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AIR QUALITY MONITORING INTELLIGENT SYSTEM

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Abstract:

The present paper sets out an intelligent instrument to monitor air quality, consisting of a six semiconductor gas sensors, each of them being embedded into a adaptation and alarm module, an data processing and acquisition module provided with a microcontroler and a decision making, display and alarm system. The six semiconductor sensors are specially designed to detect combustion gases (methane, butane etc.), toxic gases (especially carbon-monoxide), organic solvents, sulphur-compounds and complex pollutants (cigarette smoke, incomplete combustion products). The data acquisition unit consists of an INTEL 80C552 microcontroler and an EPROM. The microprocessor software ensures compensation of sensors non-linearity and assesses possible errors due to changes in humidity and temperature. The apparatus is used to determine air quality inside laboratories and working areas, to assess fire or explosion hazard as well as for didactical and research purposes.

KEY WORDS: air quality monitoring, semiconductor gas sensors, intelligent instrument.

Introduction

To monitor air quality both indoors (working areas, showrooms, public dining areas, habitation areas) and outdoors, as well as to locally monitor flammable and toxic gas present in the atmosphere, determine concentration of a relatively high number of pollutants and evaluating potential threat the respective gas mixture pres are equally important.

Atmosphere pollutants may be monitored through various methods, amount which the most frequent be y through electrochemical sensors.

Semiconductor sensors bring about, along with miniaturisation, a significant increase in accuracy of measurements and higher reliability.

The present paper sets out an intelligent instrument to monitor air quality, consisting of a six semiconductor sensors, each of them being embedded into a adaptation and alarm module, an data processing and acquisition module provided with a microcontroler and a decision making, display and alarm system.

The six semiconductor sensors are specially designed to detect combustion gases (methane, butane etc.), toxic gases (especially carbon-monoxide), organic solvents,

sulphur-compounds and complex pollutants (cigarette smoke, incomplete combustion products)

Air Quality Monitoring Electronic System

The Air Quality Monitoring Electronic System (AQMES) is build-up base of the principle of multiprocessor electronic measure and control apparatus (EMCA) hose diagram is shown in figure 1. [1]

A tell apparatus comprise two microprocessors, notably one to control the analogical circuits inside the protected housing, and the other one to ensure linkage with the human operator by means of a display and a key board. The second microprocessor facilitates, in the same time, communication through an interfaces circuit with the external data bus of the data acquisition system, or may receive instructions through a remote control.

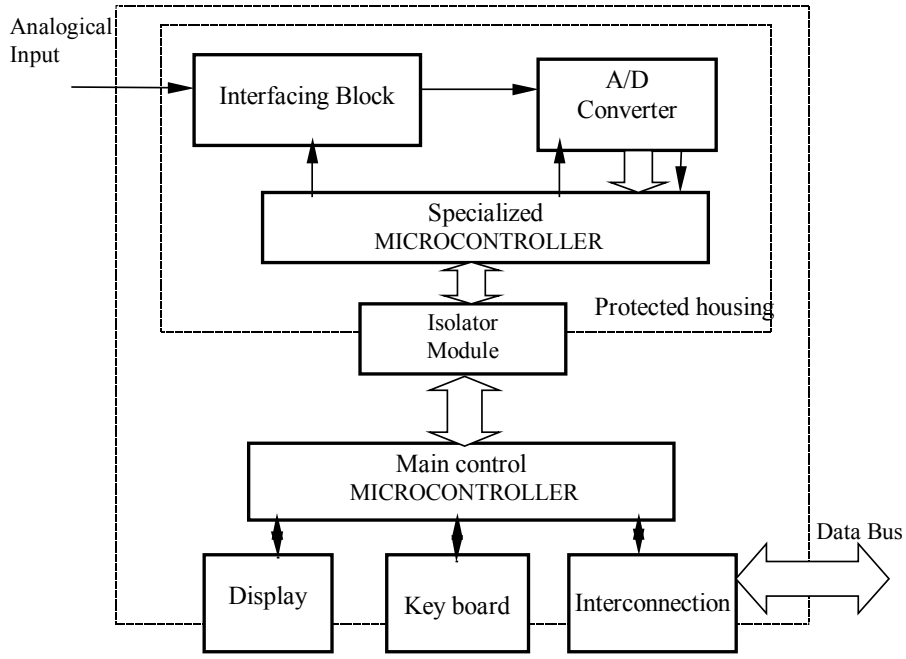

Figure 1. Diagram of a multiprocessor electronic measure and control apparatus (EMCA)

The microprocessor outside the housing works ***as main control*** and determines, based on the data receive on the key board, the tasks to be accomplished and subsequently transfers controlling data to the microprocessor inside the housing which serves as a secondary control device.

The secondary control device usually a specialized microcontroler establishes the operational status of the signal conditioning blocks performs the measurement and triggers the analogue-digital conversion cycle.

Pursuant to the reading of the results and to the primary processing thereof the data is forwarded to the main control device, which after optionally digital processing, when needed, displays the final result, memorises it and forwards it to the data acquisition system.

