

SECTION I

INTRODUCTION

The Garex Twomobile is a transmitter-receiver for operation in the 144~146 MHz amateur band. The receiver is fully tunable over the entire band and is capable of receiving both amplitude and frequency (or phase) modulated signals.

A fully transistorised double superheterodyne design is used, incorporating a squelch circuit to eliminate background noise in the absence of a signal. The appropriate detector for FM and AM is selected by a switch mounted on the front panel. FM reception employs an integrated circuit quadrature detector.

The transmitter has a nominal input power to the final power amplifier of 15 watts. The audio and oscillator/modulator units are fully transistorised; the multiplier/driver and power amplifier stages use quick-heat twin tetrodes. The modulation system (phase or amplitude) is selected by a front-panel switch, which is independent of the receiver mode switch, thus readily allowing cross-mode working.

The equipment is designed to operate from a nominal 12 volts D.C. supply, conveniently supplied from a vehicle battery. For fixed-station use, a mains-driven power supply delivering 12 volts D.C. (stabilised) at 5 Amps, maximum is required. (Under stand-by conditions the current consumption is about 0.25 Amps.)

All of the operator's controls are mounted on the front panel. An external loudspeaker is used, any 3 to 5 ohm type being suitable.

SUMMARY OF DATA

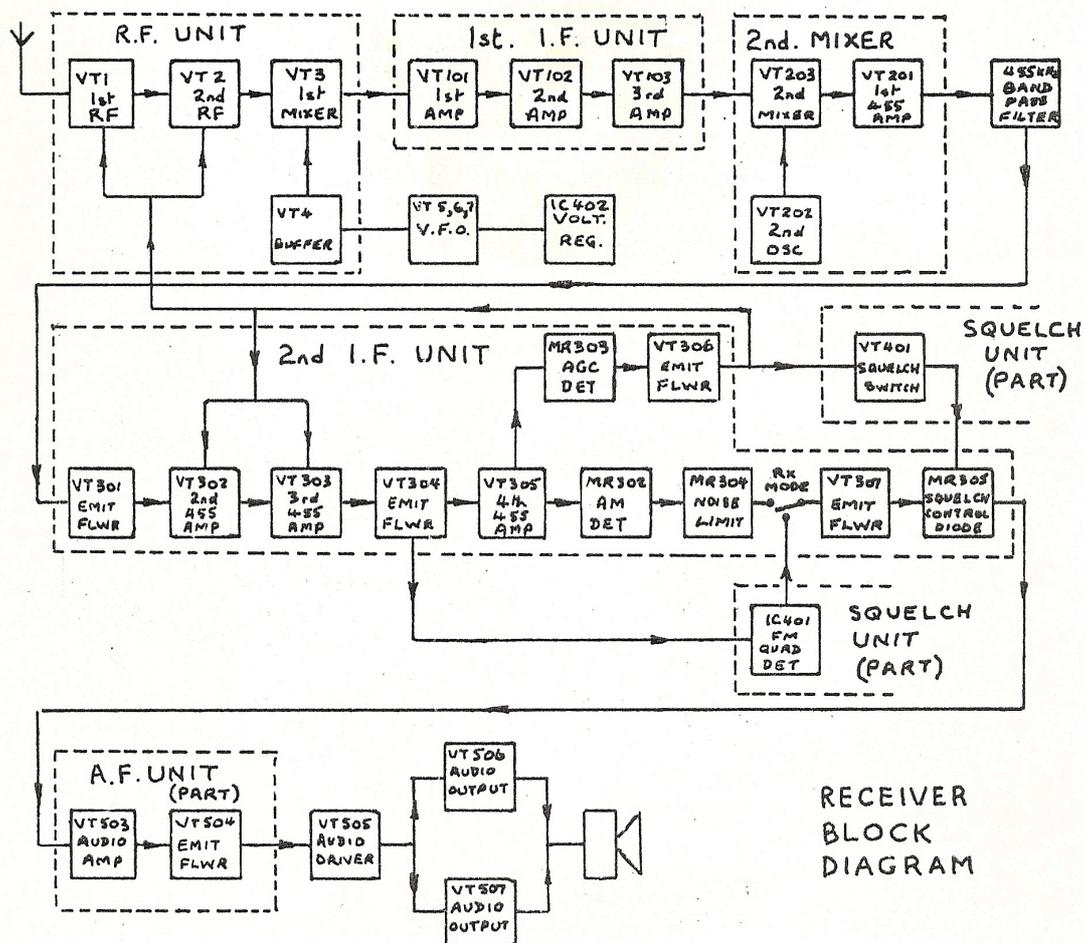
Service	A3 or F3 telephony
Frequency range	144-146 MHz
Bandwidth	10 kHz (± 5 kHz) at 6 dB down
Power supply	12 volts D.C. (nominal) Positive or negative ground, or floating
Power Consumption	RX: 200mA (no signal) TX (AM) 5 Amps. (FM) 4 Amps
Controls	Power off - Standby - Spot check switch VOLUME control SQUELCH control CHANNEL selector switch RECEIVER TUNING Tx mode (FM or AM) Rx mode (FM or AM) Transmit button (on microphone) Tone selector switch (if fitted)
Dimensions	12½" x 5½" x 9" deep
Weight	12½ lbs. (5.7 kg)
Optional features	Tone burst generator (1700 or 1750 Hz) Up to 6 transmit channels
RECEIVER	
Sensitivity	1 microvolt p.d. input for 500 mW audio output with signal-to-noise ratio of 12 dB.
Audio output	1 watt with less than 10% distortion
Intermediate frequencies	1st I.F. 10.7 MHz. 2nd I.F. 455 kHz, with band pass block filter.
Squelch	An electronic squelch circuit is fitted; it is carrier operated, and can be adjusted to cut background noise in the absence of a signal.
TRANSMITTER	
Power	15 watts input (nominal) to the final power amplifier stage.
Modulation	a) High level amplitude modulation. b) Phase modulation, adjustable up to 15 kHz deviation, normally set to 3kHz

