Cover Feature - 2

The 'WYVERN' 160 Solid State

by

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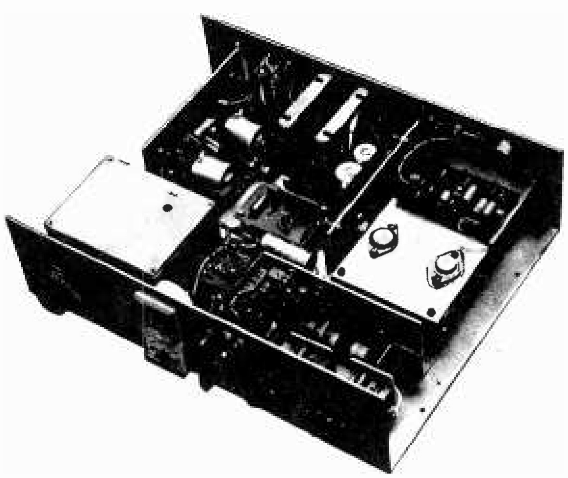


This view inside the transmitter illustrates the manner in which the circuit modules are assembled on the main chassis

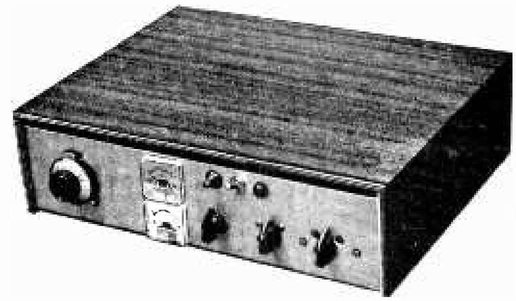
THIS ARTICLE REPRESENTS THE AUTHOR'S DEVELOPMENT of a solid state transmitter which has been in use for some two years.

Initial development of p.a. and modulation techniques began earlier, however, and the design presented is a v.f.o. controlled version of an earlier, simpler, crystal controlled transmitter. The design will appeal to those who are eager to experiment with the constructional challenge of an all-transistor transmitter, and good results should be obtained without difficulty.

The design is capable of running at least 10 watts input and provides excellent quality of modulation, good frequency stability and negligible frequency modulation. Although the overall system is quite large and complex in terms of component quantities, the modular construction simplifies the building and testing programme to a step-by-step process.

In this month's issue the v.f.o., wideband driver stage and frequency doubler and driver section are described, whilst the subsequent two articles will deal with the power amplifier stage, modulator, power supply and VU meter driver. Chassis assembly and the building and testing procedure will be discussed in the third article.

The overall system block diagram is shown in Fig.1, which is self-explanatory. The detailed operation of each section will be covered in the constructional information.



Metre Transmitter

This 3-part series deals with a comprehensive transmitter design which incorporates semiconductors throughout. The description of its construction is continued in Parts 2 and 3, which will be published in the next two issues.

