AEROSPACE DATA EXCHANGE PROGRAM TRANSMITTAL

PRODUCT CHANGE NOTICE

1. TITLE **AFFIRMATION OF MIGRATED UT63M147 RADIATION HARDNESS ASSURANCE MARGIN OVER ITS OBSOLETE PREDECESSOR**	2. DOCUMENT NUMBER SPO-2018-PCN-0001
	3. DATE *(Year, Month, Date)* 2018, July, 18
4. MANUFACTURER NAME AND ADDRESS CAES 4350 CENTENNIAL BOULEVARD COLORADO SPRINGS, COLORADO 80907-3486	5. MANUFACTURER POINT OF CONTACT NAME Tim Meade
	6. MANUFACTURER POINT OF CONTACT TELEPHONE 719-594-8000
	7. MANUFACTURER POINT OF CONTACT EMAIL Tim.l.meade@cobhamaes.com

8. CAGE CODE	9. EFFECTIVE DATE	10. PRODUCT IDENTIFICATION CODE	11. BASE PART
65342	**January 1, 2006 (LDC 0601 – Present)**	**JB01 and JB03**	**UT63M147**
12. BLANK		13. SMD NUMBER **93226**	14. DEVICE TYPE DESIGNATOR **03**
		15. RHA LEVELS **Non (-), R, F, G, H**	16. QML LEVEL **Q & V**
		17. NON QML LEVEL **Proto & HiRel**	18. GIDEP **GB4-C-16-0002**

19. PRODUCT CHANGE

BACKGROUND:

Beginning in 2004, the die used to produce the UT63M147 (SMD#5962*93226) reached a diminished inventory position with no source available to fabricate more die. Steady demand for the product motivated CAES to develop a form, fit, functional replacement for the soon-to-be-obsolete die source. Reference appendix A of this PCN for copies of the notification letters CAES used to inform customers of the product migration status.

The replacement product development completed in late 2005 with production shipments beginning in early 2006. Because the migrated product was form, fit, and functional to existing SMD specification for device type 03, CAES was not compelled to create a new device type.

Industry user's of the 5962*9322603 have raised concerns about the capability of the replacement device to meet or exceed the original radiation assurance levels. This product change notice is provided to affirm the migrated UT63M147's radiation hardness assurance margin to the original specification. Although the migrated product has more radiation capability than the obsolete device types, the manufacturer is not planning to change the historical radiation performance limits defined in the product SMD or datasheet.

Continuation on SHEET 2…

20. DISPOSITIONARY RECOMMENDATION:	CHECK & USE AS IS ☒	CONTACT MANUFACTURER ☐	REMOVE & REPLACE ☐	CORRECT & USE AS SPECIFIED ☐
21. ADEPT REPRESENTATIVE **Lin-Chi Huang**	22. SIGNATURE Timothy J Meade			23. DATE **18, July 2018**

Continuation of Block 19. PRODUCT CHANGE

COMPARISON OF MIGRATED DEVICE TO ORIGINAL DEVICE RADIATION SPECIFICATIONS:
SMD Total Ionizing Dose Hardness Specification –

1.5 Radiation features.

For device types 03 and 04:
Maximum total dose available (dose rate = 50 - 300 rads (Si)/s).....= 1 x 10^6 Rads (Si) 3/

3/ Device types 03 and 04 may be dose rate sensitivity in a space environment and may demonstrate enhanced low dose rate sensitivity (ELDRS) effects. However, radiation end point limits for the noted parameters are guaranteed only for the conditions as specified in MIL-STD-883, method 1019, condition A.

Regarding Note 3/ the migrated version of the UT63M147 is primarily CMOS with a very small percentage of the product using bipolar elements in a diode configuration. Because these elements do not rely on transitor gain, beta degradation is irrelevant to the proper operation of the 5962*9322603. To validate its analytical assessment of ELDRS immunity, CAES performed an ELDRS evaluation on the migrated product. Therefore, Note 3/ is not applicable to the migrated UT63M147. Reference Appendix B for the ELDRS report.

SMD Single Event Phenomenon (SEP) Specification–

1.5 Radiation features.

For device types 03 and 04:
Single event phenomenon (SEP):
No upsets occurs at effective linear energy transfer (LET) (see 4.4.4.5) .....≤ 14 MeV/(mg/cm^2) 4/
No latch-up (SEL) occur at effective LET (see 4.4.4.5).....≤ 35 MeV/(mg/cm^2) 4/

4/ Limits are guaranteed by design or process but not production tested unless specified by the customer through the purchase order or contract.

TABLE IB. SEP test limits. 1/ 2/ 3/

Device type	Bias V_{DD} = 4.5 V		Bias V_{DD} = 5.5 V For latch-up (SEL) test no latch-up effective LET
	Effective LET no upsets	Maximum device cross section	
03, 04	LET ≤ 14 MeV/(mg/cm^2)	2.5 x 10^{-6} cm^2/bit	LET ≤ 35 MeV/(mg/cm^2)

1/ For SEP test conditions, see 4.4.4.5 herein.
2/ Technology characterization and model verification supplemented by in-line data may be used in lieu of end-of-line testing. Test plan must be approved by TRB and qualifying activity.
3/ Worst case temperature is T_A = +25°C ±10°C for SEU and T_A = +125°C ±10°C for SEL.

