Remote Control Extender Mk1

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Introduction

The author, like many people, has a second television set in the bedroom, which is connected to the video and satellite equipment downstairs.

However, the pleasure of watching TV while lying in bed is lost by having to go downstairs to stop the video or change channel on the satellite receiver.

This project allows one to take the video recorder and satellite receiver remote controls upstairs, and operate the equipment from there. There is no additional cabling to install, the signal being carried along the existing coaxial aerial cable linking the two rooms.

The unit is in two sections, the infrared receiver that lives upstairs by the TV, and the infrared transmitter that lives downstairs and points at the equipment to be controlled.

The Works

For now, assume that the two sections of the circuit are connected directly (SK1 joined to SK2). The connections to the aerial cable will be described later.

Infrared Receiver

The infrared signal from the remote control is received by D1 (TIL100), which is connected in reversed bias mode. The reverse leakage of this device increased when it is exposed to infrared, causing a variation in the voltage on pin three of IC2.

IC2 (LF351) buffers the signal, which then passes to IC3 via a high pass filter. This filter removes low frequency variations caused by mains lighting. IC3 (LF351) has a gain of about two thousand, which increases the minuscule signal to something usable.

The unit can receive the signals from a remote control up to about three metres away, which will generally be adequate. If necessary the sensitivity can be increased by changing the value of R5 to 10M, however this will not make a huge difference and may make the unit more susceptible to noise.

C4 is not normally required, but may need to be fitted if the unit is prone to RF interference. A value between 2.2pF and 10pF would be suitable here, although this will decrease the sensitivity.

Note that the unit may pick up interference from the line output circuit of some television receivers. Since this is at 16KHz, fitting C4 will have no effect. Filtering out this interference would require a fairly steep filter, which would defeat the objective of trying to produce a simple low cost unit. If the unit is moved one metre away from the TV set the problem disappears.

The output from IC3 is converted to a squared logic signal by IC4 (CA3140), which is configured as a comparator. The output of this is connected TR1 (BC558), which in turn drives TR2 (BC548).

TR2 connects the LED D3 across the power input to the circuit. The purpose of this is to cause pulses of increased current consumption in time with the received infrared, which are in detected by the other section of the circuit. The LED flashes in time with the received infrared.

The circuit is powered from the other section of the circuit via SK1. D2 and C1 ensure that the power supplies to the IC's does not vary significantly when the LED is lit. IC1 produces a power rail at half the main supply level.

The author is aware that infrared receiver IC's are available which will achieve similar results to the above circuit. However these only appear to be available from the larger distributors, and are not likely to be found in the average constructor's junk box. Besides, there is more satisfaction in designing from scratch, rather than just lifting a circuit from a data sheet.

Infrared Transmitter/Power Supply

The variations in supply current to the receiver section cause a varying voltage drop across R20. This is converted to logic pulses by TR5 (BC558). C8, R16 and D8 cause short (8uS) pulses to be applied to the base of TR4. TR4 (BC548) and TR5 (ZTX650) are in a Darlington arrangement, and control the infrared LED.

The infrared LED (D7) has a maximum continuous current rating of 100mA, which would give a range of only a few centimetres. However the device has a pulse rating of about 2A, providing the duty cycle is short and the mean current does not exceed 100mA.

This gives a much-improved range and is the technique used in commercial remote controls, as well as this unit. C7 acts as a reservoir for the LED current, and is charged when the LED is not lit via R13. The current to D7 is limited to about 1.5A by R15; a red LED (D6) is connected across this resistor to give a visual indication that the unit is operating.

The circuit is powered by a small transformer, giving an unregulated supply of about 18V across C16. The supply reaching the infrared receiver section will be about 13V. A 100mA transformer is adequate since the current consumption is only a few milliamps when the unit is idle.

RF Connections

The units are connected to the aerial cable as shown in the interwiring diagram.

The DC voltage is isolated from the TV/video equipment by C9 and C10. This is a silver mica component which gives good performance at UHF frequencies. The high frequencies are blocked by L1 to L4, which prevent the circuit loading the signal.

There is inevitably some slight loss to the UHF signal; this has not been measured due to the author not having suitable equipment! No picture degradation occurred with the prototype, although problems may be experienced in poor reception areas.

Construction

For convenience the PCB's for the two parts of the circuit are supplied in one piece. The first job is to cut this PCB in half. Fix the PCB to a bench or table with a small G-clamp, and cut along the dotted line using a hacksaw fitted with a fine blade. The four fixing holes in each section should now be drilled out to 3mm.

