TWO-WHEELER SECURITY SYSTEM

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India is the world's largest market for two-wheelers. Newer models with improved fuel efficiency and power ratings keep hitting the market off and on. Sadly, the security aspect of two-wheelers remains neglected. This fallibility inspired us to devise a foolproof yet cost-effective security system to safeguard bikes against theft. Any attempt to move the bike or force the ignition key to start the bike will set off the bike's horn.

The concept

The two-wheeler security system (Fig. 1) comprises a handheld infrared (IR) transmitter, IR receiver/sensor, switching circuit, power supply, turbulence detection unit, alarm and ignition switch. You have to keep the handheld IR transmitter with you and hide the receiver module at a secure place in your bike.

Whenever you leave the bike, switch on the security circuit by pressing the transmitter switch while directing the transmitter towards the sensor module such that the transmitted IR rays fall on it directly. The received signal activates the security circuit to blow the horn when subsequently someone tries to steal your bike by moving the bike or by using a duplicate key. The turbulence-sensing mechanism detects manhandling of the bike to trigger the alarm.

When you return back, switch off the sensor mechanism before starting the bike. Else, you may be caught off guard as this again will trigger the alarm.

In case the transmitter unit is not working or you have misplaced it, you can still activate the security circuit simply by flipping its switch S3 to on position.

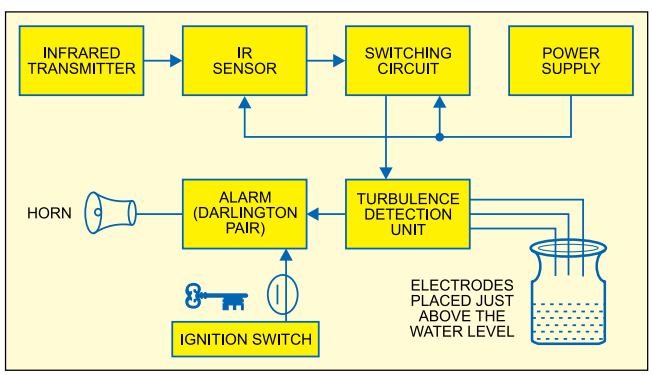

Fig. 1: Block diagram of the two-wheeler security system

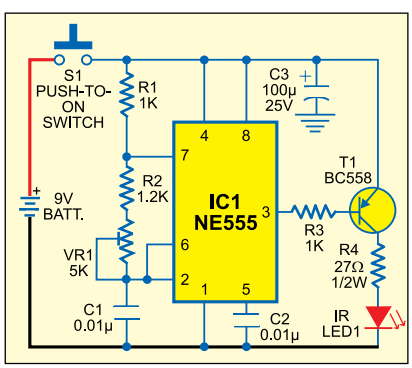

Fig. 2: Transmitter circuit

Circuit description

Transmitter circuit. The transmitter circuit (Fig. 2) works off a 9V battery. It is built around timer IC NE555, which is wired in astable multivibrator mode to generate around 38kHz frequency. The timer output is amplified by pnp transistor BC558 to drive the IR LED (LED1). Resistor R4 limits the current flowing through LED1.

When you press switch S1 momentarily, the astable multivibrator starts oscillating and the 38kHz frequency generated is transmitted through IR LED1. Make sure that IR LED1 is properly oriented towards the IR sensor module of the receiver circuit. Its transmission wavelength of 900 to 1100 nm (near-IR range) lies in the peak receptivity range of TSOP1738 receiver module.

Receiver circuit. The receiver circuit (Fig. 3) comprises power supply, sensor module, switching, turbulence detection and alarm sections.

Power supply. The receiver cir-

PARTS LIST

Semiconductors:

IC1, IC2	- NE555 timer
IC3	- CD4027 dual J-K flip-flop
IC4	- 7805, 5V regulator
IC5	- CD4081 quad two-input AND gate
IC6	- CD4071 quad two-input OR gate
T1	- BC558 pnp transistor
T2, T3, T5	- BC547 npn transistor
T4	- TIP122 npn transistor
D1-D7	- 1N4001
IR LED1	- Infrared LED
IRX1	- TSOP1738 IR receiver module

Resistors (all ¼-watt, ±5% carbon, unless stated otherwise):