As part of the product qualification, CAES performed Single Event Latchup (SEL) testing on the migrated UT63M147. The product successfully passed all SEL testing at 125°C up through a final **LET of 109 MeV/(mg/cm^2)**. Therefore, the replacement device has **74 MeV/(mg/cm^2)** of capability margin to the SMD specification limit. Reference Appendix C for the SEL test report.

The migrated version of the UT63M147 has no storage elements. Therefore, the **device is inherently upset immune** and the Single Event Upset (SEU) specification is not applicable.

May 25, 2004

Dear Customer:

Aeroflex Colorado Springs (Aeroflex) appreciates your interest and use of our products, specifically the RadHard 5-volt MIL-STD-1553 Bus Tranceivers. The purpose of this letter is to inform you that Aeroflex is proceeding with migrating the UT63M145 and UT63M147 MIL-STD-1553A/B Bus Transceivers (Standard Microcircuit Drawing 5962-93226), to a new wafer fabrication facility. Production devices from the new facility will begin shipping late in the third quarter of 2004 (i.e., September 2004). This estimate is based on a two-design pass development schedule. The new 5V-volt transceiver products are designed to be a direct replacement to the existing products currently in QML Q and V production. As a result of the wafer foundry and process change (Monolithic Bipolar to 0.6µm CMOS), differences in AC and DC electrical performance may be unavoidable. Aeroflex will keep you apprised of performance differences as they are identified via written notification and our web-site (www.Aeroflex.com). Aeroflex will continue to offer the UT63M145 and UT63M147 devices in a 24-lead flatpack (FP) and 28-pin dual-inline package (DIP).

Aeroflex has sufficient die inventory to yield approximately 1000 finished good units. The inventory of the remaining UT63M145 and UT63M147 bus transceivers are being offered to customers on a “first come, first serve” basis. All purchase orders that can be filled by old inventory will require delivery within 6 weeks of receipt and acceptance of purchase order. Additionally, Aeroflex will decline all requests for single lot date code shipments until the foundry migration is complete. Aeroflex plans to cease shipping product built from the old mask set once qualification of the migrated version is complete. We expect to use the same SMD number (5962-93226) with new device types.

If you have any questions please contact me at (719) 594-8252 or jordan@Aeroflex.com.

Regards,

Anthony F. Jordan
Director of Standard Products
Aeroflex Colorado Springs

December 20, 2004

Dear Customer:

Aeroflex Colorado Springs (Aeroflex) appreciates your interest and use of our products, specifically the 5-volt MIL-STD-1553 Bus Transceivers. This letter provides you with a status update (from our June 23, 2004 letter) for Aeroflex's UT63M147 MIL-STD-1553A/B Bus Transceiver (Standard Microcircuit Drawing 5962-93226) migration to a new wafer fabrication facility. Table 1 lists all Aeroflex products that are affected by the migration of the UT63M147. Because the migrated UT63M147 is designed to be form, fit, and functionally compatible to the original transceiver, Aeroflex does not intend to change the SMD device type for any product affected by the transceiver replacement.

In the previous customer notification letter, Aeroflex advised that the UT63M145 MIL-STD-1760 Bus Transceiver (Standard Microcircuit Drawing 5962-93226) would be migrated along with the UT63M147. However, due to low customer demand, Aeroflex is not migrating the UT63M145 (MIL-STD-1760) Bus Transceiver. **Aeroflex will accept orders for the UT63M145 until January 31, 2005, and delivery must occur by March 31, 2005. The inventory is being offered to customers on a "first come, first serve" basis.**

The only specification difference between the UT63M147 and the UT63M145 is transformer-coupled output voltage bus swing:

- 18V-27V peak-peak, line-line for the UT63M147
- 22V-27V peak-peak, line-line for the UT63M145

Aeroflex is in the second design pass for the migration of the UT63M147 MIL-STD-1553A/B Bus Transceiver. Production devices from the new facility will begin shipping June 2005. The new 5V-volt transceiver is designed to be a direct replacement to the existing product currently in prototype, reduced high-reliability, QML-Q, and QML-V production. Due to the wafer foundry and process change (Monolithic Bipolar to 0.6µm CMOS), differences in AC and DC electrical performance may be unavoidable. Aeroflex will keep you apprised of performance differences as they are identified via written notification and our web site (www.aeroflex.com/avionics).

Aeroflex will continue to offer the UT63M147 devices in a 24-lead flatpack (FP) and 28-pin dual-inline package (DIP) until qualification of the migrated version is complete. Aeroflex intends to use the same SMD number (5962-93226) for the migrated UT63M147. The die inventory for the UT63M147 is projected to expire within twelve (12) months.

Table 1 is a listing of all the Aeroflex Colorado Springs products affected by the transceiver migration.

Aeroflex Colorado Springs, Inc. • 4350 Centennial Boulevard • Colorado Springs, CO 80907-3701
Tel: 719-594-8000 • Fax: 719-594-8468 • www.aeroflex.com

Table 1. Cross Reference of the Affected Aeroflex Products

Generic Part Number	SMD Number	Device Type[1]	Old PIC#:	New PIC#:
UT63M147	5962*93226	03	AC01A	JB01A
UT63M145	5962*93226	04	AC02A	Obsolete
UT69151-DXE	5962*94663	08	MM016B	MM016B
		11	MM023A MM025A MM027A	MM023B MM025B MM027B
UT69151-XTE5	5962-94758	08	MM019E	MM019F
UT69151-RTE	5962-98587	01	MM022B	MM022C

PIC = Aeroflex Product Identification Code

Note:

1. Device types do not change with the migration

If you have any questions, please contact me at (719) 594-8252 or jordan@Aeroflex.com.

