The 'Phony Patch' — a landline interface for your ham rig

Be ready for 'phone patch when it comes. In the meantime, you can practice operating your rig over the house intercom, or whatever.

The phone patch committee*

SPECIFICATIONS — ETI-734

SENSITIVITY	
Rx-to-line (at 1 kHz)	
level pot. mid-position	3.0 V for 0.77 V (0 dBm) in line
level pot. maximum	1.5 V for 0.77 V (0 dBm) in line
Line-to-Tx (at 1 kHz)	
level pot. mid-position	0.77 V (0 dBm) in line gives 0.5 V out
level pot. maximum	0.77 V (0 dBm) in line gives 1.3 V out
CROSSTALK	
Rx output to Tx input	
level pots mid-position (dependant on level settings; decreases with higher settings)	26 dB with 0 dBm on line

* All voltages RMS; line terminated in 600 ohms

ONE OF the more positive aspects of the CB 'boom' was that it paved the way for 'third party traffic' in both the citizens bands and (later) the amateur bands.

Third party traffic means that an amateur or CB operator is allowed to relay messages, via his equipment, to another amateur or CB operator for someone else (i.e: neither of the operators).

This in itself was a 'breakthrough', but didn't go quite far enough. For it still meant that the message had to be actually re-broadcast by the operator.

The ridiculous part was that, if the message was being relayed from Australia to, say, the USA, the American amateur could connect his transceiver directly to his phone, call the party to whom the message is directed — and sit back!

This is because amateurs in the United States have long had access to 'phone patches', which were fully legal to connect to the telephone network. In Australia there has been no method of connecting a transceiver to a telephone line.

** This project was designed, developed and written up by a group of radio amateurs interested in promoting 'phone patch in Australia. They modestly wish to remain anonymous.*

The current situation is this: the Department of Communication permits third party 'phone patch' operation for amateurs, but to connect a phone patch device to Telecom lines would breach Telecom regulations — with the risk of having your service disconnected plus prosecution for effecting a 'non-permitted' attachment.

In fact, not only are phone patches not permitted, but there are no standards laid down to which equipment can be made. Certain safety standards for equipment in general are all that can be relied on.

The recent report of the Davidson Inquiry into telecommunications foreshadows that Telecom is, or shortly will be, taking a much more enlightened attitude to attachments to their phone lines. Witness the recent decision by Telecom to allow 'user connected' phone devices to be plugged in to Telecom lines (for the first time — until now any item, even permitted, had to be 'installed' by Telecom).

In light of the changing attitude of Telecom, we set about designing an interface which could, when allowed, connect transceivers to Telecom lines. In the meantime, there are a large number of private installations, intercoms, links etc, which could still make use of such a device.

In the absence of any technical specifications, the interface was made to meet all of Telecom's safety standards. It was also designed to meet the audio level requirements of other equipment.

The interface is equipped with its own monitor speaker so it can be used as a direct link between the transmitter and line. Obviously, normal transceiver operating practice must be followed as the transceiver will only operate in simplex mode.

However, the interface can make use of the ▶

transceiver's VOX, if available, for 'hands free' operation.

It is anticipated that a large number of amateur operators, and maybe even CB operators, will build the interface, ready for the time when such devices are 'legalised'. And it appears that this is not too far away!

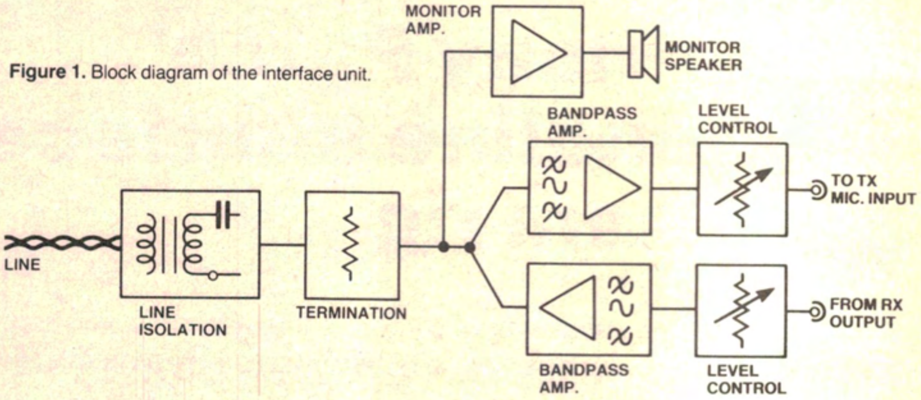


Figure 1. Block diagram of the interface unit.

