Kill those pesky TV commercials

Remote infrared TV sound control

Designed to relieve the long-suffering TV viewer from painful, brain-killing advertisements, our TV Sound Control provides remote control of volume. It gives eight steps of control, including full off, when total silence is called for. Give yourself a break and relieve advertising tedium today.

by JOHN CLARKE

To many commercial enterprises, television advertising has become an accepted means to persuade consumers to use or purchase their products. This acceptance is not necessarily mutual as far as the consumers are concerned. Of course there are alternatives to watching TV advertisements:

Viewers can opt to only watch non-commercial stations such as the ABC or multicultural television so that total protection can be had from advertisements. The only problem that can occur is what to do when a suitable program is being shown on a commercial station? Is it worth the torture of advertisements?

One alternative is to initiate conversation with fellow viewers during the advertisements, however, there is a drawback. The conversation may prove far more interesting than the television program itself, rendering the TV redundant.

Another means to escape the advertising is to make a snack at every commercial break. This does have its rewards, but with the number of commercial breaks at the present time, the practice can lead to obesity. No, if your set does not already have remote control, the only practical alternative is to build our TV Sound Control. In this way the volume of the commercial can be turned off remotely and fast; a vital and important feature. In fact, the advertisements may be more interesting without sound and certainly more humorous.

Of course the TV sound control is not only just an advertisement volume attenuator. Eight volume steps are available to adjust the sound level to a comfortable listening level. The actual level may need to be altered from time to time due to variations in ambient noise in a household situation and this is where the sound control becomes very useful. Just a touch of the button and the volume is adjusted.

The transmitter is housed in a compact plastic utility case that fits easily in the hand. Just press the down button to kill those commercials!

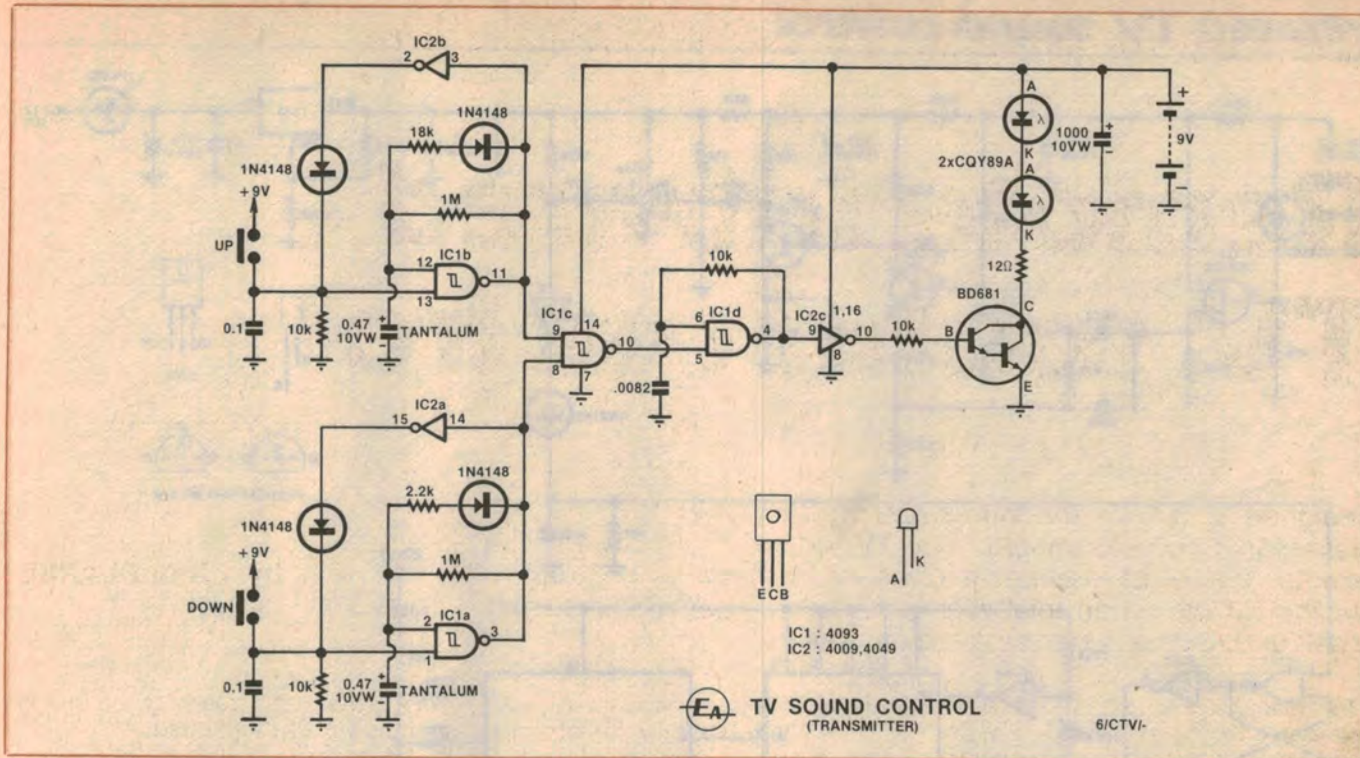
Features

The TV sound control comprises two separate circuits; the transmitter and receiver. The transmitter is housed in a small plastic utility box and contains two control buttons, one for increasing the volume, UP, and the other for decreasing the volume, DOWN. It is completely self contained, powered with a small battery and transmitting with infrared light to the receiver. The receiver is housed within the TV cabinet and is powered from the low voltage supply of the TV set. The infrared receiver diode is mounted at the rear of the TV chassis so there is no need to drill a hole in the front of the TV and mar the finish.

Two relatively simple connections need to be made to the TV set. One is to break into the volume control of the audio amplifier circuit. This is easily found by locating the volume control and finding the wiper wire. The second connection is to pick up the low voltage supply to the TV circuitry and can be found by referring to the circuit diagram supplied with the TV set.