Regards,

Anthony F. Jordan
Director of Standard Products
Aeroflex Colorado Springs

Aeroflex Colorado Springs, Inc. • 4350 Centennial Boulevard • Colorado Springs, CO 80907-3701
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April 28, 2005

Dear Customer:

Aeroflex Colorado Springs (Aeroflex) appreciates your interest and use of our products, specifically the 5-volt MIL-STD-1553 Bus Transceivers. This letter provides you with a status update (from our December 20, 2004 letter) for Aeroflex's UT63M147 MIL-STD-1553A/B Bus Transceiver (Standard Microcircuit Drawing 5962-93226) migration to a new wafer fabrication facility. Additionally, Table 1 lists all Aeroflex products, including 1553 multi-chip module products that are affected by the migration of the UT63M147. Because the migrated UT63M147 is designed to be form, fit, and functionally compatible to the original transceiver, Aeroflex does not intend to change the SMD device type for any product affected by the transceiver replacement.

In the previous customer notification letter, Aeroflex advised that the UT63M145 MIL-STD-1760 Bus Transceiver (Standard Microcircuit Drawing 5962-93226) would not be migrated along with the UT63M147. As of April 4, 2005, deliveries of the UT63M145 have ceased.

Just as a reminder, the only specification difference between the UT63M147 and the UT63M145 is transformer-coupled output voltage bus swing:

- 18V-27V peak-peak, line-line for the UT63M147
- 22V-27V peak-peak, line-line for the UT63M145

Aeroflex will continue to offer the remaining UT63M147 die in a 24-lead flatpack (FP) and 36-pin dual-inline package (DIP) until qualification of the migrated version is complete. The die inventory for the UT63M147 is projected to expire in the 2Q05.

Aeroflex is in the second design pass for the migration of the UT63M147 MIL-STD-1553A/B Bus Transceiver. Stand-alone UT63M147 transceivers and SμMMIT multi-mode modules, using the new UT63M147 transceiver, will begin shipping August 2005. The new 5V-volt transceiver is designed to be a direct replacement to the existing product currently in prototype, reduced high-reliability, QML-Q, and QML-V production. However, due to the wafer foundry and process change (Monolithic Bipolar to 0.6μm CMOS), differences in AC and DC electrical performance may be unavoidable. Aeroflex will keep you apprised of performance differences as they are identified via written notification and our web site (www.aeroflex.com/avionics).

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Table 1 is a listing of all the Aeroflex Colorado Springs products affected by the transceiver migration.

Table 1. Cross Reference of the Affected Aeroflex Products

Generic Part Number	SMD Number	Device Type[1]	Old PIC#:	New PIC#:
UT63M147	5962*93226	03	AC01A	JB01A
UT63M145	5962*93226	04	AC02A	Obsolete
UT69151-DXE	5962*94663	08	MM016B	MM016C
		11	MM023A MM025A MM027A	MM023B MM025B MM027B
UT69151-XTE5	5962-94758	08	MM019E	MM019F
UT69151-RTE	5962-98587	01	MM022B	MM022C

PIC = Aeroflex Product Identification Code

Note:

1. Device types do not change with the migration

If you have any questions, please contact me at (719) 594-8252 or jordan@Aeroflex.com.

Regards,

Anthony F. Jordan
Director of Standard Products
Aeroflex Colorado Springs

Aeroflex Colorado Springs, Inc. • 4350 Centennial Boulevard • Colorado Springs, CO 80907-3701
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June 28, 2005

Dear Customer:

Aeroflex Colorado Springs (Aeroflex) appreciates your interest and use of our MIL-STD-1553 products, specifically the 5-volt MIL-STD-1553 Bus Transceivers and the SμMMIT multi-chip modules that include these transceivers. This letter provides you with a status update (from our April, 2005 letter) for Aeroflex's UT63M147 MIL-STD-1553A/B Bus Transceiver (Standard Microcircuit Drawing 5962-93226) migration to a new wafer fabrication facility. Additionally, Table 1 lists all Aeroflex products, including 1553 multi-chip module products that are affected by the migration of the UT63M147. Because the migrated UT63M147 is designed to be form, fit, and functionally compatible to the original transceiver, Aeroflex does not intend to change the SMD device type for any product affected by the transceiver replacement.

In the previous customer notification letters, Aeroflex advised that the UT63M145 MIL-STD-1760 Bus Transceiver (Standard Microcircuit Drawing 5962-93226) would not be migrated along with the UT63M147. As of April 4, 2005, deliveries of the UT63M145 have ceased. The only specification difference between the UT63M147 and the UT63M145 is transformer-coupled output voltage bus swing:

- 18V-27V peak-peak, line-line for the UT63M147
- 22V-27V peak-peak, line-line for the UT63M145

As of June 03, 2005, the original inventory of UT63M147 die has been exhausted. Therefore, no products that are based on the UT63M147 can be shipped until the migrated version of the transceiver is qualified.

Revision C of the UT63M147 MIL-STD-1553A/B Bus Transceiver is scheduled to start wafer fabrication in early July 2005 on an expedited basis. Upon receipt of wafers, Aeroflex will expedite product qualification, 1553 validations testing, and product shipments. Aeroflex projects stand-alone UT63M147 transceivers and SμMMIT multi-mode modules, using the new UT63M147 transceiver, to be available in September 2005. We expect to fulfill all current backlog orders by October 31, 2005.

