TR.2002 CONVERSION FOR TWO METRES

DISCUSSING A USEFUL TRANSMITTER/RECEIVER COMBINATION

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The TR.2002 is as yet not very well known as surplus equipment but, as this article shows, it is of considerable interest for easy conversion as a low-power Tx on two metres, with associated receiver. At most VHF stations, its prime use would be as a stand-by rig, or for local working. It would in any case be an instructive conversion exercise for anyone looking for a quick and not too difficult start on Two Metres.—Editor.

A FURTHER release recently to the surplus market of the TR.2002 Aircraft Transreceiver presents the opportunity to get going quickly on the two-metre band. Designed to operate on 121·5 mHz from an emergency 24-volt DC supply, the TR.2002 comprises a crystal controlled transceiver complete with modulator, crystal controlled superhet receiver, 24-volt dynamotor with switching and changeover relay. Twin-chassis construction is used—the receiver is the upper, removable one—to make a compact unit measuring only 7¼ × 4¾ × 12in. A control input socket (Fig. 1) gives access for the microphone, low impedance headphones and changeover switch. The power consumption is 3 amps. at 24 volts and the input to the PA is approximately 5 watts.

Transmitter

The transmitter (Fig. 2) is easily adapted for 2 metres. A 10·125 mHz mc crystal oscillator/tripler (V5) produces 30·375 mHz to drive a doubler (V6) which in turn drives a second doubler (V7) to produce RF at 121·5 mHz into the PA (V8). Replace the crystal with one from the 8 mHz range. Wire a 10 pF silver mica capacitor in parallel with C10 to resonate the anode tuned circuit of V5 at 24 mHz. V6 now functions as a tripler. Remove L3 (it is fixed to the chassis by a single bolt), reduce the number of turns from 5½ to 3½ and refit, peaking the anode tuned circuit of V6 to 72 mHz. V7 then doubles to 144 mHz when the number of turns on the self-supporting coil L4 is reduced from 3½ to two. Remove 2½ turns from the end of the PA coil (L5) remote from the aerial tap, to resonate the PA anode circuit at 145 mHz. The Tx modifications are now complete. The valve and trimmer designations used in Fig. 2 are those engraved on the chassis beside the respective components, preceded in the case of the transmitter section by the symbol 1.

A number of test points are brought out to the rear of the transmitter chassis. Those marked TP1 to TP4 in Fig. 2 are connected to the grid circuits of V5 to V8 respectively; a 5 mA meter connected between one of these points and chassis gives sufficient indication of grid drive for peaking. The anode current of the PA valve is monitored by connecting a low range milliameter between TP6 and TP7 which will measure the voltage drop across the 10-ohm resistor in series with the HT feed to the PA anode. A calibrated absorption wavemeter should be used to ensure that the correct harmonic has been selected at each stage.

The modifications described above are on the underside of the lower chassis and can be carried out without any dismantling. The upper chassis is very easy to take out. Pull the 12-pin Paignton plug and coax plug out of their sockets on the receiver. Loosen four instrument-type screws on the front panel, remove a single bolt from the rear supporting plate and lift out the receiver.

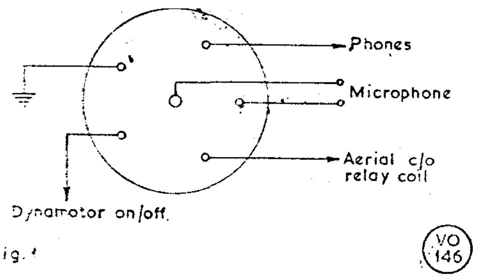

Fig. 1. Control socket as fitted on the TR.2002.