In use, the transmitter is located on the arm of the chair within easy reach of the viewer. When an advertisement intrudes the DOWN button can be pressed and almost immediately the sound is completely attenuated. When the adverts have finished, the UP button is pressed and the volume increases until the required volume is reached whereupon the button is released.

The eight volume steps can be chosen by either: a momentary press of the Up or Down button, whereby the volume will alter by one step only; or by holding the button, the volume will glide from one step to another at a 0.5 second rate.



The transmitter circuit uses three gated oscillators and a Darlington transistor driving a pair of infrared LEDs.

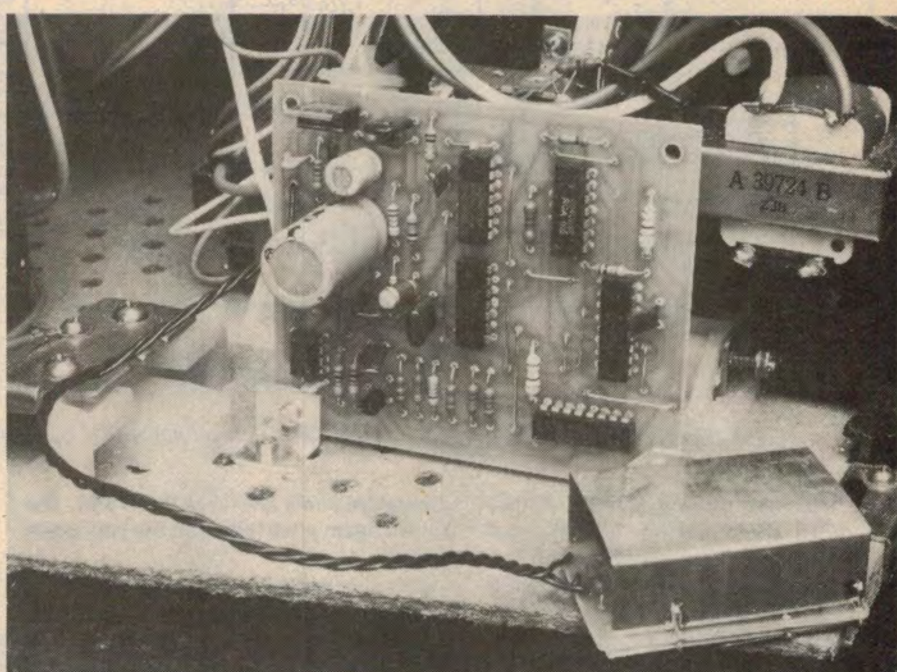
When the volume reaches the extremes, either maximum or minimum volume, the volume will stay at that level until a change in volume direction is selected.

At first switch on of the TV set, the sound control will automatically reset to half volume. It is envisaged that the normal listening level will be first adjusted on the TV set volume control, and any further volume adjustments made solely with the remote control.

Attenuation at the highest volume level can be regarded as 0dB. From there down the attenuation increases in approximate steps of −3, 4, 5, 6, 7, 8dB and complete attenuation on the last step. The reason for this apparently strange series of attenuation steps rather than having, say, 3dB per step is that greater control is desirable at higher volume levels.

Infrared signals

The transmitter provides two types of signals: a 10kHz signal of 5ms duration for an UP code and a 10kHz signal of 1ms duration for a DOWN code. So that the TV volume will glide up or down through each attenuation level, the 10kHz signals need to be repeated at regular intervals whenever the UP or DOWN buttons are pressed. In addition it is necessary that a complete five or 1ms pulse is generated regardless whether the UP or DOWN button is pressed or released during this transmitting interval. Without this feature, an UP signal may be truncated to the length of a DOWN signal and be interpreted incorrectly as a DOWN code by the receiver circuitry.



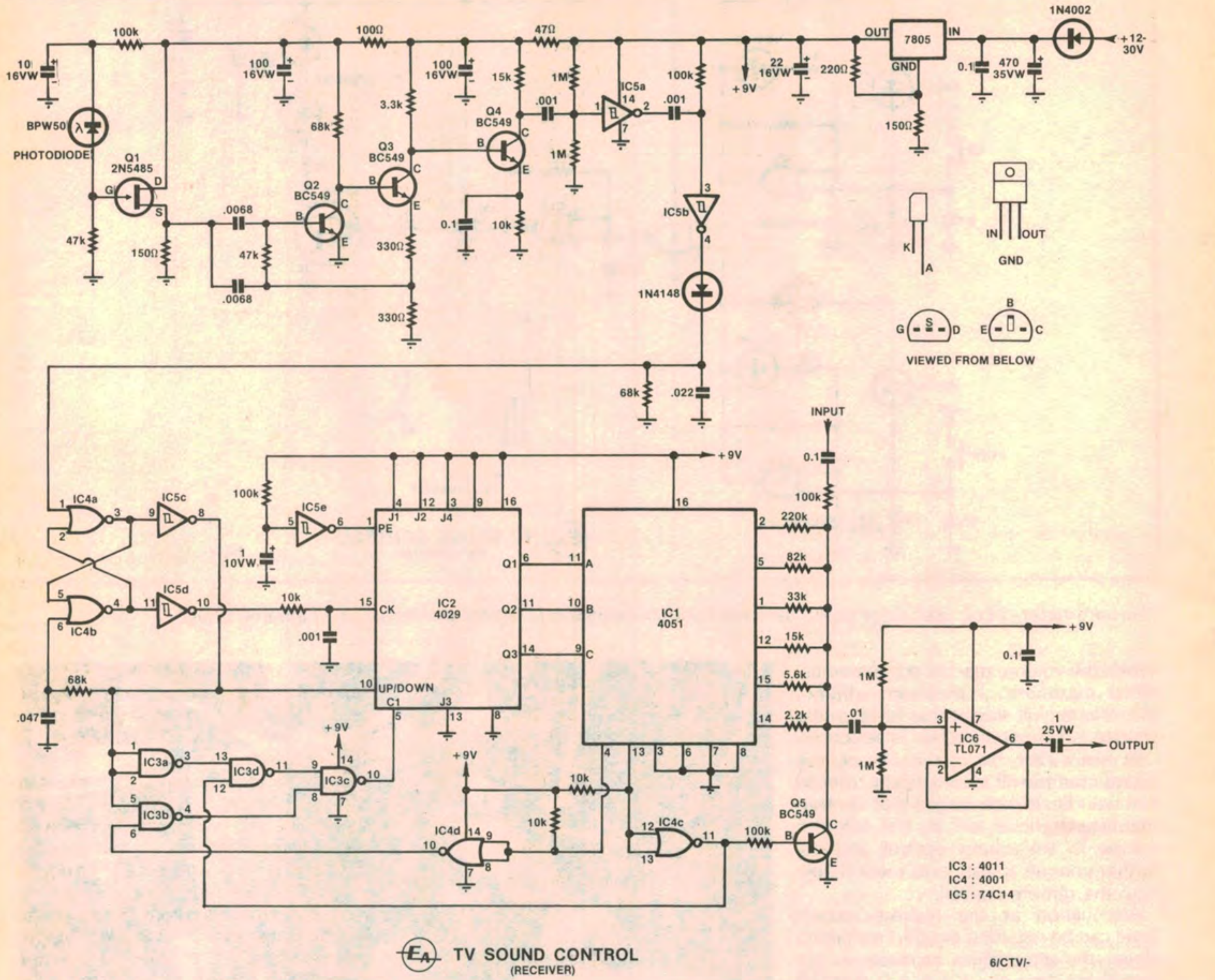
This photo shows the amplifier and demodulator boards mounted in a TV chassis. Metal shielding is fitted to the amplifier module to protect the circuit from line flyback pulses generated by the TV receiver.

