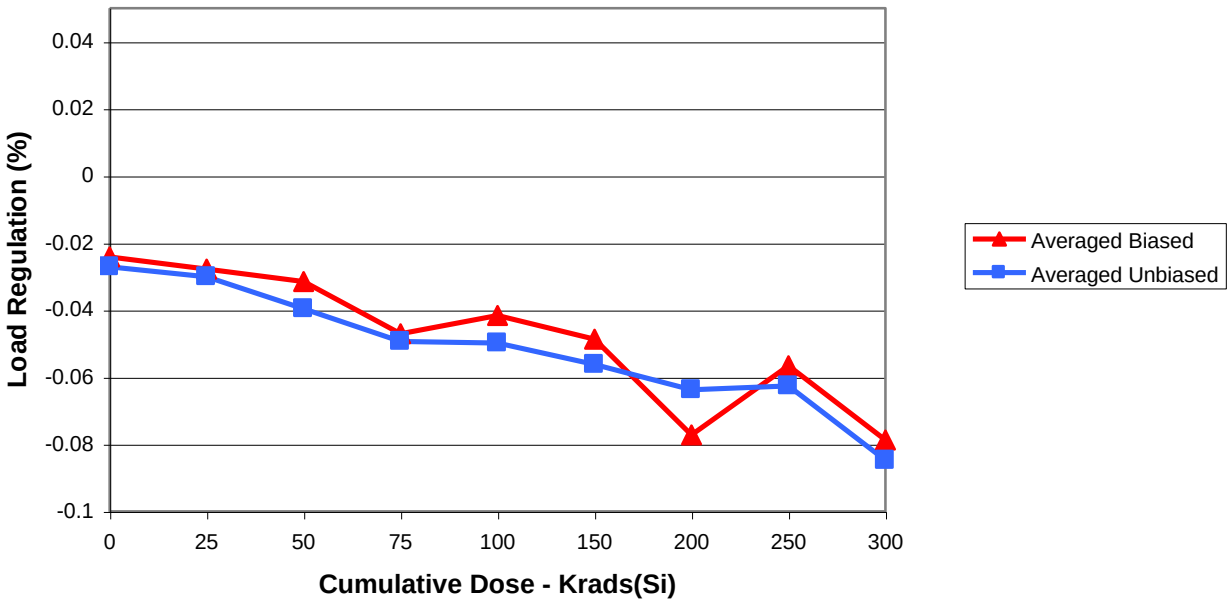
MSK 5900RH Feedback Voltage 7.5V, 1 A



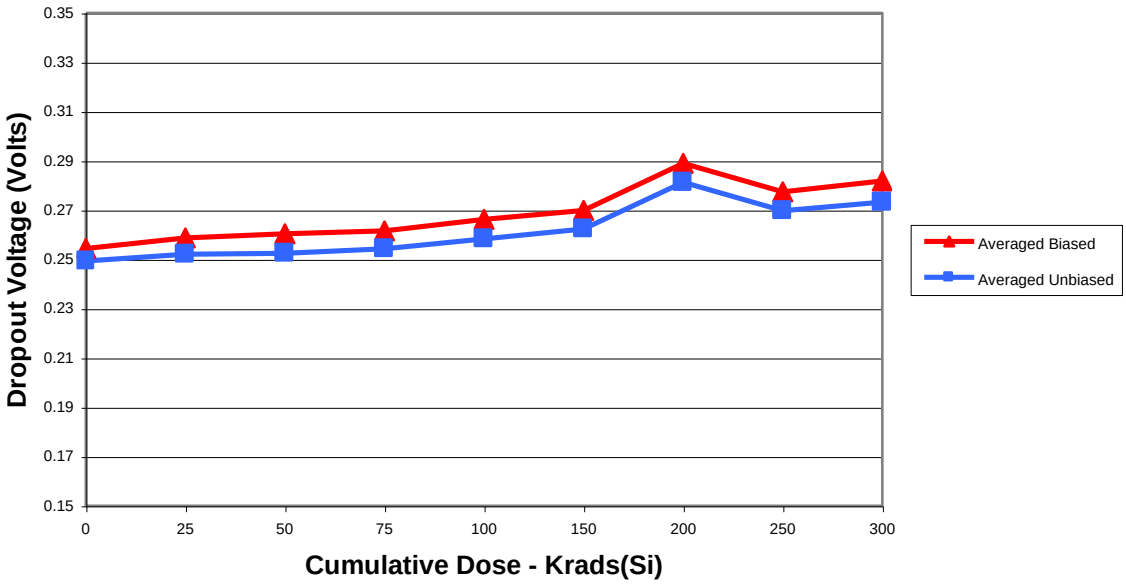
MSK 5900RH Line Regulation 2.8V - 7.5V



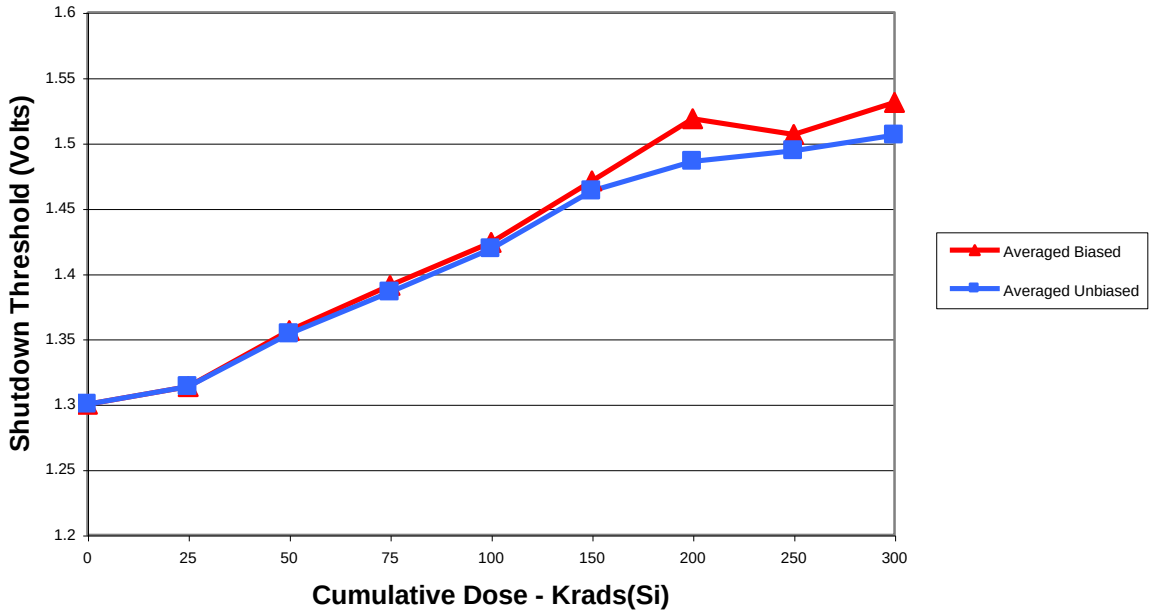
