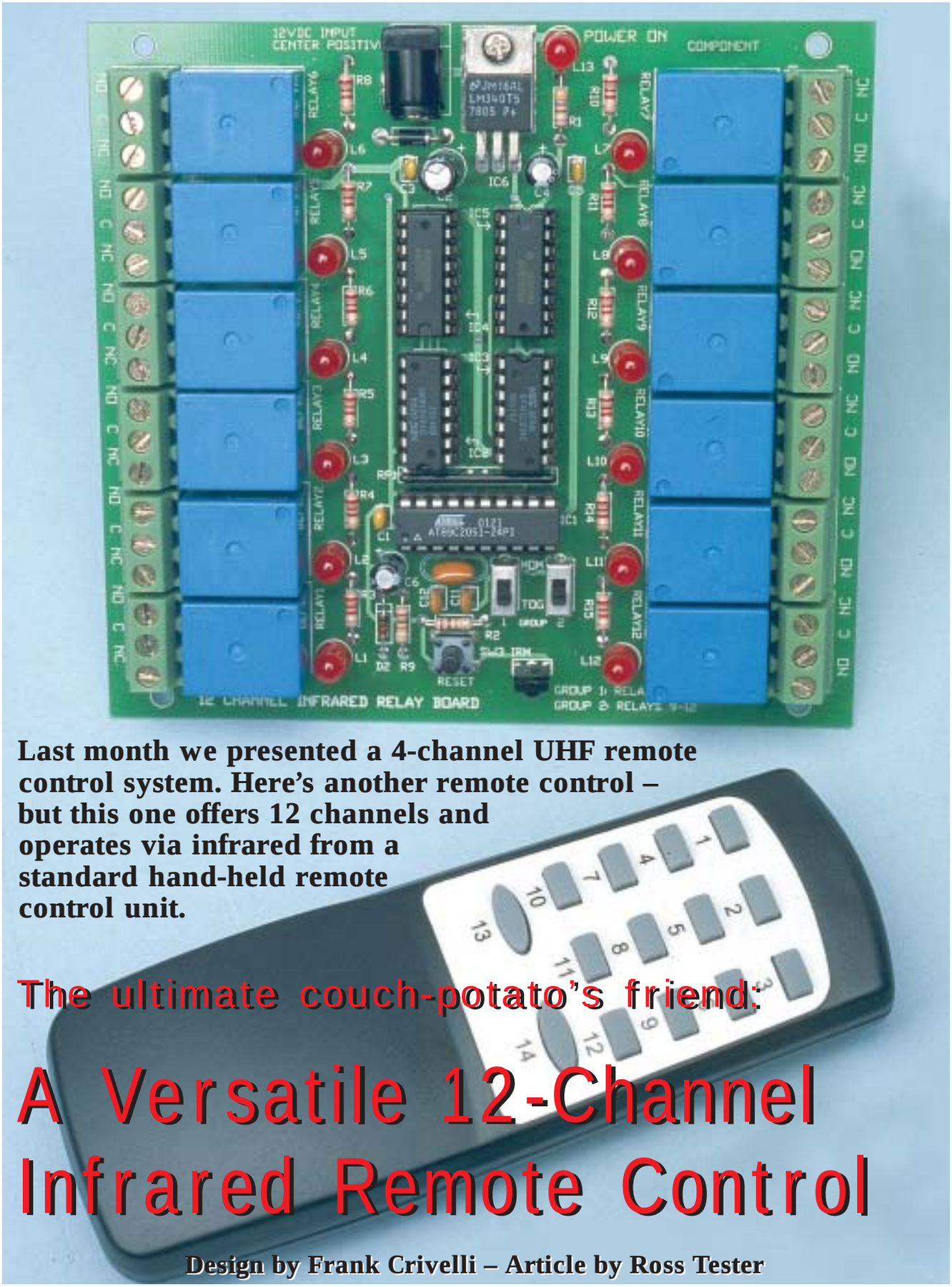


Last month we presented a 4-channel UHF remote control system. Here's another remote control – but this one offers 12 channels and operates via infrared from a standard hand-held remote control unit.

