ISTITUTO NAZIONALE DI FISICA NUCLEARE

Sezione di Milano

INFN/TC-87/12
6 Ottobre 1987

R.Bassini, C. Boiano, S. Brambilla, I. Iori, A. Moroni and Zhang Yinji:

A VME PRESSURE REGULATION SYSTEM FOR GAS DETECTORS

Servizio Documentazione
dei Laboratori Nazionali di Frascati

INFN - Istituto Nazionale di Fisica Nucleare
Sezione di Milano

INFN/TC-87/12
6 Ottobre 1987

A VME PRESSURE REGULATION SYSTEM FOR GAS DETECTORS

R. Bassini, C. Boiano, S. Brambilla, I.Iori, A. Moroni, Zhang Yinji*
Dipartimento di Fisica, Università di Milano and I.N.F.N. Sezione di Milano, Via Celoria, 16 - 20133 Milano
*on leave from Institute of Nuclear Research, Shanghai, Cina.

ABSTRACT

To regulate the gas pressure and high voltage bias in a large number of gas-filled detectors, a system has been realized based on the VME bus.
The amount of gas is kept constant adjusting the pressure value as a function of the temperature.
The performances of this system have been tested and compared with a commercial device. The results satisfy our requirement.

1.- INTRODUCTION

For their performance and characteristics, gas detectors are widely used in experimental nuclear physics at low and high energy.
Ionization chambers and position sensitive multi-wire proportional chambers are typical examples of gas detectors which we are interested in, for low and medium energy heavy-ion nuclear physics.
For good performance of these detectors, a reliable system for pressure and gas flow regulation is needed, to mantain a constant amount of gas in the detector volume.
We will not discuss here standard or commercial systems used to assure a constant value of the gas pressure. Special systems, using commercial valves and pressure transducers, have been constructed in nuclear physics laboratories[1,2]: they have good performances but are not always convenient to handle detector systems based on a large number of elements, moreover they are limited by their cost and sizable need of room.
The gas pressure regulation system described in the following has been designed to mantain constant, at the operating value, the quantity of gas in a large number of gas detectors. Furthermore it can be integrated into the control system where other parameters, as temperature and bias voltage, can be set to the desired values and/or monitored.
The main criteria followed in the system design are:
- easy handling of a large number of gas systems with local or remote operation
- automatic control of the gas pressure with steady-state variations within $\pm$ 0.2 mbar for pressures <100 mbar and $\pm$ 0.5 mbar for higher pressures
- Pressure values adjusted as a function of gas temperature, to keep at the desired value the amount of gas

- safe transition to operational conditions
- possibility of handling other parameters
- easy connection to data acquisition systems based on the VME bus
- limitation of the cost and overall size.

2.- SYSTEM DESCRIPTION

The proposed control system, sketched in Fig. 1, is based on a microprocessor operating in a VME environment.

The user can set the desired pressure and bias voltage values through the console of the MVME 110 processor. This is connected to the high voltage system (C.A.E.N. SY 127) by a serial interface (MVME 400) and to the pressure control system through analog to digital (ADCs;MVME 600, 601) and digital to analog (DACs;MVME 605) converters.

The operating pressure is set by software control. The rate of pressure variation is chosen to be safe for the thin windows of the gas detectors: typical values are 0.5-1 mbar/s.

The DACs transmit a voltage signal, proportional to these pressure values hereafter quoted as reference values, while the ADCs notify the CPU of the actual pressure and temperature values (or any other parameter of interest), given by proper transducers.

The Control Unit of Solenoid Valves (CUSV), developed in our laboratory, opens or closes the gas flow control valves (MKS 248A) according to the difference between the reference and the actual values.

The system shown in Fig. 1 can handle 32 gas detectors and can be easily connected to a data acquisition system present in another VME crate.

2.1- Description of the modules

MVME 110:

It is a high performance processing module designed to operate as a CPU element in a multiprocessor VME bus configuration. An important feature for our application is the I/O channel, which can be used to interface many optional cards as the MVME 400, 600, 601 and 605.

The software has been written using a MVME 319 development system.

The final code may be resident on a diskette unit or on EPROM in the MVME110 processing module.