SECTION II

CIRCUIT DESCRIPTION

RECEIVER

An all-transistor double super heterodyne circuit is used* Two r.f. amplifiers are followed by a low-noise F.E.T. mixer; the first local oscillator is variable over a 2MHz range to allow tuning over the Two metre band. The first I.F. is 10.7 MHz which is amplified in three stages and passed to the second mixer, also an F.E.T.; the second local oscillator is crystal controlled at 10.245 MHz, producing the second IF of 455 kHz. The second i.f. is amplified and passed through a bandpass block filter, after which there are a further five, stages of amplification. Amplitude modulated signals pass via the detector and noise limiter to the mode selection switch. Frequency modulated signals are taken from the fourth amplifier stage and processed by an integrated circuit quadrature detector. The resultant audio is fed to the mode switch. From this switch the audio passes via the squelch gate to the audio amplifier and output stages.



DETAILED DESCRIPTION

R.F. Unit

The antenna changeover relay contacts RLA 1 connect the signal input to the r.f. amplifiers VT 1, VT 2 which is coupled to the P.E.T. mixer VT 3 by the tuned circuit L 4. The local oscillator frequency is generated by a temperature compensated F.E.T, variable frequency oscillator having a 2 MHz tuning range. Buffer stages, including VT 4f isolate the wanted frequency. The output from VT 3 is the first i.f. of 10.7 MHz.

1st I.F. Unit

VT101, VT102, VT103 are transformer coupled cascade amplifiers at 10.7 Mhz. The output is coupled by transformer T104 to the second mixer VT203.

2nd Mixer Unit

The mixer F.E.T. VT203 combines the 10.7 MHz first i.f. with the 10.245 MHz output from the local oscillator VT202, producing the 2nd i.f. of 455 kHz, which passes through a single stage amplifier VT201 to the 455 kHz bandpass filter.

455 kHz Bandpass Filter

This filter is a sealed unit which determines the selectivity of the receiver. The band width is 10 kHz (\pm 5kHz) which allows a good compromise between selectivity and satisfactory resolution of frequency modulated signals with a peak deviation of up to \pm 3 kHz.

2nd I.F. Unit

The output from the bandpass filter is coupled to the two amplifying stages VT302, VT303 and emitter followers VT301, VT 304.' When receiving amplitude modulated signals a third amplifying stage VT305 is used, transformer T302 in its collector circuit has two secondary windings, which are connected respectively to the signal detector MR302 and the a.g.c. detector MR303. The rectified output from MR303 is fed back via emitter follower VT306 as a.g.c. bias to the r.f. stages VT1, VT2, and the i.f. amplifiers VT302, VT303.

The rectified output from MR302 passes through the noise limiter MR304 to the receiver mode selection switch fs2).

Frequency modulated signals are taken from the emitter of VT304 to the input of the quadrature detector IC402. The audio output from IC402 is taken to S2. Audio then passes to the emitter follower VT307 and the squelch diode MR305.

Squelch Unit

VT401 is a switching stage controlled by the a.g.c. bias level. Under no signal conditions VT401 maintains the cathode of MR305 at a level less negative than its anode, which is controlled by VT307, thereby MR305 is prevented from conducting. When a signal is received the a.g.c. voltage becomes less negative allowing MR305 to conduct and

permit the audio to pass to the volume control and audio amplifying stages. The setting of VR1 (located on the front panel) determines the emitter voltage of VT401, and thus the level at which the squelch operates.

AF Section

The a.f. from the volume control VR2 (located on the front panel) is amplified by VT503 and coupled via the emitter-follower VT504 to the driver VT505. Phase splitting transformer T502 in the collector of VT505 drives the push-pull output stage VT505, VT507. T503 is the loudspeaker output transformer.

