A slow-control system for the CBM-RICH gas system

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The gas system for the CBM-RICH prototype was built to provide pure CO_2 gas to the RICH prototype at a constant differential pressure of about 2 mbar. In addition it supports the necessary purity of the gas using a purification unit. A computer-driven slow control system monitors all of the process variables and provides differential pressure stabilization. Besides, the control system reacts on some gas system faults and takes care for automatic recovering.

The gas system is controlled by a custom slow-control subsystem that is based on the DAQ32 module [1]. This module (Fig. 1) was designed for controlling small cryogenic and gas supply systems. It provides reading of up to 32 sensors with industrial standard voltage or current output. The device accuracy is 0.004% of the measurement scale that can be selected from the range of +4 V, $\pm$5 V, +10 V, $\pm$10 V. The module is also equipped with 16 buffered digital outputs to control acting devices like solenoid valves or compressors, and 4 analog voltage output channels for flow controllers or heaters control. Such input-output channel density in a standard 100×160 mm^2 board allows using a single module to control small systems like the CBM-RICH gas system.

The variety of the data exchange interfaces simplifies a connection of the instrument to the external control system or computer. Flexible controller firmware allows implementing the necessary control algorithms, like PID regulation, directly in the firmware. Two of these modules (one working and one spare) are mounted in the gas system rack.

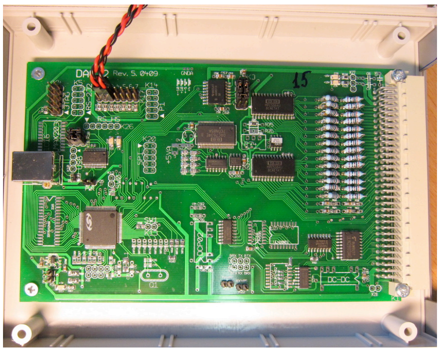

Figure 1: The DAQ32 module

The control computer software [2] was developed for the Windows platform. It provides reliable data acquisition, automated alarm condition handling and manual control of the gas system. All alarm events and system variables are logged into a database. The software is divided into multiple processes that communicate, making use of special operating system kernel objects.

The main process reads all sensor values and passes them to other processes. In order to make the software more reliable, it was divided into two threads: one for the Graphical User Interface (GUI) and one for the data acquisition. The GUI thread shows all gas system parameters including valve states in the main window. The operator can also use the controls to manage the system manually as well as adjust alarm parameters.

The DAQ thread acquires all the process variables, writes them into shared memory and checks alarm conditions. Every alarm setting contains an alarm threshold, alarm message and control template. The template indicates alarm set and releases actions for every controlled device, e.g. valve or compressor. The system makes corrective actions automatically and alerts the operator about the trouble. Usage of the alarm control template provides the user a high degree of flexibility when setting up the system. All process variables are written into the MS Access database with specified period. In case of alarm trigger, current values are also written out of turn. All alarm events and software messages are also logged into the same database.

It is also useful to have fast access to particular data and plot the results during the gas system operation. A special tool (DBViewer) was developed to work with the gas system database. It provides visualization of the data for any gas system process variable and exports data from the database to MS Excel or a tab-delimited text file for further analysis.

Another program was designed for the visualization of the actual state of the system. This program (Charts) displays up to ten selected parameters in the time chart format. Besides, it can be used for tabular display of the process variables, with extra alarm signals for every parameter in the table. In addition, a TCP/IP client/server is implemented in the Charts software so that it can be used remotely for monitoring the system under control.

The gas system control software was successfully used in nine gas systems [3, 4] of various detectors in the STAR and PHENIX experiments at RHIC.

References

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