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T540 Mobile Two Way Radio

UHF FM 175-225MHz

PROVISIONAL

(TM-540)

Issue A

TECHNICAL INFORMATION

For further information about this manual, or the equipment it describes, contact Product Distribution Group, Tait Electronics Ltd, at the above address.

UPDATING EQUIPMENT AND SERVICE MANUALS

In the interests of improving performance, reliability or servicing, Tait Electronics Ltd reserve the right to update their equipment and/or Service Manuals without prior notice.

SCOPE OF MANUAL

This manual covers the 'General', 'Technical' and 'Servicing' Information on the T540 mobile two way radio.

Ordering Tait Service Manuals

When ordering Tait Service manuals quote the Tait Internal Part Number (IPN) (and where applicable the version) viz;

IPN TM-540 T540 Service Manual (All Versions).

Issue A Published November 1985 (Provisional)

CONTENTS

SECTION 4 INSTALLATION

SECTION 5 SERVICING

LIST OF ILLUSTRATIONS

DIAGRAMS

SECTION 1 GENERAL INFORMATION

1.1 INTRODUCTION

The T540 is a high performance, synthesized mobile two way radio with a nominal RF power output of 25 watts. It is intended for operation in the 175 to 225MHz frequency range with channel spacing increments of 6.25kHz, bandwidth of 15kHz or 7.5kHz and transmitter deviation of ±5kHz maximum. The standard set has a two channel capacity.

Operation of the T540 is by hand held microphone and press-to-talk switch, plus five front panel mounted controls, 'Volume', 'Squelch', 'Channel Change', 'Call' and 'On/Off switch'. Visual indication of 'Channel Selected', 'Transmit', 'Busy' and 'Call' (if Selcall is fitted) is by illuminated front panel display.

Provision is made for Selcall and CTCSS to be incorporated within the case of the T540.

The two injection moulded plastic covers and the plastic front panel can be easily removed to expose both sides of the printed circuit board for ease of servicing.

The T540 employs the dual modulus system of frequency synthesis. Channel information is held on a plug-in diode matrix board which can be field programmed with a pair of diagonal cutters.

The dual conversion receiver employs both discrete components and integrated circuits. It also includes a signal-to-noise ratio operated squelch circuit. The receiver delivers approximately 4 watts of audio power to a 4 ohm speaker.

The transmitter VCO provides about 10 milliwatts of frequency modulated RF drive to the five stage broad band RF power amplifier. An audio processor provides modulation level control and deviation limiting and a transmit timer returns the T540 to receive after approximately one and a half minutes of transmission.

The T540 is light and compact and is supplied with a versatile mounting system to allow easy installation in any vehicle. Mains operation is possible when the T540 is used with the T508 power supply.

The DC supply to the set must be negative earth and may be between 10.8 and 16 volts. The T540 is protected against reversal of the DC supply polarity.

1.2 SPECIFICATIONS

1.2.1 GENERAL

The performance figures given are typical figures, unless otherwise indicated, for equipment tuned with the maximum switching band and operating at standard room temperature (22°C to 28°C). Unless otherwise indicated, the figures apply to all versions.

Where applicable the test methods used to obtain the following performance figures are those described in the UK Department of Trade and Industry Specification MPT1323.

Details of test methods and the conditions which apply for type approval testing in all countries can be obtained from Tait Electronics Ltd.

Modulation Type	.. Frequency Modulation
Frequency Range	.. 175 to 225MHz
Channel Separation:	
Narrow Band (T540C)	.. 12.5kHz
Wide Band (T540B)	.. 25kHz
Frequency Increment	.. 6.25kHz (minimum)
Number Of Channels	.. 2
Switching Range:	
Transmitter & Receiver	.. 8MHz
Supply Voltage:	
Operating Range	.. 10.8 to 16 Volts DC
Standard Test Voltage	.. 13.8 Volts DC
Polarity	.. Negative earth only
Polarity Protection	.. Internal crow-bar diode
Supply Current:	
Receiver-Squelched	.. 150mA
Receiver-Full Audio	.. 700mA
Transmitter	.. 5.5 Amps
Antenna Impedance	.. 50 ohms
T/R Change-over Switching	.. Solid State
Operating Temperature Range:	
Standard	.. -10°C to +60°C
With crystal heater (/9 versions)	.. -30°C to +60°C

Dimensions:

Length	.. 225mm
Width	.. 150mm
Height	.. 45mm
Weight	.. 1.2kg

1.2.2 RECEIVER

Type	.. Dual conversion superhet
I.F Amplifiers:	
Frequencies	.. 21.4MHz and 455kHz
Bandwidth:	
Narrow	.. 7.5kHz
Wide	.. 15kHz
Sensitivity:	
12dB Sinad	.. -120dBm (0.22µV pd)
20dB Sinad psophometrically weighted	.. -1dBµV emf (-114dBm)
Signal-to-Noise Ratio:	
Narrowband	.. 32dB
Wideband	.. 35dB
(RF: -107dBm, modulated at 1kHz to full system deviation)	
Selectivity (adjacent channel)	.. 70dB
Spurious Response Attenuation	.. 75dB
Intermodulation Response Attenuation	.. 75dB
Spurious Emissions:	
Conducted	.. -60dBm
Audio:	
Output into internal 8 ohm speaker	.. 2 watts
Output into external 4 ohm speaker only	.. 4 watts
Distortion (at rated power)	.. 2%
Minimum Load Impedance	.. 2 ohms
Audio Response (all versions)	.. Within +1, -3dB of a 6dB/octave de-emphasis characteristic (ref. 1kHz)
Audio Bandwidth:	
Version /3	.. 450Hz to 3kHz
Squelch:	
Sensitivity	.. 6dB to 20dB Sinad
Ratio	.. 70dB

1.2.3 TRANSMITTER

Power Output	.. 25 watts
Transmit Timer	.. 1.5 minutes
Frequency Stability	.. (ref. 1.2.4)
Mismatch Capability:	
Stability	.. VSWR < 5:1 (all phase angles)
Ruggedness	.. 2 minute transmit into infinite VSWR (all phase angles)
Spurious Emissions:	
Conducted	.. -26dBm
Adjacent Channel Power	
Narrowband	.. 65dB below carrier
Wideband	.. 80dB below carrier
Modulation System	.. Direct FM
Deviation Response:	
In limiting: 500Hz to 3kHz (/3 version)	.. Within +0dB, -4dB of max. system deviation
Below limiting: 500Hz to 3kHz (/3 version)	.. Within +1, -3dB of 6dB/octave pre-emphasis (ref. 1kHz)
Frequencies above 3kHz	.. Greater than 25dB/octave roll-off
Deviation Limiting	.. ±5kHz (peak) maximum Adjustable to ±5kHz
Audio Input For Maximum Deviation	.. 1mV rms at 1kHz
Audio Distortion (Modulated at 1kHz to 60% of maximum deviation)	.. 2%
Hum & Noise (below ±3kHz peak deviation)	.. 45dB

1.2.4 FREQUENCY REFERENCE

Crystal Type:	
± 5ppm (-10°C to +60°C)	.. TE/9
± 5ppm (-30°C to +60°C)	.. TE/9 plus crystal oven
Crystal heater warm-up time (below 0°C)	.. 1 minute
Oscillator frequency:	
For channel spacing at multiples of 6.25kHz	.. 12.8MHz

1.3 VERSIONS

1. T540C/3 — 174-225MHz frequency range
   7.5kHz IF bandwidth
   6.25kHz frequency increments
   2.5kHz deviation
   (UK)

1.4 OPERATING INSTRUCTIONS

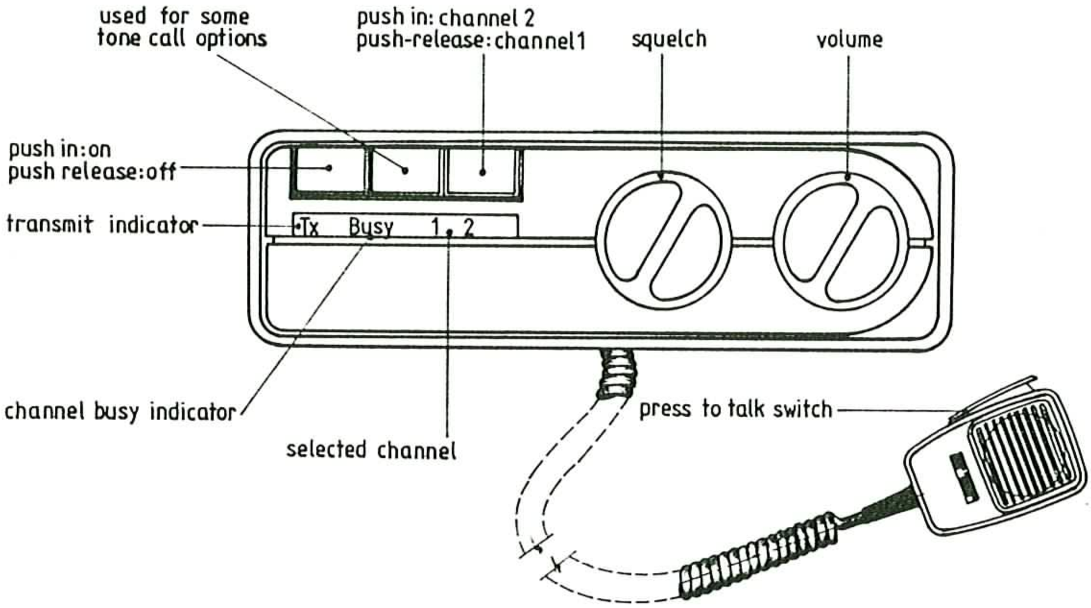


Figure 1 Front Panel Layout

To receive:

a) The front panel display will indicate which channel has been selected.

b) Turn the squelch control clockwise until noise is heard, then turn it anticlockwise 5° beyond the point at which the receiver quietens.

Note: Where CTCSS is used without a hook monitoring facility, it will be necessary to view the 'Busy' indicator when setting the squelch.

To transmit:

a) Check that the channel is vacant before transmitting.

b) Close the press-to-talk switch before beginning to speak.

c) The T540 will automatically revert to receive after 1.5 minutes of transmission. To continue transmitting, release, then close the press-to-talk switch.

d) Always replace the microphone in the clip when not in use.

SECTION 2 CIRCUIT OPERATION

Refer to the Block Diagram and Circuit Diagram (A1C523) at the rear of this manual.

2.1 SYNTHESIZER

The dual modulus synthesizer of the T540 features separate on-frequency VCOs for receive and for transmit. Each VCO consists of a J-FET oscillator buffered by a dual gate MOSFET. The transmit VCO is frequency modulated by the application of audio to the varicap diode D51.

A crystal provides a stable reference frequency of 12.8MHz which is divided down to 6.25kHz and fed to one input of a phase comparator within IC8. Alternately a 10.24MHz crystal is used to give a 5kHz reference where channel spacing in multiples of 5kHz is required. For applications which require high frequency stability over a wide temperature range, a crystal heater is added. The crystal and heater are mounted on the LED board.

The VCO frequency is divided by the 40/41 prescaler, IC9, and then further divided within IC8 to provide the other input to the phase comparator. The division ratio in IC8, and hence the channel frequency, is determined by the diode matrix board.

The phase comparator output (pins 7 & 8 of IC8) is fed to both VCO varicaps via the speedup circuit (Q27, Q28) and the loop filter (R181, C177, R183, C178). Then to either varicap D35 via R187 & C186 on receive, or to varicap D50 via R233 & C226 on transmit.

2.2 RECEIVER

The RF signal from the PIN switch is amplified by Q15 and fed to the balanced mixer (Q16, Q17) via a triple tuned circuit. 10mW from the receive VCO is fed in antiphase to the gates of the two mixer J-FET's.

The IF output from the mixer passes through the 21.4MHz crystal filter and is amplified by Q18 before being fed to IC7.

IC7 provides the following functions: IF conversion from 21.4MHz to 455kHz with external crystal X1 (CF1 sets the 455kHz IF bandwidth); amplitude limiting; quadrature detection with CD1; and squelch. · Q19 provides additional limiting gain.

Audio from pin 9 of IC7 is de-emphasised by R68 and C55 and is fed through the audio processor (see Section 2.4.2) to the audio output amplifier, IC4a.