The ultimate couch-potato's friend:

A Versatile 12-Channel Infrared Remote Control

Design by Frank Crivelli – Article by Ross Tester

One of the advantages of infrared remote is that there is no radio signal for crooks to monitor and record for use against you later on. Instead, there is a beam of invisible infrared light which comes from a standard hand-held remote control unit.

So from that point of view, it is pretty secure. However, the receiver can be actuated by anyone who has a remote control which uses the same code as yours. So maybe it's not the type of thing you would use to protect the Crown jewels!

There is, though, an enormous variety of tasks to which you could put the unit. Just think of the myriad of things in your home these days which use infrared remote to turn things on and off, change levels, open and close . . . Anything which can be connected to a set of relay contacts, whether normally open nor normally closed, can be converted to remote control.

Perhaps you want to motorise curtains? Turn lights on or off (perhaps some low voltage garden lights)? Add remote control to something that has not already got it? (Oh, come on, there must be something!)

As far as the hand-held remote control itself is concerned, it is a typical commercial unit with 14 pushbuttons. But it does have the advantage of being nondescript – no labelling or branding to identify it nor give any clues as to which of the many infrared codes it uses.

How it works

Each button on the hand-held remote control unit transmits a unique code train which modulates a 38kHz carrier, sending a pulse stream from an infrared diode. This method is used in most, if not all, infrared remote controls as it offers a high degree of noise immunity against interfering light sources.

That's about all you need to know about the remote control transmitter. Oh, OK, it's battery operated and it's black!

At the receiver end, an infrared receiver module picks up the modulated infrared signal and extracts the data signal. This is fed into an Atmel 89C2051 microcontroller which has been programmed to decode the signal, determine which one of the 14 it is and set the output pin corresponding to the received code low.

Each output goes to an inverter, one of six in a 74HC04 chip. As you will note from the circuit diagram, fig.1, there are two such chips and each of their outputs in turn connects to an input in a ULN2003A. This chip contains six relay drivers, actually Darlington pairs (for clarity, only one of the transistors in each Darlington is shown).

In the collector circuit of each of the Darlingtons is an SPDT relay along with a LED and resistor.

When the Darlington turns on, the relay pulls in and the LED lights, giving a visual indication of relay activity. You can hear the relay pull in but with 12 of them on the PC board, it's not easy to work out which one it is!

Each of the relays has a set of changeover (ie, SPDT) contacts. While these contacts are rated at 10A, their associated PC board track widths are not, due to their close spacing. About 5A would be the absolute maximum. (Thickening up the tracks with wire links can increase the current handling capacity).

And for the same (close spacing of tracks) reason, this PC board is NOT rated to handle 240V AC mains voltages. Steer clear of mains: it bites!

You might wonder where the usual spike-suppression diodes are across the relay coils. They're actually inside the ULN2003A, so a separate diode is not required.

The relays are organized into two banks, one of eight and one of four, with buttons 1 to 12 on the remote control operating the corresponding relays (button 1 operates relay 1, etc)

Each of the two banks can be independently set to operate in "momentary" or "toggle" mode via slide switches SW1 and SW2. In the momentary mode, the relay is energized or closed while ever the keypad button remains pressed. In the toggle mode, one button push closes its relay and a second push of the same button releases it.

And yes, you can have one bank set to momentary and the other set to toggle if you wish.

What of the other two buttons on the remote control – the 13 and 14 buttons?

They are used to release all relays when the circuit is set to the "toggle" mode. Pressing button 13 will release relays 1 to 8, while pressing button 14 releases relays 9 to 12.

Pressing the "reset" switch (S3) on the receiver board does the same as pressing both the 13 and 14 buttons on the transmitter – it releases all relays.

The only other sections of the circuit we have not yet mentioned are pretty conventional: a 12MHz ceramic resonator to give the micro-controller its clock pulses, along with a plug-pack-powered nominal 12V DC supply (to power the relays and drivers) and a regulated 5V DC supply (to power the rest of the circuit).

Finally, you might wonder why the signal is inverted twice. Why not eliminate the first inverter (IC2 or 3) and simply use an active high output from the microcontroller to the relay driver chips? It's all to do with what happens on reset.

