

Smart Switch based High Voltage Distribution System for Mu2e Electron Tracker

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The design and development of a High Voltage distribution system (HVDS), Smart Switch (SS) which acts as a Demultiplexer, to distribute one high voltage(HV) input into six High Voltage output channels. It provides, and independently voltage and current monitors. Each output channel of the SS has independent, ON-OFF, current and HV monitoring, as well as filtration, isolation, and a crowbar for over-current protection. The inter-communication system is based on TCP/IP protocol through a Raspberry Pi. The performance of the HVDS was found to be comparable to commercial High Voltage Power supplies.

Summary (500 words)

The descriptions of the HVDS, are summarized below. The Electron Tracker (ETD) consists of eighteen stations with each station containing 1152 straw detectors. stations has 2 planes and each plane has six panels of 96 straw detectors. Each plane has independent HV input, control, filtration, and crowbar systems. The high voltage power supplies have active, over-voltage protection for each plane. A ground reference for the HV-power return is established at the panel by a connection to the station ground. There is a supply and return cable for each panel, and power connections are made through vacuum penetrations which are isolated electrically from the supporting structure.

Ground loops are eliminated by using isolated power supply outputs. Each plane has independent HV input, control, filtration, and crowbar systems. Safety ground is provided by station ground connections. To minimize delay and provide a fast crowbar trip, the detector HVDS is placed near the stations. A straw drift field voltage of 1.45 to 1.5 kV, with a maximum, supplied current of 250 μ A (beam on target) is provided. The accuracy of a voltage is approximately 0.1V The current readout is better than 15 bits (10 nA @ 250 μ A max). There are four connections to the HVMB; A low voltage output and ground and two outputs to interface with an Arduino board. Each panel has independent HV input, and a filtration and crowbar system. The high voltage power supplies have active, over-voltage protection to each unit when an abnormal fault is sensed. A ground reference for the HV-power return is established at the panel by a connection to the station ground. There is a supply and return cable for each panel, and power connections are made through= vacuum penetrations which are isolated electrically from the supporting structure. Ground loops are eliminated by using isolated power supply outputs. Safety ground in this design is provided by station ground connections. To minimize delay and provide a fast crowbar trip, the detector HVDS is placed near the stations. A straw drift field voltage of 1.45 to 1.5 kV, with a maximum, supplied current of 250 μ A. A (beam on target) is provided. The accuracy of the voltages is approximately 0.1V and the current readout is better than 15 bits (10 nA @ 250 μ A). The new High Voltage Mother Board (HVMB) has 12 daughter boards. There are six Smart Switches for each panel, one HVMB for each station. For testing of the SS, we develop HVMB contains six SS boards with the crowbar circuit. It is a small board, "2 x 4", and has the capability of ON-OFF for individual channels, HV/LV isolation up to 2 KV, filtration, and panel protection if the discharge occurs in a panel. The size of all the SS boards is identical. Each SS has two ADCs one is a voltage monitor using a voltage divider (1000 to 1) and the other a current monitor using a shunt from an isolation amplifier.

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