Table of Values

Fig. 2. Transmitter section of the TR.2002 (*top right*)

C1	= 15 μμF	R2, R3, R6, R7, R10, R14	= 1,000 ohms
C2	= 175 μμF	R5, R9	= 150,000 ohms
C3, C7, C12	= ·002 μF	R8, R12	= 27,000 ohms
C4, C5, C8, C9, C13, C14, C17, C18, C19, C21	= 330 μμF	R11	= 470 ohms
C6, C11, C16	= 100 μμF	R13	= 39,000 ohms
C10, V15, C20, C24	= var., as fitted	R15	= 12,000 ohms
R1, R4	= 100,000 ohms	X1	= 10·125 mHz, as fitted (*see text*)
		L1, L6	= RF chokes
		L2, L3, L4, L5	= as fitted (*see text*)
		V5, V6, V7, V8	= 6F17

Table of Values

Fig. 3. Modulator as fitted TR.2002 (*opposite*)

C1, C2, C3	= 330 μμF	R7, R9	= 10 ohms
C4	= ·002 μF	R8	= 1,000 ohms
C5	= ·01 μF	R10	= 150,000 ohms
R1, R2	= 4,700 ohms	T1	= Mic. xformer
R3, R4	= 220,000 ohms	T2	= Mod. xformer
R5	= 2,700 ohms	V1, V2	= 6BR7
R6	= 1·1 megohm	V3, V4	= 6F17

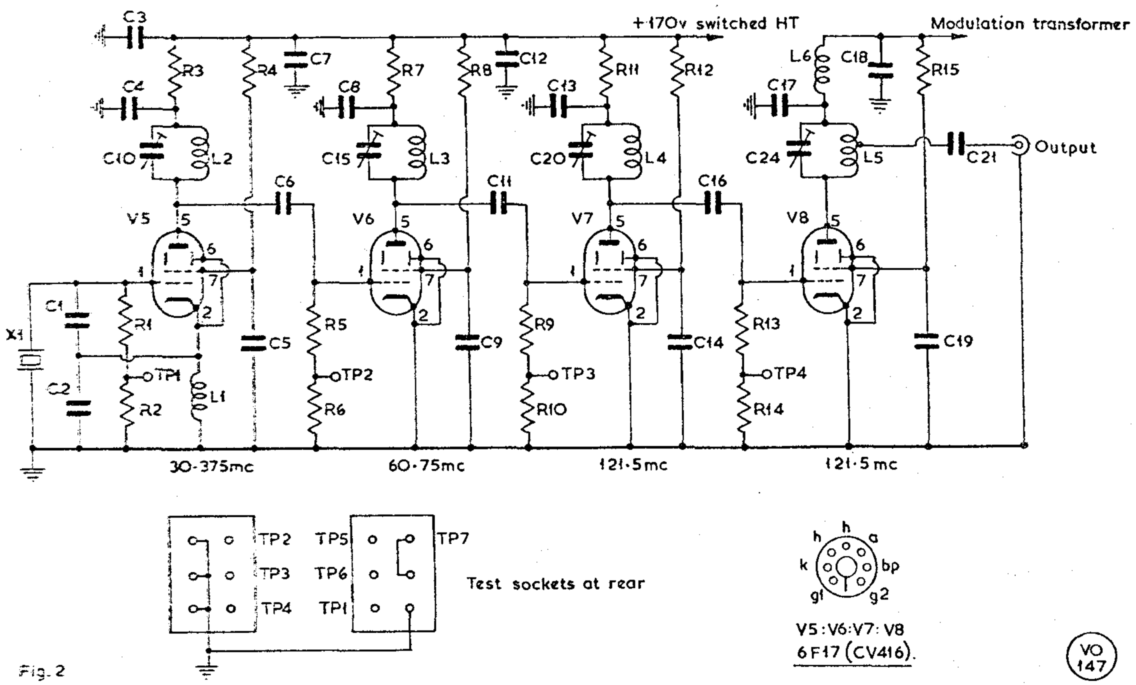

Fig. 2. Transmitter section of the TR.2002.