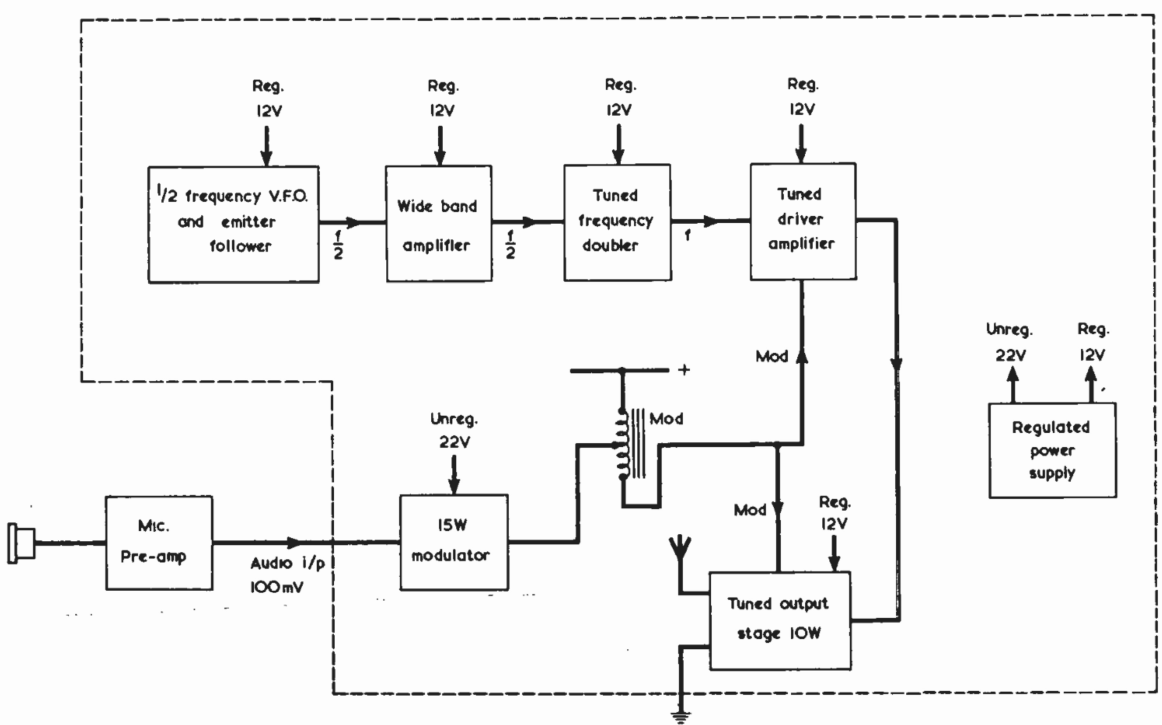


Fig. 1. Block diagram showing the sections of the all-transistor 160 metre transmitter

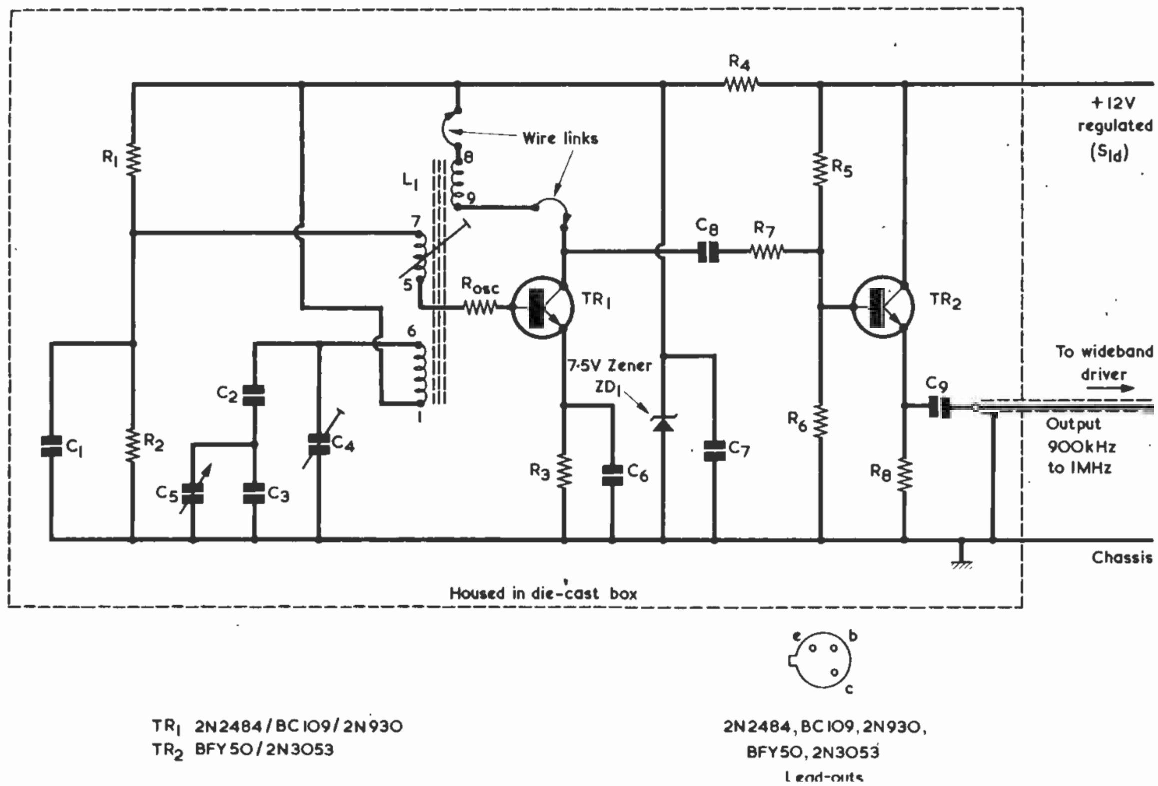


Fig. 2. Circuit diagram for the v.f.o. stage

THE V.F.O. STAGE

The circuit diagram of the v.f.o. stage is shown in Fig.2. The frequency range covered is 900kHz to 1MHz, i.e. half the output frequency, since during development it was found impractical to run the oscillator at the fundamental frequency due to serious 'f.m. pulling' and asymmetric modulation which this produced.

