WIDEBAND ANTENNA AMPLIFIER

This simple to build antenna booster offers a gain of some 20 dB over a frequency range that covers the VHF FM radio band and the whole of the UHF TV band.

an ELV design

AN antenna amplifier is useful in cases where reception of a VHF or UHF station is marginal, or where several radios or TV sets share a single antenna. In the latter case, the loss introduced by a 'splitter' has to be overcome with some additional gain. Since an antenna amplifier raises noise as well as signals within its pass-band, it is essential that it be mounted as close as possible to the antenna, where its beneficial effect is greatest.

The antenna amplifier described here is designed such that it can be connected to the antenna via a very short cable, without the need of a separate power supply being fitted close by on the roof top.

The amplifier is powered via the output coax cable. This arrangement is called a phantom supply. Figure 1 gives an indication of the RF performance that may be expected from the amplifier. It is seen that a gain of about 20 dB is achieved at frequencies between 40 MHz and 860 MHz.

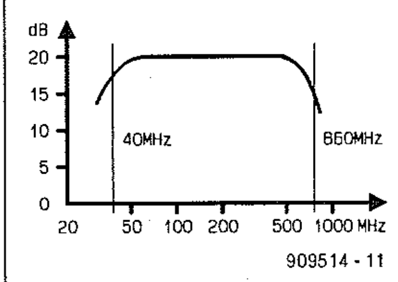


Fig. 1. Pass-band of the amplifier.

Use and function

The antenna amplifier is inserted between two coax connectors in the existing cable near the antenna. The connection is broken, and the coax plug at the side of the antenna is inserted into the input socket of the antenna amplifier. The amplifier output socket is connected to the plug fitted on the downlead cable, i.e., the coax cable that leads to the TV set. That is all there is to the basic installation of the amplifier.

Once installed, the amplifier provides a gain of 20 dB, which is ample to prevent a fairly long downlead cable or other attenuating devices (including splitter boxes and connectors) degrading the signal-to-noise that exists at the antenna terminals — the upshot is that you have a better signal/noise ratio at the end of the downlead cable, i.e., at the input of your TV set.

The amplifier is phantom-powered, that is, it receives its supply voltage via the downlead cable, obviating the need of separate (low-power d.c.) wiring. The phantom supply for the amplifier is inserted into the cable at the antenna input of the TV set. The antenna plug is pulled out of the TV antenna input, and plugged into the input of the phantom supply unit. Next, the output plug of the phantom supply unit is plugged into the antenna socket on the TV set. The supply voltage for the phantom unit must lie between 5 V and 8 V d.c., and is best provided by a small mains adaptor. When an unregulated adaptor is used, care should be taken to keep the output voltage below 7 V. Given that the current consumption of the antenna amplifier is a few milliamps only, this may mean that the output voltage switch must be set to 4.5 V, which usually gives a no-load output voltage of between 6.5 V and 7 V. Make sure that the tip of the 3.5-mm jack plug is the **positive** supply. The 3.5-mm jack plug of the mains adaptor is inserted into the socket on the phantom supply unit, which takes care of the d.c. decoupling at the input of the TV set.

The circuit

The circuit diagram of the antenna amplifier is given in Fig. 2. The RF signal supplied by the antenna arrives at the input of a Type NE5205 RF integrated amplifier via input socket BU4 and coupling capacitor C3. The NE5205 raises the signal ten times, which corresponds to a voltage gain of 20 dB. The output signal of the IC is fed to the input of the TV set via capacitor C4, socket BU5, the downlead cable and the phantom supply unit. Inductor L2 blocks the RF signal, and so provides a d.c. path for the positive supply voltage on the signal connection of BU5. Likewise, capacitor C4 blocks the d.c. supply voltage at the output of the amplifier IC. The IC supply voltage is decoupled for RF as well as lower frequencies by a parallel combination of an SMA (surface-mount assembly) capacitor, C6, and an electrolytic capacitor, C5.