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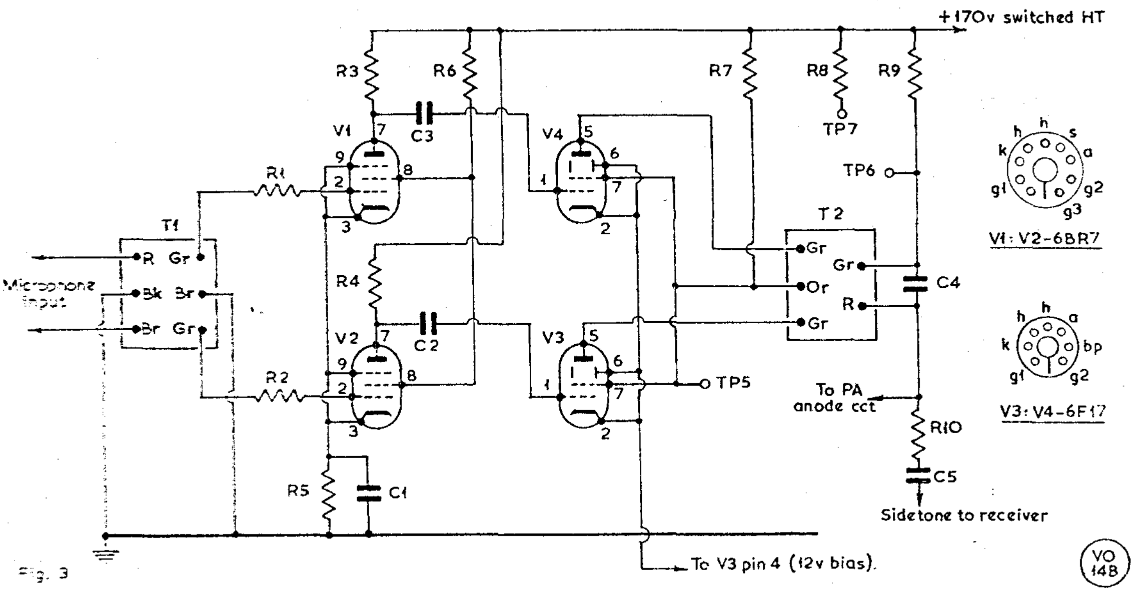

Fig. 3. Modulator as fitted in the TR.2002.

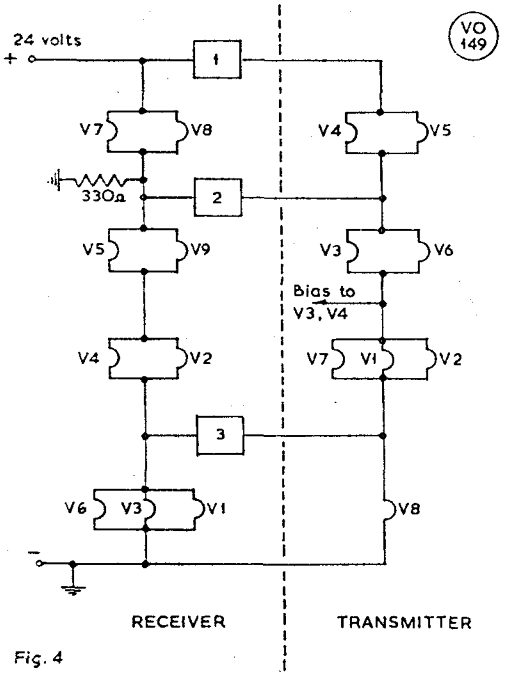

Fig. 4. Heater wiring as in the original.

The crystal holder is a HC6U type which will have to be changed if popular 10XJ surplus crystals are used. Remove the spigot and adjacent " mod " label for easy access to the chassis beneath the crystal holder. Enlarge the holes left by the HC6U holder to take wander sockets at ½in. spacing and solder on the wires removed from the old holder. Crystals in the 6 mHz range can be used

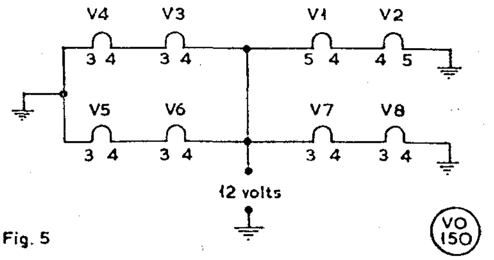

Fig. 5. TR.2002 Tx heaters as modified for 12-volt input.

without further modification to the transmitter, though the drive to V6 will be lower since V5 is now quadrupling instead of tripling.

