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Constructional Project

PARKING WARNING SYSTEM

by TOM WEBB

How to avoid having an unwanted rear entrance to your garage!

This is a device to aid you in parkiar in a garage by providing a visual and audible warning. It is easily set up by mounting it onto the wall at the end of the garage.

The device produces a coded infrared (IR) beam which detects the proximity of the vehicle by bouncing IR off it as it approaches, without being confused by other IR sources. When the vehicle is within the preset range, an audible warning is given and a group of light emitting diodes (LEDs) are turned on.

The block diagram in Fig.1 shows how the circuit is split up into separate sections.

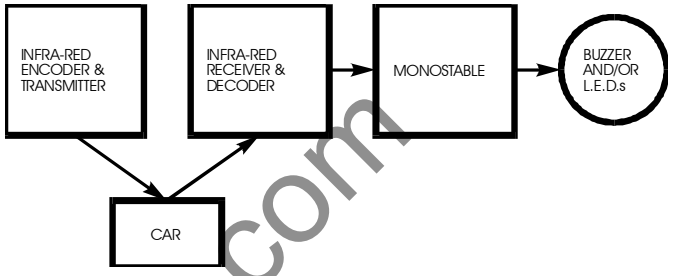

Fig.1. Parking Warning System block diagram.

INFRARED CODING

A system based on a continuous IR signal would fail in this type of application, since the receiving circuit would be heavily influenced by stray background IR emission from lights etc. A coded IR signal is better since the receiver can be set up to only accept a specific code.

There are a number of encoding and decoding ICs available, but two from Holtek are used for this circuit. The HT12B transmitter encodes the signal and adds a 38kHz carrier signal for greater reliability. A separate demodulating sensor detects the coded signal and provides a clean output waveform with the 38kHz carrier removed. An HT12D decoder then decodes the signal to give a steady output.

Fig.1. Parking Warning System block diagram.

CODED TRANSMITTER

Either the HT12A or HT12B transmitter devices may be used in the coded transmission circuit. They work in exactly the same way except the four data outputs of the HT12A are inverted as compared with the HT12B. However, since these outputs are not used in this circuit, this is of no importance.

Referring to the full circuit diagram in Fig.2, pins A0 to A7 of the transmitter IC2 set the coded signal for the IR transmission, which can only be accepted by a decoder chip (IC3 in Fig.2) with the same settings. The printed circuit board is designed so that pins A0 and A1 are connected to the 0V supply line, pins A2 to A7 being left unconnected.

Pin 9 of IC2 is connected to 0V and pin 18 connected to the

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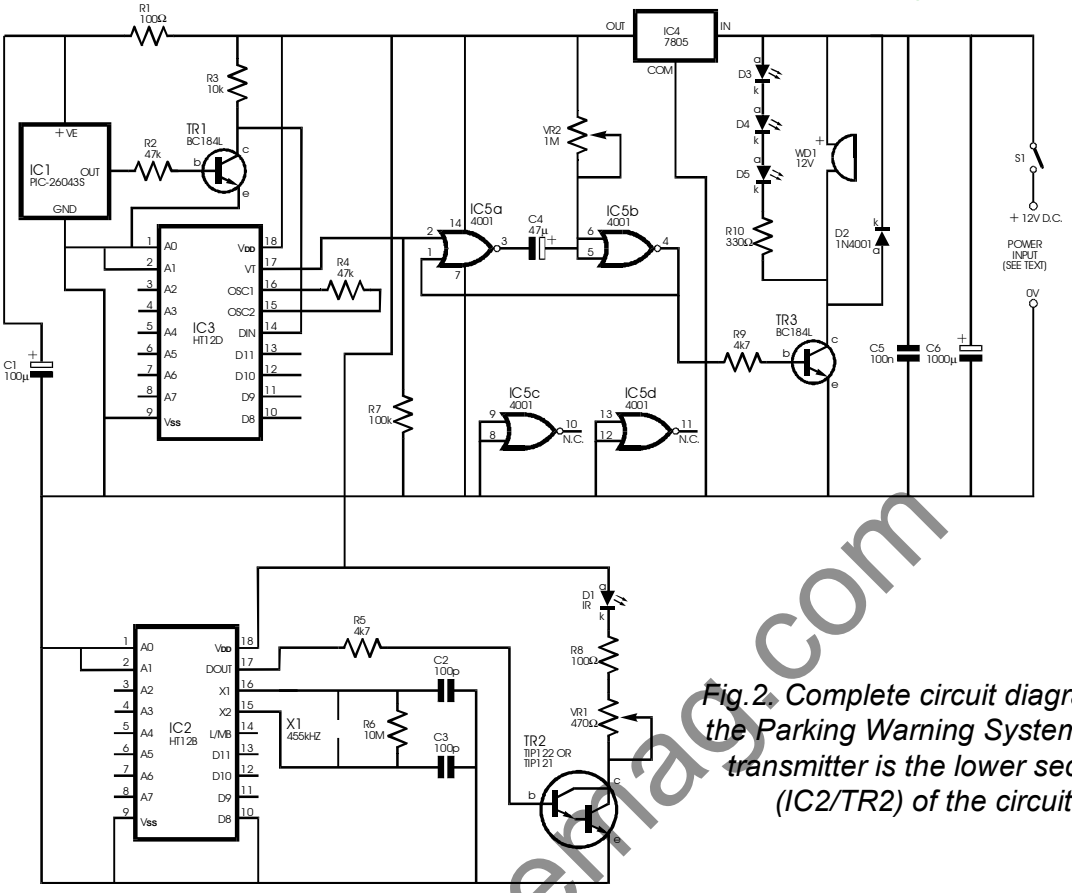