The receiver needs to reliably decode the transmitted signals and switch attenuating resistors to provide the requisite volume.

The circuit

The total circuitry for this TV sound control is relatively simple and low in cost. The hand held transmitter uses a mere handful of components comprising two CMOS ICs, a Darlington transistor and a couple of infrared LEDS plus a few resistors, capacitors and diodes. The receiver includes six low cost ICs, a photodiode, voltage regulator and a few resistors, capacitors and diodes.

Let's look at the transmitter circuit first: There are three gated oscillators in this



The receiver consists of an amplifier (Q1-Q4), demodulator (IC2-IC5), and audio attenuator (IC1, IC6).

circuit, each comprising Schmitt NAND gates. IC1d provides the 10kHz signal and is enabled, ie, it runs, when pin 5 is high. This only occurs when either pin 8 or pin 9 of IC1c is low. IC1b provides the low 5ms pulse, suitable for an UP signal. Similarly, IC1a provides a low 1ms pulse suitable for a DOWN signal.

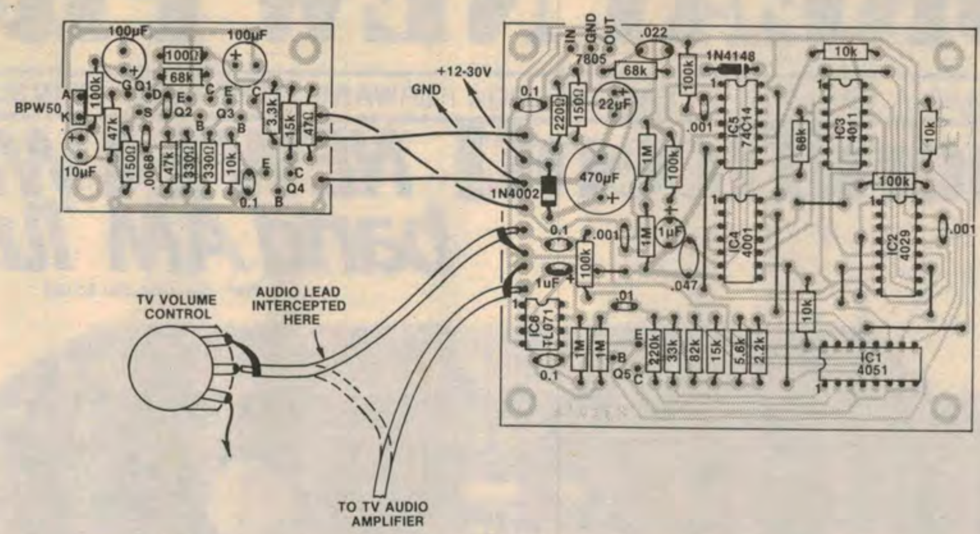
To see how these Schmitt NAND gate oscillators function, we shall take IC1d as an example. Assuming pin 5 is high and the .0082μF capacitor is initially discharged, the NAND gate now functions as an inverter with pin 6 low and the output high. The capacitor now begins to charge via the 10kΩ resistor. When the capacitor voltage reaches the high threshold of the Schmitt, the output changes to a low state and the capacitor now begins to discharge through the 10kΩ resistor. When the capacitor voltage reaches the low threshold, the output again goes high and the sequence repeats.

With the capacitor and resistor values specified, the oscillator runs at 10kHz. Whenever pin 5 goes low, the output of IC1d is forced to go high and remain in that state. This provides a simple method of gating the oscillator on and off.

IC1b oscillates in a similar manner to IC1d, except that two separate charging and discharging paths for the 0.47μF capacitor are provided. When the output, pin 11, is high, the capacitor takes about 0.5 seconds to charge via the 1MΩ resistor. This is the period in which the 10kHz oscillator is gated off. When the output of IC1b is low, the capacitor can discharge through the 1MΩ resistor and the 18kΩ resistor and forward-biased diode. This allows the capacitor to discharge quickly providing the 5ms low signal to gate on the 10kHz oscillator.