Oscillation is achieved with the Denco coil L1 (Yellow, Range 2T, Transistor) wired in a positive feedback mode. Frequency stability is maintained by:

(a) using a 7.5 volt zener stabilized supply;

(b) coupling the coil to TR1 as 'loosely' as possible (which maintains a high Q and also, incidentally, improves the output waveform and helps to prevent parasitic oscillations) by selecting Rosc;

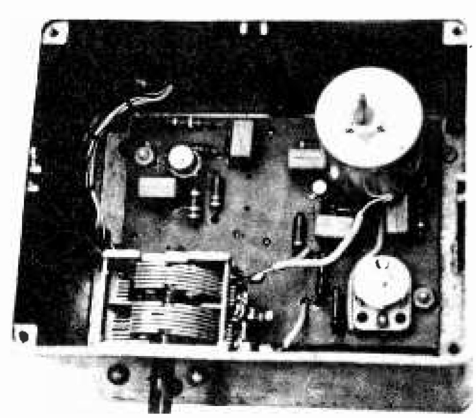
(c) running TR1 at low power to prevent heating.

Oscillation can only occur if the coil is wired for positive feedback so connections 8 and 9 may have to be reversed if the circuit will not oscillate. Pin 1 of the coil is returned to the positive supply rail as this simplifies the printed circuit layout.

When testing, start with Rosc as a short-circuit link. When oscillation is obtained in the correct frequency band (by adjustment of the coil core) begin increasing the value of Rosc, starting at say 2.2kΩ, and go on increasing until oscillation stops. Finally, reduce Rosc to the highest preferred value which still permits reliable oscillation.

The emitter follower, TR2, presents a high impedance to the oscillator, buffers it from the next stage and provides a low impedance output.

The regulated 12 volt supply is obtained from switch S1(d), which will be described in Part 2.



A view inside the v.f.o. box. Note the manner in which the coil can connect to chassis via the tuning capacitor frame.

COMPONENTS

Resistors
(All $\frac{1}{2}$ watt 10%)

Rosc	See text	R13	220Ω
R1	18kΩ	R14	4.7kΩ
R2	8.2kΩ	R15	1kΩ
R3	1kΩ	R16	47Ω
R4	390Ω	R17	4.7kΩ
R5	10kΩ	R18	47Ω
R6	10kΩ	R19	47Ω
R7	100Ω	R20	47Ω
R8	470Ω	R21	See text
R9	18kΩ	R22	47Ω
R10	5.6kΩ	R23	47Ω
R11	680Ω	R24	22Ω
R12	390Ω	R25	See text

Capacitors

C1	0.1μF plastic foil
C2	390pF silvered mica
C3	200pF silvered mica
C4	30pF trimmer, air-spaced
C5	300pF variable
C6	0.1μF plastic foil
C7	0.1μF plastic foil
C8	0.1μF plastic foil
C9	0.1μF plastic foil
C10	25μF electrolytic, 25 V.Wkg.
C11	0.1μF plastic foil
C12	0.1μF plastic foil
C13	0.1μF plastic foil
C14	25μF electrolytic, 25 V.Wkg.
C15	68pF silvered mica
C16	0.1μF plastic foil
C17	240pF silvered mica
C18	68pF silvered mica
C19	0.1μF plastic foil
C20	240pF silvered mica
C21	0.1μF plastic foil
C22	0.1μF plastic foil

Inductors

L1	Denco Miniature Dual Purpose Coil, Yellow, Range 2T, transistor usage
L2, 3	Denco Miniature Dual Purpose Coil, Yellow, Range 3T, transistor usage

Semiconductors

TR1	2N2486/BC109/2N930
TR2	BFY50/2N3053
TR3	2N2484/BC109/2N930
TR4	BFX88
TR5, 6	2N3053
ZD1	7.5V, 200mW, zener diode

Miscellaneous
Die-cast box, $4\frac{3}{4}$ins. by $3\frac{3}{4}$ins. by $3\frac{5}{32}$ins.
3 B9A valveholders, printed circuit type (for L1, L2 and L3)
2 TO5 heat sinks (for TR5 and TR6)
Slow-motion drive, Eagle T502 or similar
Printed circuit board
16 s.w.g. aluminium
Coaxial cable

