Low Dose Rate TID Test of Commercial Bipolar Op Amp

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Abstract: My summer internship involved Total Ionizing Dose (TID) tests at the GSFC radiation chamber. The tests were performed using a TLE2022 Bipolar op amp as the Device Under Test (DUT). The DUT was subject to a Cobalt 60 source at a Low Dose Rate (LDR). The main values observed were the input bias current, supply current, voltage offset, and current offset. The implication from the results support that the device has characteristics of radiation hardened.

Introduction

Once Flight Projects leave the Earth's atmosphere they are exposed to various doses of radiation. During this project we evaluated a single electrical component, which would go into an integrated circuit. The circuit could be part of a future flight project. By replicating the incident by means of a Low Dose Rate (LDR) test, we can determine if the component will be a good candidate for a potential flight project.

Back in 1996, a similar commercial duel op amp was tested at GSFC - FET facility. The device was tested and passed up to 10krads at a low dose rate between .05 mrads/s and .35 mrads/s.

The purpose of this experiment was to determine if the increased speed, lower power consumption, precision, and the newly developed Excalibur process would affect the device after being subjected to only a Total Ionizing Dose (TID) test. Also we wanted to increase the total amount of radiation the op amp would be exposed to 30krads. It is a known problem that op amp devices have a tendency to draw too much current, which often causes it to exceed its specification and/or fail after being exposed to a TID test.

Device Under Test (DUT)

Generic Part Number	TLE2022
Full Part Number	TLE2022BM
Manufacturer	Texas Instrument
Lot Date Code (LDC)	0947A
Quantity tested	8, with two control
Part Function	Duel Op Amp
Part Technology	Excalibur Bipolar Process
Package Style	8 pin CER-DIP
Manufacturer Datasheet	TLE202xB

Table 1: TLE2022 Test Data.

Figure 2: Photo of TLE2022B Op Amp

Parameter	Condition	Min.	Typical	Max.	Units
V_{in} (Input Offset)	V_{dd}=5V, V_{ss}=-5V (1)			250	uV
I_{in} (Input Offset Current)	V_{dd}=5V, V_{ss}=-5V, V_{in}=0V (1)		.3	6	nA
I_{in} (Input bias Current)	V_{dd}=5V, V_{ss}=-5V, V_{in}=0V (1)		30	70	nA
I_{ss} (Supply Current)	V_{dd}=5V, V_{ss}=-5V		450	600	uA

Table 1: Parameter For TLE2022B at 25°C

Test Method

We tested eight devices. Four devices were tested in an application specific bias condition and the other four devices were tested with all pins grounded. The devices were irradiated at a rate of 20 mRad/s at the Goddard Space Flight Center(GSFC) Radiation Effect Field (REF) for 17-20 days. A power supply voltage of 5V was used for the biased parts. The parts were irradiated between 2 to 5 krads. Two devices were held as controls. The goal was to get each part to receive a total dose of approximately 30 Krads. After each dose step, each DUT was tested on the Keithley 4200 Parameter Analyzer in a closed lid test, on a HP Test Fixture.

