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T555TR Trunked Mobile Two Way Radio

UHF FM 400-520MHz

(M555-91)

Provisional Issue

TECHNICAL INFORMATION

For further information about this Manual or the equipment it describes, contact the 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 contains general, technical and servicing information on the T555TR trunked 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.

Date Of Issue

IPN M555-91 T555TR Service Manual

Provisional Issue published May 1991

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SECTION 1 GENERAL INFORMATION

1.1 INTRODUCTION

The T555TR is a high performance, synthesised mobile two way radio with a nominal RF power output of 25W. It is intended for operation in the 400 to 520MHz frequency range with 25kHz channel spacing and ±5kHz deviation, or 12.5kHz channel spacing and ±2.5kHz deviation. The T555TR is for use on trunking systems.

Operation of the T555TR is by hand-held microphone and press-to-talk switch, plus six front panel mounted controls: 'Volume', 'Call', three push buttons for ident selection and an 'On/Off' switch. Visual indication of 'Transmit', 'Go', 'System' and ident number is by illuminated front panel display.

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

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 2W of audio power to an 8 ohm internal speaker.

The VCO provides about 10mW of frequency modulated RF drive to the four stage broad band RF power amplifier. An audio processor contains modulation level control and deviation limiting circuits.

A trunking control board is plugged onto the radio unit and together they form a trunked radio. A display PCB is mounted behind the front panel itself and this is plugged as a unit onto the trunking control board.

The T555TR is light and compact and is supplied with a rugged mounting system which allows easy installation in any vehicle. Mains operation is possible when the T555TR is used with the Tait T508 power supply.

The DC supply to the T555TR must be negative earth and between 10.8 and 16V. The T555TR is protected against reversal of the DC supply polarity.

1.2 SPECIFICATIONS

1.2.1 INTRODUCTION

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.

1.2.2 GENERAL

Modulation Type	.. Frequency Modulation
Frequency Ranges	.. 400 to 520MHz
Frequency Increment	.. 12.5kHz (minimum)
Number Of Channels	.. 480 (maximum) [system dependent]
Switching Range:	
Transmitter & Receiver	.. 6MHz
Supply Voltage:	
Operating Range	.. 10.8 to 16V DC
Standard Test Voltage	.. 13.8V DC
Polarity	.. negative earth only
Polarity Protection	.. internal crowbar diode
Supply Current:	
Receiver - Squelched	.. 250mA
Receiver - Full Audio	.. 700mA
Transmitter	.. 5.5A
Antenna Impedance	.. 50 ohms (nominal)
T/R Changeover Switching	.. solid state
Operating Temperature Range (refer to Section 1.2.4)	.. -30°C to +60°C
Dimensions:	
Length	.. 238mm
Width	.. 150mm
Height	.. 45mm
Weight	.. 1.2kg

1.2.3 RECEIVER

Type	.. dual conversion superhet
12dB Sinad Sensitivity:	
Wide Band	.. -117dBm (0.32µV)
Narrow Band	.. -116dBm (0.35µV)
I.F Amplifiers:	
Frequencies	.. 21.4MHz and 455kHz
Bandwidth:	
Narrow	.. 7.5kHz
Wide	.. 15kHz
Signal+Noise-to-Noise Ratio:	
Narrow Band	.. 28dB
Wide Band	.. 33dB
Selectivity (adjacent channel)	.. 75dB
Spurious Response Attenuation	.. 70dB
Intermodulation Response Attenuation	.. 75dB
Spurious Emissions:	
Conducted	.. -60dBm
Radiated ($\frac{1}{2}$-wavelength dipole)	.. -57dBm
Audio:	
Output into internal 8 ohm speaker	.. 2W
Output into external 3.5 ohm speaker	.. 4W
Distortion (at rated power)	.. <5%
Minimum Load Impedance	.. 2 ohms
Audio Response	.. within +1, -3dB of a 6dB/octave de-emphasis characteristic (ref. 1kHz)
Audio Bandwidth	.. 300Hz to 3kHz
Squelch:	
Threshold	.. -117dBm (0.32µV pd)/3dB sinad
Hard Setting	.. -110dBm (0.71µV pd)/16dB sinad
Ratio	.. 70dB