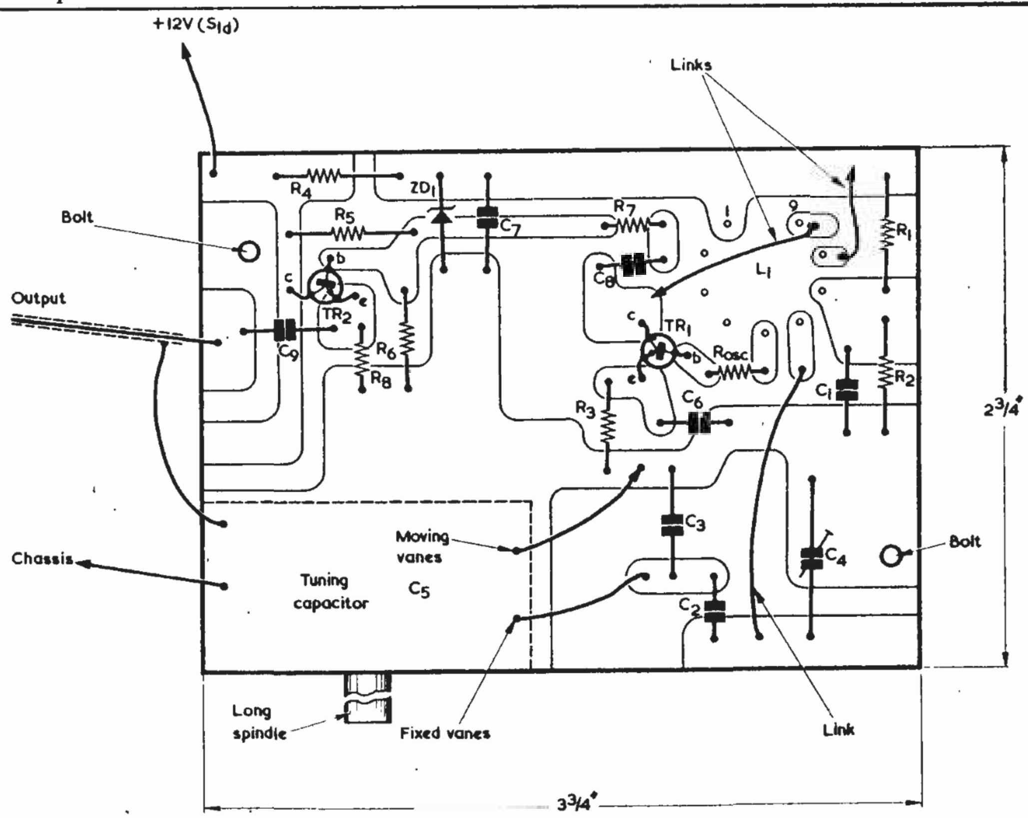


Fig. 3. The layout of the v.f.o. printed circuit board. This view is with the components towards the reader

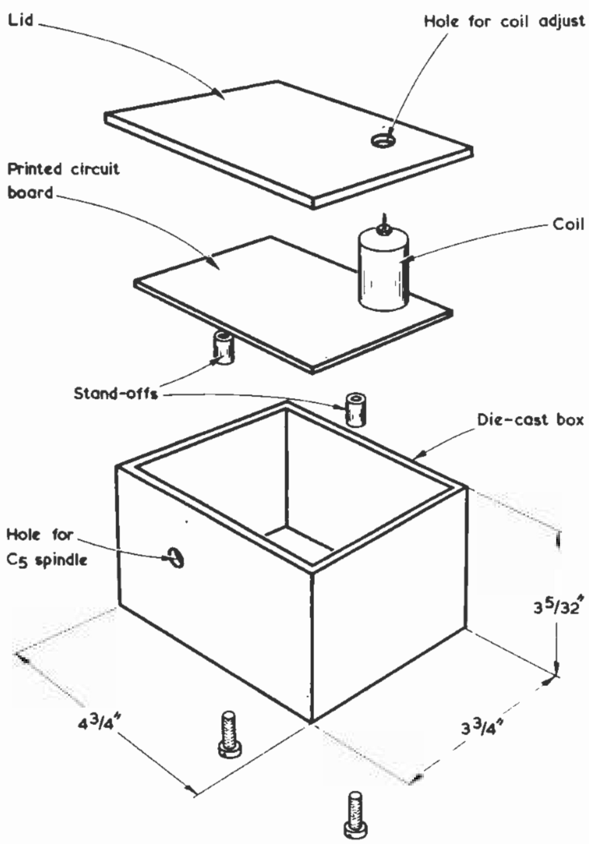


Fig. 4. How the v.f.o. printed circuit board is fitted in the die-cast box

The printed circuit layout is given in Fig. 3 and the housing details in Fig. 4. It is necessary for the v.f.o. to be screened and it is fitted in a die-cast box having the dimensions shown. The author obtained this box from G. W. Smith & Co. (Radio) Ltd., 3 Lisle St., London, W.C.2.

The printed circuit is shown full-size in Fig.3, and the diagram may be traced, if desired. The view is of the component side of the board. The tags of a printed circuit type B9A valveholder (in which the coil is fitted) pass through the board at the holes indicated and these holes should be marked out from the valveholder itself as the hole positioning in the diagram is approximate only. Since Fig.3 shows the component side of the board, the valveholder tags are numbered from 1 to 9 in an *anti*-clockwise direction. As may be seen from the photograph of the v.f.o. circuit, the coil is fitted with a screening can. This is made from the can in which the coil is supplied, it being cut down to clear components adjacent to the coil. The can has a solder tag at its lower end and is earthed to the frame of the tuning capacitor. The latter requires a long spindle (or needs to be fitted with a spindle extender) to enable it to couple to the slow-motion drive on the front panel of the complete transmitter. The tuning capacitor is bolted to the front of the die-cast box and is not mounted on the printed circuit.

