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THE CONSTRUCTION OF THE MEASURING INSTRUMENTS AS THE SUBJECT OF MASTER'S THESES FROM METROLOGY OF NON-ELECTRICAL QUANTITIES

The students of automation and robotics, electronic and telecommunication are preparing their master's theses in Measurement Systems Group of Institute of Automatic Control. They also include the projecting and constructing of measuring instruments and measuring systems. These are dedicated to the laboratories in the Institute, as well for industry. The pocket radiometer was projected and constructed. It consists of the primary device with Geiger-Müller counter, the secondary device and of the power supply. The radiometer has series connections RS232C. The calibration stand for rotameters based on the soap film flowmeter principle was projected and constructed and put on the market. The digital measuring interface was projected and constructed for investigating of the piezoresistors (for strange gages, pressure gages, ...). The universal interface for transducers UTI and the microcomputer AT89C52 are used. The sensors can be used in the bridge or half-bridge, and for the resistance of 120 - 10000 ohms. The results of measurements are displayed on LCD display. The instrument is connected with help of the RS 232C interface with computer.

Key words: construction of measuring instruments, flowmeter, radiometer, strain and pressure measurement.

1. INTRODUCTION

The measuring instrument is the part of the automatic control system and therefore in the Institute of Automatic Control in the Measurement systems Group master's theses from metrology of non-electrical quantities are done. The metrology is one of the links

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of the education chain of control engineer [9]. In the frame of specialization "Measurement systems" which is learned in the Measurement systems group various masters' theses are done, and in the paper four theses as an example of the role of projecting and construction in students' education are presented. They are represent three different measuring instruments: the measurement stand for calibration of small flowmeters [3], pocket radiometer battery supplied which enables gathering measurement data for further computer processing [6] and the measurement system for strain and pressure measurement [5, 13].

2. MEASURING SYSTEM FOR ROTAMETERS CALIBRATION

In the firm ROTAMETR in Gliwice for calibration of rotameters the rotameter legalized by Head Office of Measures in Warszawa was used. The firm decided to construct (or buy) the stand with better metrological properties for calibration of rotameters (for the measurement of small volume flow-rate of gases). In the frame of master's thesis [3] the preliminary analysis of constructional solutions of the installation is introduced. The orifice flowmeter is simple, but it is difficult to reach the wide span of flow-rates. Bell-type tester needs the mercury for tightening and therefore this classical solution was eliminated. Also piston tester and soap film flowmeter were analysed and the last solution was chosen. At first the simple model was projected and constructed and its metrological properties were enough good, that the firm decided to build the measuring installation that can be put on the market [1]. In fig. 1 is shown this measuring system.