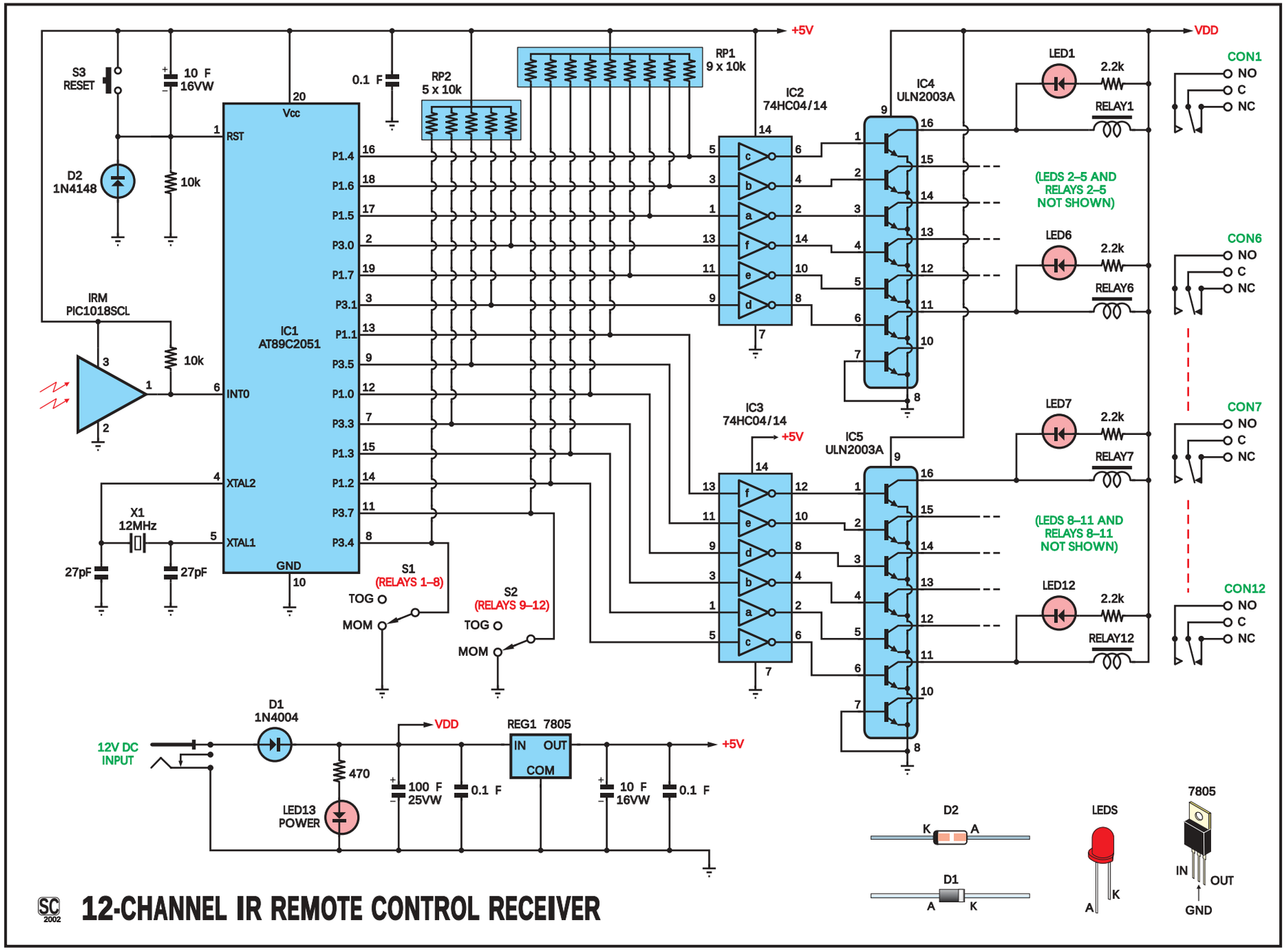
On reset (either with the reset switch or via the 10µF/10kΩ resistor power-on reset) the microcontroller's I/O ports are configured as inputs (via internal hardware) and "float" high. If the outputs were connected directly to the relay drivers then the relays would briefly operate during reset.