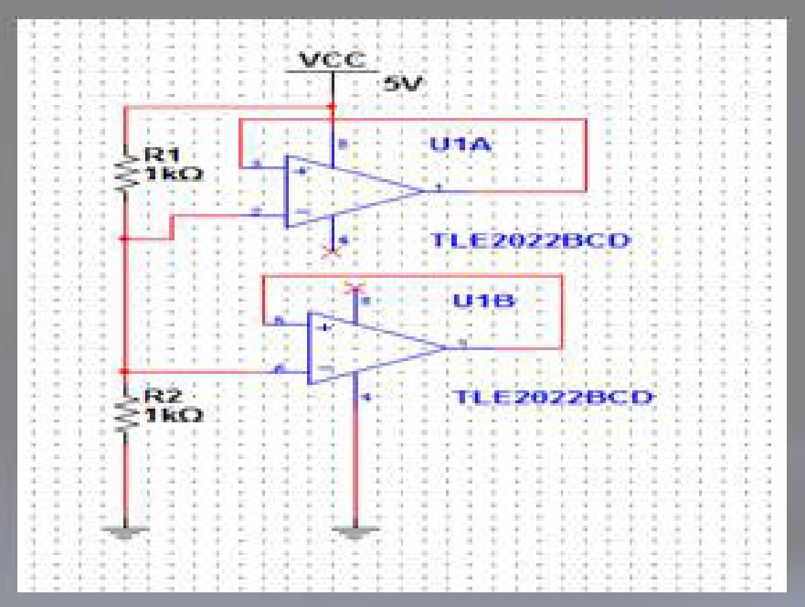


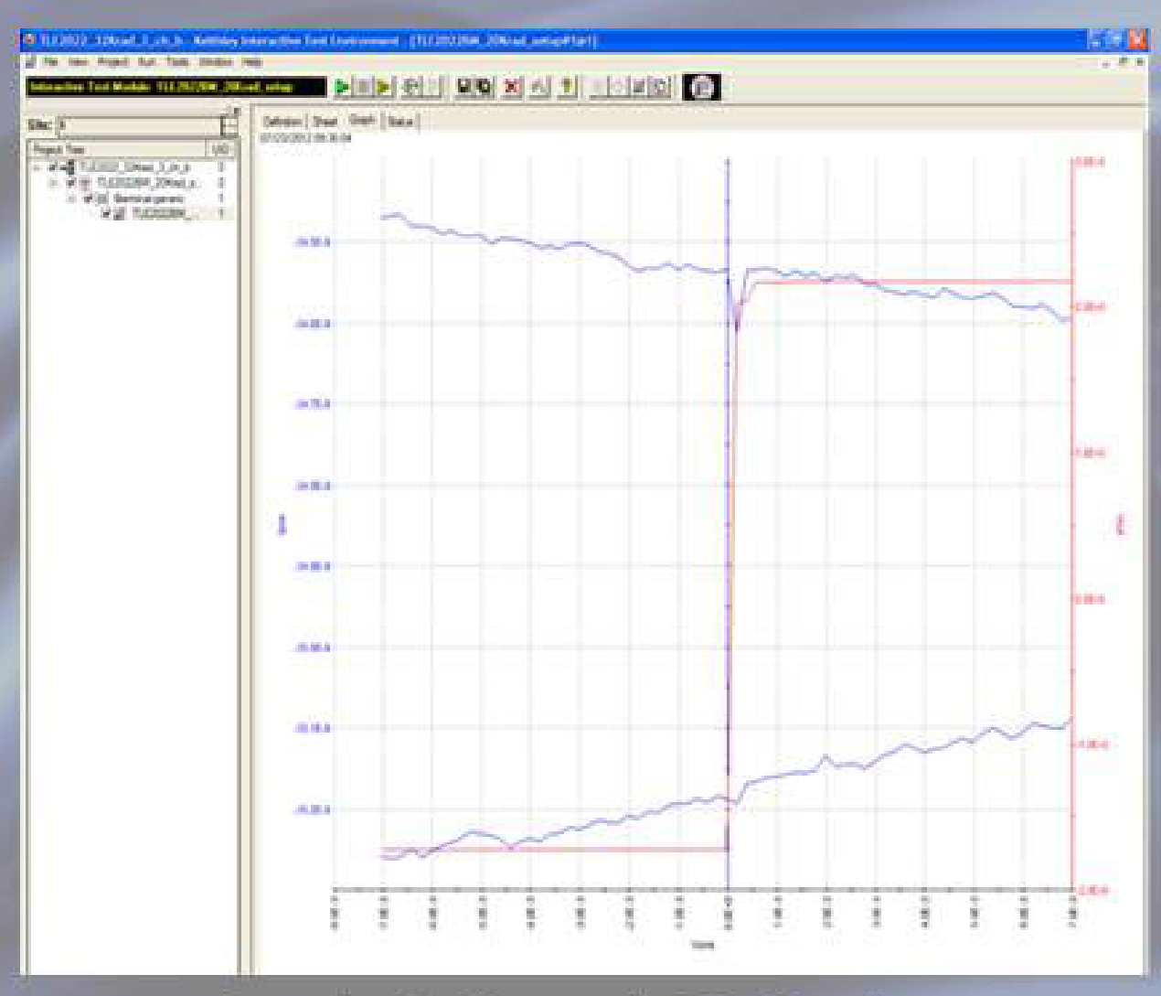
Fig.2 Schematic for Biased Board

Fig.3 Biased Board for Radiation Chamber

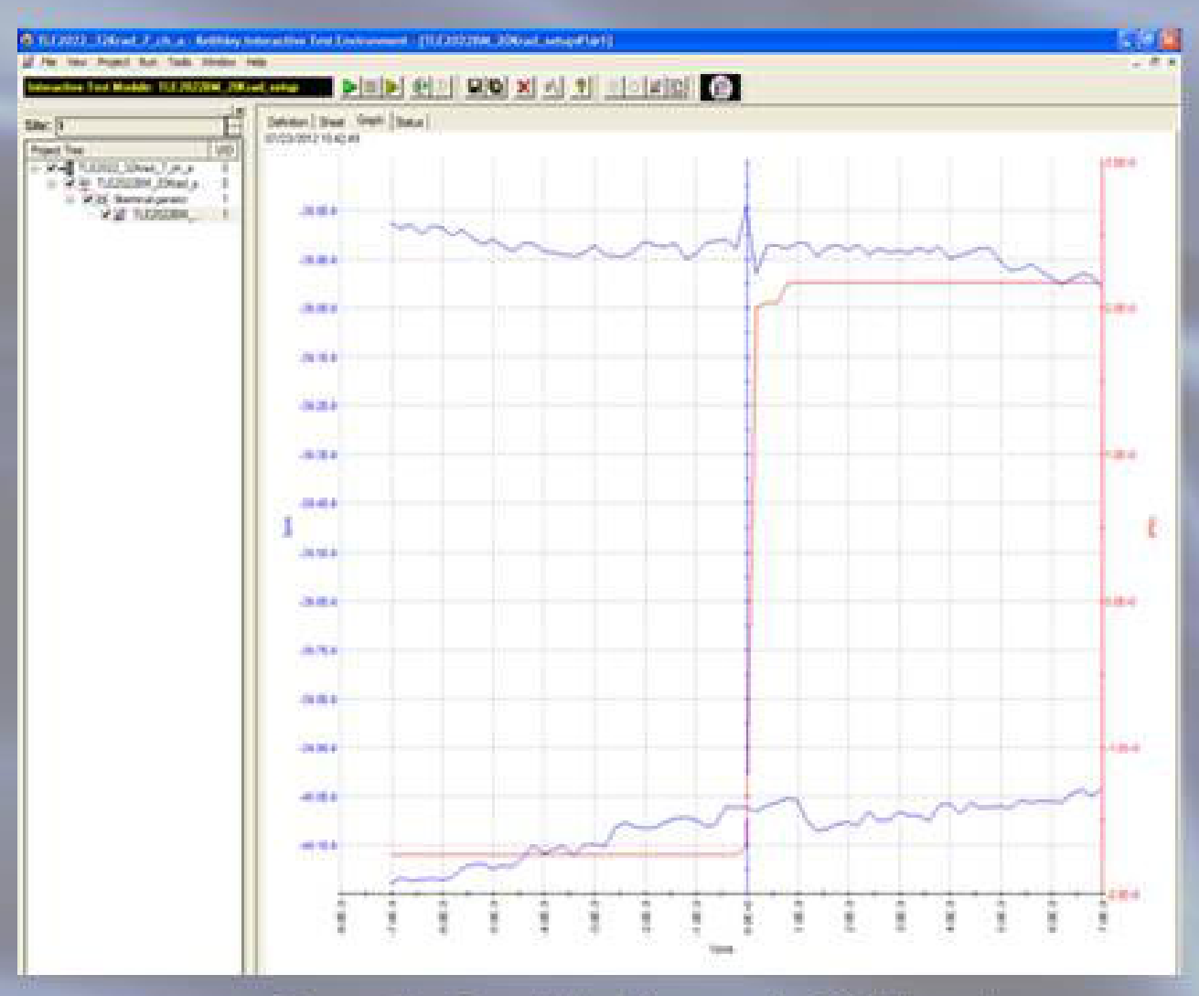
Fig.4 Keithley Test Setup

Results

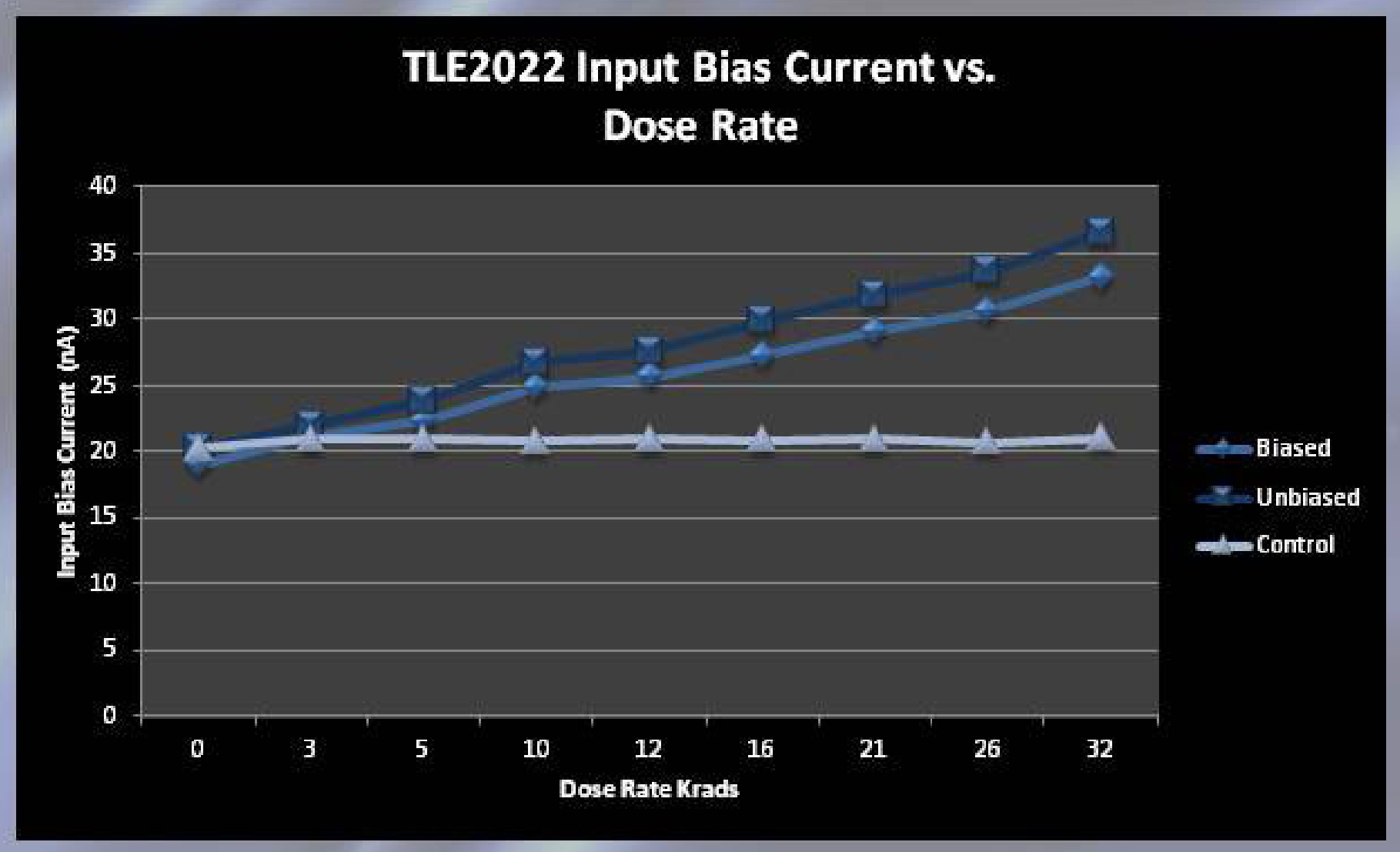
Graph 1. Pre-rad



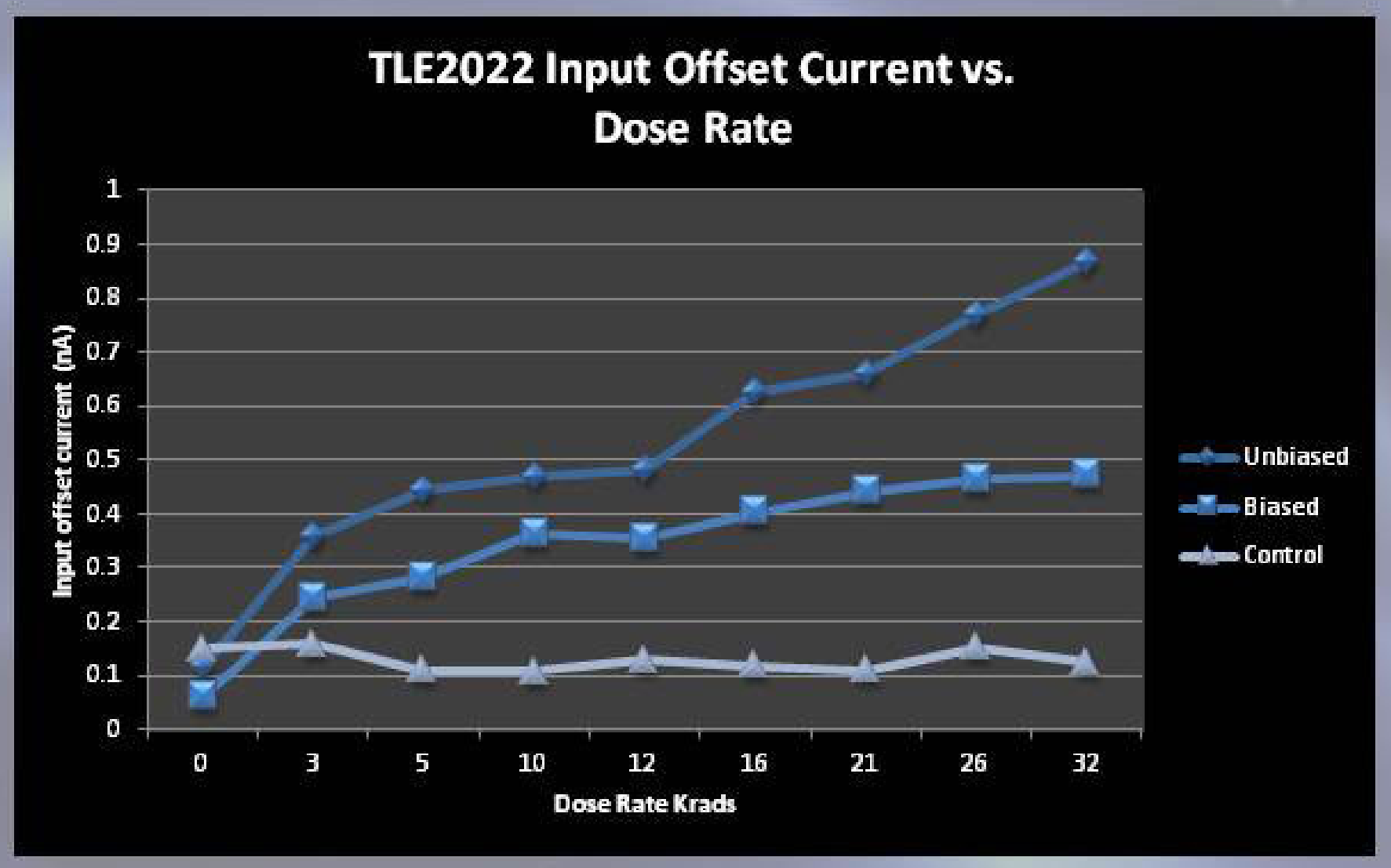
Graph 2. Biased 32 Krad



Graph 3. Unbiased 32Krad



Graph 4



Graph 5

There are two main points noted from the first graph. First, from the pre-rad to 32Krad, the input currents width per division change. Second, the input current going into the device is most affected by the unbiased connection. The bottom graphs show how at each dose step, the unbiased connection receives a greater affect from the radiation. However, since there was only minimum change and the device stayed within specification, there was no graph. The voltage offset and supply currents stayed at control levels and had no significant curves to graph.

Conclusion

Results of LDR irradiation on a bipolar op amp are presented. It was observed that most degradation occurred at the input current and bias current regions of this device. In the worst case scenario of all pins grounded, the TLE2022 did not fail or go out of specification. In the cases of the voltage offset and supply current, the effects of the radiation caused little to no change compared to the LDR control up to 30Krads.

After looking over these results, it was concluded that the advancements done to this device with the inclusion of the Excalibur process made this device no more or less susceptible to radiation. This device at a LDR irradiation test could have a promising future for Flight Projects that need this type of design. It is recommended that this device be further researched and tested in a Single Event Effect (SEE) test and at a High Dose Rate (HDR) for TID.

Acknowledgments

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