A&QT-R 2002 (THETA 13)
International Conference on Automation, Quality and Testing, Robotics
May 23 – 25, 2002, Cluj-Napoca, Romania

COMPUTERIZED SYSTEM FOR THE ON-LINE IDENTIFICATON OF THE VENTILATION PROCESS

prof.univ.dr.ing. Aron Poanta , ass.univ.drd.ing. Dan Dojcsar

University of Petrosani, e-mail : apoanta@mail.com *or* apoanta@upet.ro

Abstract : The automatic command of the ventilation process involves a good knowledge of the mathematical models, which describes the behavior in static and dynamic regime. Because of the advance of the mining debates, or because of the technological conditions, the model parameters varies in time. The actualization of the parameters values involves a proper acquisition and processing systems. This paper presents the deduced mathematical models for the static and dynamic characteristics of the ventilation process, as well the system conceived to taking over and process the process parameters with the end in the actualization of the parameters values of this model. It is presented the hardware structure of the system and it is insisted on the process interface and its mode of connection to a computer which will administrates the running of the whole system. The system can be used in other industries where appears the accumulations of the toxic and explosive gas.

Keywords : automatic control , computers , numerical systems , interface , programmable logic

1. INTRODUCTION

The ventilation process ensures the microclimate necessary to progress the working in underground, with implications concerning to the labor productivity and especially to the labor security. The automatic command of this process represents a complex problem but necessary, taking into consideration this process importance, especially in the context of the industries where there are toxic or explosive gas emission. This complexity is gyved on the one hand by the elements distribution on surface and in deepness of the ventilation process, and on the other hand by the insufficient elaboration of the mathematical models which characterizes the process. This mentioned factors involves the existence of a proper acquisition systems which allows the taking over the parameters of interest and process them with the end in view of the process identification, the signaling of the damage states, the prognoses of the areas where there are hazardous gas emission.

The elements of the ventilation system, which has a static and dynamic characteristics which has to know, can be mentioned : the mining working like an object of the system of automatic adjustment of the concentrations, respective the fans.

In the point of view of mining working, through correlation and regression analysis we obtained the static characteristic in form :

$$C = C_0 + k_{CQ} \cdot Q \qquad (1)$$

, where C – methane concentration, Q – air flow.

The k_{CQ} coefficient results by the expression :

$$k_{CQ} = r_{CQ} \cdot \frac{\vartheta_C}{\vartheta_Q} \tag{2}$$

, where r_{CQ} – correlation coefficient, ϑ_C and ϑ_Q – medium square deviations.

The free term of the characteristic is calculated in function of the medium values for concentrations $\overline{C}$ respective flow $\overline{Q}$:

$$C_0 = \overline{C} - k_{CQ} \cdot \overline{Q} \tag{3}$$

The in-out mathematical model was deduced from the linearisation in about at static point of working :

$$G(s) = \frac{C(s)}{Q(s)} = \frac{K_Q}{1 + T_e \cdot s} \tag{4}$$

The K_Q coefficient and the working time constant are described in the following expressions :

$$K_Q = -\frac{C_0}{Q_0} \tag{5}$$

$$T_e = \frac{V}{Q_0} \tag{6}$$

, where V – working volume.

On the ground of this model, taking into consideration like state variables, the relative variations of the flow and concentration, it results :

$$\begin{cases} x_1 = \dfrac{Q - Q_0}{Q_0} \\ x_2 = \dfrac{C - C_0}{C_0} \end{cases} \tag{7}$$

, and, if we take the flow like input variable, we will obtain the in-state-out equations.

This model is in form :

$$\begin{cases} \dot{x}_1 = u \\ \dot{x}_2 = -\dfrac{1}{T_e} \cdot x_1 - \dfrac{1}{T_e} \cdot x_2 + \dfrac{K_Q - T_e}{T_e} \cdot u \\ y = x_1 + x_2 \end{cases} \tag{8}$$

For the parameters determination of the static and dynamic characteristics it is necessary to have a systems of taking over and process which allows the real time calculation. The conceived system, which will be presented in this paper, has the purpose to achieve these tasks.

2. THE SYSTEM STRUCTURE

For the system synthesis it was formulated the technical and functional specifications which takes into consideration both the process interface and the commands realization mode. The process interface is structured in this way to permit a 128 of measurement points. The command in the initial system [2] was achieved by a CPU based on a 8 bits microprocessor, and for the output information was used the system display. To increase the performance and the processing volume, we analyzed the possibility to command it through a microcomputer.