2.3 SQUELCH

An input signal to the squelch circuit is obtained from the audio output of IC7 via RV149. This signal has a noise level which is inversely related to the level of an RF signal at the receiver input.

An op-amp within IC7 is used in a band pass filter configuration to select and amplify noise frequencies above the audio band. The centre frequency is approximately 8kHz for the wideband T540 and 4.5kHz for the narrowband version.

The band pass filter output is rectified by Q20 to give a positive going DC voltage which is an inverse function of the RF signal strength.

This DC voltage is then fed to a threshold detector within IC7, in such a way that pin 14 of IC7 is high in the presence of noise and low in the absence of noise. The threshold point occurs at approximately 0.7 volts.

The switching signal from the threshold detector is then inverted by Q7. D9, C17 (when fitted) and R26 provide an extended tail time (to prevent squelch closure during rapid fades) while maintaining a fast opening time.

Q6 drives the squelch element, which is part of the audio processor, and the 'Busy' LED.

2.4 TRANSMITTER

2.4.1 RF STAGES

The 10mW output of the frequency modulated transmit VCO is amplified to a level of 25 watts by a 5 stage broad band amplifier (Q40, Q41, Q42, Q46, Q47). High level RF then passes via the aerial PIN switch through the low pass filter to the aerial connector.

The transmit power output is set at 25 watts by RV256 which, with Q44 & Q45, controls the collector voltage of Q42, and hence the gain of the broad band amplifier. The circuit utilises a power detector, D61, and a feed back loop to hold the transmitter power to 25 watts under conditions of varying supply voltage.

Transistor Q43 prevents the transmitter turning on when the synthesizer is out of lock.

2.4.2 AUDIO PROCESSOR

Transistor Q10 provides microphone preamplification while IC2 provides the necessary gain limiting and filter functions for the audio signal. An automatic level control (ALC) function is performed by detector Q11 and shunt elements D15 and D16. The analogue switches within IC3 allow either transmit or receive audio to be directed through the audio processor. Connection points for CTCSS or Selcall options are shown on the circuit diagram.

2.5 POWER SUPPLY

2.5.1 GENERAL

Note: The T540 is suitable for negative earth applications only.

The unit is protected by a crowbar diode (D1) which will blow the fuse if the supply is reverse connected.

DC is connected to the audio output IC and the transmitter final, driver, and power turn-down stages whenever the T540 is connected to a supply.

2.5.2 CONTINUOUS SUPPLIES

DC from the on/off switch supplies the audio output IC enable and the short circuit protected 9 volt regulator. A continuous 9 volts is applied to the audio processor and synthesizer.

2.5.3 RECEIVE

When the PTT switch is open IC1 turns Q5 on and Q4 off, enabling the following circuits:

that part of the diode matrix board containing receive channel information
receive VCO
receiver
squelch control
IC3b
receive diode in the aerial switch.

2.5.4 TRANSMIT

When the PTT switch is closed IC1 turns Q4 on and Q5 off enabling the following circuits:

that part of the diode matrix board containing transmit channel information
transmit VCO
low power transmitter stages
IC3a and IC3d
transmit diode in the aerial switch

Closing the PTT switch also initiates a timer circuit around IC1 which will return the T540 to receive after 1.5 minutes of transmission.

2.5.5 FREQUENCY INFORMATION

The diode matrix board has four rows of diodes. A row is selected by D44 to D47 and R216 to R219 according to the channel switch position and whether the T540 is in the receive or transmit mode. The channel frequency is selected by removing diodes as described in Table 1 such that the correct pattern of '0's and '1's is presented to IC8.

SECTION 3 ANCILLARY EQUIPMENT

3.1 T508 POWER SUPPLY

The T508 Power Supply will allow operation of a T500 Series two way radio from a 230V (nominal) 50Hz or a 115V (nominal) 60Hz mains supply (specify voltage when ordering).

The T508 is an attractively styled unit which matches the T500 Series two way radios. The radio can be mounted on the T508 to give a compact desk top installation, or they can be separately wall mounted to save desk space.

The T508 provides a 13.8V DC 6.5A (intermittent) regulated supply for the T500 Series two way radios and incorporates current limiting and thermal protection.

3.2 T220/2 REMOTE SPEAKER ASSEMBLY

The T220/2 remote speaker assembly may be used with the T540. It comprises a heavy duty 3 watt speaker mounted in a rugged enclosure which pivots on its mounting bracket. The 3.5 ohm voice coil of the speaker is connected by a short lead terminated in a 2 pin cord mounted connector. The enclosure is compact and easily mounted in any convenient position.

3.3 TA-500/2 TONE

The TA-500/2 Tone is a two tone signalling unit which allows a T500 Series two way radio to be selectively called by a suitably equipped base radio, and also to selectively call one other two way radio.

The TA-500/2 Tone is programmed for one transmit code and one receive code from a total of 200 possible codes and is mounted within a T500 Series two way radio.

For further details refer to the Telcall System Service Manual.

3.4 TA-101S

The TA-101S is a two tone signalling unit which allows a T500 Series two way radio to be selectively called by a suitably equipped radio, and also to selectively call other radios on the same RF channel.

The TA-101S is programmed for one receive code; 200 transmit codes are selectable via a keyboard.

The TA-101S is mounted externally to a T500 Series two way radio with an interfacing cable.

For further details refer to the Telcall System Service Manual.

3.5 TA-500/5 TONE

The TA-500/5 Tone is a five tone signalling unit which allows a T500 Series two way radio to be selectively called by a suitably equipped radio, and also to selectively call another radio and/or transmit status information.

The TA-500/5 Tone is programmed for one receive code and two transmit codes from 100,000 possible codes, and is mounted within a T500 Series two way radio.

For further details refer to the TA-500/5 Tone Service Manual.

3.6 TA-500/CTCSS

3.6.1 INTRODUCTION

The TA-500/CTCSS unit is a plug-in option and requires no wiring to install. It will encode and decode CTCSS tone frequencies within the range 67Hz to 250.3Hz with separate adjustment for each channel. Hook switch monitoring and transmit inhibit on busy may be field selected.

3.6.2 SPECIFICATIONS

Details of test methods and conditions which apply for Type Approval testing can be obtained from Tait Electronics Ltd.

Fully tunable	.. over all Group A & B frequencies
Encode stability over -30°C to +60°C temperature range and 8.1 to 9.9V supply voltage	.. ±0.125% typical .. ±0.5 % maximum
Opening Sinad	.. 4dB typical 6dB maximum
Opening Time (Sinad >20dB)	.. 130ms typical 250ms maximum
Encoded Tone Distortion	
at 67Hz	.. 3.5% typical
at 250Hz	.. 1.0% typical
maximum all frequencies	.. 10%
Decoder Bandwidth	.. 8Hz typical
Over temperature Range -30°C to +60°C and supply voltage 8.1 to 9.9V.	.. Accept > 5Hz Reject > 9Hz

The TA-500/CTCSS may be used with interleaved tone frequencies by changing R423 to 1M ohm (1% ±50ppm MF) and R430 to 270K. This reduces the decode bandwidth to 3Hz typical, and increases opening time to 190ms typical.

3.6.3 CIRCUIT DESCRIPTION

(Refer to Circuit Diagram A2C500 at rear of manual)

Rx audio is AC coupled to the unit via C405. IC401b then amplifies and buffers the signal, DC bias being provided by R407. The Rx audio is then filtered by a 3 pole low pass filter (centred around IC401d) to remove audio frequencies over 300Hz. The signal is then amplified until the waveform is hard clipped by limiter IC401c. The filtered and limited signal is then applied to the detect filter.

The detect filter consists of the four amplifiers found in IC402 and their associated components. The centre frequency is determined by the gain of IC402d which is set by either RV428 or RV429 depending upon which transmission gate, IC404a or IC404d is on.

The detect filter is DC biassed from the half rail voltage source based around IC401a.

The outputs of the detect filter (both DC and AC components) are attenuated by R445 and R446. The resultant level is then compared against half rail voltage by IC403a. A negative switching pulse at IC403a will then result for the period that the AC waveform at the output of the detect filter is greater than Vref (1-y)/y

where y = R446/(R446 & R445) and Vref = ½ reg.

A small amount of hysteresis in the comparator prevents 'chatter' and ensures a minimum output pulse width from the comparator.

R446 and R445 are 1% metal film resistors chosen to give a detect pulse from the output of the comparator when the incoming CTCSS tone is within the 3dB bandwidth of the detect filter. The output of the comparator, IC403a, is of the open collector type and so a 100k pull up resistor is required. C418 provides a fall-out time to prevent squelch 'chatter' in fading situations. IC403d buffers the comparator output and compares it against half rail. At the output of IC403d, R457 and C419 provide an acquisition time to prevent detection on spurious transitions of IC403a due to noise and transient shifts in the detect filter.

The detect time for the whole TA-500/CTCSS is dependent therefore on the rise time of the detect filter and acquisition time of the detect comparators. IC403c buffers R457 and C419 to provide a detect output. The detect output is then wire OR'd with the hang up detect circuit, IC403b (when link is fitted), and inverted via Q405 to control the radio squelch.

The detect signal of IC403c pin 14 also prevents transmit inhibit (when D407 is fitted) when attempting to access a repeater just vacated by another user belonging to the same CTCSS tone group. Note that where hook switch monitoring is required Tx inhibit is not necessary. Therefore the link should be fitted and D407 removed.

Where no hookswitch monitoring is allowed and Tx inhibit is required the link must be removed and D407 fitted.

The hook switch function is integral with the PTT line on T500 Series two way radios (in common with the Tait T190 Series mobiles). On hook is detected by Q403 sensing the path to ground via the 12k ohm resistor fitted in the microphone.

When transmitting, the TA-500/CTCSS unit is made to oscillate by feeding the output of the detect filter back to the limiter input stage via IC404c transmission gate. Any noise present in the detect filter when IC404c is turned on causes transients in the limiter output. This makes the detect filter 'ring' at its tuned frequency. Positive feedback maintains the oscillation.

The rise time of the filter is constant for all tuned frequencies (due to variable Q factor) and would be about 60-80ms were R430 not used. During encoding IC404b transmission gate turns on and shunts R423 with R430.

Varying R423 only affects the Q of the circuit and not the tuned frequency or gain. Hence upon transmit the Q of the detect filter is halved and so the rise time of the output is halved to 30-40ms. If the detect bandwidth of the TA-500/CTCSS is required to be lower, then R423 may be increased resulting in a higher Q. A better noise performance will also result but at the cost of increased detect time.

During encoding Q401 is turned on to prevent noise from the radio feeding through to the limiter input and so causing a frequency jitter on the encode tone.

The encode tone is fed to the radio transmitter circuitry via C417 and RV447. RV447 is used to set up transmitter deviation.

3.6.4 ADJUSTMENTS

(a) Set the CTCSS tone frequencies by connecting a counter to the 'tone output' pin A5. Close the press-to-talk switch for tone to be encoded. Adjust the appropriate potentiometer (RV429, Channel 1; RV428, Channel 2).

Note 1: For sets with CTCSS requirements for only one of two used channels, see Section 3.6.6 'Modifications To TA-500/CTCSS'.

Note 2: For accurate CTCSS tone adjustment it is recommended that either a rate multiplier be used with the counter, or alternatively that the output be compared with a known frequency source on an oscilloscope, using the Lissajous Figures Method.

(b) Modulation levels (refer also to Section 5.7.2 Modulation Adjustment)

[i] Adjust RV447 to set the CTCSS tone deviation between ±500Hz and ±1kHz. For a ±5kHz system deviation the recommended CTCSS deviation is ±750Hz. For a ±2.5kHz system, the CTCSS deviation may need to be greater than ½ of 750Hz for acceptable reliability.

[ii] Reset the transmitter deviation in accordance with Section 5.7.2 of this Service Manual so that the full rated system deviation (±5kHz or ±2.5kHz) is not exceeded when both normal and CTCSS modulation are present.

3.6.5 TESTING

If retrofitting a TA-500/CTCSS unit into a T540, the following tests should be carried out:

1. Set the squelch control fully clockwise. Earth the microphone button to check hook switch operation. Ensure that receiver reverts to muted condition with microphone button earthed, and un-mutes when microphone button not earthed.

2. Set squelch control to normal muted condition. Connect RF signal generator to aerial input connector at an output of -107dBm. Modulate with correct CTCSS tone for particular channel and deviated ±500Hz. Apply signal from signal generator. Ensure that receiver unmutes while the signal is present.