Although the new 5V-volt transceiver is designed to be a direct replacement to the existing UT63M147 product, the wafer foundry and process change (Monolithic Bipolar to 0.6μm CMOS), may result in AC and DC electrical performance differences. Aeroflex will keep you apprised of any performance differences that are identified via written notification and our web site (www.aeroflex.com/avionics).

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Table 1 is a listing of all the Aeroflex Colorado Springs products affected by the transceiver migration.

Table 1. Cross Reference of the Affected Aeroflex Products

Generic Part Number	SMD Number	Device Type[1]	Old PIC#:	New PIC#:
UT63M147	5962*93226	03	AC01A	JB01A
UT63M145	5962*93226	04	AC02A	Obsolete
UT69151-DXE	5962*94663	08	MM016B	MM016C
		11	MM023A MM025A MM027A	MM023B MM025B MM027B
UT69151-XTE5	5962-94758	08	MM019E	MM019F
UT69151-RTE	5962-98587	01	MM022B	MM022C

PIC = Aeroflex Product Identification Code

Note:

1. Device types do not change with the migration

If you have any questions, please contact me at (719) 594-8252 or jordan@Aeroflex.com.

Regards,

Anthony F. Jordan
Director of Standard Products
Aeroflex Colorado Springs

Aeroflex Colorado Springs, Inc. • 4350 Centennial Boulevard • Colorado Springs, CO 80907-3701
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October 7, 2005

Dear Customer:

Aeroflex Colorado Springs (Aeroflex) appreciates your interest and use of our MIL-STD-1553 products, specifically the 5-volt MIL-STD-1553 Bus Transceivers. This letter provides you with a status update (from our June 2005 letter) for Aeroflex's UT63M147 MIL-STD-1553A/B Bus Transceiver (Standard Microcircuit Drawing 5962-93226) migration to a new wafer fabrication facility. Table 1 lists the remaining Aeroflex products that are affected by the migration of the UT63M147. **Note:** The 1553 multi-chip module shipments with the new transceiver began in September, 2005. Because the migrated UT63M147 is designed to be form, fit, and functionally compatible to the original transceiver, Aeroflex does not intend to change the SMD device type for any product affected by the transceiver replacement.

In the previous customer notification letters, Aeroflex advised that the UT63M145 MIL-STD-1760 Bus Transceiver (Standard Microcircuit Drawing 5962-93226) would not be migrated along with the UT63M147. Deliveries of the UT63M145 have ceased. The only specification difference between the UT63M147 and the UT63M145 is transformer-coupled output voltage bus swing:

- 18V-27V peak-peak, line-line for the UT63M147
- 22V-27V peak-peak, line-line for the UT63M145

As of June 03, 2005, the original inventory of UT63M147 die has been exhausted.

The UT63M147 MIL-STD-1553A/B Bus Transceiver is scheduled to start wafer fabrication in October 2005. Upon receipt of wafers, Aeroflex will expedite product qualification, 1553 validations testing, and product shipments. Aeroflex projects stand-alone UT63M147 transceivers to be available in February 2006. We expect to fulfill all current backlog orders by March 2006.

Although the new 5V transceiver is designed to be a direct replacement to the existing UT63M147 product, the wafer foundry and process change (Monolithic Bipolar to 0.6µm CMOS), may result in AC and DC electrical performance differences. Aeroflex will keep you apprised of any performance differences that are identified via written notification and our web site (www.aeroflex.com/avionics).

Table 1 is a listing of all the Aeroflex Colorado Springs products affected by the transceiver migration.

Table 1. Cross Reference of the Affected Aeroflex Products

Generic Part Number	SMD Number	Device Type[1]	Old PIC#:	New PIC#:
UT63M147	5962*93226	03	AC01A	JB03A
UT63M145	5962*93226	04	AC02A	Obsolete

PIC = Aeroflex Product Identification Code

Note:

1. Device types do not change with the migration

If you have any questions, please contact me at (719) 594-8252 or jordan@Aeroflex.com.

Regards,

Anthony F. Jordan
Director of Standard Products
Aeroflex Colorado Springs

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March 3, 2006

Dear Customer:

Aeroflex Colorado Springs (Aeroflex) appreciates your interest and use of our MIL-STD-1553 products, specifically the 5-volt MIL-STD-1553 Bus Transceivers. This letter provides you with a status update (from our October 2005 letter) for Aeroflex's UT63M147 MIL-STD-1553A/B Bus Transceiver (Standard Microcircuit Drawing 5962-93226, device type 03) migration to a new wafer fabrication facility. **Note:** The 1553 multi-chip module shipments with the new transceiver began in September, 2005. Because the migrated UT63M147 is designed to be form, fit, and functionally compatible to the original transceiver, Aeroflex does not intend to change the SMD device type for any product affected by the transceiver replacement.

In the previous customer notification letters, Aeroflex advised that the UT63M145 MIL-STD-1760 Bus Transceiver (Standard Microcircuit Drawing 5962-93226) would not be migrated along with the UT63M147. Deliveries of the UT63M145 have ceased. The only specification difference between the UT63M147 and the UT63M145 is transformer-coupled output voltage bus swing:

- 18V-27V peak-peak, line-line for the UT63M147
- 22V-27V peak-peak, line-line for the UT63M145

The UT63M147 MIL-STD-1553A/B Bus Transceiver entered production in February 2006. We expect to fulfill all current backlog orders by May 2006.