The following features have been implemented:

- select the desired pressure and voltage values
- have a status report of any actual value
- handle anomalous conditions reported by the H.V. control system
- adjust the pressure reference values according to the gas temperature

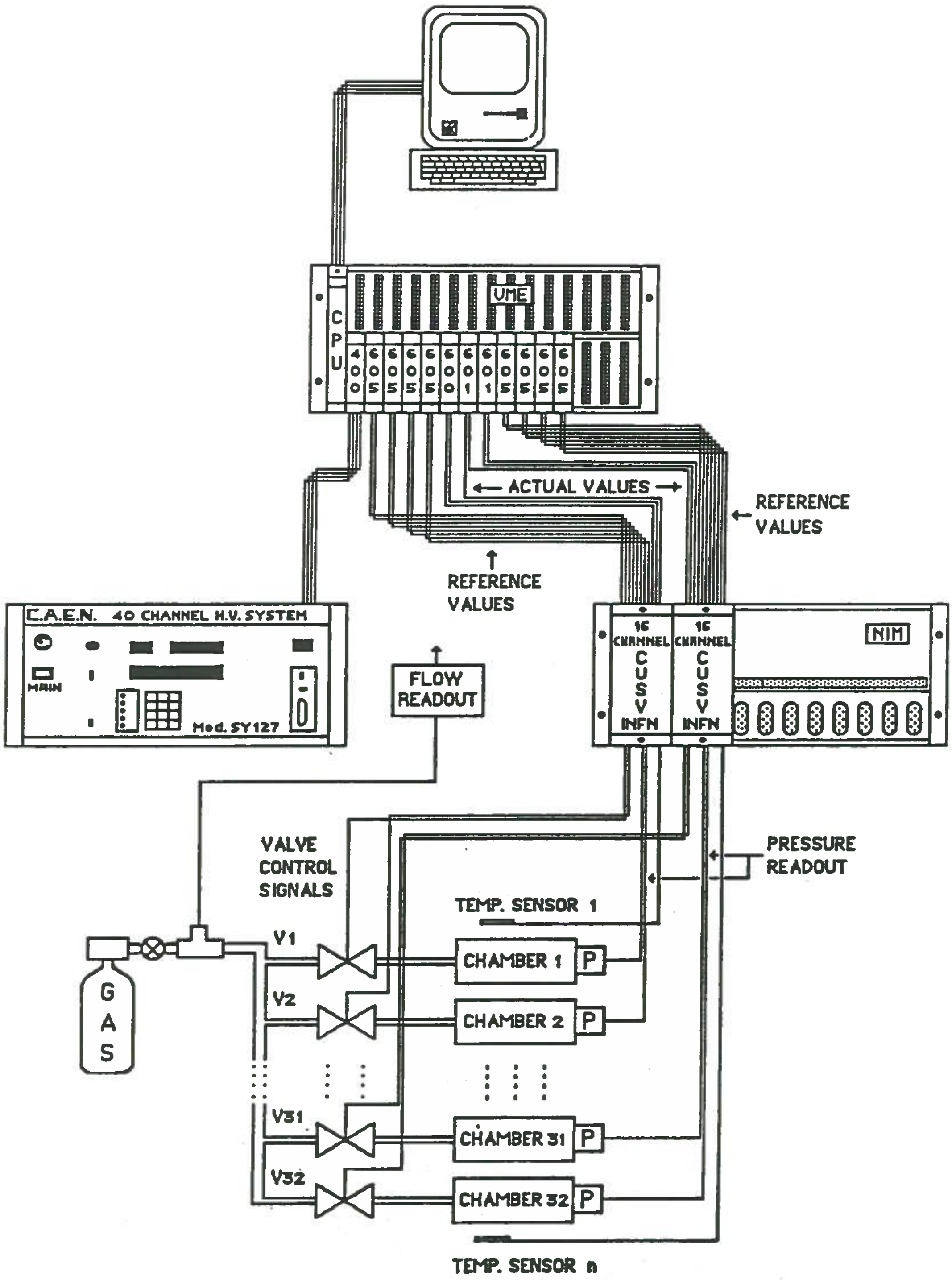


Fig. 1 - CONTROL SYSTEM FOR PRESSURE AND BIAS VOLTAGE

changes, to mantain the desired quantity of gas. The law of the ideal gas is used

- generate alarm signals in case of temperature or pressure variations outside the limits of a selected range
- force the appropriate flow valve to the close position for fast changes of pressure values, during the steady state operation.

MVME 600 (601):

This module is able to sample a voltage level, converting it into a 12 bit binary value. The full scale value (±10, ±5, ±1, ±0.5V) can be selected via software and print-board jumpers. Inputs are provided for 16 single-ended analog channels. The total number of channels can be increased using 601 cards, each of them offering 16 additional inputs. The configuration of Fig.1 can thus handle up to 48 analog signals.

