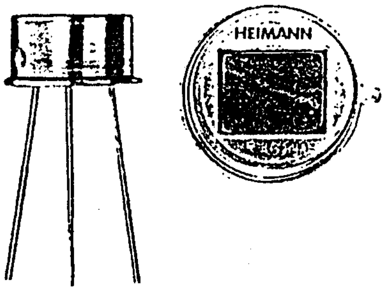
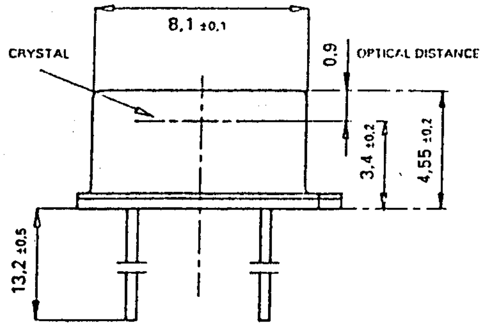
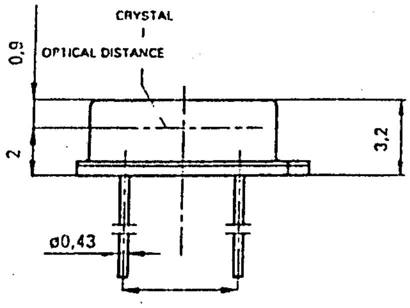
HEIMANN

Pyroelectric IR-Sensors LHi 954, LHi 958

Dual Element IR-Sensors

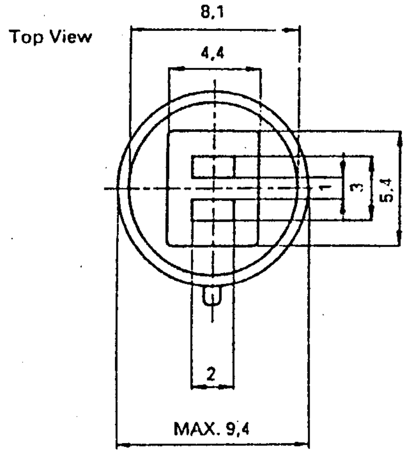




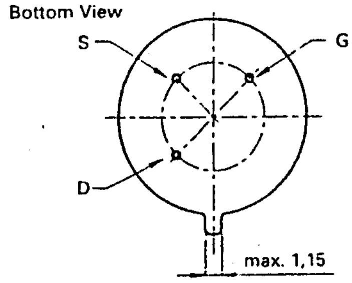


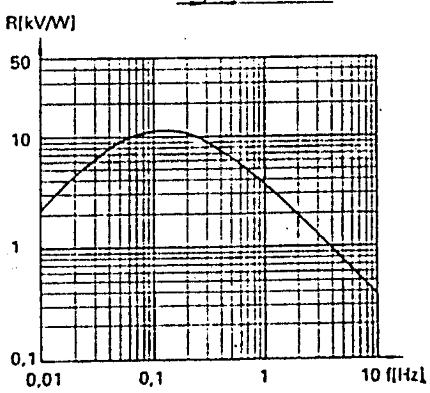
Two sensing elements of size 2 x 1 are connected with each other in opposite polarity with 1 mm optical spacing, and matched with a special low noise FET in source follower configuration. The dual element series is avaiable in TO-39 or TO-5 metal housing with optical filter 6 – 14 µm.

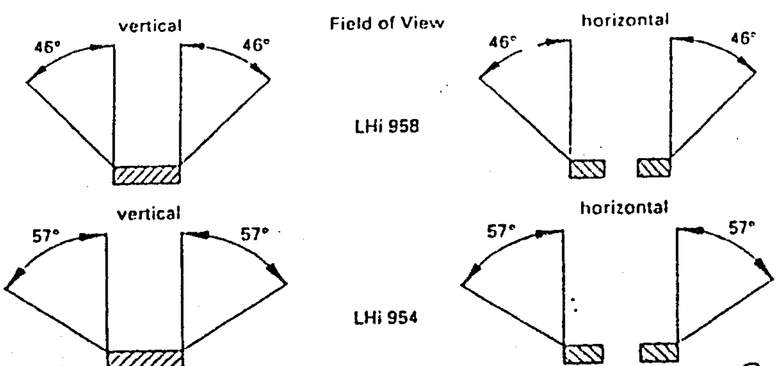
The major advantages of this series are low radio interference sensitivity, low noise, specially suited spectral response, high responsivity, and extremely tolaranced balance of the two elements. The dual element series is designed for all kind of motion detection circuits using passive infra-red techniques.



