Project

ACN – HIFAS

Total Dose Radiation Test Report

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Change Record

Revision	Date	Paragraph	Comment
A		All	Initial release

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1 Test setup and procedure

1.1 Device under test

The primary device under test were the HIFAS full custom ASIC.

Additional main devices also present on the test board, were an Actel ProAsic Plus FPGA and two Linear Technology DACs for reference level generation.

Figure 1.1 shows the test board which after slight modification, was used for the radiation test.

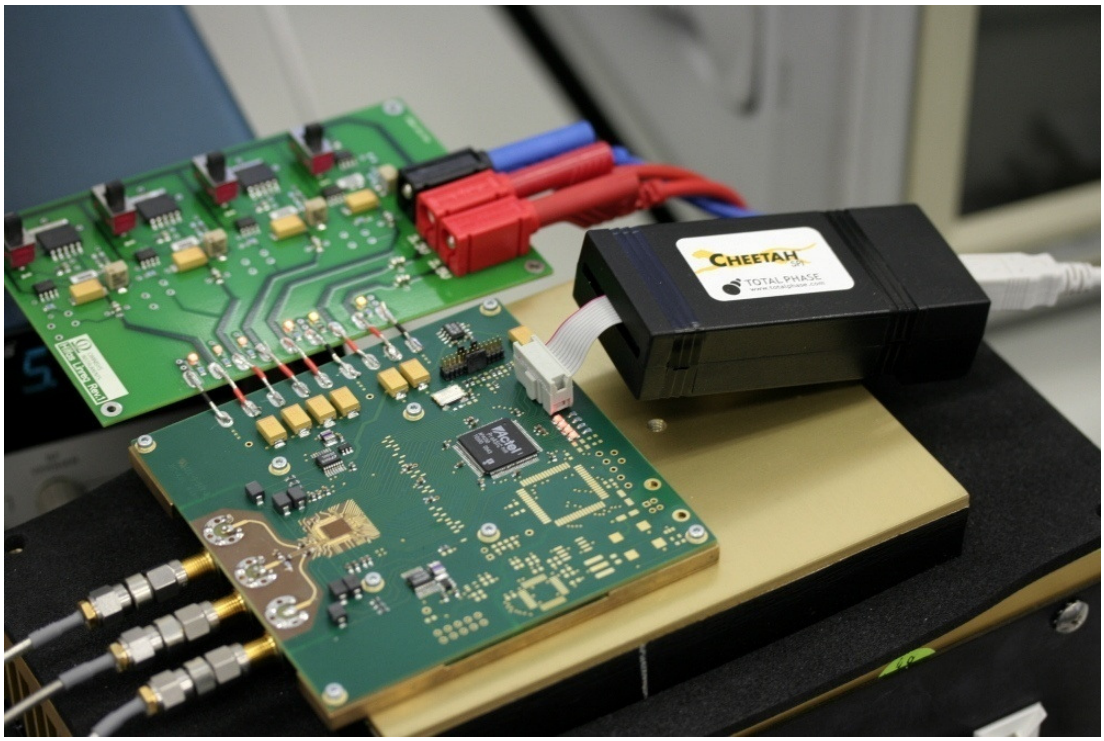

Figure 1.1 Radiation testboard

The original plan was to irradiate only the HIFAS chip. However, it proved to be better to irradiate an area of about 50 x 50mm centred on the HIFAS chip to get a more reliable dose rate measure.

1.2 Test setup

The irradiation was performed at Sahlgrenska (University Hospital in Gothenburg), using a cobalt-60 source calibrated for a dose rate of about 500 Rad/h, calculated to give about 30kRad over a 3-day test campaign.

The dose rate was calculated using the following method:

The radiation source (60-Co) has a certain activity (X TBq). The distance from the source, the collimation and the depth in, for instance, a plastic phantom influence the radiation dose (Gy or

rad) or dos-rate (Gy/h or rad/h) where the sample is irradiated. For determination of these quantities (dose or dose-rate) we use an ionisation chamber which is calibrated in a reference radiation field. With help of the calibration factor as well as the measured signal (charge, nC) and correction factors the dose or dose-rate can be calculated.