3. (a) Disconnect the signal generator & replace it with an RF load. Rotate squelch control until the 'Busy LED' is illuminated. Close press-to-talk switch. Ensure that the transmitter does not come on or the Tx LED illuminate, indicating that Tx inhibit is operational.

   (b) Insert reverse protection between the signal generator and the two way radio (see Section 5.4.1, item 15).

   With unit detecting tone and busy lamp lit, press the PTT. Check that the two way radio Tx lamp illuminates.

3.6.6 MODIFICATIONS TO TA-500/CTCSS

After testing:

If the hook switch monitoring is not required - cut the disable wire link.
If the Tx inhibit is not required - cut D407.

Where a 2 channel requirement with only one channel CTCSS control arises, a 1N4148 diode must be soldered between IC402d pin 12 (diode anode) and IC404a/d pin 12 (no tone on channel 2), or, pin 13 (no tone on channel 1). This will:

(a) prevent an encode tone being produced on Transmit, and
(b) there will be no mute control from the CTCSS unit on Receive.

To allow Tx inhibit on the non-CTCSS channel - cut D406; but note that on the CTCSS channel the user can no longer access the repeater on the squelch tail of the same group CTCSS mobile.

3.7 TA-500/MEM

The TA-500/MEM is a replacement, plug-in memory unit complete with all diodes.

3.8 TA-500/CRDL

The TA-500/CRDL is a mounting cradle supplied with microphone clip and mounting screws to mount T500 Series two way radios.

SECTION 4 INSTALLATION

CAUTION: The T540 is suitable for negative earth installation only.

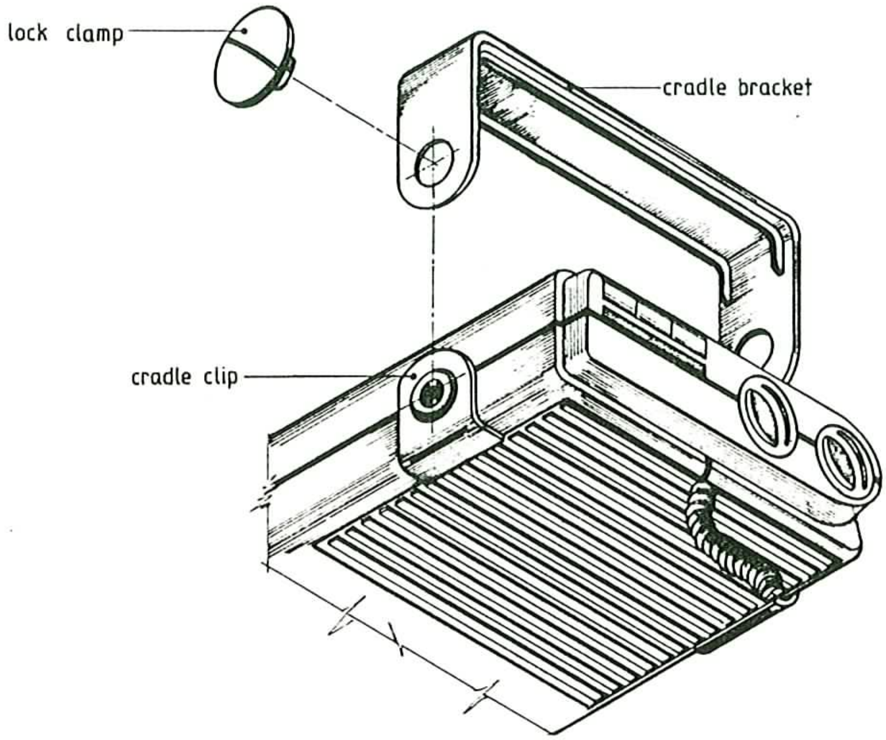


Figure 2 T540 Mounting System

4.1 MOUNTING SYSTEM

The T540 is supplied complete with a versatile mounting system. The mounting hardware includes one bracket, two clamps, two clips, and an assortment of self tapping screws.

To detach the bracket, rotate each clamp ¼ turn anticlockwise with a suitable coin. The two clips which mesh into the speaker grill are now free to be removed and refitted anywhere along the sides of the T540. The bracket can be attached in any position above or below the T540.

4.2 VEHICLE INSTALLATION

Consider the following when looking for a suitable mounting position:

If the speaker grill is obscured an external speaker will be necessary.

The aerial and power connectors protrude beyond the heatsink fins.

The versatility of the mounting system allows the T540 to be inclined and/or moved back and forth once the bracket is mounted.

4.3 EXTERNAL SPEAKER

An external speaker may be necessary when the T540 is used in noisy conditions. Use Tait speaker type T220/2, 3.5 ohms.

Mount the speaker as close to the operator as is practicable.

Connect the speaker cable to the T540 4 way connector socket as shown in Figure 3.

The T540 speaker can be disconnected internally or may remain connected provided that the impedance presented to the audio output stage does not fall below 2 ohms.

4.4 DC SUPPLY

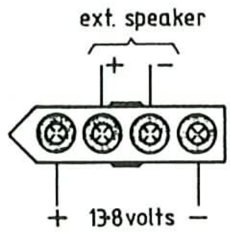


Figure 3 T540 Power Socket

The pins for the four way connector should be attached to the wires using an appropriate crimping tool.

Take both the positive (red) and the negative (black) from the 4 way socket directly to the vehicle battery (see Figure 3).

Fit an in-line fuse in the positive cable close to the battery. The fuse rating is 10 amps

4.5 AERIAL

4.5.1 GENERAL

Mount the aerial in the centre of the vehicle roof where possible.

Use 50 ohm coax, eg. RG58 or UR76.

Use the UHF connector supplied to connect the aerial to the T540 (see Section 4.5.2 for the assembly procedure).

Otherwise use a similar good quality UHF connector (such as a Greenpar GE 40001, plus GE 40008) which may require a different assembly procedure.

Tune the aerial by connecting a VSWR indicator or a thru-line wattmeter (eg. Bird 43) between the T540 and aerial cable.

4.5.2 AERIAL CONNECTOR

Place the coupling nut over the cable, as shown in Figure 4.

Trim the outer sheath, braid and dielectric to the dimensions indicated.

Tin the exposed braid and centre conductor.

Screw the body sub-assembly onto the cable as far as it will go.

Solder the braid to the body sub-assembly, then solder the centre conductor to the contact.

Screw the coupling nut forward over the body sub-assembly.

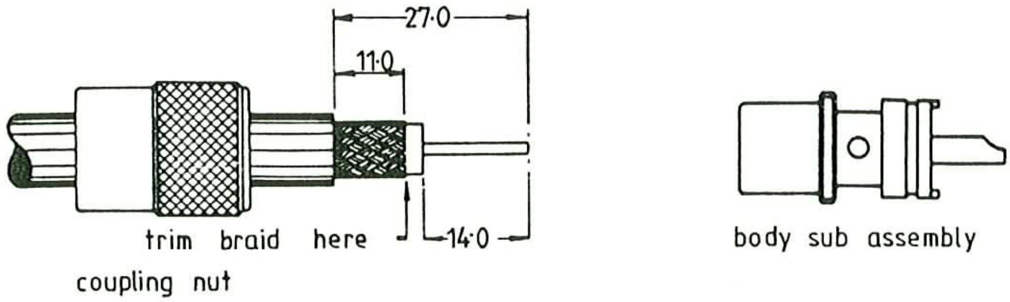


Figure 4 Aerial Connector Assembly

4.6 MICROPHONE CLIP

The mic. clip must be earthed (to negative) if the CTCSS hook monitoring facility is required.

Ensure that the mic. clip is mounted in a position where the PTT switch cannot be inadvertently jammed on.

Refer to Section 1.4 for operating instructions.

SECTION 5 SERVICING

5.1 GENERAL

5.1.1 NOTES

If further information is required about the T540 or this manual, it may be obtained from Tait Electronics Ltd or accredited agents. When requesting this information, please quote either the equipment type number (eg. T540C/3), or serial number (found adjacent to the aerial connector at the back of the set). In the case of the Circuit Diagrams quote the 'Title' and 'Issue' and for the Service Manual quote the internal part number (IPN) and issue eg. TM-540 Issue A.

CAUTION: AERIAL LOADING.

The equipment has been designed to operate over a wide range of aerial loading conditions. However it is strongly recommended that the transmitter is not operated in the absence of a suitable load. Failure to observe this precaution may result in damage to the transmitter power output stage.

CAUTION: CLEANING.

This is a plastic based product with a secondary finish on the outer case. Use a cloth dampened with warm, soapy water to clean. If solvent cleaners are to be used for stubborn stains, test first on a part of the set normally out of sight.

CAUTION: BERYLLIUM OXIDE & POWER TRANSISTORS.

The RF power transistors in current use all contain some beryllium oxide. This substance, while perfectly harmless in its normal solid form, can become a severe health hazard when it has been reduced to dust. For this reason the RF power transistors should not be scratched, mutilated, filed, machined, or physically damaged in any way that can produce dust particles.

CAUTION: CMOS DEVICES.

The equipment contains CMOS devices which are susceptible to damage from static charges. Care when handling these devices is essential. For correct handling procedures refer to the manufacturers data books, eg Philips data books covering CMOS devices, or Motorola CMOS data books, Section 5 'Handling', etc.

5.1.2 TECHNICAL INSTRUCTIONS

From time to time 'Technical Instructions' (TIs) are issued by Tait Electronics Engineering Division. These TI's may be used to update equipment or information, or to meet specific operational requirements.

5.2 MECHANICAL

5.2.1 POSIDRIV RECESS HEAD SCREWS

Posidriv screws are the preferred standard on all Tait manufactured equipment. The very real advantages of this type of screw will not be realised unless the correct screwdrivers are used by servicing personnel.

Posidriv No 1 screwdrivers will fit the posidriv screws used in the T540. Phillips cross-head screwdrivers are not satisfactory for use on these screws.

5.2.2 DISASSEMBLY INSTRUCTIONS

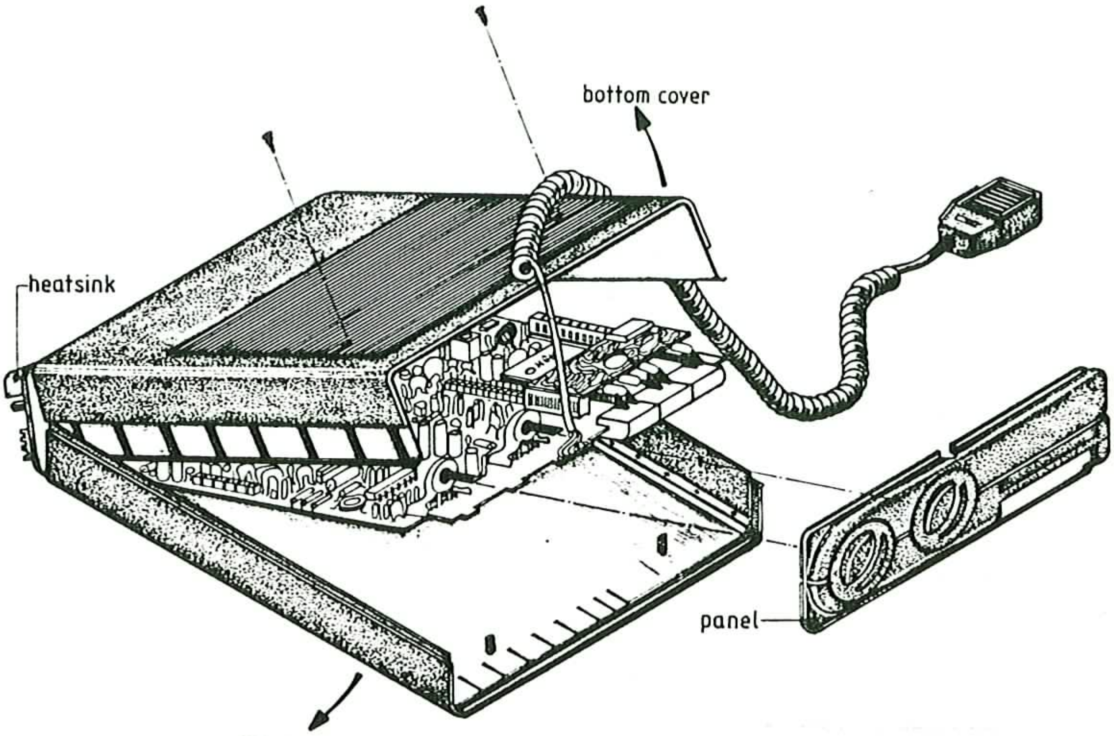


Figure 5 T540 Exploded View

Note 1: To carry out alignment procedures it is only necessary to remove the bottom cover as given in (1.) below.