Design

A block diagram of the interface is shown in Figure 1. The object is to convert a 'four wire' communications path — a pair for the receiver output and a pair for the transmitter input — to a 'two wire' link.

For safety's sake, and to take into account the later likelihood of the unit requiring approval for attachment to Telecom lines, the interface is isolated from the line by a special transformer and a high voltage, high reliability capacitor. This is terminated in a resistance of a value that provides a close match to the general line impedance of about 600 ohms.

A bidirectional amplifier system is attached to this to pass audio from the line to the transmitter mic. input and from the receiver output to the line. Each of these amplifiers has a bandpass response. Figure 2 shows the two response curves.

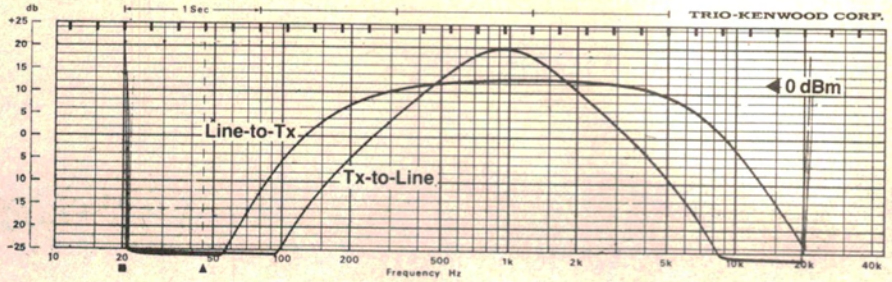


Figure 2. Response curves of the 'Rx-to-line' and 'Line-to-Tx' stages of the interface. (Measured on the prototype using ETI's Trio SE-3000 acoustic test set.)

The response from receiver output to the line shows a narrow bandwidth with steep rolloff above and below the speech midband frequency of 1 kHz. The −6 dB bandwidth is from about 500 Hz to 1.7 kHz, rolling off at about 12 dB per octave below 500 Hz and at about 15 dB per octave above 1.7 kHz. This is perfectly adequate for speech, and in fact, provides a measure of improvement with noisy signals as well as attenuating noise and heterodynes that may be passed down the line.

The response from the line to the transmitter mic. input is considerably broader, the −6 dB bandwidth running from about 200 Hz to 6 kHz. Rolloff below 200 Hz is about 12 dB per octave, about −15 dB per octave above 6 kHz. Why is it different? Well, many modern transceivers incorporate speech filtering and bandwidth shaping to improve the effectiveness and clarity of the signal. Any filter in the mic. line may adversely affect the performance of a transceiver's own speech filter. But, any extraneous noise (hum, clicks-pops, etc) that may be on the line should not be passed to the transceiver, either. Hence the line-to-Tx filter response was rolled off above and below the usual speech band limits of 3 kHz and 300 Hz, respectively.

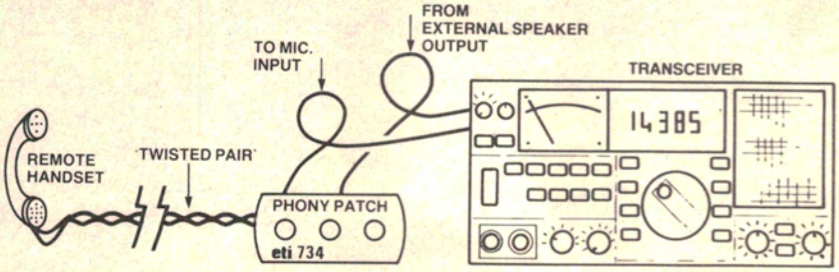
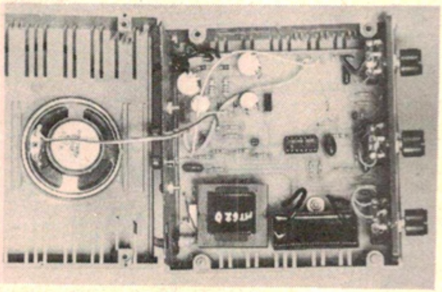


Figure 3. General arrangement of how the ETI-734 interface unit is hooked up.