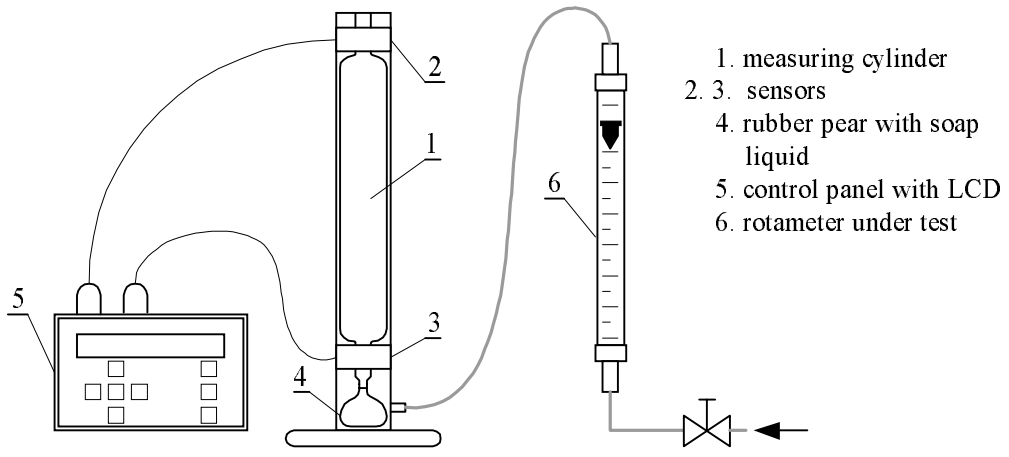

Fig. 1. Measuring system for rotameter calibration

For the detection of the soap film infrared receiver SFH 506 was used. To avoid the influence of the light, which is intensive when the sun is shining, the modulated source of infrared beam was used. In the receiver the collimator was used to achieve the highest sensitivity for emitted beam. The processing system is based on 80C535 microcomputer and his roles are the detection of the soup film and average volume flow-rate calculation. Microprocessor-based control system use one-cheep microcomputer 80C535 with 12 MHz. Clock. The main role of the system is to detection of moving soap film with help of light beam, time measurement and flow-rate calculation. Acoustic signal informs about the beginning and ending the measurement of flow-rate and about the incorrectness of system functioning. The measuring spans are: 2-20 dm3/h, 5-50 dm3/h and 10-100 dm3/h with accuracy class of 0,4; 0,6 and 1. Supply voltage 220 VAC, power supply: 10 VA and mass of the system is about 2 kg. The information about this measurement system was published in [10].

3. POCKET RADIOMETER WITH SERIES INTERFACE

After Czernobyl disaster the interest of isotope radiation measurements increased. It concerns both dose and pollution measurement [12]. The first pocket radiometer was constructed as the master's thesis in 1991 [Plaza]. Some problems connected with projecting and construction of pocket radiometer is introduced in [11]. The use of personal computer is widespread and therefore is the need of new construction of radiometer, which enables data gathering and than to send them with help of an interface to personal computer for their gathering and processing. For this purpose the pocket radiometer was projected and constructed [6].

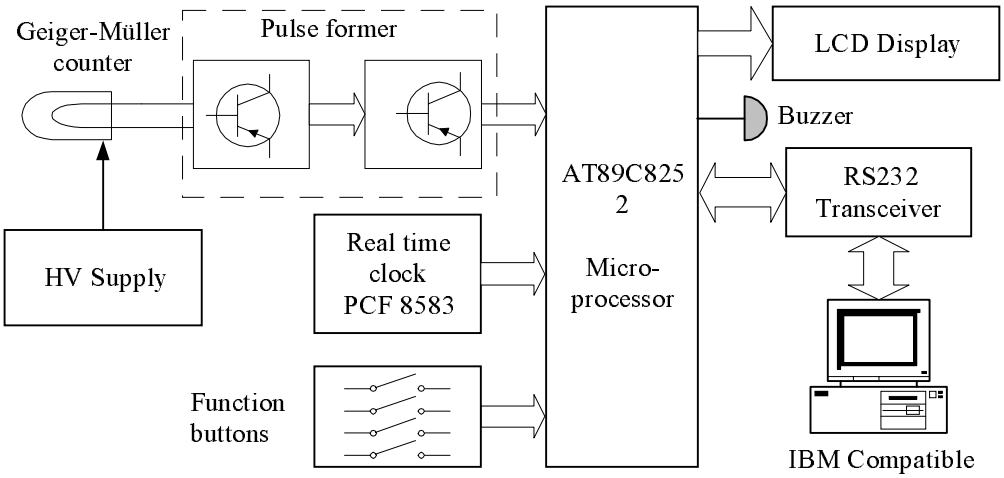

Fig. 2. Pocket radiometer block diagram

At the beginning the investigation of Geiger-Müller counter were made in purpose to establish the working voltage and the dead time. The radiometer consists of the primary device, the secondary device and of the power supply.

The primary device is the probe with the Geiger-Müller counter. The secondary device consists of the counting system, data processing, and real time clock. The pulses from the Geiger-Müller counter are sent to the Darlington circuit. The counting and processing system is based on 89S8252 microcomputer. The radiometer has serial interface RS232C.

4. STRAIN GAUGE MONITORING SYSTEM

In master's thesis [5] gauge monitoring system for measurements with help of resistive sensors was projected and constructed. It is digital instrument that respond to classic analogue extensometer bridge. This measuring system can be used with such sensors as strain gauges or piezoresistive pressure sensors. Block diagram of the instrument is shown in fig. 3.