The apparatus may operate either in real time and local alarming mode or in monitoring mode through taking over and conveying data to an outer system, in order to be subsequently analyzed.

The diagram representing the air quality monitoring electronic system (AQMES) is shown in figure 2. The system is built-up based on the diagram of figure 1, with the following specifications:

- each of the six sensors is comprised by an adjusting and alarming module;
- the alarming modules comprise a unit for conditioning the signal received from the sensors that outputs the analogical signal to be processed by the micro-controller;
- the data acquisition unit, provided with a INTEL 80C552 micro-controller and serial communication performs the multiplexing, the analogical-digital conversion and the primary processing of the data, the micro-controller playing the role of secondary controlling device;
- a PC simulates the main controlling device.

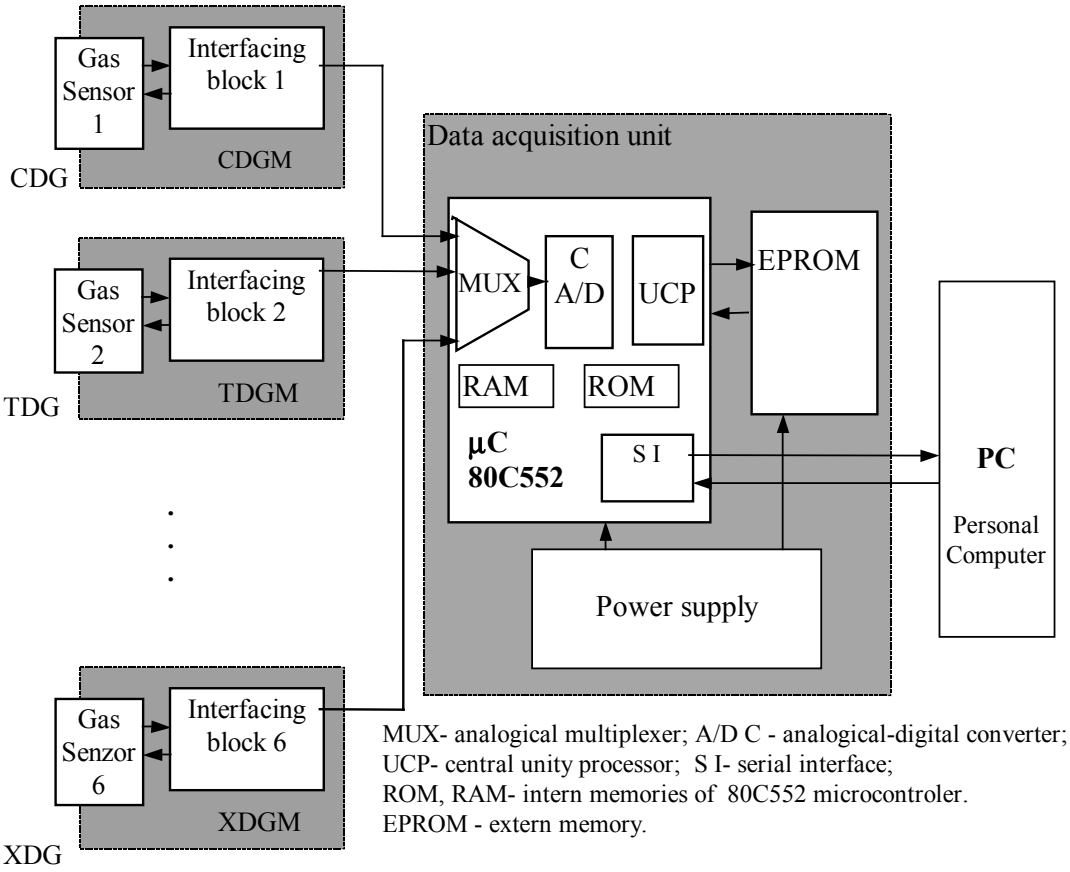

Figure 2. Diagram of a **Air Quality Monitoring Electronic System**

Each of the six detection modules comprises a FIGARO semiconductor gas sensor (SnO_2), standard measuring circuit (figure 3), an analogical output under voltage, connected to an input of the data acquisition unit and an optical/acoustical local alarming circuit to detect outweighing dangerous levels. Two of the units are meant to detect and alarm presence of combustion gases (CGD), two of them are meant to detect and alarm presence of toxic gases (especially carbon monoxide, TGD), one of them is

meant to detect organic solvents and the sixth is meant to detect complex pollutants (cigarettes smokes, XGD).