The 'Rx output' is intended to come from the transceiver's external speaker output or a high level, low impedance auxilliary output. Most modern transceivers have an audio power output of around two to three watts. Under normal use, average output power into the speaker is perhaps 0.5 W, which is about 2 V into an eight ohm load. Hence, this amplifier was designed to deal with signals from about 1.5 V RMS (level control at maximum) to produce 0 dBm in the line (0.77 V in 600 ohms).

With the line-to-Tx amplifier, 0 dBm on the line will produce a maximum output of about 1.3 V RMS (level control at maximum), which should be more than adequate to handle the majority of situations.


Inside story. General internal view of the project.

For local monitoring, a simple amplifier picks audio off at the isolation stage and drives a small loudspeaker in the interface.

Power is derived from an ac plugpack so that mains is not brought into the unit at all — again, for safety's sake.

Construction

All the electronic components, with the exception of the pots, are mounted on a single printed circuit board measuring 113 mm square. This fits nicely inside an ARLEC PC1 plastic case which we used to house the project. This case has a plastic front panel and a metal rear panel. The pc board has four mounting holes at each corner that match the plastic pegs in the bottom half of the ARLEC case so that the board is easily secured with four small self-tapping screws.

The three pots mount on the front panel and all the external 'interfacing' connections exit via the back panel. The transceiver connections are made via two RCA sockets. The line enters via a grommet and is soldered to the appropriate pc board points. A flying lead with a suitable plug attached permits convenient connection to and removal from the line. The ac plugpack adaptor was hard wired direct to the board using figure-8 cable. Some plugpacks come with a flying lead of Figure-8 cable, some have two screw terminals on the plugpack body.

We dressed up the front panel with an aluminium Scotchcal label, the artwork for which is reproduced elsewhere in the article. The monitor speaker was mounted on the lid, simply glued in place with Silastic. Holes were drilled in the lid over the speaker position, before mounting (it's too hard afterwards!).

Probably the best way to go about constructing the project is to tackle the pc board first. If you're making your own board, give it a thorough check after etching and drilling it. Even if you've purchased a ready-made board or a kit, check the board for missed holes, bridges between tracks (particularly between IC pins) and holes not drilled to the correct size. Make sure the four mounting holes line up with the pegs in the base of the box. Correct any problems and then proceed with mounting the components.

Assemble the resistors, capacitors (except C2) and semiconductors first. If you wish, a socket can be used for IC1. Watch the orientation of the electrolytic capacitors and all the diodes, especially. The orientation of the transistors and IC1 should be clear from the overlay diagram.

Leave the line isolation transformer, T1, and capacitor C2 until last as these are bulky components. We used pc stakes for all the external leads from the board. These should be mounted next. Check everything so far. All OK? Now bolt C2 in place, then mount T1. C2 has flying leads, note, while T1 has been designed for direct pc board mounting.

Now you can attach the flying leads to the pc board stakes around the perimeter of the board. Make sure the leads are long enough to reach their destination, but not too long so that they form a 'rat's nest' inside the box when it's all assembled. Don't attach the line or ac input leads yet.

Now you can tackle the box. Mark out and drill the front and rear panels. The Scotchcal label can be used as a template to mark out the front panel. Drill holes in the box top where the speaker will be positioned, then glue the speaker in place.

The Scotchcal label can now be applied to the front panel. Trim the label to size first. Cut it slightly undersize, the box pieces have an overhanging lip which covers the panel all round the edge. Peel off the backing strip and carefully position one end of the label on the panel. Smooth the Scotchcal onto the panel slowly, then give it a hard rub all over, using a soft cloth, when you've got it in place. Trim off any overhanging bits.

Now mount the potentiometers to the front panel. Position them so that their terminals face upwards; this makes it easier to solder the leads to them. Put grommets in the holes in the rear panel where the line and ac input leads will pass through. Mount the stereo RCA connector strip (or two individual RCA sockets).

Screw the pc board into place in the bottom

AC PLUGPACKS

There are a number of ac plugpacks available that will suit this project.

The prototype was powered by a **Dick Smith Electronics M-9555** ac plugpack which is rated at 12 Vac/500 mA.

The **ARLEC APP.V/79309/60672** is rated to deliver 12.8 Vac no load, 9.3 Vac at 1 A. The project draws about 125 mA (quiescent) and this plugpack will deliver around 12.5 Vac at that load current.

The **Ferguson PPB 8/1000** is rated to deliver 8 Vac at 1 A, and delivers about 11.5 V or so at around 150 mA, so it will suit, as would their **PPB 12/500** (12 V @ 500 mA).