type		LHi 954	LHi 958	unit	condition
sensor type		Dual	Dual		
housing		T0-39	T0-5		
element size		2 x 1		mm	
spacing		1		mm	
responsivity R	min.	2700		V/W	6...14 µm,
	typ.	3500			1 Hz, 100°C
noise	typ.	15		µV	25°C, pk pk,
	max.	40			0,3...10 Hz
offsetvoltage	min.	0,2		V	25°C,
	typ	0,8			Rs = 47kΩ
	max	1,5			
NEP	typ	$8,6 \cdot 10^{-10}$		W/√Hz	6...14 µm, 1 Hz,
	max.	$2,8 \cdot 10^{-9}$			1 Hz, 100°C
D*	min.	$5 \cdot 10^{7}$		cm√Hz/W	6...14 µm,
	typ.	$1,7 \cdot 10^{8}$			1Hz, 1 Hz
output impedance	typ.	5		kΩ	Rs = 47 kΩ
	max.	10			
operating voltage		3...15		V	dc
operating current	min.	1		µA	dc
operating temp.		-40...+70		°C	
storage temp.		-40...+100		°C	







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Technical Publication

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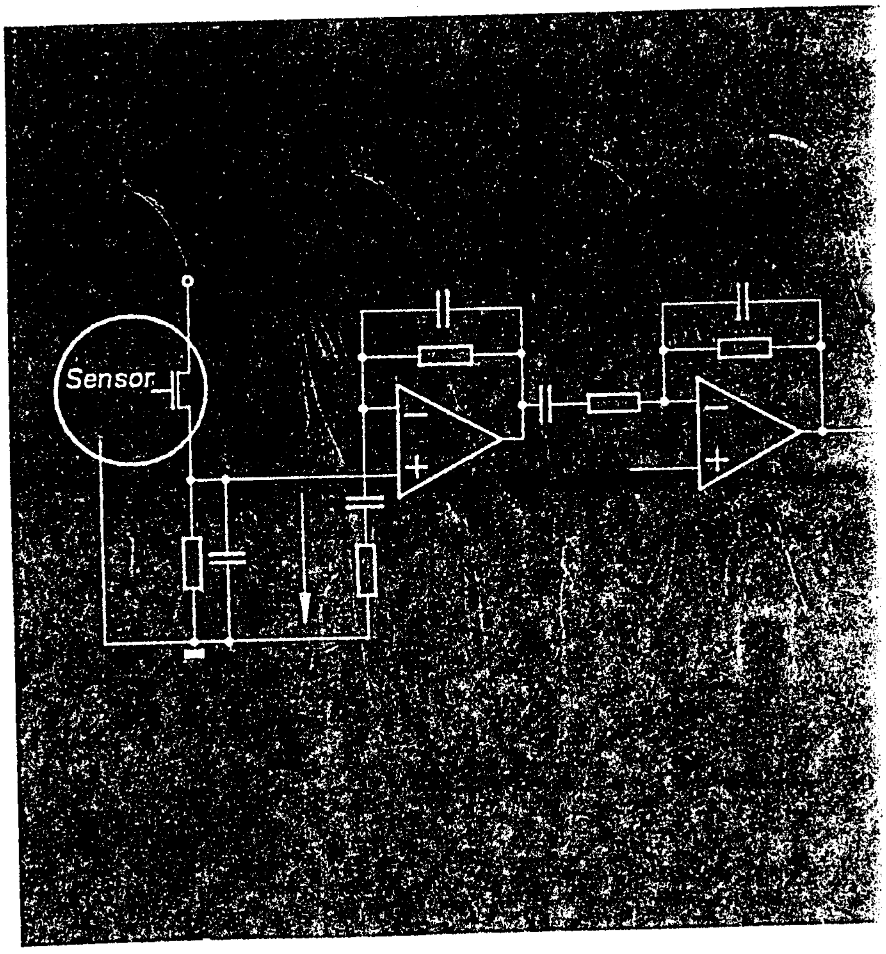
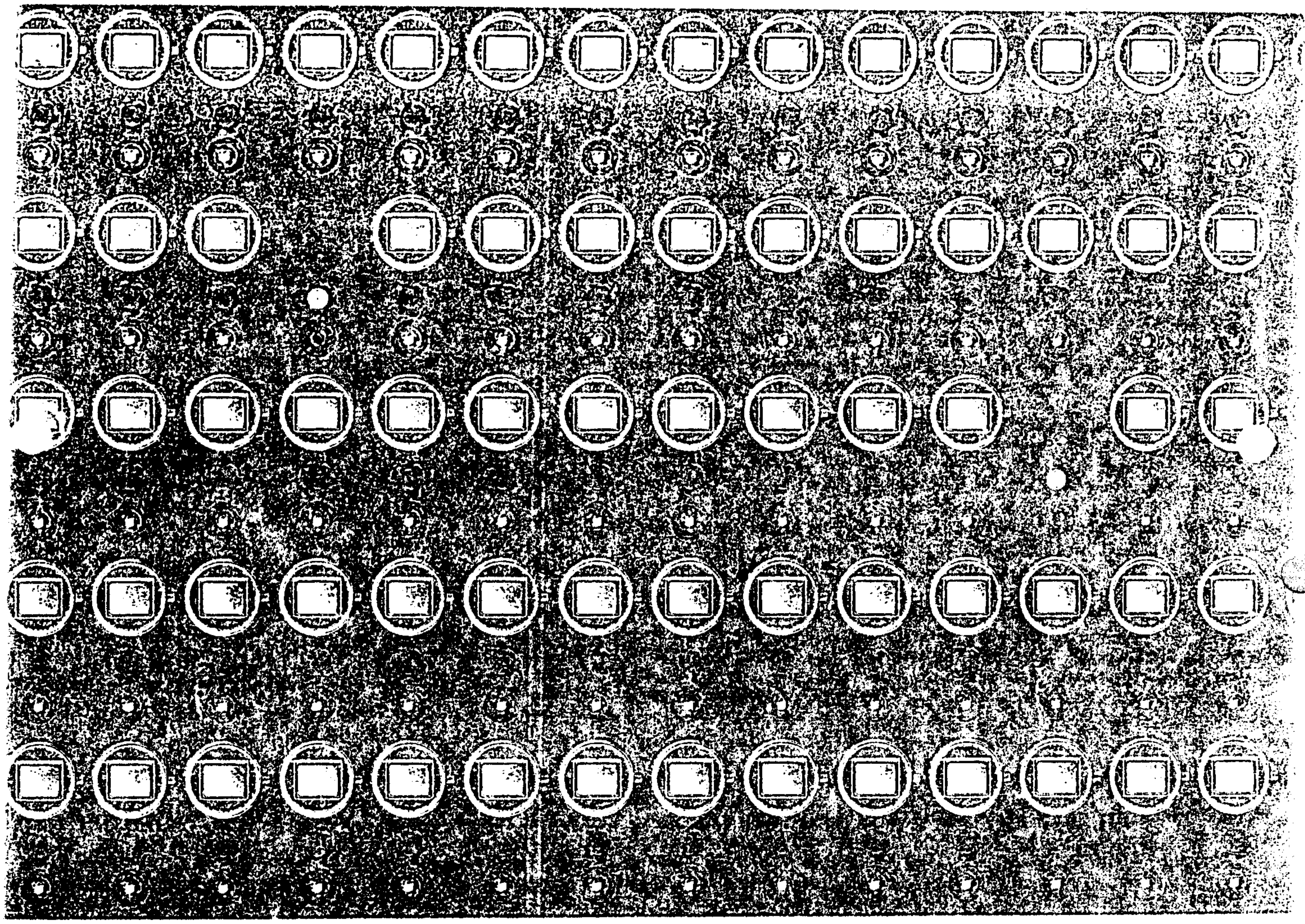
Electronics of Motion Detectors

Dipl.-Ing. Wolfgang Schmidt

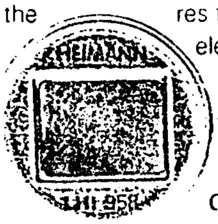


100% QUALITY
LHI SENSORS PROVE IT IN 100%



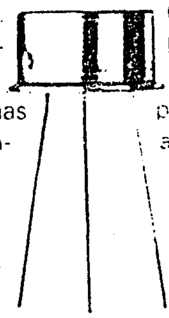
Excellent performance – 100% tested.

