

HIGH VOLTAGE POWER SUPPLY FOR THE PROTON ARM SPECTROMETER OF THE R³B EXPERIMENT AT FAIR

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The design and construction of the high voltage power supply (HVPS) for the proton arm spectrometer (PAS) at FAIR further developed the ideas implemented in the design and construction of the high voltage distribution system (HVDS) for photomultiplier tubes (PMTs) for the new large-area neutron detector (NeuLAND) described in Ref. [1].

PAS [2, 3] consists of four straw-tube walls (STW), two pairs of which are either horizontal or vertical. The first STW (X1) is made of thin-walled Kapton (or Mylar) tubes. The remaining three STWs (Y1, X2, Y2) are made of aluminum tubes with a wall thickness of about 300 μm . Straw tubes require a higher input voltage but draw less current than PMTs. Each HVDS channel feeds one PMT, whereas each HVPS channel serves an array of 48 straws. Thus, the total number of high voltage (HV) channels for PAS is about 40 (with a total number of straws less than 2 000), while the total number of HV channels for NeuLAND is 6 000.

HVPS for PAS consists of two modules: high voltage control board – master (HVCB–MASTER) and distributor board (DB50), Fig. 1.

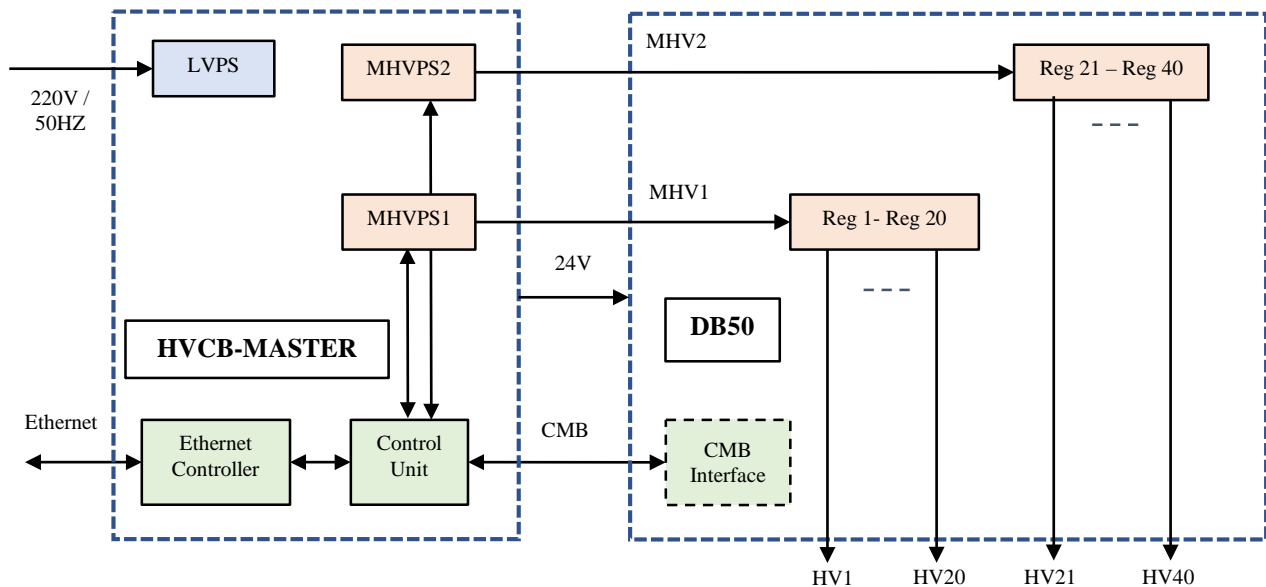


Fig. 1. High voltage power supply block diagram

HVCB–MASTER integrates in one module:

- Two Master HVPS (MHVPS1 and MHVPS2) based on the Spellman UM4P30/E 4 kV / 7.5 mA module;
- HVCB, which provides communication with the main computer and performs setting and monitoring of voltages and currents in MHVPSs and DB50 regulators;
- Low voltage power supply (LVPS, 24 V) for DB50 and itself.

The DB50 is a modified module originally designed for HVDS, containing HV regulators individually adjustable for each channel. Firstly, the two previously jumpered HV connectors are now separated, with each connector feeding exactly half of the regulators. Secondly, only 40 slots for the regulators are populated with modified 3 kV plug-in cards, since PAS requires only 40 HV channels.

The control and monitor bus (CMB) is a serial link between modules over an Ethernet patch cord with RJ45 connectors. HV cables with save HV (SHV) connectors carry the master HV (MHV) from the HVCB–MASTER to the DB50.

The HVCB–MASTER provides a 100 Mbps Ethernet connection to the host computer. The host software allows one to download required voltage setting and read back voltage and current monitor values to/from the

buffer memory of the control unit (CU). The finite state machine (FSM) in the CU field programmable gate array communicates directly with the MHVPSs in the HVCB–MASTER and *via* the CMB with the regulators in the DB50. The CMB interface on the DB50 converts serial CU commands and monitoring data back and forth. Every 20 ms, the FSM updates the voltage set values from the buffer memory to the MHVPS/regulators and the voltage and current monitor values from the MHVPS/regulators to the buffer memory. In this way, the host computer can promptly process trip conditions in the straw tubes.

The main system parameters are as follows:

- Control range of a single channel – 0 to 3.0 kV;
- Voltage setting and monitor step – 2 V;
- Output current, max – 240 μ A;
- Current monitor step, min (non-linear scale) – 0.1 μ A;
- Current trip level – under software control;
- Voltage ramp up and down rate – under software control.

HVPS modules are shown in Fig. 2*a–c*.



Fig. 2. Module: *a* – HVCB–MASTER; *b* – DB50; *c* – HVPS

The host computer runs software developed within the visual components library for Windows of the Delphi integrated development environment (IDE) to manage and monitor the HVPS. Delphi IDE uses the Delphi dialect of the Object Pascal programming language. New application libraries have been developed. The software has a friendly and intuitive graphical user interface. The software is described in detail in the “HVPS-40 Operating Manual”.

References

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3. A.A. Fetisov, A.G. Krivshich, D.A. Maisuzenko, Description of the High Voltage System for the PAS R³B Detector: Technical Design Report, 7 (2018).