

## REFERENCES

1. Pravallika Vinnakota. Управление двигателем с помощью Arduino: Пример информационного моделирования и разработки системы управления [Электронный ресурс]. – Режим доступа: <http://matlab.ru/articles/motor-control-with-arduino.pdf>. – Дата доступа 10.10.2014.
2. Семейство микроконтроллеров MSP430x2xx. Архитектура, программирование, разработка приложений / пер. с англ. А.В. Евстифеева. – М. : Додэка-XXI, 2010. – 544 с. – (Серия «Мировая электроника»).
3. MATLAB и быстрое преобразование Фурье [Электронный ресурс]. – Режим доступа: <http://habrahabr.ru/post/112068/>. – Дата доступа 04.09.2014.
4. NET.addAssembly [Электронный ресурс]. – Режим доступа: <http://www.mathworks.com/help/matlab/ref/net.addassembly.html>. – Дата доступа 20.09.2014.
5. MathWorks. Accelerating the pace of engineering and science [Electronic resource] / The MathWorks, Inc., 2013. – Mode of access: <http://www.mathworks.com/index.html/>. – Date of access: 28.02.2013.

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## SENSORS OF ALARM SYSTEMS

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*The standard structure of alarm systems has been considered. The description of the principles of operation of sensors has been provided. Alternative options of touch elements of security system have been shown.*

Security alarm is a complex of electronic security devices, which allows to provide object's protection from offences by means of the owner or law enforcement bodies alerting. There are two main types of alarm acute for Belarus: 1) the alarm using MIA security department brigade of the Republic of Belarus call, with monthly pay; 2) GSM-alarm, the activation of which alert message by means of SMS or mobile phone-call is delivered to the owner.

The security alarm system consists of the control unit (with GSM-module or without it) and different sensory devices depending on the guarded object. The system also contains uninterruptible power supply unit with an accumulator battery and security systems' cable. Control-security device may be wire-connected – with sensory devices, as well as unwired – the connection between sensory devices is realized with the help of radiofrequency signal (power supply is wire-connected). Control of radio-security may be realized by means of wireless radio-breloques [1]. Control unit shows current alarm mode (“Attention”, “Warning”, “Removal”), it's also activates/deactivates with the help of Touch Memory key or SMS-message. Let's look at the principles of sensory devices' working and its configuration. There are three main sensory devices in the system: a movement-detecting device, the device of a door opening/locking fixing process and the one of glass-breaking.

Let's consider a movement-detecting sensory device. It is based on IR-detector, that uses deposition of thermal energy the perimeter breaker emits. Movement-detecting IR-sensors are used for the security of armed bank buildings - cash operating units, depositories. The principle of thermal movement-detecting method is based on the physical theory of electromagnetic waves' radiating by objects, the temperature of which is above the absolute zero point. Movement-detecting and presence sensory devices react on the photocell IR-light occurrence and disappearance. Such IR-light occurrence-disappearance are often caused by human activity, more seldom – by factors which aren't connected with man, for example, by warm air moving from a radiator etc.

That's why false activations are observed with all of the movement-detecting (presence) sensors. Movement-detecting devices are more simple in its construction and they react only on active movements, of a walking man, for example. A general arrangement drawing of IR-sensor work is represented at figure 1 [2].

There are various constructions of movement-detecting IR-sensors, which are intended for specific technical objectives and conditions. The most popular construction of the movement-detecting IR-sensor is given in figure 2 [3].

The principle of movement-detecting sensor on pyroelement is the following: perimeter breaker's thermal stream goes to the Fresnel lens, which focuses radiation on the pyroelement, after that thermal stream is transformed into pyroelement's temperature change. The internal structure of the pyroelement redistributes (charges rearrange themselves) and potential (voltage) appears on the pyroelement's leading-outs. This signal enters sensory device control unit, i.e. cascade of growing and its transformation into digital form.

One of the important parts of modern security system is a door opening/locking sensory device.