The quality of electronic components is as defined by the convergence of requirements and realization. Today's demands on IR-Sensors are best quality at reasonable prices. The manufacturer's task is to ensure both in the long term. The sensor LHI 958 has fulfilled this task successfully, satisfied customers testify to it.



High technology production lines ensure top quality at mass production output. In addition to continiuous in-process-control all products have to pass the 100% outgoing inspection. Each sensor is tested for leakage according to MIL standards and checked for its sensitivity. The definite values are measured by HERMES (Heimann Responsivity Measuring). The Noise Test at elevated temperatures for a 30 min duration within the electrical bandwidth of 0.1 – 10 Hz has resulted in outstanding performance and safety against false operations.

Continuous operation tests performed on samples taken from production ensure performance life data. Among these tests are high and low temperature operation as well as climatic cycles. The resulting life data are excellent.



For all applications of motion detection by passive infrared techniques like Intrusion Alarm, Light Switches, Door Openers and others, the LHI 958 Sensor suits the requirements best. Excellent performance can only be achieved when using top quality sensors. Don't miss this advantage.

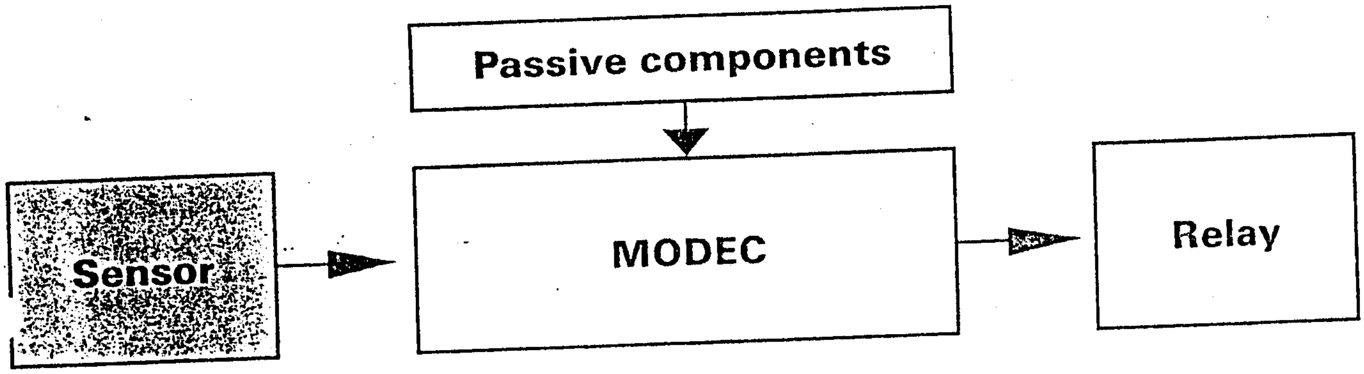
Thus, our circuit consists of the coupling of the sensor and the band-pass filter as shown in figure 3, and the comparator as shown in figure 6. In this circuit, the offset-tolerances of the detector do not effect the output- signal. Any further signal processing is dependent upon the application. The passive-infrared-alarm very often uses a pulse counter which transmits a message to the main control unit of the alarm system only after the second or third signal occurance. Furthermore, a light emitting diode and a main circuit are built-in for the "walk-test".

The automatic light switch additionally observes condition of the ambient light: a photoconductive cell decides by means of an adjustable comparator on releasing or not- releasing. A following time function element holds the output relay or the thyristor drive in accordance with the set time. Depending upon the requirement made on the device the electronics contains 4 to 8 operational amplifiers as well as an approximate 50 to 80 passive components such as capacitors and resistors. Not only this expenditure of work but also the space requirements can be reduced by integration.

HEIMANN is offering now an integrated circuit in a Standard Dual-In-Line housing which contains the above mentioned functions: amplification, switching thresholds, environmental conditions, time function element and output drive.

The external wiring not only determines the amplification and the band- pass filter characteristics but secondary conditions and pulse counter as well. It also sets the time function element. The whole electronic circuit layout contains at the maximum 5 capacitors, 10 resistors and 2 potis.