1.2.4 TRANSMITTER

Power Output	.. 25W
Spurious Emissions:	
Conducted	.. -36dBm
Radiated ($\frac{1}{2}$-wavelength dipole)	.. -26dBm
Adjacent Channel Power:	
Narrow Band	.. -60dBc
Wide Band	.. -80dBc

Modulation System:

Type	.. direct FM
Deviation Limiting	.. ±5kHz (peak) maximum
Bandwidth	.. 300Hz to 3kHz
Responses:	
In Limiting	.. within +0dB, -4dB of max. system deviation
Below Limiting	.. within +1, -3dB of 6dB/octave pre-emphasis (ref. 1kHz)
Frequencies Above 3kHz	.. greater than 25dB/octave roll-off

Audio:

Input For 60% Maximum Deviation (at 1kHz)	.. 6mV rms
Distortion	.. <5%
Hum & Noise	.. 45dB

Mismatch Capability:

Stability	.. VSWR < 5:1 (all phase angles)
Ruggedness	.. 2 minute transmit into infinite VSWR (all phase angles)

Transmit Timer .. 1.5 minutes

1.2.5 FREQUENCY REFERENCE

Stability:

±5ppm (-10°C to +60°C)	.. TE/9 or TE/37
±4ppm (-10°C to +60°C)	.. TE/24 or TE/26
±3ppm (-10°C to +60°C)	.. TCXO

Oscillator frequency:

For channel spacing at multiples of 12.5kHz .. 12.8MHz

1.3 VERSIONS

1.	T555-81	400-470MHz Frequency Range 15kHz IF Bandwidth Rugged Cradle
2.	T555-91	400-470MHz Frequency Range 7.5kHz IF Bandwidth TCXO Rugged Cradle