PARTS LIST — ETI-734

Resistors	all ¼W, 5%
R1	82R
R2, R4	150k
R3	15k
R5, R8	1k5
R6, 7, 22, 23	220R
R9, R10	2R2
R11, 14, 17, 20	68k
R12	560R
R13	39k
R15, R18	4k7
R16	1k2
R19	1M5
R21	22k
RV1	22k/C log. pot.
RV2	500R/C log. pot.
RV3	5k/C log. pot.

Capacitors	
C1	10n/400 V or 630 V greencap
C2	2u/440 Vac film cap. (see text)
C3	10n greencap
C4, 6, 10	100n greencap
C5	33n greencap
C7	220n greencap
C8, C9	4n7 greencap
C11, C12	330u/25 V RB electro.
C13, C14	1000u/16 V RB electro.

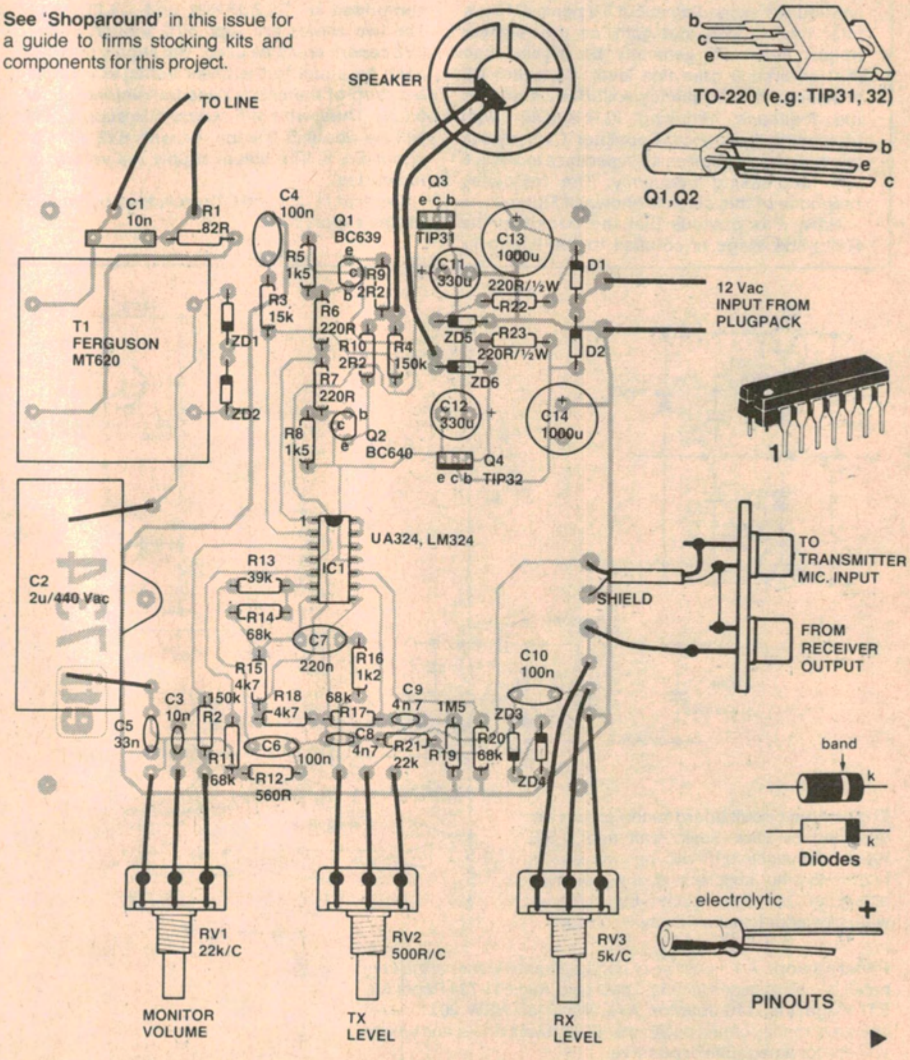
Semiconductors	
D1, D2	1N4001, 1N4002, EM401, EM402, etc.
IC1	uA324, LM324, etc.
Q1	BC639
Q2	BC640
Q3	TIP31
Q4	TIP32
ZD1, 2, 5, 6	5V6/1 W zeners
ZD3, ZD4	4V7/1 W zeners

Miscellaneous	
T1	Ferguson MT620 line isolation transformer

ETI-734 pc board; Arlec PC1 box or similar (plastic, 140 x 130 x 78 mm); 50 mm diameter 8 ohm speaker; Arlec ac plugpack adaptor 9.3 V @ 1 A, or similar; stereo RCA socket strip; one rubber grommet; knobs; Scotchcal front panel; wire, etc.