Note 2: To assist in separating the top and bottom covers, a thin plastic strip (such as a plastic rule) may be inserted between the covers and used as a lever.

1. To Gain Access To The Component Side Of The PCB

Place the T540 upside down on the bench.

Remove the 2 bottom cover retaining screws.

Gently lift the front end of the bottom cover until it clears the front panel.

Pull the cover forward to disengage the four small plastic lugs at the rear of the bottom cover.

Lift away the bottom cover.

2. To Gain Access To The Track Side Of The PCB

Remove the bottom cover as in (1.) above.

Turn the T540 over on the bench.

Gently raise the front end of the top cover until it clears the front panel.

Pull the cover forward to disengage the 4 lugs at the rear of the cover.

3. To Remove The Front Panel

Remove the bottom and top covers as in (1.) & (2.) above.

Slide the front panel forward.

It is not necessary to remove the knobs, they may be left in situ.

4. To Gain Access To The PA Components

To gain access to the PA, remove the shield cover from its position forward of the heatsink.

5.2.3 VCO CAN

CAUTION: When loosening or tightening the 4 retaining screws of the VCO can, support the can from the component side as undue pressure on the PCB may fracture some of the chip capacitors.

5.2.4 RE-ASSEMBLY

NOTE: If the PCB has been removed, it must be refitted hard up against the heatsink along its entire length, as shown in Fig. 6.

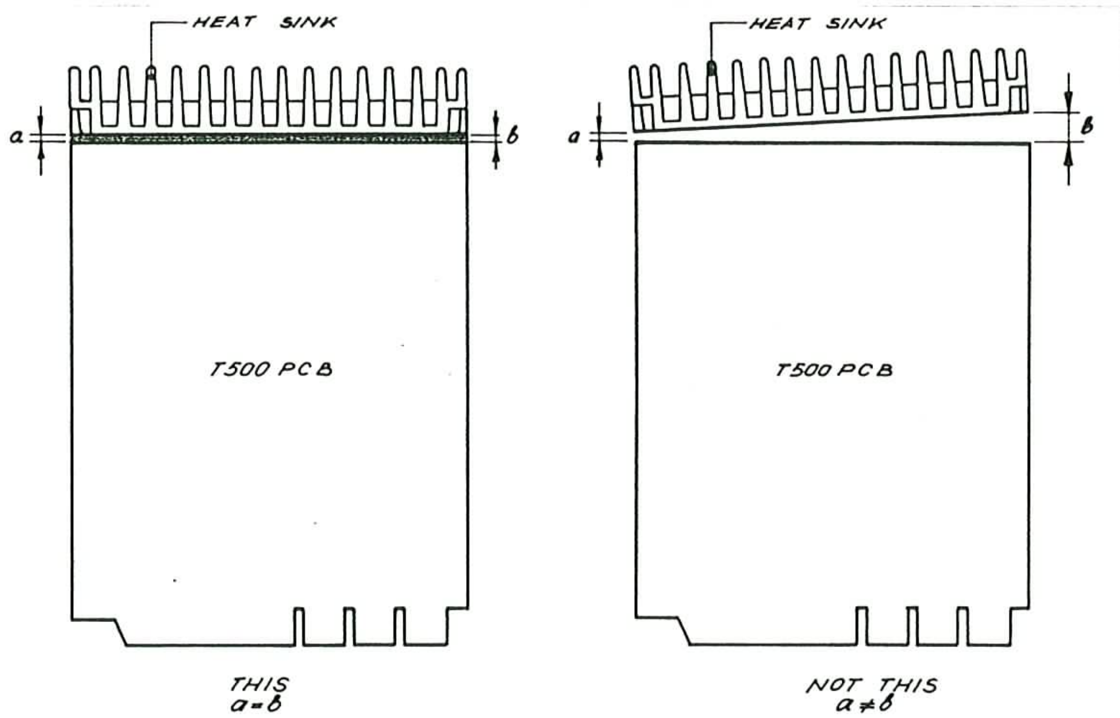


Figure 6 Fitting The Heatsink

Re-assembly is carried out in the reverse order of the above.

Replace the PA Shield.

Slide on the front panel taking care to guide the four LEDs into their respective channels in the plastic moulding.

Press the microphone cord into its retaining slot.

Ensure that the metal shields are correctly in position in the covers.

Fit the top cover:

With the top cover at an angle of about 20° slide the 4 plastic lugs at the rear of the cover into their respective slots in the heatsink.

Gently press the cover into position taking care not to damage the 4 lugs. Ensure that the rim of the front panel fits into the groove round the front of the top cover.

Fit the bottom cover:

Invert the T540

With the bottom cover at an angle of about 20° slide the 4 plastic lugs into their respective slots in the heatsink.

Gently press the cover into position taking care not to damage the 4 lugs. Ensure that the rim of the front panel fits into the groove round the front of the bottom cover.

While fitting the bottom cover check that the right hand retaining screw pillar slides into the hole in the LED PCB.

5.2.5 PA - SPECIAL INSTRUCTIONS

CAUTION: As the location of certain components in the PA is critical to performance, it is important that any components removed or disturbed be refitted in exactly the same location.

1. TO REPLACE THE PA TRANSISTORS

Unsolder the tabs by heating them with a soldering iron, then lifting them up towards the transistor with a thin stainless steel spike or screwdriver. Unscrew the transistor mounting screws or stud nuts and remove the transistor.

Trim the tabs of the replacement to make them similar to the faulty item, then lightly tin the underside of the tabs.

Smear the underside of the transistor with heatsink compound.

Screw the transistor tightly to the heatsink then solder the tabs.

CAUTION: Do not solder the tabs before tightening the screws/nut, as this will fracture the device.

2. TO REMOVE CASED MICA CAPACITORS

Apply a heavy duty soldering iron to the top of the capacitor case.

When the solder is molten, ease the capacitor away from the PCB with a thin stainless steel spike or screwdriver.

5.3 REPAIR

5.3.1 COMPONENT CHECKS

If a transistor is suspected of faulty operation, an indication of its performance can be assessed by measuring the forward and reverse resistance of the junctions. First make sure that the transistor is not shunted by some circuit resistance, (unless the device is completely unsoldered). An AVO model 8 or equivalent meter should be used for taking the measurements, using only the medium or low resistance ranges.

The collector current drawn by multijunction transistors is a further guide to their operating performance.

If an integrated circuit (IC) is suspect, the most reliable check is to measure the DC operating voltages. Due to the catastrophic nature of most IC failures, the pin voltages will usually be markedly different from the recommended values in the presence of a fault. These values can be found on the Circuit Diagram, or in the component data catalogue.

5.3.2 COMPONENT REPLACEMENT

Whenever components are removed from, or fitted to the printed circuit track, care must be taken to avoid damage to the track. If it is necessary to remove a component from the track, the following procedure is recommended:

Remove the solder from the component leads using a solder wick.
Loosen the individual leads from the printed track.
Withdraw the component from the top of the PCB.

Because of the delicate nature of the printed track, the use of solder suckers is not recommended.

Do not remove the component from the PCB while the solder is still molten.

Keep all soldering operations, and the heat and solder applied, to a minimum. A thermally controlled, fine tip soldering iron should be used. Ensure that the iron is earthed back to the frame of the set.

5.3.3 CRYSTAL FILTER REPLACEMENT

Should it become necessary to replace the crystal filter, both cans should be replaced together as the new parts are supplied as matched pairs. Observe polarity when fitting.

5.3.4 CHIP COMPONENT REMOVAL/REPLACEMENT

Note: The temperature of the soldering iron must be maintained at 320-370°C (600-700°F) and low temperature solder should be used.

(a) Removal

1. Place soldering iron tip directly on component in order to melt solder and glue as shown in Figure 7. Remove component with tweezers or long nose pliers.

2. Completely remove old solder from PCB, using a solder wick. Application of a small amount of flux will greatly aid in the removal of old solder. The use of 'solder suckers' is not recommended.

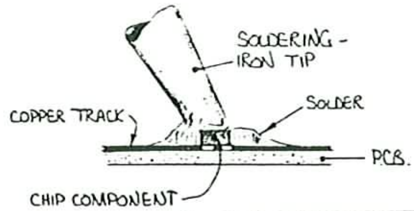


Figure 7

(b) Replacement

1. After a component has been removed and the PCB pattern cleaned, apply a small amount of solder on PC pattern and allow to cool, as shown in Figure 8.

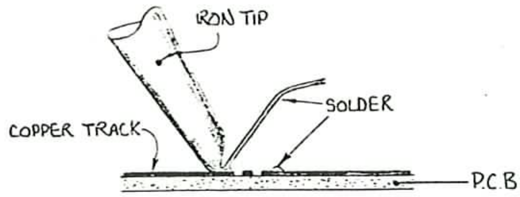


Figure 8

2. Insert new components and apply soldering iron tip to PC pattern as shown in Figure 9 (a), (b) and (c).

Caution: As patterns and components are close to each other, extreme care must be excercised when soldering, so as not to damage components, or bridge the PCB pattern paths. High soldering iron temperatures can cause component damage. Do not apply the soldering iron tip to the new component during installation.

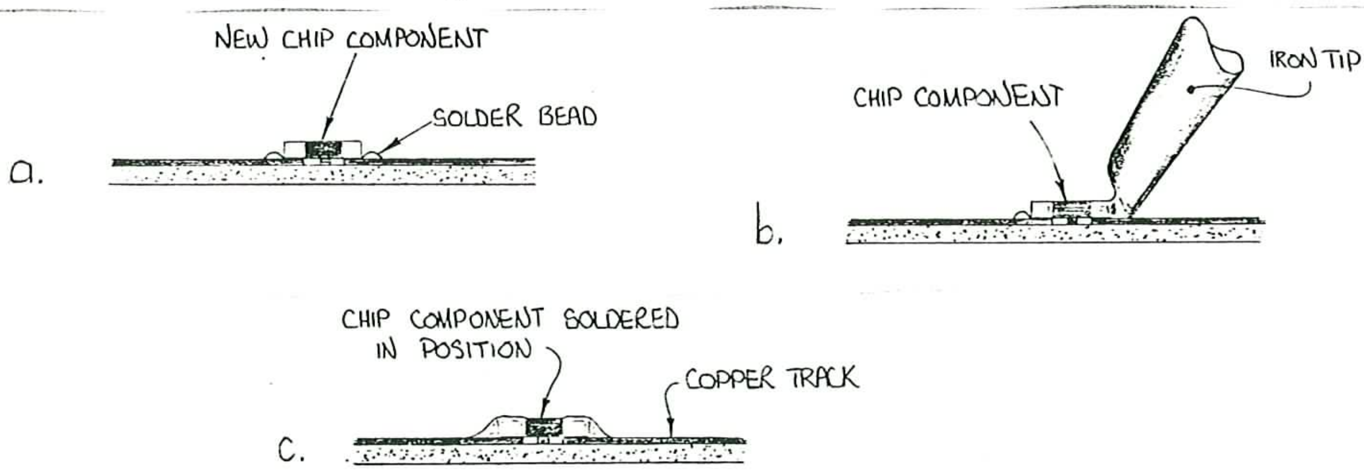


Figure 9

5.3.5 INTER BOARD CONNECTIONS

To assist circuit tracing, all plugs and connections are shown on the outer edge of the Circuit Diagram, where the 'Function' is shown.

