TEXAS INSTRUMENTS

Radiation Report

SLUK017–May 2017

UC1846-SP Total Ionizing Dose

Space and High Reliability

ABSTRACT

This report discusses the results of the *Total Ionizing Dose* (TID) testing for the *Radiation Hardness Assured* (RHA), QML Class V certified Texas Instrument's UC1846-SP (5962P8680603VEA and 5962P8680603VFA). The RHA-qualified UC1846-SP passes up to 30 krad (Si) *Low Dose Rate* (LDR).

NOTE: For questions or comments, contact hirelmarketing@list.ti.com.

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1 Device Information

1.1 Product Description

The UC1846-SP is a current mode controller, used to support various topologies such as forward, flyback, half-bridge, full bridge, push-pull configurations and is 30 krad (Si) *Radiation Hardness Assured* (RHA). It provides all of the necessary features to implement fixed frequency, current mode control schemes while maintaining a minimum external parts count. The superior performance of this technique can be measured in improved line regulation, enhanced load response characteristics, and a simpler, easier-to-design control loop. Topological advantages include inherent pulse-by-pulse current limiting capability, automatic symmetry correction for push-pull converters, and the ability to parallel “power modules" while maintaining equal current sharing. The 30 krad (Si) RHA-qualified device is orderable with SMD 5962P8680603VEA for the ceramic dual in-line package and SMD 5962P8680603VFA for the ceramic flat pack package.

1.2 Device Details

Table 1 lists the device information used in the initial RHA TID characterization and qualification of LDR tests. Current production lot RLAT data can always be found in the Group E report shipped. The process for pulling the group E report from TI is described in Section 3.2.

Table 1. Device and Exposure Details

TID LDR Details: up to 45 krad (Si)	
TI Device Number	UC1846A-SP (5962P8680603VEA)
Package	16 Pin Ceramic DIP (J)
Technology	JI-PWR1
Die Lot Number	5114388SHE
A/T Lot Number / Date Code	6002587MMT / 1614A
Quantity Tested	57 devices including 3 control device
Lot Accept/Reject	Devices passed 3 krad (Si), 10 krad (Si), 30 krad (Si), 45 krad (Si) (1)
LDR Radiation Facility	RAD/Aeroflex in Colorado Springs, Colorado
LDR Dose Level	3 krad (Si), 10 krad (Si), 30 krad (Si), 45 krad (Si) (1)
LDR Dose Rate	0.01 rad/s
LDR Radiation Source	Gammacell JLSA 81-24 Co-60
Irradiation Temperature	Ambient, room temperature

(1) 45 krad (Si) units pass, per MIL-STD-883 1019.9, Paragraph 3.13.3.b acceleration annealing test.

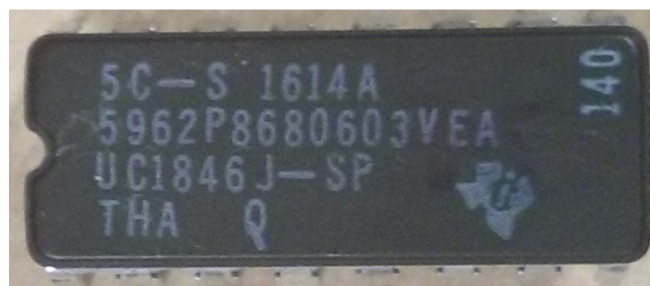

Figure 1. Device Used in Exposure

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2 Total Dose Test Setup

2.1 Test Overview

The UC1846-SP was tested according to MIL-STD-883J, Test Method 1019.9. For this testing, Condition D was used. For this test, the product was irradiated up to 1.5× the rated radiation level and then put through full electrical parametric testing on the production *Automated Test Equipment* (ATE). The device was functional and passed all parametric tests within (guard bands) of the *Standard Microcircuit Drawing* (SMD) electrical specification limits. The UC1846-SP J1 Bipolar technology contains only bipolar components; therefore, an *Enhanced Low Dose Rate Sensitivity* (ELDRS) study was performed to determine if the device has a *Low Dose Rate* (LDR) sensitivity.

2.2 Test Description and Facilities

The UC1846-SP LDR exposure was performed on biased and unbiased devices in a Co60 gamma cell under a 10 mrad (Si) / sec exposure rate. The dose rate of the irradiator used in the exposure ranges from < 10 mrad (Si) / sec to a maximum of approximately 65 rad (Si) / sec, determined by the distance from the source. For the LDR (10 mrad (Si) / sec) exposure, the test box was positioned approximately 2 m from the source. The exposure boards are housed in a lead-aluminum box (as specified in MIL-STD-883 TM 1019.9) to harden the gamma spectrum and minimize dose enhancement effects. The irradiator calibration is maintained by Logmire Laboratories using *Thermoluminescence Dosimeters* (TLDs) traceable to the *National Institute of Standards and Technology* (NIST) and the dosimetry was verified using TLDs prior to the radiation exposures. After exposure, the devices were packed in dry ice (per MIL-STD-883 Method 1019.9 section 3.10) and returned to TI Dallas for a full post radiation electrical evaluation using Texas Instruments production ATE. ATE guard band test limits are set within SMD electrical limits to ensure a minimum Cpk and test error margin based on initial qualification and characterization data. Post radiation measurements were taken within 30 minutes of removal of the devices form the dry ice container. The devices were allowed to reach room temperature prior to electrical post radiation measurements.

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2.3 Test Setup Details

The devices under LDR exposure were tested in both biased and unbiased conditions in two conditions as described as follows.

2.3.1 Unbiased

For the unbiased LDR conditions, the exposure was performed with all pins grounded.

2.3.2 Biased

Figure 2 shows the diagram for LDR exposure.

