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Quality assurance for space instruments built with COTS

Peter Buch Guldager*, Gøsta G. Thuesen, John Leif Jørgensen

*ØRSTED*DTU, Measurement and Instrumentation Systems, Building 327, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark*

Abstract

Instruments for space can be built with COTS. However no radiation data are available for COTS, so the only way to ensure that the components can survive the space environment is to irradiate each component. Samples from each Lot have to be irradiated, because the manufacturing process can be changed at any time and have major consequences to the components ability to survive the space environment. A safe way to protect to components, which are not Latch-Up immune, is to protect the components with a Latch-Up protection circuit. A strict control has to be established, when procuring COTS component, testing and manufacturing the instrument before the instrument is qualified for space. By having a strict control with instrument built with COTS, it is possible to manufacture a reliable instrument as with Rad-Hard components.

1. Introduction

There are several ways to build an instrument for space; you can manufacture the instruments by using components designed for space (Rad-Hard components)/military components or by using COTS. If you are using components qualified for space applications, the size of the instrument will be larger and more power consuming compared to instruments based on COTS SMD. The advantage of using COTS is the increased functionality, the speed of the instrument and less power consuming, but how do you ensure, that the instrument will survive the launch, the radiation aspects for EEE components in space and the lifetime in space? How do you control the production of an instrument, when using COTS?

2. Selection procedure for COTS

There is not the same traceability with COTS compared to space/military components, but this does not imply that it is not possible to use COTS when designing an instrument for space. How do you control the quality of the instrument, when it is built with COTS? The way to do this is by testing at component level or at board level or at unit level. For instruments used in space, one of the major concerns is the radiation aspect for the EEE components. When using COTS, no radiation data are available for the EEE component and you have to ensure the component will survive

* Corresponding author. Tel.: +45 45253460; fax: +45 45887133.
E-mail address: pbg@oersted.dtu.dk (P.B. Guldager).

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the entire lifetime of the mission. A reliable way to do this is to test each component for total ionizing dose (TID) and monitoring different parameters for each component during the irradiation. Comparison of the test results from the irradiation test with the results from space shows that this is a very reliable way to ensure the radiation tolerance [1].

When designing a new instrument, different candidates of the components have to be chosen. Test samples of the components have to be irradiated to see if they can survive the radiation and the best candidate is selected. If the component has passed the radiation test, a new Lot is acquired and more samples are irradiated to verify the same result as from the test samples. When the new Lot has passed this radiation test, it can be used on the final instrument, if it does not fail any of the other tests later on (radiation, EMC, vibration, thermal cycling, outgassing, proton testing (30–300 MeV), shock, accelerated life test, etc.). The EEE components and the instrument have to pass all the other tests, before it has proven its reliability and quality for space.

3. Variations in Lot-to-Lot and manufacturing process for COTS

The manufacturing process can be changed at any time without any notice to the end-user of the EEE components. The changes can be minor or major, but the result of these changes can have major impact on the components capability to survive in space due to the radiation environment. The next section will show the consequences, when minor and major changes have been done on the manufacturing process, which will affect the EEE component resistance to radiation.

3.1. Variation due to changes in the manufacturing process

When using COTS for manufacturing instruments for use in space, the buyer of the EEE component has to be aware of the possibility, that the manufacturer of the EEE component can change the manufacturing process without any notice to the end-user of the components. The reason for changing the manufacturing process can be many; it can be to minimize the number of failures during the chip manufacturing or changing rise/fall time for a parameter to increase the speed for the component etc.

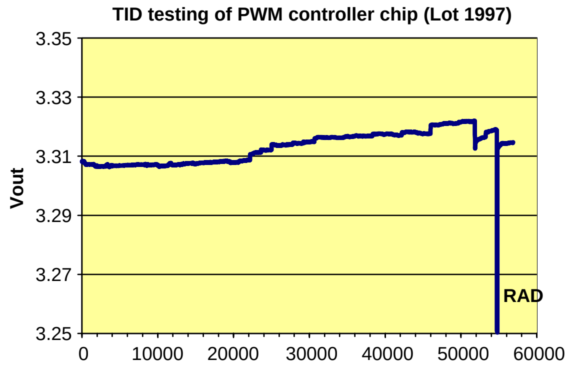

Fig. 1. TID results for the old Lot before any changes in the manufacturing.

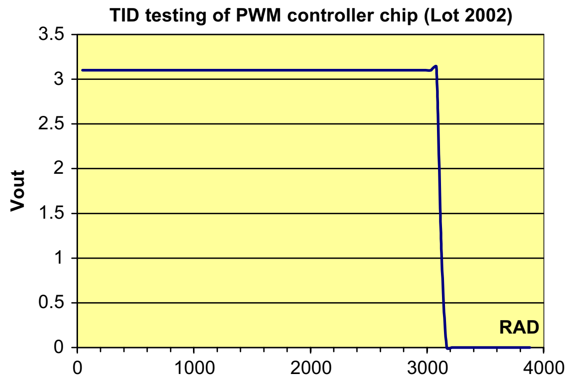

Fig. 2. TID results for the new Lot after the manufacturing process have been changed.

The impact for instruments built with COTS is very critical, if the manufacturing process changes. Figs. 1 and 2 show a radiation test of a controller chip used in a DC/DC converter (3.3 V output). The TID test shows the current-mode PWM controller for the DC/DC converter before (Fig. 1) and after (Fig. 2) the manufacturing process was changed. The two figures show the output voltage as function of dose rate. For the old Lot from 1997 the first symptoms that the irradiation of the chip, starts to impact the chip from 52 Krad (the voltage drops), and at 54 Krad a failure in the output voltage (0.5 V, cannot be seen in Fig. 1).

For the same chip from the Lot 2002, Fig. 2 shows that the controller chip fails at 3.1 Krad. This shows,