For detailed descriptive information on MODEC (Motion Detection Electronic Circuit) we refer you to our data-sheet. Thanks to its versatility, MODEC is very well suited for passive-infrared-alarms e.g. with pulse-counter as well as for light switch applications with timer and light level conditions.



Literature:

1. Konzeption passiver Infrarotmelder, Heimann 1986

2. Pyroelektrische Detektoren für viele Anwendungen, W. Schmidt, Polyskope 4/87

3. Prüfen von pyroelektrischen IR-Detektoren, W. Schmidt, Polyskope, 17/87

4. Pyroelektrische Sensoren für Bewegungsmeldung, Heimann 1988

5. Passiv-Infrarot-Bewegungswächter, K.U. Erbse, der elektromeister de 22/87

6. Wärmebildkameras mit pyroelektrischem Vidikon, optoelektr. magazin vol 4,3,88

Another possibility for coupling is the layout of the sensor-FET as amplifier. Compared to the layout in figure 3, an amplification of 10 dB to 12 dB is achieved, whereby however, the inherent noise of the sensor is also being amplified.

The disadvantage of this circuit design it is highly dependent upon the FET characteristics and supply voltage. The occuring slope tolerances cause the output signal to vary strongly and thus impending all further processing. If supply is too low, no output will be generated.

The output signal of the described amplifiers is a direct-current with a superimposed signal. The positive as well as the negative amplitude of the wanted signal is actually transmitted to a threshold comparator. The determination of the positive and the negative threshold is decisive for the later safety against failure of the device: if thresholds are too high they will reduce the effective working distance, if they are too low they will increase the susceptance to failure.

The reference values for the computation of the switching thresholds are the parameters of the sensor and the amplification of the electronics. The following recommendation has been well tried:

With relation to the output signal of the sensor, the switching threshold should be at least six times the value of the maximum inherent noise of the sensor.

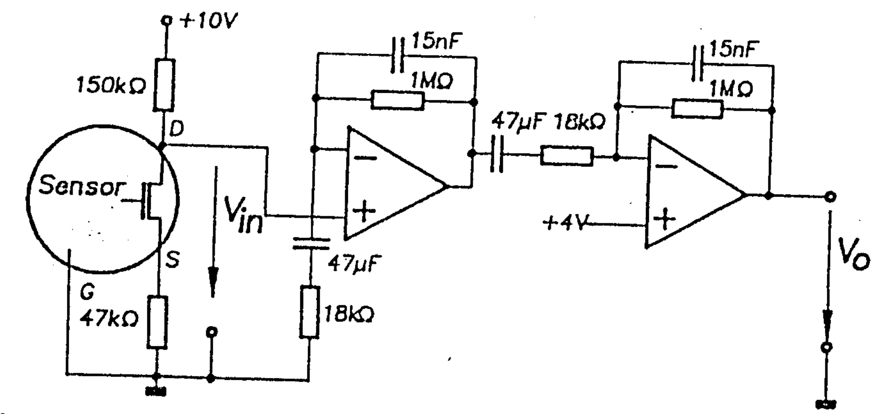
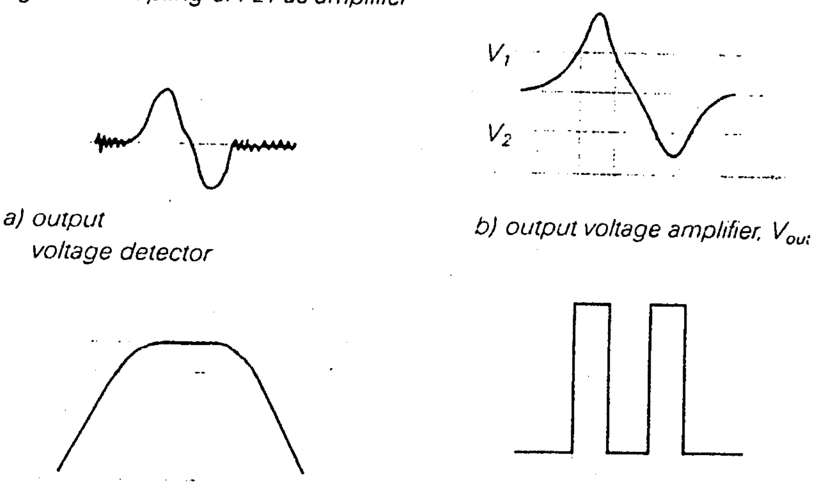