MVME 605:

This four channel digital to analog module can accept 12 bit data from an host CPU on the I/O channel, and place the equivalent analog value on the appropriate output. The full scale (±10, ±5, ±2.5V) can be jumper selected.

This card has been slightly modified: it gives unipolar output signals, improving the resolution.

In our configuration, eight of these cards (32 analog outputs) are used to send the reference voltage values to the CUSV modules.

CUSV:

The 16 channel Control Unit of the Solenoid Valves is a two slot NIM bin module that can supply current intensities ($I_{max} \sim$ 120mA) adequate to drive most of the commercial electromagnetic valves. The inputs of any of the 16 identical channels are the reference value coming from the CPU or the PRC and the actual value from the pressure transducer. These values are compared and the output current feeding the solenoid valve is varied according to the value of their difference.

The system is complemented with circuitries to bias the temperature sensor and to transmit the actual pressure and temperature values to a remote controller.

The system described herein can control the pressure and high voltage of 32 gas detectors. For a smaller number of detectors we have developed a Pressure Remote Control Unit (PRC) which can be easily connected to the CUSV (Fig.2): the direct connection to the CUSV is simpler and cheaper than the general solution of Fig.1.

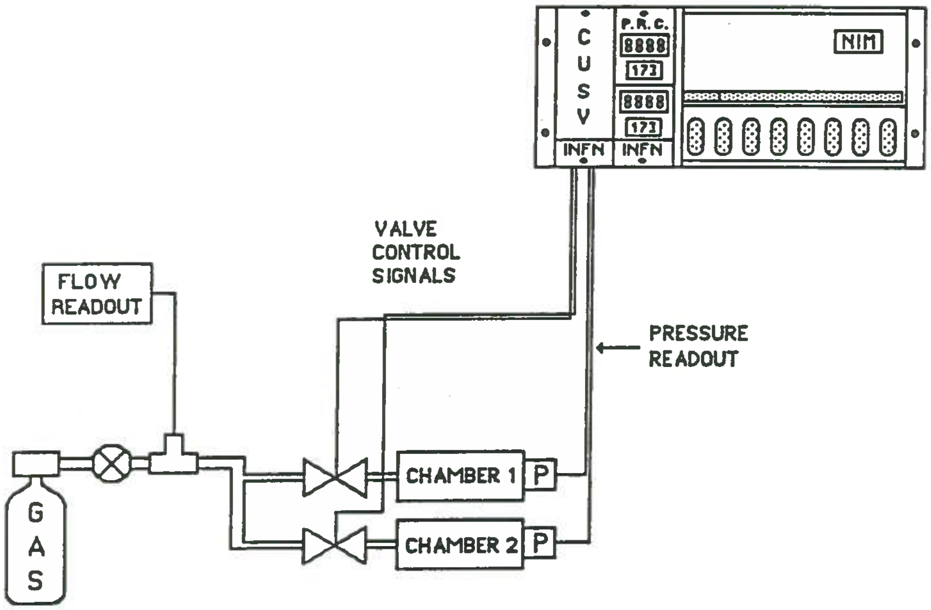


Fig. 2 - PRESSURE CONTROL SYSTEM USING THE PRC, ADEQUATE FOR A SMALL NUMBER OF GAS DETECTORS.

PRC:

The Pressure Remote Control module is a two channel unit. Each channel contains two separate parts:

a) A digital voltmeter, with 4 1/2 digit display, used to visualize the actual pressure value (from the CUSV output) or any other voltage level from proper transducers, as flowmeters or temperature sensors.

b) A voltage generator that supplies a voltage level proportional to the digital value set via contraves. The conversion factor is 10mV/mbar.

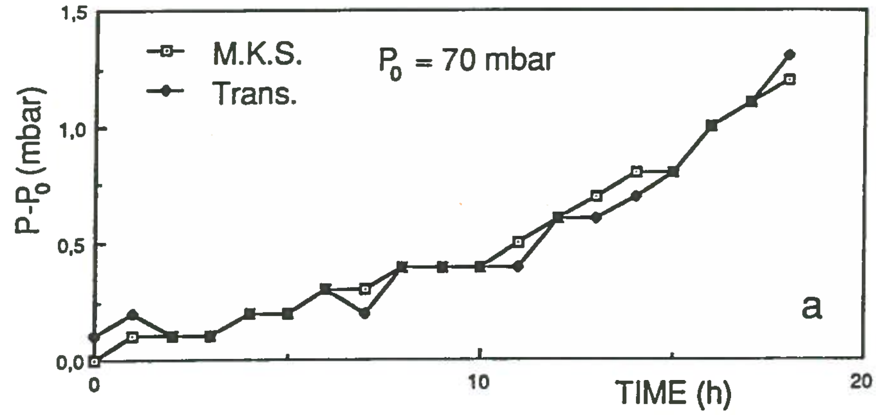
Two trimmers allow offset and gain fine adjustement. This module can be directly connected to the 'reference' input of the CUSV module.