Although printed circuit construction is neat and reliable, some constructors may prefer to use plain Veroboard and 'Cir-Kit'. This is, of course, quite permissible although it is wise to stick to a similar layout.

The use of Veroboard with copper strips is not recommended due to the multiple feedback capacitance paths this offers, which could produce instability.

Note the wire links between tags 8 and 9 of L1 and the remainder of the circuit. These enable the connections to these tags to be reversed, if necessary, to obtain positive feedback.

The printed circuit board is spaced off from the bottom of the die-cast box by means of suitable stand-off spacing washers. A hole in the lid provides access to the adjusting screw of the coil core. The supply and output leads are taken out in a laced-up harness through a hole in the rear of the die-cast box. This hole is not shown in Fig.4, but it may be seen in the photograph of the v.f.o. unit. The output, taken via coaxial cable, connects to the input of the wideband driver section.

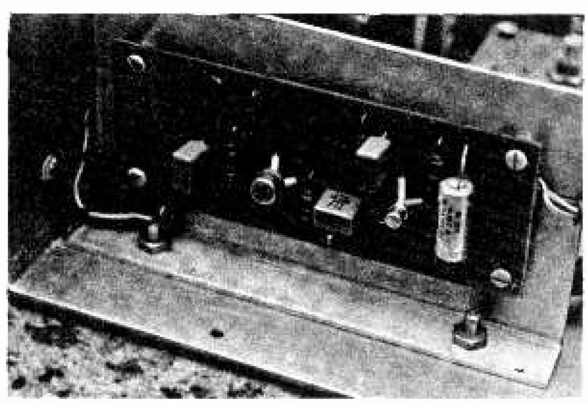
WIDEBAND DRIVER SECTION

This second section, whose circuit is given in Fig.5, uses a conventional amplifier stage (TR3) to raise the signal from the v.f.o. to a level which causes TR4 to be switched on and off. TR4 then provides pulses of current to drive the frequency doubler.

The printed circuit layout is shown in Fig.6. Again, the view is from the component side of the board, and as the board is reproduced full-size, the diagram may be traced. The board is mounted on Chassis Bracket No.1, which is illustrated in Fig.7. Four spacing washers stand the board off the bracket surface. As will be seen later, when the overall chassis assembly is dealt with, the board is mounted with its input end close to the v.f.o. box.

FREQUENCY DOUBLER AND DRIVER

The frequency doubler and driver section incorporates higher power transistors (2N3053) which are biased to be cut off and switched on only by incoming positive-going r.f. pulses. These pulses are obtained from the wideband driver. The circuit of the doubler and driver



The wideband driver board in position on Chassis Bracket No. 1

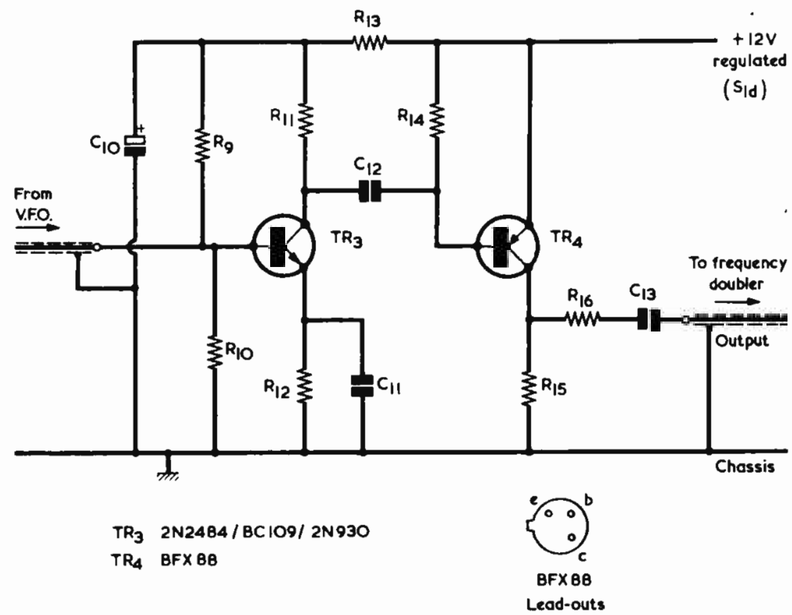


Fig. 5. The circuit of the wideband driver. Its output is passed to the frequency doubler

