Everything you've ever wanted in a

GARAGE DOOR OR GATE REMOTE CONTROLLER

If you're sick of getting out of the car in the rain (what rain!) to open the garage door or gate, it's about time you got into the twenty-first century and made them remote controlled. This circuit is a beauty, giving you all the features you've ever thought you'd need and probably many more besides.

This controller uses an assembled UHF transmitter and receiver to make life easy for you. Output from the receiver is used to control the motor drive circuitry, the action depending on the pushbutton pressed on the remote transmitter.

It may be used to directly control a 12V DC motor for a garage door opener or gate opener, or (with appropriate care and safeguards) to control an external relay or contactor which in turn controls 240V or even industrial 415V (three phase) motor as often found on large and high roller doors.

While the circuit is complete, the details of the mechanical drive system for your particular garage door or gate opener are up to you. For inspiration, you might refer to our previous article on a garage door opener in the April & May 1998 issues. Similarly, for a practical gate opener system, have a look at the August 1997 issue of Silicon Chip.

Both the drive systems referred to are based on 12V automotive windscreen wiper motors which have the advantage of being cheap, readily available, powerful and compact.

This controller circuit suits those motors and incorporates a large 12V SLA battery as the power source. If you are considering a motor other than a windscreen wiper motor, bear in mind that most "straight" 12VDC motors will rotate too fast to be of much use in a garage door or gate opener. They need a gearbox to not only reduce the speed but increase torque.

Using 12V as the power source is safe and convenient as well as providing extra insurance in case of a power blackout – when that happens, you can still operate the garage door/gate.

The 12V SLA battery is kept charged via an on-board charger which is powered by a 9V AC plugpack. Note that this charger is NOT intended to charge 12V automotive-type batteries, which many people use as a backup. Trying to charge a flat 12V vehicle battery with this circuit would almost certainly burn it out.

