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## **A PIR motion detector**

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### **1. Introduction**

You probably know those invisible servants who helpfully open department store doors, switch on outside lighting when you (or your cat) walk by or open the tap when you approach the basin. Everywhere motion detectors are installed which trigger those procedures. Most of the time the PIR (**P**assive **I**nfra**R**ed) principle is used. What about utilizing this technology for BASIC-Tiger®?

Motion detectors are available for little money, but they are mostly integrated into complete systems, such as outside lighting. Single detectors are usually designed as components of home electricity systems. For a developer it is less attractive to “cannibalize” a complete lighting just for an integrated motion detector. Besides integrated sensors both on the supply side (220V) and from the output system (relays or triacs) can only be adapted to the BASIC-Tiger® system with much effort, because it works with 5 V supply voltage and levels between 0 and 5 V. The aim of this article is to find out about the technology of PIR sensors, introduce a suitable sensor construction kit for developers and discuss application options for the BASIC-Tiger® system.

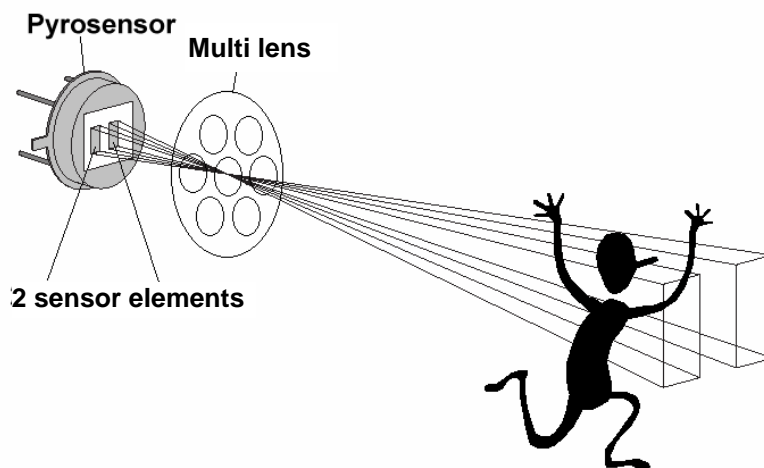
### **2. The PIR principle**

Passive InfraRed – that is all we need to know. A PIR sensor passively detects infrared radiation in its surrounding area. Since this technology is also used in fire detectors, sensors are also called pyrosensors. They are called passive because they only analyse signals which are transmitted from the object itself. In contrast to radar or ultrasound sensors an active transmitter is not needed. Infrared is the wavelength beyond visible red light. Here wavelengths around a few  $\mu\text{m}$  are analysed – the specific heat radiation which is emitted by e.g. the human body. It is obvious that a PIR motion detector only reacts to objects that are distinctly warmer than the surroundings, for example humans, animals or warm vehicles. It is important to know that the sensor does not sense absolute heat radiation but only temporal and local changes in radiation. That is required to avoid steady and immobile heat radiators to set off the switching operation.

The sensor principle is based on infrared radiation causing a charge transfer on a special membrane which resembles a capacitor. In order to perceive only changes in infrared radiation (i.e. movements of an object) the dynamic states of charge of at least two equal sensor elements are analysed, while “common mode signals” are compensated. This compensation takes place by either series or parallel connection of these single elements while the pyroelectric sensor membranes are polarized opposing each other. The advantage of this system lies in the oppression of surrounding temperature influences which change

temperature of both sensitive elements by convection, thermal conduction and occurring heat radiation. A specific amplifying circuit with additional elaborate electrical filters is attached for analysing very weak signals. Additional optical filters insure that only radiation required for detecting movements is let through. Interfering radiation sources are also shielded optically.

Usually specific lens systems (multi or Fresnell lenses), which focus optical irradiations from different directions to the sensor, are added to complete the movement detector. This widens the sensor detection range (horizontal and vertical angle) immensely. Such a wide detection range, however, is often not desired. So in order to use the system for experimental purposes removable or rather exchangeable lens systems are preferable.



*Fig. 1 General arrangement of PIR motion detector parts*

### 3. ELV motion detector PIR 13

To let you know beforehand – PIR 13 is a construction kit, which means the user has to equip a small circuit card. Since we use SMD technology we will need specific soldering technology (SMD tin-solder, electric soldering iron with a fine point), bright lighting, a freestanding magnifier as possible and a fine pair of tweezers. It is also important to avoid the delivered bits and pieces to get lost or confused – note that SMD capacitors have no imprints! The complete construction kit is delivered by ELV for currently €11.95.

Order number: 36-563-67  
Address: ELV-Elektronik AG, 26787 Leer, Germany  
Phone number: 0049 - 491 - 600888

The construction kit contains a detailed description and a construction manual, a rather small two-sided circuit card (25 x 37 mm with components layout imprint and solder resist) as well as PIR sensor and lens system (figures 2 and 3).