The modulator (Fig. 3) does not require modification, but it should be noted that the common lead from the cathodes of V3 and V4 is taken to a 12-volt tapping point on the heater chain to provide bias (Fig. 4). The writer removed the tapping and connected a 820-ohm 1-watt resistor from the commoned cathodes to chassis, so that the biasing would be independent of the heater chain and

Table of Values

Fig. 6A. Main receiver circuit, TR.2002

Component	Value
C1	Ae. trim
C2, C3, C6, C7, C8, C11, C13	330 μμF
C4, C5	trimmers
C9, C17	100 μμF
C10, C12, C14, C15, C16	·01 μF
R1	150,000 ohms
R2	220 ohms
R3, R7, R8, R12	2,200 ohms
R4	27,000 ohms
R5	47,000 ohms
R6, R9, R10	100,000 ohms
R11	190 ohms
T1, T2	as fitted
L1, L2, L3	as fitted
V1, V2	6AK5
V3	EF92

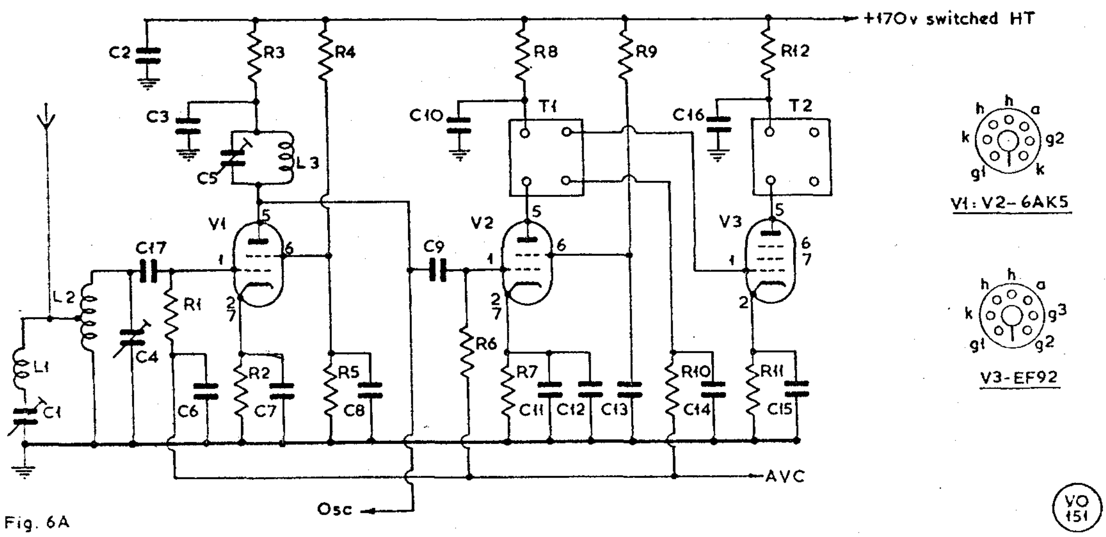

Fig. 6A. Main receiver section, TR.2002.

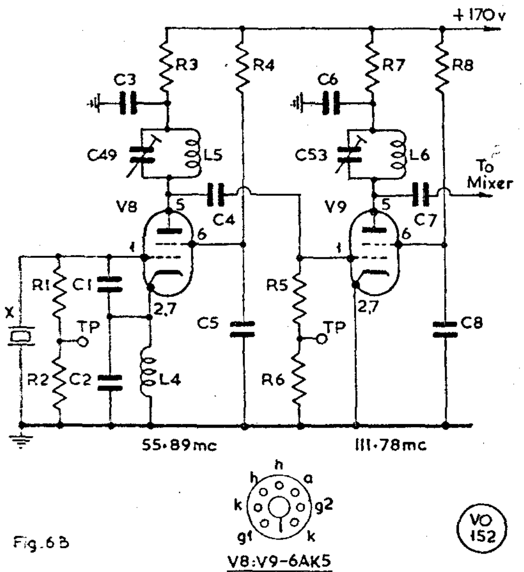

Fig. 6B. The receiver oscillator-amplifier—see text.