The microcomputer's used eliminates the two existing cards (CPU and video processor) and permits the extension of the achieved functions. To be able to use a microcomputer for the command of the process interface is necessary to conceive and achieve a command block which permits to connect the microcomputer to the process interface. On the ground of this, the block scheme of the system can be represented according to figure 1.

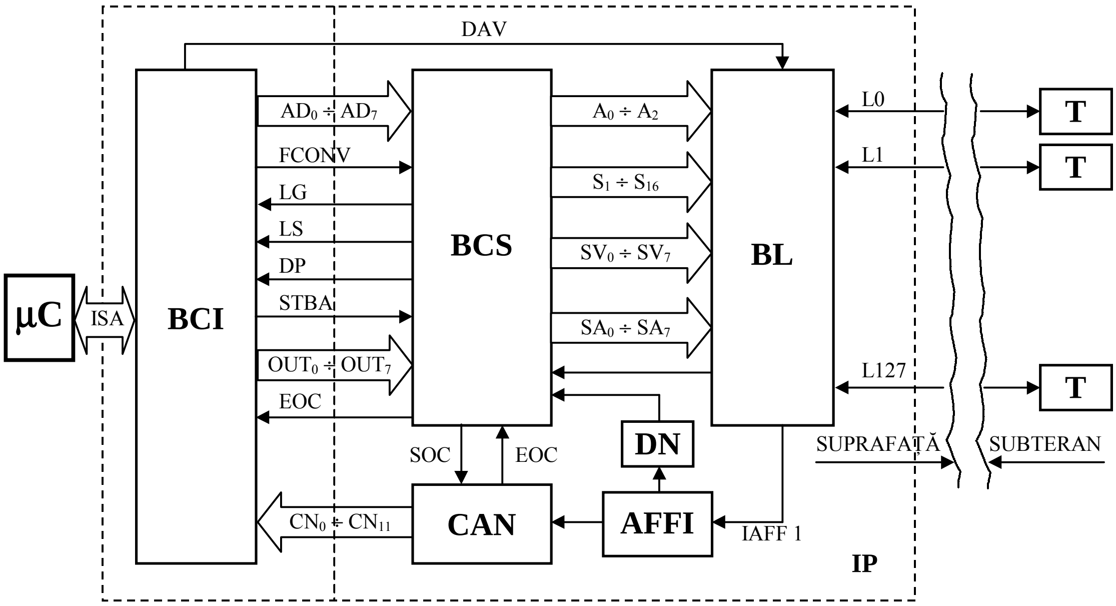

Fig. 1. The block scheme of the system

The system contains the process interface (IP), the command and interface block (BCI) and microcomputer (μC). The process interface contains the command and selection block (BCS), the lines block (BL), the amplifier filter and impulses former block (AFFI), the level detector (DN) and the analog – numerical conveyor (CAN).

The process interface (IP) ensures the connection of the system to the telemeasurement lines which are connected to the transducers. The connection is achieved through the lines block (BL) which is commanded through the command and selection block (BCS). This block receives the commands $AD_0 \div AD_7$, $OUT_0 \div OUT_7$, the alarm strobe signal (STBA) and it synthesizes the line selection addresses ($A_0 \div A_2$), the modules selection addresses ($S_1 \div S_{16}$), the lines verification addresses ($SV_0 \div SV_7$), the alarm transmission addresses ($SA_0 \div SA_7$) signals transmitted to the line block (BL). Besides the command signals (BL and BCS), this block generates the signal for the command of the analog – numerical conveyor (CAN).

The analog signal received from the transducers through BL is filtered, amplified and formed thorough AFFI and then transmitted to the analog – numerical conveyor (CAN). At the end of conversion CAN generates the signal $\overline{EOC}$ which is transmitted to the command and selection block.

Through the command and selection block it is synthesized and transmitted also a series of state signals : LS (line in short circuit), LG (void line), DP (overflow); necessary for the integrity supervision of the telemeasurement lines.

The signals, which are transmitted to BCS or synthesized by BCS, represents signals of communication either with a personal CPU or, in this case, with the microcomputer. For communication with microcomputer it must be synthesized the command and interface block (BCI).

For easy understanding of the conceived system we will presents afterwards the lines block (BL) and the command and interface block (BCI).

3. THE STRUCTURE OF THE LINES BLOCK

The synthesis of the functional blocks afferent to the process interface was achieved taking into consideration the functions who it must to achieved.

The lines block (BL) has a modular conception, and it is organized in a several line modules (ML), its number depending on the acquisition system capacity.