TRANSMITTER

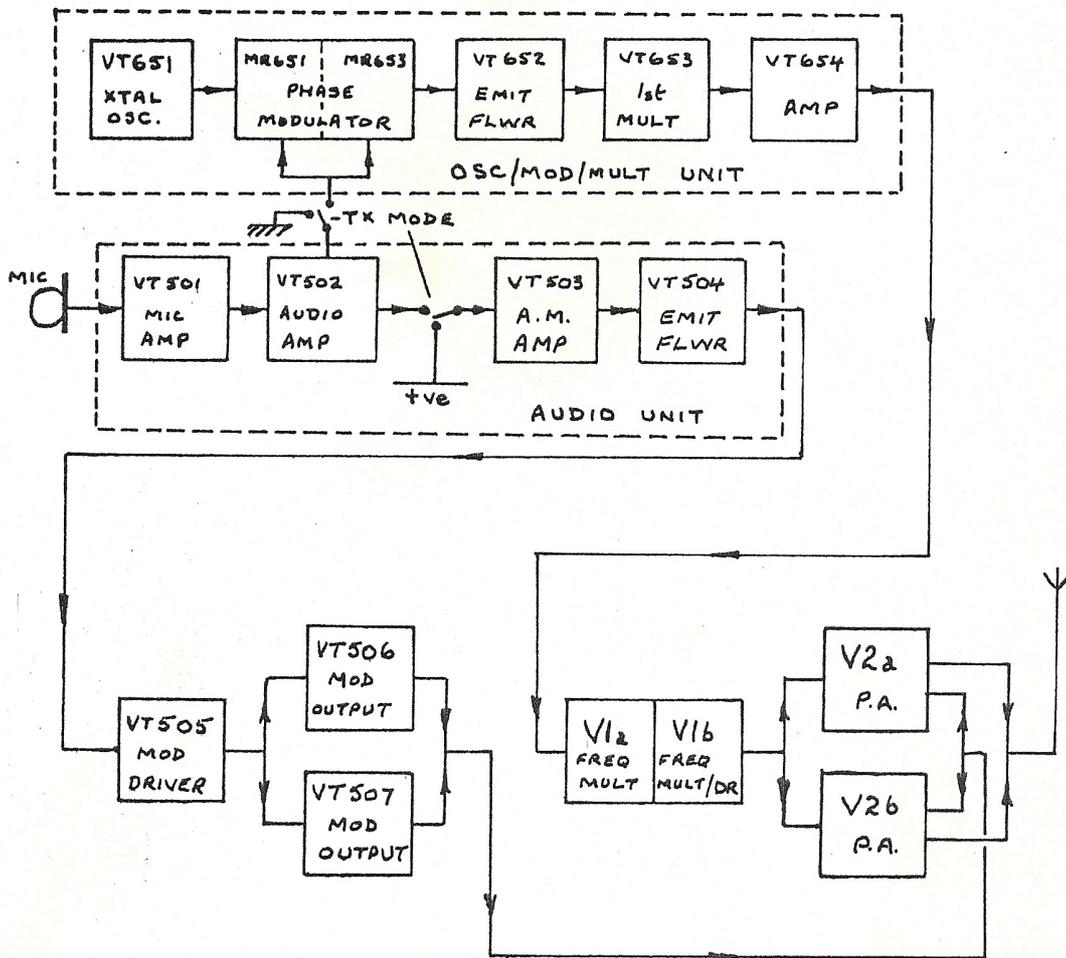
The r.f. section of the transmitter comprises a transistorised crystal oscillator and multipliers. The multiplier/driver and r.f. power amplifier use quick-heat tetrodes.

Phase Modulation

The output from the crystal oscillator is phase modulated by the variable capacitance diodes and multiplied by the following stages.

Amplitude Modulation

The a.f. section (part of which is used in the receiver) provides anode and screen modulation of the transmitter power amplifier.



BLOCK DIAGRAM OF TRANSMITTER

DETAILED DESCRIPTION

R.F. Section

The transistor VT651 is a crystal-controlled oscillator; the required crystal and trimming capacitor are switched into circuit by the channel switch, S4 (located on the front panel). The oscillator is capacity coupled to the phase modulator which is tuned to the crystal frequency. When using phase modulation the microphone output is amplified by VT501, VT502 and the resultant output, limited by MR501, and MR502, is connected to the variable capacitance diodes MR651 and MR653. Capacitance changes at these diodes due to the audio input results in phase modulation of the carrier.

The audio input to these diodes is shorted out when using amplitude modulation.

The emitter follower VT652 matches the impedance of the phase modulator to the frequency multiplier and buffer stages* VT654 is coupled by means of a pi-network to the two final multiplier stages Via and V1b. The power amplifier V2 is a twin tetrode operating in push-pull, the output from its tank circuit is fed to the antenna via the coupling coil L609 and the relay contact RL1«

A.F. Section (Phase modulation)

Output from the microphone is amplified by VT501 and VT502 coupled by T501 to the series diodes MR501 and WR502 which limit the audio, and hence the peak deviation. After limiting, the audio is taken through a low-pass filter, integrated by R514 and C508, and via the peak deviation control VR|501 to the variable capacitance diodes MR651 and MR653.

A.F. Section (Amplitude modulation)

The microphone output is amplified as described above. After limiting, the audio, passes to the potential divider R545 and R546. The required audio level from the divider is fed via the relay contacts RLB2 to the amplifier and driver stages 7T503, VT504, VT505. The phase-splitting transformer T502 couples the driver to the push-pull stage VT506, VT507. The relay contacts RLB3 and RLB4 connect the output from the push-pull stage to the modulation transformer T504. A secondary winding on T504 provides anode and screen modulation of the r.f. power amplifier V2.