5.4 SETTING UP

5.4.1 TEST EQUIPMENT REQUIRED

1. Multimeter (eg. AVO Model 8)

2. DC electronic voltmeter (eg. Tech TE65)

3. RF power meter 50 ohm, 30 watts FSD usable to 250MHz (eg. Bird Model 6154 or 611).

4. Power Supply - output adjustable between 9 and 16 volts DC with a capacity of at least 8 amps.

5. Modulation meter (eg. Sayrosa 252)

6. Sinad meter (eg. Helper Instruments Sinadder)

7. UHF signal generator. Good quality FM 50 ohm. Useable from 0.1μV (-127dBm) to 200mV (0dBm) pd. (eg. HP 8640B).

8. UHF frequency counter accurate to within 2ppm.

9. 10.7MHz Crystal marker (second harmonic gives beat for 21.4MHz IF)

10. Audio oscillator, 10Hz to 10kHz (eg. HP 204C/D)

11. Tone Box: Audio amplifier, with about 1.5 watts output, to drive a small speaker which can be coupled to the T540 microphone. An adaptor should be made whch will hold the speaker and microphone close together.

12. AC millivoltmeter

13. Calibrated oscilloscope

14. Speaker 4 ohm voice coil

15. RF power attenuator 50 ohm, total attenuation 50dB (eg. Weinschel 40-40-33 30dB 150W, plus Coline 1200 85 20dB 1w)

16. RF diode probe (eg.Greenpar GE 88202)

5.4.2 TUNING HINTS

1. Diagram 1 shows the test set-up for receiver and transmitter alignment.

2. For accurate tuning, the test cable connecting the signal generator or power meter to the T540 should be as short as practical and fitted with a 'mating' UHF connector. Do not use adaptors, 'sniffer' couplings, etc, which introduce changes to cable impedance and errors in test results.

3. Non-metallic tuning tools must be used for the alignment of all coil slugs to avoid the tuning errors introduced by the use of metallic tools. Tuning tools need to be of correct size to avoid the damage to slugs which results from the use of incorrect tuning tools.

Tuning tool WT 11 (Tait IPN 9360112) is suitable for adjusting trimming capacitors, and hexagonal tuning tool (IPN 9360113) is used for the receiver coils.

4. When using the RF diode probe, the earth return should be kept as short as possible and connected as close as possible to the point at which the measurement is being taken. This is to minimise stray pick-up which may affect the reading.

5. The front panel 'on/off' switch removes power from the regulated supplies only. The RF power amplifier, the audio output IC and the DC hash filter are not controlled by this switch.

6. Check for obvious mechanical faults in the printed circuit board, controls, microphone etc.

7. Check the printed fuse on the PCB. Its rating is about 2 amps, and it can be replaced by a 0.1mm diameter copper link.

5.4.3 CHANNEL PROGRAMMING

Note 1: Transmit VCO operation is restricted to an 8MHz switching range within the band covering 175 to 225MHz. Receive VCO operation is restricted to an 8MHz switching range within the band covering 153 to 204MHz.

Do not programme frequencies outside these limits.

The switching range is defined by the minimum change in frequency for loop voltages between 1.75 and 6.5 volts; ie, 8MHz at the bottom of the band.

Note 2: For single channel applications, channel 2 should be programmed to the same frequencies as channel 1.

The programming of each of the two transmit and receive channels is accomplished by clipping diodes from each of the columns of diodes as required (see Figure 10).

A connected diode pulls IC8 input low and deletes the frequency increment.

A cut diode allows IC8 input to go high and adds the frequency increment.

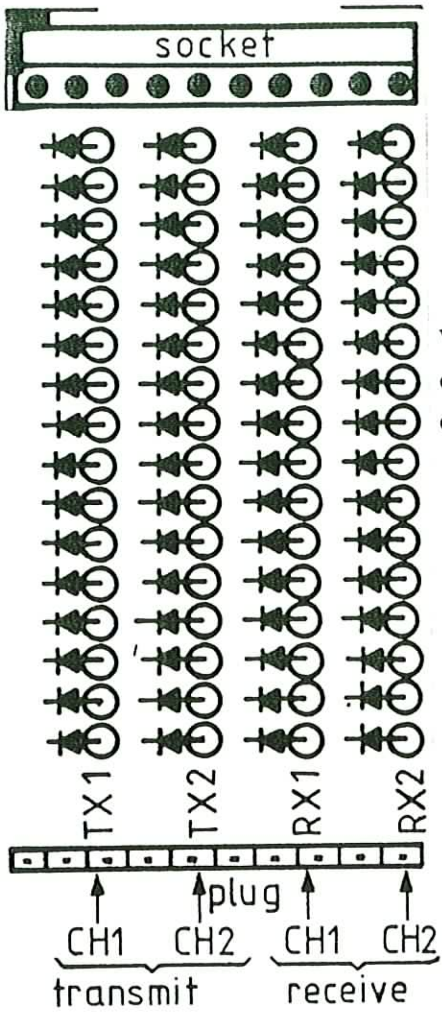
Figure 10

(a) PROGRAMMING TWO WAY RADIOS WITH 6.25kHz REFERENCE (All standard versions)

Table 1 shows how, when starting with A0, each successive diode influences the synthesizer frequency by a multiple of 6.25kHz in an ascending binary sequence.

Table 1

Frequency Increment	Code
128MHz	N9
64MHz	N8
32MHz	N7
16MHz	N6
8MHz	N5
4MHz	N4
2MHz	N3
1MHz	N2
500kHz	N1
250kHz	N0
200kHz	A5
100kHz	A4
50kHz	A3
25kHz	A2
12.5kHz	A1
6.25kHz	A0



Viewed from component side of diode board

When a diode is clipped its corresponding frequency is added to the VCO frequency.

The following examples show a simple method of calculating the correct diode programme.

Example 1

Tx frequency = 184.0MHz

In each case subtract the largest value from Table 1 which yields a positive result.

Continue the process until zero is reached.

VCO frequency:	184	
subtract	128	cut diode N9
	56	
subtract	32	cut diode N7
	24	
subtract	16	cut diode N6
	8	
subtract	8	cut diode N5
	0	

To check: The sum of the extracted values should equal the required VCO frequency.

N9 + N7 + N6 + N5 = VCO

128 + 32 + 16 + 8 = 184MHz

Example 2

Rx frequency = 195.375. The receiver has a 21.4MHz IF and low side injection.
$f_{VCO} = f_{Rx} - 21.4 = 173.975$

	VCO frequency:	173.975	
	subtract	128.000	cut diode N9
		45.975	
	subtract	32.000	cut diode N7
		13.975	
In each case subtract the largest value from Table 1 which yields a positive result.	subtract	8.000	cut diode N5
		5.975	
	subtract	4.000	cut diode N4
		1.975	
	subtract	1.000	cut diode N2
		0.975	
	subtract	.500	cut diode N1
		.475	
	subtract	.250	cut diode N0
		.225	
	subtract	.200	cut diode A5
		.025	
Continue the process until zero is reached.	subtract	.025	cut diode A2
		.000	

Check:

N9 + N7 + N5 + N4 + N2 + N1 + N0 + A5 + A2 = VCO

128 + 32 + 8 + 4 + 1 + .5 + .25 + .2 + .025 = 173.975

173.975 + 21.4 = 195.375

Once the correct diode programme has been calculated, remove the diode matrix board from the T540 and clip diodes as required. Figure 10 shows where to cut the diode leads, and Table 1 shows the diode position on the matrix board.

Replace the diode matrix board in the T540.

5.5 VCO ADJUSTMENTS

5.5.1 LINK ADJUSTMENT

For Rx VCO operation above 178.6MHz (ie. Rx operation above 200MHz), disconnect C188 by unsoldering link 'a' in the Rx VCO. C188 must remain connected through link 'a' for Rx VCO operation below 178.6MHz.

5.5.2 VCO ALIGNMENT

Connect the T540 to a dummy RF load.

Plug a UHF frequency counter onto the test plug (TP3):

Connect:

centre pin	to	ground
left pin	to	Rx VCO
right pin	to	Tx VCO

Ensure that a correctly programmed diode matrix PCB is fitted.

Connect 13.8 volts of the correct polarity.

Monitor the loop voltage (centre pin of TP2) with a high impedance voltmeter (0-10 volt range).

Single channel operation:

Receive mode:

Adjust CV191 for 4 volts at TP2.

Check frequency.

Transmit mode (PTT switch closed):

Adjust CV232 for 4 volts at TP2.

Check frequency.

Dual channel operation:

Receive mode:

Adjust CV191 so that when switching between channel 1 and channel 2, the loop voltages are symmetrically placed around 4 volts, but within the limits of 1.75 and 6.5 volts.

Check both frequencies.

Transmit mode: (PTT switch closed):

Adjust CV232 so that when switching between channel 1 and channel 2 the loop voltages are symmetrically placed around 4 volts, but within the limits of 1.75 and 6.5 volts.

Check both frequencies.

Note: A loop voltage of less than 0.6V or more than 7.5V indicates the synthesizer is out of lock.

5.6 REFERENCE FREQUENCY ADJUSTMENT

The 12.5kHz reference frequency must be accurately set. This is measured indirectly by monitoring the VCO frequency.

Connect a frequency counter to required VCO output (TP3).

Select channel 1.

Adjust L30 for the correct VCO frequency.

Repeat this measurement for receive and transmit on both channels to verify the diode programming.

5.7 TRANSMITTER ADJUSTMENTS

5.7.1 ALIGNMENT

Note: In this and the following sections measurements are given which differ for wideband and narrowband sets. In these cases the figures for wideband sets are given first followed by figures for the narrowband versions in square brackets [ ].

Connect a power meter to the aerial socket.

Set RV256 (power control) fully clockwise (viewed from component side).

Close the PTT switch.

Adjust CV272 for maximum power.

Adjust CV289 for maximum power consistent with best efficiency.

Note: For two channel operation tune CV272 and CV289 for optimum performance on both channels.

Adjust RV256 to reduce the output power to 25 watts.

Check that the transmit current does not exceed 5.0 amps for 25 watts output, with 13.8 volts at the set.

5.7.2 MODULATION ADJUSTMENT

Connect the T540 antenna output through a 50dB RF power attenuator (see Section 5.4.1, item 15) to a modulation meter.

Short circuit C49 to disable the ALC circuitry.

Connect the microphone to the tone box (see Section 5.4.1, item 11) or connect the audio oscillator to the microphone pads on the PCB.

Apply a 1kHz sine wave to give -40dBm (8mV rms) at the microphone pads.

Set the channel switch to the lowest frequency channel.

Set the modulation meter to read '-' deviation.

Close the PTT switch and adjust RV79 for approximately -5kHz [-2.5kHz] deviation.

Reduce the audio input to obtain -3kHz [-1.5kHz] deviation, and then increase it by 20dB.

Sweep the audio frequency 300Hz to 3kHz and find the frequency of maximum '-' deviation.

Set RV79 to give -5kHz [-2.5kHz] deviation at this frequency.

Set the modulation meter to read '+' deviation.

Sweep the audio signal 300Hz to 3kHz and readjust RV79 if a peak exceeding +5kHz [+2.5kHz] is found.

Set the channel switch for the other channel and check that ±5kHz [±2.5kHz] deviation is not exceeded for any modulation frequency.

Remove the short from C49.

5.8 RECEIVER ADJUSTMENTS

5.8.1 RECEIVER COIL TAP CHANGES

For receiver operation between 175 and 200MHz:

Disconnect receiver coil links 'b' and connect receiver coil links 'a'.

For receiver operation between 200 and 225MHz:

Disconnect receiver coil links 'a' and connect receiver coil links 'b'.

5.8.2 RECEIVER ALIGNMENT

Connect a signal generator modulated to ±5kHz [±2.5kHz] at 1kHz AF.

Connect a sinad meter across the speaker terminals.

Increase the signal generator output until 12dB sinad is reached.

Tune L16, L15, L14, L13, L12 and L11 for best sinad while reducing the signal generator output level to maintain approximately 12dB sinad.

Note: The signal generator frequency must be accurately set (zero beat) when tuning L16.

Repeat the above tuning.

Reduce the signal generator deviation to ±3kHz [±1.5kHz].

Check that the signal generator output does not exceed -119dBm [-118dBm] for 12dB sinad.

For dual channel operation, readjust L15, L14, L13, L12 and L11 for equal sensitivity on both channels.

Note: Sensitivity will degrade towards -116dBm [-115dBm] (worst case) as the channel separation extends to 8MHz.

5.9 FAULT FINDING

5.9.1 GENERAL

During servicing it may be necessary to measure specific performance parameters as a means of verifying the presence of a fault condition.

The following performance tests provide a means for checking the various two way radio parameters. When used in conjunction with the voltage level test points which are given on the circuit diagrams (shown in blue) a fault can be readily pin-pointed.