Of course the relays would be released after reset once the onboard software took over. However the relays would "flick" on momentarily during reset – and that could be embarrassing!

Features:

- 12 channels, each individually controlled
- Infrared operated from commercial hand-held infrared remote
- Long range (>15m) operation
- Relay output – 5A rated changeover contacts
- Two banks of relays (eight and four)
- Each bank can be set to momentary or toggle (push on, push off) modes
- Remote can reset each bank with one button in toggle mode
- One button reset on receiver board
- Receiver is 12V DC operated (30mA standby, 450mA all relays toggled)

Fig.1 (facing page): the circuit of the receiver section. The transmitter is not shown as it is pre-assembled.



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12-CHANNEL IR REMOTE CONTROL RECEIVER

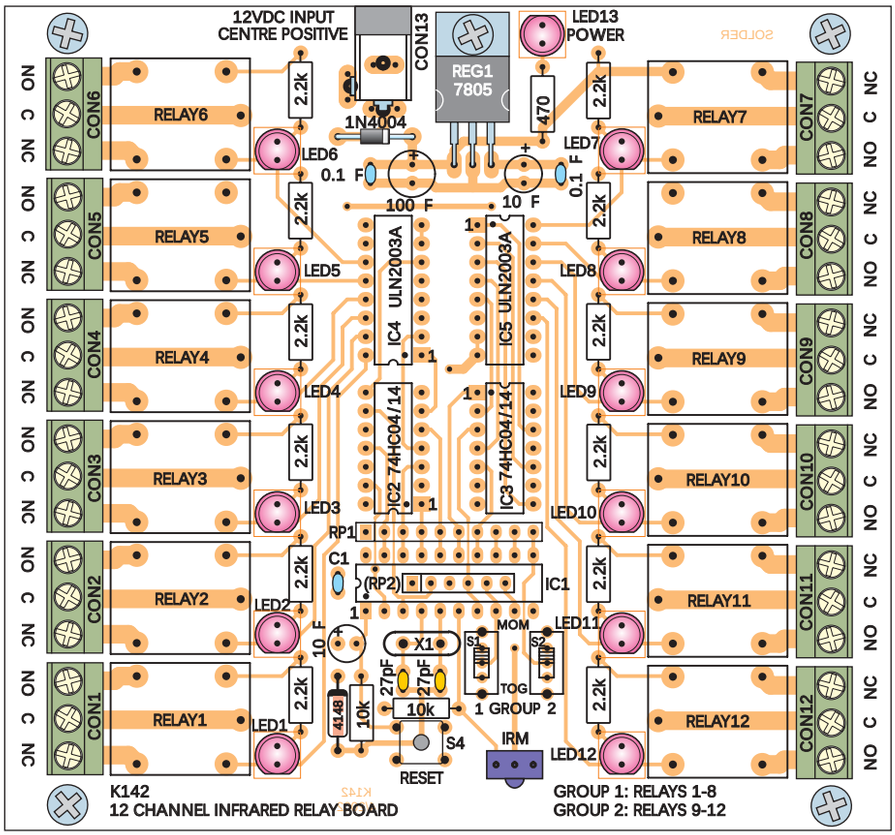
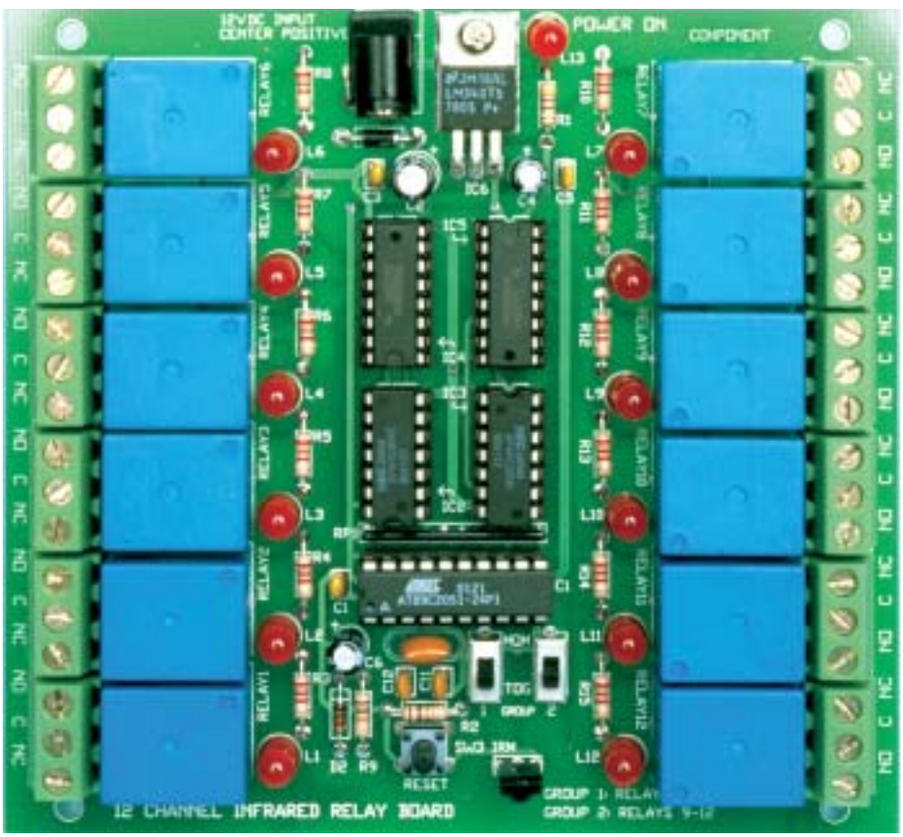