The PCB overlay is shown in fig **. There is nothing out of the ordinary about the PCB assembly - simply fit the components in the usual size order. The IC's may be fitted in sockets, but since they are low cost devices this is not really necessary. Terminal pins should be used for the off-board connections. Do not forget the two links on the receiver section.

The LED's and infrared photodiode are mounted in line with the edge of the PCB, about 10mm above the surface. This should be visible in the photographs. Check the height of the larger electrolytic capacitors, it may be necessary to lay these components on their sides or obtain small modern devices.

The general layout in the two cases can be seen in the photographs.

The prototype infrared receiver is housed in a plastic case 110mm * 61mm * 30mm, which was purchased from Tandy. However, cases of this size do not appear to be readily available by mail order. It would probably be better to obtain something larger, such as a type MB2, which is readily available and will match the transmitter case. A metal case may reduce the probability of interference from the TV set (this has not been tested), however this would be more difficult to machine.

The receiver case has a rectangular window in one end, approx. 30mm * 14mm. Remove any PCB mounting guides from this area. A piece of red filter material is then fitted behind the cut-out, in the prototype this was held in place by the PCB and LED. If the filter has a non-reflective surface this should face outwards. The PCB is positioned in the case immediately behind the window, and fitted with M3 screws, nuts and spacers. The two coax sockets are fitted on the opposite end of the case to the window.

The infrared transmitter is housed in a type MB3 plastic box, 118mm * 98mm * 45mm. A similar rectangular window is made in one end, 50mm * 14mm. The red filter material is again retained by the PCB and LEDs. The PCB is fitted behind the window, with the red LED in the centre of the window. The transformer and connectors may now be fitted as shown in the photograph. The hole for the power cable should be fitted with a grommet, and the cable secured. The transformer should ideally be fitted with nylon screws.

Cutting tidy rectangular holes in plastic cases is not easy! The author drilled a series of small holes around the outside, removed the centre section, and then filed the edges smooth - a time-consuming approach. If a fretsaw is available this could significantly reduce the amount of filing required. Do not rush this section if you want to achieve a tidy job.

The red filter material used in the prototype was obtained from RS, however any type should be suitable. Thin material (0.5 - 1.0mm) is ideal since this can be cut with a pair of scissors. Test that the material chosen does not block infrared, by holding it in front of a remote control, and checking that the range is not significantly reduced.

The units can then be wired up as shown in fig **. The two core mains flex is joined to the transformer leads with a choc-block connector. The secondary leads from the transformer connect to the terminals on the PCB as shown.

The screen connectors of the two coax connectors should be linked with a heavy piece of wire - the braid from a piece of screened cable is suitable. Connect the silver mica capacitor directly between the centre conductor pins.

The inductors consist of about five turns of enamelled wire, approx. 22 SWG. Cut four 5" lengths and wind the six turns round the shank of a 3mm drill bit, towards one end of the wire. Connect the inductor wires as shown in fig **, with the coil towards the coax sockets.

Testing

No setting up is required, testing merely involves connecting the two sections and seeing if they work! When testing, ensure that the light from the transmitter does not reach the receiver, or feedback will cause odd results.

Connect the two sections with a good length coaxial aerial cable between the Link sockets. Alternatively a length of two-core cable may be used; this may be soldered directly to the pins on the PCB's for convenience.

Connect the transmitter section to the mains and position it such that it is pointing at a video recorder, from about 2 metres away. Take the receiver and the video's remote control into another room, and try using the remote control about 2 metres from the receiver.

When the remote control is operated the red LEDs on the receiver and transmitter should flash. If the channel change buttons are operated, the corresponding changes should be heard from the TV in the other room.

Fault Finding

If the unit does not work, there are a few points to check before embarking on a full faultfinding procedure.

First check the power supply voltages. There should be about 18V across C6 and C7, and around 15V at SK2. The power supply rail in the receiver should be about 13V, and the voltage on pin six of IC1 should be half this.

Check the polarity of D1, this device is used in reverse biased mode, and should have around 6V across it when the unit in inactive. Measure the voltage on pin six of IC2, if the voltage is around one volt or less then D1 is probably backwards. If the input of IC2 is touched with a finger the red LEDs should light or flicker. Make sure the infrared sensitive face of D1 is towards the window - with the half-round types available from Maplin (TIL100 equivalent) this the curved side.