Figure 1.2 shows the test setup.

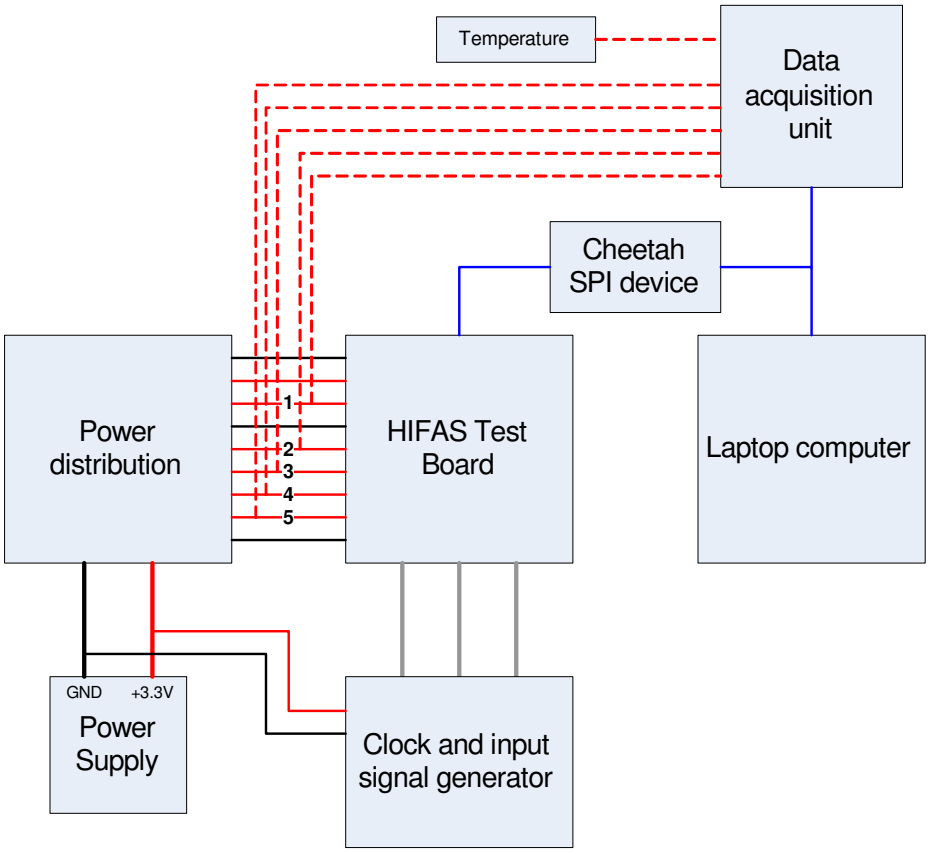

Figure 1.2 Test setup

A power supply provides the +3.3V power source needed by the distribution board to generate all necessary voltage rails for the test board.

A clock and input signal generator board generates a 1GHz sampling clock and a 100MHz data signal which is fed to both I and Q input.

A data acquisition unit is used to log voltages and currents to the HIFAS test board as well as the ambient temperature.

A Cheetah SPI adapter is used to communicate with the test board (read out data).

A Laptop computer is used to control the data acquisition unit and store the HIFAS chip data.

1.3 Monitored signals

The following signals were monitored by the data acquisition unit:

+3.3V supply voltage for the reference level DACs noted as ‘1’ in Figure 1.2.

+3.0V supply voltage and current for HIFAS chip data readout buffers noted as ‘2’ in Figure 1.2.

+1.8V supply voltage and current for HIFAS chip CMOS core power, noted as ‘3’ in Figure 1.2.

+1.8V supply voltage and current for HIFAS chip bipolar digital power, noted as ‘4’ in Figure 1.2.

+2.5V supply voltage and current for HIFAS chip bipolar analog power, noted as ‘5’ in Figure 1.2.

Besides the above mentioned voltages and currents, the ambient temperature was also monitored.

1.4 Test procedure

The HIFAS correlator was set up to run in complex mode with maximum number of lags (4x512) enabled. It was set to constantly correlate the input signal of 100 MHz with a 1 GHz clock during the irradiation period but no readout was performed.