Fig.2: all components mount on the one PC board, shown above same size. It is a double-sided board but only the underside tracks have been shown, for clarity. Shown below is the same-size photograph of the board which should help you in assembly.



Using the extra inverter means we can use an active LOW output to operate the relay and a HIGH to release it - just right during reset! External 10kΩ pullup resistors (all part of resistor arrays RP1 and 2), are used to ensure a 'solid' high level signal to turn a relay off.

Construction

Use the component overlay on the PC board itself, along with Fig.2, to place the components. The following order is a logical way to do it – but do not insert any ICs until after the "Testing" section.

1. Resistors and diodes.
2. IC sockets
3. Resistor networks. Note that RP2 is inserted inside the IC1 IC socket. The small dot at one end of the resistor networks denotes pin 1.
4. Ceramic resonator, capacitors and IR receiver module. The lens bump of the IR module faces outwards.
5. Three switches.
6. DC power jack and 7805 regulator. Use needle nosed pliers to bend the leads of the regulator down 90°. It does not require a heatsink.
7. All LEDs (watch polarity!).
8. Electrolytic capacitors. Make sure you insert them the correct way around.
9. Terminal blocks. Note the terminal blocks do NOT slide together. Also make sure the wire entry side faces out from the PCB!
10. Relays

Testing

After you have inspected your placement and soldering, connect a 12V DC plugpack. The power LED should light. If it doesn't, check the polarity of your plugpack – it should be standard (centre positive) or the circuit will not work.

Use a multimeter to measure the 5V output from the regulator. The easiest way to do this is across pins 10 and 20 of the IC1 socket (pin 20 is positive).

If all is well you can remove the power and insert the ICs. Take care that none of the IC leads are bent under when inserting them into their sockets.

Connect the 12V plugpack again. Put the slide switches in the momentary (MOM) position and press button 1 on the remote control unit. Relay 1 should operate and LED L1 should light. Release the button and the relay

should release. Check each of the other relays in turn by pressing the other buttons. Buttons 13 and 14 have no affect in momentary mode.

Now put the slide switches in the toggle (TOG) position. Press and release button 1 on the remote control unit. Relay 1 should operate (you'll hear it click in) and stay operated. LED L1 should also be on. Press each of the other buttons 2 to 12 in turn and note that each relay and its LED is on.

At this point all the relays and LEDs should be on. Now press button 13. All Group 1 relays (1-8) should release and LEDs 1-8 should go off. Pressing button 14 should release all Group 2 (9-12) relays and turn off their associated LEDs, 9-12.

Repeat the process except for pressing buttons 13 and 14. Instead, press the "reset" button on the receiver and again, all LEDs should go out and relays release.

