Contribution ID: **69** Type: **Oral**

Design and Radiation Assessment of Optoelectronic Transceiver Circuits for ITER

Tuesday, 16 September 2008 17:05 (25 minutes)

We present the design and characterization results of different electronic building blocks for a MGy gamma radiation tolerant optoelectronic transceiver aiming at ITER applications. The circuits are implemented using the 70GHz fT SiGe HBT in a 0.35µm BiCMOS technology. A VCSEL driver circuit has been designed and measured up to a TID of 1.6 MGy and up to a bit rate of 622Mbps. No significant degradation is seen in the eye opening of the output signal. On the receiver side, both a 1GHz, 3kΩ transimpedance and a 5GHz, 20dB Cherry-Hooper amplifier have been designed.

Summary

In future nuclear fusion reactors, in casu ITER (International Thermonuclear Experimental Reactor), the requirements of integrated electronic circuits with respect to radiation tolerance are quite severe. For instance, during remote-handled maintenance tasks, several systems and circuits will need to remain operational even after exposure to a TID (Total Ionizing Dose) in the order of MGy. The development of instrumentation for controlling the robotics needed to perform these periodic maintenance tasks in the reactor core is therefore challenging. The anticipated gamma radiation levels are similar to those expected in the S-LHC. This paper will focus on the potential use of a fiber optic communication link as an umbilical between the robotics and the control room. More specifically we will present and discuss our recent results on the design and assessment of the radiation hard optical transceiver electronics. All circuits are implemented using the 70GHz fT SiGe HBT in a 0.35µm BiCMOS technology.

For the transmitter side a driver was implemented for a long wavelength (1550nm) VCSEL (Vertical Cavity Surface Emitting Laser). The circuit was tested before, during and after several Co60 gamma irradiation experiments up to a TID of 1.6MGy. The off-line measurements of the driver applying a 27-1 PRBS up to 622Mbps reveal a near constant eye opening in the output signal. The output current through the laser for a digital 1 input will be shown to remain constant within 0.2%, as obtained from the measured data during irradiation. These results can be related -through SPICE simulations- to the characterization results of the individual transistor components under the same radiation conditions. Even though several transistor parameters are observed to shift dramatically, the performance characteristics of the driver show only minimal degradation.

On the receiver side several electronic building blocks have been designed in the same 0.35µm BiCMOS technology. The TIA (TransImpedance Amplifier) is the first block after the photodiode and converts the diode current into a voltage, sufficiently high above the noise floor of the subsequent PA (PostAmplifier). The TIA features a transimpedance gain of 3kΩ for a 1GHz bandwidth. The equivalent input noise current given by the integrated output noise voltage divided by the transimpedance gain is 0.6µA. The circuit was designed taking transistor radiation effects into account. We included the previously measured degradation in the simulation via a DC SPICE model extension of the bipolar transistors. For the PA a sequence of differential bipolar Cherry-Hooper amplifiers was designed with a simulated bandwidth of 5GHz and a gain of 20dB per stage. The receiver circuits are currently being processed.

In summary, we will present recent design and characterization results on the most critical electronic building blocks in a MGy radiation tolerant optoelectronic transceiver for application in ITER. All circuits were designed in a 0.35µm SiGe BiCMOS technology.

Primary author: Prof. LEROUX, Paul (K.H.Kempen)

Co-authors: Dr VAN UFFELEN, Marco (SCK-CEN); Dr DE COCK, Wouter (SCK-CEN)

Presenter: Prof. LEROUX, Paul (K.H.Kempen)

Session Classification: Parallel session B2 - Optoelectronics