The architecture of the line module (ML) was synthesized (figure 2) on the ground of the technical and functional specifications.

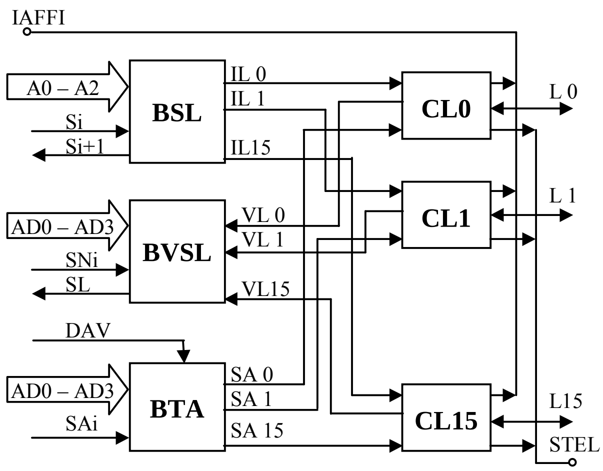

Fig. 2. The architecture of the line module

The line module contains the line circuits ($CL_0 \div CL_{15}$), the line selection block (BSL), the line state verification block (BVSL) and the alarm transmission block (BTA).

The line circuits (CLx) ensure the effective connection of the telemeasurement line to the interface circuit (figure 3).

This block ensures the galvanic isolation of the interface form the telemeasurement line too. The others blocks of the line module were synthesized and achieved using integrated circuits of CMOS type.

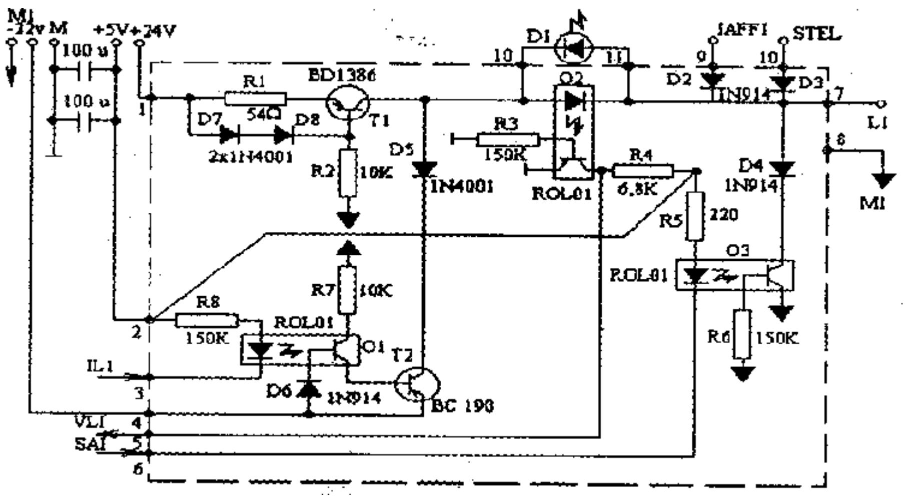

Fig. 3. The structure of the line circuit

4. THE SYNTHESIS OF THE COMMAND AND INTERFACE BLOCK

For the synthesis of the command and interface block we taken into consideration its technical and functional specification. According to the general structure, this block must ensure on the one hand the transmission of the necessary command signals from microcomputer, and on the other hand the taking over of the sampled and converted values and the state information. On the ground of this it was conceived the following bloc structure (figure 4).