If you have any questions, please contact me at (719) 594-8252 or jordan@Aeroflex.com.

Regards,

Anthony F. Jordan
Director of Standard Products
Aeroflex Colorado Springs

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UT63M147 MIL-STD-1553A/B Bus Transceiver Enhanced Low Dose Rate Sensitivity Characterization

Craig Hafer
Standard Products Technology Manager
Aeroflex Colorado Springs
Final electrical test date: October 11, 2007
b: removed bias configuration

SUMMARY—The Aeroflex Colorado Springs (Aeroflex) UT63M147 MIL-STD-1553A/B Bus Transceiver device has been characterized for enhanced low dose rate sensitivity (ELDRS) and found to be insensitive to ELDRS effects to a total dose of 118 krad(Si). The UT63M147 (JB03A) devices were irradiated in two biasing configurations per MIL-STD-883 Method 1019 at Boeing Radiation Effects Laboratory (BREL) at a dose rate of 8 to 10 mrad(Si)/s and electrically tested pre-irradiation and at 50 krad(Si) and 118 krad(Si). The devices passed the Standard Microcircuit Drawing (SMD) pre-irradiation electrical performance specification at all electrical measurement points. In addition, the post- to pre-irradiation electrical parameter shifts are negligible at both 50 krad(Si) and 118 krad(Si).

Although the total ionizing dose (TID) level is specified to higher levels for the UT63M147 device, the ELDRS characterization was done up to a TID level of only 118 krad(Si) due to the practicality of completing the ELDRS characterization in a reasonable amount of time. It is expected that if this device were ELDRS sensitive, the sensitivity would be observed at a total dose of 118 krad(Si).

Introduction

This summary describes the total ionizing dose (TID) ELDRS test procedure and data collected on the UT63M147 MIL-STD-1553A/B Bus Transceiver (JB03A) device. The JB03A device is part of Aeroflex's standard product offering. It operates with the power supply at a nominal 5.0V.

The JB03A devices are built on a 0.6µm CMOS process, but utilize some bipolar transistors connected in a diode configuration. The foundry provides a bipolar transistor model which describes the electrical performance of this forward biased diode; this is the only reason the bipolar transistor was used for a diode. Unlike conventional bipolar transistors which could have gain degradation in a low total ionizing dose rate environment (enhanced low dose rate sensitivity – ELDRS), affecting circuit functionality and performance, the diode configuration should not suffer from ELDRS. Furthermore, because the bipolar transistor diodes are used in differential circuitry, any ELDRS related degradation will be matched in the circuit and automatically canceled-out. No circuit performance degradation was expected.

This diode is utilized in the reference voltage (Vref) portion of the JB03A circuitry. Aeroflex also evaluated this Vref voltage directly in two JB03A devices packaged in a 144-Pin grid array (PGA) characterization package. The ELDRS testing was performed to confirm the statement in the above paragraph with empirical data.

ELDRS Test Setup and Conditions

The ELDRS characterization procedures were carried out according to MIL-STD-883 Method 1019 ("Ionizing Radiation (Total Dose) Test Procedure"). A low dose rate (8 to 10 mrad(Si)/s) ^{60}Co gamma cell at BREL was used as the TID radiation source. Per Method 1019 two groups of devices were irradiated; one group was biased at the normal high dose rate biasing condition and the other group had all pins grounded. The production 36-pin dual in-line (DIP) package is a dual die multiple-chip module (MCM). Therefore only seven 36-pin DIP packages were used to satisfy the five devices per group and control requirement of Method 1019. The devices in the production 36-pin DIP package were burned-in and three temperature (-55°C, +25°C, +125°C) electrically tested prior to irradiation. For the biased group, V_{DD} = 5.5V during irradiation. All devices were electrically tested on the production Teradyne tester pre- and post-irradiation to the production electrical test program. The production test program was used for functional, AC, and DC parameter testing at the extremes of the operating power supply voltage range (i.e. 4.5V and 5.5V).

In addition to the devices irradiated in the production package, three devices assembled in a 144-pin grid array (PGA) package for direct measurement of the internal reference voltage were used for ELDRS characterization. Two of these devices were irradiated – one with biasing and one with all pins grounded. The third device was used as the control. These devices were not burned-in. Vref was measured in the laboratory with an HP34401A six-digit resolution meter.

For both the production packaged and characterization packaged devices, a control device was tested at each test point to verify the electrical test setup. Also, the same hardware was used at all electrical measurement points. That is, the 36-pin DIP devices were tested on the same Teradyne tester with the same loadboard and test program at each electrical measurement point. The characterization 144-PGA devices were measured in the laboratory with the same equipment and cabling at all electrical measurement points. Irradiation and all post-irradiation electrical measurements were done at room temperature.

The irradiation dose rate was 8 to 10 mrad(Si)/s. Two device under test (DUT) boards were required for irradiation to accommodate all devices. The DUT boards were positioned one behind the other radially from the ^{60}Co source so that the front (closest to the source) DUT board received radiation at a rate of 10 mrad(Si)/s and the back (furthest from the source) received radiation at 8 mrad(Si)/s. The position of the boards were interchanged approximately weekly so that each board received radiation at an average rate of about 9 mrad(Si)/s. During the exposure from 50 krad(Si) to 118 krad(Si), the DUT boards were removed from the ^{60}Co chamber for approximately 20 days to allow for maintenance. Accounting for this additional time the effective dose rate for this exposure period was close to 7.5 mrad(Si)/s. The radiation exposure started 4/25/2007. The devices were pulled from the ^{60}Co chamber on 6/25/2007 at a total dose of 50 krad(Si), electrically tested on 6/26/2007 and returned to the ^{60}Co chamber on 6/27/2007. The devices were pulled from the ^{60}Co chamber on 10/10/2007 at a total dose of 118 krad(Si) and electrically tested on 10/11/2007.

