Development of High Voltage Power supply for RPC detectors

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Introduction

To study the performance of Resistive Plate Chambers (RPCs) a standard High Voltage Power supply unit (HVPSU) is developed**.** The importance of such HVPSU for nuclear radiation detectors used in High Energy Physics Experiments are well known from the developments reported by several laboratories [1]. The developments are based on stability, noise immunity [2], reliability of operation, monitoring capability, modular construction and most important one is the cost of the unit. A large number of RPC detectors with Single and double-gap streamer –mode RPCs have so far found application in cosmic ray experiments need to be biased preferably with positive and negative polarity high voltage supplies for each detectors, like COVER_PLASTEX and EAST-TOP, CERN, Switzerland; BARBAR at SLAC, United States; and BELLE at KEK, Japan [3], the ALICE experiment at the Large Hadron Collider (LHC), being also used in the Magnetized Iron Calorimeter(ICAL) detector of the INO project.

The imported high voltage converter (HVC) module can generate positive adjustable high voltage proportional to the control voltage input. The functionality of such units like compact, overload protected has made easier in building HVPSU, reduces the job to the generation of proper control voltages and displaying the monitor signals [4]. The HVC based HVPS unit makes easier to develop multichannel HVPSU to operate such RPC detectors in a wide dimension. The unit endows low noise output and the facility of current –limit status output brings the RPC detector experimental setup up to an efficient level. The HVC model no. 15A24-P15-F-M,UV, being the heart of the HVPSU selected from Ultra Volt, USA is a regulated encapsulated DC-DC converter addresses the needs of the miniature PCB muon regulated adjustable positive 15 KV power supply. The HVC module operates with a switch frequency of < 100 KHz and provides full power operation at case temperatures from -40 to $+60^0$C. The facility of precision reference makes the system easier, so that the remote control can program the power supply for a specific voltage. Ones the voltage at enable pin is raised above a TTL1, the converter starts to switch. PWM based fixed frequency is applied to control the MOSFET push-pull power stage for driving the high voltage transformer.

To sense the current limit signal coming out of the Enable/Disable terminal, a resistor of 100 KΩ is connected from the enable/disable terminal to ground in order to sink sufficient current. Ones the HVPS goes into current limit mode, the enable pin 4 goes low, causing the transistor to turn off and collector of the transistor becomes high as a result the LED is turn on. After execution of this service the voltage at the terminal will again rise to +5V and the transistor becomes turn on, which prevents the voltage across the LED from being high enough to allow it to light. The on time of this signal is inversely proportional to the overload placed on the high voltage power supply. Hence the front panel LED indicates the Status of mode for the HVPS. The 10 turn potentiometer P1, placed on the front panel, controls the final output HV and the potentiometer P2 sets the maximum allowed loading current. To assemble the module PC trace software is used for design of PCB. To make complete HVPSU, the PCB with complete control circuit is established in an

aluminum frame covered by 4mm Perspex transparent material. For measurement of output voltage two Amphenol high voltage connectors are established on the rear panel of the cabinet.

Results

The HVPSU has been used for providing high voltage biasing to a Bakelite RPC detector. The I-V characteristic for the RPC detector biased by the unit is shown in Fig.1. The I-V characteristics of the RPC detector at bias voltage 4.8 KV with different time frames indicate the expected behavior of a good RPC detector. For an operational RPC we measure the detector cathode current to study about the stability of the detector. The multiple graphs show the detector behaviors in Fig.1. It is observed that the current takes an initial period to stabilize which is known as warm up period of the detector. The detector warm up time is about 5 minutes for 30 cm x 30 cm size Bakelite RPC detector during which the current falls and reaches a stable condition. At stable condition the average cathode current is found 135 μA at bias voltage 4.8 kV of 30 cm x 30 cm, single gap RPC.

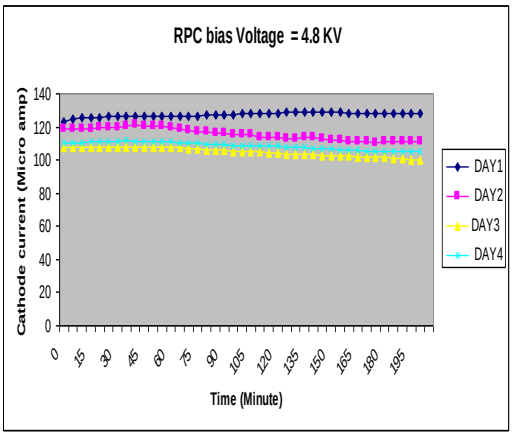

Fig.1 Detector (30 cm x 30 cm, size) cathode current variation as a function of time in minute

References

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