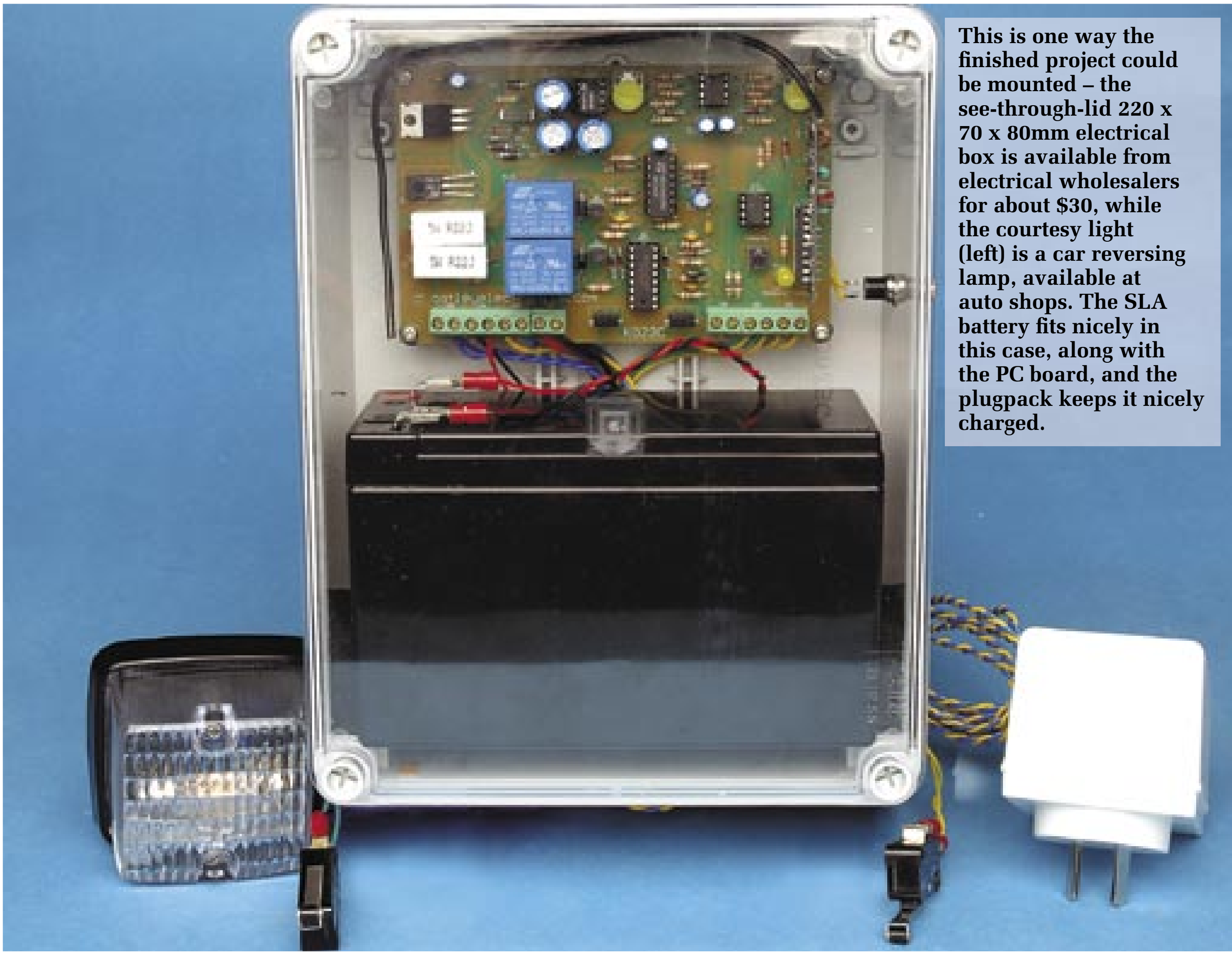
Features

The main features of the controller circuit are provision for upper and lower door travel limit switches and over-current sensing for UP and DOWN modes of operation. This latter feature can be used to detect obstructions and immediately stop door operation to prevent damage to the motor, drive mechanism or possibly even your car (or you!).

Keyfob remote

The unit is based on a pre-built UHF receiver module and features a small keyfob transmitter that has more than half a million possible codes. You press a button on the transmitter and the door goes up; press the same button again and the door goes down.

There is also provision for a manual switch which can be mounted somewhere on the wall inside the garage.



This is one way the finished project could be mounted – the see-through-lid 220 x 70 x 80mm electrical box is available from electrical wholesalers for about $30, while the courtesy light (left) is a car reversing lamp, available at auto shops. The SLA battery fits nicely in this case, along with the PC board, and the plugpack keeps it nicely charged.

This works in a similar way to the button on the transmitter: press it once for the door to go up and press it again to make the door go down.

If you press the button before the door reaches the end of its travel, it will stop. You then have to press the button again to make the door go in the opposite direction. This applies also to operation via the transmitter and is exactly the same convention used by commercial garage door openers.

Circuit description

The receiver is based on a pre-built UHF "front-end" module. This processes the signal received from the keyfob transmitter which has four buttons.

One of the receiver outputs switches to +5V, depending on the button pressed. Door operation can be set to work with button "A" or "B", selected by making connections at point "A" or "B" under the PC board.

The connection marked "VT" can also be used but the door will then operate with any button on the transmitter. This connection can be made by shorting the selected pads together with solder.

The main IC on the receiver module is a Tri-state decoder chip which is used to decode the pulse signal generated by the transmitter. This device has eight address lines and these must be connected to match the transmitter code.

(For more on this topic, see the Coding section of this text). If the code sequence is valid, the selected output switches high and LED1 is lit.