The operation of the phantom supply unit is apparent from Fig. 3. The output signal of the antenna amplifier arrives at socket BU2, and is fed through to BU3 via coupling

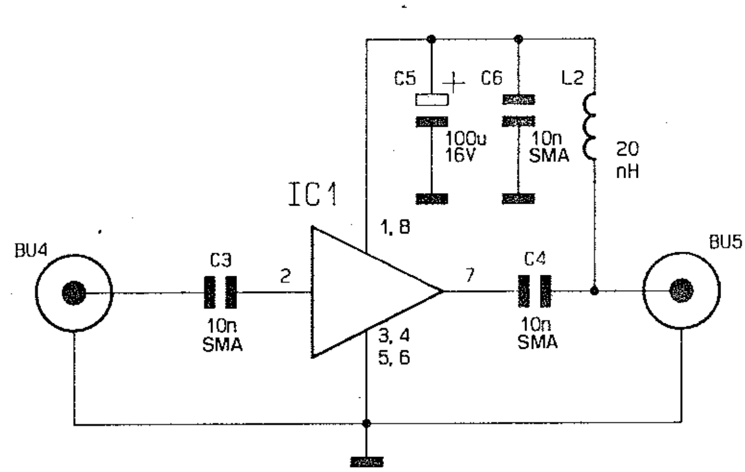


Fig. 2. Circuit diagram of the masthead amplifier.

capacitor C2. The output connector, BU3, is plugged into the antenna input on the TV set. Inductor L1 prevents RF signals being short-circuited by the power supply, and feeds the direct voltage applied to BU1 (the supply input socket) to the core of the coax cable. In this way, the RF signal is superimposed on the direct supply voltage of the amplifier. This supply voltage can not arrive at the antenna input of the TV set because it is blocked by capacitor C8.

Construction

Provided you have some experience in working with miniature circuits, the construction of the antenna amplifier is straightforward.

Start the construction by positioning and soldering the three SMA capacitors at the track side of the amplifier board. Next, mount IC1 at the component side, and solder its terminals at the track side. Finally, mount inductor L2 at the component side, taking care not to create short-circuits.

The strip of sheet metal supplied with the kit is bent around the PCB edges to form the amplifier case. Next, the input socket and the output plug are fitted to the short sides, and soldered at the inside of the 'case'.

Push the amplifier PCB into the case, such that the side with the IC on it rests against the pins of the coax connectors. Align the PCB, and solder one of the long sides to the metal case, at about 4 mm from the underside of the case. Next, clamp the case into its final shape, and solder the ends of the metal plate where they join. Secure the PCB in the case by soldering it all around to the metal plate. Likewise seal the input and output connector by soldering at the outside of the enclosure. The 6-mm hole in one of the long sides of the enclosure must also be sealed by soldering.

Connect the centre pins of the coax connectors on the amplifier to the copper tracks at the other side of the board by inserting short pieces of silver-plated wire (supplied with the kit) into the respective holes, and soldering at the track side and the connector pin.

The phantom supply does not require a separate circuit board. The input and output coax connectors are fitted on to the metal sheet enclosure as with the amplifier. Here, however, the 6-mm hole in one of the long sides is used to mount the 3.5-mm jack socket for the d.c. supply voltage. The centre pins of the coax connector are connected by capacitor C2. The centre pin of the input coax connector is connected to the centre pin of the supply socket via inductor L1. Next, solder the ground connection of the supply socket to the inside of the enclosure. Finally, fit decoupling capacitor C1 across the supply socket terminals.

Carefully check the construction of the amplifier and the phantom supply unit before you run a short test on them. Next, seal the enclosures completely by fitting the cover plates, and soldering these securely to the enclosures. ■