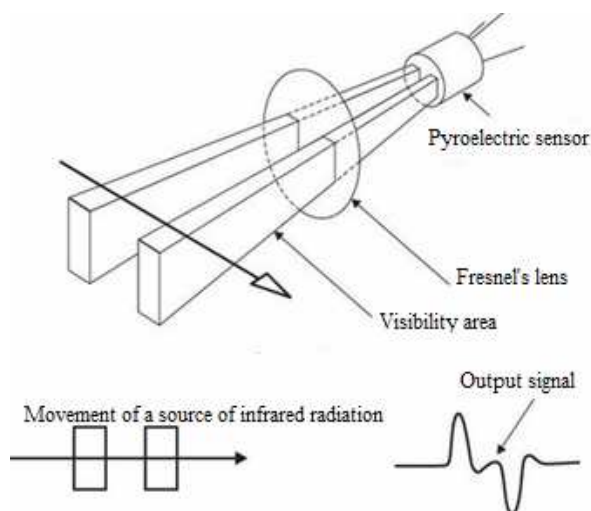


Fig. 1. The block diagram of functioning the movement-detecting sensor on a pyroelement

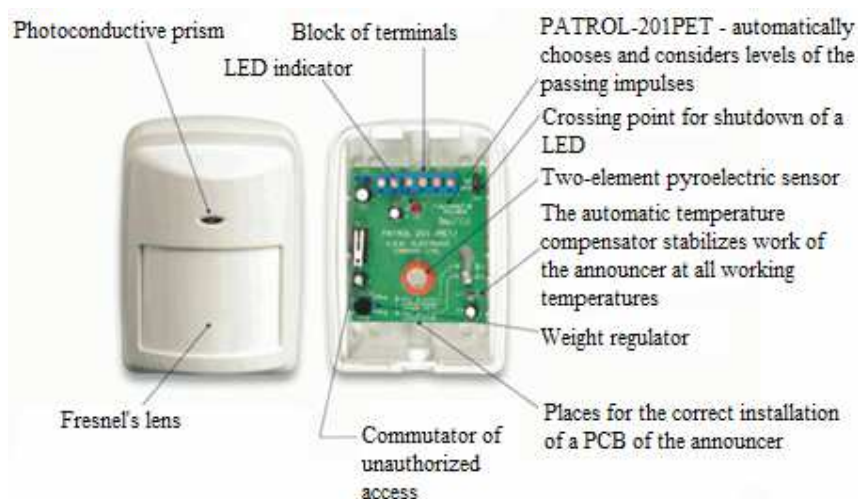


Fig. 2. Construction of movement-detecting IR-sensor

Sealed contact sensor is a special device created for separate objects' protection level increasing. The main active components of such product are sealed contact and magnet, according to which the device was named. The sensor reacts on doors-opening in detached houses or garages, utility rooms. Sealed contact working is based on interaction of two main elements: permanent magnet as a master element and sealed contact as an actuating element.

Sealed contact is a unique element in radio electronics, which consists of two or three permalloy patterns weld airproof inside of the glass balloon with nitrogen at high pressure. Such construction technology allows to exclude completely any oxidizing process appearance in sealed contact. Sealed contact interface details are covered with special lightweight film made of noble metals, so that low transient resistance, high wear-resistance and the possibility of current commutation is provided.

A master element, or permanent magnet, is fixed on flexible part of the guarded object, an actuating element, or sealed contact, with all commutational tools and wires – on stationary part of the object. When the master and the actuating elements of sealed contact sensor are placed together, sealed contact leads are locked under the influence of magnetic field. In this case sensor works in "Security" mode. If these elements are separate, weakening of magnetic field influence on sealed contact is observed, as a result, leads are disconnected, and the sensor turns to "Warning" mode. The amounts of the distances between the main elements are described in operating instructions of each sensory device, what provides stable forming of the above-described modes.

The principle of operation of the sensor of breaking glass consists in response to fluctuations with a frequency in limits 1,5 kHz, which arise when glass breaks, or higher frequency in cases when glass is cut out by means of the special tool. If the range of noise contains a component, which coincides with a range of glass, which was damaged, it means that the sensor was actuated. In this task as the sensor of breaking glass, will be

used the acoustic sensor. When using the acoustic sensor the electret microphone will be a sensitive element. The signal is amplified and analyzed by the electronic scheme.

As a result, it is possible to tell, that the system is hi-tech and represents very reliable device. To increase functionality of security system some sensors it is possible to change. We will consider analogs of these sensors and their principle of action.