figure 4: coupling of FET as amplifier



a) output voltage detector

b) output voltage amplifier, V_{out}

c) gain characteristic

d) output voltage comparator, V_c

figure 5: signal processing

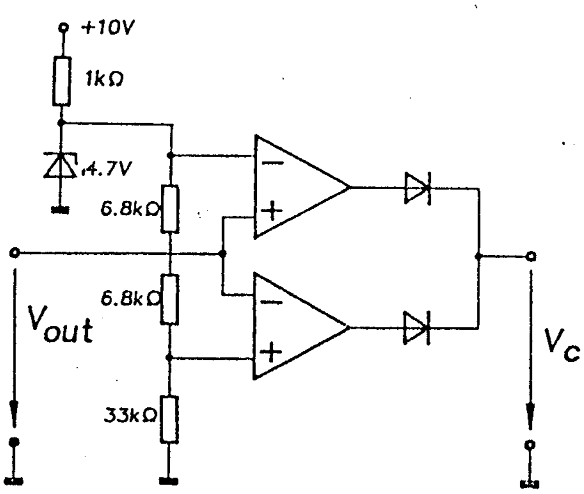


figure 6: comparator circuit

This is to be clarified by an example: sensor, type LHi 954 with a responsivity of 2.6 kV/W to 3 kV/W, grants a maximum noise of 75 µV pp. at ambient temperature. The amplification of the circuity is assumed to be 70 dB or 3.100, the 3 dB cut off frequencies of the band-pass filter are 0.28 Hz and 8.4 Hz.

In accordance with the preceding rule-of-thumb, the smallest detector output signal, which is further processed and which is within the frequency range, is 225 µV pp.

At a given voltage offset of the amplifier of 4 V, the switching thresholds are determined at

Threshold = 4 V ± (225 µV x 3.100)

V_1 = 3.3 V

V_2 = 4.7 V

A comparator circuit with two operational amplifiers is shown in figure 6.

Final observation

The sensor system of an IR-motion-detector is based on a dual-element detector adjusted to a special optic. The resulting electrical signals are of extremly low frequencies and bandpass character. The electronic circuit has to be designed into these requirements in order to achieve best results.
As sensing elements a variety of IR-detector types is available. Regarding the electrical values and the optical characteristics pyroelectric detectors of lithium tantalate top the quality list of detectors. The meanwhile established production methods have helped to reduce the production costs and paved the way for a broader use.

As far as PDVF-detectors are concerned the technical limitations make their use doubtful, particularly because of the lack of price advantage. IR-detectors with PZT-ceramics are comparable to lithium tantalate detectors within certain limits in performance as they show lower values of some electric parameters.
Finally it can be stipulated the necessity to chose the type of detector according to the peripheral conditions and the requirements of the final device to achieve best operation and satisfactory results.

Characteristics of passive Infrared-detectors

Model	RPY 97	KRX 11	iRAE002 sx4	SBA-02	SDA 02	5192	LHI 958	LHI 968
Type	Dual Element series con.	Dual Element series con.	Dual Element series con.	Dual Element series con.	Dual Element series con.	Dual Element parallel opp.	Dual Element parallel opp.	Dual Element parallel opp.
Housing	TO-5	Flat pack	TO-5	TO-5	TO-5	TO-5	TO-5	TO-5
Spectral range	6,5–14 µm	6,5–14 µm	7–14 µm	6,5–14 µm	6,5–14 µm	7,5–12 µm	7–14 µm	7–14 µm
Field of view	120°	100°	105°	110°	110°	120°	110°	110°
Responsivity, typ. max	720V/W (10 Hz)	850µV/25µW	1.300 V/W	2 VPP/ 72.5 dB, 13 µW	1.3 Vpp/ 72.5 dB, 13 µW	2.700 V/W	2.800 V/W 3.000 V/W	3.500 V/W 3.800 V/W
Noise, typ.	25µVpp/√Hz	30µVpp (0.4–5 Hz)	–	300 mV pp/ 72.5 dB, 20 s	200 mV pp/ 72.5 dB, 20 s	20µVpp/√Hz	15µVpp/ (0.3–10 Hz)	15µV pp (0.3–10 Hz)
NEP, typ.	2.5×10^{-9}	–	–	–	–	1.9×10^{-9} W/√Hz	1.7×10^{-9} W/√Hz	1.3×10^{-9} W/√Hz
Temperature operating range	–40°C to +55°C	–	–	–10°C to +50°C	–10°C to +60°C	–	–40°C to +75°C	–40°C to +75°C