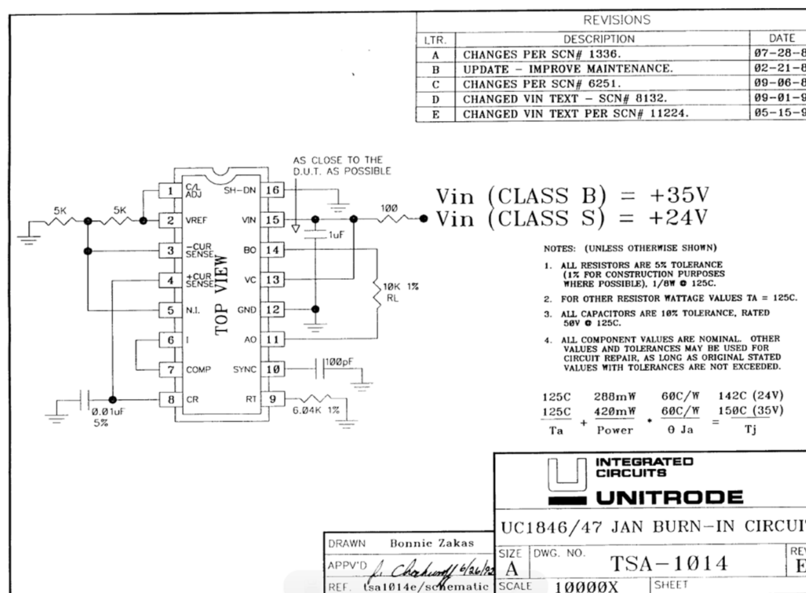

Figure 2. Bias Diagram Used in TID Exposure

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2.4 Test Configuration and Condition

A step-stress (3 krad, 10 krad, 30 krad and 45 krad) test method was used to determine the TID hardness level. That is, after a predetermined TID level was reached, an electrical test was performed on a given sample of parts to verify that the units are within specified SMD electrical test limits. MIL-STD-883, Test Method 1019.9, Condition D was used in this case. If this passes, then the wafer lot can be certified as an RHA wafer lot.

Table 2 and Table 3 list the samples used during the RHA characterization.

Table 2. LDR Biased Device Information[(1)]

Total Samples: 10/dose rate (5 Biased)			
Exposure Duration and Level			
3 krad	10 krad	30 krad	45 krad (RLAT)
118 (Wafer 3)	118 (Wafer 3)	118 (Wafer 3)	103,114,115,117,119,120 (Wafer 3) 121,122,123,124,125,126 (Wafer 3) 127,128,129, 131, 171, 184 (Wafer 3) 188, 194, 197, 198 (Wafer 3)
141 (Wafer 3)	141 (Wafer 3)	141 (Wafer 3)	
179 (Wafer 3)	179 (Wafer 3)	179 (Wafer 3)	
187 (Wafer 3)	187 (Wafer 3)	187 (Wafer 3)	
195 (Wafer 3)	195 (Wafer 3)	195 (Wafer 3)	

(1) Control Unit: 140 (wafer 3), 168 (wafer 3), 169 (wafer 3)

Table 3. LDR UnBiased Device Information[(1)]

Total Samples: 10/dose rate (5 Unbiased)			
Exposure Duration and Level			
3 krad	10 krad	30 krad	45 krad (RLAT)
116 (Wafer 3)	116 (Wafer 3)	116 (Wafer 3)	102,144,146,147,148,150 (Wafer 3) 152,153,154,155,156,159 (Wafer 3) 160,161,163, 165, 166, 181 (Wafer 3) 182, 183, 189, 192 (Wafer 3)
133 (Wafer 3)	133 (Wafer 3)	133 (Wafer 3)	
139 (Wafer 3)	139 (Wafer 3)	139 (Wafer 3)	
145 (Wafer 3)	145 (Wafer 3)	145 (Wafer 3)	
190 (Wafer 3)	190 (Wafer 3)	190 (Wafer 3)	

(1) Control Unit: 140 (wafer 3), 168 (wafer 3), 169 (wafer 3)

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3 Total Ionizing Dose (RHA) Characterization Test Results

3.1 Total Ionizing Dose RHA Characterization Summary Results

The parametric data for the UC1846-SP passes up to 30 krad (Si) Low Dose Rate TID.

The drift of SMD electrical parameters through low dose rate (LDR) were within the pre-radiation characterization limits. The device is tested to maximum total dose of 45 krad (Si) per MIL-TD-883, TM1090 condition D.

The UC1846-SP passed post electrical test over all the conditions below indicating that this lot can be certified as 30 krad RHA.

- LDR (0.01 rad / sec) unbiased: Post 3 krad (Si), 10 krad (Si), 30 krad (Si), 45 krad (Si)
- LDR (0.01 rad / sec) biased: Post 3 krad (Si), 10 krad (Si), 30 krad (Si), 45 krad (Si)

NOTE: 45 krad (Si) units pass, per MIL-STD-883 1019.9, Condition D, section 3.12 accelerated annealing test

3.2 Group E Full RHA Radiation Lot Acceptance (RLAT) Report

The Group E RHA RLAT summary is shipped with each TI RHA QMLV product. To see the full list of all documents shipped with TI QMLV products review our *TI QML Lot Documents* summary (SBOA140). This document also has instructions on how to pull the full RHA (Group E) report.

4 Applicable and Reference Documents

4.1 Applicable Documents

UC1846-SP Class-V, Radiation Hardened PWM Controller data sheet (SLUS871)

4.2 Reference Documents

Texas Instruments total ionizing dose radiation (total dose) test procedure follows the standards put forth in MIL-STD-883 TM 1019. The document is found at the DLA website.

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