Fig.2. Complete circuit diagram for the Parking Warning System. The transmitter is the lower section (IC2/TR2) of the circuit.

positive supply, which should not exceed +5V. IC2 pins 11 to 14 are not used. The pins labeled X1 and X2 are the oscillator control pins, and require a 455kHz ceramic resonator (component X1) along with resistor R6 and two capacitors, C2 and C3.

The D_{out} pin provides a coded output superimposed on a carrier signal of 38kHz which, with the aid of Darlington transistor amplifier TR2, operates the IR light emitting diode D1.

Potentiometer VR1 allows the transmission power to be varied. Ballast resistor R8 prevents a power supply short circuit through D1 and TR2 when VR1 is set to minimum resistance.

IC2 pin 10 is connected to ground to hold the transmitter perpetually triggered.

INFRARED RECEIVER

The IR sensor/amplifier/demodulator, IC1, is housed in a package resembling a small power transistor. The receiver rejects all IR transmissions except the required 38kHz signal, and provides a clean output (easily viewed on an oscilloscope). There are three possible receivers that perform the functions required, but in tests the best performer for this circuit was the PIC26043S (not a PIC microcontroller!).

When the detector detects a signal having a frequency of 38kHz, its output goes high. Transistor TR1 inverts this level and supplies it to the decoder IC3 at DIN (pin 14).

The code to which IC3 responds is set by its pins A0 to A7. Since pins A0 and A1 on transmitter IC2 are connected to 0V, the same pins on IC3 are also connected to 0V.

Resistor R4 sets the oscillation frequency for IC3 to the required 150kHz. The value is chosen to suit a power supply of between 4·5V and 5V. When IC3 receives a correctly coded signal, its pin 17 (VT) goes high. This triggers the monostable formed by IC5a and IC5b. When the VT pin of IC3 is open circuit (no signal being received), resistor R7 draws the input pin of the monostable to 0V. Once triggered, the monostable's output remains high for a period set by the values of C4 and VR2.

The formula used to calculate this period is T = 0·7 x R x C. With VR2 set to 100kΩ , the period will be 0·7 x 0·1MΩ x 47uF = 3·29 seconds.

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COMPONENTS

Resistors
R1, R8 100 ohms (2 off)
R2, R4 47k (2 off)
R3 10k
R5, R9 4k7 (2 off)
R6 10M
R7 100k
R10 330 ohms

Potentiometers
VR1 470 ohm miniature horizontal skeleton preset
VR2 1M miniature horizontal skeleton preset

Capacitors
C1 100u radial electrolytic, 25V
C2, C3 100p (2 off)
C4 47u radial electrolytic, 25V
C5 100n ceramic
C6 1000u radial electrolytic, 25V

Semiconductors
D1 IR diode
D2 1N4001 rectifier diode
D3 to D5 red LEDs (3mm or 5mm)
TR1, TR3 BC184L *npn* transistors (2 off)
TR2 TOP122 (or TIP121) *npn* Darlington transistor
IC1 PIC26043S IR receiver
IC2 HT12B (or HT12A) encoder
IC3 HT12D decoder
IC4 78L05 +5V 100mA regulator
IC5 4001B quad NOR gate

Miscellaneous
S1 s.p.s.t. toggle switch (optional)
WD1 buzzer, 12V
X1 455kHz resonator

Printed circuit board available from the *EPE Online Store*, code 7000258 (www.epemag.com); plastic case to suit (2 off, see text); 14-pin DIL socket; 18-pin DIL socket (2 off); connectors for power and LED cables (see text); PCB pillars (4 off); connecting wire, solder, etc.