5.9.2 RECEIVER PERFORMANCE TESTS

Carry out the following checks only after the alignment has been completed.

5.9.2.1 SQUELCH

(a) To Check the Squelch Operation.

Connect a Sinad meter across the speaker terminals.

Connect a UHF signal generator to the aerial input terminal.

Set the signal generator output level to zero and the modulation to ±3kHz [±1.5kHz] deviation at 1kHz.

Adjust the front panel squelch control until the noise just disappears.

Slowly increase the signal generator output level until the squelch gate 'opens', this should be at about 6dB sinad.

(b) To Check the Squelch Ratio

Set the signal generator output level to -107dBm (1µV), modulated to ±5kHz [±2.5kHz] deviation at 1kHz.

Replace the sinad meter with a mV/meter across the speaker terminals.

Turn the squelch control fully anti-clockwise.

Adjust the volume control to give a reading of 3 volts on the mV/meter.

Reduce the signal generator output level to zero.

The fall in output is the 'squelch ratio' and this should be at least 70dB.

5.9.2.2 TO CHECK THE AUDIO OUTPUT LEVEL

Connect an AC mV/meter and an oscilloscope across the speaker terminals.

Connect a UHF signal generator to the aerial input socket, with the output set to -107dBm (1μV) modulated to ±5kHz [±2.5kHz] deviation at 1kHz.

Set the volume control to the onset of clipping.

The receiver output should be 3.7 volts across 4 ohms at +13.8V supply.

Check the distortion with the aid of a distortion analyzer connected across the speaker terminals.

The distortion should not exceed 5%.

5.9.2.3 TO CHECK THE VCO INJECTION TO THE MIXER

Connect a DC EVM to the junction of R107/C112 via a 33k ohm isolating resistor at the probe tip.

Short the two gates of the mixer J-FET's together.

Check that the EVM reads approximately 2V DC.

Remove the short and note the increase in EVM reading.

The EVM reading should increase by approximately 2 volts for a single channel set. For a dual channel set the increase will be reduced to approximately 0.5 volts as the channel separation extends towards 8MHz.

5.9.2.4 TO CHECK THE SINAD SENSITIVITY

Connect a sinad meter across the speaker terminals.

Connect the signal generator to the aerial input terminal.

Set the signal generator accurately to the receive frequency. (Couple a 10.7MHz reference oscillator loosely into the receiver IF stage, tune the signal generator for a zero beat, then uncouple the reference oscillator).

Set the signal generator deviation to ±3kHz [±1.5kHz] at 1kHz.

Note: It is important that the modulating frequency matches the notch of the sinad meter.

Set the signal generator output level to zero.

Increase the signal generator output level until a sinad of 12dB is reached.

The signal generator output should not be greater than -119dBm [-118dBm] and is typically -122dBm [-121dBm], for single channel use or two channels separated by less than 3MHz. As the channel separation extends towards 8MHz the sinad sensitivity will degrade towards -116dBm [-115dBm] (worst case).

5.9.2.5 TO CHECK THE SIGNAL+NOISE TO NOISE RATIO

Set-up the signal generator and mV/meter as in section 5.9.2.1 (b).

Set the squelch control fully clockwise.

Set the volume control for a reading of 0.8V ('0'dB) on a convenient scale on the mV/meter.

Switch the signal generator modulation off.

Note the reading on the mV/meter.

The fall in reading when the modulation is switched off should be at least 30dB [27dB] for single channel use or two channels separated by less than 3MHz. As the channel separation extends towards 8MHz, the signal + noise to noise ratio will degrade towards 27dB [24dB].

5.9.2.6 TO CHECK ULTIMATE SIGNAL TO NOISE RATIO

Note: A good quality low noise RF signal generator should be used for this check (eg, HP8640B or 8656).

Set the signal generator to give an 'on channel' signal, modulated to ±5kHz [±2.5kHz] with a 1kHz tone.

Set the signal generator output level to -47dBm.

Connect an AC mV/meter across the speaker terminals.

Adjust the volume control for a reading of 0.8V ('0'dBm) on a convenient scale.

Turn the signal generator modulation off.

Note the reading on the mV/meter.

The fall in reading when the modulation is switched off should be at least 45dB. (A low reading could be caused by a faulty IC7 or a noisy VCO).

5.9.3 TRANSMITTER PERFORMANCE TESTS

5.9.3.1 AUDIO PROCESSOR

(a) TO CHECK THE LIMITER CIRCUIT.

Connect an oscilloscope to monitor the waveform at pin 14 of IC2d.

Provide an audio signal to the audio processor as in Section 5.7.2.

Set the frequency of the audio signal generator to 1kHz.

Slowly increase the signal generator output level until the waveform begins to distort (squaring), indicating that limiting has commenced.

Any further increase in signal generator output level should not increase the amplitude of the waveform.

(b) TO CHECK THE AUDIO ALC OPERATION

Set up the audio signal as described above (Section 5.7.2).

Set the oscilloscope to monitor the waveform at pin 1 of IC2a.

Connect an EVM to the junction of C49/R52.

Increase the output level of the signal generator to 10dB above the limiting level [Section 5.9.3.1(a)]. Note the amplitude on the oscilloscope, then increase the signal generator output level by another 10dB.

Check that the amplitude of the waveform does not increase or distort significantly.

The EVM should show a 'positive DC' reading.

(c) TO CHECK THE GAIN OF THE AUDIO PROCESSOR

Provide an audio signal to the audio processor as in Section 5.7.2.

Connect the T540 antenna output through a 50dB RF power Attenuator (see Section 5.4.1 item 15) to a modulation meter.

Connect a mV/meter across the microphone terminals on the PCB. (To monitor the input to the audio processor).

Set the frequency of the audio signal generator to 1kHz.

Check the deviation control, RV79, as in Section 5.7.2.

Slowly increase the output level of the audio signal generator until a deviation of ±3kHz is reached.

Check that the mV/meter reads approximately 1mV rms.

Note: The audio processor gain must be checked at a level below that at which the audio ALC or limiting are influencing the measurements.

5.9.3.2 MODULATION CHARACTERISTICS

(a) TO CHECK THE ABOVE LIMITING RESPONSE

Connect the T540 aerial output via a 50dB RF power attenuator to a modulation meter.

Provide an audio signal to the audio processor.

Increase the audio signal generator output level to 20dB above the limiting level [Section 5.9.3.1 (a)].

Vary the frequency of the signal generator between 0.3 and 10kHz

Note the deviation on the modulation meter.

Between 450Hz and 3kHz the deviation should be within 4dB of maximum.

Above 3kHz the deviation should decrease in excess of 25dB/octave.

(b) TO CHECK THE BELOW LIMITING RESPONSE

Decrease the audio signal generator output level to 10dB below the limiting level [Section 5.9.3.1 (a)].

Vary the frequency of the audio signal generator between 0.3 and 10kHz.

Note the reading on the modulation meter.

From 450Hz to 3kHz the deviation should increase at the rate of 6dB/octave (+1 -3dB relative to 1kHz).

Above 3kHz the deviation should decrease in excess of 25dB/octave.

5.9.3.3 TO CHECK THE RF POWER CONTROL CIRCUIT

Connect an RF power meter to the transmitter output.

Close the PTT switch.

Ensure that the transmitter is correctly tuned (Section 5.7).

Vary the supply voltage between 10 and 16 volts.

Above 13.8 volts the RF power output should not increase by more than 2 watts.

At 10.8 volts the RF power output should be more than 10 watts.

5.9.3.4 TO CHECK THE TRANSMISSION TIMER.

Connect an RF power meter to the transmitter output.

Close the PTT switch.

Check that the T540 reverts to 'receive' after approximately 1.5 minutes (+15, -45 seconds) of transmission time .

The transmission time may be set accurately by changing the value of either C16 (100µF) and/or R17 (1M).

To increase the transmission time increase the value of resistance or capacitance as required.

5.9.3.5 TO CHECK THE VCO CONTROL RANGE

Plug a frequency counter onto the VCO test plug (TP3).

Short the middle pin on TP2 alternately to each of the outer pins of TP2.

The frequency shift should be more than 10MHz.

5.9.4 SYNTHESIZER FAULT FINDING

5.9.4.1 IF THE VCO GIVES NO OUTPUT

Ensure the frequency counter is connected to the correct pin of TP3.

Check the supply voltages at R191 (6.5V) and L38 (8V) for the Rx VCO, and at R230 (6.5V) and L55 (8V) for the Tx VCO.

Remove the VCO box and check for shorts inside.

Check the gate and source voltages as per the Circuit Diagram.

5.9.4.2 IF THE SYNTHESIZER DOES NOT LOCK UP

Check the VCO control range following the instructions in Section 5.9.3.5.

If the control range is less than 10MHz, check the circuit for faults between TP2 and the varicaps. The voltage on the varicaps must be the same as the loop voltage.

Tune the Rx VCO until its programmed frequency is within the switching range.

If the loop voltage is still either less than 0.6V or more than 7.5V, check pin 7 and pin 8 of the synthesizer (IC 8):

> (Under normal operating conditions the loop voltage is between 1.75 and 6.5V and both pin 7 and pin 8 are high, except for very narrow pulses [100ns] at the same rate as the reference frequency.)

(a) if pin 7 pulses low and the loop voltage is low (TP2), or if pin 8 pulses low and the loop voltage is high, check the circuitry between R176/D32 and TP2. The voltage at C176 (use a 10M ohm probe) and TP2 should differ by no more than 200mV. If not check the behaviour of the buffer amplifier (Q29, Q30).

(b) if both stay high and the loop voltage is high, check the crystal oscillator.

Measure the VCO frequency.

Measure the prescaler output frequency (pin 3).

Check that $f_{prescaler} = f_{VCO}/40$

Note: The prescaler should not be loaded with 50 ohms - a 1M ohm input counter must be used.

Check that the input voltage of the synthesizer (pin 1) is more than 500mV pp.

5.9.4.3 TO CHECK THE VCO OUTPUT FREQUENCY STABILITY

If the synthesizer locks up but does not reach a stable VCO output frequency, or if the VCO output frequency is a few channels off frequency, check:

(a) that the input power to the prescaler from the VCO is not too low.

check the VCO output power and the circuitry between the VCO and the prescaler.

(b) that the modulus control pulse (pin 1 of the prescaler) is more than 4.0V.

5.9.4.4 TO CHECK TRANSMITTER SWITCH-ON

If the synthesizer locks up but there is no transmitter power, check:

(a) that if the synthesizer is locked, the lock detect output (IC8, pin2) is high. (This output pulses low if the synthesizer is out of lock.)

(b) that the voltages are as shown in the Circuit Diagram (Q25, Q43).