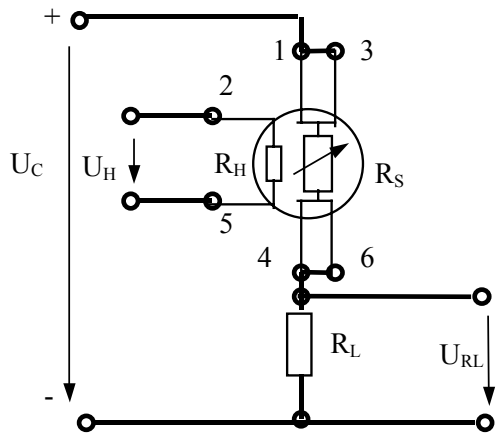

Figure 3.. Standard measuring circuit of a SnO_2 gas sensor

The detection module respond, generally to all gases of interest (see figure 4) but display each a higher sensitivity as exposed to certain gases or solvents. All responses from the six sensors allow a correct assessment of the atmosphere pollution due to present combustion or toxic gases, ranging between distant values, as shown in table 1.

Gas Type	Concentration range	Applications
methane, propane, butane	100 -10000 ppm	pollution detection , explosion risk
hydrogen	50 - 1000 ppm	pollution detection , explosion risk
carbon-monoxide	20 - 1000 ppm	incomplete combustion protection, health protection
alcohol organics solvencies	20 - 500 ppm	explosion risk, technological losses
hydrogen sulfide	2 - 200 ppm	pollution detection, health protection
ammoniac	10 - 300 ppm	pollution detection, health protection
Chlorofluorocarbons	30 - 3000 ppm	pollution detection, health protection, technological losses

Table 1. Gases types and concentration range detected with AQMES

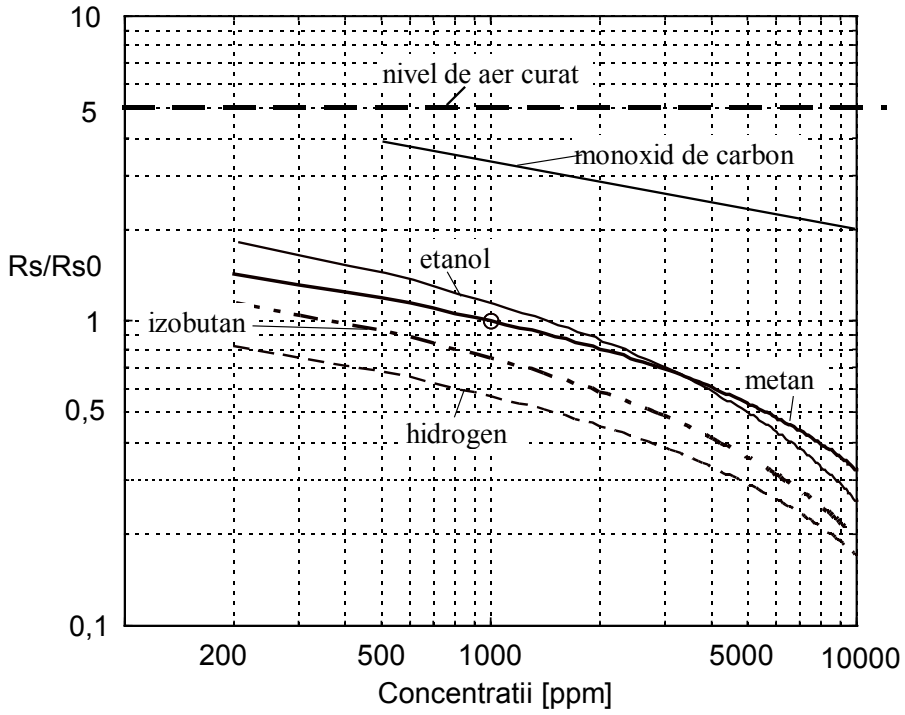

Figure 4. Responds of a SnO_2 gas sensor to different combustibles gases

The data acquisition unit consists of an INTEL 80C552 micro-controller, an EPROM and a power supply. The micro-controller, provided with an analogical eight-channel multiplexer (MUX) and an analogical-digital converter (C A/D), controlled by the software inside its own memory an the one residing inside the EPROM, takes over the responses from the detection units, processes and memorizes them. The microprocessor software ensures compensation of sensors non-linearity and assesses possible errors due to changes in humidity and temperature. The availability of two analogical channels (besides the six intended to the detection units) ensures assessment of temperature and humidity through specific sensors.

The micro-controller, through its own serial interface, ensures communication with the PC and the data transfer towards the user. [2]

The data acquisition unit may independently memorize up to 42 data full-sets, that it conveys to the computer. After the data transfer the system may resume measurements.

Depending on the power supply, either through batteries or from the 220V/50 Hz network, the electronic air pollution monitoring apparatus is portable, or fixed to a certain location.

Conclusion

As presented, the air quality monitoring electronic apparatus (AQMES) has proven to equal or outweighs, as to the operational performance, similar products of famous brands like OLDHAM or NEOTRONICS.

The apparatus is used to determine air quality inside laboratories and working areas, to assess fire or explosion hazard as well as for didactical and research purposes.

References

[1] Bodea, M., Mihut, I (1985) *Aparate electronice de masurare si control,* Editura didactica si pedagogica Bucuresti, pag. 304-321.

[2] Cociorva Sorin (1998) *Metode si aparate pentru determinarea calitatii aerului,* teza de doctorat, U.T.C. Bucuresti, pag. 139-144.