See also the SHOP TALK Page!

Approx. Cost Guidance Only **$29**

The output from the monostable, at IC5b pin 4, is fed to transistor TR3 via resistor R9. When the output level is high, TR3 is turned on and drives the warning buzzer WD1 and turns on LEDs D3 to D5. Diode D2 prevents back EMF from the buzzer which might otherwise damage the circuit. R10 is a ballast resistor to limit the current through the LEDs.

POWER SUPPLY

Power to the circuit is intended to be from a 12V mains adapter as the circuit will need to be left switched on for long periods of time. A supply of 12V is required in order to power the buzzer. The power supply is regulated down to 5V by IC4 to suit the rest of the circuit.

If a buzzer is not being used, then diode D2 can be omitted and a supply of 5V (or 4·5V) could be used by inserting a wire link in the place of regulator IC4 (between its In and Out pins). However, in this case, the value of LED ballast resistor R10 should be reduced to about 180 ohms. This also means that batteries could be used as the standby current is less than 10mA.

Capacitors C5 and C6 decouple the power fed to IC4. Capacitor C1 and resistor R1 smooth out the voltage supplied to the receiver device, IC1.

CONSTRUCTION

Apart from the buzzer and LEDs, all the components are contained on a single printed circuit board (PCB). The topside component layout and full size underside copper foil master are shown in Fig.3. This board is available from the *EPE Online Store* (code 7000258) at **www.epemag.com**

Begin construction by soldering in the resistors and the four wire links. Ensure the correct orientation in the PCB for components C1, C4, C6, TR1 to TR3, D1 and D2. Capacitors C2, C3 and C5 may be connected either way round.

Note that on the IR diode, D1, the long leg is likely to be the cathode (k), but check this with the component supplier's catalog.

Infrared receiver IC1 has a "dome" on its sensitive side, which should face outwards from the PCB. Once soldered in, IC1 should be bent back to so that the dome is facing upwards.

Use IC sockets for IC2, IC3 and IC5. Do not insert the dual-in-line (DIL) ICs until construction has been completed and fully checked.

CASING

Two plastic cases will be needed as the LEDs need their own separate case in order to be seen through the rear windscreen of the car.

The circuit board is mounted in its own case on small PCB supports which firmly secure it in place, see Fig.4. Drill holes in the case to suit the positions of the IR receiver and IR diode, see photographs. The hole for the IR receiver should not be too small otherwise the range will be reduced. If maximum range is required then the IR receiver should be positioned right by the hole.

If you prefer to have plugged connections for the power supply input and for the output to the LEDs, suitable holes should also be drilled for their sockets. You also need a hole for the power on/off switch if you decide to use one, although one was not used on the prototype.

Additionally, two holes are required to allow adjustment access to the two preset potentiometers, using a small screwdriver. All holes should be drilled accurately to correspond

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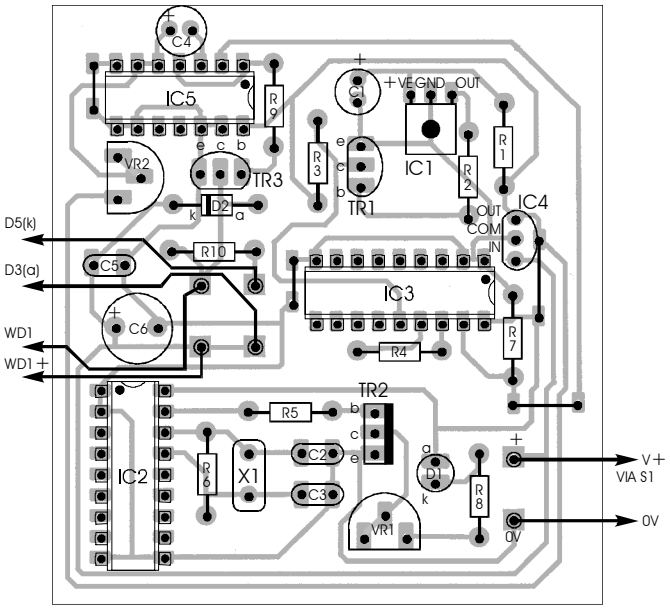