Table 1

0.08 Hz, the cut off frequency at 11 Hz. Generally speaking, cut off should be far below 50 Hz to avoid outside disturbances. The responsivity of a Heimann sensor LHi 954, which curve is shown by figure 4, proves to be suited best for our example by having maximum responsivity at 0.1 Hz, which grants detection of movements in long distance. If the walking distance of the object is closer to the passive infrared device, the radiated power exposed to the iR sensor

Focus and working distance

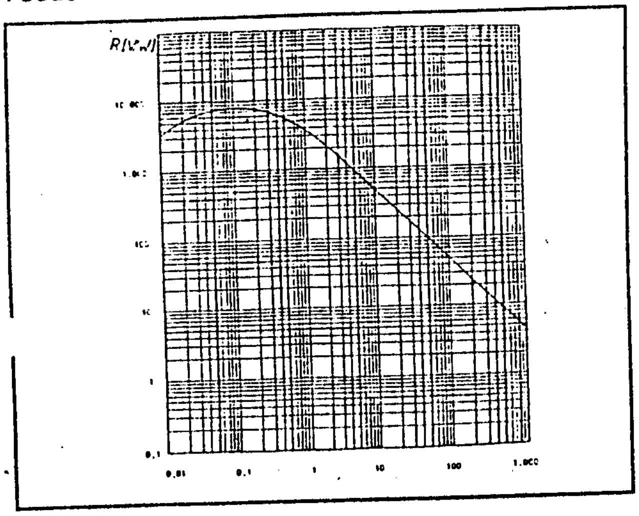
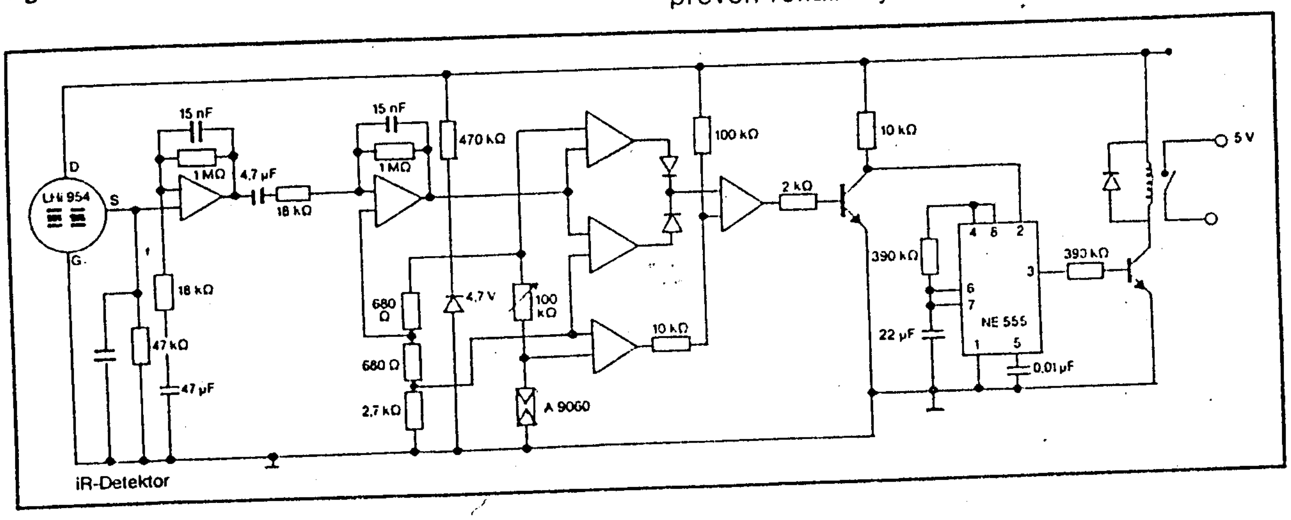


figure 4

increases and thereby compensates the 1/f decrease of responsivity of the iR sensor.
New developments in the field of Intrusion Alarm show the trend to more redundancy in the device, which means more safety against false alarms. Carried out consequently, this philosophy leads to the redundant iR sensor, which is two sensors in one. To cope with the requirement of this market, Heimann has introduced the twin detector series of type LHI 1158. Further to this, another version has been developped, which is 4 elements in a row to allow more intelligent signal comparison by electronic circuitry.