The test sequence was as follows:

1. Burn-in and three temperature test the 36-pin DIP devices. Electrically test Vref on the 144-PGA characterization devices.
2. Overnight mail the seven DIP devices and three PGA devices to Boeing Radiation Effects Laboratory (BREL) in a cooler with blue ice. The cooler and blue ice was necessary at this step to demonstrate the cold shipping technique prior to a post-irradiation shipment.

3. Irradiate six DIP devices and two PGA devices at 8 to 10 mrad(Si)/s to a total dose of 50 krad(Si) under two biasing configurations each, as described above. The remaining two devices were maintained as control devices.
4. Overnight cold ship the devices from BREL to Aeroflex.
5. Perform electrical test measurements on all devices at Aeroflex the same day the devices were received.
6. Overnight cold ship the devices from Aeroflex to BREL.
7. Continue irradiation within 56 hours after pulling the devices out of the ^{60}Co chamber for the 50 krad(Si) read point. Irradiate the devices under the same bias configurations as previous to a total cumulative dose of 118 krad(Si). For consistency of Aeroflex personnel performing the electrical test, the final TID level was extended beyond 100 krad(Si).
8. Overnight cold ship the devices from BREL to Aeroflex.
9. Perform electrical test measurements at Aeroflex the same day the devices were received.

ELDRS Characterization Results

All production 36-pin DIP devices passed electrical test (ET) on the production Teradyne tester pre-irradiation, post-50 krad(Si), and post-118 krad(Si). All parameters are specified with the same limits pre- and post-irradiation per the data sheet and the standard microcircuit drawing (SMD) [1,2]. The last sentence in Method 1019 section 3.13.1.1 Characterization test to determine if a part exhibits ELDRS, refers to a Δpara (radiation induced change in parameter) low dose rate to high dose rate ratio calculation and states "This test does not apply to parameters which exhibit changes that are within experimental error or whose values are below the pre-irradiation electrical specification limits at low lose rate at the specification dose." Therefore, the 50-300 rad(Si)/s (high dose rate) irradiation is not required and this device type is ELDRS immune to a total dose of 118 krad(Si). It is expected that since no ELDRS was observed at 118 krad(Si), no ELDRS would be observed at higher total doses on this device. Table 1 below summarizes the 36-pin DIP testing results on the Teradyne automated production tester.

Table 1. Electrical Test Summary of 36-pin DIP Devices Irradiated at 8 to 10 mrad(Si)/s

Serial Number	Irradiation Bias	Pre-irradiation Electrical Test	Post-50 krad(Si) Electrical Test	Post-118 krad(Si) Electrical Test
1	Control, no irradiation	Passed all ET parameters	Passed all ET parameters	Passed all ET parameters
8	Biased	Passed all ET parameters	Passed all ET parameters	Passed all ET parameters
9	Biased	Passed all ET parameters	Passed all ET parameters	Passed all ET parameters
10	Biased	Passed all ET parameters	Passed all ET parameters	Passed all ET parameters
11	All pins grounded	Passed all ET parameters	Passed all ET parameters	Passed all ET parameters
12	All pins grounded	Passed all ET parameters	Passed all ET parameters	Passed all ET parameters
13	All pins grounded	Passed all ET parameters	Passed all ET parameters	Passed all ET parameters

There are three reference voltage circuits in the JB03A device each containing at least one diode with the forward biased electrical characteristics modeled with the foundry's bipolar transistor model. All three reference voltages (Vref) were measured directly pre- and post-irradiation in the 144-PGA device. The three reference voltages are called "ref," "pos," and "neg." The maximum percentage shift for Vref was negligible as shown in Tables 2 to 4 below with a maximum shift of

-1.7% (Table 4). The electrical test dates for these devices were 12/11/2006, 6/26/2007, and 10/11/2007 for pre-irradiation, post-50 krad(Si), and post-118 krad(Si).

Table 2 Electrical Test Summary of "ref" Vref from 144-PGA Devices Irradiated at 8 to 10 mrad(Si)/s

Serial #	Irradiation Bias	ET V_{DD} (V)	Pre- (V)	Post-50 krad(Si) (V)	Post-118 krad(Si) (V)	Percent Change 50 krad(Si) (%)	Percent Change 118 krad(Si) (%)
2	Biased	5	1.33	1.35	1/	1.60	1/
2	Biased	5.5	1.35	1.33	1/	-1.11	1/
2	Biased	4.5	1.31	1.31	1/	0.19	1/
4	Control, no irradiation	5	1.40	1.40	1.40	-0.02	-0.03
4	Control, no irradiation	5.5	1.38	1.38	1.38	0.01	-0.01
4	Control, no irradiation	4.5	1.36	1.36	1.36	0.01	0.00
5	All pins grounded	5	1.31	1.31	1.31	0.11	0.02
5	All pins grounded	5.5	1.29	1.29	1.29	0.13	0.03
5	All pins grounded	4.5	1.27	1.27	1.27	0.12	0.02