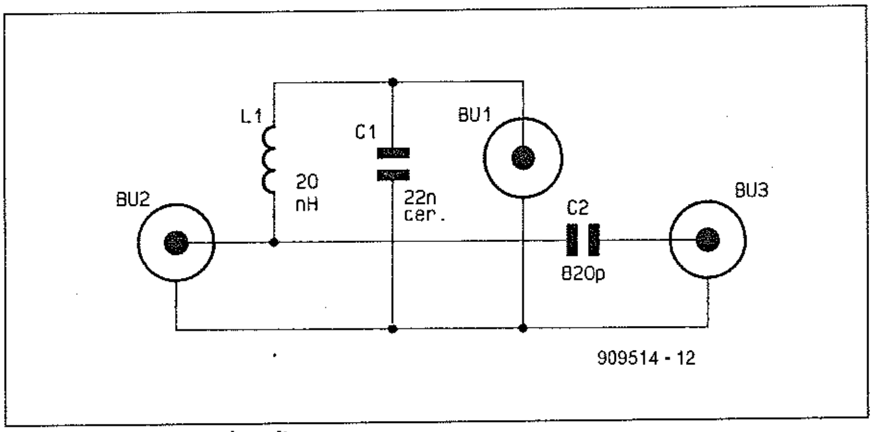


Fig. 3. Phantom supply unit.

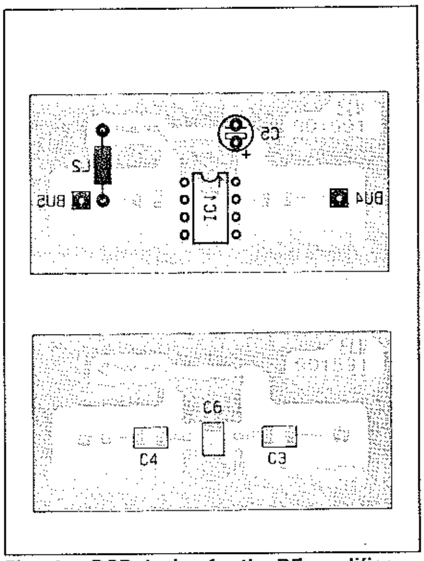


Fig. 4. PCB design for the RF amplifier.

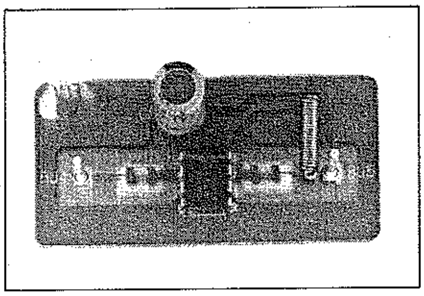


Fig. 5. Component side view of the completed amplifier board.

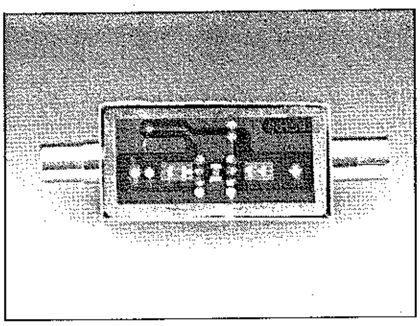


Fig. 6. Track side view of the amplifier board before it is soldered to the inside of the enclosure.

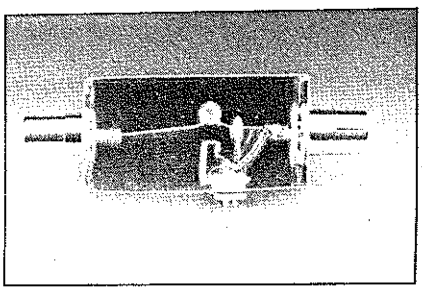


Fig. 7. Completed phantom supply unit.