Fig. 2 PIR sensor...

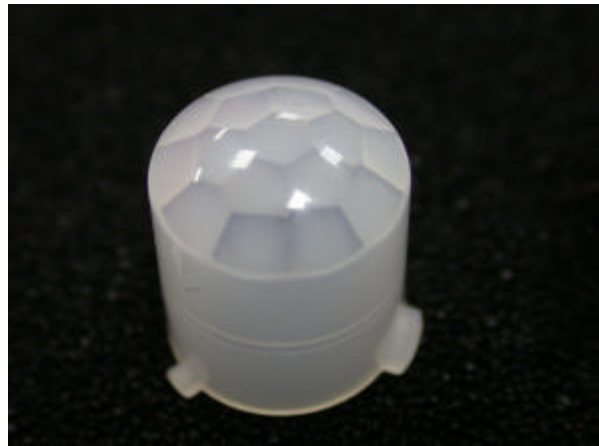


Fig. 3 ... and the suitable lens system

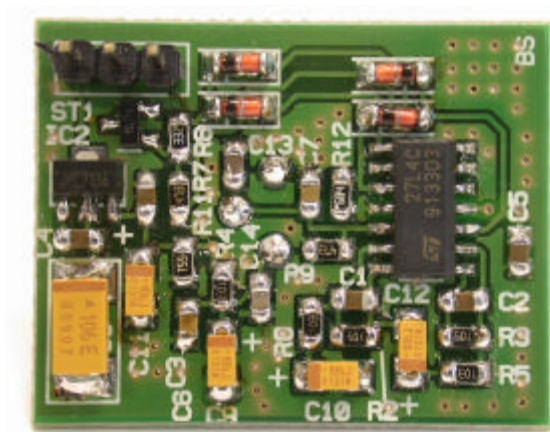


Fig. 4 Equipped back side...



Fig. 5 ... and front side

The complete circuit is fine with 5 – 24 V operating voltage, so it is adapted well to the 5 V BASIC-Tigers® VCC. A voltage regulator (HT-7136) existing on the circuit generates a 3.6 V operating voltage from a 5 V raw voltage for the sensor board.

The low current consumption of the circuit (only 40  $\mu$ A non-operative) is ideal. This enables you to use battery-operated “wake-up” applications, i.e. BASIC-Tiger® only operates when a person moves towards it.

On the output side an open collector circuit is used. In a case of “alarm” the output is pulled to ground which it is at high-resistance otherwise. With a simple resistor against Vcc 0 V and +5 V logic levels can be generated easily like this. Triggering a relay, a LED or other components is similarly easy, since the output transistor can easily drive 100 mA. Here circuit voltage can go up to 30 V!

A few more words to the motion detector’s behaviour in real action: Due to the physical principle it takes the sensor a few seconds to get “loaded” after an alarm was set off. In case

of an automatic lighting control this is desired and the effect is increased by practical circuit measures (integrated time switch). For applications that require fast reactions PIR motion detectors are less suitable.

#### **4. Operating PIR with BASIC-Tiger®**

Actually we could leave out this chapter. The module contains a 3-pin connector. Its pins have to be connected as follows:

Ground	→	BASIC-Tiger® systems GND
Operating voltage	→	BASIC-Tiger® systems Vcc
Output	→	Open collector, with 10 kΩ at Vcc normal logic levels

Like this the sensor can be connected to any BASIC-Tigers® input. You decide what it does with the signal!

Finally some possible application examples for using the sensor:

- Alarm system with several outside sensors and text output via display or serial interface. By using a suitable software this allows you to be informed about the alarm time and location. In contrast to simple motion detectors alarms can also be recorded when nobody is at home.
- This system can be combined with already known components such as mobile phones that send a text message in a case of alarm (see application not No. 056 “BASIC-Tiger® sends text message via SMS”).
- Robots and other vehicles equipped with several PIR sensors avoid people. You can modify the sensor module multi lens so that only one facet remains open (e.g. by taping the rest). Like this the visual range is narrowed. By installing several of such sensors for different directions and connecting each to a separate input of BASIC-Tiger® the robot senses people approaching from different directions. You can for example program it to evade to an unobstructed direction. Please keep in mind that sensor surfaces are extremely irritable against contamination, for example to grease.
- A BASIC-Tiger® system is only supposed to operate when an object is approaching which is interesting for instance in advertising terminals. The sensor can be supplied with a 9V block battery due to its low current consumption). It switches on power supply for the BASIC-Tiger® with its open collector output in a case of alarm. BASIC-Tiger® displays data for a defined period of time. Then the system switches itself off again.

This offers us a broad range of further experiment – doesn't it?