Table of Values

Fig. 6B. Oscillator-amplifier, Rx side, TR.2002

C1	= 15 µµF	R4	= 47,000 ohms
C2	= 170 µµF	R8	= 68,000 ohms
C3, C5, C6, C8	= 330 µµF	L7	= RF choke
C4	= 100 µµF	L5, L6	= *see text*
C7	= 1 µµF	X	= 13·972 mHz (*see text*)
R1, R5	= 100,000 ohms	V8, V9	= 6AK5
R2, R3, R6, R7	= 2,200 ohms		

the latter could be run from AC. A magnetic type of microphone connected to one half of the primary winding of the input transformer gives satisfactory results.

Although the complete transreceiver works from 24 volts DC it will probably be more convenient to operate the Tx side alone from external HT and heater supplies. The power requirements are 170 volts at 100 mA or so and either 12 volts at 1·05 amps. or 6 volts at 2·1 amps. Fig. 4 shows the series-parallel heater interconnections between the transmitter and receiver. Fig. 5 gives a conversion to 12-volt working for the heater circuit of the transmitter alone, which utilises some of the existing wiring. To convert from 12 volts to 6 volts:

(*a*) Join together V2 pin 4, V4 pin 4, V6 pin 3, V7 pin 4,

(*b*) Transfer supply from V1 pin 5 to V1 pin 4,

(*c*) Connect V1 pin 5 to chassis.

HT is brought from the dynamotor *via* a red lead running beneath the chassis to a centrally positioned tag. Remove this lead and replace by one from the external HT supply. The relay fixed to the underside of the chassis controls the dynamotor. The writer took out the relay, dynamotor,

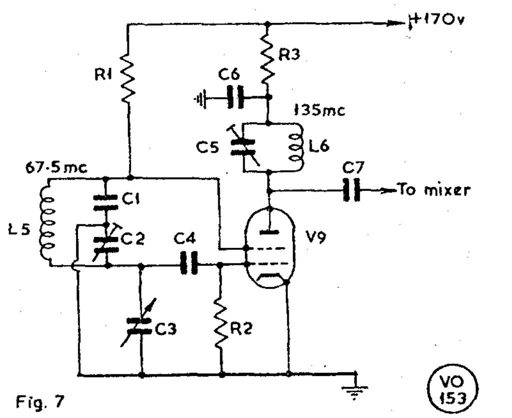

Fig. 7. Modification for circuit Fig. 6B. Values are: C1, 50 pF; C2, C5, as fitted; C3, 5 pF, main tuning; C4, 100 pF; C6, 330 pF; C7, 1 pF; R1, 68K; R2, 100K; R3, 2·2K; L5, L6, see text and refer Fig. 6B; and V9, as V9 in Fig. 6B.

associated chokes and wiring, clearing a large area of surplus components. The send/receive relay, mounted on the front panel adjacent to the aerial socket, will operate from 12 volts DC. Alternatively, the relay may be replaced by a manually-operated switch.

Receiver

The circuit of the front-end of the receiver is shown in Figs. 6A and 6B. A 13·972 mHz crystal oscillator/quadrupler (V8) drives a doubler (V9)—*see* Fig. 6B—to supply 111·8 mHz to the mixer (V2), Fig. 6A. Incoming signals from the aerial are amplified by a single RF stage (V1) before they are applied to the mixer to produce an IF of 9·7 mHz. Three IF stages are followed by detection and a single stage of LF amplification (V7) to feed a transformer which gives an output suitable for low impedance phones. Delayed AVC is applied to the RF, mixer and IF valves. LF gain is controlled by a preset

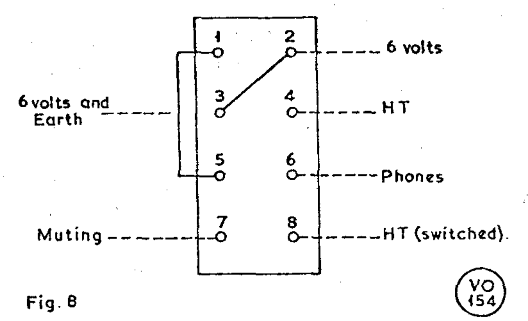

Fig. 8. Modification connections for the Paignton socket on the TR2002—see below.