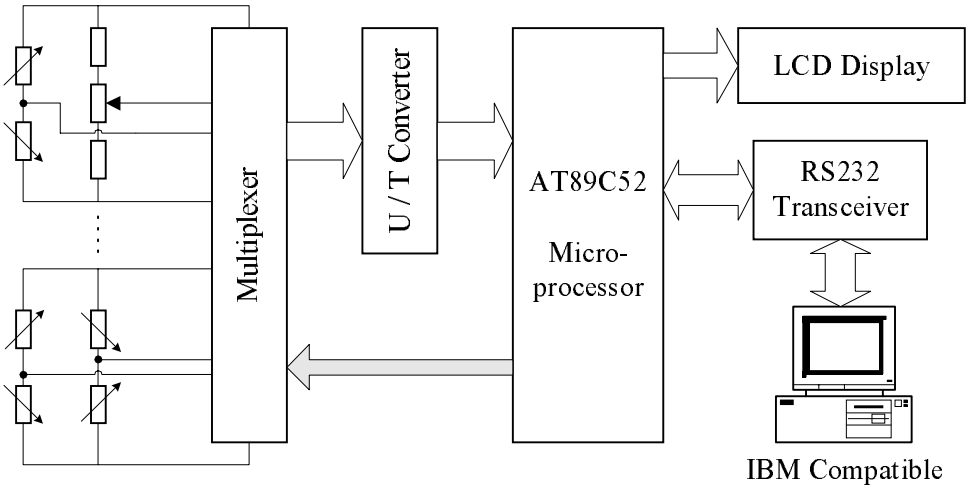

Fig. 3. Strain gauges measuring instrument block diagram

Measuring system has four channels. Sensor with the resistance of 120 to 10000 Ω in the arrangement of full-bridge or half-bridge can be connected to every channel. Each channel a special zero balancing assembly, which doesn't influence on the sensitivity of the bridge and doesn't give additional temperature errors. For sensors, which has been prebalanced the zero assembly can be switch off.

Output signal from chosen bridge by multiplexer is converted to pulse time, what enables direct signal connection to counter input of microcontroller and direct A/D conversion by clock pulse counting method. Microprocessor is controller of the whole system, digitally processes results of measurement and transmits them to local LCD display in proper units. Measuring system has digital serial interface (RS-232C) to connect it to personal microcomputer and remote reading of measurement results.

Student in his master thesis projected and constructed physically the whole system. He wrote and tested software, made experimental measurements using constructed instrument and estimated the maximum permissible errors. He gave recommendation for further instrument improvements.

5. CONCLUSIONS

Masters thesis, which concerns construction of real measuring instrument, in the paper author's opinion is the best summary of the study of metrological specialisation. Student preparing such thesis must integrate the knowledge from many subjects from study programme: metrology, integrated solid-state sensors, industrial measurements, measurement systems hardware and software, analogue electronic circuits, digital-circuit engineering, microcontroller technique, measuring interfaces, digital data processing. Student is evaluated according to results of solving concrete, real problems similar to such problems which he can meet in future professional practice.

The theses are done according to following methodology: formulating the goal of the thesis, analysis of known solutions, introductive laboratory investigations and/or computer simulation, hardware and software projecting, construction and/or completing of system, tests and investigation of metrological properties of ready instrument.

Using of information science methods has important part of each constructional thesis. It concerns control of the instrument, introductory information processing and possibility to join with personal computer. It enables: data acquisition, analysis and presentation results.

It must be stressed that masters' theses need a lot of students' affords including experimental investigations in measurement laboratory. During preparing the masters' theses students can help with some general and concrete guidelines [8].

The tutor leading such masters' theses must have not only theoretical knowledge, but also wide practical experiences. Sometimes student needs the consultation from another discipline engineers.

The level of many constructional masters' theses is so, that achieved results can be published in all-Polish technical literature [7, 10]. The result of good made masters' thesis can be useful measuring instrument, which can enrich and supplement educational laboratories of institute. Masters' theses [5, 6] will be used in the laboratory of

the industrial measurement of Measurement Systems Group. It is rarely success the constructed instrument is the prototype, which can be applying in the practice. Results of masters' thesis [3] were implemented in firm "Rotametr" and the instrument was put on the market [1].

We observe for many years that students making constructional theses prepare them in a longer time in comparison with students writing purely theoretical masters' theses. Realisation of constructional theses demands not only affords of laboratory staff but also the financial resources. Such theses demand not only engineering but also economic attitude

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