APPLICATION NOTE

Gamma Total Dose Radiation Performance of Skyworks Optocouplers

(Provided Through Isolink, a Wholly-Owned Subsidiary of Skyworks Solutions)

Steady state total dose irradiation test, MIL-STD-883C, Method 019.2, was performed on various Isolink optocouplers and LED emitters to evaluate the effects of ionizing gamma radiation on their electrical and optical parameters. The results of the test overall showed excellent performance to 300K rads(Si) gamma total dose.

Test Procedure

The steady state total dose irradiation test was conducted using a Gamma Cell 220 made by Atomic Energy of Canada with Cobalt-60 as a gamma radiation source at a dose rate of 24.4 rad(Si) / sec. The samples are Isolink optocouplers OLH100, OLH300, OLH400, OLH500 and several LED emitters used in Isolink products. The OLH100 is a phototransistor detector optocoupler (similar to OLI100, OLS100, 4N2X, and 4N4X). The OLH300 is an integrated photodiode-transistor detector optocoupler (similar to OLI300 and OLS300). The OLH400 is an integrated photodiode Darlington detector optocoupler (similar to OLI400, and OLS400). The OLH500 is an integrated photodiode-amplifier logic gate detector optocoupler (similar to OLI500 and OLS500). All test samples were packaged in standard TO-5 packages. The LED's are packaged in TO-18 headers. The LED samples were irradiated to determine the contribution of the change of LED light output to the change in the forward transfer characteristics of the optocouplers.

The test consists of exposing these devices to gamma radiation for various intervals. The intervals used were total doses of 10K, 50K, 100K, and 300K rads(Si). Electrical measurements were made immediately after each interval at room temperature to minimize any annealing effects. For the LED'S, an external non-irradiated photodiode detector is used to measure the photo current generated at different LED forward currents before and after each exposure to gamma radiation.

Test Results

The various data sheet parameters were measured and recorded for each device type. The major interest is in the change of the forward transfer characteristics and the dark current of the optocouplers. For the OLH100, 300, and 400 the change in current transfer ratio, is plotted. (Figures 1, 2, 3).

The current transfer ratio is defined as the ratio of current generated at the output of the optocoupler divided by the input LED current. Forthe OLH500 logic gate optocoupler, the change in threshold current is plotted. (Figure 4) The threshold current is defined as the input LED current needed to cause a change of logic state in the output of the optocoupler.

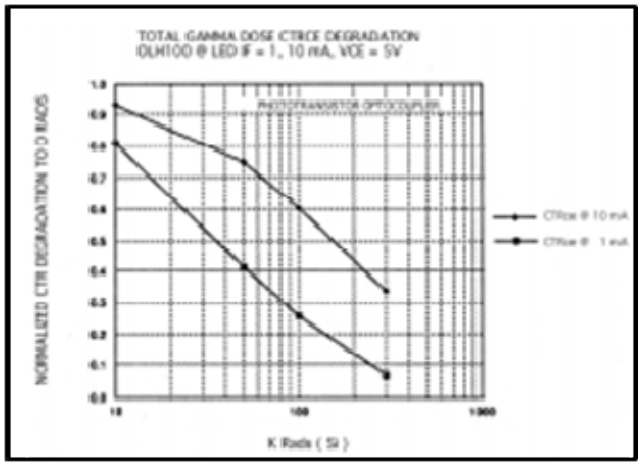

Figure 1. OLH100 Phototransistor Optocoupler Normalized CTR vs. Total Gamma Dose

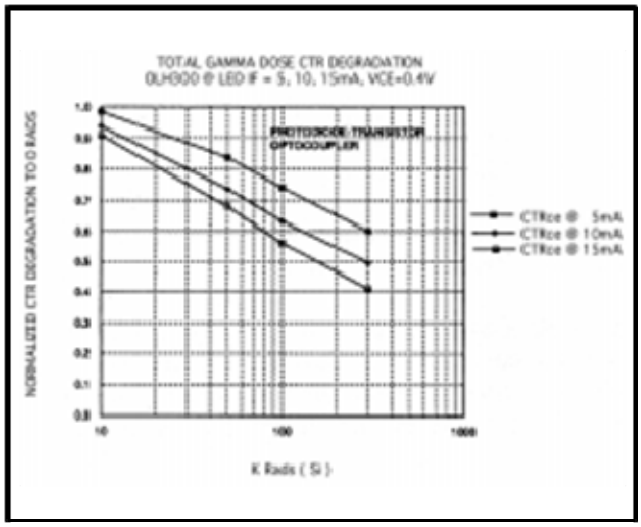

Figure 2. OLH 300 Photodiode-transistor Optocoupler Normalized CTR vs. Total Gamma Dose

