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Development of a compact test board for silicon sensors IV/CV characterization

To build a new CMS Phase II tracker system [1] in the framework of High Luminosity LHC (HL-LHC), more than ten thousand silicon strip modules have to be produced and tested. The Belgium production center at the IIHE, contributing to this collective task, has decided to build about 2000 dual silicon strip modules for one endcap of the outer silicon tracker. Integration centers in UCL (Belgium) and Lyon (France) will assemble those modules to form one endcap that will be later installed in the CMS detector at CERN. The modules in the new tracker will have to reliably work during 10 years under harsh irradiation conditions, as it will be impossible to replace a failing module once installed inside CMS. It means that reliable and rigorous testing of strip modules and its components becomes necessary. There are numerous tests to be done for the quality control (QC) of them: hybrid functional tests, sensor test including visual inspection and IV/CV measurements, module functional tests, etc. To sustain the production throughput we should be able to test several modules in parallel. For this reason a fast, reliable, scalable and cost effective production QC test bench has to be designed and implemented. For the CV and IV measurements of sensors and modules we are developing a low-cost (less than 500€) integrated electronic board which will be scaled up to ten channels to measure DUTs (device under test) in parallel to provide the following features:
• generation of high reverse bias voltage up to 1 kV to deplete the silicon sensors;
• provide 250 mV, 1 kHz sine wave and adequate biasing for CV measurements;
• measure of the reverse-bias leakage current and the junction capacitance;
• low voltage supplies for front-end electronics found on modules;
• monitoring environmental data (temperature and humidity);
• overcurrent protection on High voltage channels with hardware and firmware sequences to safely handle faults.
In the current work the design of the IV/CV board and the calibration procedure to increase the accuracy of the current and capacitance measurements, for which a special calibration dipole board based on tight tolerance capacitors and resistors has been designed, as well as future development plans are described.

[1] CMS Collaboration. “The Phase-2 Upgrade of the CMS Tracker Technical Design Report”, CERN-LHCC-2017-009, CMS-TDR-014, 2017.
[2] Ali Safa. “Characterisation of the new tracker sensors for the CMS experiment at CERN”. Master thesis (2019).

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