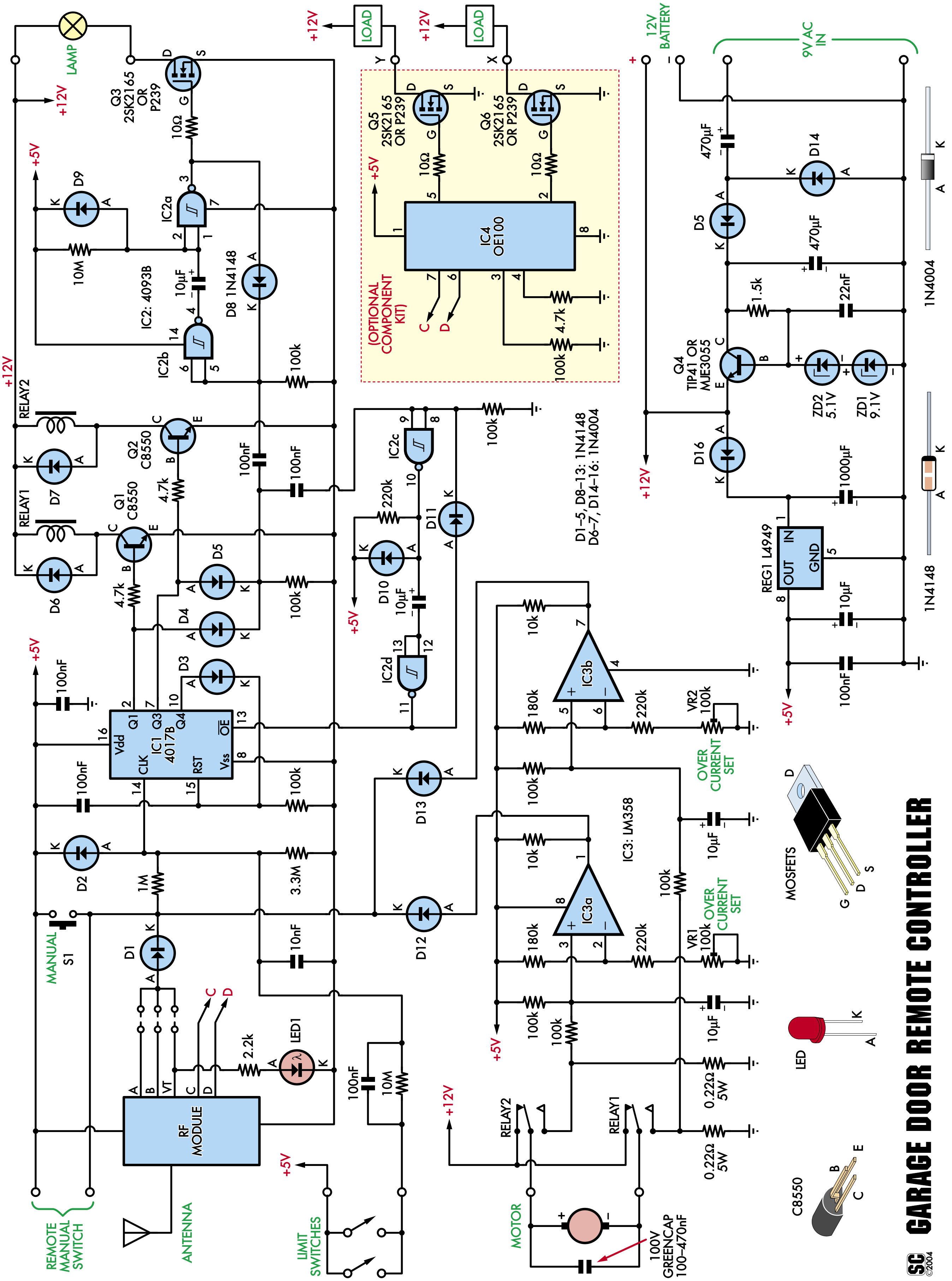
The selected output connects via diode D1 to the clock input, pin 14, of IC1, a 4017 decade counter. This counter can also be clocked by manual switch S1 and by the limit switches.

The length of the clock pulses produced by the operation of the limit switches is limited by the time constant of the associated 100nF (0.1μF) capacitor and 3.3MΩ resistor. The 10nF (.01μF) capacitor filters out any noise picked up by the wires used to connect to the limit switches, while the 10MΩ resistor discharges the 100nF capacitor after the switches have been operated.

