

REFRIGERATORS are among the hungriest of household appliances in terms of electrical power consumption. Every time a refrigerator door is opened, cold air spills out and the warm air that replaces it must be cooled. Needless to say, it pays in dollars and cents to limit the time the door is open to as brief a period as possible. The low-cost Fridge Alarm described here may be just what you need to limit the time you study the contents of your refrigerator or your child forgets to close the door.

The Fridge Alarm is a photoelectric device that is activated as soon as the door opens and the refrigerator's light goes on. It sounds an insistent two-tone signal if the door remains open past a given number of seconds.

About the Circuit. As shown in Fig. 1, when light strikes its photosensitive surface, *Q1* triggers into conduction and causes *Q2* to saturate. This places pin 1 of *IC1* close to ground potential and allows the timer to start operating (Fig. 2). Since the voltage across *C1* is initially zero, *IC1* is triggered into immediate operation. Timing is controlled by *R8*, *R1*, and *C1*.

During the timing sequence, the output of *IC1* at pin 3 remains high (almost at V_{CC}) and keeps *IC2* and *IC3* cut off, since pin 1 of each of these integrated

circuits is connected to this line.

Most electrolytic and many aluminum capacitors can have sizable leakage currents. Hence, they should not be used in timing circuits. To avoid this problem, *C1* should be a tantalum capacitor. Using the time constants shown, *R8* can be set for periods of from 4 to 17 seconds. (This range was selected because 8 seconds is about the mean time for access to a refrigerator.) Because *C1* discharges through *D1* and the 15,000-ohm internal resistance of *IC1*, pin 7 is left unconnected.

If the light striking *Q1* is interrupted during the timing cycle, both *Q1* and *Q2* turn off and timing capacitor *C1* rapidly discharges through *D1* and *IC1*, resetting the timer. In darkness, *Q1* has a very high collector-emitter resistance. With *Q2* in cutoff, standby current is extremely low.

Should the light striking *Q1* be constant, the timing cycle will run its course and the output at pin 3 of *IC1* goes low. This effectively grounds pin 1 of both *IC2* and *IC3*, activating these ICs.

Integrated circuits *IC2* and *IC3* are wired to operate as astable multivibrators. The oscillating frequency of *IC2* is about 4 Hz. This 4-Hz signal "modulates" *IC3*, and the output of *IC3* directly drives a small loudspeaker.

The two-tone sound is created by al-

ternately shunting the *IC2* end of *R4* between V_{CC} and ground at a 4-Hz rate. When pin 3 of *IC2* is high, the parallel combination of *R4* and *R5* produces about a 500-Hz tone. When pin 3 is low, *R4* is effectively shunted to ground. This reduces the voltage at pin 7 of *IC3*. Since *C6* must now charge to 80% and then discharge to 40% of this new value to activate the comparators inside *IC3*, about a 330-Hz tone is generated. The two tones alternate at a 4-Hz rate as long as the circuit is activated.

Construction. All components, except *B1* (and its optional battery holder) and the small loudspeaker can be mounted on a printed circuit board. The actual-size etching-and-drilling guide and components-placement guide for the pc board are shown in Fig. 3.

The leads of *Q1* can be identified with the aid of an ohmmeter and light source if an unmarked phototransistor is used.

The project can be mounted inside a small translucent box that permits sufficient light to pass through and trigger *Q1* into conduction. Any of the various polyethylene refrigerator-type storage containers on the market will suffice as long as they are large enough to accommodate the circuit. The loudspeaker is best secured to the bottom of the container (after drilling a number of small holes for