To enable this oscillator, the second input of IC1b, pin 13, must be brought high and this can be done in two ways. Firstly, to begin the oscillator sequence, the Up button must be pressed, which pulls the input high. The switch contact debounce circuit consists of the 0.1μF capacitor and 10kΩ resistor. (The resistor keeps pin 13 low when the Up switch is open circuit.) The oscillator starts and after about 0.5 seconds the output goes low. IC2b inverts this to a high which keeps pin 13 high via the forward-biased diode. This second means of enabling the oscillator ensures a complete 5ms low output regardless of when the Up switch is released.

The Down oscillator, IC1a, operates in



Above: parts overlay and wiring diagram for the receiver circuitry.

a similar manner to the Up oscillator with the exception that the discharge time is reduced to 1ms by using a 2.2kΩ resistor.

The output from IC1d, the 10kHz oscillator, is inverted with IC2c which provides a normally low signal when IC1d is gated off. This inverter drives a BD681 Darlington transistor via the 10kΩ resistor. The Darlington provides the necessary gain and high current capability to drive the LEDs while the 12Ω series resistor limits the current to prevent damage to the LEDs.

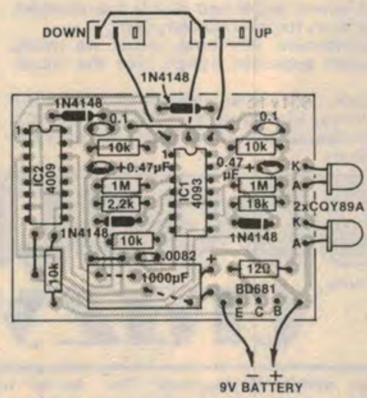
Even so, the peak current is about 300mA which is more than the battery could supply on its own. Most of this peak current is supplied by the 1000μF capacitor across the battery. When the buttons are not being pressed, the current drawn from the battery is very low, typically around 10μA. Consequently, an on/off switch is unnecessary and even with frequent usage, the battery should last for more than a year.

The infrared LEDs used are either Philips CQY89A or Siemens LD271. These are similar in appearance to the more usual red LEDs, except that they are encased in a dark blue epoxy encapsulation which is translucent to infrared radiation.

Let us now turn to the receiver circuit which consists of three sections: the amplifier, demodulator and the audio attenuator.

Infrared light generated by the transmitter LEDs is received by an infrared photodiode. This is a Philips BPW50 and is specifically designed to match the CQY89A LED. The diode also has an integral infrared filter which almost completely rejects visible light.

The photodiode has its cathode connected to the 9V rail via an RC decoupling network, while the anode is connected via a 47kΩ resistor to ground. In operation, the photodiode acts as a current source such that it generates a current proportional to the incident light. The current signal is converted to a voltage by the 47kΩ resistor.



Switch connections for the transmitter are made to the common and normally open terminals, as marked on the switch body.

The signal from the photodiode is fed to the input of Q1, an N-channel FET, connected as a source follower. The gain of this stage is about 0.5.

Output impedance of the FET stage is about 100Ω and this drives a bandpass filter consisting of transistors Q2 and Q3. The centre frequency of the filter is about 10kHz and it has a Q of 10; ie the bandwidth is 1kHz. This bandwidth is wide enough to pass the 10kHz signal from the transmitter, even allowing for some mistuning, yet effectively eliminates interference from other sources (eg fluorescent lights).

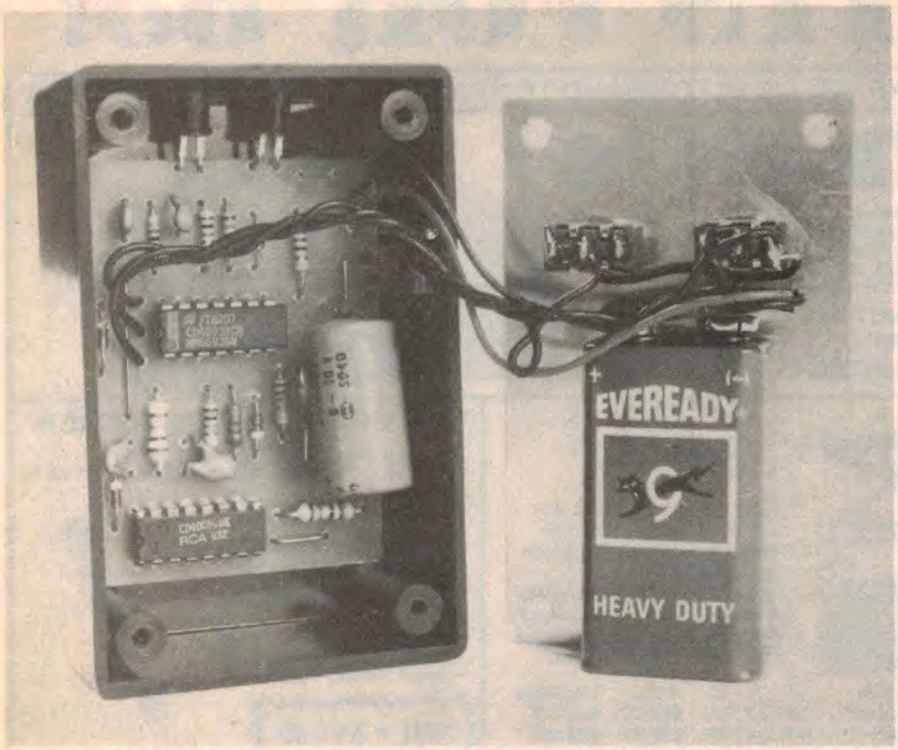
Disregarding the two .0068μF capacitors for the moment, Q2 and Q3 form a two-stage inverting amplifier. Both transistors operate as common emitter amplifiers, with the second stage providing two separate outputs: one from the junction of the two 330Ω resistors and the second from Q3's collector. The first output has a low impedance and is used to drive the filter and to provide DC feedback via the 47kΩ resistor to bias Q2.

The filter components are the two .0068μF capacitors and the 47kΩ bias resistor (for Q2) which, together with the low output impedance of the previous FET stage, determine the centre frequency and Q of the filter.