Note that when the power is first applied, IC1 is reset by a short pulse to pin 15, by virtue of the 10nF (0.1μF) capacitor connected to the +5V supply line. The counter is also reset when its Q4 output (pin 10) goes high, via diode D3.

This means that IC4 can only have four exclusive output states: Q0 high, Q1 high, Q2 high or Q3 high. Outputs Q0 and Q2 do not drive anything so they correspond to "stop" modes while outputs Q1 and Q3 switch the "up" and "down" relays (via transistors Q1 and Q2).

Thus, a succession of clock pulses from the receiver correspond to the following modes: Stop, Up, Stop, Down, Stop, Up, etc. Two separate over-current detectors, comprising op


GARAGE DOOR REMOTE CONTROLLER
SC ©2004
LAMP
Q3 2SK2165 OR P239
Q5 2SK2165 OR P239
Q6 2SK2165 OR P239
LOAD
LOAD
IC4 OE100
(OPTIONAL COMPONENT KIT)
12V BATTERY
9V AC IN
IC2: 4093B
D8 1N4148
RELAY2
RELAY1
Q2 C8550
Q1 C8550
D1–5, D8–13: 1N4148
D6–7, D14–16: 1N4004
Q4 TIP41 OR MJE3055
ZD2 5.1V
ZD1 9.1V
REG1 L4949
1N4004
1N4148
IC1 4017B
IC3: LM358
OVER CURRENT SET
MOSFETS
LED
C8550
REMOTE MANUAL SWITCH
MANUAL S1
ANTENNA
RF MODULE
LED1
LIMIT SWITCHES
MOTOR
100V GREENCAP 100–470nF
0.22Ω 5W

amp comparators IC3a and IC3b, detect higher than normal motor currents that would result when the door reaches its up or down stop positions or if the door is obstructed. The outputs of these over-current detectors then apply a pulse to the clock input of IC1, which causes it to go into the Stop mode.

The counter can be disabled by have its pin 13 being held at 0V. The output of the monostable comprising Schmitt NAND gates IC3a & IC3b is normally high, thus enabling the counter to clock.

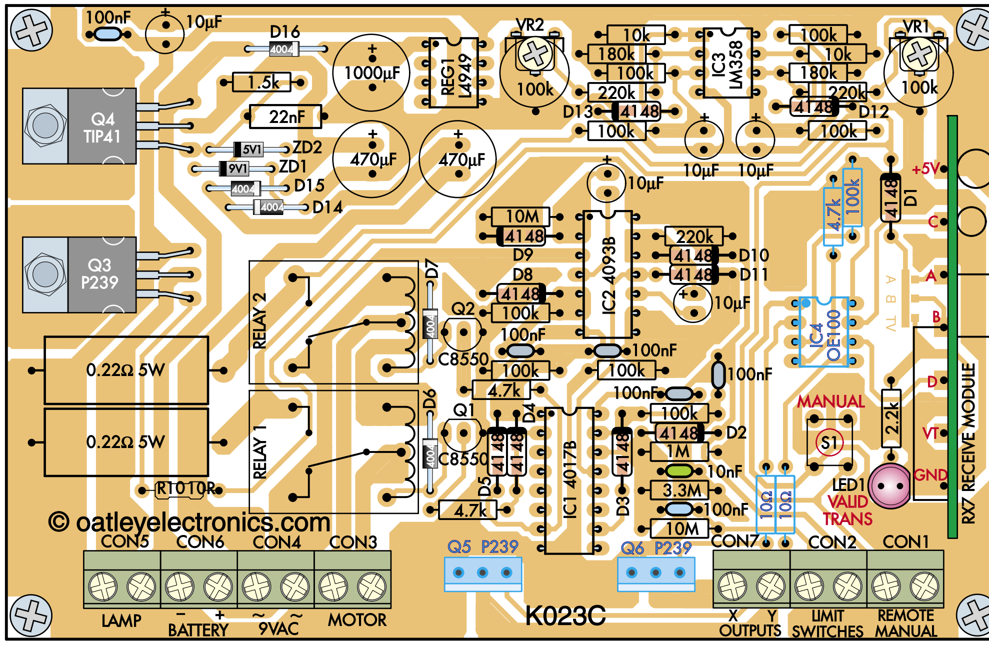
However, this monostable is triggered via isolating diodes D4 & D5 each time Q1 (up) or Q3 (down) of IC2 first go high. This monostable therefore prevents the counter from stepping for approximately two seconds after the up or down modes are first activated.

