Report on the Results of the Tests Performed on the CAEN SY4527 Mainframes and A7030TN Modules Procured for the Photomultiplier Tubes of the Hall C Neutral Particle Spectrometer

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Essential features—voltage stability, current stability, current trip, and voltage ramp—of the CAEN SY4527 mainframe and the associated A7030TN high voltage modules procured for the photomultiplier tubes (PMTs) of Hall C's Neutral Particle Spectrometer (NPS) were tested [1–22]. For these tests, requisite hardware and software were developed. This report presents the test results.

The NPS high voltage system comprises two CAEN SY4527 mainframes and thirty-four A7030TN modules. Features—voltage stability, current stability, current trip, and voltage ramps—essential for operating the PMTs of NPS were tested.

Figure 1 shows the test stand—a fully populated crate with 16 modules, in which each of the 36 channels to be tested is connected via a Radiall-connector-to-SHV-connectors adapter box to a 2 MΩ resistor in the a load chassis.

FIG. 1 Test stand.

To test relevant CAEN output control and monitoring parameters and to check whether their setpoints were stable, values of all channels of all modules in the crate were recorded with CAEN's proprietary GECO2020 software.

A package of programs in Java, EPICS, and Python was developed to analyze the acquired data.

Initial testing identified errors in parameter setpoints (channel parameters randomly changed their values), monitoring (incorrect readback values), and EPICS control commands (latencies—random channels did not receive EPICS commands the first time they were sent). To resolve these issues, firmware revisions were implemented in the mainframe and in all the modules.

For the voltage stability and current stability tests, voltage of all channels of all 16 modules in the crate was set to 1500 V. Voltage and current readings of all 36 channels of all modules were recorded for ~24 hours.

Data were analyzed with the Python program *stabilityVandC.py*, which was developed to plot the average readback voltage, as well as the average readback current for all channels of all modules tested. For each channel, the average and the standard deviation over the ~24-hour-period dataset were computed by the program.

Voltage stability analysis indicates that most modules perform as expected. Of the 34 modules tested, two modules, #297 and #299, are defective.

Current stability analysis indicates that channel #9 of all modules, except module #353, is ~2 μA higher than the specification.

To test the trip feature, each channel's current limit and time-over-threshold was set to 740 μA and 1 s, respectively. Using a Javascript embedded in a CSS-BOY screen, via EPICS commands sent to the module's process variables, each channel of the module under test was ramped, one at a time, at a rate of ~200 V/s, from 0 V to 1500 V. When the channel reached the voltage at which the current was greater than 740 μA, the channel entered the *Over Current* state and tripped.

From the logged data, the Python program *tripAnalysis.py* generated plots, which were analyzed and issues noted. Trip test analysis indicates one channel, #15 of module #128, did not trip.

For the ramp test, all channels of the 16 modules in the crate were simultaneously ramped up and down three times from 0 V to 1500 V at a ramp rate of ~200 V/s, with a dwell time of 3 s at 1500 V and at 0 V. To send commands directly to the modules' process variables, the Python program *rampCommand.py* was developed.

To generate plots from the acquired data, the Python program *rampAnalysis.py* was developed. Ramp test analysis indicates that except for channel #13 of module #349, which failed to ramp above 75 V, all channels ramped up and down as expected. No latencies were observed.

In summary, crucial features—voltage stability, current stability, current trip, and voltage ramp—were tested.

Most modules, with the exception of a few channels in some modules, performed as expected; see summary. Modules with issues should be returned to CAEN for repairs.

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