The collector output of Q3 provides an amplified version of the filter output. This output is DC-coupled to the next stage which consists of transistor Q4 in another common emitter amplifier circuit. Gain of this stage is at least 150. A 0.1μF emitter bypass capacitor is included to provide further attenuation of unwanted low frequency signals.

Following Q4, the signal is AC-coupled to IC5a which is a CMOS Schmitt trigger. When the signal peaks from Q4 exceed the upper and lower thresholds of the Schmitt trigger, the device will square up the signal and provide a constant level 10kHz square wave output. If the input signal drops below the trigger thresholds, the 10kHz signals from the output will cease and the Schmitt will remain in its last state, either high or low. IC5b is capacitively driven from IC5a and has a normally low output due to the 100kΩ resistor connected to +9V at its input.

To convert the presence or absence of a 10kHz signal into a simple high or a low signal, the output of IC5b is filtered with the .022μF capacitor connected via



View inside the transmitter case.

the 1N4148 diode. This allows the capacitor to charge when the output of IC5b is high and the 68kΩ resistor dischages the capacitor when IC5b is low. Providing there is a 10kHz signal the capacitor voltage will be high. When there is no signal, the capacitor is discharged.

The output of the rectifier filter will appear as a pulse on pin 1 of IC4a and with the filter time constant used the duration of the pulse will be approximately the same as the signal originally transmitted. As noted above the "down" pulse is about 1ms long while the "up" pulse is about 5ms long. This difference in pulse length is decoded by NOR gates IC4a and IC4b (connected as an RS flipflop), and the inverter IC5c.

Normally both inputs to the flipflop, pin 1 of IC4a and pin 6 of IC4b, are low, but when a pulse from the filter arrives the flipflop is set, with the output of gate IC4a low and the output of gate IC4b high. The flipflop would remain in this state if it were not for the resistor at the output of IC5c charging the 0.047μF capacitor at the input of IC4b, pin 6, to form a time delay reset.

The reset for the flipflop occurs about 2.5ms after the leading edge of pin 1 goes high which is after a down pulse would finish and before an up pulse would finish. So if an up pulse was received the output of IC4a would be low since pin 1 will still be high immediately after the flipflop is reset. If a down pulse is received however, pin 1 would be low by the time the flipflop is reset and the output of IC4a will therefore be high.

The leading edge of the reset pulse is also used to clock IC2, a binary up/down counter, and the output of IC5c is connected to the up/down input of the counter. Since the output of IC5c will be low for a down pulse and high for an "up" pulse after the reset signal, the counter will count up for an "up" pulse and down for a "down" pulse.

The 10kΩ resistor and .001μF capacitor at the clock input of the counter delays the reset pulse slightly so that the up/down signal will have been present for an appropriate time before the counter is clocked.

Naturally, the most important part of the remote control is the audio attenuation circuit which consists of an eight channel analog multiplexer, IC1, and an op amp, IC6. The attenuation is passive, performed by a voltage divider consisting of a 100kΩ resistor in series with the input signal and one of six shunt resistors or a transistor (for full attenuation), which are individually selected by the multiplexer.

We estimate that the current cost of components for this project is approximately

$40

This includes sales tax.

Whenever pin 13 of IC1 is selected, driving the input of IC4c low and consequently the output high, the transistor is switched on to shunt the audio signal to ground. At the highest volume level, pin 4 is low and no resistor is switched in to attenuate the signal. This output when low drives the output of IC4d high.

IC4d and IC4c are used to detect the maximum volume level and minimum volume level respectively and these are connected to a gating arrangement formed by the NAND gates IC3. These gates prevent the volume level from changing from the highest to the lowest level or from the lowest to the highest level. IC3 therefore prevents further clocking in the same direction if the maximum or minimum volume levels have already been reached.

If the counter is being clocked up and it is already at the highest level, the output of gate IC3b will go low forcing the output of gate IC3c high and inhibiting counting. Similarly if the counter is being clocked down when it is already at its lowest level, gate IC3d will go low and inhibit counting.

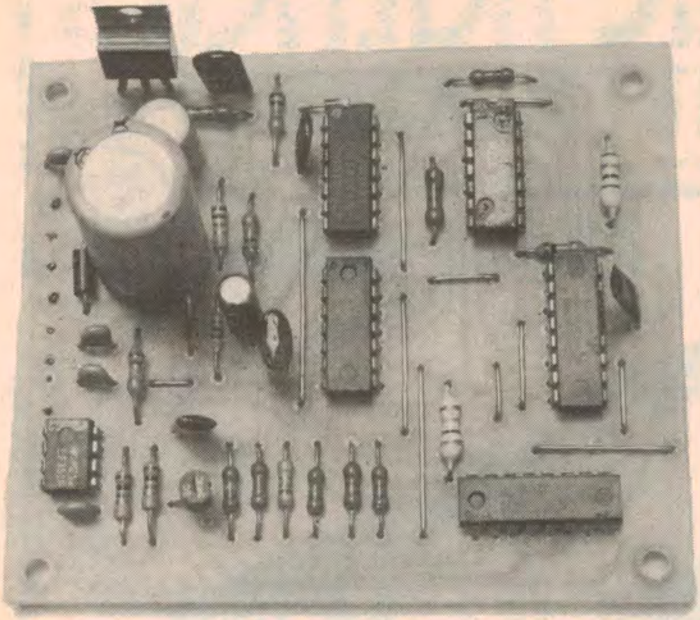
The attenuating signal from IC1 is buffered by a TL071 op amp connected as a voltage follower to provide unity gain. DC biasing of the op amp is provided by two 1MΩ resistors, one from ground and the other from the positive rail. So that this DC level will not upset the attenuator, capacitive signal coupling is used. The output of the op amp is also capacitively coupled to remove the DC bias.