MSK 5900RH Load Regulation 10 mA - 1A



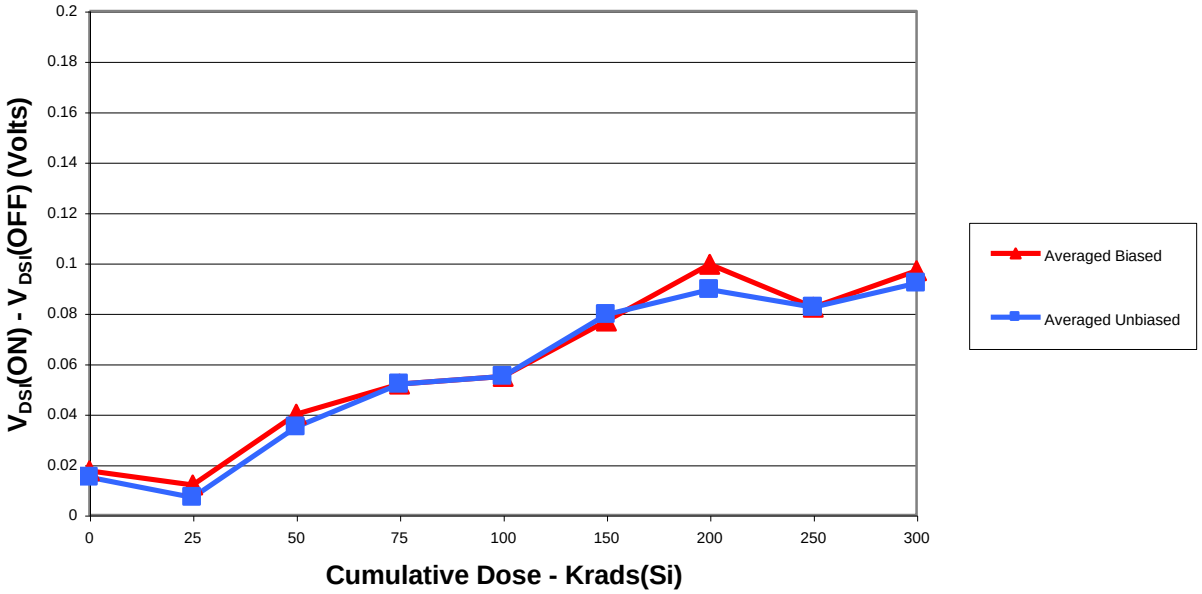
MSK 5900RH Dropout Voltage Vfb Delta = 1%



MSK 5900RH Shutdown Threshold



MSK 5900RH Shutdown Hysterisis



MSK 5900RH Output Current Limit