Movement-detecting sensor DRM-01 can be used as the presence sensor. The sensor allows to define the movement through wooden boards, glass and plastic. Movement-detecting sensor DRM radiates and accepts the reflected high-frequency electromagnetic waves with a frequency 5,8 Hz. The sensor defines changes in the reflected waves caused by movement of object in a controlled zone. It is also defines the movement of object, both on approach, and on removal. The movement in a controlled zone leads to automatic inclusion of lighting. From the moment of inclusion, each movement supports continuous lighting. Only lack of the movement in a controlled zone disconnects time of maintenance of the included lighting. The next movement in a controlled zone or its absence during counting of the set time reckon time at first. Motion of action allows using DRM as presence sensor. After the set time lighting will be switched off automatically. The motion sensor is supplied with the photosensitive automatic breaker which blocks lighting inclusion in the afternoon. The sensor is activated in a verification regime of the movement and readiness for lighting inclusion only after approach of twilight. The consumer by means of a potentiometer can set time of activation of the sensor. In addition there is a possibility of adjustment of the area of the review of the detector in a radius of action of a beam from 3 to 10 m (with an installation height  $h = 2,5$  m), and also adjustment of time of inclusion of lighting in the range from 5 seconds up to 12 minutes. Inclusion of the consumer is signaled by a luminescence of a green light-emitting diode. The movement-detecting sensor can work out of rooms.

Sensor of breaking glass pyronix Break Glass 2000 — it is the acoustic sensor of breaking glass [4]. It is intended for detection of destruction of the glazed surfaces: breaking glass of windows, show-windows, partitions. For minimization of false operations sensor of breaking glass pyronix Break Glass 2000 uses microprocessor algorithm of processing of a signal on HF-LF-components: fixes a characteristic sound of withdrawal panes of glass against pressure difference owing to blow. As a result sensor of breaking glass pyronix Break Glass-2000 have the balanced characteristic of reliability of operation and is calculated on work with the majority of all-widespread types and the sizes of glass, including double-glazed windows, the tempered and armored glass.

The main particularities of the given sensors is that they can provide measurement with a contactless method.

The sensor of opening/closing of doors or windows belongs to contact type of sensors in this system. Wireless sensor of opening of a door/window Ajax WS-401 is intended for detecting of opening of doors, windows, hatches, gate, etc [5]. The sensor consists of two parts – a magnet and the block with sealed contact. The principle of operation of the sensor of opening of a door/window is based on properties of a sealed contact – the element that is carrying out current under the influence of a variation magnetic field. In a normal state, the magnet and the block with the sealed contact are closed. As soon as the door, on which the sensor is installed, opens – the magnet moves away from a sealed contact, contacts are disconnected and repkon ceases to carry out current. When closing a door there are return processes: the magnet comes nearer to a sealed contact, contacts are closed and sealed contact starts carrying out current. In both situations, the sensor works and instantly sends the message on alarm on the central block. Difference of the sensor consists in: it is protected from opening by a tamper, thanks to special algorithm of energy saving works from the battery till five years, response level – 1 cm, there is a possibility of a choice of logic of work (reacts only to opening, or both to opening, and to closing).

Increase of reliability of security systems is an actual problem. Now in the majority of security alarm systems, both import, and a domestic production magneto-contact sensors are used (sealed contact). However, use of sensors on the basis of effect of the Hall, instead of sealed contact promotes increase in reliability of security system (because of lack of any effect of contact) also allows to realize the security sensor with more flexible characteristics (adjustable sensitivity).

Now on the basis of Hall effect many firms make different sensors, as for measurement of directly magnetic induction (teslameters), and for the applied purposes, for example, production automation. However, in security sensors not enough attention, even on pages of producers is paid to use of Hall effect. In these time using of the Hall sensors in security systems allows to increase their reliability and flexibility in comparison with traditional magnetic and contact sensors, and furthermore the simple contact.

We will give advantages from using of the Hall sensors as security sensors, there are:

- default of the closing-disconnecting contacts;
- higher sensitivity on distance;
- possibility of adjustment of sensitivity;
- the dime-size that is important for the hidden installation.