Modulation Switching

Switch S3 (located on the front panel) selects the required modulation mode. In the phase modulation position the output from the potential divider R545 and R546 is shorted out by S3a effectively blocking the passage of audio to the amplitude modulation stages.

In the amplitude modulation position S3b shorts the peak deviation control VR501, preventing audio from reaching the variable capacitance diodes MR651 and MR653.

POWER SUPPLY SECTION

The 12v D.C. supply is connected to the equipment via the 7A fuses FS1, FS2. and the power switch S1 on the front panel. When the equipment is switched on the positive and negative sides of the supply are connected to the receiver and the green lamp illuminates. The positive side of the supply is connected to the D.C, converter.

The D.C. converter consists of VT701, VT702 in a push-pull blocking oscillator circuit. A.C. is developed in the secondary of T701, rectified by a full-wave bridge rectifier MR701(a-d) and smoothed by L701, R701, C702a and C702b. Another secondary winding provides heater supplies for V601, V602 via a choke-capacitor filter.

When the transmit button on the microphone is pressed the transmit relay RLB is energised, RLB1 changes over to break the negative supply to the receiver and connects it to the converter to provide the h.t. and heater supplies to the transmitter valves.

The red Tx lamp is connected in parallel with the energising coils of RLA and RLB and illuminates when the microphone switch is operated.

Reversed Polarity Protection

A silicon rectifier MR702 is connected across the D.C. supply and is normally non-conducting. If the supply polarity is reversed, MR702 will conduct and blow one or both of the supply fuses. It is vital that the correct fuses are fitted (7A rating).

RELAYS

The coils of the relays RLA and RLB are each connected to the negative side of the 12v supply. The positive side is connected to the relays via the microphone press-to-talk switch.

RLA is the antenna changeover relay and transfers the antenna connection from the receiver input to the transmitter output.

RLB is the transmit relay.

RLB1 transfers the 12v negative supply from the receiver to the D.C. converter.

RLB2 transfers the input connection to the audio amplifier (VT50.3) from the receiver volume control to the output from microphone preamplifier (VT502).

RLB3/RLB4 transfer the a.f. output from the loudspeaker transformer T503 to the modulation transformer T504.

SECTION III

OPERATION

Before operating the equipment, remove the outer case and check that all valves, crystals, lamp holders and hinged printed circuit "boards are firmly seated in position and that no damage has occurred in transit.

The outer case is secured by the 6BA screw located at the top centre of the front panel. The feet beneath the case should also be removed by unscrewing their 6BA screws, to avoid fouling the lower edge of the rear panel. The unit may now be withdrawn from the case in a forward direction, taking care that the flange at the top front of the case does not foul components mounted high in the chassis assembly, in particular the power switch, audio smoothing electrolytic and voltage regulator panel (if this is fitted above the modulation transformer).

To reassemble, reverse the procedure, ensuring that the correct number of packing washers are used on the screws fixing the feet.

The red supply lead must be connected to the positive terminal of the 12v D.C. supply and the black supply lead to the negative. Reversal of these connections will blow one or both of the 7A fuses. It is important to ensure that the correct rating and type of fuse is used as a replacement.

The test voltage for alignment and test purposes is 13»2v measured at the input to the equipment.

Receiver

Connect a 3-5 ohm loudspeaker to the terminal block on the outside of the rear panel. With the 12v D.C. supply connected as above, turn the power switch to 'ON', The green pilot light should illuminate and upon turning the squelch and volume controls in a clockwise direction receiver noise should be heard. Connect a suitable antenna (50 ohm impedance) to the antenna socket. The tuning dial is directly calibrated for the 2 metre band. Set the Rx mode switch to 'FM' or 'All' as required. For general band-searching it is suggested that this switch be kept in the 'FM' position; signals are then easily located by the quietening of the background noise when tuned to the centre of the carrier. AM signals are resolved instantly by switching modes. When receiving frequency modulated signals having a deviation in excess of \sim kHz some distortion will result.

To silence the Rx noise in the absence of a signal turn the squelch control carefully anticlockwise until muting just occurs.

Transmitter

Do not operate the transmitter unless an antenna or dummy load is connected to the antenna socket.

Select the appropriate crystal by setting the channel switch on the front panel. Turn the power switch to 'SPOT¹' and tune the receiver to the nominal transmitter frequency. A strong carrier should be heard. Reset the power switch to 'ON¹', when the carrier should disappear.

Select the required transmit mode, listen briefly to the receiver to verify that the selected channel is clear, then press the transmit button on the microphone. It should be possible to hear a whine from the D.C. converter. Wait for approximately one second for the quick-heat valves to reach operating temperature, then speak at normal voice level across the face of the microphone at a distance of 2-3 inches (do not speak directly at the face of the microphone).

When first using a particular antenna system the transmitter should be correctly loaded to the antenna as follows: using a field strength meter or reflectometer adjust the antenna trimmer (accessible through the side of the case) for maximum radiation.