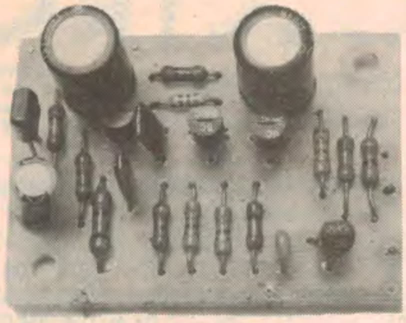
As mentioned previously, power for the receiver is derived from the main DC (12-30V) supply of the TV set. This is filtered with a 470μF capacitor and regulated with a three terminal regulator. Although a 5V regulator is used, the output voltage is around 9V and this voltage increase is achieved as follows: Since the regulator supplies 5V between the GND pin and output, there will be 23mA flowing through the 220Ω resistor. This current plus the quiescent current from the GND terminal (about 4mA) produce about 4V across the 150Ω resistor. Consequently when the 5V of the regulator is added to this, the output voltage is about 9V.

The 0.1μF capacitor at the input of the regulator ensures stability, while the 22μF capacitor at the output provides improved transient response of the regulator.

Construction

Construction of the circuit involves three printed cicruit boards. One PCB coded 83tv1c is used for the transmitter





The demodulator (left) and amplifier PCBs are shown here approximately actual size.

and is housed in a plastic utility box measuring 28 × 54 × 83mm. Of the two other PCBs, one coded 83tv1b and measuring 37 × 53mm is the amplifier while that coded 83tv1a and measuring 79 × 93mm is the decoder.

Start construction on each PCB by placing all the links, resistors and diodes into position. Make sure that the diodes are pointing in the correct direction. When soldering the ICs make sure that they are oriented correctly and that the power supply pins are soldered first, with the barrel of the soldering iron connected to the ground track of the PCB. Again when placing the transistors and capacitors in position ensure they are oriented correctly. The 1000μF capacitor in the transmitter is bent over and lies across the PCB, so ensure that there is enough lead length to facilitate this.

The 0.47μF tantalum capacitors in the transmitter are bent over sideways so that the 9V battery can be placed on top of the PCB and clear the lid. In fact this is the way in which the PCB is held within the case. The battery provides very little clearance between the lid and so holds the PCB in place. Holes for the two IR LEDs should be drilled as well as those for the switches, after the Scotchcal label has been placed onto the front panel.

Wiring to the transmitter switches can now be completed and the switches secured to the lid. Note that these are oriented sideways to allow clearance for the battery. Place the PCB into the case, insert the battery with some foam insulation, and screw the lid down. The transmitter is now complete.

When the receiver PCBs have been completed, the TV sound control is ready to be tested. It is not recommended that you test the unit within the TV set initially since many TV sets have a live chassis, rendering any testing in this situation dangerous. Consequently it is advisable to ensure the circuit is operating as expected before installation into the TV set.

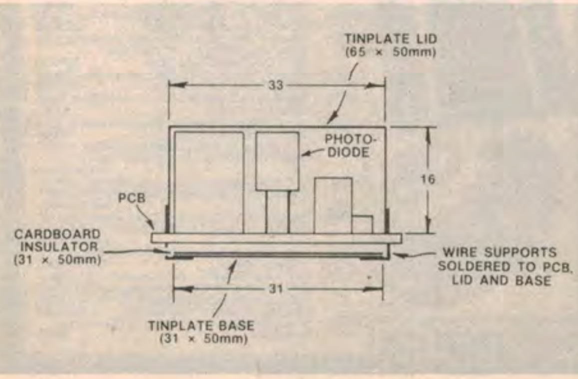
Wire the interconnecting leads between the two PCBs and connect a voltage between 12 and 30V DC from a suitable power supply to the decoder PCB. Check that the voltage regulator is supplying around 9V and that all the ICs are receiving power.

To check that the receiver is operating correctly and attenuating the signal, it will be necessary to connect in a sound source and monitor it after attenuation. A suitable source would be from the eaphone socket of a radio, or a tone from a function generator connected to the audio input of the decoder PCB. Monitoring can be done by listening with an earphone at the audio output of the decoder or by amplifying the signal and listening with loudspeakers. Alternatively, the tape monitoring facilities provided on most amplifiers can be used by switching to tape monitor and connecting the audio output to the Tape input and the audio input to the Tape output.