Sounds an alarm after preset time when refrigerator door is left open

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FRIDGE ALARM *Continued*

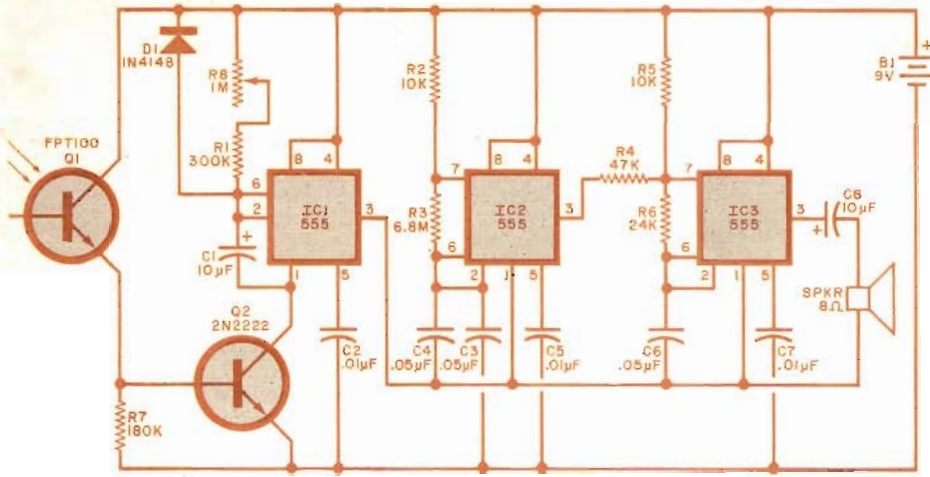


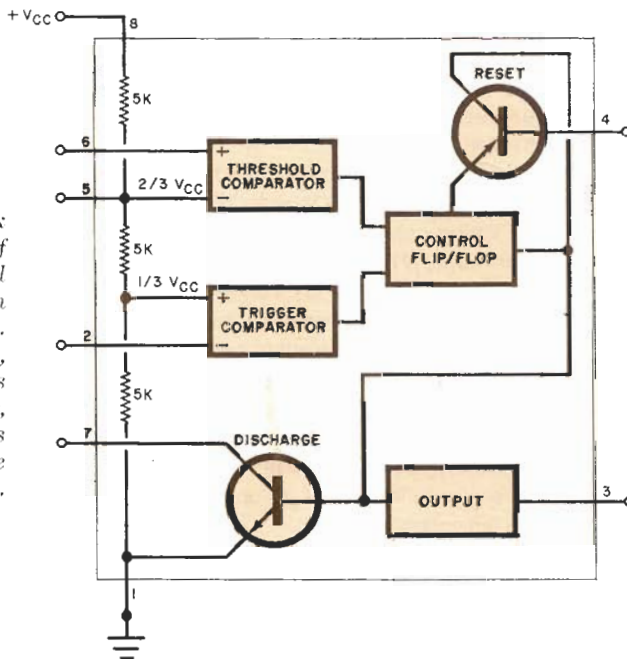
Fig. 1. Timing action of circuit is initiated by light striking Q1.

PARTS LIST

- B1 - 9-volt battery
- C1 - 10- μ F, 25-V tantalum capacitor
- C2, C5, C7 - 0.01- μ F disc capacitor

- C3, C4, C6 - 0.05- μ F disc capacitor
 - C8 - 10- μ F, 25-V aluminum capacitor
 - D1 - 1N4148 or similar diode
 - IC1, IC2, IC3 - 555 timer
 - Q1 - FPT100 or equivalent
 - Q2 - 2N2222 or similar transistor
 - All resistors 1/4-watt, 10% tolerance:
 - R1 - 300,000 ohms
 - R2, R5 - 10,000 ohms
 - R3 - 6.8 megohms
 - R4 - 47,000 ohms
 - R6 - 24,000 ohms
 - R7 - 180,000 ohms
 - R8 - 1-megohm trimmer potentiometer
 - SPKR - Miniature 8-ohm loudspeaker
 - Misc. - Battery holder; translucent plastic refrigerator container (about 3" square); silicone-rubber cement; hookup wire; etc.
- Note: The following items are available from Rand Laboratories, P.O. Box 468, Cape Canaveral, FL 32920: complete kit of parts including drilled case for \$9.95 postpaid. Also available: pc board only, \$4.25 postpaid. Florida residents, please add sales tax.

Fig. 2. Block diagram of principal circuits in the 555 IC. In this case, one 555 is used as timer, and two as astable multivibrators.



the sound to escape down through the shelf) with silicone-rubber cement. The speaker and pc board are interconnected with #20 wire so that the board can be positioned to allow maximum exposure of Q1 to the lamp.

The assembled alarm can be tested by placing it in a darkened location and shining a light on it. After a several-second delay, the alarm should sound. Count the number of seconds between the time the light goes on and the alarm sounds. Adjust R8 as needed for the desired delay between the two events.

Place the Fridge Alarm inside your refrigerator in a location where it will receive the maximum amount of light from the refrigerator's lamp. Make sure it is in a location where there will be no possibility of liquid spills on it. Equally important, make sure that the selected location will obviate any possibility of obstructing the light. \diamond

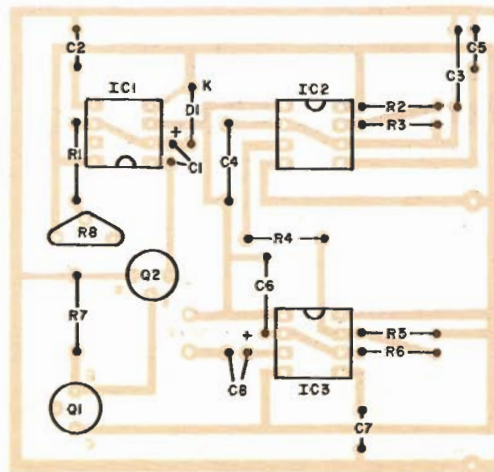
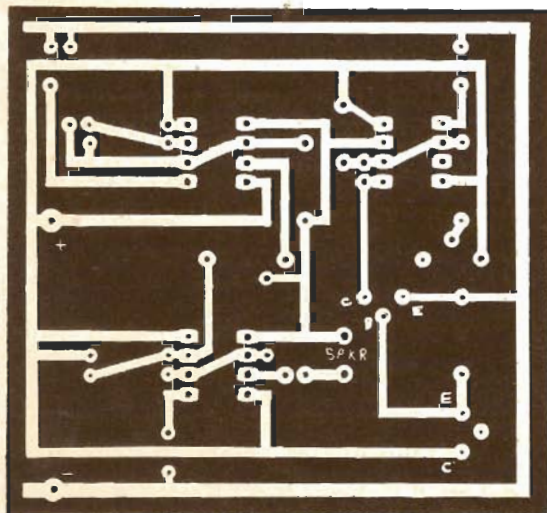


Fig. 3. Components are mounted on board as shown at left and enclosed in a translucent box.