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A radiation evaluation was performed on SI9110AK to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through IV and Figure 1.

The total dose testing was performed using a cobalt-60 gamma ray source. During the radiation testing, eight parts were irradiated under bias (see Figure 1 for bias configuration), and two parts were used as control samples. The total dose radiation steps were 2.5, 5, 7.5, 10, 15, 20, 30, 50, 75 and 100 krad. After 100 krad, parts were annealed at 25°C for 48 and 168 hours. The dose rate was between 0.07 - 1.25 krad/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits listed in Table III.

All parts except two (SNs 62 and 63) passed all tests on irradiation up to 10 krad. The failures of SNs 62 and 63 were marginal, as these parts showed lower readings than the minimum specification limit for Error Amp VFB and Error Amp Source Current, at 7.5 krad and 10 krad respectively. At the following radiation steps of 15 and 20 krad, all (8) parts showed degradation of Error Amp VFB, Error Amp Source Current, and Supply Current beyond the specified limits. After 30 krad, parts failed to meet the specification limits on the following parameters: Oscillator Accuracy, Oscillator Voltage Stability, Error Amp AVOL, Error Amp Source/Sink, PreRegulator Input Leakage, Supply Current and Output High Voltage.

Parts continued to degrade more and more with increasing radiation exposures. At 50 krad, the oscillator accuracy measurements on all parts were 0kHz. A zero reading on this parameter indicates that the oscillator and the output sections were not functioning correctly. The failure of these sections was
also evident from the fact that no rise time measurements could be made on some parts after 50 krads of radiation exposure. The degradation in parts continued at 75 and 100 krads, with parts failing a large number of the parametric measurements, including Reference Output Voltage, Maximum Oscillator Frequency, Oscillator Accuracy, Oscillator Stability, VFB, I source/sink, Current Limit Threshold Voltage, Input Leakage, Turn Off Threshold Voltage, Under Voltage Lockout, Supply Current, VOH, and Output Rise Time.

Parts showed partial recovery on annealing for 48 and 168 hours, but the recovery was not enough to bring the failing parameters within the specification limits. Table IV provides the mean and standard deviation values for each parameter after different radiation exposures and annealing treatments.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at 731-8954.
<table>
<thead>
<tr>
<th><strong>TABLE I. Part Information</strong></th>
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<tbody>
<tr>
<td><strong>Generic Part Number:</strong></td>
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<td><strong>SMEX Common Buy Part Number:</strong></td>
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<tr>
<td><strong>SMEX Common Buy Control Number:</strong></td>
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<tr>
<td><strong>Manufacturer:</strong></td>
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<td><strong>Lot Date Code:</strong></td>
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<tr>
<td><strong>Serial Numbers of Radiation Samples:</strong></td>
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<td><strong>Serial Numbers of Control Samples:</strong></td>
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<td><strong>Part Function:</strong></td>
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<td><strong>Part Technology:</strong></td>
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TABLE II. Radiation Schedule

