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A High Voltage System with 60 High Voltage Power Supply Channels in 2U Height EURO Crate

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A high voltage system includes 60 high voltage power supply channels in a 2U height EURO crate. The system is interfaced with a computer through USB interface. The output voltage of the channel ranges from 1 kV to 4 kV with an output current of more than 100 uA. Ripples on the output voltage is less than 100 mV in peak-to-peak amplitude. The output voltage can be set and monitored with 1 V resolution. The output current is monitored with 9-bit resolution at the sampling rate of 80 Hz. The channel is provided with over-current shut-down. A hardwired logic turns off the output voltage when the output current exceeds a prescribed limit current in a predefined time interval, where the limit current and the time interval can be set by the computer. Since high voltage is generated by a ceramic transformer, the system can be operated in a magnetic field of 1 T. The high voltage system satisfies the CERN Radiation Hard Criteria required for TGC power supplies.

Summary

A high voltage system includes 60 high voltage power supply channels in a 2U height EURO crate. The system is composed of 20 high voltage (HV) card and an interface card, where the interface card is located at the 21-th slot. Three high voltage power supply channels are implemented on the HV card with control logic. A back-plane bus is shared among the cards for communication and voltage distribution.

A ceramic transformer is utilized to generate high voltage in the channel. The high voltage is rectified to be the output voltage. A driver circuit generates a carrier to drive the ceramic transformer. The HV card is supplied with 3.5 V and ±5V. The driver circuit is supplied with 3.5 V. An analog circuit to stabilize the output voltage is powered by ±5V. The control logic on the HV card is mostly digital logic electrified by 5 V. The system is supplied in total with 40 A of 3.5 V, 20 A of 5 V and 1 A of -5 V.

The interface card is equipped with USB interface, and the high voltage system is connected to a computer by a USB cable. The channel can supply the output voltage ranging from 1 kV to 4 kV with a load of larger than 30 Megohms. Ripples on the output voltage is less than 100 mV in peak-to-peak amplitude. The output voltage can be set and monitored with 1 V resolution. The output current is monitored with 9-bit resolution at the sampling rate of 80 Hz. The channel is provided with over-current shut-down. A hardwired logic turns off the output voltage when the output current exceeds a prescribed limit current in a predefined time interval, where the limit current and the time interval can be set by the computer.

The ceramic transformer takes the place of the conventional magnetic transformer. The ceramic transformer utilizes piezoelectric effect to generate high voltage. The ceramic transformer is constructed from a ceramic bar and does not include any magnetic material. So the transformer is free of leakage of magnetic flux and can be operated efficiently under a magnetic field. The high voltage system can work without a loss of efficiency under a magnetic field of 1 T.

The HV cards have been irradiated by cobalt 60 up to 300 krad successfully. The HV cards have been exposed to a protons flux at PSI. The exposure amounts 60 MeV 1E11 protons without causing problems. The exposure is equivalent to 1E11 neutrons and 14 krad. So the radiation test shows the HV card and then the high voltage system satisfies CERN Radiation Hard Criteria required for TGC power supplies.

The high voltage system is now used in a beam test of TGC in CERN. The high voltage system is now put to final cost reduction. The price is not yet settled, while the

design goal of the price is targeted between 100 euros and dollars per channel.

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