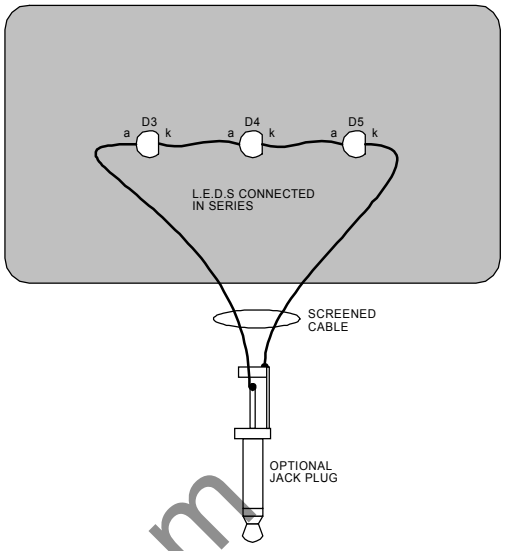

Fig.4 (below). Wiring from the circuit board to the optional LED jack socket and power connector.

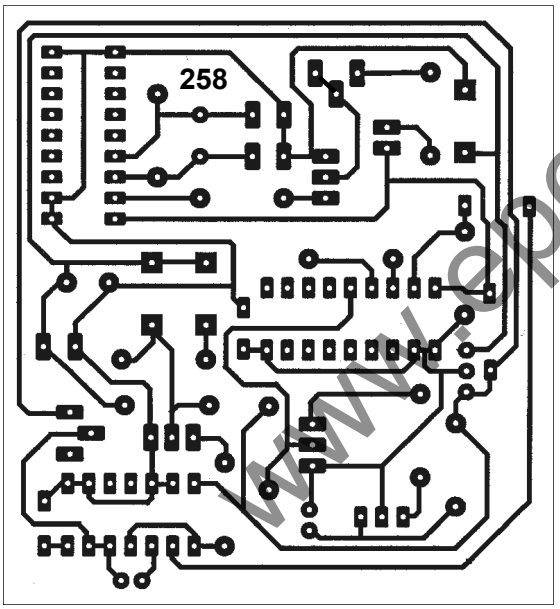

Fig.3. Printed circuit board topside component layout and (top right) approximately full-size underside copper foil master.

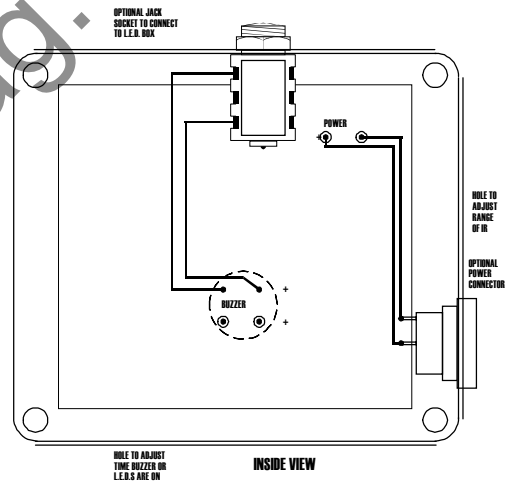

Fig.5 (above). The LEDs mounted in a separate case and connected via screened cable and jack plug to the

with their respective components.

The LEDs mounted in their separate case can be connected to the circuit using single screened wire, as shown in Fig.5.

TESTING

The first check is to make sure the voltage regulator IC4 is the correct way around. Connect the circuit to the 12V power supply and then check that 5V is present on the output pin of IC4. If it is, then disconnect the power and insert the remaining chips, correctly orientated.

Testing of the IR modules presents a problem as if one doesn't work then the other will seem not to be working as well. If in doubt use a voltmeter or oscilloscope as follows:

Test the voltage on the VT pin (pin 17) on IC3 of the receiver module. It should

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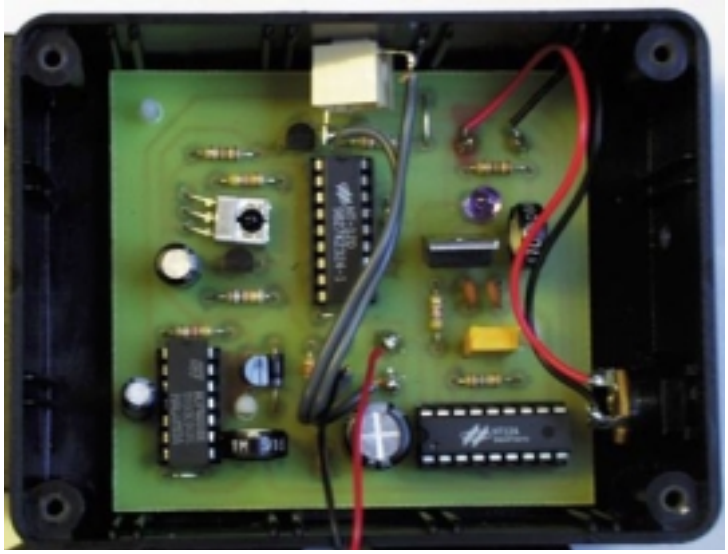
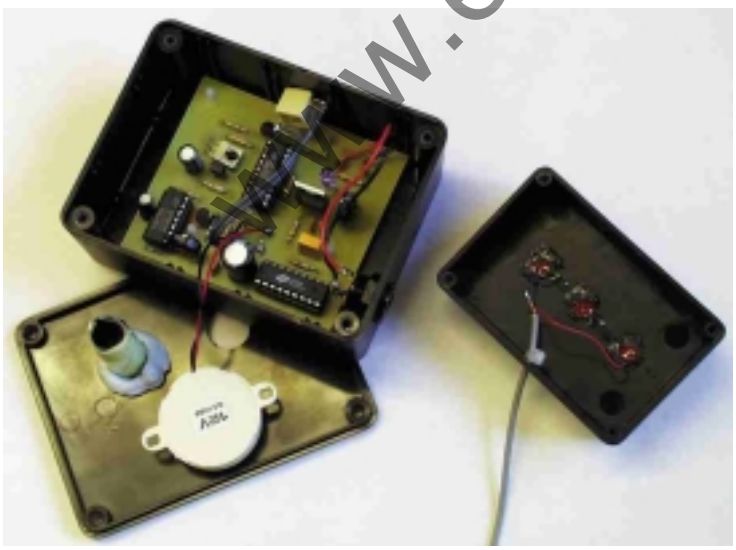


Completed circuit board mounted inside its box.

normally be at 0V but change to about 5V when a signal is received. Now check the voltage on the pins of IC1. Pin 3 should be at 5V and pin 2 at 0V. When a signal is not being received, pin 1 (the output pin) should be at just under 4V. When a signal is received this voltage should fall by about 1V.

Note that as the signal is oscillating, a voltmeter provides a rather approximate guide to voltage. If an oscilloscope is available it should be possible to view the encoded signal, in which case the trace will rise and fall between 4V and 0V. If this test fails then try sending a signal from a TV remote control unit. The signal will not be decoded, but you will at least know if the receiver IC is working, and hence determine if the fault lies in the transmitter or receiver or both.



The transmitter/receiver case and the smaller LED box with their lids removed. Note the "tube" of black card to stop stray reflections from reaching the IR receiver chip.

If the output from IC1 is working, test the signal at pin 14 (Din) of IC3 on the receiver module. It should be at about 0V when no signal is received, rising to about 1·3V (as seen on a voltmeter) when a signal is received. Again, an oscilloscope will show that the signal actually pulses to about 5V.

If the VT pin on the receiver is working then simple voltmeter tests should establish the position of any other faults.

If the circuit is triggered straight away then IC1 may be receiving IR straight from the IR diode D1, through stray reflection inside the case. If this happens the transmitter should be surrounded by a rolled piece of black card.

SETTING UP

The presets VR1 and VR2 can be adjusted to suit the user's own particular needs. The following is a summary of their functions:

VR1: Adjusts the range of the IR beam by decreasing or increasing the power going through IR diode D1. Reducing the resistance extends the range.

VR2: Sets the time the buzzer and LEDs stay on by controlling how much recharging current is input to the monostable. Reducing the resistance reduces the time.

COMMON PROBLEMS

Typical mistakes include dry joints and bridged pads, i.e. adjacent pads accidentally

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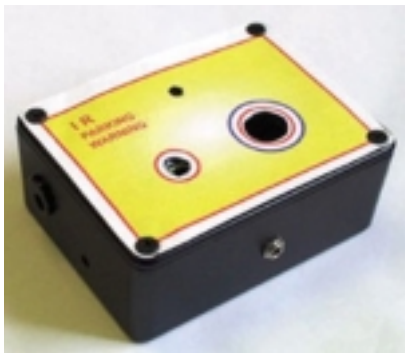

joined together with solder. Other problems include failure to insert wire links. Also check that the components are correctly placed, and the correct way round. Note again that some IR LEDs are unusual in that the longer lead denotes cathode (k).

IN USE

Completed remote LED warning box.

This Parking Warning System should be set up with the IR sensors lining up with the extremity of the car, e.g. bumper. The LED box should be positioned so as to be seen through the rear windscreen. The time the LEDs and buzzer are on, and the range of the IR can easily be changed using a screwdriver to adjust the presets VR1 and VR2.

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Go to next section

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