The Twomobile transmitter is designed for intermittent operation, especially when using amplitude modulation, long periods of transmission should be avoided. If used as a fixed station, where long periods of transmission are more prevalent than under mobile conditions there is some merit in reducing the power input to the final power amplifier by about 20% (see Tx adjustments). Adequate ventilation, especially of the P. A. and driver area is essential.

SECTION IV

SERVICING & TESTING

Do not attempt realignment without adequate test equipment. Remember that most faults do not necessitate realignment! The majority of faults can be located readily with simple test equipment and a logical approach.

General Checks

Remove the case as described in Section III and carry out a physical inspection for obvious defects.

Check the supply voltage at the input to the equipment.

Check the antenna and connections.

Receiver

Locate the positive and negative supply inputs to each Rx board and check that the appropriate voltage is present. Typical voltages at various points are shown on the circuit diagrams. For the detailed alignment procedure, refer to the receiver alignment chart.

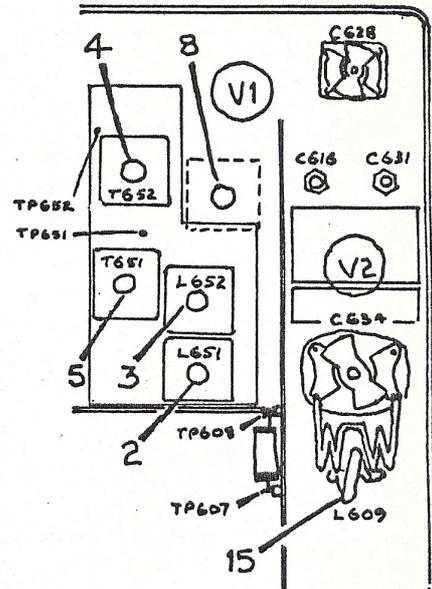
Transmitter

Typical voltages at various points are shown on the circuit diagram.

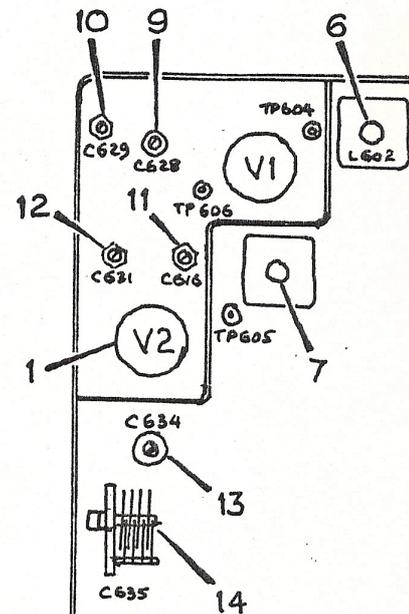
The transmitter should maintain its performance over a bandwidth of about 500 kHz, some adjustments to the tuning of the r.f. stages will be necessary when changing to a different segment of the 2 metre band. Refer to the transmitter alignment chart for details.

TRANSMITTER ALIGNMENT CHART

REF	TEST POINT	ADJUSTMENT	TYPICAL READING
1		REMOVE V2	
		CONNECT METER (2.5V RANGE) BETWEEN TP AND -VE.	
2 & 3	TP 651	SET CORES IN MID POSITION ADJUST ALTERNATELY (1/2 TURN AT A TIME) INTO BOARD UNTIL INDICATION IS OBTAINED THEN ADJUST ALTERNATELY FOR MAXIMUM	+ VE
5	TP651	ADJUST FOR MINIMUM (DIP)	
		CONNECT METER (2.5V RANGE) BETWEEN TP652 AND -VE.	
4	TP652	ADJUST FOR MAXIMUM	
5	TP652	ADJUST FOR MAXIMUM	+0.5VOLT
		CONNECT METER (2.5V RANGE) BETWEEN TP604 & CHASSIS.	
6	TP604	ADJUST FOR MAXIMUM	-0.5VOLT
		CONNECT METER (2.5V RANGE) BETWEEN TP605 & CHASSIS	
7	TP605	ADJUST FROM TOP OF CHASSIS FOR INDICATION	-VE
8	TP605	ADJUST FROM UNDERSIDE OF CHASSIS FOR MAXIMUM	
7 & 8	TP605	ADJUST ALTERNATELY FOR MAXIMUM	-0.7VOLT
1		REPLACE V2	
		CONNECT POWER OUTPUT METER TO ANTENNA SOCKET. CONNECT METER (2.5V RANGE) BETWEEN TP606 & CHASSIS.	
9	TP606	ADJUST FOR INDICATION	-VE
9 & 10	TP606	ADJUST TOGETHER FOR MAXIMUM	
11 & 12	TP606	ADJUST TOGETHER FOR MAXIMUM	-1.5VOLT
13		ADJUST FOR MAXIMUM RF OUTPUT.	
14		ADJUST FOR MINIMUM RF OUTPUT	
		CONNECT METER (2.5V RANGE) BETWEEN TP607 AND TP608	
13	TP607 TP608	ADJUST FOR MINIMUM	<0.5VOLT
14	TP607 TP608	ADJUST FOR MAXIMUM RF OUTPUT. CHECK THAT METER READING IS BETWEEN +0.55 AND +0.65 VOLT	5 WATTS MINIMUM
		IF METER READING OR RF OUTPUT IS NOT WITHIN LIMITS REPEAT FOLLOWING PROCEDURE UNTIL 5 WATTS RF OUTPUT IS OBTAINED WITH A METER READING OF +0.55 TO +0.65 VOLT	
15		REMOVE PA BOTTOM COVER ADJUST ANTENNA COUPLING COIL TO OBTAIN MAXIMUM RF POWER WITHIN ABOVE VOLTAGE LIMITS. REPLACE COVER AND REPEAT FROM REFERENCE 9 ONWARDS	



