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DIGITIZATION IS THE FUTURE OF MEDICINE

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O‘ZBEKISTON RESPUBLIKASI
OLIY VA O‘RTA MAXSUS TA’LIM VAZIRLIGI

O‘ZBEKISTON RESPUBLIKASI SOG‘LIQNI SAQLASH VAZIRLIGI

TOSHKENT DAVLAT TIBBIYOT UNIVERSITETI

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МИНИСТЕРСТВО ВЫСШЕГО И СРЕДНЕГО СПЕЦИАЛЬНОГО
ОБРАЗОВАНИЯ РЕСПУБЛИКИ УЗБЕКИСТАН

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ
УЗБЕКИСТАН

ТАШКЕНТСКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ

СБОРНИК МАТЕРИАЛОВ III МЕЖДУНАРОДНОЙ СТУДЕНЧЕСКОЙ КОНФЕРЕНЦИИ «ЦИФРОВИЗАЦИЯ-БУДУЩЕЕ МЕДИЦИНЫ»

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Future directions for integrating measurement and signal conversion systems in medical instrumentation

[1]Abdurazzokov J.T., [2]Ermetov E. Ya., [3]Maksudov V.G., [4]Safarov U.Q. [1,2,3,4] Tashkent Medical Academy

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Abstract. *The study investigates the fundamental characteristics of silicon-based, integrated, fiber-optic, and thin-film converters. Particular attention is given to the practical implementation of silicon transducers in monitoring temperature, radiation intensity, and humidity. Furthermore, the article evaluates the distinct advantages of silicon-integrated technologies in the context of computed tomography (CT) imaging and discusses the strategic developmental trends of converter techniques in high-precision measurement systems.*

Keywords: *integral, fiber-optic and film converters, hybrid, power of optical radiation, high strength of silicon, mechanical hysteresis, Whitson bridge.*

I. INTRODUCTION

The rapid development of electronics industry technologies has enabled the mass production of low-cost converters and the emergence of entirely new types of converters. In addition, as the physical size of devices increases according to constructive and technological criteria, converters are specially classified based on their manufacturing technology. As a result, inexpensive silicon, integrated, hybrid, fiber-optic, ceramic, and thin-film converters have appeared. According to the nature of their interaction with the external environment, converters are divided into two main types: point (localized) and distributed. A converter is called a point type if the measured physical quantity changes very little across the environment and its variation is comparable to the size of the converter's sensitive element. Distributed converters, in turn, can be either continuously distributed or discretely distributed. In the discrete case, the converter essentially consists of an array of multiple point converters. It should be noted that this classification is not limited to the above criteria. For example, converters are also divided into contact and non-contact types, active and passive types, and other similar categories. Among all types of converters, silicon-based ones are the most widely used. Silicon, as a sensitive element, possesses several important advantages: stability of its electrophysical characteristics, high sensitivity to external influences, and the absence of mechanical hysteresis..

The high strength of the silicon keeps it usable even at accelerations of up to 105g. The power potential of planar technology played a decisive role in the development of silicon converters. Starting with pressure measurement techniques, silicon converters have been used to measure temperature, radiation intensity, acceleration, consumption, positioning (in robotics), force, humidity, gas composition analysis, and more. Converter technology, unlike electronic integrated circuits, does not depend on special electrophysical properties. Therefore, in the production of converters, traditional electronic technology can also use scrap materials. Thus, the production of converters ensures waste-free operation in the production of electronic integrated circuits.

Measuring quantities (force, pressure, acceleration) in devices, the basis of the converter is the piezoelectric effect, which changes the mechanical effect into electrical resistance, the piezoresistivity of semiconductor tensor resistors is almost 100 times greater than such a parameter

of the corresponding wire thermo-resistor. The sensitive element of such converters consists of a silicon membrane or a silicon console attached to a rod, and a piezoresistor is defused into it. Changing the shape of the sensitive element as a result of mechanical impact causes a change in the resistance of the piezoresistor, which is recorded using a bridge circuit. Temperature compensation is created with the help of an additional resistor and is connected to the Whitson bridge together with the measuring resistor. The pressure measuring silicon converter (KK) has a high degree of linearity and a converter error of 0.2-1%.

II. THE PROSPECT OF USING CONVERTER TECHNOLOGIES

In semiconductors, the mobility and density of charge carriers depends on temperature, so it is possible to know about them by looking at the change in electrical resistance of the semiconductor. Temperature measuring instruments have a favorable combination of properties: linearity, stability of the coefficient of variation, high accuracy, simplicity and low cost. Thermal converters can be semiconductor diodes or transistors by design, and the emitter-base voltage depends on the action when they are constant in a constant current collector. CCs have a sensitivity of about 2mV/K. The linearity of the converter is 0.1K in the temperature range of 220-400K and 1K in the range of 220-530K. The conversion error of the converter calibration at three temperature values is 0.01 K, taking into account its non-linearity.γSilicon is used as a sensitive element in radiation converters up to the ultra-high frequency (UHF) range of radiation. The principle of operation of KOs can be different. To measure the power of optical radiation, the bolometric method is sometimes used - in which the sensitive element heats up when it absorbs energy. Another method of recording optical radiation is based on the photoeffect: under the influence of light, an electron-hole pair appears in the semiconductor, which creates conductivity in the material. When measuring ionizing radiation, silicon detectors have greater sensitivity than gas-filled ionization chambers.

