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HYBRID FIBER OPTIC TEMPERATURE SENSOR USING PULSE CODING OF OPTICAL SIGNAL

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Abstract – In this paper, the model of fiber optic temperature sensor is described. The sensor uses pulse coding of optical information signal, so that uncertainties caused by changes of optical signal power are excluded.

Keywords: fiber sensor, temperature, measurement

1. INTRODUCTION

It is well-known that one of advantages of fiber optic sensors is their explosion safety and the noise immunity, allowing to receive the precise measuring information at presence of powerful electromagnetic fields. Basically these advantages are due to applying optical fiber as a transmission media for measurement data. One of possible ways of wide implementing of sensors in industrial applications is development of the hybrid sensors combining well-known advantages of a fiber path of transfer, and also cheapness and availability of sensitive elements of sensors with electrical feeding. An optically powered sensor uses conventional electronics for the measurement of analog physical parameters such as voltage, temperature and pressure; however, power delivery and sensor data retrieval are all accomplished over optical fibers [1, 2]. Two-channel fiber optic hybrid temperature sensor using pulse coding of optical signal is developed in current work. The main advantage of the developed sensor is the frequency principle of coding of the measurement data that excludes uncertainty caused by changes of optical signal power. Another advantage is extremely low power consumption of the remote module unit of sensor system.

2. SENSOR DESCRIPTION

Sensor system (Fig.1) includes remote and local module units (RMU and LMU respectively). Duplex fiber optic link (2, 10) connecting them performs optical power delivery from LMU to RMU and data acquisition back from RMU to LMU. RMU contains photovoltaic converter (3), voltage converter (4), pulse generator (5), two sensitive elements (6) and pulse transmission system. Photovoltaic converter (Fig.2) consists of four consequently connected Si-photodiodes and performs electrical feeding of RMU. Sensitive elements (6) are based on thermoresistors made of semi-conductor monocrystals of synthetic diamond (TRA-1, TRA-2). These elements have a very good long time stability of characteristics and very low inertion. Isolated termoresistors are hermetically sealed and are able to operate in conditions of aggressive environments and raised radiation. They are placed in ceramic tubes of about 0.3 m length and can be placed in high temperature industry zones. Thermoresistors itself work in temperature range of 80-600K.

Sensitive elements (6) are connected with pulse generator (5) so that one sensitive element defines frequency and another one defines duration of outgoing pulses formed by pulse generator (5).

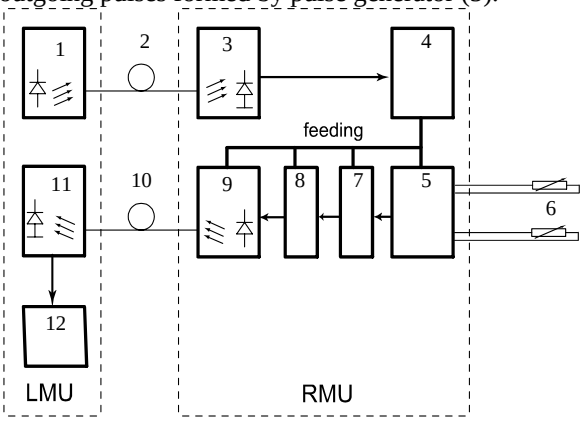

Fig. 1. Structure of the sensor

Sensitive elements are the part of pulse generator feedback circuit so that sequence parameters (pulse length and frequency) depend on resistance of sensitive elements (first and second one respectively). This sequence follows to short pulse generator (7), which produces pulses of very high on-off time ratio (Fig.3b) at each (positive and negative) front of input pulse sequence (Fig3a).

Short pulse sequence goes to the key (8), which operates the current of light emitting diode (LED)(9). Light transmitted by LED (9) through optical fiber (10) to LMU is received by photodiode (11). Pulse signal from photodiode (11) is received by unit (12). Unit (12) contains trigger that restores pulse sequence at Fig.3a. On-off ratio of this pulses is always exeeds

two. It is made in order to unequivocally assign frequency and pulse length to the respective sensor channel. Then restored pulse sequence is processed by microprocessor system and then temperature values are indicated.

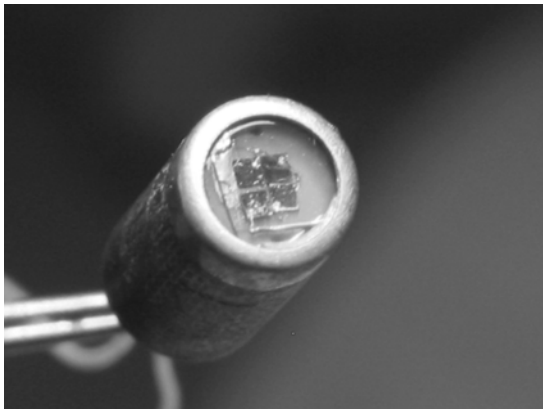

Fig. 2. Photovoltaic converter

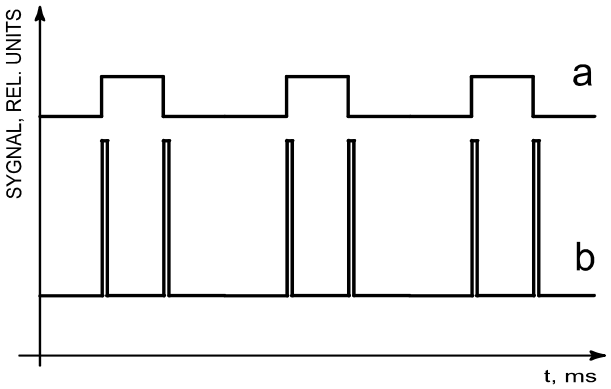

Fig.3

Sensor is calibrated by comparison with high precision thermometer in points close to triple point of water and boiling point of water so that International Temperature Scale of 1990 (ITS-90) [3] is provided.

3. CONCLUSION

Note that developed principle of construction of sensors makes possible creation of the measuring systems allowing simultaneously to supervise various two parameters in a measurements area, for example, two values of temperature, two values of pressure (the charge of working substance), pressure and temperature of environment etc., and thus measuring system with high safety and noise immunity is provided.

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