UNDERSIDE OF CHASSIS

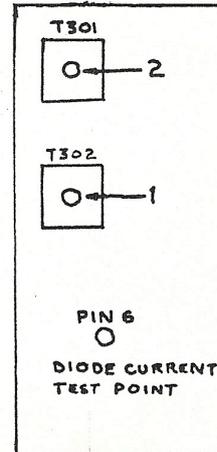


TOP OF CHASSIS

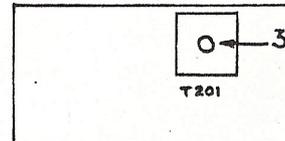
NB. ADJUSTMENTS UP TO REF. 5 MAY BE CONDUCTED WITH THE 'POWER' SWITCH IN THE 'SPOT' POSITION INSTEAD OF PRESSING THE MICROPHONE BUTTON.

RECEIVER ALIGNMENT CHART

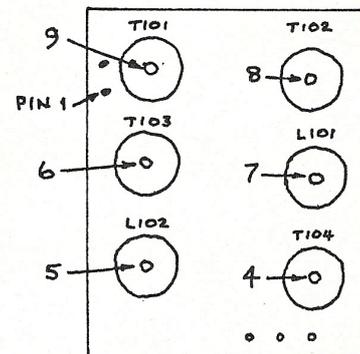
REF	ADJUSTMENT
	SET THE RECEIVER MODE SWITCH TO 'AM' SET THE TUNING DIAL TO 195.0 MHz CONNECT A TEST METER (50µA RANGE) BETWEEN THE DIODE CURRENT TEST POINT AND +VE LINE. CONNECT THE SIGNAL GENERATOR TO THE ANTENNA SOCKET AND ADJUST THE FREQUENCY AND OUT- PUT TO OBTAIN A METER READING OF ABOUT 10µA. DURING THE ALIGNMENT OPERATION REDUCE THE OUTPUT OF THE GENERATOR TO PREVENT THE METER READING EXCEEDING 16µA.
1&2	ADJUST FOR MAXIMUM DIODE CURRENT. HINGE UP 2nd I.F. UNIT
3	ADJUST FOR MAXIMUM DIODE CURRENT REPLACE AND LOCK 2ND I.F. UNIT
4 to 9	ADJUST IN SEQUENCE FOR MAX. DIODE CURRENT CONNECT METER (1mA RANGE) IN PLACE OF LINK BETWEEN PIN 1 OF 1st. I.F. UNIT AND PIN 3 OF RF. UNIT.
10 & 11	ADJUST FOR MAXIMUM METER READING (0.7 mA APPROX) REMOVE TEST METER AND REPLACE LINK RECONNECT METER TO DIODE CURRENT TEST POINT AS ABOVE.
12 to 15	ADJUST IN SEQUENCE FOR MAXIMUM DIODE CURRENT SET RECEIVER MODE SWITCH TO 'FM' HINGE UP 2nd I.F. AND AUDIO BOARDS ADJUST FREQUENCY AND OUTPUT OF SIGNAL GENERATOR TO OBTAIN NOISE QUIETING OF AUDIO OUTPUT
16	ADJUST FOR MAXIMUM AUDIO OUTPUT
17	CHECK THAT VOLTAGE AT PIN 8 OF IC401 IS APPROXIMATELY -5 VOLTS WITH RESPECT TO +VE LINE REPLACE AND LOCK 2nd I.F. AND AUDIO UNITS
12 to 15	CHECK THE RECEIVER PERFORMANCE AT DIAL SETTINGS 144.0 MHz AND 146.0 MHz. STAGGER-TUNE TO GIVE AN EVEN PERFOR- MANCE OVER THE BAND IF NECESSARY