R1, R3, R8, R10, R18	- 1-kilo-ohm
R2	- 1.2-kilo-ohm
R4	- 27-ohm, 0.5W
R5, R11	- 100-ohm
R6, R13	- 10-kilo-ohm
R7	- 220-kilo-ohm
R9, R12	- 470-ohm
R14-R16	- 22-kilo-ohm
R17	- 100-kilo-ohm

Capacitors:

C1, C2, C6	- 0.01µF ceramic disk
C3	- 100µF, 25V electrolytic
C4	- 1µF, 25V electrolytic
C5	- 10µF, 25V electrolytic
C7	- 0.1µF ceramic disk
C8	- 100µF, 25V electrolytic

Miscellaneous:

S1	- Push-to-on switch
S2	- Motor bike switch
S3	- On/off-switch
LS1	- 12V horn
E1-E3	- Thin steel rod
	- Plastic bottle
	- 9V battery
RL1	- 12V, 285-ohm, 1C/O relay

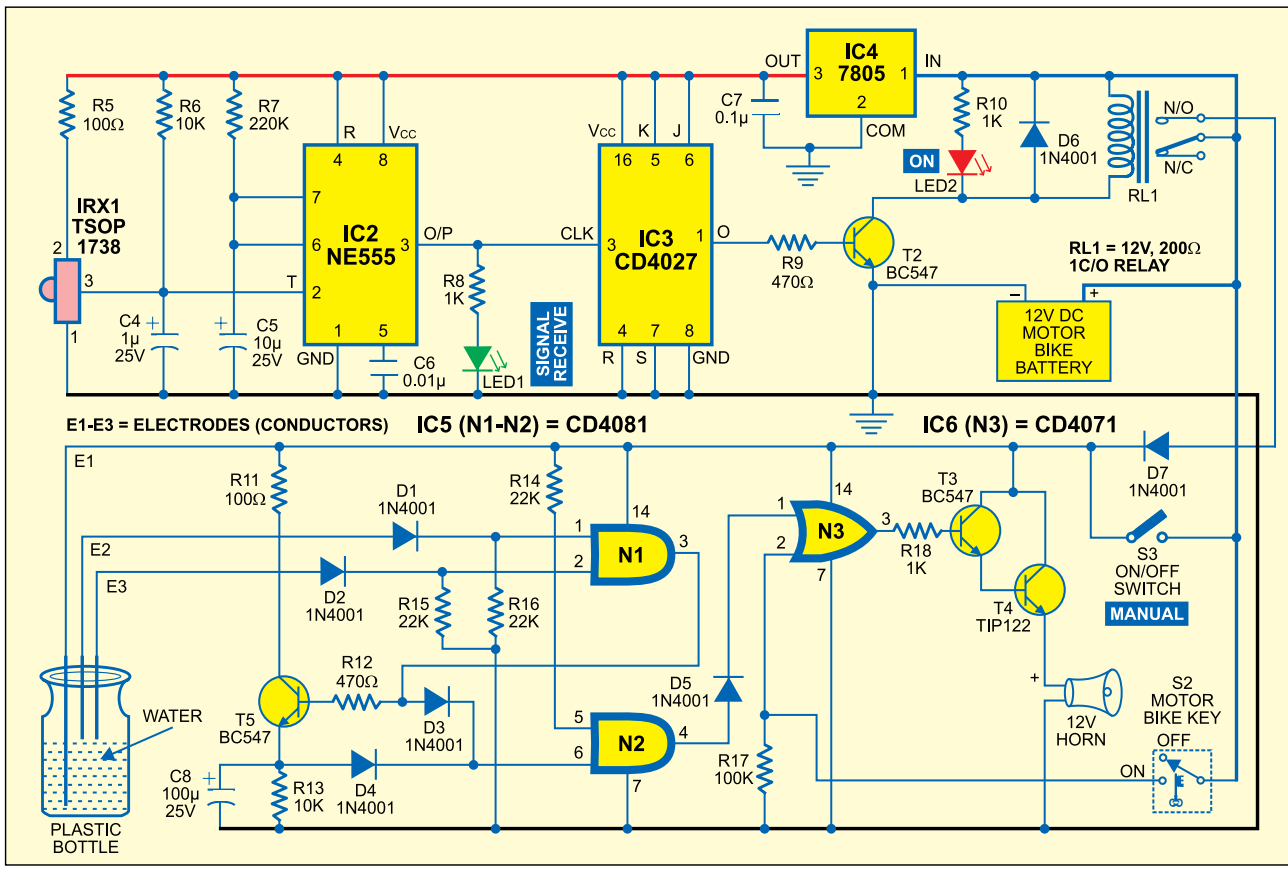

Fig. 3: Circuit of the two-wheeler security system

cuit excluding IR receiver module TSOP1738, timer NE555 (IC2) and J-K flip-flop CD4027 (IC3) works off the 12V battery of the bike. The 12V supply is down-converted to 5V by regulator IC 7805 (IC4) to drive TSOP1738, IC2 and IC3.