Check that the LEDs are the right way round. The details in catalogues and data sheets can be confusing when it comes to identifying the polarity of LEDs, and different manufacturers use different arrangements. However, there is a foolproof method. Look at the innards of the LED from one side, the larger piece of metal is the cathode and the smaller bit is the anode. The author always uses this technique and it hasn't failed him yet!

Check the aerial fly-leads for continuity, and short circuits. One of the two purchased by the author for these units was found to be open-circuit on the centre core!

If all this checks out, it's down to good old-fashioned fault finding procedures. The circuit is not complicated so this should not take too long. As mentioned before, make sure the infrared output of the transmitter does not reach the input of the receiver.

Installation and Use

In the interests of safety, all equipment should be from the mains before making any connections.

The receiver should be positioned about one metre from the television, in clear sight of the normal viewing positions. Unplug the aerial cable from the TV, and connect it to the Link socket of this unit. Using a standard aerial fly-lead, connect the TV socket on this unit to the aerial socket on the TV.

The transmitter positioning is more involved, and is left to the ingenuity of the individual constructor. The unit needs to be located so that the infrared output reaches the front of the equipment to be controlled. In addition the cables need to reach (or be extended), and the installation should look tidy if peace is to be maintained! The prototype was placed on a cabinet on an adjacent wall, and although the infrared reached the equipment from an angle of about 45 degrees no problems were experienced.

It may be easier in some cases to mount the infrared LED remotely, and link it to the electronics with a length of thin two core cable. Two or three LEDs could be wired in series, and placed near the receivers on the equipment to be controlled.

Some constructors may wish to try bouncing the infrared off a wall mirror at the opposite side of the room, although the distances involved may be too great.

There will presumably already be a Y-splitter connected to the output of the video recorder, with its outputs connected to the local and remote TV sets. Unplug the lead to the remote TV, and connect it to the Link socket on the infrared transmitter unit. Connect the Video socket on the infrared transmitter to the splitter.

Note that the infrared transmitter and infrared receiver must be at opposite ends of the link cable. There must be no splitters, attenuators, filters or other equipment between the two units, since this will block or load the DC path.

Finally connect the system to the mains (via a 3-Amp fuse) and test it.

If the LED on the receiver remains lit, it is picking up interference from something, try moving it further away from the TV set or other electronic equipment.

The receiver should respond from a distance of about three metres, if the remote control is aimed reasonably accurately. The range will vary somewhat with different makes of remote control. If the signal is weak the LED may still flash, but the remote equipment will fail to respond, this is caused by the receiver picking up only part of the signal. Try moving closer or putting new batteries in the remote control.

The transmitter should control the equipment from a distance of three metres or more, although this will drop off as the angle increases. Again this will vary with different equipment.

There should be no reduction in picture quality with this system installed. In areas of very poor reception it may be preferable to install a separate cable for this system, thin two-core cable (used for doorbells and speakers) is ideal. In this case, omit L1 to L4, C9, C10, and coax sockets from the units. Fit spring loaded loudspeaker terminals or similar, connected directly to the PCB's.

Hopefully this unit will allow you to be even more lazy, just don't forget to take the remote control with you! Happy viewing.

Parts

Resistors (0.25W, 5% or better)

R1,2,6	10K
R3,7	100K
R4,11,16	1K0
R5	2M2
R8,10,18	4K7
R9,19	22K
R12,13	220R
R14	22R
R15	10R
R17	330R
R20	470R

Capacitors

C1	470u 16V
C2	10u 16V
C3	1n0
C4	(See Text)
C5	10n
C6	1000u 25V
C7	2200u 25V
C8	2n2
C9,10	220p Silver Mica

Semiconductors

D1	IR Photodiode (Maplin YH71N)
D2,4,5	1N4001
D3,6	Red LED
D7	IR LED (Maplin YH70M)
D8	1N4148

TR1,5	BC558
TR2,4	BC548
TR3	ZTX650

IC1	741

IC2,3	LF351
IC4	CA3140

Miscellaneous

PCB
12-0-12V 100mA Transformer
2 Cases (see text)
Red Filter
4 Co-ax Sockets
22 SWG Enamelled Wire for L1-L4
2 Aerial Fly-Leads or Leads to Suit
2 Core 3 Amp Mains Flex
13 Amp Plug with 3 Amp Fuse