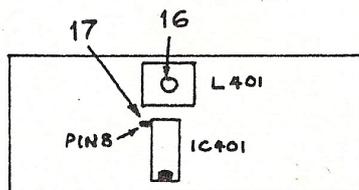
2nd I.F. UNIT



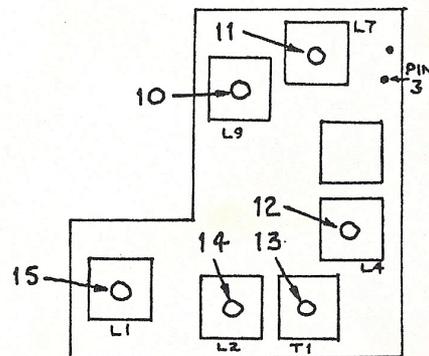
2nd MIXER UNIT



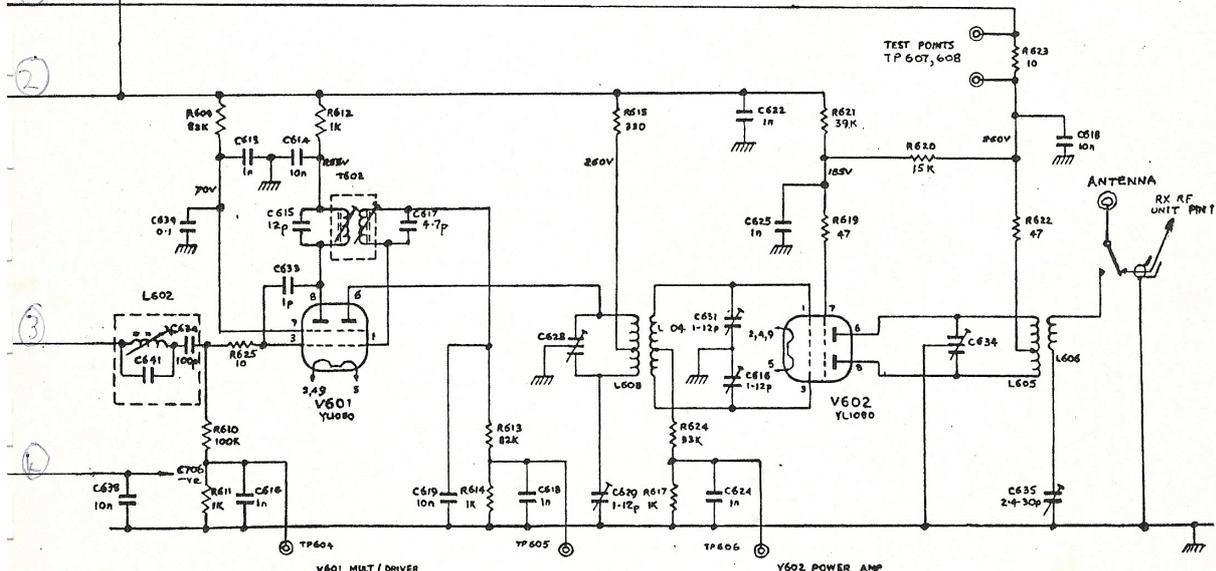
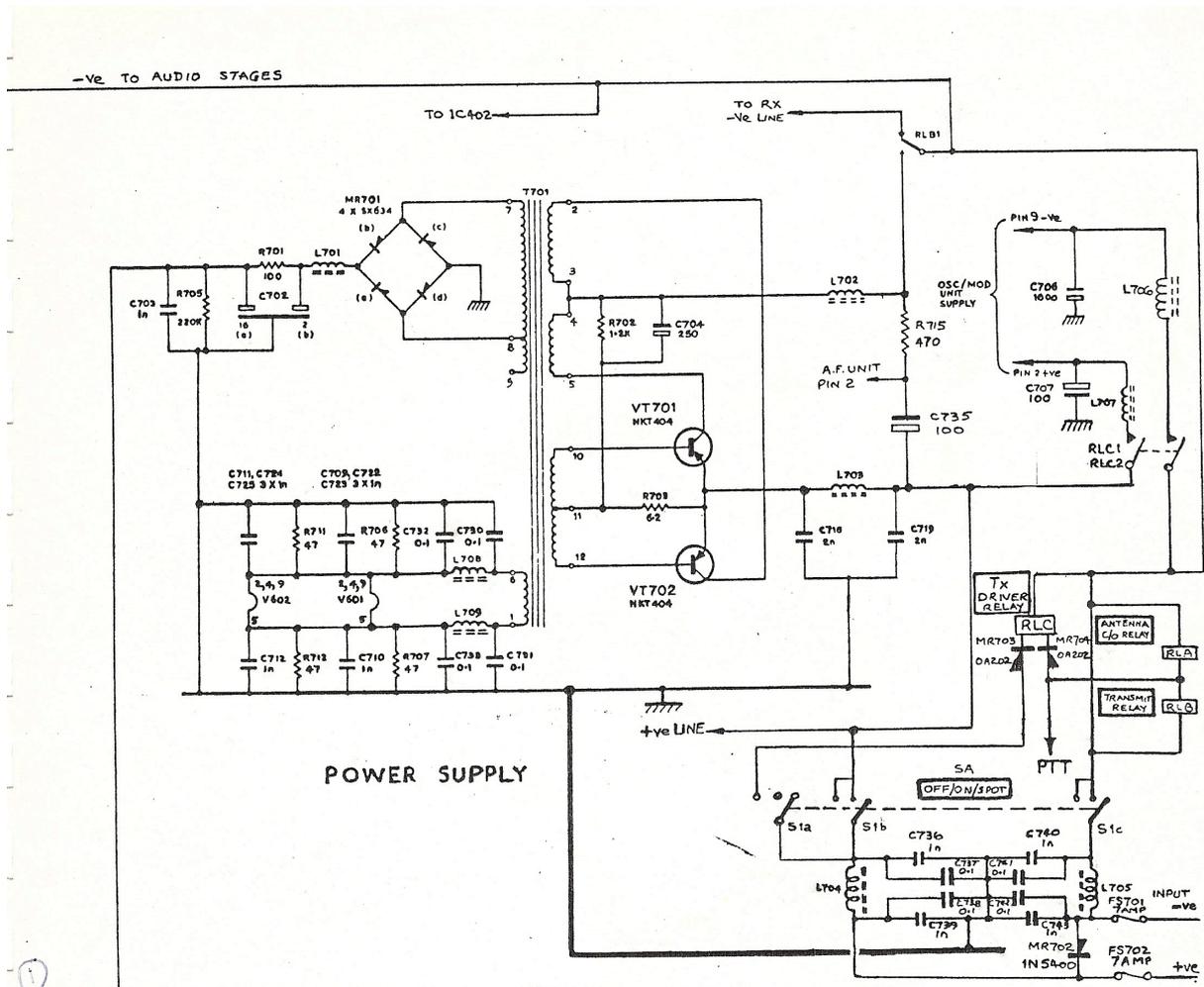
1st. I.F. UNIT