The higher density and volume of the semiconductor material compared to the gas together (about 10 times) cause it to absorb more energy and provide a larger electrical signal at the detector output. In order to use the capabilities of the silicon detector (KD), it is necessary to cool it (for example, to the temperature of liquid nitrogen, 77 K), and to record and process electrical signals, it is necessary to use low-noise electronic devices. This type of silicon photodiode (receiver) has good performance with a high-mass epitaxial base in a structure with a small diameter used for medical X-ray endoscopy. It has a light-reflective coating between them, and it has good spectral characteristics in the wavelength range of 500-1000 nm. In the dynamic range up to 30 dB, the signal has high linearity, and the constant of its conversion coefficient is around 1-2%. The advantages of silicon technology are manifested in the creation of transducers for computed tomography. It is necessary to create hundreds of converters with the same characteristics in each tomograph, which cannot be ensured in individual production. Electrophysical properties of semiconductors are sensitive to various connections and impurities. This feature of them is used in the analysis of the chemical composition of the controlled environment.

The detector based on monocrystalline silicon has a very low sensitivity, because a yeast film is formed on the surface of the semiconductor, which protects the element's sensitivity and reduces chemical activity. Therefore, the surface of the sensitive element is pre-coated with some material. If the surface is covered with lithium monolayer or other alkali metal atoms, the sensitivity of the converter to gas concentration increases. For example, an exposure of 110 seconds allows measuring molecular oxygen pressure up to 10-6 Pa with an accuracy of 5%. The

small dimensions of the converter ensure that various gases are registered even in micro-spaces. Another way to increase KO sensitivity is to cover the silicon surface with polymers, whose dielectric constant and specific resistance change under the influence of gases. Converters have been created that are sensitive to CO, CO2, CH4, SO2, NH4 and other gases. KOs that measure moisture also work on the basis of this principle. The phenomenon of Hall effect and magnetoresistance in semiconductors makes it possible to record magnetic fields using semiconductor converters. The Hall voltage depends on the current flowing through the sample and the magnetic induction. Characteristic sensitivity of Hall KOs is 100mV/mTl. Sensory organs of robots constitute a separate group of converters: state (position), linear input, touch, sliding, proximity, force converters are among them. At the heart of methods of recording the state of an object is the conversion of the object into electrical signals. For example, using a light beam, a mirror and a photodetector. In a different way based on the magnetic technique of change of state and migration in the medium, the photodetector with the glass magnet is replaced by the converter sensitive to the magnet. The position transducer can register the monitored object in the environment with an error of 2-10 μm.

Creators of complex equipment, such as robots, need multifunctional converters, that is, converters that can change several physical quantities. Currently, single-crystal converters for measuring temperature and pressure have been developed. The physical meaning of such converters is based on the different effects of mechanical stress and temperature on the electrical conductivity of the tensor elements of the anisotropic semiconductor material. . IS 2002 Transsensory Devices Inc. (A Sh) single-crystal pressure and temperature converter for temperature measurement, 0, 1 K and has an error of 60Pa in pressure measurement. The role of semiconductor technology in measuring technology is fully manifested in hybrid converters, which consist of a means of processing measurement information and a constructive combination of sensitive elements. As the first step in this direction, they were made together with sensitive elements and performed the following functions: amplification, linearization, temperature compensation, and converted the analog signal into a vibration frequency.

A natural consequence of the further development of hybrid converters was the creation of converters combined with a microprocessor. Their accuracy, resistance to interference increased, the possibility of information exchange between the converter and the digital control system appeared. Despite the advantages of hybrid converters, the process of its further integration is proceeding at a steady pace. First, the cost of microprocessor converters does not allow them to compete equally with well-designed analog converters. Secondly, the reliability of microprocessor converters is much lower than that of conventional converters. If an analog converter resets itself after exceeding its set limits, microprocessor converters do not reset if they fail. In addition, interference disrupts the work of micro-processors, and at the same time, the analog converter maintains its operability after the impact of the destruction by reducing some of its characteristics. Therefore, the technological possibilities of creating monolithic solid-state measurement converters are not fully used. In some cases, converters must withstand high pressure, strong magnetic fields and increased radiation. In extreme cases, two ways can be distinguished to maintain the operability of converters.

First, it is necessary to protect the insulation of the converter and its connecting wires with hard-to-melt metal and ferromagnetic material.

Secondly, a radical way to protect the converters from extreme external environment is to ensure the operation of the communication line in these conditions.

III. CONCLUSION

In conclusion, such devices are unbeatable in making measurements in strong electric and magnetic fields, and they do not use conductive elements. In addition, the alternating fields create an inductive current in the metal parts, which heats up these areas, creates a parasitic heat flux and reduces the signal at the output of the converter. The use of optical fiber technology is the initial stage, the principle of their operation is based on the change of the condition of propagation of electromagnetic waves in the wave transmitter made of dielectric under the influence of the measured physical phenomenon. The measuring system will have a minimum light source, a detector and a light transmitting fiber. The measurement method is based on the transmission or reflection of light. In the first case, the measurement action changes the wave propagation constant in the light transmitter and is recorded by the detector, while in the second case, the effect (pressure, temperature, object condition) changes the boundary condition of the light transmitter, thereby together the returning wave and the interference change the landscape as well. Information about the transformed magnitude value is obtained according to the intensity of the returned radiation. the indicator is selected depending on the measurement conditions and the physical quantity.

The prospects of fiber optic converters are primarily related to the development of integrated optics. Wider use of coherent vibrations, use of birefringent light transmitters, the selection of components according to the polarization and the use of single-mode light transmitters allow to create a family of small-sized high-sensitivity converters that are not very expensive. For this, integrated optics will have to go the same way as semiconductor planar technology. The rate of development of fiber optic system measurement technique is very high (about 30% per year). A radical means of protecting the signal at the output of converters is the use of a digital converter in the immediate vicinity of the converter. In such a converter, the output signal is a digital code, which is more protected from interference signals than analog signals. For this, integrated optics will have to go the same way as semiconductor planar technology.

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