2048-Channel System for High Voltage Power Supply

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Abstract

A new 2048-channel system in EURO3 crates for high voltage power supply of scintillation detectors has been developed. Up to 3 cassettes containing 16 channels each could be mounted in one crate. The system is computer-controlled by a local control station and remote surver through local area network but some additional signals are fed manually from the control panel of each crate. The main features of the system are the small volume of the channels, its flexibility and the sophisticated control software.

The described system is designed to supply with high voltage mainly scintillation counters. It consists of 2048 High-Voltage Modules (HVM), physically situated in standard 19' EURO3 crates. In one EURO3 crate could be connected 1, 2 or 3 cassettes containing 16 HVM (channels) each.

The high-voltage modules are assembled for either negative or positive polarity and they can give output voltage in the range of 50-2500V at maximum current 1mA. The other parameters are as follows: Ripple&Noise ≤ 50mV peak to peak (20Hz-50MHz), stability of the output voltage ≤ 0.01%/hr, temperature coefficient ≤ ±50ppm/°C after 1 hr warm-up for operating temperature range from 10 to 33°C, variation in output voltage ≤ 0.001% for line and load changes. Custom hybrid IC, containing precision resistor dividers and operational amplifiers, as well as modern SMD technology are used to obtain the required parameters. The ratio *NUMBER OF CHANNELS/VOLUME* of the system is very high, which was the main task to be achieved. The dimesions of the module are 262×32×25 mm (L×W×H) and the high-voltage output connector is LEMO type. The system is flexible, giving the opportunity in each cassette modules with different polarity to be connected.

The developed system is remotely controlled by a computer, which is connected to a local area network (Fig.1). There are three levels of control of the system : **a)** from the control panel of each crate; **b)** from the control station and **c)** from remote host/surver via local area network. The control station is a personal computer, PC486DX33 or equivalent, with RS232 and Ethernet interface cards. The computer sends to the modules commands and receives data from them through RS232 and displays on the screen the status of each channel. The HVM can send information on its output voltage, output current, status and other parameters on

request by the control station. The computer can communicate only with one HVM at a time, and immediately after the command phase the control station receives the present status of the same module. Between the computer and all the high-voltage channels there is a controller for converting the signals from RS232 to C7μBus, which is a specially developed version of the I^2C bus with a built-in partition of 16 segments. Each segment comprises 128 modules controlled by a separate output port from the RS232 to C7μBus converter via I^2C bus and it is galvanically isolated from the control station. Additionally, the converter has a watch-dog feature needed to ensure uninterruptable function the system. The action of the watch-dog is to reset the control station if some hang-up occurs.

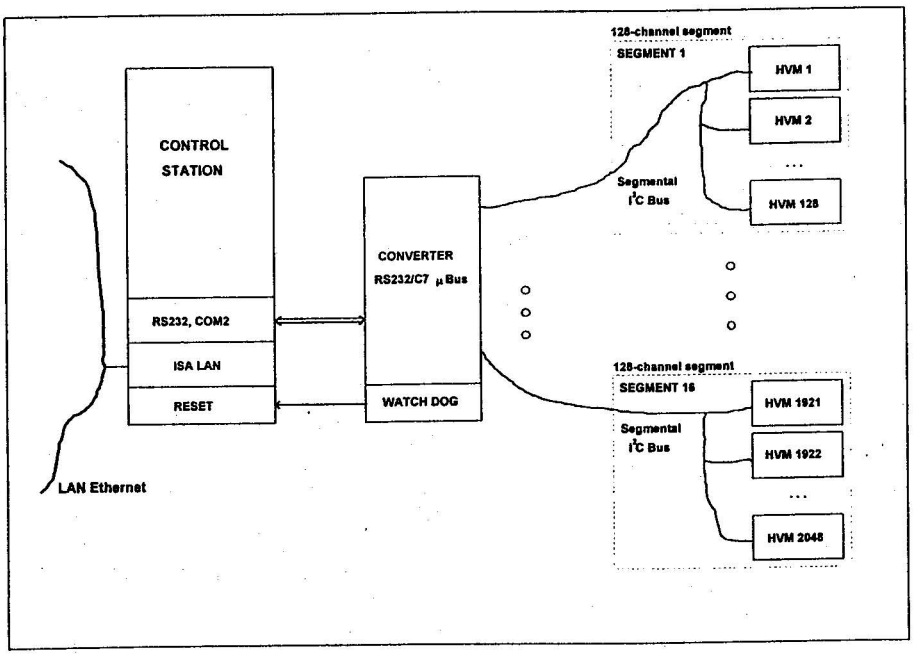

Fig. 1. Block diagram of the system

The HVM consists of a microcontroller, 3 Digital-to-Analog Converters (DAC), DC/DC converter and a protection circuitry (Fig. 2). The DC/DC converter produces output voltage proportional to the input voltage, given by DAC1. The voltage and current limits for the protection circuit are given by DAC2 and DAC3. The DC/DC converter is a push-pull type and uses pulse-width modulation control circuit, power MOSFET transistors and voltage tripler at the output.

There are two different levels for the output voltage, current and voltage limit, which can be selected externally by digital signals from the control panel

independently from the control station. Another digital signal KILL from the control panel is used for fast switching off of all the HVM in the crate.

