Measurement Schemes of opt electron Converters Light Flow Receiving Devices

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ABSTRACT

Thus, the basic measurement schemes of the light current receiving devices of optoelectronic converters studied above show that the measurement scheme of a photodiode with a negative bias voltage has several advantages and ensures stable operation of the circuit, that is, a secondary converter-operation that converts the photodiode current into a voltage characteristic of its output circuit amplifier circuit is included. It can be seen from the diagram that the double filtering of the output signal increases the accuracy of the photoelectric characteristics of the photodiode measuring circuit to a high level.

Keywords: Photoeffect, photoresistor, photodiode, phototransistor, photocell, photomultiplier, buffer capacitors, concentration.

Measuring circuits of light flux receiving devices are used to measure displacement and angular quantities with the help of optoelectronic transducers. Photoresistor, phototransistor and photodiode circuits are used for this purpose. Let's look at several devices that work on the basis of the photoeffect phenomenon. Photoelectric devices are devices that convert radiation energy into electrical energy. Such devices are implemented in vacuum, gas, and semiconductors based on the photoeffect phenomenon. The principle of operation of the most common photoelectric devices at the present time is based on the internal photoeffect phenomenon that occurs in a semiconductor.

The true essence of the internal photoeffect phenomenon is that when light falls on a semiconductor, the concentration of charge-carrying electrons inside it increases, and in turn, the conductivity of the semiconductor occurs. Such conductivity of a semiconductor is called photoconductivity. Photoconductivity, that is, the increase in the concentration of photoelectrons, depends on the intensity and spectral content of the external radiation current falling on the semiconductor. The intrinsic photoeffect is used in various types of semiconductor devices.

Photoelectric accessories are divided into two groups: accessories working with external photoeffect; accessories working with internal photoeffect. External photoelectric devices include vacuum and gas-filled photocells and photoelectric multipliers. Devices with internal photoeffect include photoresistor, photodiode, phototransistor and photothyristors. Sunlight, incandescent bulbs and other light sources are used as sources of radiation.

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A photocell consists of an electrovacuum or gas discharge diode, consisting of an anode and a cathode located in a glass cylinder. The photocathode is a semiconductor coated on the inner surface of a glass cylinder, and is exposed from the outside

can sense the flow of light very well. Its anode is made in the form of a circle or frame and is placed inside a glass cylinder (Fig. 1). Photocells are divided into gas discharge and vacuum photocells. If no external light falls on it, the anode current will be zero.

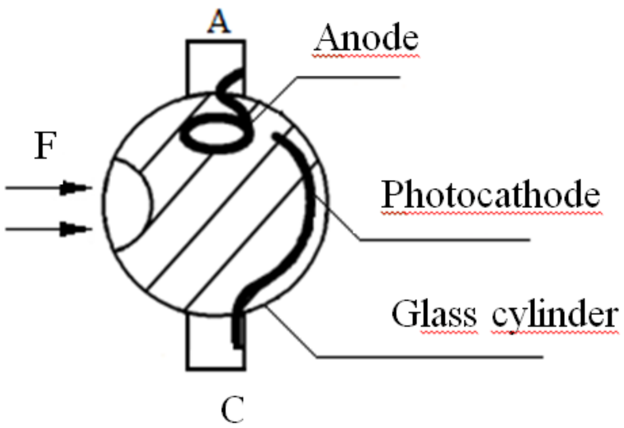

Figure 1. Construction and elements of a photocell.

When the photocathode is irradiated, a current is generated in the anode circuit as a result of photoemission. Photocells are considered primary information converters.

A photomultiplier is an electrovacuum measuring device that converts electromagnetic radiation energy into electrical signals as a result of secondary electron emission. It consists of a glass cylinder, inside which there are amplifying, multiplying electrodes and an anode. When the photocathode is irradiated, a stream of electrons is generated, and this stream is focused and directed to the multiplying electrodes. The current increases due to secondary emission and falls on the anode, creating a current.