Three times during the test period, the radiation source was paused for 5 minutes or so and a test measurement with an integration time of one second was performed to see that the correlator was still working as expected.

A backup of all logged data was also performed.

2 Results

2.1 Voltage variations

Figure 2.1 shows the monitored test board supply voltage variations versus radiated dose. All variations are small and within normal behaviour.

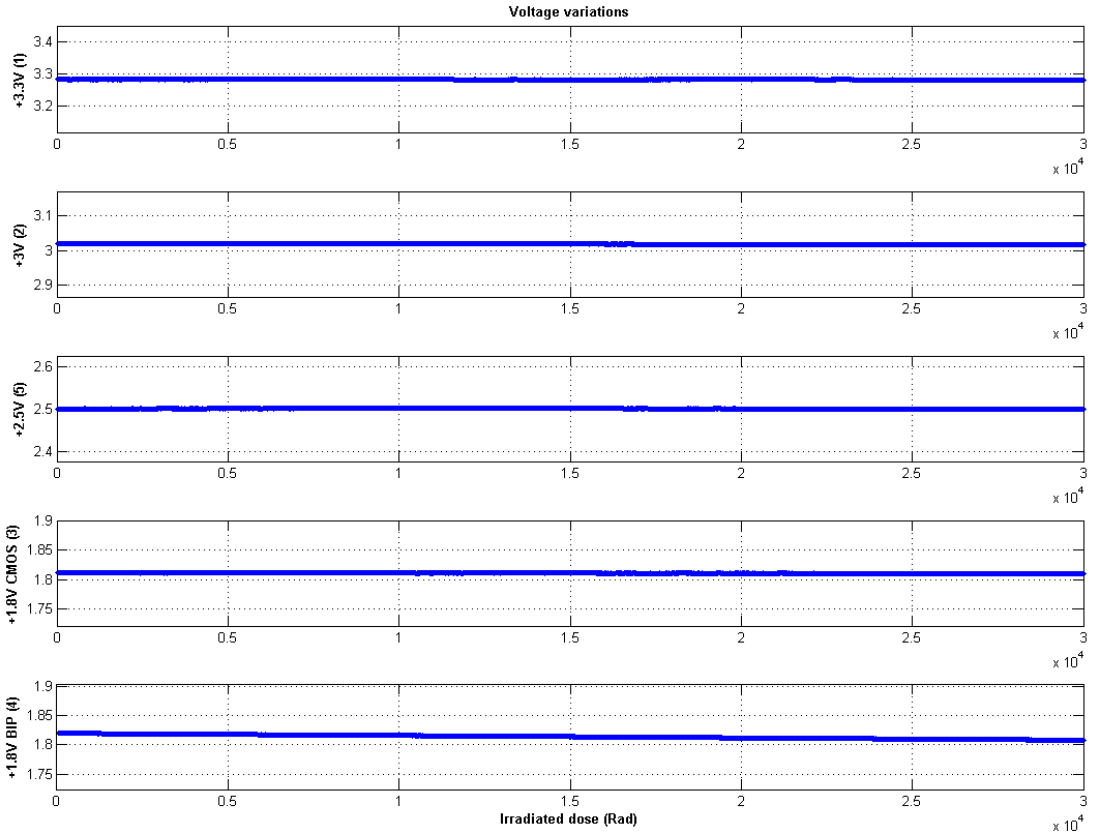

Figure 2.1 Voltage variations versus irradiated dose

2.2 Current variations

Figure 2.2 shows the monitored test board supply current variations versus radiated dose. All variations are small and within normal behaviour.