Table 3. Electrical Test Summary of "pos" Vref from 144-PGA Devices Irradiated at 8 to 10 mrad(Si)/s

Serial #	Irradiation Bias	ET V_{DD} (V)	Pre- (V)	Post-50 krad(Si) (V)	Post-118 krad(Si) (V)	Percent Change 50 krad(Si) (%)	Percent Change 118 krad(Si) (%)
2	Biased	5	1.49	1.51	1/	1.48	1/
2	Biased	5.5	1.51	1.49	1/	-1.15	1/
2	Biased	4.5	1.47	1.47	1/	0.12	1/
4	Control, no irradiation	5	1.60	1.60	1.60	-0.04	-0.06
4	Control, no irradiation	5.5	1.58	1.58	1.58	-0.03	-0.06
4	Control, no irradiation	4.5	1.56	1.56	1.56	-0.01	-0.06
5	All pins grounded	5	1.49	1.49	1.48	0.01	-0.38
5	All pins grounded	5.5	1.47	1.47	1.46	0.00	-0.39
5	All pins grounded	4.5	1.44	1.44	1.44	0.01	-0.37

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Table 4. Electrical Test Summary of "neg" Vref from 144-PGA Devices Irradiated at 8 to 10 mrad(Si)/s

Serial #	Irradiation Bias	ET V_{DD} (V)	Pre- (V)	Post-50 krad(Si) (V)	Post-118 krad(Si) (V)	Percent Change 50 krad(Si) (%)	Percent Change 118 krad(Si) (%)
2	Biased	5	1.17	1.18	1/	0.98	1/
2	Biased	5.5	1.18	1.16	1/	-1.68	1/
2	Biased	4.5	1.15	1.15	1/	-0.38	1/
4	Control, no irradiation	5	1.24	1.24	1.24	-0.06	-0.07
4	Control, no irradiation	5.5	1.23	1.23	1.23	-0.03	-0.07
4	Control, no irradiation	4.5	1.21	1.21	1.21	-0.02	-0.06
5	All pins grounded	5	1.18	1.17	1.17	-0.31	-0.16
5	All pins grounded	5.5	1.16	1.16	1.15	-0.31	-0.15
5	All pins grounded	4.5	1.14	1.14	1.14	-0.33	-0.15

1/ The device labeled serial number 2 was damaged during the 118 krad(Si) irradiation. Failure analysis indicates the device was electrically overstressed in a manner indicative of an incorrect socket insertion (e.g. rotated 90° or 180°). See Appendix A for photographs of this device with melted bond wires.

The blue ice used in the cooler to keep the devices cool during shipment remained frozen during all shipments back and forth between Aeroflex and BREL. All equipment used for irradiation and electrical testing was calibrated and traceable to the National Institute of Standards and Technology (NIST). All irradiation and post-irradiation electrical testing was performed at room temperature.

Summary/Conclusions

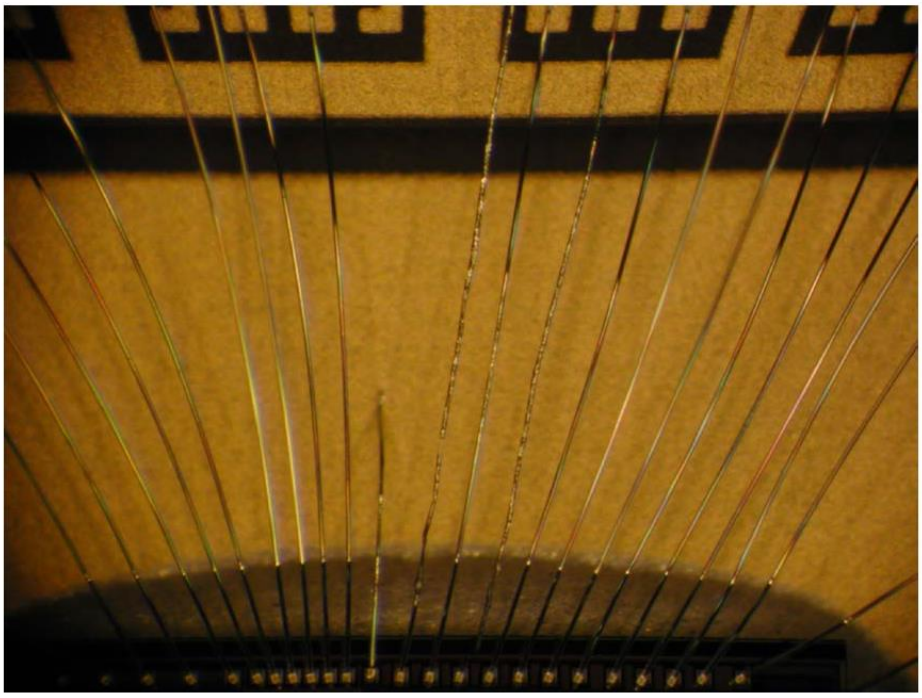
The Aeroflex UT63M147 MIL-STD-1553A/B Bus Transceiver device has been characterized for ELDRS and found to be insensitive to ELDRS effects to a total dose of 118 krad(Si). The JB03A devices were irradiated in two biasing configurations per MIL-STD-883 Method 1019 at BREL at a dose rate of 8 to 10 mrad(Si)/s and electrically tested pre-irradiation and at 50 krad(Si) and 118 krad(Si). The devices passed the SMD pre-irradiation electrical performance specification at all electrical measurement points. In addition, the post- to pre-irradiation electrical parameter shifts are negligible at both 50 krad(Si) and 118 krad(Si).