Price estimate
$55 — $65

See **'Shoparound'** in this issue for a guide to firms stocking kits and components for this project.



HOW IT WORKS — ETI-734

The overall design of the interface is detailed under design notes in the main text.

The line and interface are coupled via T1 which provides isolation to Telecom requirements. Further isolation is provided by the coupling capacitor, C2. Capacitor C1 and resistor R1 attenuate transients on the line. Two back-to-back zener diodes, ZD1 and ZD2, clip any signals with amplitudes above about 6 V peak.

The interface side of T1 is terminated by R12, which provides a close match to the 600 ohm line impedance. The junction of R12-C6-C8-R17-etc is a 'virtual earth' point.

Signals going in the line-to-Tx direction are coupled into IC1b via R11. The output of IC1b is coupled to the level control via C7 and R16. Capacitor C5 provides high frequency rolloff, as its impedance decreases with increasing frequency, while C6 provides low frequency rolloff as its impedance increases with decreasing frequency and the feedback ratio increases (R14 divided by the impedance of R13-C6). Frequency response is shown in Figure 2. The characteristics of T1 also affect the high frequency rolloff. IC1b has a mid-band gain of a little under two.

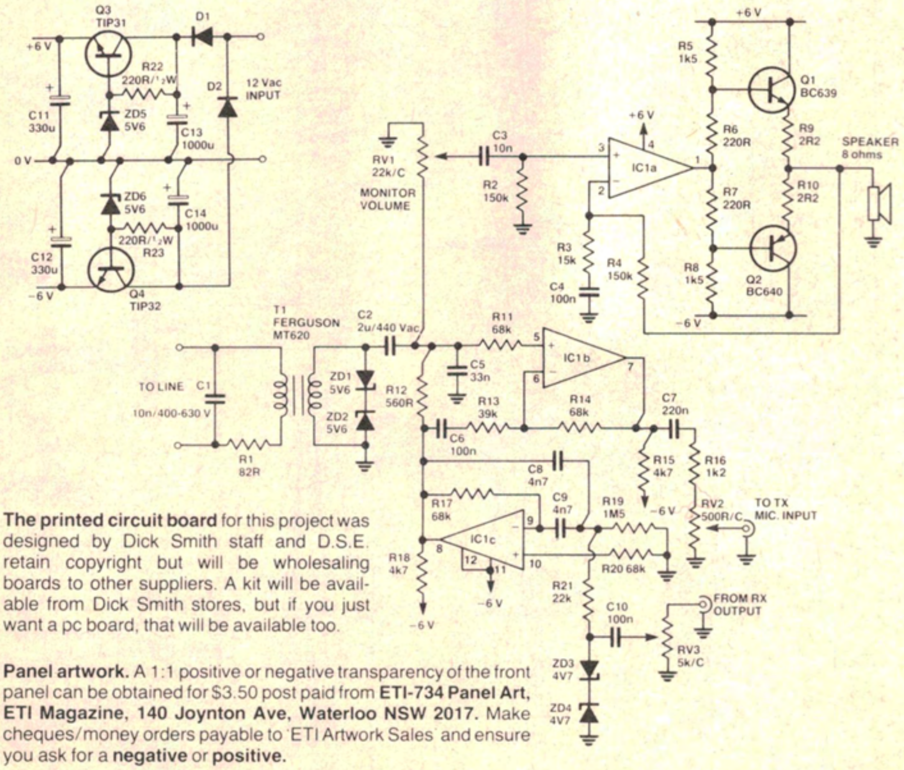
Signals going in the Rx-to-line direction pass via the level control RV3, then via C10, R21 and C9 to the input of IC1c. Two zener diodes, ZD3 and ZD4, clip any signals with amplitudes exceeding about 5 V peak. IC1c is a filter having loss, not gain, as the receiver output level will generally be higher than the required 0 dBm line level. Capacitor C8 provides high frequency rolloff as it shunts the feedback, reducing IC1c's gain with increasing frequency. Capacitor C9 provides low frequency rolloff as its impedance increases with decreasing frequency. The frequency response of this stage is shown in Figure 2.