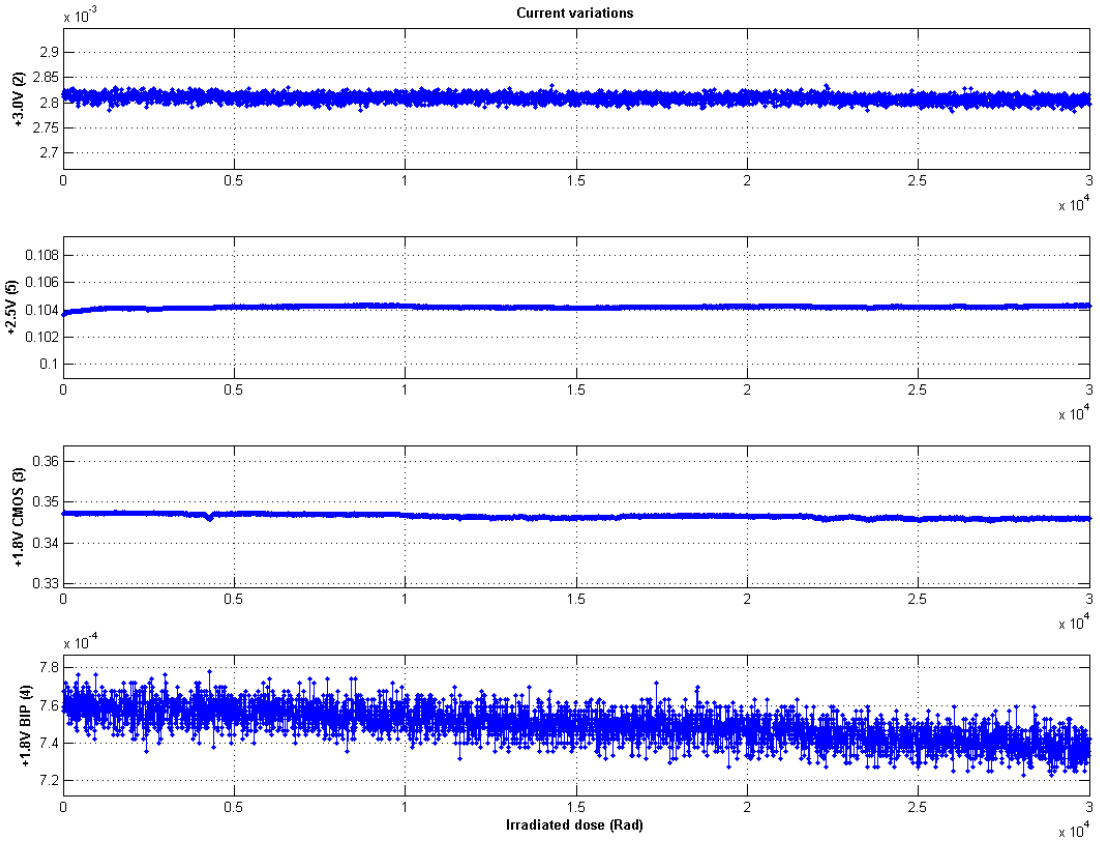

Figure 2.2 Current variations versus irradiated dose

2.3 Temperature variations

Figure 2.3 shows the ambient temperature variations during the measurement time. The variations are within 0.5 degrees.