Sensor. IR receiver module TSOP1738 is sensitive to the IR radiation modulated at 38 kHz. Its normally high output goes low when any IR radiation is detected.

Switching. The high-to-low transition of the receiver output triggers timer IC2, which is rigged up in the monostable mode, and the green LED (LED1) glows to indicate signal reception and it also generates a positive-going clock pulse for the flip-flop.

The output of IC2 is fed to the clock input of IC3. Here IC3 is wired in toggle mode by connecting its J and K inputs to +5V, and Set and Reset pins to ground. IC3 is triggered by the clock pulse received from IC2 and transistor T2 conducts to energise relay RL1 and the +12V supply energises electrode E1, turbulence-detection section (comprising AND gate CD4081 (IC5) and OR gate CD4071 (IC6)) and the alarm section. The red LED (LED2) glows to indicate enabling of these sections.

When the transmitter switch is pressed again, the relay gets de-energised by the toggling action of the flip-flop and electrode E1, turbulence-detection section (built around IC5 and IC6) and the alarm section (comprising Darlington pair transistors T3 and T4) are disabled. The red LED now goes off. A free-wheeling diode (D6) used in parallel to the relay prevents the transistor from damage when the relay de-energises.

Turbulence detection. The turbulence-detection section detects sudden bike jerks, provided relay RL1 is in energised state. It consists of a small, watertight bottle with three electrodes inserted into it to detect the turbulence caused.

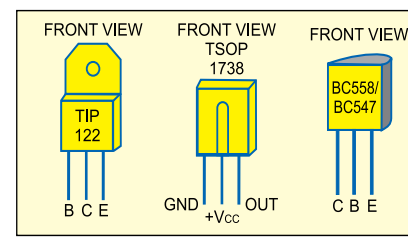

Fig. 4: Pin configurations of TIP122, TSOP1738 and BC558/BC547

When the bike is moved, water inside the bottle shakes to short all the three electrodes inside the bottle together momentarily and the inputs of AND gate N1 go high. The inputs of AND gate N2 also go high and its high output makes output pin 3 of OR gate N3 high. This causes forward biasing of Darlington pair of transistors T3 and T4 and the horn blows.

At the same time, npn transistor T5 gets forward biased to charge capacitor C8. As a result, pin 6 of AND gate N2 remains high for some time even after the electrodes are no longer shorted by the splash of water in the bottle. Hence,