When looking at applications of automatic light switches, similar demands to those mentioned above become necessary. However, the standards of safety against false triffering are not as critical as in the intrusion alarm. New requirements for those devices are the necessity of operating direct at network supplv and of switching light bulbs, neonlights and inductive loads. For the indoor applications it is also required to minimize the size of all electronic circuits: Such automatic light switches are to fit in standard under wall housings. The most important feature is the easy installable and well designed housing which makes the product desirable to be operated in each household. By using a photoconductive cell – Heimann recommends Type A 90 60 – in addition to the iR-sensor, the switch device ensures that function 'light swith' is only activated when light level is below a certain value which has been adjusted by the user. Devices available on the market for outdoor use specify maximum working distance of 12 – 16 m, or even 25 m are achievable. Indoor devices normally work up to 10 m.
Picture 5 and 6 show simple layouts for the electronic circuits, also with adjustable light level for the enable of function 'switch on'. Switch off is normally verified by adjustable time delay. However, it is to state that these circuits do not take reference to necessary methods of surge suppression of network supply. For applications of door controls, lavatories or automatic use, the required working distances are lower than specified above. In these cases the frequency range and calculation of speed response become most important for the layout of the devise. Again, table as per picture 3 may give some assistance.
Finally it is to say that iR sensors of Heimann – series LHi 954 and LHi 958 – are being used for many years in applications as lined out in this article. As well as intrusion alarm as automatic light switches are concerned these sensors have been established worldwide and have proven reliability and excellent parameters.

figure 5 + 6



TESTING OF PYROELECTRIC IR-DETECTORS

The careful consideration of requirements and application terms for each component is one neccessity of major importance while developing and designing passive IR-Detector devices and producing on line as well. In addition to this the manufacturer ist responsible to ensure a certain quality level and therefore to be aware of correct data and parameters of all electronic components. As far as pyroelectric sensors are concerned the user is in a difficult situation to be confronted with various test methods from the established sensor manufacturers which make comparison difficult. Sometimes also correlation between testing and designer's application seems not achievable. This article is to clarify some of the basics of testing pyroelectric sensors and furtheron illustrates a measurement method which gives reproducible data and correlates with user's application.

From theories of physics we know various parameters for IR-Detectors. Among the electrical data we find Responsivity, Noise Equivalent Power NEP, Detectivity D*, Offset voltage and Noise. The specified values depend on testing conditions, as temperature of radiating body used for the test, modulatin frequency, bandwidth of the electrical devices, spectrum bandwidth and ambient temperature. Among the available specifications the user finds radiation temperatures between 400 °K and 600 °K.

For the design Engineer the decisive value is the output signal of the sensor caused by the radiation of a moving body. This signal should be high above the basic noise level of the sensor. Hereby we have found the two major requirements of the sensor: Responsivity and Noise at ambient temperature. Ambient temperature ist equal to room temperature and defined between 20 °C and 25 °C. Responsivity is generally defined as output voltage per incident radiation power in Watt, related to each sensing crystal and depends on frequency. The Cut-on frequency is given by electric crystal capacity and the gate resistor of the FET.

According to Kirchhoff's law at a given wavelength and temperature the spectral emissivity of any body equals his spectral absorbation. The emissivity varies for differenzt bodies dependent on the materials (refer also to table 1).

Thus, using a test radiator, the testing person must care for the radiator temperature and also factor the emissivity. Therefore the most common test radiator is a special set-up called

Emissivity of various materials

Table 1:

Aluminum, polished	0,05
Chromium	0,3
Copper, polished	0,05
Gold, polished	0,02
Steel	0,1–0,2
Silver, polished	0,03
Wood	0,9
Carbon, pure powder	0,95
Oil	0,8
Soil	0,9
Glass, polished	0,9
Cotton	0,8
Paper	0,7–0,9
Sand	0,8–0,9
Water, pure	0,96
Snow	0,85
Human Skin	0,98
Black Body (ideal)	1