Let's consider the measurement schemes of the photodiode, one of the photoelectric converters discussed above. A photodiode can operate in two modes, i.e. galvanic and photodiode mode. In the photodiode mode, the p-n junction is shifted by a reverse voltage, so this voltage can be from several tens of volts to hundreds of volts, depending on the type of photodiode. The greater the bias voltage, the faster it operates and the greater the current that flows through it. One of the disadvantages of the photodiode mode is that as the reverse voltage and current increase, the noise level in it increases, but the useful signal remains almost unchanged, and the diode in this mode has a small time constant.

In photovoltaic mode, no voltage is supplied to the photodiode and it itself remains an electrically conducting power source with a large internal resistance. One of the disadvantages of the photovoltaic mode is that the useful signal is reduced due to fluctuating radiation, but the noise level remains unchanged.

Figure 2 shows the measurement scheme of the photodiode. The given scheme is universal and can be used to test other devices. By changing the resistance of the variable resistance resistor, it is possible to select the optimal operating mode of the photodiode. By changing the resistance of this variable resistance resistor to its minimum and maximum values, it is possible to set the optimal shift mode of the photodiode. If we reduce the resistance of the resistor to a minimum and connect its active contact to the ground, the circuit is photovoltaic A photodiode can also be used with the correct voltage, but in this case, the diode should be connected in the opposite direction than in the circuit. The main function of the capacitor in the circuit is not to transfer a constant component to the output.

Figure 3 shows a much improved version of the photodiode measurement circuit.

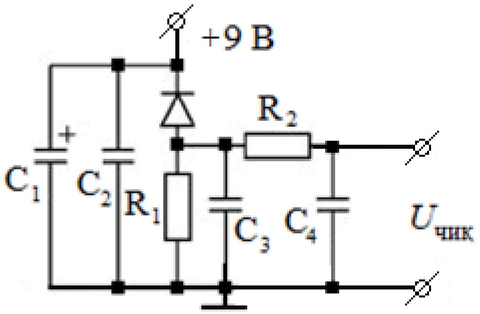

Figure 3. An improved version of the photodiode measurement scheme

In order to reduce noise and other parasitic signals in the given circuit, the buffer capacitors C_1 and R_2, the charge collecting capacitor C_3 and the R_2C_4 integration circuit at the output are added to the current source circuit of the circuit. An integrated signal is obtained at the output.

To ensure maximum speed of the circuit, a common-base transistor cascade or an operational amplifier according to the "current-voltage" scheme, which can work very quickly, is used as a sample (Fig. 4).

The measuring circuit of the negative bias voltage photodiode has several advantages and ensures the stability of the output signal. Therefore, the introduction of a secondary converter-operational amplifier, which converts the photodiode current into a voltage characteristic of the output of the circuit, increases the stability and sensitivity of the measuring circuit. In this case, the speed of the scheme increases several times. In order to reduce noise and other parasitic signals in the given circuit, the current source circuit of the circuit consists of an electrolytic capacitor C_0 and a resistor R_0 filter chain included. Deep positive feedback is provided through resistor R_2 and it forms an output filter with capacitor C_2.

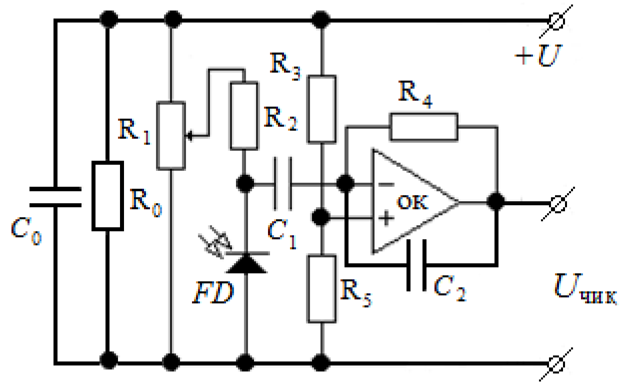

Figure 4. Measurement scheme with an operational amplifier

Thus, the basic measurement schemes of the light current receiving devices of optoelectronic converters studied above show that the measurement scheme of a photodiode with a negative bias voltage has several advantages and ensures stable operation of the circuit, that is, a secondary converter-operation that converts the photodiode current into a voltage characteristic of its output circuit amplifier circuit is included. It can be seen from the diagram that the output signal is filtered twice. This increases the photoelectric characteristics of the photodiode measuring circuit to a higher level.

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