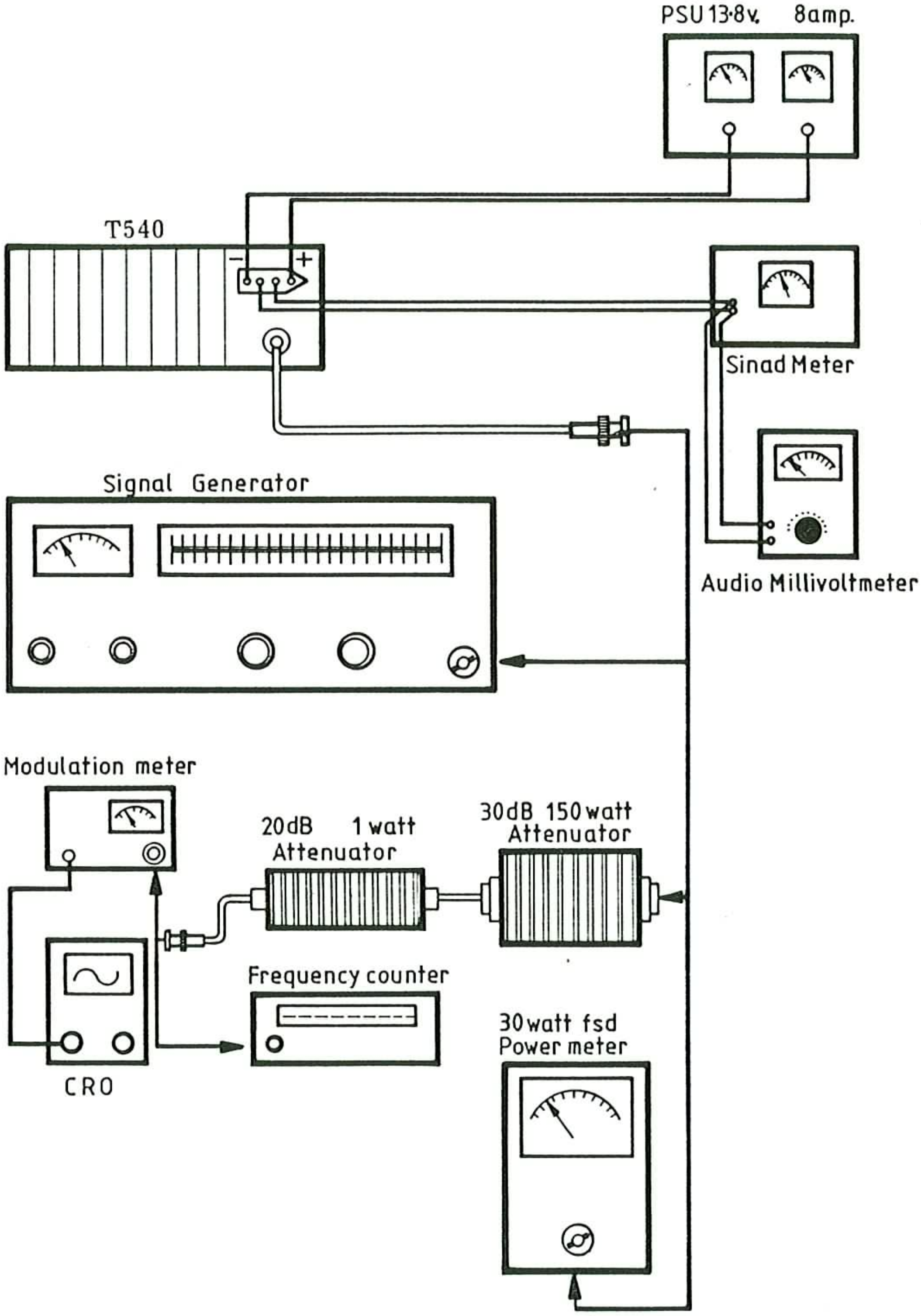


Diagram 1 Suggested Test Equipment Set-up

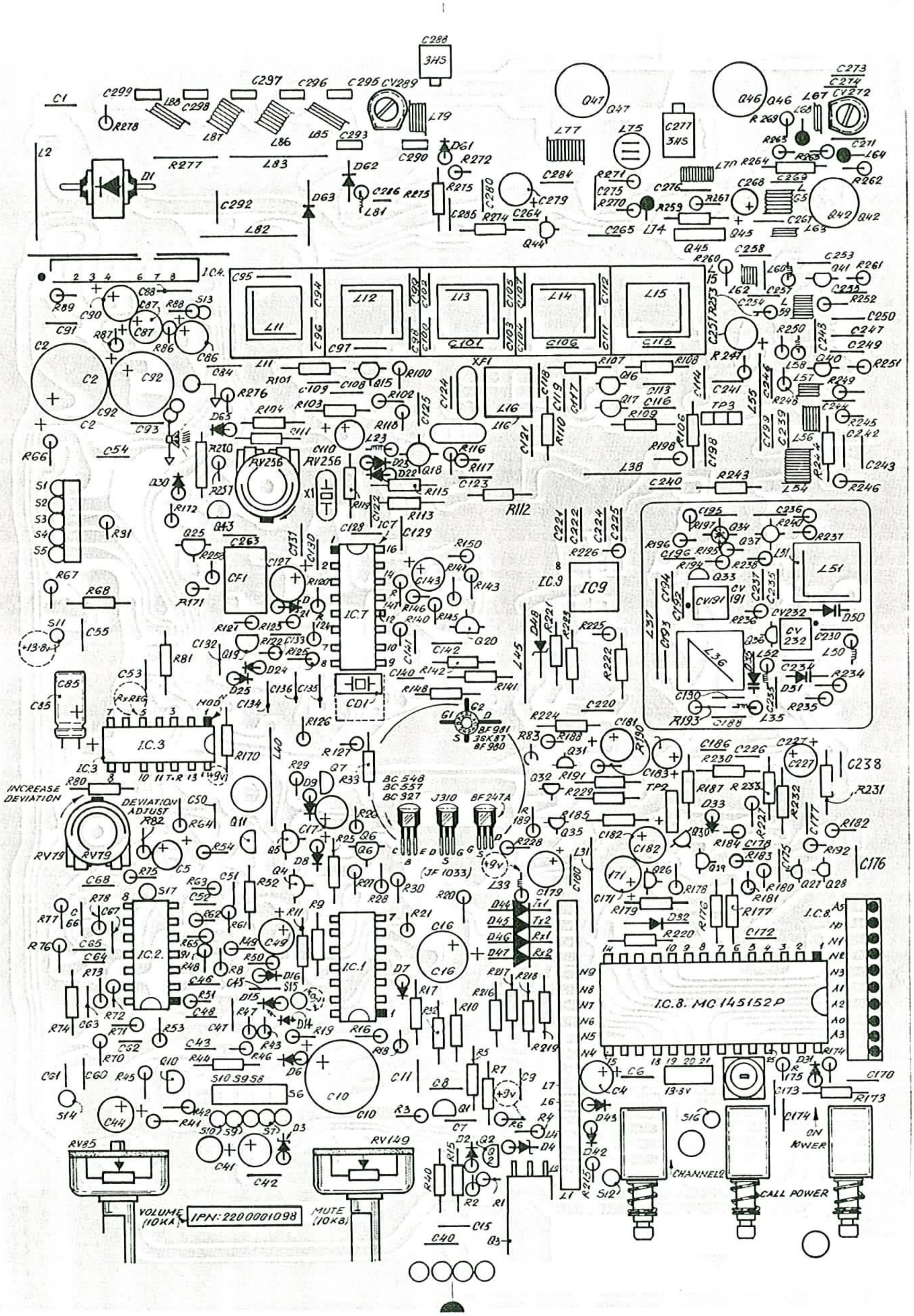


Diagram 2 T540 PCB Encoding

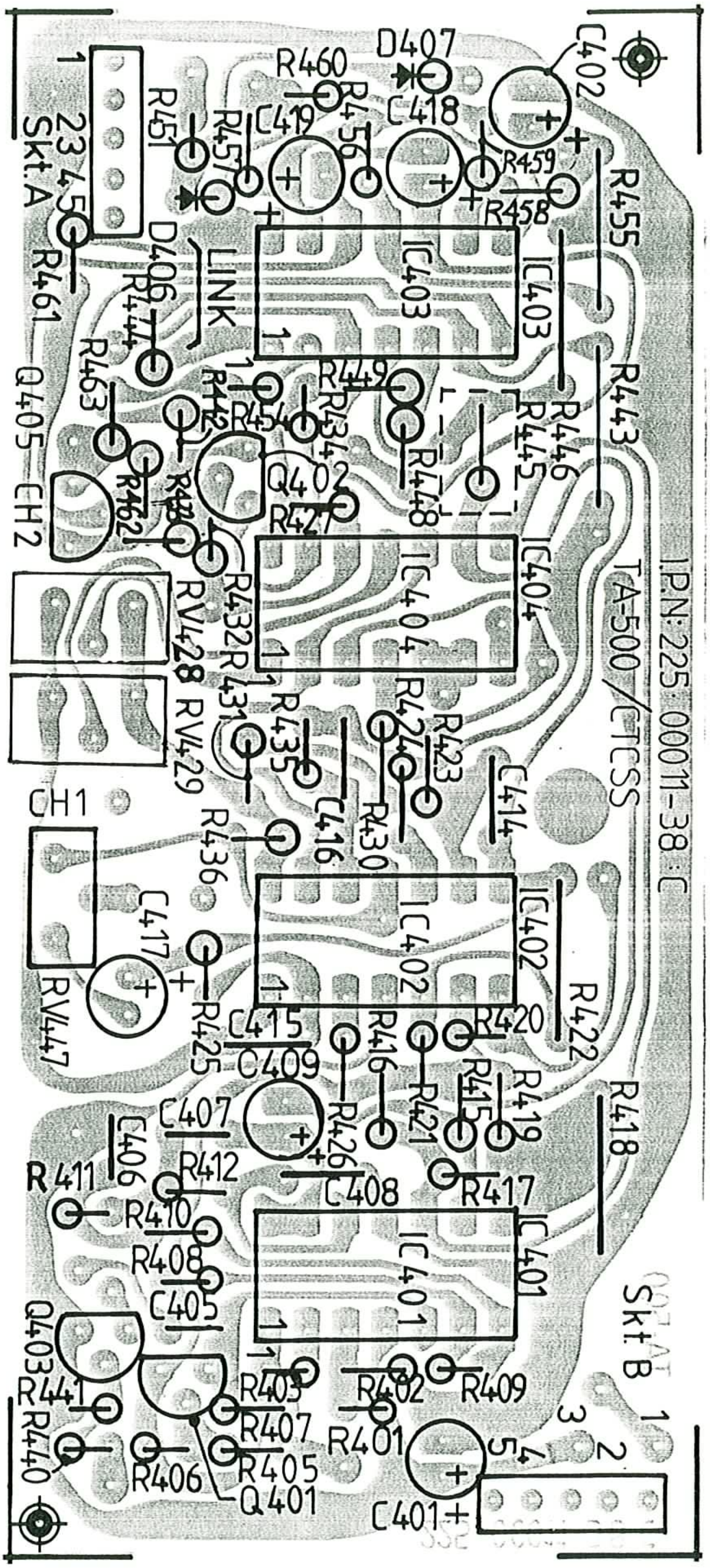


Diagram 3 TA-500/CTCSS PCB Encoding

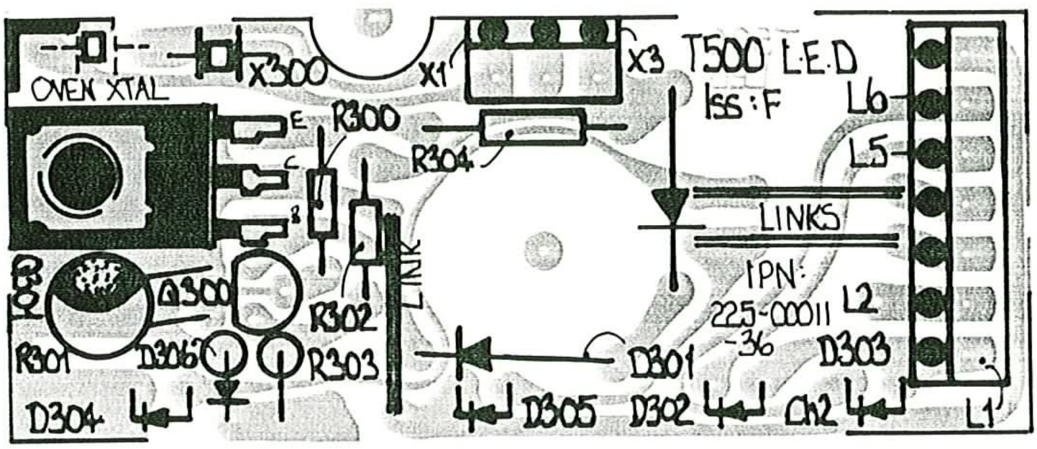
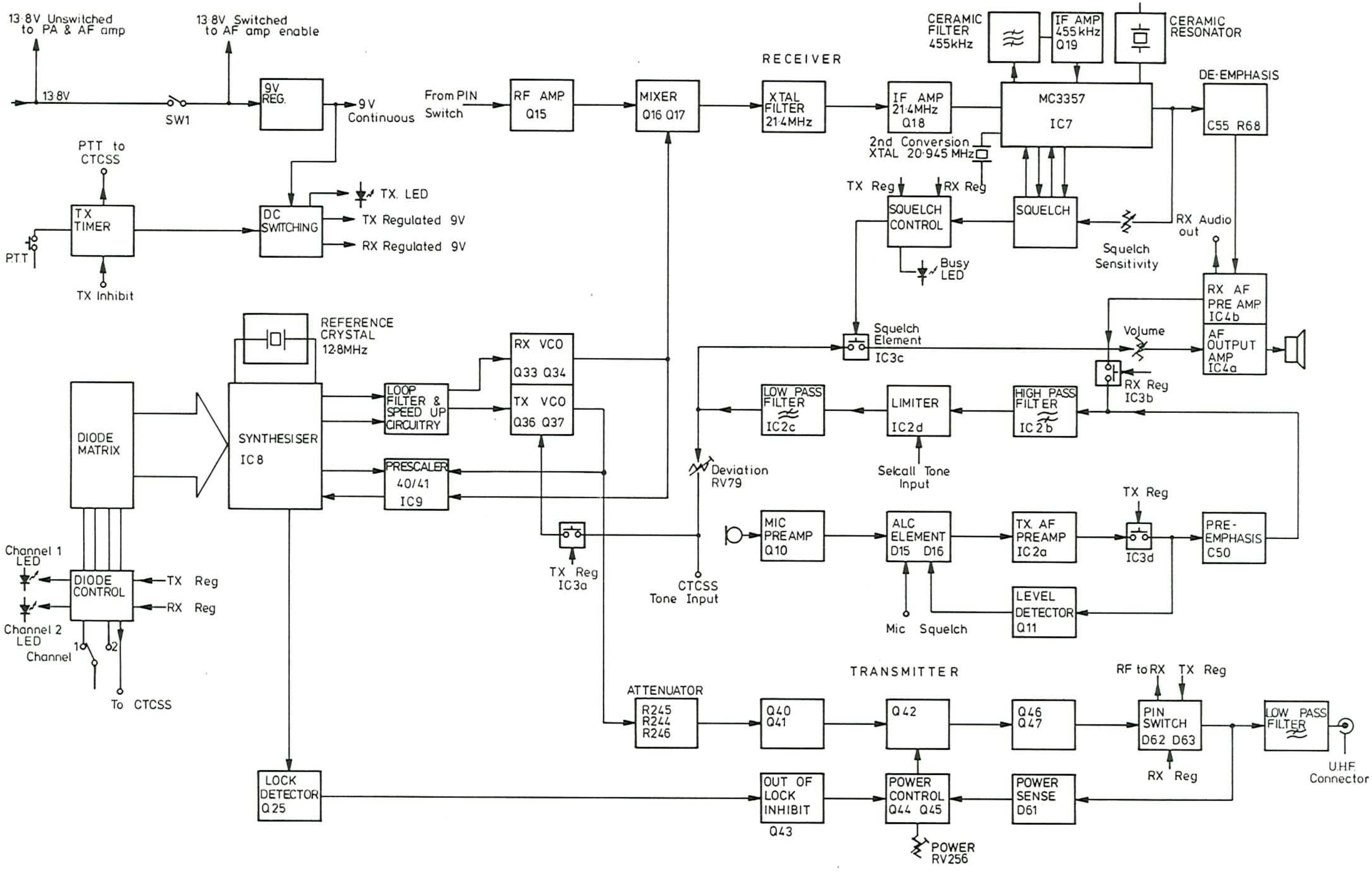


Diagram 4 T500/LED & Crystal Heater PCB Encoding



ISSUE	AMENDMENTS	DRN.	CHKD	APVD	DATE	ISSUE	AMENDMENTS	DRN.	CHKD	APVD	DATE
A	ORIGINAL	D.H.	D.J.	D.J.	27.11.85						

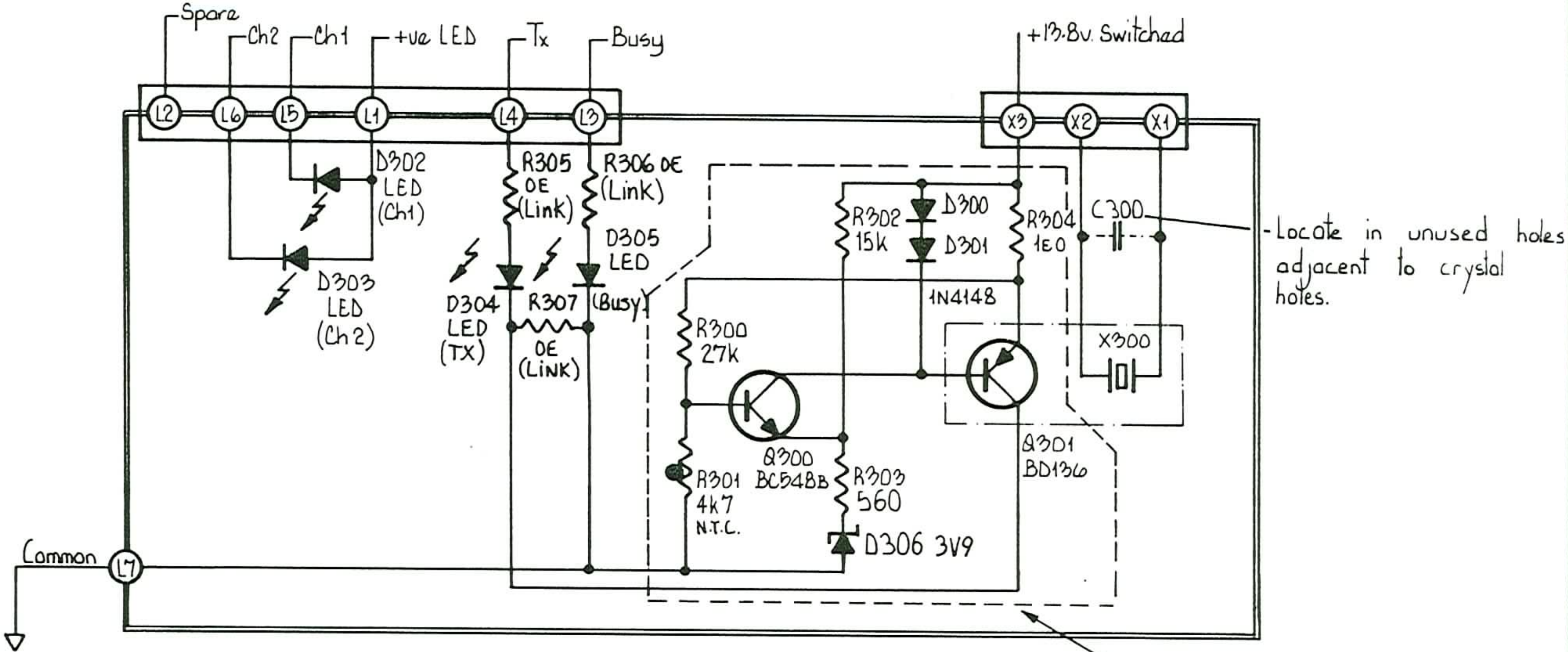
BLOCK DIAGRAM T540

TAIT ELECTRONICS Ltd.
Christchurch New Zealand

DRAWING NUMBER A2M1865

ISSUE A

DO NOT SCALE OFF DRAWING



CH. SPACE	X300	C300
6.25 KHz	12.8	not fitted
5kHz	10.24	1p8

SCALE :
MATERIAL :
FINISH :
GEN. LIMITS :

ISS	AMENDMENTS	DRN	CHKD	APVD	DATE
A	ORIGINAL	W.W.	MM	[illegible]	30-11-84
