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Overview of Electronics Developed by ISE for the European Spallation Source Project

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The Institute of Electronic Systems (ISE) of shall design and deliver hundreds of pieces of various control, signal distribution, and safety modules to be used at the European Spallation Source research facility by the Low-Level RF control, Phase Reference, and Beam Diagnostic systems. This contribution presents the design, as well as strategies and results of acceptance testing of selected modules produced by ISE for the project.

Summary

European Spallation Source (ESS), currently constructed in Lund (Sweden), is a research facility based on a 2000 MeV proton linac, that will deliver neutrons for material sciences. A significant part of the project is designed and delivered by partner laboratories as in-kind contributions from various countries. The Institute of Electronic Systems (ISE) of the Warsaw University of Technology (WUT) shall design and deliver hundreds of pieces of various control, signal distribution, and safety modules to be used at the ESS facility by the Low-Level RF (LLRF) control, Phase Reference and Beam Diagnostic systems.
An RF SplitBox module was designed by the ISE team to distribute RF signals shared between the LLRF control and interlock systems. The device must be configurable at the production phase to support different RF power levels and frequencies. It must also introduce as little temperature induced phase drifts as possible. Multiple long-term measurements of various high-frequency power dividers were performed. Transformer and integrated components were rejected in favor of a custom designed Wilkinson divider. Scattering parameters of each unit are measured to verify proper operation by an automatic test-stand.
The Phase Reference Line system for the ESS is designed as a passive, almost 600 m long 1 5/8” coaxial rigid line distributing 352 MHz and 704 MHz signals to almost 300 outputs located along the proton linac tunnel. The entire line is temperature stabilized down to +/- 0.1 degree C to assure phase stability reaching 0.1 degree. The PRL project consists (among others) of more than 150 sections of the coaxial rigid line including precise temperature control hardware, 56 diplexer and power splitter modules as well as almost 20 temperature control boxes. All PRL components passed rigorous RF parameters, signal phase drift and production tests within test setups designed for this project.
The Personal Safety System Relay Switch shuts off the RF signal at the input of a high power amplifier feeding the accelerating cavities. It must be robust and assure high reliability. The testing procedure includes measurement of current consumption and logic outputs as well as scattering parameters.
ISE also co-designed and manufactured front-end modules for signal conditioning of the Beam Current Monitors (BCM). To assure reliable operation of devices each piece must be tested in a repeatable manner. A dedicated automated test-stand was prepared for the BCM subproject. The BCM front-end filters the input signals and matches their voltage range to the level compatible with the uTCA digitizer cards. The stable-over-time pulses can be generated to calibrate the system. To achieve high availability, two redundant power supplies were used and are automatically switched on-line in case of failure. A random unit was selected for long-term observation. Every second a calibration pulse was triggered and recorded with an oscilloscope. One hundred thousand waveforms were acquired and compared with each other. Later each device was tested with waveform count reduced to 200 cycles.
This contribution presents strategies and results of acceptance testing of selected modules produced by ISE

for the ESS project.

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