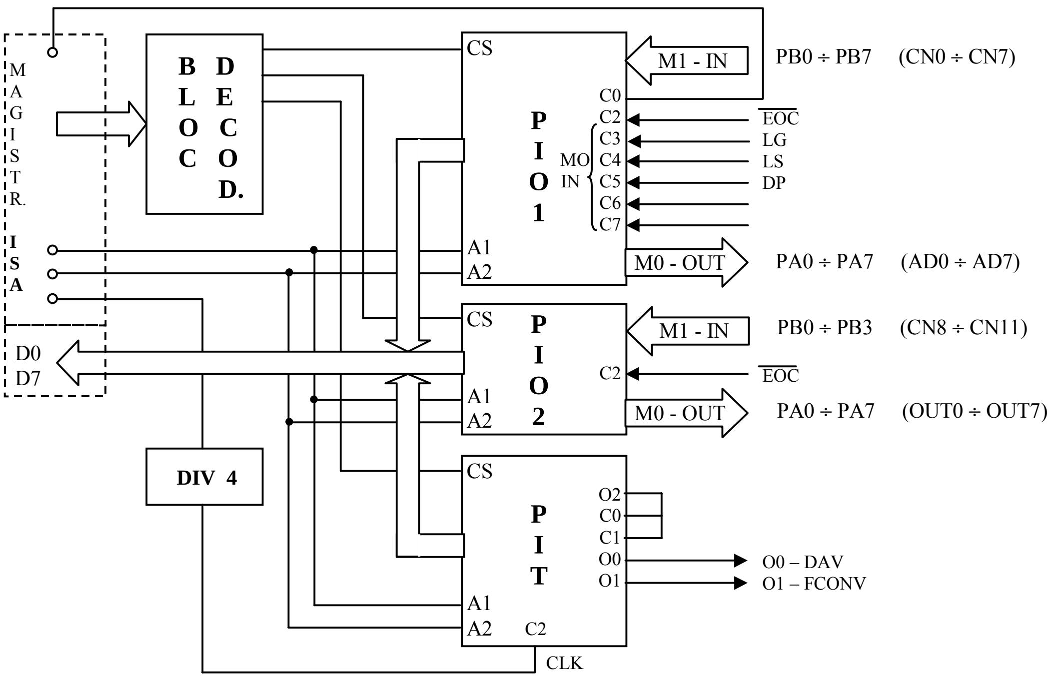

Fig. 4. The structure of the command and interface block

This block contains two PIO circuits (I 8255), one PIT circuit (I 8253) and a decoder block which establishes the afferent ports addresses. The circuits communication with the microcomputer is through to ISA bus.

The command signals $OUT_0 \div OUT_7$ will be obtained from the port A of the PIO2 circuit, programmed in mode 0 – output. The command signals for the addresses $AD_0 \div AD_7$ are obtained from the port A of the PIO1 circuit, programmed in mode 0 – output too. The data signals supplied by CAN is taking over in port B of the PIO1 circuit (bits 0 ÷ 7), respectively in port B of the PIO2 circuit (bits 8 ÷ 11), if we desires the using of the all 12 bits. The ports B of the two PIO circuits are programmed in mode 1 – input, the data load strobe being obtained from BCS, synthesized from $\overline{EOC}$ signal of CAN. The signals LG (void line), LS (line in short circuit), DP (overflow) and $\overline{EOC}$ (end of conversion) or others signals perceived form process are received through the lines $C_3 \div C_7$ at the port C of PIO1 circuit which can be programmed to function either like a simply input port (without interrupts) and which, in this case, must be read periodically by the microcomputer, or like a input port with interrupts, when all the signal lines (LG, LS, DP, etc) will generate a specific interruption through one of the $IRQ_2 \div IRQ_7$ lines of the ISA bus.

The I 8255 circuit is used for obtain the necessary command signals. The counter C2, programmed in mode 3, is used for obtain a 200 Hz frequency which is applied to the others two counters. From this signal, the counter C1, programmed in mode 3, synthesized the FCONV signal of 100 Hz frequency necessary for the CAN command, and counter C0, programmed in mode 2, generates the DAV signal with a period of 250 ms (5 ms this signal is low, in the rest is high). The frequency for circuit command is obtained through a divisor counter from OSC signal of the ISA bus.

5. CONCLUSIONS

The conceived system has a modular structure which permits the monitoring of 128 measurement points. The system capacity can be adapted, in function of necessity, from 16 to 128 points.

The changing of CPU's system with a microcomputer increases the system performances by increasing the processing capacity and adding the new functions which can be implemented. An other advantage is the well-known flexibility of a microcomputer which made this system to be used (with eventual small modifications) in any domain where is needed to display a process with many measurement points.

This system can be used either like a local system with its CPU board, or in the achievement of a complex monitory system.

REFERENCES

[1] Poanta A. (1994), The Mathematical Model of the Ventilation Process as Automation Object, *System Analysis Control & Design – Lyon – France 1994*, Vol 3, p221 - 226.

[2] Poanta A., Pop E. , Instalație pentru controlul parametrilor atmosferei din subteran, *Brevet invenție 99112* .

[3] Poanta A. , Pătrăşcoiu N. (1997) - Circuite şi echipamente electronice în industria minieră, Ed. Didactică şi Pedagogică , Bucureşti

[4] Pop E. (1999) – Programarea în limbaj de asamblare, Ed. Didactică şi Pedagogică , Bucureşti

[5] Scot Muller (1999) - PC Hardware, Ed. Teora, Bucureşti

[6] * * * - Automat programabil PS 306. Manual de utilzare

[7] * * * - www.epanorama.net - PC Hardware – The ISA Bus Architecture