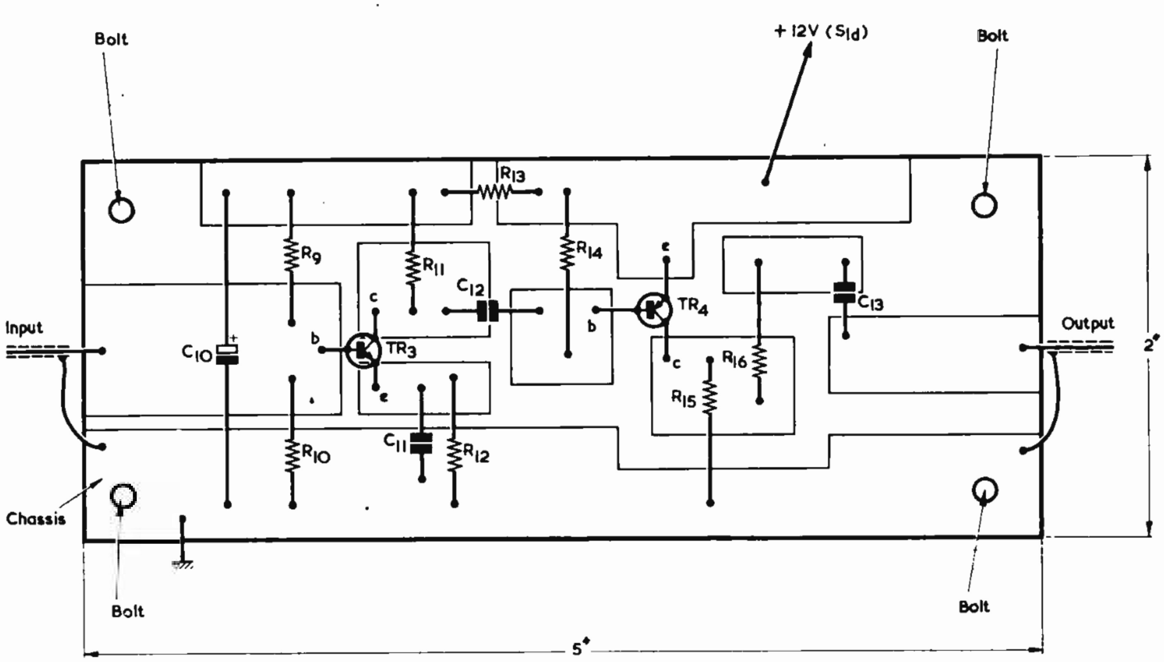


Fig. 6. Printed circuit layout for the wideband driver, as viewed from the component side

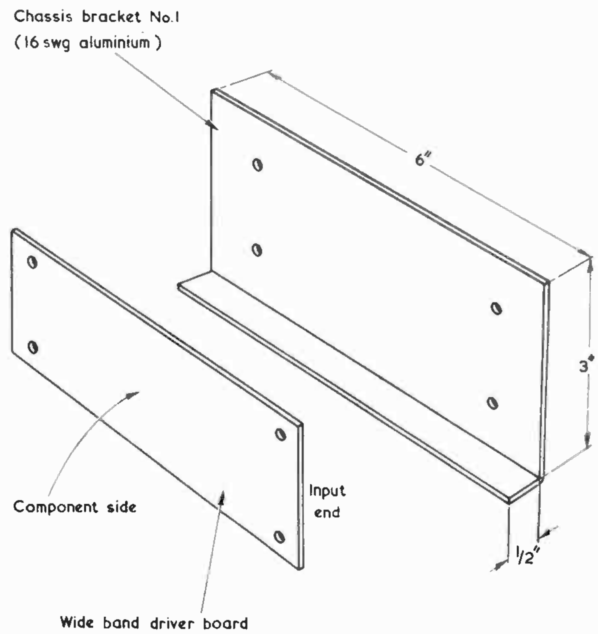
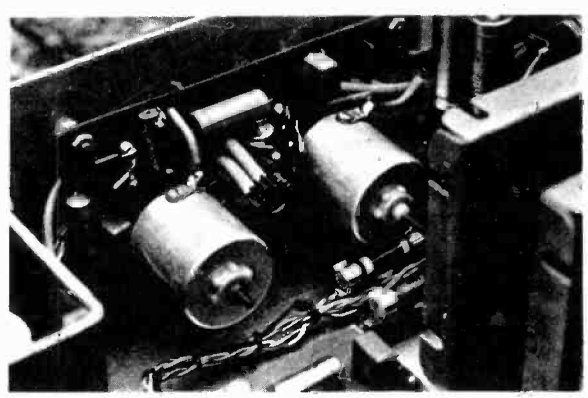


Fig. 7. The board is mounted on Chassis Bracket No. 1

section appears in Fig. 8. The references, at the supply input points, to S1(c) and S1(d) will be explained when the power amplifier stage is described.