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<tr>
<td>1) Initial Electrical Measurements</td>
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<td>2) 2.5 krads irradiation @ 125 rads/hr Post 2.5 krads Electrical Measurements</td>
<td>12/10/90</td>
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<td></td>
<td>12/11/90</td>
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<tr>
<td>3) 5.0 krads irradiation @ 125 rads/hr Post 5.0 krads Electrical Measurements</td>
<td>12/11/90</td>
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<td>12/12/90</td>
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<tr>
<td>4) 7.5 krads irradiation @ 125 rads/hr Post 7.5 krads Electrical Measurements</td>
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<tr>
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<td></td>
<td>12/14/90</td>
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<tr>
<td>6) 15 krads irradiation @ 73 rads/hr Post 15 krads Electrical Measurements</td>
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<td></td>
<td>12/17/90</td>
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<tr>
<td>7) 20 krads irradiation @ 250 rads/hr Post 20 krads Electrical Measurements</td>
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<tr>
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<td>12/19/90</td>
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<tr>
<td>9) 50 krads irradiation @ 1000 rads/hr Post 50 krads Electrical Measurements</td>
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<tr>
<td></td>
<td>12/20/90</td>
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<td>12/21/90</td>
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<td>12) 48 hrs annealing Post 48 hr Electrical Measurements</td>
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<td>13) 168 hrs annealing Post 168 hr Electrical Measurements</td>
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<td>12/31/90</td>
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Notes:
- All parts were radiated under bias at the cobalt-60 gamma ray facility at GSFC.
- All electrical measurements were performed off-site at 25°C.
- Annealing was performed at 25°C under bias.
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<tr>
<th>Test</th>
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<td>Reference Short Circuit Current (ISC)</td>
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<td>Maximum Oscillator Frequency (Max Freq)</td>
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<td>5.0MHz</td>
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<td>Initial Oscillator Accuracy (Osc. Acc.)</td>
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<td>10.0%</td>
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<td>3.95V</td>
<td>4.04V</td>
</tr>
<tr>
<td>Error Amp IBIAS</td>
<td>0.0nA</td>
<td>500nA</td>
</tr>
<tr>
<td>Error Amp AVOL</td>
<td>60.0dB</td>
<td>200.0dB</td>
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<td>Error Amp ISOURCE</td>
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<td>14.0mA</td>
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<td>Error Amp ISTNK</td>
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<td>1.2mA</td>
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<td>200.0dB</td>
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<td>Current Limit Threshold Voltage (VCLT)</td>
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<td>1.4V</td>
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<td>PreRegulator Input Leakage (IIL)</td>
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<td>Undervoltage Lockout (VLKOUT)</td>
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<td>Supply Current (ICC)</td>
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<td>1.0mA</td>
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<tr>
<td>Supply Bias Current (IBIAS)</td>
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<td>50.0uA</td>
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<td>5.0uA</td>
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<tr>
<td>Shutdown IIL (IIL1)</td>
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<td>35.0uA</td>
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<td>5.0uA</td>
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<tr>
<td>Reset IIL (IIL2)</td>
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<td>Output Low Voltage (VOL)</td>
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Table IV. Summary of Electrical Measurements after Total Dose Exposures and Aging for SI9110AK

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<th>Parameters</th>
<th>Spec. Limits</th>
<th>Initials</th>
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<td>V</td>
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<td>112</td>
<td>2</td>
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<td>2</td>
<td>110</td>
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<td>104</td>
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<td>1.0</td>
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<td>150</td>
<td>10</td>
<td>150</td>
<td>10</td>
<td>150</td>
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<tr>
<td>* AVOL</td>
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<td>152</td>
<td>1</td>
<td>152</td>
<td>1</td>
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<td>1.4</td>
<td>.2</td>
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<td>.0</td>
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<td>.0</td>
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<tr>
<td>* PSRR</td>
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<td>47</td>
<td>3</td>
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<td>1.4</td>
<td>.0</td>
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<td>11.0</td>
<td>1.0</td>
<td>11.0</td>
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* At 50 krad and above, oscillator accuracy readings varied from 0 to 500 kHz. A zero reading implies that the part would not oscillate under the measurement conditions of this test, and is indicative of functional failure of the oscillator and output sections.

** No rise time measurements could be made on several parts at 50 krad and above. This is indicative of functional failure of the oscillator section of the parts.
<table>
<thead>
<tr>
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<th>Spec. Limits</th>
<th>Total Dose (krads)</th>
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<td></td>
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<tr>
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<tr>
<td>Volt. Stab.</td>
<td>%</td>
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<td>10.0</td>
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<tr>
<td>Error Amp VFB V</td>
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<td>4.04</td>
<td>3.65</td>
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Notes:
1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

*** No VOH measurements could be made on several parts at 75 krads and above.
Figure 1. Radiation Bias Circuit for SI9110AK

NOTES:  
R1 = 330 kΩ, 1/4 W  
R2 = 1 kΩ, 2 W  
R3 = 1 kΩ, 2 W  
R4 = 10 kΩ, 1/4 W  
C1 = 0.1 µF, 50 V  

All resistors are ±10% tolerance.