And that's just about all there is to it. All you have to do now is work out how to link it into whatever you are going to control. Remember, you have a normally open and a normally closed contact on each relay (normally open means open circuit when the associated LED is off).

Aw, shucks – it doesn't work!

First thing to check is that you have batteries in your remote control. Yes, it sounds stupid . . . until you check and they aren't there (none are supplied in the kit because they could be dead by the time you get them!)

Next, check your component placement (and polarity) on the receiver board once again.

And while you're at it, check all soldered joints carefully under a good light. Dry joints are the most common reason for circuits not working. Resolder any that look suspicious.

Are the electrolytic capacitors and diodes the right way around? Are the ICs the right way around? Are any IC leads bent up under the IC body (ie, not in the sockets)? Check again that the regulator is still producing 5V.

If it still doesn't work, turn it off and carefully remove the microcon-troller IC from its socket, then reconnect power. In turn, short pins 1, 3, 5, 9, 11 and 13 of each of the inverter ICs (IC2, IC3) to ground. That should cause the relays to pull in and the LEDs to light.

If it does, the problem lies earlier on – either in the microcontroller or before it. Check that the infrared receiver module is properly soldered in.

A properly function infrared receiver module will have around 5V between output and ground at rest, dropping to about 4.5V when it is receiving a signal from the hand-held transmitter.

If you get this result, the problem almost certainly lies in the microcontroller – more than likely one of its pins not seated properly in the socket.

Where from, how much?

The circuit is copyright © Kits-R-Us. Kits can be purchased from Ozitronics via their website (**www.ozitronics.com**). The complete kit, including the pre-assembled hand-held remote control unit, is $128.70 including GST, postage and handling.

A four-channel "short form" kit (ie, with four relays but otherwise identical) is available from Oatley Electronics (**www.oatleyelectronics.com**) for $79.00 plus P&P. They have 4-relay expansion kits for $16.00 each and, if you need additional remote controls, they are available for $8.00 each. **SC**

Parts List – 12-Channel Infrared Remote Control

1	PC board, 122 x 113mm, coded K142	
1	Remote control unit (Batteries NOT supplied)	
1	Ceramic resonator,12MHz	(X1)
12	Relays, 12Vcoil, SPDT contacts	(RELAY1-12)
4	3-way terminal blocks, PC mounting	
1	DC power jack, 2.5mm	
2	Slide switches, SPDT	(SW1,2)
1	Pushbutton switch	(SW3)
2	IC sockets, 14 pin	(for IC2,3)
2	IC sockets, 16 pin	(for IC4,5)
1	IC socket, 20 pin	(for IC1)
1	3mm screw, 6mm long	(for REG1)
1	3mm nut	(for REG1)

Semiconductors

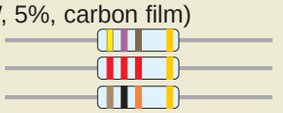
1	AT89C2051 pre-programmed microcontroller	(IC1)
2	74HC04 or 74HC14 Hex Inverters	(IC2,3)
2	ULN2003A Relay drivers	(IC4,5)
1	7805 voltage regulator	(REG1)
1	IR receiver module 'Waitrony' PIC1018SCL	(IRM)
13	5mm Red LEDs	(LED1-13)
1	1N4004 diode	(D1)
1	1N4148 diode	(D2)

Capacitors

1	100µF 25V electrolytic
2	10µF 16V electrolytic
3	0.1µF monobloc (code 104 or 100n)
2	27pF ceramic (code 27 or 27p)

Resistors (1/4W, 5%, carbon film)

1	470Ω	
12	2.2kΩ	
2	10kΩ	
1	10kΩ resistor array 10 pin 9 resistor 'A' type	(RP1)
1	10kΩ resistor array 6 pin 5 resistor 'A' type	(RP2)



More info?

If you would like more info on the Waitrony Infrared Receiver Module it can be downloaded from **http://kitsrus.com/pdf/pic1018scl.pdf**.

Data on the AT89C2051 microcontroller can be found on the Atmel website at **www.atmel.com**.

For any technical problems or questions, contact the kit developer at **frank@ozitronics.com**.

Information on other kits in the Kits-R-Us range is available from the web page at **http://kitsrus.com**.