The PRC has been tested, with cables up to 100 m. long, taking as

reference a Keithley 192 programmable D.M.M.. The discrepancies with respect to this instrument are $\leq$2mV in the 0-10V range.
In this case the automatic pressure adjustment as a function of temperature is not available. However, temperature changes can be monitored through the voltmeter section of another PRC unit.
An alarm signal is generated if trimmer selected thresholds are reached.

3 - Tests and performances

The experimental tests of the VME control system have been performed comparing it to a commercial system based on M.K.S. units.
The central part of this system is the 250B controller, a sophisticated and versatile module that, however, requires long practice to operate it optimally. It is connected to a 248A solenoid valve and to the 227A pressure transducer.
In remote control, a PRC unit was used to send the reference voltage to the 250B.
The tests, for both systems, have been performed using the 258B flowmeter, connected to the Power Supply Digital Read Out PDR-C-1B unit.
We examined some pressure sensors commercially available. A good compromise between our requirements (as the possible use of a corrosive gas) and their cost and performance, is met with the BHL3040 Transamerica transducer which has been used for testing the VME system. The linearity of the instrument has been controlled: it is better than 0.3% up to 1 bar. However we are examining other possible solutions.
The BHL3040 sensor has been placed as near as possible to the 227A and the pressure values from both sensors have been recorded and compared. The pressure readings from both instruments, in static conditions, at a pressure of 70 mbar, are reported in Fig. 3a: the two instruments have a similar behaviour. Fig. 3b shows the difference between the two sensors when the gas flow is controlled by the M.K.S. system, at a pressure of 100 mbar.



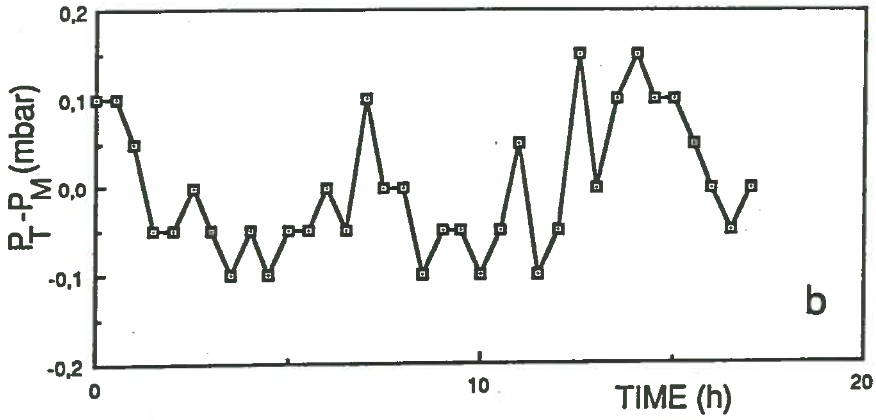


Fig. 3 - a) PRESSURE READINGS FROM THE M.K.S. AND TRANSAMERICA INSTRUMENTS AT A STATIC PRESSURE OF 70 mbar,,AS A FUNCTION OF TIME

b) DIFFERENCE BETWEEN THE READINGS OF THE TRANSAMERICA (P_T) AND M.K.S.(P_M) INSTRUMENTS : THE GAS IS FLOWING AT A PRESSURE OF 100 mbar CONTROLLED BY THE M.K.S. SYSTEM.

These tests being satisfactory, the BHL3040 sensor was used in the VME system.

Fig. 4 shows the actual pressure values when changing the pressure from 200 to 250 mbar. In the VME system the final value is reached in a smooth way without any oscillation.