Both the coils, L2 and L3, are Denco Yellow, Range 3T, transistor usage types, and they are tuned, by their cores, to approximately 1.9MHz. For optimum band coverage they should be stagger-tuned, say to 1.86MHz and 1.94MHz. Damping resistors R21 and R25 present a method of lowering the Q of the coils, but at the expense of drive. Their values are selected as necessary for the desired band coverage.



The frequency doubler and driver board. This is also mounted on Chassis Bracket No. 1

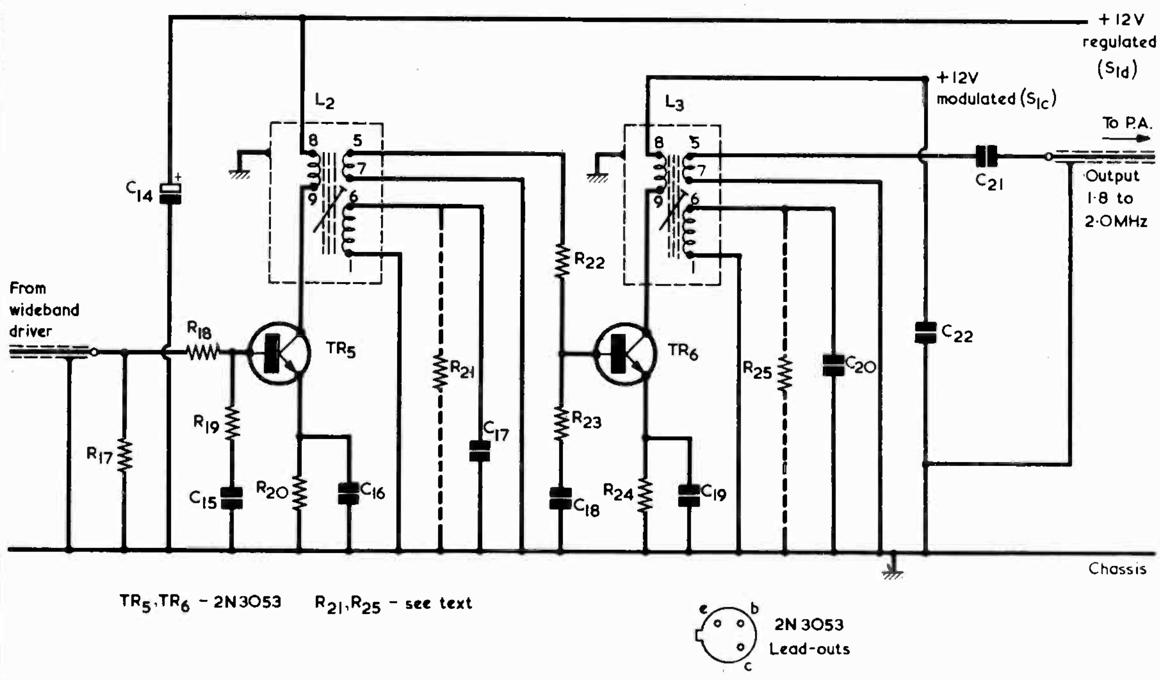
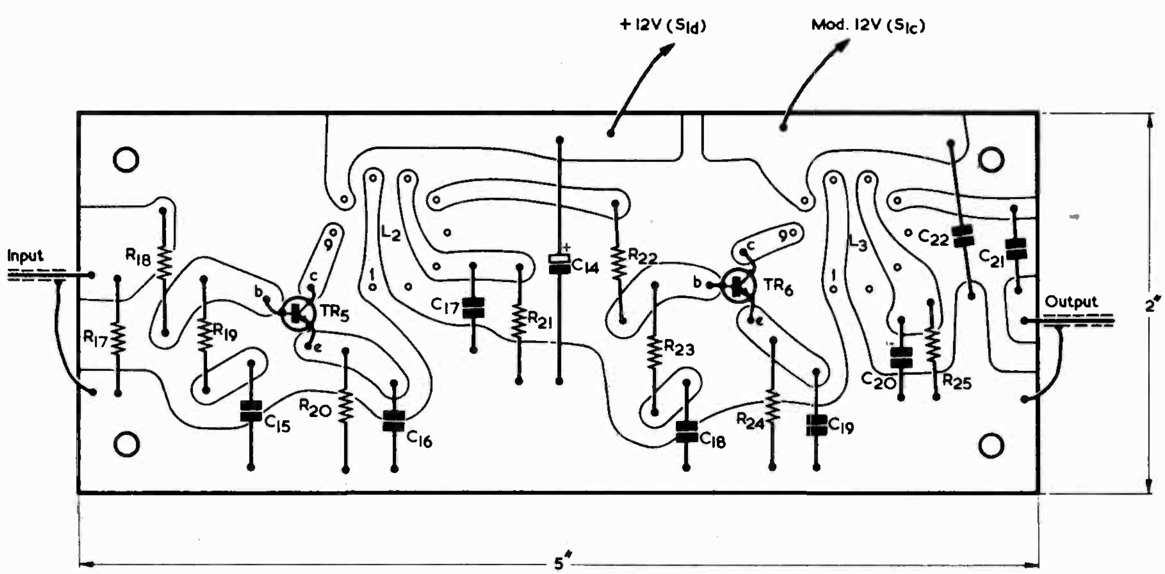