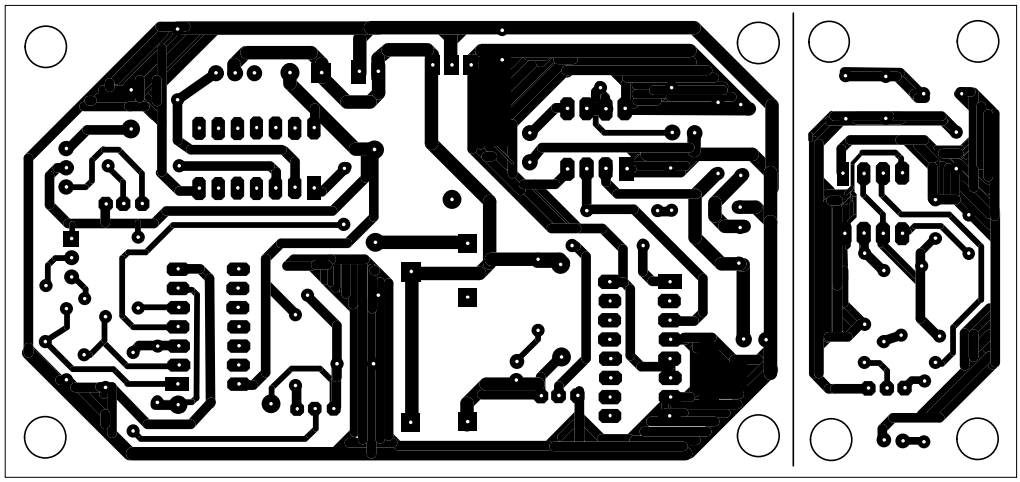

Fig. 5: Actual-size, single-side PCB layout for two-wheeler security system

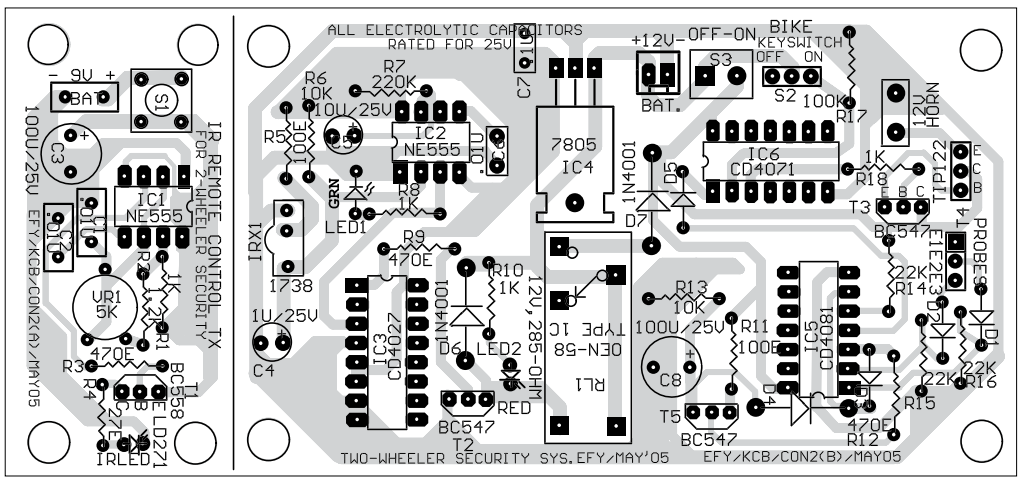

Fig. 6: Component layout for the PCB

the horn blows until capacitor C1 discharges below the threshold level of CMOS gate via resistor R13.

The basic aim of the turbulence detection module is to activate the horn when the bike is moved or ignition key is forced to start the bike. This is achieved by using two-input OR gate N3 (IC CD4071), which is connected to:

1. The output of AND gate N2, which is virtually the output of the turbulence detection module

2. A lead from the 'on' terminal of the bike key

When either or both the inputs of N3 are high, its output goes high to provide sufficient current to drive the Darlington pair transistors of the warning-indication section and the horn blows.

Alarm. The alarm section comprises a high-current gain Darlington pair of transistors pumping current into the bike's horn. The emitter of transistor T4 is directly connected to the positive terminal of 12V horn. A heat-sink is used to dissipate the excessive heat generated by npn power transistor TIP122.

Fabrication

Assemble the transmitter and receiver circuits on separate general-purpose PCBs as you have to carry the transmitter unit with you and install the receiver unit in the bike. The lid of the water-filled plastic bottle should be tight enough so that the water does not leak out.

Fig. 4 shows pin configurations of power transistor TIP122, IR sensor module TSOP1738 and npn transistor BC558 (or BC547).

The combined actual-size, single-side PCB for the transmitter and receiver circuits (Figs 2 and 3) is shown in Fig. 5 and its component layout in Fig. 6. You can separate the two PCBs by cutting along the vertical line of the PCB. Make sure that manual switch S3 in the PCB is easily accessible, so that you may use it to switch on/off the security circuit in case the transmitter is not working or you've lost it.

Demerits

1. Two logic gates of CD4081 and three logic gates of 4071 are left unutilised.

2. TSOP1738 may get triggered by a TV remote.

3. Short range of the transmitter (4 to 5 metres).

Precautions

1. Make sure that electrode E1 is always dipped into the water.

2. Hang the two electrodes (E2 and E3) to rest just above the water level so that they easily get shorted by the shaking water when the bike is moved.

3. Make sure the bike's battery is fully charged.

4. Keep the circuit protected from water and high temperature.

Other applications

1. Turbulence detection.

2. The circuit can be modified to function as an overflow indicator in water tanks.

3. The receiver unit itself can be used as an infrared toggle switch. ●