This two-second disabling of the counter prevents it being triggered by the over-current detectors, which would otherwise happen since a motor draws relatively high currents when it first starts up.

A second monostable made up of gates IC2a & IC2b is used to switch a courtesy lamp via Mosfet Q3. This monostable is also operated via diodes D4 & D5 each time Q1 (up) or Q3 (down) of IC2 goes high. The time constant of the monostable causes the courtesy lamp to light for just under two minutes – enough time to exit the car and garage and/or turn other lights on if necessary.

As already noted, a combination of a 12V SLA battery and 9V AC plugpack is used to power the controller and charge the battery. The battery is charged via NPN transistor Q4 (TIP41) which has its output set by zener diodes ZD1 & ZD2.

An L4949 regulator IC provides +5V supply for the receiver, while the relays and motor are driven directly from the 12V battery.



COMPONENTS SHOWN IN BLUE ARE IN THE OPTIONAL COMPONENTS KIT

The PC board shown both as an overlay and matching photograph (both shown very close to right size). Watch polarities on the semiconductors, electrolytics and the UHF receiver module.

Construction

We're only going to cover the basic assembly details in this article, up to the point where you put it in a case of some description.

Final installation will of course depend on individual situations so we won't attempt to cover that here.

First check that your PC board appears properly etched. These days it is most unusual for boards to be crook but it still pays to check for shorts/bridges and over-etching.

If you're happy with the board, start construction by mounting all of the resistors first of all.

Good construction practice means that you will orient all the resistors in the same way – eg, horizintally mounted resistors with their multiplier bands to the right and vertically mounted resistors with their multiplier bands to the bottom of the board. This makes

A close-up view of the UHF receiver module, showing which way around it mounts on the main PC board. The cable at top left is the antenna wire.

troubleshooting a lot easier, too.

Next follow the other low profile components such as small capacitors, diodes, etc, then the larger capacitors, LEDs, the small transistors, etc. Follow the PC board overlay and the photographs to ensure you get the polarised components the right way around.

The larger transistors and MOSFETs, plus the sockets for the ICs (if you are using them) go in next, followed by the trimpots, terminal blocks and (almost!) finally, the relays.

Apart from the UHF receiver module, your board should now be pretty well populated. If there are empty holes (apart from the seven down the right-hand edge), check to see what you out!

The receiver module

Give your board a good check against the overlay and photo to make sure everything is in and in correctly.

Before soldering in the receiver module, cut a 230mm length of insulated hookup wire and bare 5mm on one end. This will be the receiving antenna and it connects directly to the UHF receiver module.

Solder it in position on the receiver module, then solder the module itself onto the main PC board. Again, use the photos to make sure you get it the right way around.

Coding

The transmitter and receiver come with their encoder ICs unencoded. After the system is operating correctly, you may code the transmitter and receiver as leaving it uncoded is a high security risk.

Data inputs are pins 1 through to 8 on both the encoder IC in the transmitter and decoder IC on the receiver module. Data coding inputs are Tri-state, ie, each data pin may be either left floating, tied high (+5V) or tied to 0V.

Ensure that the coding state on each pin number on the encoder IC is wired with the same coding state as the corresponding pin on the decoder IC, otherwise the remote control will not operate. These connections can also be made with a solder blob between the IC pins and their nearby exposed 0V or +5V tracks.

The over-current setting trimpots (VR1 & VR2) are set during installation of the door mechanism.

Mounting it!