COMPONENTS LIST

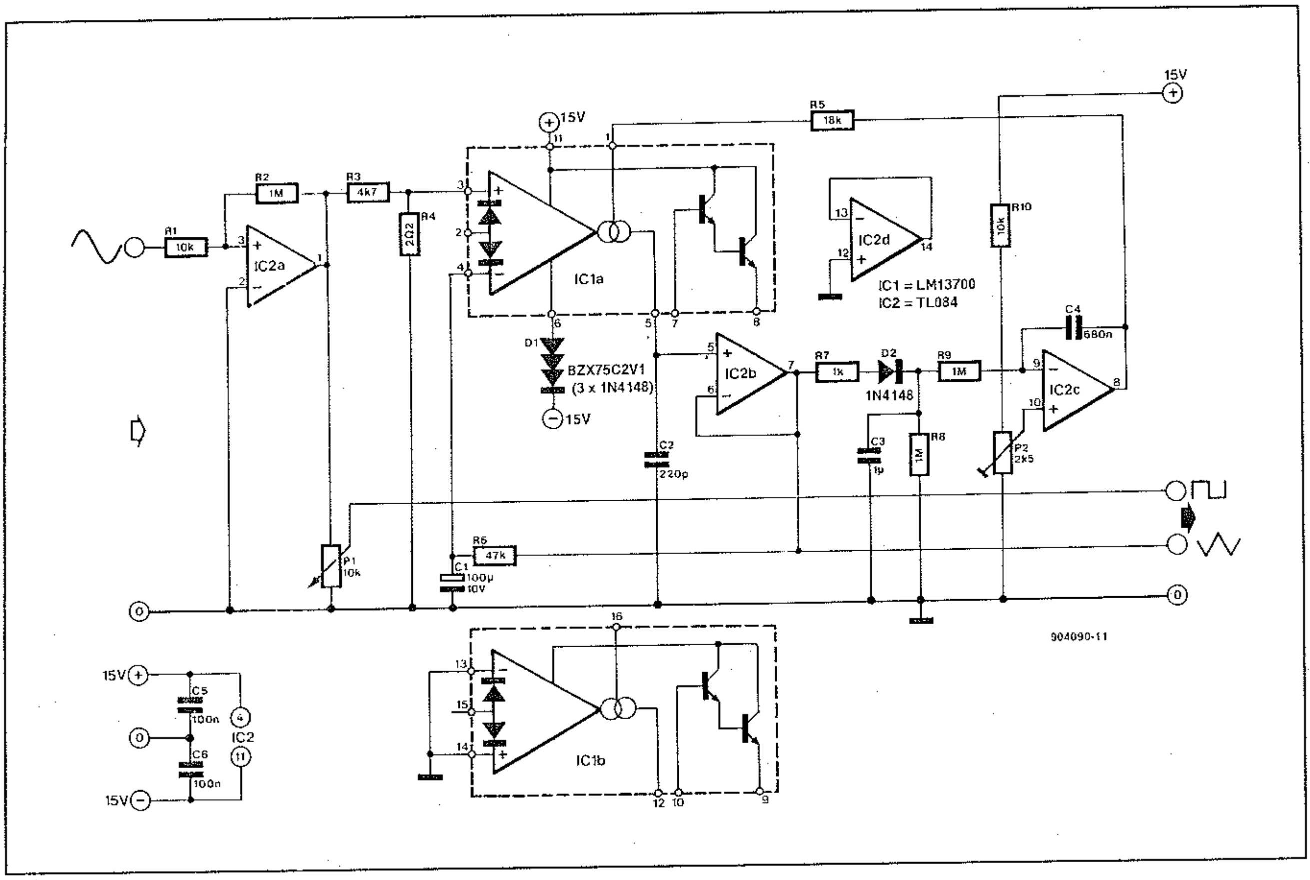
Content of kit supplied by ELV

Capacitors:		
1	820pF	C2
3	10nF SMA	C3;C4;C6
1	22nF ceramic	C1
1	100µF 16V radial	C5
Semiconductors:		
1	NE5205	IC1
Miscellaneous:		
2	20nH inductor	L1;L2
1	3.5-mm jack socket	BU1
2	Coax socket, chassis mount	BU2;BU4
2	Coax plug, chassis mount	BU3;BU5
2	sheet metal enclosure	
	70mm silver-plated wire	
1	Printed circuit board	

A complete kit of parts for the wideband antenna amplifier described here is available from the designers' head office and worldwide distribution centre:

ELV GmbH
P.O. Box 1000
D-2950 Leer
GERMANY

Telephone: +49 491-60080
Facsimile: +49 491-72030



put of IC2c, is applied to the current source at the output of IC1 via R5. This arrangement ensures that the level of the output voltage is virtually independent of the frequency of the rectangular signal or the sinusoidal input.