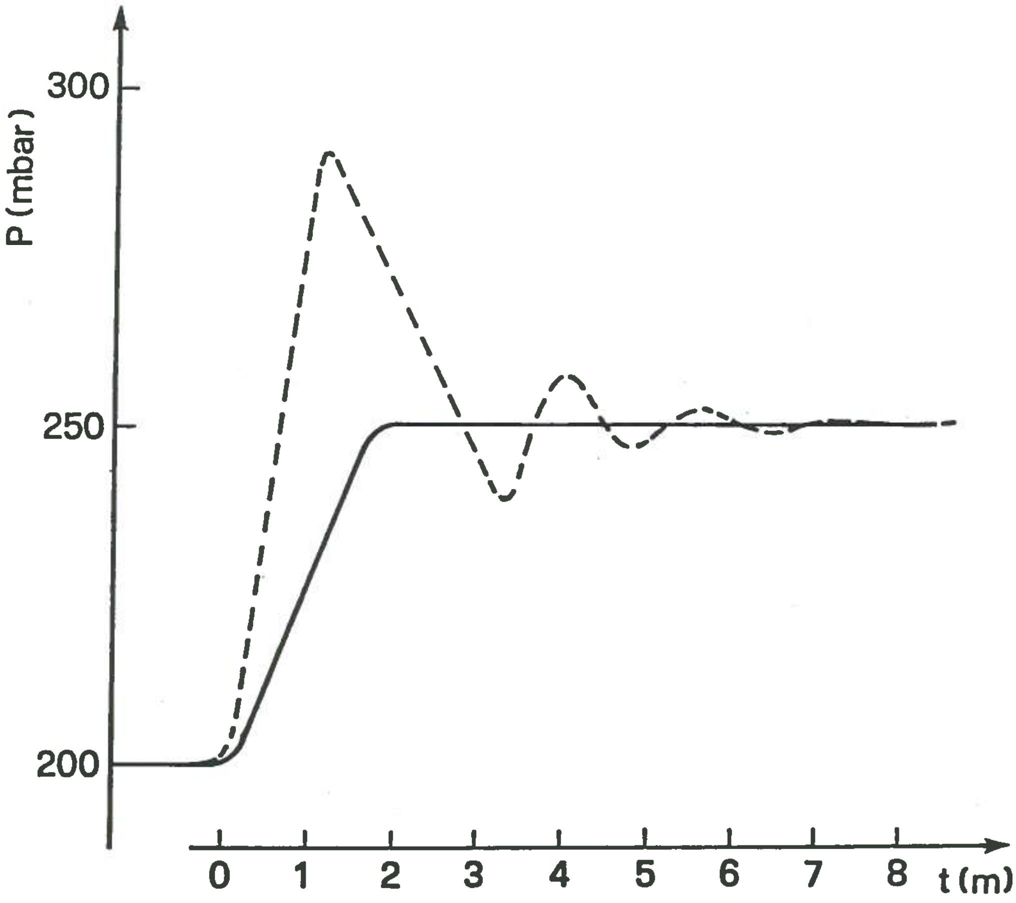


Fig. 4 - PRESSURE TRANSIENT TO THE OPERATING VALUE FOR THE M.K.S. SYSTEM (DASHED LINE) AND THE VME SYSTEM (FULL LINE).

The stability of the system has been verified: table I shows the pressure variations around the reference values, registered during 24 hours of operation, after the steady state was reached. We notice a maximum variation of ±0.3 mbar in the pressure range of interest, which is completely satisfactory for our purposes.

TAB. I - PRESSURE VARIATIONS FOR THE M.K.S. AND THE VME SYSTEMS.

PRESSURE (mbar)	ΔP (mbar)	
	M.K.S.	VME
10	±0.1	±0.1
30	±0.1	±0.2
100	±0.2	±0.2
200	±0.2	±0.3
400	±0.2	±0.3

The results reported here have been obtained when the temperature varied no more than ±2°C but no pressure correction in the VME system was made,to be consistent with the MKS system.
The temperature information is obtained from the National LM35 sensor. It is a low cost (15$), small size sensor that has been proven satisfactory in the temperature range of interest (15°-30°C) when compared with a precision sensor as the G.L.A. Electronics 91-10.
The tests have shown that the adjustment of the pressure values as a function of the temperature, is as expected.

5 - Conclusions

The control unit we have built, as far as sensitivity and stability are concerned, completely satisfies the requirements necessary for handling gas systems of multiple detectors. At the moment our system can handle 32 gas systems but it can be extended to larger numbers without any difficulty. Moreover it requires little space and is much cheaper than commercially available systems.
It is worthwile to note that the cost of the CUSV module amounts to ~350$ and the PRC to ~200$.
A useful improvement planned for this system, is the automatic control of all the preliminary operations that have to be made before the detectors are ready to be set at the operating pressure.

References:

1) R.J. McDonald, Report L.B.L.21931
2) Gas Pressure Control Unit, THA Darmstadt