B	Ch/N 85/08 304, 09 353 10 374, 10 384	D.H.	H.O.	S.C.	21.10.85
C	Ch/N 86-07-175	[illegible]	[illegible]	S.C.	5.9.86
D	Ch/N 86-07-165	[illegible]	[illegible]	S.C.	7.10.86
E	ChN: 86-12-379	[illegible]	S.C.	S.C.	19.1.87

USED ON
T510
T520
T530
T540
T550

IPN

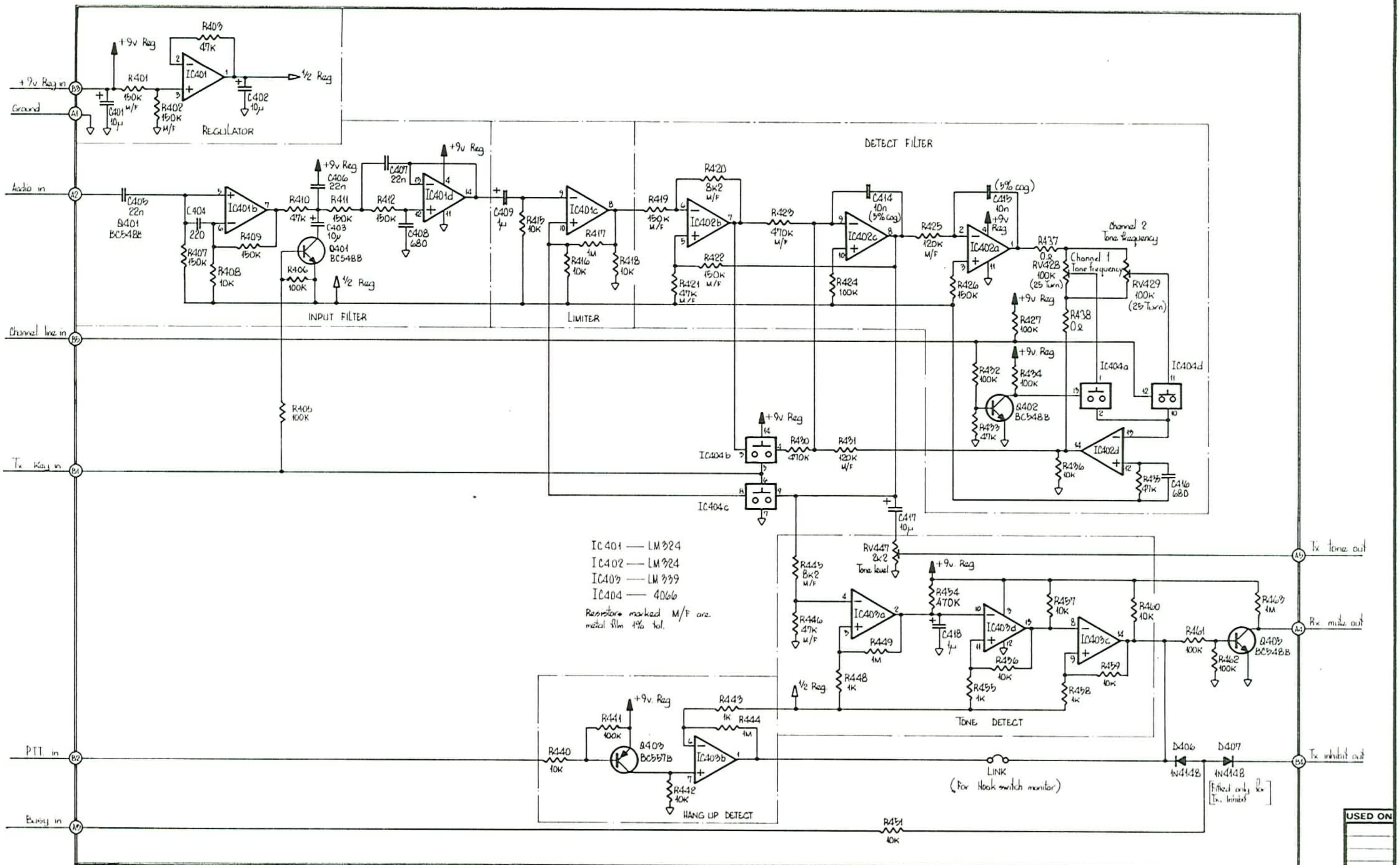
CIRCUIT DIAGRAM—T500/LED & OPTIONAL CRYSTAL HEATER.

TAIT ELECTRONICS LTD.

DRAWING NUMBER A4 C509

ISSUE A B C D E

DO NOT SCALE OFF DRAWING



SCALE :
MATERIAL :
FINISH :
GEN. LIMITS :

ISSUE	AMENDMENTS	DRN.	CHKD	APVD	DATE
A	ORIGINAL	W.W.	MM	SGB	24/4/85
B	Ch/N 86/02 024	A.G.	S.C.	S.C.	19.2.86
C	Ch/N 86/06 150, 07/182	D.N.	D.C.	S.C.	15.7.86
D	Ch N 86-09-206	[illegible]	D.C.	S.C.	2.9.86

ISSUE	AMENDMENTS	DRN.	CHKD	APVD	DATE

DO NOT SCALE OFF DRAWING

CIRCUIT DIAGRAM: TA-500/CTCSS

TAIT ELECTRONICS Ltd.
Christchurch New Zealand

DRAWING NUMBER A2 C500

ISSUE A B C D

IPN

USED ON