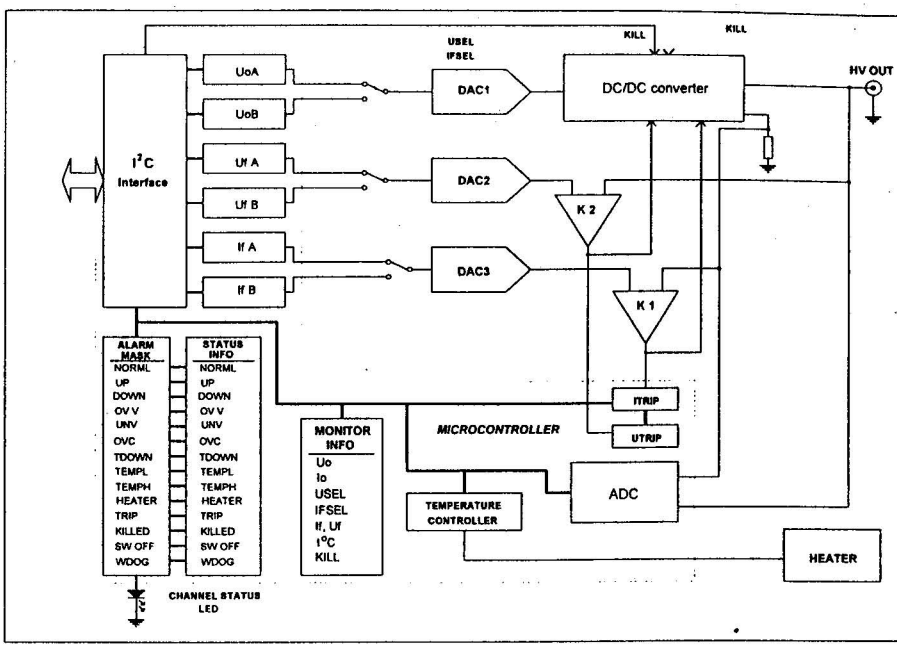

Fig. 2. The internal structure of the HVM

The microcontroller constantly measures the output voltage and current, as well as the temperature with 14-bit accuracy. It monitors the status of all control signals and protection circuits and produces several flags, grouped in the Status Info box. The control station sets the two values for the output voltage UoA and UoB and for the voltage and current protection UfA, UfB, IfA and IfB, as well as the rates for changing the output voltage RampUp and RampDown and the desired temperature for the temperature controller. When the HVM is increasing or decreasing the output voltage the corresponding flag UP or DOWN is set. In overcurrent conditions the comparator K1 trips and the DC/DC converter automatically switches to constant current mode of operation with output current IfA or IfB, and the microcontroller sets the flag OVC. In overvoltage condition the comparator K2 switches, the output voltage is limited by UfA or UfB and the flag OVV is set. In both cases the corresponding software delay ITRIP or UTRIP is initiated. After the end of the delay the microcontroller starts decreasing the output voltage with rate RampDown and the flag TDOWN is set. In case that the output voltage is below the settled value the flag UNV is set and when the HVM is operating normally the flag NORML is held high.

Another three flags that are connected with the temperature controller are TEMPL, TEMPH and HEATER. They indicate when the temperature inside the module is lower (TEMPL) or higher (TEMPH) than the desired value and when the heater is switched on (HEATER). The flag TRIP indicates that the channel has been tripped after overload condition and the output voltage has been set to zero. Any HVM can be switched off in maximum 100ms with the remote signal KILL and in that condition the microcontroller sets the corresponding flag KILLED. Besides, any channel could be swithed off remotely for a long time and then the flag SW OFF is set. The flag WDOG held high means that an internal error has occured in the channel.

Every HVM has a channel status LED situated on the front panel next to the HV LEMO connector, which is on when the logic "OR" between the flags in the Status Info box is logic high. Only these flags, that are not masked by the bits in the Alarm Mask box could switch on the channel status LED.

The microcontroller measures the output voltage Vo, output current Io, the values Uf and If and the temperature with its built-in ADC. Additionally it monitors the digital signals USEL, IFSEL and KILL. These values and signals are grouped in the Monitor Info box. The control station reads these parameters and the status of the channel and displays the data with software running under Windows. All input parameters and values for the channels are supplied to the program as an input file, that can be created by a text editor or with the program itself. The program can also receive this file from a remote computer and to send it through the RS232 to C7μBus converter to the HVM. From the channel information the program receives an output file is generated, which contains full information about the HVM.

One the main modes of the program is the GENERAL VIEW mode, in which all the channels are displayed as a small boxes with colours corresponding to their 4 most important states - normally working, killed, tripped or not connected module. The grid on the screen allows the number of channel corresponding to each box to be easily found. By selecting the desired box with a mouse or keyboard the user can receive full information about the corresponding HVM, which is the mode ZOOM CHANNEL. In this mode the parameters can be edited and send again to the channel as input file. The program makes also a log journal file, in which all important events are recorded, such as the time when some parameters have been changed by the operator, when the status of the channels has been changed and so on. The program is protected by a password and allows only authorized persons to change the parameters of the system. All the others have access only to the GENERAL VIEW mode. The software is user-friendly and allows the operator to work with it without any special training.

Due to its flexibility and versatility the system could find wide application it the nuclear physics experiments.