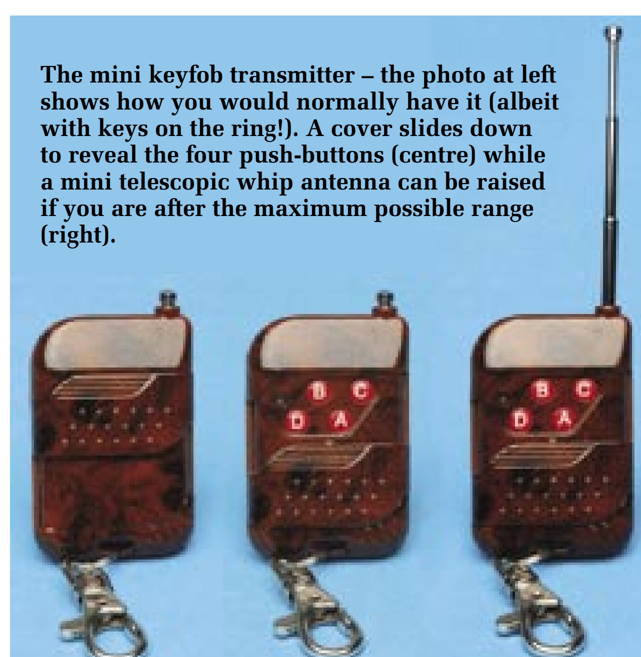
We've shown one possible arrangement using a box intended for electrical switchgear. With a screw-on, see through lid this box measures 220 x 170 x 80mm and is available from most electrical fitting wholesalers.

This box is a good size because it's an easy fit for both the PC board and the SLA battery. We mounted the board in the upper side of the case via some 20mm tapped stand-offs and took all of the cabling out through the bottom, via a 20mm cable gland. Perhaps that's a bit of overkill but it makes a nice, neat job.

The cables go to the plugpack, the two limit switches, the 12V courtesy light and of course a pair of relatively heavy leads to the motor.

Other connections within the case are for the 12V SLA battery (these leads fitted with a pair of spade lugs for convenience) and another pair of wires to the manual push-button switch, which we mounted on the side of the case. This may or may not be convenient for you but rememember, you can fit other switches in parallel if you so wish.

Standard SPDT microswitches are used for limit switches. These are NOT supplied in the Oatley Electronics kit.



