Ethernet PHY Characterisation

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Time Triggered Ethernet (TTE), as a safety oriented bus, is a potential candidate for the main avionics bus for launchers and manned missions. The decision to use TTE was made for two significant projects: NASA-Orion and ESA-Ariane 6 launcher.

The introduction of an Ethernet-based network in spacecraft systems will require the availability of an appropriate Ethernet PHY. This transceiver shall be able to withstand the harsh environmental constraints in terms of radiation, thermal variations, vacuum. Developing a high reliability component that meets these stringent requirements is a long and very expensive process, while its market share is very narrow. The use of commercial off-the-shelf components could become an attractive solution, at the price that significant effort has to be dedicated towards the part qualification.

In this activity we have selected three different COTS transceiver originating from different manufacturers: Marvel (88E1111), Lantiq (XWAY PHY11GPEF 7072) and Vitesse (VSC8501) and developed an FPGA based EGSE platform for testing. Environmental and radiation tests (TID, SEE), were performed to achieve a well-characterized Ethernet transceiver wafer lot and to assess the suitability for use in space systems.

Environmental tests

A number of three samples per each manufacturer was used for each test.

Thermal cycles

Electrical and functional tests were conducted before and after the test. The time lapse for the test amounted to approximately 11 days and 100 cycles were programmed, with temperature ranging from -55°C to 125°C. All samples remained fully functional after the test.

Vacuum test

The samples were placed in a small vacuum chamber and they were heated at 55°C. The pressure in the chamber reached 10^{-5} mbar and it was maintained for 24 hours. The samples passed successfully the vacuum test.

Outgassing

Test specification and performance are in accordance with the ESA ECSS-Q-ST-70-02C standard. All samples were found to be compliant.

Offgasing

The offgasing test was conducted in accordance to the ESA ECSS-Q-ST-70-29C standard. All the suppliers have passed the acceptance test.

Radiation tests: Total ionizing dose

The samples were irradiated up to a TID level of 50krad and found functional.

Heavy ions and protons Soft Error Effects

The parts were irradiated with heavy ions up to an LET of 60MeVcm2/mg and the soft error modes were mapped and quantified. Following was observed:

-Lantiq parts were sensitive to micro-latch-up and latch-up effects.

-Vitesse, Lantiq and Marvell parts have the onset LET threshold of the Single Event of Data Loss at an LET of 20 MeV cm^2/mg.

-all parts are more sensitive to Single Event Upsets in the Gb/s mode than in the 100 Mb/s mode- by approximately a factor 10.

From the radiation point of view, Lantiq could be excluded from the selected parts. The Vitesse transceiver has smaller SEU cross-sections than Marvell, which translates in a smaller error rate in all possible mission scenarios. The question of device availability during soft error functional interrupts has to be addressed specifically for every mission type, since here the cross-sections are higher that of the data loss.

All in all, in the perimeter of this activity it was shown that all the parts passed successfully the environmental tests, while one supplier failed at the radiation testing.