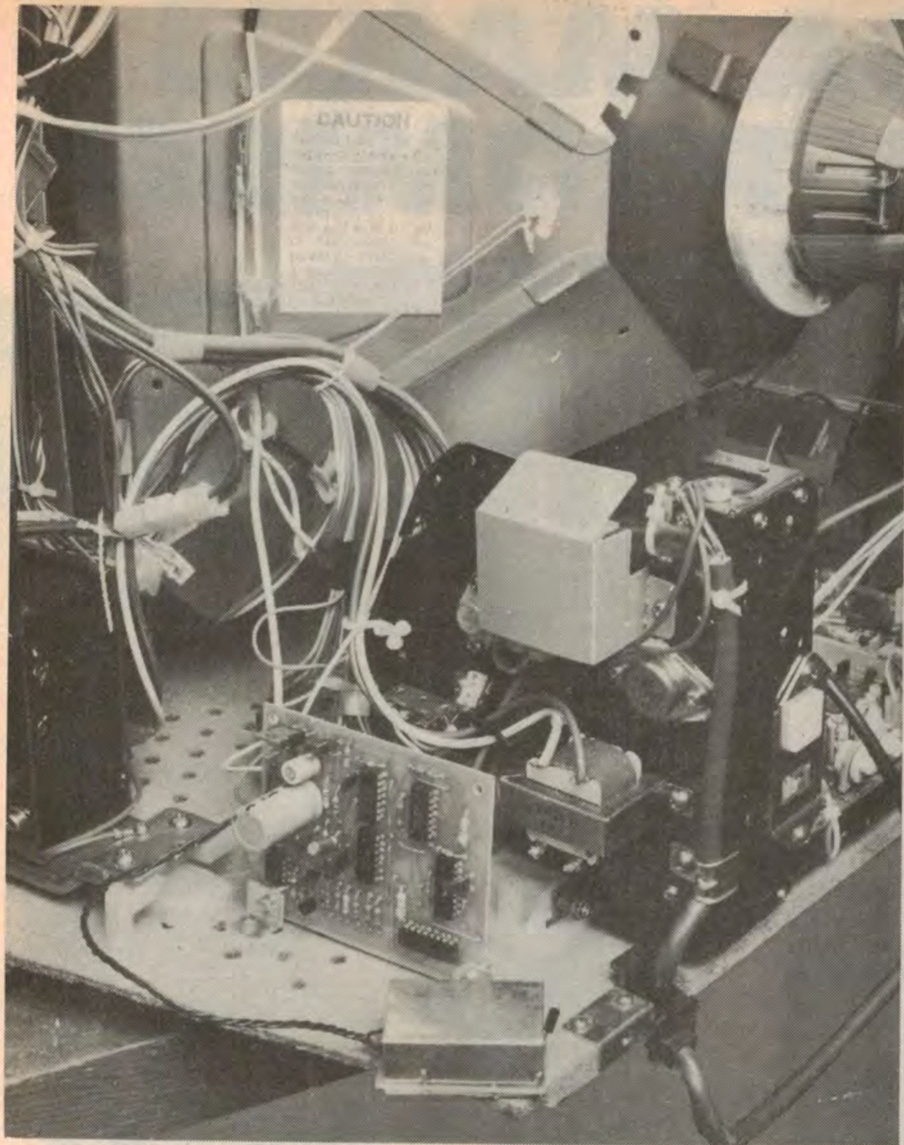
When the Down button is pressed, the receiver should attenuate the signal at a rate of one step every 0.5 seconds. Pressing the Up button should increase the volume until maximum volume is reached. At first switch-on of the receiver the volume should be at mid volume setting with pin 12 of IC1 selected. Pin 9 of IC1 should be low and pins 10 and 11 high. At maximum volume, pins 9, 10 and 11 are all high and pin 4 is selected, while at minimum volume the pins are low and pin 13 is selected.

If the unit does not appear to operate correctly, check all the PCBs for broken or shorted tracks, incorrectly oriented components, bad solder joints and power supply connections to the ICs. If the sensitivity appears low, the gain can be increased by increasing the value of the 47kΩ resistor at the anode of the photodiode. Values of up to 470kΩ can be used. Do not increase the value to such an extent as to cause the circuit to trigger on ambient light.

The amplifier PCB requires a shield to protect the sensitive circuitry from the high level of line flyback pulses generated by the TV circuitry which would otherwise render the circuit in-



This diagram shows how the amplifier module is shielded using tinplate sheeting. Note that shielding is used on both sides of the PCB.



Power for the receiver circuitry is derived from a suitable 12-30V supply within the TV set. The photodiode should face through a hole in the rear of the cabinet, so that it receives energy reflected from the wall.

operative. We used tinplate sheeting salvaged from a tin can to make the shield. Use the diagram to aid you in construction of the shield. Wire links are used to mechanically support the shield above and below the PCB and these pass through the pads provided. There are three pad positions on each side of the board and all are connected to the ground rail rendering the shield earthed when soldered to these points.

The decoder PCB can now be installed into the TV cabinet. Before removing the rear cover of the TV set ensure that the power plug is removed from the wall socket to prevent electric shock. Note that many modern TV sets have a live chassis. Do not work on these sets when they are switched on under any circumstances. The PCB should be secured to the chassis with suitable angle brackets in a position that is close to the screened leads from the volume control potentiometer. We mounted our decoder board vertically on two angle brackets and intercepted the audio lead from the wiper of the volume control at a point close to the decoder PCB.

Depending upon the positioning of the TV set, whether it is free standing with wall space behind it or wall mounted, the shielded receiver will need to be mounted at the front of the TV set or preferably at the rear (provided that light from the transmitter can be reflected from the wall behind a free standing TV). The receiver should be supported using suitable brackets and screws onto a convenient structurally solid point within the TV. With a front mounted receiver, it should be located so that a 4mm hole can be drilled in front of the TV opposite the IR photodiode and preferably in an inconspicuous position. Similarly for a rear mounted receiver, a 4mm hole should be drilled for the photodiode. The photodiode should not protrude from this hole.

PARTS LIST

1 PCB coded 83tv1a, 79 × 93mm
1 PCB coded 83tv1b, 37 × 53mm
1 PCB coded 83tv1c, 61 × 45mm
1 plastic utility box 28 × 54 × 83mm
1 216 9V battery and battery clip lead
1 tinplated steel sheet, 53 × 120mm
2 C&K momentary contact switches (C&K preferred)

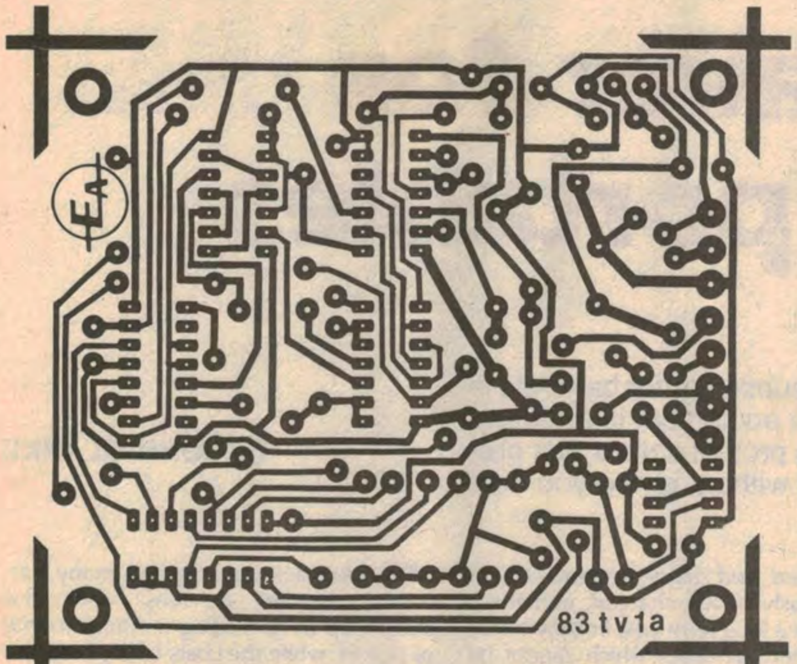
SEMICONDUCTORS
1 4051 single eight-channel analog multiplexer/demultiplexer
1 4029 binary decade up/down presettable counter
1 74C14 hex Schmitt trigger
1 4011 quad two input NAND gate
1 4001 quad two input NOR gate
1 4093 quad two input NAND Schmitt trigger
1 4009, 4094 hex inverting buffer
1 7805 positive 5V three terminal regulator
1 TL071, LF351, CA3140 op amp
1 2N5485 N-channel FET
4 BC549 NPN transistors
1 BD681, BD263 NPN Darlington transistor
2 CQY89A IR LEDS
1 BPW50 photodiode
5 1N4148, 1N914 small signal diodes
1 1N4002 1A rectifier diode