For carrying out tests some versions are chosen movement-detecting infrared sensors various producers. When developing the program of tests were considered State All-Union standard (USSR State standard specification) P 50777-95 (IEC 839-2-6-90) [6]. Tests were carried out on the following items:

- range of action. As “object”, the standard student was used by weight 70 kg and length 175 cm. An “object” passed across “half line” a way to three meters. Was considered that the device “took” a distance if it reacted to the object moving with a speed from 0,3 to 3 m/s. Range of steady operation on the violator of the protected perimeter at the tested infrared sensors was fluctuate in limits from 0,3 to 12 m. It should be noted that the maximum range when carrying out experiences made 20 meters. The probability of detection of the violator in the range of 12 – 20 meters made 80% in this connection it is possible to consider that this distance isn't a zone of sure operation.

- resistance to an external flare. The movement-detecting infrared sensors has to react only to emergence in an area of coverage of the person and not notice, for example, “spot of sunlight” or light of automobile headlights. For research of this characteristic, various sensors were located in the dark box closed from all directions except a lobby. The beam of a bright lamp went to it, but to exclude influence of infrared part of a range, on the way of a beam established a double double-glazed window of firm Rehau. Practically we modelled a life situation: operation on the passing car. This experiment was made 5 times within 20 seconds. All sensors successfully passed tests as didn't react to external excitement.

- resistance to change of the feeding tension from 187 to 242 V. Fluctuations of mains voltage are very frequent and in rural areas, and in the city. Thus, there is a probability of failures in operation of IR sensors, consisting of a sensitive element and an electronic binding. At a supply voltage variation from lowered for 15% to rather standard raised for 15% (220 V) it was established that these changes had no essential impact on work of a sensitive element of the IR sensor as its food (12 V) was stabilized by the central block A6-04 [1].

Test of sensors of breaking glass were imitated by means of fluctuations of the glass jar filled with small metal subjects – nuts, screws, washers, etc. Change of frequency of sound vibrations was formed by various filling of glass capacity, changing amplitude and time intervals of stirrings.

Also we was made experiment with the sensor of opening/closing of doors. Sealed contact settled down on doors of laboratory as it is specified in figure 3.

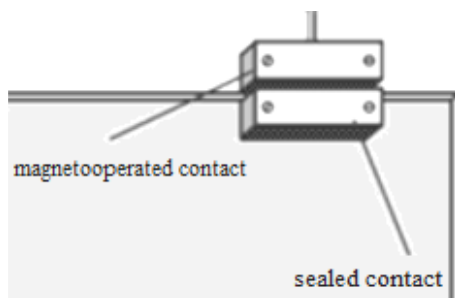


Fig. 3. Scheme of connection of the sensor of opening/closing of doors

Experiment was made as follows:

1. The knot with a permanent magnet the sizes of 25x8x8 mm from пермаллоя was established directly on a door;
2. The module of a sealed contact was fixed on a doorway;
3. When opening a door the distance between a magnet and sealed contact increased, the magnetic energy operating on the module of the sealed contact that led to disconnection of contact in the sealed contact decreased. The maximum distance at which else there is a short circuit of the sealed contact exceed 9 cm.

#### REFERENCES

1. Руководство по эксплуатации прибора приемно-контрольный охранно-пожарный А6-04 РЮИВ 170100.000: ОКП РБ 31.62.11.570. – Паспорт исполнение А6-04.
2. Интернет портал [Электронный ресурс] / ООО “ПКФ ТЭК” // Разработки датчиков и датчиковой аппаратуры. – М., 2014. – Режим доступа: <http://www.tek-el.ru/articles/detectors/motion/>. – Дата доступа 15.12.2014;
3. Интернет портал [электронный ресурс]/Актив – Москва, 2014. Режим доступа: <http://www.aktivsb.ru/prod-12397.html>. – Дата доступа: 21.11.2014.
4. Интернет портал [Электронный ресурс] / ООО “Раронix” // Датчиковая аппаратура. – М., 2014. – Режим доступа: <http://www.pyronix.ru/catalog/9/r/45/ю> – Дата доступа: 01.12.2014.
5. Интернет портал [Электронный ресурс] / Системы охраны и сигнализации. – М., 2014. – Режим доступа: [http://www.xn--80abmi5aecftcl4j.com.ua/ajax\\_ws-401](http://www.xn--80abmi5aecftcl4j.com.ua/ajax_ws-401). – Дата доступа: 11.12.2014.
6. Интернет портал [Электронный ресурс] / Город мастеров. – Системы тревожной сигнализации. – М., 2014. – Режим доступа: <http://old.mastercity.ru/cgi-bin/ml.cgi?test&24>. – Дата доступа 21.11.2014.