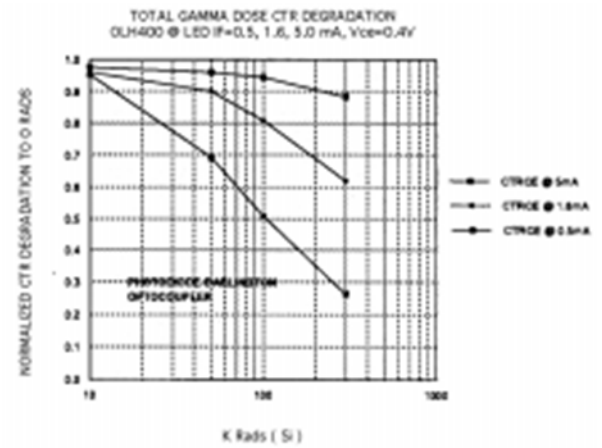

Figure 3. OLH 400 Photodiode Darlington Optocoupler Normalized CTR vs. Total Gamma Dose

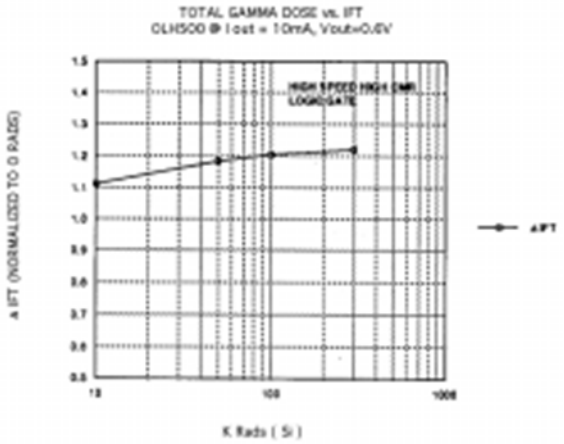

Figure 4. OLH500 High Speed High CMR Logic Gate Optocoupler Normalized Threshold Current vs. Total Gamma Dose

The dark current on all these test units showed no significant change after 300K rads (Si) total dose.

The LED samples did not show any significant light output change after 300K rads (Si) total dose.

The results showed CTR degraded more at lower LED forward currents. Since the LED light output did not change significantly after irradiation, the decrease in CTR is mainly due to the decrease in gain of the optocoupler detector. Measurements of the Hfe of the transistors showed Hfe decreased with increasing irradiation and the change is especially more pronounced at the low base current region. This explains the cause of higher CTR degradation at the lower LED forward currents.

Alternate samples of OLH300 were also tested to further improve on the gamma radiation performance of the optocoupler. The samples were designated as OLH300R. The construction is the same as the OLH300 except the LED was replaced by a more efficient LED. This LED change essentially resulted in higher photocurrent to the base of the output transistor. The gamma total dose results for the OLH300R showed even better improvement over the excellent OLH300 results.

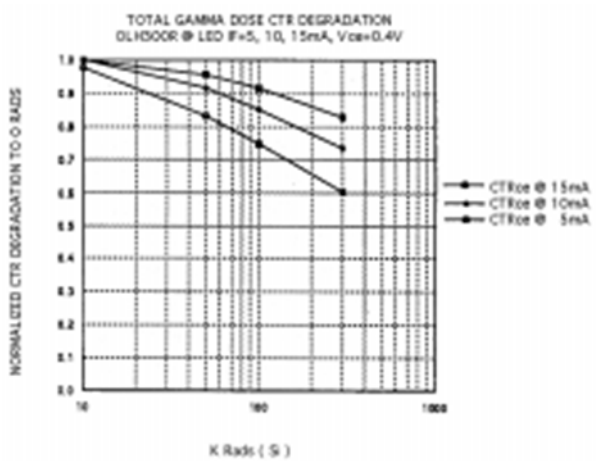

Figure 5. OLH300R Photodiode-transistor Optocoupler Normalized CTR vs. Total Gamma Dose

Conclusion

The above results show that Isolink optocouplers can be used reliably in applications that require exposures to steady state gamma radiation. The results provide circuit designers actual performance data to work with and more optocoupler options for their designs. They are not limited to designing just with phototransistor optocouplers with their larger active areas and deeper device junctions depths that are more prone to radiation damage. This data, together with the neutron irradiation data presented in Application Note 1001 (Skyworks Document 204661) , show that Isolink optocouplers can perform well to Radiation Hardness Assurance (RHA) Levels for Class B and Class S microelectronic devices in MIL-M-38510H and for hybrid devices in MIL-H-38534. However this data only pertains to Isolink's optocouplers and cannot be generalized to other optocouplers. The materials, LED'S, active area sizes, junction depths, construction and other device parameters from other manufacturers can differ significantly and will affect the performance of the optocouplers under radiation exposure.