Now, it is obvious that the output of the Rx-to-line stage is coupled to the line-to-Tx stage. Why then, doesn't the output of the receiver appear at the Tx mic. input? Well, R12 ties the inverting and non-inverting inputs of IC1b together, the Tx output looks like a common-mode signal and will not be amplified by IC1b. It's not a 'perfect' arrangement, but the cross-coupling between the Tx output and Tx mic. input is adequately low.

For the purpose of local monitoring, signals appearing at the common coupling point — the junction of C2 and R12 — are 'picked off' by RV1, the monitor volume control. Signals are coupled to the input of IC1a via C3/R2. The output of IC1a drives a simple class B amplifier comprised of Q1,Q2 and associated resistors, which drives a small eight ohm loudspeaker. Negative feedback is provided via R4 to the inverting input of IC1a. This stage has a midband gain of 10. Low frequency rolloff is provided by C4, the impedance of which rises with decreasing frequency, thus increasing the feedback ratio.

The interface requires positive and negative power rails. An ac plugpack, delivering 12 Vac output, provides power and isolation from the mains for safety. Two halfwave rectifiers, D1 and D2, provide positive and negative dc rails, of about 16 V or so, smoothed by capacitors C13 and C14 respectively. These are each regulated to about 5 V or 6 V using simple zener controlled series pass regulators comprised of Q3,ZD5,R22 and Q4,ZD6,R23. The two zeners are each 5V6, though 6V2 or 6V8 zeners could be used. The supply rails will each be equal to the zener voltages less the b-e drop of the series pass transistors (about 0.6 V). Thus, with 5V6 zeners, the supply rails will be about 5 V each, or with 6V2 zeners, about 5½ V. The actual supply rail voltage is not critical.

Capacitors C11 and C12 provide ac bypassing for the supply rails.



The printed circuit board for this project was designed by Dick Smith staff and D.S.E. retain copyright but will be wholesaling boards to other suppliers. A kit will be available from Dick Smith stores, but if you just want a pc board, that will be available too.

Panel artwork. A 1:1 positive or negative transparency of the front panel can be obtained for $3.50 post paid from **ETI-734 Panel Art, ETI Magazine, 140 Joynton Ave, Waterloo NSW 2017.** Make cheques/money orders payable to 'ETI Artwork Sales' and ensure you ask for a **negative** or **positive.**

In and out. Rear view of the interface showing the ac input line at left, the RCA sockets for connections to the transceiver and the cable to the line at right.

half of the box. Slip the front and rear panels in place and solder the appropriate flying leads to the three pots and the RCA connectors. Solder the speaker leads in place, then pass the line lead and ac input lead through their respective grommets and knot them just inside the box, to prevent strain on the board terminals, if they're pulled, then solder them to their respective pc stakes.

Put the lid on the box and you're ready to test it.

Getting it on the air

Apply power and run a multimeter over the supply rails. These should be within one volt of the specified rail voltage (see the circuit diagram). If you've used 5V6 zeners, for ZD5 and ZD6, the rails will be around 5 V, or a bit over 6 V if you've used 6V8 zeners.

Check the voltage on pin 1 of IC1. This should be less than ±100 mV. The base of Q1 should be about 0.6 V positive, the base of Q2 about 0.6 V negative. See that pin 4 of IC1 is at the positive supply rail and pin 11 at the negative supply rail.

Temporarily hook up a 'phone handset to the line and your transceiver to the RCA connectors. Use a shielded lead to the transmitter mic. input. You won't need a shielded lead between the interface's 'receiver output' socket and the rig's external speaker output as you're dealing with high levels and low impedances. Figure-8 cable is quite OK.

Set the Rx and Tx gain controls to about half way and the monitor gain well down, or you'll get 'howl round' feedback. Set your transceiver VOX controls to where you normally have them, as well as the transmitter mic. gain (if your rig has a mic. gain control).

Turn up the rig's audio gain and listen in the handset for band noise or signals. Set the interface unit's 'Rx output level' control for a comfortable volume in the earpiece.

Talk and the VOX should operate the transceiver. Adjust the interface's 'Tx input level' control and your rig's VOX controls if necessary to get the desired operation.

With the handset located at the end of your twisted pair line, check the overall operation. Adjust the interface monitor level to suit.

Have fun with your 'Phony Patch'!

When the authorities get around to permitting 'phone patch for amateurs, you'll be ready. In the meantime, remember it's an offence to use this unit on the public telephone network. ●