One problem with a precision integrator is its being affected by offset voltages and bias currents. Feedback loop R6-C1 ensures that the output follows the potential across R4 accurately, although tiny deviations may be caused by the bias current in circuit IC1, which is not greater than 8 µA at 70° C.

The time constant R6-C1 is large for a purpose: to ensure that the triangular signal, even at low frequencies, can not affect the waveform of the signal to be integrated—the rectangular shape must be retained.

The converter can process signals at frequencies from 6 Hz—where the amplitude is not affected—to 60 kHz—where the amplitude is reduced by 10%.

Because of the long time constants, the time taken for the recovery of the amplitude of the triangular signal at frequencies above 1 kHz is rather long. The peak value of this signal should be set to 1 V.

Diode D1 is a so-called stabistor—three diodes in one package. It may be replaced by three discrete Type 1N4148 diodes.

The current drawn by the converter is of the order of 9 mA. ■

(*T. Giffard*)

ELECTRONIC ANTENNA SELECTOR 036

The electronic antenna selector is intended to switch between two FM antennas by means of a logic signal.

Gates IC1 and IC1b ensure a clean switching action and at the same time form the interface between the 5 V logic level (probably available from the receiver) and the 12 V supply voltage for the selector. Depending on the type of gate used, a digital TTL or CMOS control signal is available in direct and inverted form at the outputs of IC1.

When input A is logic high, the output of IC1a is low and that of IC1b is high. Current then flows from the positive supply line to IC1a via T2, R9 and D8; T2 is switched on and D9 lights.

Because direct currents flow through R1-D1-R2 and R5-D3-R4, diodes D1 and D3 conduct and pass the VHF signal from input A to output D. At the same time, a direct current flows through R6-D4 so that D4 conducts. This arrangement ensures that any VHF signal at input C can not reach the output via the parasitic capacitances of the relay contacts and the wiring.

When A is logic low, and IC1b is therefore low, current flows from the positive supply line to IC1b via T1, R7 and D17; T1 is then switched on and D10 lights. At the same time, the two series-connected relays, Re1 and Re2, are energized, their contacts close and the VHF signal at input C is fed to output D. Moreover, a direct current flows through R3-D2 so that D2 conducts. Any signal at input B is then shorted to ground via D2.

All resistors should be carbon film types, because these have a higher parasitic series inductance than metal film resistors, so that the attenuation of the VHF signal caused by them is reduced to a minimum.

The attenuation losses caused by the diode junctions (5–10 dB) are somewhat larger than those caused by the relays. It is thus advisable to connect the antenna that provides the weaker signal (normally the domestic one) to input C.

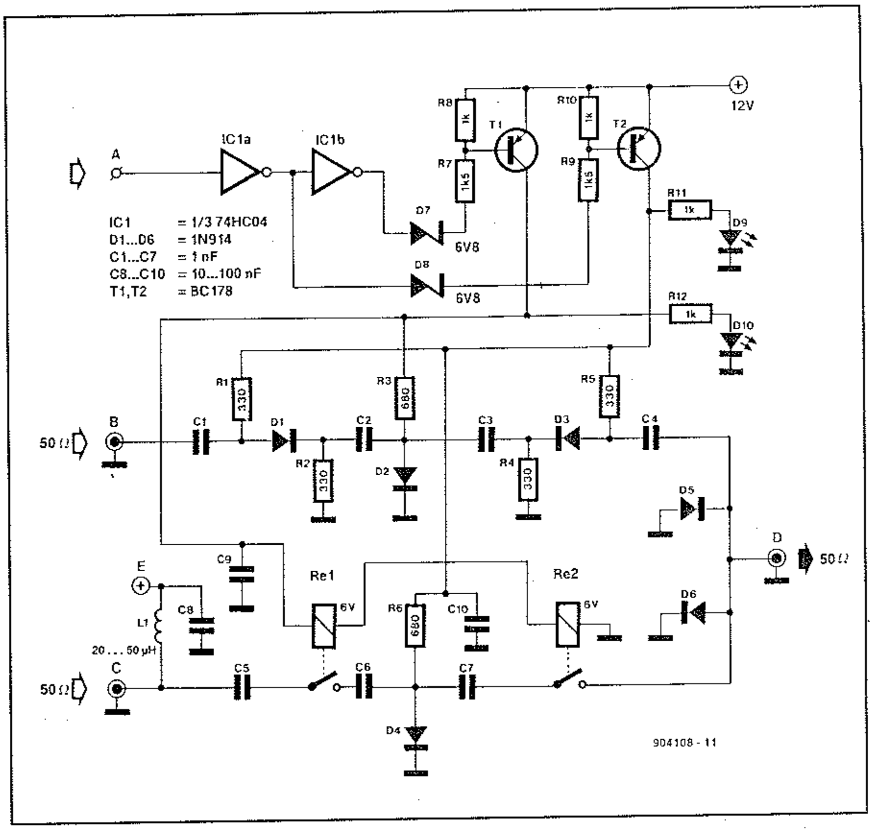
If the domestic antenna is equipped with an antenna amplifier, it may be supplied via terminal E.