Fig. 8. The doubler and driver section of the solid state transmitter



TR_5 and TR_6 fitted with TO5 heat sink clips

Fig. 9. Component side of the printed circuit board for the doubler and driver section

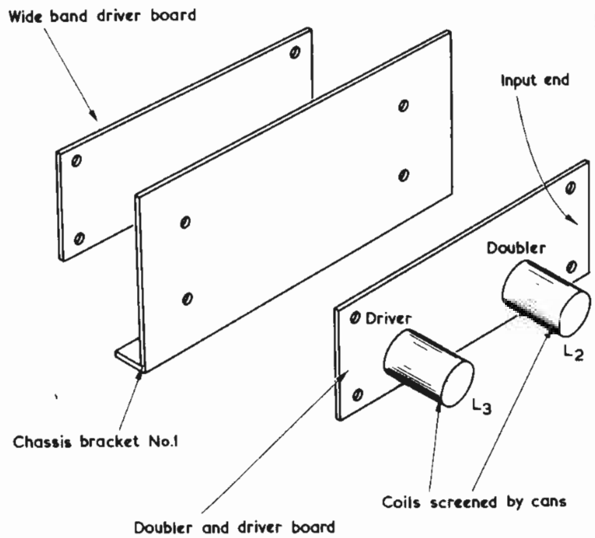


Fig. 10. The doubler and driver board is mounted on Chassis Bracket No. 1 on the opposite side to the wideband driver board

The pulses of current from TR4 in the wideband driver stage therefore switch TR5 at 900kHz to 1MHz, and this frequency is doubled by the tuning of L2. The pulses of current from L2 in turn switch TR6, which pulses L3 at 1.8 to 2.0MHz. The stage should provide approximately 500mW to 1W of drive.

The components R18, R19, C15, R22, R23 and C18 are included for stability. They prevent self-oscillation or the generation of parasitic oscillations.

Should the stage fail to provide sufficient drive, this may be increased by using two transistors in parallel for TR5 and TR6 and halving the value of resistors R20 and R24.

The printed circuit layout is shown in Fig.9, where it is reproduced full size and may be traced. The holes for the B9A coilholder tags are positioned only approximately in this diagram and they should be marked out on the board with the aid of the valveholders themselves. The view in Fig.9 is of the component side of the board. This results in the valveholder tags proceeding from 1 to 9 in an anti-clockwise direction.

A TO5 heat sink clip should be fitted to both TR5 and TR6.

The two coils are screened (as an additional precaution against instability) the screening cans being made from the cans in which the coils are supplied. Each can is cut down so that it does not foul components near the coils, and is fitted with a solder tag to enable it to connect to the copper section which is at chassis potential.

When completed, the board is fitted, using stand-off spacing washers, to the Chassis Bracket No.1 on the opposite side to the wideband driver board. The input end of the doubler board is at the rear of the bracket, adjacent to the output end of the wideband driver board. See Fig.10. The output of the wideband driver board is wired to the input of the doubler board.

(*To be continued*)

Multimeter Resistance

THE CIRCUIT TO BE DESCRIBED IS A SIMPLE EXTRA THAT can be added to a multi-testmeter having a 50μA direct current range. The circuit causes the input resistance to be boosted to valve voltmeter standards.

It must be pointed out that, since the two transistors employed in the circuit have a relatively wide gain spread and are operated at a low voltage, and since the testmeter input resistance may vary for different models of meter, the circuit has to be classed as experimental. It is possible that resistor values other than those specified here may be required in other units built up to the circuit, and construction should only be attempted

COMPONENTS

Resistors
(All fixed values ½ watt 5%)

R1	2MΩ
R2	5MΩ
R3	3MΩ
R4	10MΩ
R5	1MΩ
R6	1kΩ
R7	39kΩ
VR1	1.5kΩ potentiometer, skeleton
VR2	10kΩ potentiometer, wire-wound.

Transistors

TR1	BC169C
TR2	BC169C

Switches

S1(a)(b)	2 pole 3 way, rotary
S2(a)(b)	d.p.s.t., toggle

Batteries

B1	1.5 volt cell type HP7 (Ever Ready)
B2	1.5 volt cell type HP7 (Ever Ready)

Miscellaneous
4 insulated sockets
2 pointer knobs
Twin battery holder
Groupboard, case, etc.,