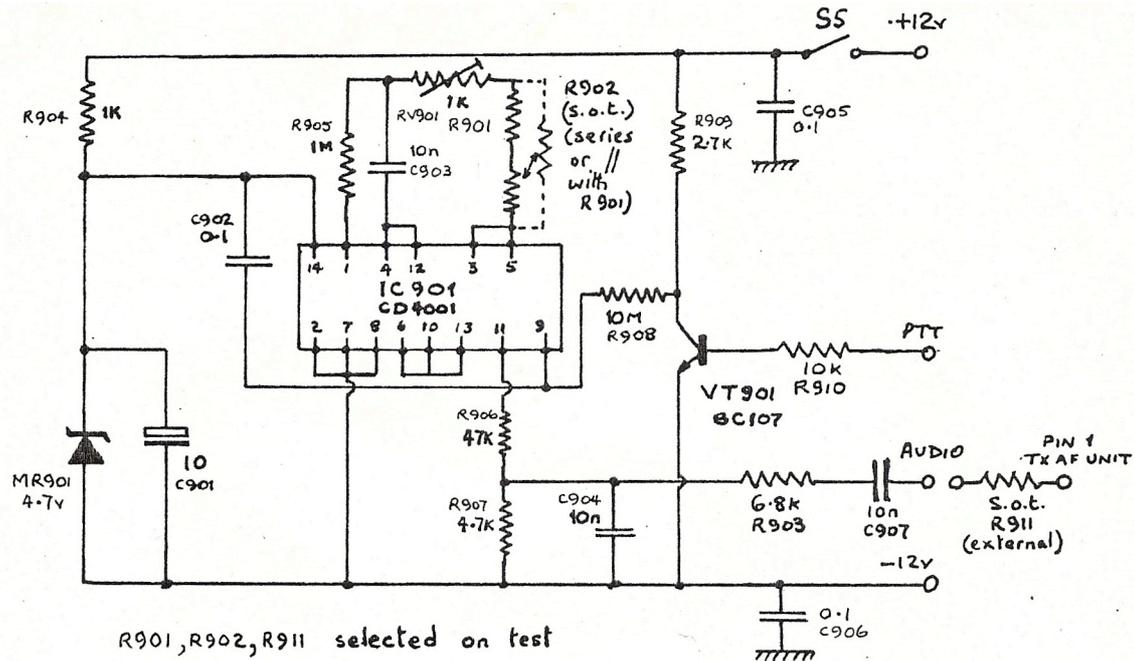
F.M. DETECTOR



R.F. UNIT



TONE-BURST GENERATOR



Circuit Features

IC901 is a quad 2-input NOR gate. Two gates are used in an RC oscillator network with R901, R902, R905, RV901 and C903. The third and fourth gates switch the output of the oscillator to the TX audio stages.

In the standby mode VT901 is non-conducting and C902 has both ends effectively connected to the positive supply rail via R908 and R909, and is thereby discharged resulting in the switching gates being open, which allows the tone to pass to the TX audio stages via the output load resistor R906, R907 and the de-emphasis network C904, R903.

When the PTT contact is made to the positive rail, VT901 is switched on, causing its collector potential to drop almost to zero, C902 then charges at a rate controlled by R908 until the logic level of the switching gates changes to block the passage of the tone. The delay while C902 charge gives the required tone-burst.

With switch S5 in the 'TONE' (ON) position, a tone-burst will be transmitted automatically each time the PTT contact is operated.

Adjustment

Using a suitable frequency measuring instrument check the tone frequency. A suitable connection point, giving approximately 0.5 volts of audio, is across the "PEAK DEVIATION" potentiometer RV501 on the TX audio board. Disconnect the "PTT" lead from the tone-burst generator at the microphone termination panel (this will disable the timing circuit). Set S5 in the 'TONE' (ON) position and operate the PTT contact. Adjust. RV901 for the required 'frequency.'

R911 should be adjusted to give the required carrier deviation, having first set RV501 for normal speech levels.