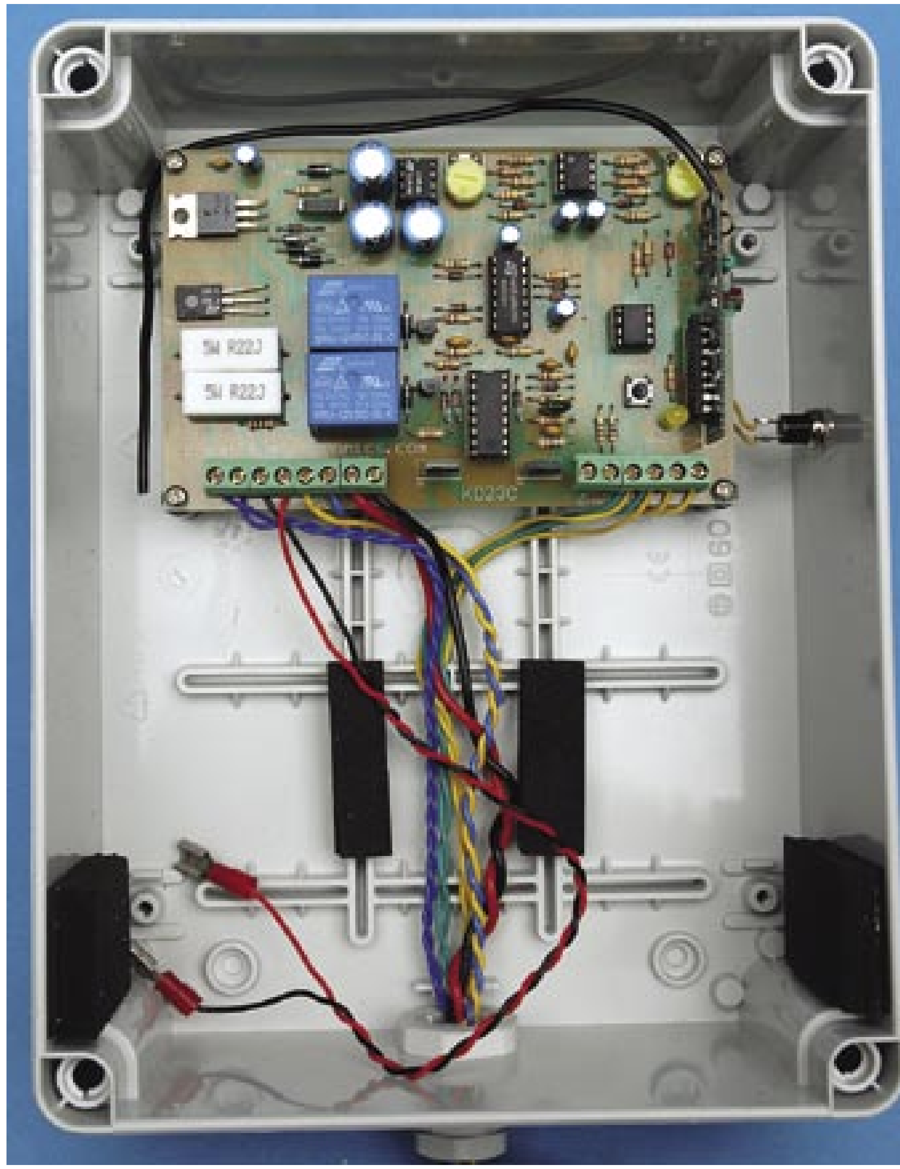
The mini keyfob transmitter – the photo at left shows how you would normally have it (albeit with keys on the ring!). A cover slides down to reveal the four push-buttons (centre) while a mini telescopic whip antenna can be raised if you are after the maximum possible range (right).

The 12V SLA battery is just a little too big to be left "slopping around" in this case so we glued some high-density foam rubber to the sides and the back of the case, making it a nice, snug fit.

The antenna position

Ideally the antenna should hang straight down from the receiver board – but as you will note from the photo at right, we draped it around the top of the PC board, out of the way.

In all but the most critical of applications, this should be more than satisfactory. If you really want to get picky, you could use a length of stiff wire and run it out through a hole drilled in the top of the case. But we'd wager you wouldn't gain any additional range doing so!



A shot inside the case with the battery removed so you can see how everything fits together. The switch on the upper right is the manual door switch – some may prefer to mount this outside the case in a more convenient position.

The mechanical side

As we said at the outset, we did not intend to get into this area in this particular article. All this project provides is the switched 12V DC with reversing polarity to drive what ever motor arrangement you think appropriate.

There are many different ways of opening and closing doors and gates, just as there are many different styles of doors and gates. It's all up to you and your application.

The motor

We will make one other comment about the motor you use. As we mentioned, most 12V DC motors without gearboxes will have too much speed and probably not enough torque to be of much use in this role.

Apart from the windscreen wiper motor option already covered, Oatley Electronics have made us aware of a 24V DC motor which they have available which looks perfect for the job. It runs more than adequately on 12VDC and has the right sort of power and speed. Best of all, the sprocket suits a standard bike chain so mechanically it should be relatively easy to incorporate. It retails for around $70.00.

This 24V DC geared motor from Oatley has lots of power, has bike sprocket output and operates perfectly from 12V. It should suit this project well.

Where from, how much?

Oatley Electronics own the copyright on this design and the PC Board.

The main kit of parts for the project, (K023C, retailing for $39.00) consists of the PC board and all on-board components, except for those marked optional. The optional components kit retails for $12.00, as do the TX7 4-channel keyfob transmitters (you can use as many as you like as long as they are all coded the same).

The 12V 7Ah SLA battery (PB6) retails for $25, while a suitable 9VAC 1A plugpack (K023CP) sells for $6.00.

Contact Oatley Electronics on (02) 9584 3563 or via their website, www.oatleye.com. SC