

Isbas: An Infrared Sensor Burglar Alert System

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Abstract: A burglar alert system using infrared sensor and detector mechanism has been constructed and tested. A special feature of the system is the detection of human motion across the path of the infrared sensor with a relay output that activates an alarm. Its simple operation is powered by a 12 volt DC battery, from which power is drawn mainly when detection is made by the primary sensing device. Effective detection of human motion and its low power consumption are ensured by the passive nature of the sensor component.

Key words: Infrared sensor, ISBAS, LED, relay, alarm, low power consumption

INTRODUCTION

Amid steady growth in world population with incommensurate employment opportunities and pressures of a more complex society, the incidences of human intrusion and burglaries in private and public places are on the increase.

Heightened security concerns at homes, banks, shopping malls, schools, offices, etc. have led to continued search for different and improved security gadgets. Such concerns are apparent in the form of installations of remote cameras, the presence of security guards and other monitoring devices and alarm systems, which are in constant use (Hart, 1995).

However, many such devices and services are relatively costly and usually require a high and steady power supply for their operation (Hart, 1995). An Infrared Sensor Burglar Alert System (ISBAS), which has been constructed and tested, offers the advantages of low cost and low power consumption in its operation.

Its concept is based on the fact that virtually all matter radiates infrared at all times and at various ranges (Hebert, 1972; Cohen and Caligiuri, 1975). Thus, the human body emits some form of thermal radiation which is detectable on appropriately fabricated sensor.

The primary sensing component is of a passive nature (Hart, 1995; Adams, 1997) and is activated by the infrared radiation emitted by any intruder within its range of coverage, thus rendering the system more difficult to be detected. In normal use, relatively low power is required, as the additional power required to energize the alarm or buzzer is only supplied sequel to any detection by the primary sensor.

MATERIALS AND METHODS

The sensor circuit: The sensor circuit in ISBAS operates a full wave detection of infrared wave from a source. It is made up of two pins of which pins 1 and 2 are connected on the horizontal plane as shown in Fig. 1. In addition, the sensor has two elements connected in a voltage-bucking configuration. This arrangement cancels signals caused by vibration temperature changes within the sensor due to sunlight. A human being passing in front of the sensor will activate the first element and then the other, whereas other sources will affect both elements simultaneously and be cancelled out. Thus, for any horizontal motion across the range of the sensor, the elements are sequentially exposed to infrared radiation (Giolab, 2005).

ISBAS switch selection: ISBAS makes use of three switching circuits. The function of the circuit is to turn ON and OFF the current in the circuit. A 12-volt relay is used to sustain the buzzer once the micro-switch is released, whenever the sensor detects human motion. Figure 2 is a representation of relay switch in ISBAS circuit.

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field, which attracts a lever and changes the switch contacts. The coil current can be ON or OFF so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit, which can be completely separate from the first. For example, a low voltage battery circuit can use a relay to switch a 230 V AC mains circuit. There is no electrical connection inside the relay between the two circuits the link is magnetic and mechanical.

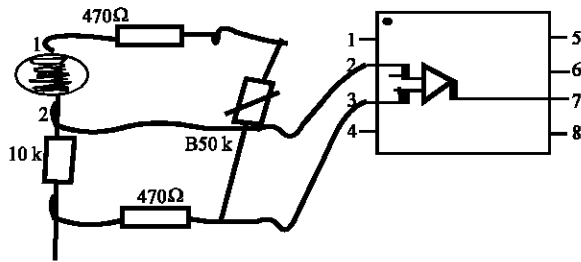


Fig. 1: IR sensor circuit in ISBAS

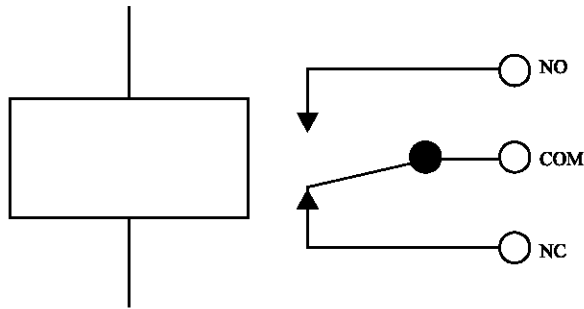


Fig. 2: A relay switch representation in the ISBAS

The coil of a relay passes a relatively large current typically 30 mA for a 12 V relay but it can be as much as 100 mA for relays designed to operate from lower voltages. Relays are usually SPDT or DPDT but they can have many more sets of switch contacts.

The Fig. 2 shows a working relay with its coil and switch contacts. A lever on the left is being attracted by magnetism, when the coil is switched on. This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT. The relay's switch connections are usually labeled COM, NC and NO:

- COM = Common, always connect to this; it is the moving part of the switch
- NC = Normally Closed, COM is connected to this when the relay coil is off
- NO = Normally Open, COM is connected to this when the relay coil is on

A transistor (NPN) is also used as a switch in ISBAS circuit design. This operates between two states thus: saturated and cut-off states. The saturated state occurs when both emitter-base junction of a transistor is forward biased. The cut-off state occurs when both junctions are reverse biased. The 741 OP amp IC (chip) cannot provide the actual current required by the mechanical switch (relay), hence the transistor is used to amplify the small IC current to the larger value required for the relay coil.

