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ТЕХНИКА ИЗМЕРЕНИЯ ФОТОМЕТРИЧЕСКОЙ ОКСИМЕТРИИ

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THE MEASUREMENTS TECHNIQUE OF PHOTOMETRIC OXIMETRY

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Аннотация. Поставлены основные задачи разработки устройства для измерения сатурации образца крови. Описана кратко техническая часть работы устройства. Показаны основные его преимущества.

Ключевые слова: оксиметрия, сатурация, оптический излучатель и приемник, интенсивность излучения, светодиод, фотоприемник.

Abstract. The major problems of development of device for measuring oxygen saturation of the blood sample are given. The technical part of the device is briefly described. The basic advantages of one are shown.

Keywords: oximetry, oxygen saturation, optical transmitter and receiver, radiation intensity, LED (Light Emitting Diode), photodetector.

Clinical monitoring of blood gases is an essential part of diagnosis of the patient body state in the treatment of patients in department of intensive therapy. The percent of oxygen saturation and carbon dioxide saturation of hemoglobin in arterial and venous blood are resulting values in this diagnostics. There are many methods of optoelectronic diagnostic of these parameters. They all have their advantages and disadvantages.

To determine of the amount of oxygen in the blood by the photometric method can not do without an optical transmitter and receiver. That’s why as the base we used the next model: optical emitter – blood sample – optical receiver [1].

This method of measurement has own its main advantages. They are the portable devices, the simplicity and speed of the measurement method.

In turn arise the following tasks:

1) the radiation to the sample must be clear and precise directional;

2) radiation losses and other sources of radiation, which would lead to large errors of measurement must be eliminated;

3) need to obtain accurate output signal in results of which can be to draw conclusions about the sample.

To solve the problems described above was analyzed all kinds of electronic components and optical electronic components from the entire set and chosen the most suitable.

It is known that for photometric oximetry method to determine the oxygen in the blood need to use sources of radiation of two different wavelengths [2]. The depending on the frequency of the radiation light absorption coefficients of hemoglobin and oxyhemoglobin are substantially different. So at a wavelength of 660 nm (red area) hemoglobin absorbs about 10 times more light output than oxyhemoglobin. And at a wavelength of 940 nm (infrared) oxyhemoglobin absorbs light more than hemoglobin. Using this fact we applied as radiation emitter two different LEDs (Light Emitting Diode). The red LED which works at 680 nm and infrared LED wavelength range of it is 940 nm. As there are a great many LEDs, we elect them based on the size of the measuring cell and used a blood sample.

Next the resulting radiation through a cell must be recorded without loss and transmitted to further visualization. As the signal at the output of the system is too low it is a very difficult to measure without errors using standard measuring devices.

For this purpose we used single monolithic integrated circuit (IC) which allows taking radiation in fairly wide range. It’s consists of a photodiode and a transimpedance amplifier with elements of the feedback (fig. 1). This IC have improved amplifier offset-voltage stability and low power consumption.

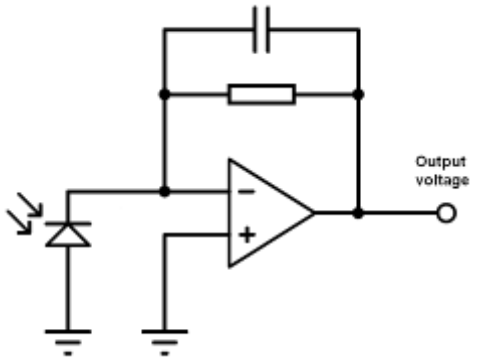

Figure 1. Functional Block Diagram.

Using this element in the creation of the measuring system solves two problems at once:

1) since we have chosen the element is designed to accept a wide range of radiation (fig. 2). Using one simple photodetector for both red and the infrared wavelength range it simplifies the design;

2) since we have embedded operation amplifier it simplifies the design of the receiving part of the system in terms of reinforcing the site, the use of which would

be useless (fig. 1). The output signal is simply sent to the recording device. In our case it's analog-to-digital converter (ADC).

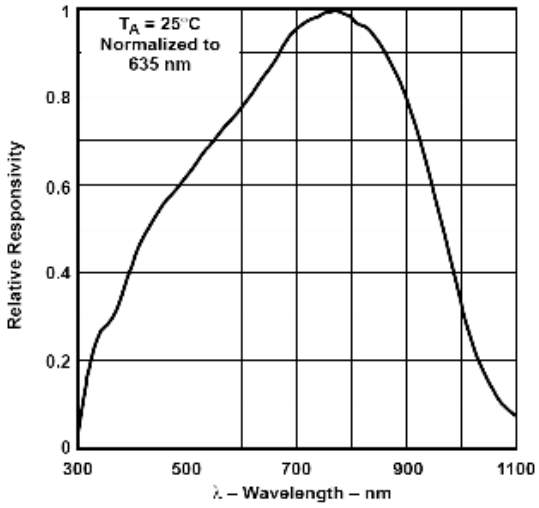

Figure 2. Photodetector spectral responsivity.

The main parameter of the system is the output voltage of the sensor. It characterized by the extent of absorption of oxygen blood sample in the measuring cell. The whole measurement system is placed in a sealed enclosure which refrains from other outside radiation.

Since it is very important that the intensity of the input light is not changed the LED should be provided a constant voltage i.e. the current of the LED should not be changed. This problem we have decided by the following ways:

1) using an independent source of DC voltage – the battery or cell battery as power supplies to make the chain variable components of the harmonics, which leads to some measurement error;

2) using of the integral voltage regulator which allows to keep the required level of voltage applied to the LED's (this eliminates the dependence of the system of self-discharge of the battery or accumulator);

3) using of indicator which signals a low battery for it's replacement.

Thus the developed system is a portable and compact device for measuring blood oxygen absorption.

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