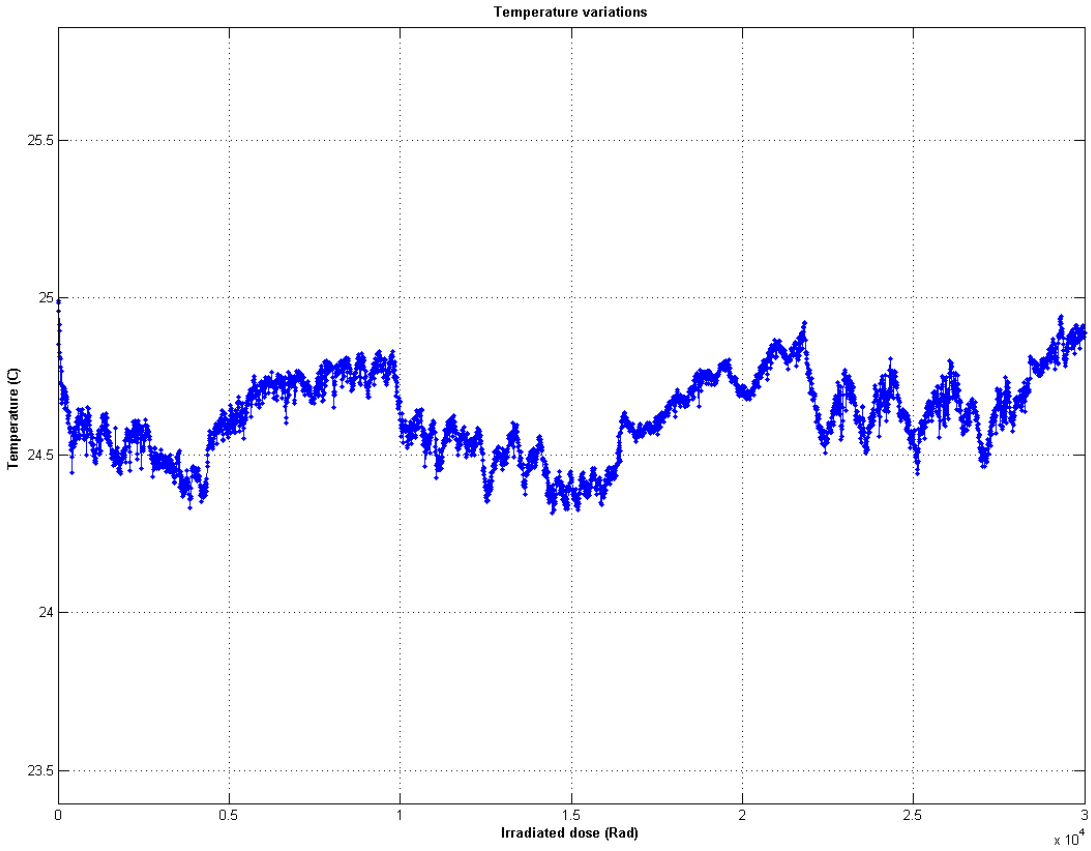

Figure 2.3 Ambient temperature variations versus irradiated dose

3 Performance after radiation

3.1 Maximum speed test

A performance measurement, maximum speed, was performed in our lab after the total dose radiation campaign after annealing of 4 weeks at room temperature. This test investigates the maximum possible clock frequency when running with a CW signal.

3.2 Test setup

A sweeper CW signal of 1.9 GHz is connected to a splitter and routed to both I and Q inputs. Another sweeper is connected as a clock source for the correlator.

3.3 Test procedure

The correlator is set up with full resolution and real mode.

One second integrations are then performed and the clock frequency increased with 100 MHz until the frequency is found, where the data “fades out”.

3.4 Result

The maximum clock frequency is 6100MHz which is the same as before radiation for this test board. See Figure 3.1 for plots of both successful and failing measurement.

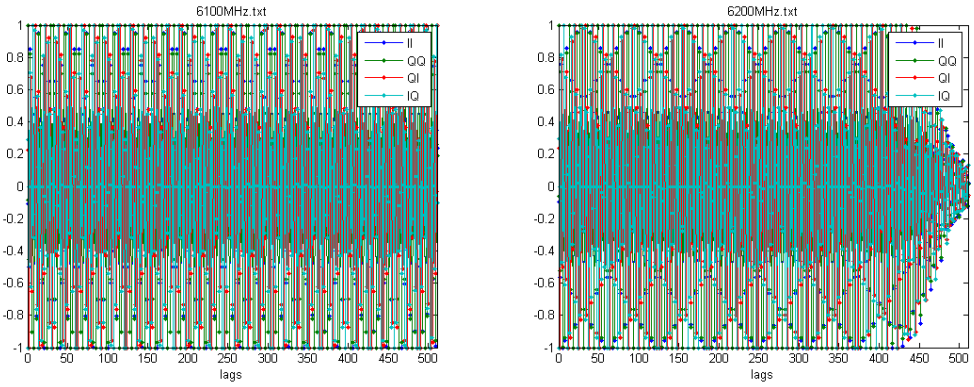

Figure 3.1 Maximum speed performance

4 Conclusions

The HIFAS chip was not visibly affected by the 30kRad radiation dose from the cobalt-60 source.