Connections to the Paignton plug are: Pins 1, 2, 3—Heaters (*see* Fig. 4); Pin 4—170 volts HT for output valve only; Pin 5—Chassis (Earth); Pin 6—Phones; Pin 7—Muting; Pin 8—170 volts switched HT.

pot, adjustable from the top. In spite of the high value of IF and consequent wide bandwidth, the receiver should be useful for portable or local working and it was decided to use it in its entirety rather than adapt the front end for use as a converter. The crystal and the oscillator valve (V8) in Fig. 6B are not required and are removed. The associated doubler (V9) is modified to work as a free-running oscillator/doubler at 67·5 mHz using components from the crystal oscillator. Remove 3 turns from L5 and wire up as indicated in Fig. 7. A front panel is fixed to the receiver with a 5 pF variable capacitor mounted on it and wired to the oscillator through a short length of coax positioned above the chassis. Reduce the number of turns on L6 (Fig. 6B) from 6 to 5 so that the tuned circuit in the anode of V9 can be adjusted to 135 mHz. Remove two turns from the aerial coil L2 (Fig. 6A) and a single turn from L3 and adjust the associated tuned circuits to resonate at 145 mHz.

The receiver power requirements are 170 volts at 60 mA and either 12 volts at 0·9 amps. or 6 volts at 1·8 amps. A rewire will be necessary to convert to 12-volt working. For six volts working: (*a*) Run an additional wire from V9 pin 4 to chassis; (*b*) Rewire the Paignton plug as shown in Fig. 8 on p.21.

CALCULATION SIMPLIFIED

FOR F, L AND C

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For many people, formulae can be very off-putting. Those who revel in the purity of mathematics may raise an eyebrow as they read this article—but it is common-sense, and should make things a lot easier for many others while, as our contributor shows, giving answers near-enough for all practical purposes.—Editor.

$$f = \frac{1}{2\pi\sqrt{LC}}$$

THIS equation, fundamental in radio, is often considered a nuisance to solve. If a large number of accurate solutions is required this is true, even if logarithms are used, although if less accuracy is acceptable the nomogram (*abac*) offers a quick and easy way of obtaining the answers. But for *practical* purposes, where absolute accuracy is not necessary, the equation can easily be solved in the head by the method which follows.

The expression π occurs in the denominator. If you are working with a GDO, the scale of which is not likely to be less than 5% in error, and are using 20% tolerance capacitors, then it is ridiculous to say $\pi = 3{\cdot}14159$: Call π 3 and the arithmetic is at once reduced, and any error resulting is likely to be less than the errors arising from coil-winding.

The equation then reduces to

$$f = \frac{1}{6\sqrt{LC}}$$

If in addition we are working in μH, pF and mHz the equation becomes:

$$f = \frac{1{,}000}{6\sqrt{LC}}$$

and we are able from this to evolve the following simple rules for obtaining *f*:

(*a*) multiply the values of the inductance and capacity together;

(*b*) take the square root of the answer;

(*c*) divide this into 1,000;

(*d*) divide the result by 6 and the answer is the frequency in mHz, near enough.

Do all calculations mentally, approximating where convenient.

Example 1. What is the frequency of a circuit in which

$\begin{cases} L = 10\ \mu H \\ C = 100\ pF \end{cases}$

Answer $LC = 10 \times 100 = 1{,}000$
$\sqrt{LC}$ is about 30
1,000/30 is about 30
$f = 30/6 = 5$ mHz

Example 2. $\begin{cases} L = 3{\cdot}5\ \mu H \\ C = 27\ pF \end{cases}$

Answer $LC = 94$
$\sqrt{LC}$ is about 10
$1{,}000/10 = 100$
$f = 100/6$, about 17 mHz.

If you are having difficulty in extracting those square roots in your head, you can be shown in a minute how to do it. Meanwhile, the mathematical types, with table books at hand, might note that quite an accurate answer can be obtained as follows:

(*a*) multiply the values of the inductance and capacitance together;

(*b*) look up their square root;

(*c*) look up the reciprocal of this;

(*d*) multiply the reciprocal by 1,000;

(*e*) divide by 6.

Because we assumed the value of π to be 3, this result will be about 5% too high: if you correct for this, you will be very near indeed to the correct value of *f*.

Now to the mental calculation of square roots. In the first place, do not be afraid of continually approximating; as a rule, the errors caused by approximating will eventually nearly cancel out. In Example 1 we said