Diodes D5 and D6 protect the circuit against high voltage spikes that occur during the on and off switching.

The selector draws a current of around 65 mA. ■

(T. Shaerer)

A = control input – '1' = central antenna system
'0' = domestic antenna
B = central antenna (cable) input
C = domestic antenna input
D = output to receiver
E = supply output to antenna amplifier



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VOLUME INDICATOR FOR ALL-SOLID-STATE PREAMPLIFIER

The indicator is intended for use with the all-solid-state preamplifier we published some time ago (see reference), but may also be used in other applications where a number of steps or changes must be counted rapidly.

To prevent interference with the audio signal, the circuit is a static design. This means that if the volume control is not adjusted, the circuit does nothing.

The circuit does not need an external clock signal, since this is derived from any changes in the least significant bit—LSB. This is done by two differentiating networks: R9-C1 and R10-C2, which double the frequency of an available LSB signal.

Moreover, to ensure that the counters of the indicator remain in step with the volume control, signals 'up/down' and 'preset' from the preamplifier are used. It may seem rather extravagant to couple the state of the counters in the preamplifier with that of the present counters, but it is a good way of keeping the connections between the two units to a minimum. Furthermore, the present counters operate in 8-bit BCD instead of 6-bit binary as used by those in the volume control (in the preamplifier). All that is required to display the state of the volume control are a couple of BCD-to-seven-segment decoders and seven-segment displays.

The preset in the indicator must be set in BCD code (whereas that of the control in the preamplifier is set in binary code). It is, of course, possible to give the preset in the indicator the same value as that in the preamplifier control to give a display that varies from 00 to 63. It is, however, perhaps rather more realistic to have a display from 01 to 64, because the minimum attenuation is 78.75 dB , not infinity. There is no suppression of leading zeros, so that numbers up to and including 9 are displayed starting with a 0.

The DIP switches and resistors R1–R8 in the diagram may be omitted if only one fixed preset is likely to be used. The resistors should be replaced by jump leads.

The balance control of the preamplifier may also be indicated, but the present circuit should then be duplicated, with the exception of IC5, which has two gates to spare. The LSB connection of one indicator is coupled to IC23 in the volume control stages, while the other indicator is linked to IC25. The current drawn is, of course, doubled to around 220 mA. This makes it necessary to increase the rating of the mains fuses and to change the inscription on the relevant label from 100 mAT to 200 mAT.

The supply voltage may be taken from the preamplifier, but careful account should be taken of the cooling of the voltage regulators, particularly if two indicators are used. It may be necessary to improve that cooling.

The interference suppression of the regulators, IC33 and IC34 in the preamplifier, may also be improved by additional 10 µF, 10 V electrolytic capacitors at their adjust pins.

Finally, placing the displays behind red perspex makes them easily readable in all circumstances. ■

(T. Giffard)

Reference: "All-solid-state preamplifier", *Elektor Electronics*, December 1989.