CAPACITORS
1 1000μF /10VW pigtail electrolytic
1 470μF/35VW PC electrolytic
2 100μF/16VW PC electrolytic
1 22μF/16VW PC electrolytic
1 10μF/16VW PC electrolytic
1 1μF/25VW PC electrolytic
1 1μF/10VW PC electrolytic
2 0.47μF/10VW tantalum
6 0.1μF monolithic ceramic
1 .047μF metallised polyester
1 .022μF metallised polyester
1 .01μF metallised polyester
1 .0082μF metallised polyester
2 .0068μF metallised polyester
3 .001μF metallised polyester

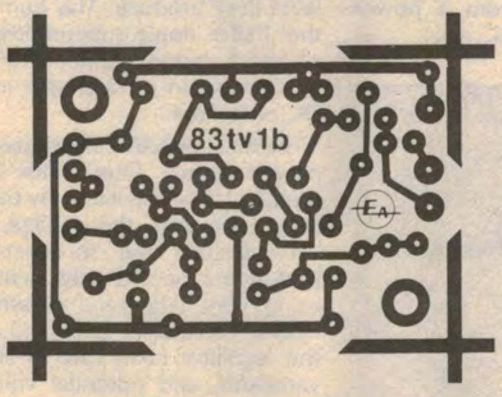
RESISTORS (1/4W, 5%)
6 × 1MΩ, 1 × 220kΩ, 5 × 100kΩ, 1 × 82kΩ, 3 × 68kΩ, 2 × 47kΩ, 1 × 33kΩ, 1 × 18kΩ, 2 × 15kΩ, 8 × 10kΩ, 1 × 5.6kΩ, 1 × 3.3kΩ, 2 × 2.2kΩ, 2 × 330Ω, 1 × 220Ω, 2 × 150Ω, 1 × 100Ω, 1 × 47Ω, 1 × 12Ω.

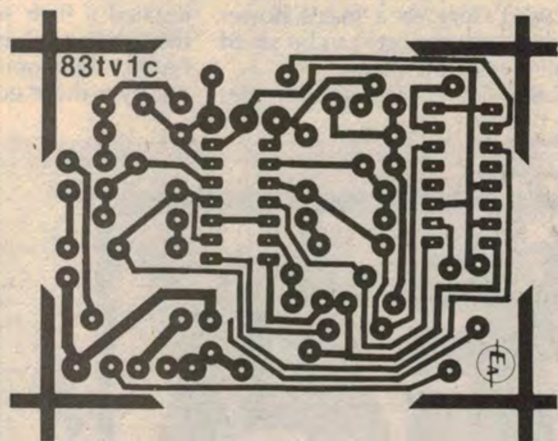
MISCELLANEOUS
Hook up wire, solder, mounting screws, brackets, etc.

NOTE: Components specified are those used in the prototype. Generally higher ratings can be used provided they are physically compatible.



Here are actual size reproductions of the three PC artworks and the transmitter front panel.





In either case, if the TV has a live chassis, in other words there is no power transformer, no screws should be exposed on the cabinet exterior since these may be live.

Wiring to the PCBs can now be completed. The audio lead from the TV volume potentiometer is intercepted and the attenuator on the decoder PCB connected in series with the line. The wiper from the potentiometer connects to the input of the attenuator while the output of the attenuator continues the audio signal back into the lead to complete the circuit.

The power supply connection to the TV set can be found by referring to the circuit diagram supplied with the TV set. Any DC voltage from 12 to 30V will be suitable and should be obtained from the main DC power supply of the TV circuity.

When all wiring is complete and the PCBs secured to the TV chassis, the cabinet back should be replaced and the unit tested. If not functioning satisfactorily, the power supply from the TV circuit could be derived from the wrong point or line flyback pulses could be entering the receiver. Ensure that there is a heavy earth lead running from the shield connection to an earth point in the TV.

In the case of a rear-mounted photodiode, the receiver obtains the light from the transmitter by reflection from the wall behind the TV set so the transmitter needs to be pointed towards the TV. Do not expect the transmitter to produce sufficient energy so as to allow light to reflect from one wall to another then to the photodiode.

We trust that you will enjoy having absolute control over the sound level of your most disliked TV adverts. Don't they look funny when soundlessly banging their gums together?

Stop Press

As this article went to press it was discovered that some recent model TV sets have a two-wire volume control which varies a DC voltage to a control pin on the sound IF detector IC. This means that the circuit published here needs to be tapped into the TV circuit at the input to the sound output stage. This will probably require the removal of a signal-coupling capacitor so that the input and output leads of the Sound Control can be connected.

An alternative and easier method is to reconfigure the Sound Control so that it directly varies the volume control DC level. The transmitter buttons then need to be swapped over to account for the fact that reducing the control voltage increases the sound level. Details of the modified circuit will be published next month.