Although the total ionizing dose (TID) level is specified to higher levels for the UT63M147 device, the ELDRS characterization was done up to a TID level of only 118 krad(Si) due to the practicality of completing the ELDRS characterization in a reasonable amount of time. It is expected that if this device were ELDRS sensitive, the sensitivity would be observed at a total dose of 118 krad(Si).

References

[1] Data sheet, http://ams.aeroflex.com/ProductFiles/DataSheets/1553/Ut63M147.pdf
[2] SMD 5962-93226, MICROCIRCUIT, DIGITAL, BIPOLAR, DUAL CHANNEL, BUS TRANSCEIVER, MONOLITHIC SILICON

Appendix A: Photographs of 144-PGA device electrically overstressed due to incorrect socket insertion



MIL-STD-1553A/B UT63M14X Bus Transceiver Single Event Latchup Qualification Summary

Craig Hafer
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Aeroflex Colorado Springs
12/10/05 TAMU Test Date

SUMMARY--Single event latchup (SEL) qualification was performed on the Aeroflex Colorado Springs MIL-STD-1553A/B UT63M14X Bus Transceiver (Aeroflex PIC number JB03A) at Texas A&M University's (TAMU) Cyclotron Institute using their K500 cyclotron. Four JB03A devices were tested in dual cavity 36-pin dual in-line packages (DIPs) and were found to be immune to Single Event Latchup (SEL) to a linear energy transfer (LET) of 109 MeV-cm^2/mg when tested at 125°C and 5.5V V_{DD} (considered worst-case conditions for SEL). Each of the devices was exposed to an effective fluence of 1E7 ions/cm^2.

Introduction

This summary describes the SEL test procedure and data collected on the Aeroflex UT63M14X Bus Transceiver (JB03A). The JB03A is part of Aeroflex's standard product offering. It is a single power supply 5V V_{DD} 1553 bus transceiver.

The JB03A devices were fabricated at AMI Semiconductor, Inc. using their 0.5µm EPI CMOS silicon process. Total dose and single event radiation hardness is achieved using design and/or process techniques.

Experimental Conditions

To qualify the devices for SEL, xenon ions were used at a 60° angle of incidence from normal. The effective LET was 109 MeV-cm^2/mg. The 25 MeV/amu ion beam was used at TAMU.

The parts were tested under worst-case temperature and voltage for inducing single event latchup (SEL). In accordance with EIA/JESD57, SEL testing was done at 125°C and 5.5V V_{DD}. The devices were delidded prior to ion beam exposure.

The qualification test board contained a single 36-pin socket to accommodate the 36-pin dual die JB03A DIP. Channel A and channel B (device one and two of the dual die multi-chip module 36-pin DIP) were tested serially during SEL testing.

The JB03A devices were statically biased during SEL testing. Each device was exposed to an effective fluence of 1E7 ions/cm^2. The effective LET is equal to the LET at normal incidence multiplied by the secant of the angle of incidence while the effective fluence is equal to the fluence at normal incidence multiplied by the cosine of the angle of incidence.

Figure 1 shows a simplified diagram of the SEL test setup using a power supply with current meter interfacing to the device under test (DUT) board.

Aeroflex JB03A Qualification Summary

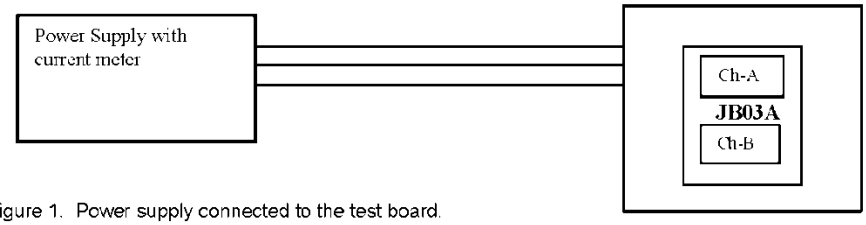

Figure 1. Power supply connected to the test board.

SEL Results

Four JB03A devices were tested for SEL, as discussed above. Table 1 summarizes the results of the test. As seen in the table, no single event induced latchups were measured at an effective LET of 109 MeV-cm^2/mg when exposed to an effective fluence of 1E7 ions/cm^2.

Table 1. Single event latchup data for the JB03A tested samples.

SN	Temp (°C)	V_{DD} (V)	Ion	Angle (Degrees)	Eff. LET (MeV-cm^2/mg)	Eff. Fluence (ions/cm^2)	Pre Current (mA)	Post Current (mA)	Latchup Y/N
1a	125	5.7	Xe	60	109	1.0E+07	42	42	N
1b	125	5.7	Xe	60	109	1.0E+07	42	42	N
2a	125	5.6	Xe	60	109	1.0E+07	43	43	N
2b	125	5.6	Xe	60	109	1.0E+07	43	43	N

Summary/Conclusions

Four devices of the JB03A were tested for SEL and were found to be immune to single event latchup to a LET of 109 MeV-cm^2/mg. All devices were tested to a fluence of 1E7 ions/cm^2. The devices were irradiated with 25 MeV/amu xenon ions at TAMU. The devices were tested under worst case voltage and temperature in accordance with EIA/JESD57 "Test Procedures for the Measurement of Single–Event Effects in Semiconductor Devices from Heavy Ion Irradiation."