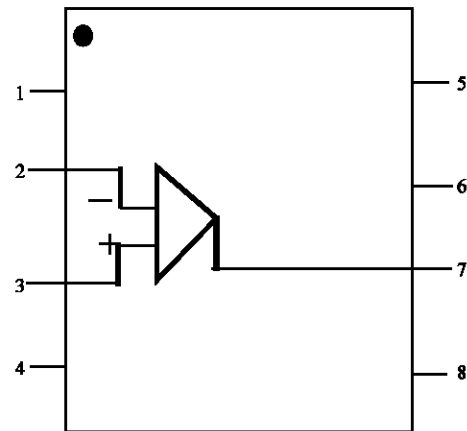


Fig. 3: OP Amp 741 circuit

741 OP AMP IC: 741 Op amp is a differential amplifier. The output is directly proportional to the difference in voltage between the two inputs of the Op-amp. They can amplify a voltage from zero frequency to a very high frequency. The Op-amp is usually made of 8-pins, dual-in-line packages (Nelkon and Parker, 1995). The 741 type was used in this construction known to be a high performance Op-amp IC.

The pins are numbered anti-clockwise around the IC (chip) starting near the notch or dot. Figure 3 shows the numbering for 8-pin, this principle holds for all sizes.

Light Emitting Diodes (LEDs): ISBAS makes use of an LED as the pilot lamp for indication when the entire system is ON or OFF. LEDs emit light when an electric current passes through them in a forward biased way (Hewes, 2007). They are tiny light bulbs that fit easily into electrical/electronics circuits. Solely the movement of electrons in a semiconductor illuminates them. The semiconductor used in LEDs is of different types, but for ISBAS, GaP (Gallium Phosphide) semiconductor was used, which emits red light.

The power supply: A power supply is an electronic instrument that provides voltage, current and power to the circuit from an AC power lines or batteries form, suitable for use in various applications to power electronic equipment (Floyd, 1991). The ISBAS uses simple DC voltage (battery).

RESULTS AND DISCUSSION

ISBAS main circuit: The circuit in Fig. 4 is the complete circuit diagram of the ISBAS. The positive and negative terminals are shown clearly. The sensor is mainly for

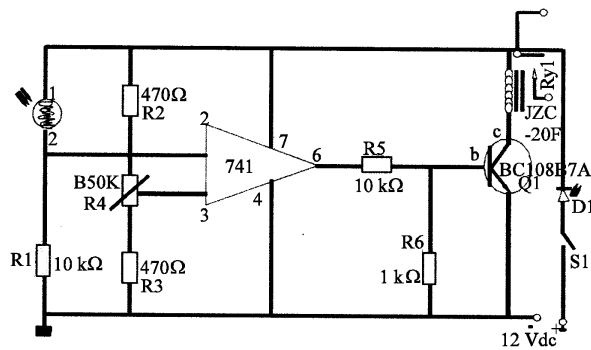


Fig. 4: The ISBAS circuit diagram

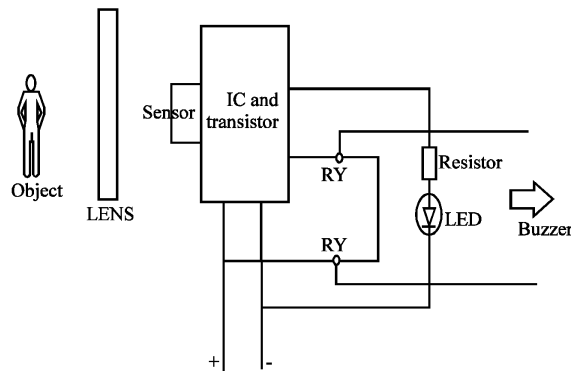


Fig. 5: ISBAS operational chart

detection, the resistors are for filtering and balancing, while the IC, transistor and the relay are for amplification and switching, when ever there is signal from the sensor.

Mode of operation: Power is supplied to the circuit through the terminals as shown in Fig. 4. This power is fed to pin 1 of the IR sensor. The signal output at pin 2 of the sensor is connected to a 10 kΩ resistor by passed to the ground.

When the power is supplied to the device, there may be a false triggering of the buzzer. This is because even when there is no signal applied to the input, the internal components of the Op-amp may supply a small differential voltage to the inputs.

Even if the voltage is small, the gain of the Op-amp results in a large offset voltage being present at the output, which is supposed to give out exactly 0 V when no signal is recorded. This offset voltage is removed by adjusting the R4 until the output is exactly 0 V with no signal present at the input.

When motion is detected, the sensor will output a very small voltage transition at pin 2 of the sensor. This voltage is amplified by using an Op-amp IC.

Table 1: Complete list of components used

Name/Description of components	Quantity	References
10 KΩ	2	R1, R5
470 Ω	2	R2, R3
50 KΩ	1	R4
1 KΩ	1	R6
Op-amp IC (UA741CN)	1	IC
NPN transistor (BC08)	1	Q1
LED (red)	1	D1
Relay (JZC-20F)	1	RY1
Infra red sensor	1	IR
Power switch	1	S1

The Op-amp IC supplies power to the transistor through the output pin 6. The transistor controls the flow of power through the relay circuit.

The transistor will then make up the actual current required by the relay to trigger on the buzzer, whenever there is signal. The operational diagram of ISBAS is shown in the Fig. 5.

ISBAS power supply is efficient, simple DC battery and does not require any inversion or rectification. The sensor ability is efficient, it responds to horizontal motion between 0-2 m without infrared fresnel lens and up to 90 m with an infrared fresnel lens when in use.

The ISBAS is reliable and efficient in that it gives a good sensing and detection capability and complexity was reduced in the choice of components. Maintenance and repair can be easily carried out in case of malfunction. The required electronics components listed are readily available and can be sourced locally. It can run for several weeks without exhausting its operating power.

CONCLUSION

ISBAS is designed to provide a good surveillance for any user and it operates automatically once installed with the sensor concealed at entrance of facility requiring protection.

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