1.4 OPERATING INSTRUCTIONS

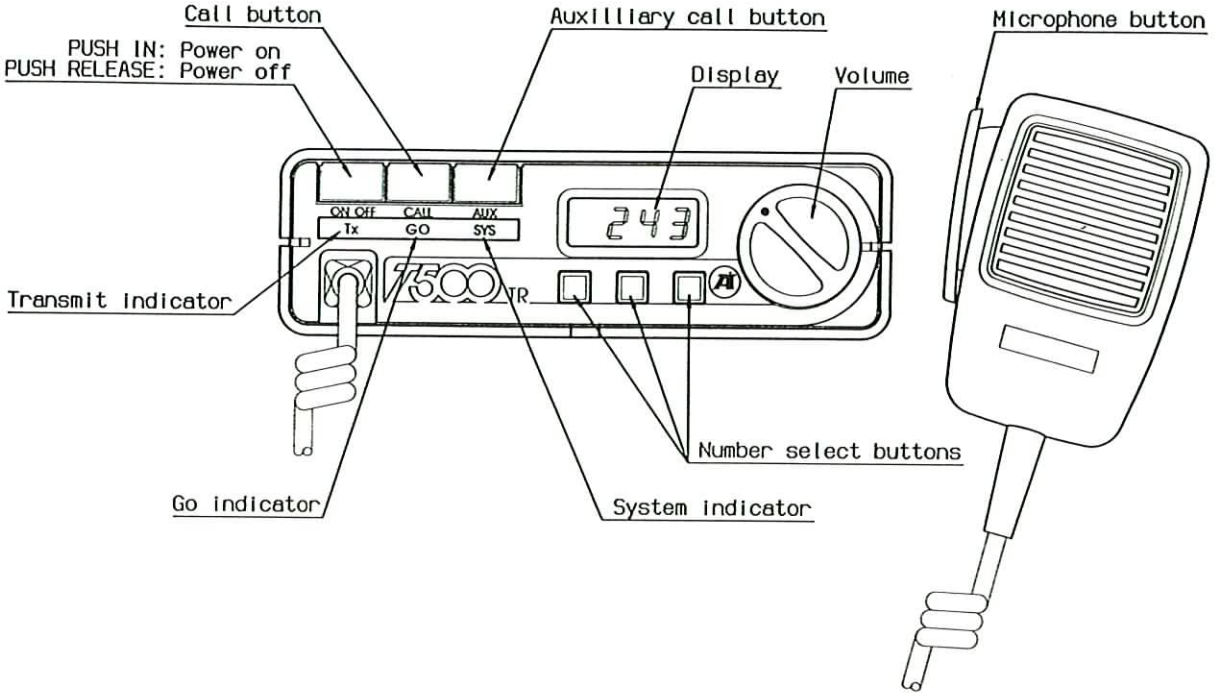


Figure 1 T555TR Front Panel

1.4.1 GENERAL

The following instructions assume that the radio is correctly installed (see Section 4). Some aspects of radio operation are dependent on the trunking system in use; contact your supplier or service facility in case of difficulty.

1.4.2 SWITCHING ON

The 'On/Off' switch turns the radio on when it is pressed, and pressing it again turns the radio off. When the radio is turned on, it will momentarily show the mobile unit number, and will then display the last button entry made before the radio was switched off.

The system indicator ('SYS') will light if the radio is in range of the trunked system and is receiving valid digital information from the control channel transmitter.

CAUTION: A functioning T555TR is always active and can respond automatically to an incoming call. It is therefore advisable to switch the T555TR off with the 'On/Off' button when entering a petrol station.

The T555TR should always be switched off if the aerial is disconnected.

1.4.3 MAKING A CALL

1. Enter the number of the mobile or despatcher to be called by pressing the appropriate call number buttons.

   Pressing each of the buttons alters the appropriate digit of the display in single digit increments upwards. Attempts to call invalid idents or idents of mobiles or despatchers not available to the user will cause the characters 'UA' to be displayed.

2. Momentarily press the 'Call' button or PTT switch.

   The transmit indicator will light and may flash on and off while the call is being established. If the called party is available, an audible indicator will be heard from the speaker and the display will indicate a countdown of the call time remaining in minutes and seconds.

3. If the call is not connected immediately, an audible indicator is sounded. If the indicator changes to a lower frequency, this means the call has been queued by the system and will be connected shortly.

4. To talk, press the PTT switch on the microphone.

   Speak directly into the microphone, holding it approximately 100mm from the mouth.

   To listen, release the PTT switch.

   Adjust the volume control clockwise to increase and anticlockwise to reduce the volume.

5. The call can be cleared by returning the microphone to the hook or by pressing one of the three call number buttons. During the last few seconds allowed to a call, a pip will sound each second as a warning. Cleardown will take place automatically at the termination of the countdown time.

1.4.4 MAKING A GROUP CALL

Group calls are made (if the radio is programmed for them) by entering the group call number on the front panel and making the call as normal.

1.4.5 RECEIVING A CALL

Incoming calls are audibly indicated by the ringing tone.

Lift the microphone off the hookswitch and acknowledge the call in the normal manner, pressing the PTT switch to talk and releasing it to listen.

The ident number of the mobile or despatcher making the call will be displayed for five seconds on the front panel, followed by the "call time remaining" display.

Note: A call may be cleared down if neither party transmits within a specific time period.

SECTION 2 CIRCUIT OPERATION

Refer to the Block and Circuit Diagrams at the rear of this Manual.

2.1 SYNTHESISER

The dual modulus synthesiser of the T555TR 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 source of Q36.

A crystal provides a stable reference frequency of 12.8MHz which is divided down to 12.5kHz and fed to one input of a phase comparator within IC8. For narrow band operation a TCXO is used to provided the necessary frequency stability.

The VCO frequency is divided by the 64/65 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 16-bit binary word from the trunking control board (TCB).

2.2 RECEIVER

The RF signal from the PIN switch is amplified by Q15 and fed to the gate of the mixer FET (Q16) via a triple tuned circuit (note the use of LC circuits rather than helical resonators). 10mW from the receive VCO is fed to the source of the mixer.

The IF output from the mixer passes through the first 21.4MHz crystal filter and is amplified by Q21 and Q2. It then passes through the second 21.4MHz crystal filter 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. An RSSI signal is derived from the 455kHz IF to be fed to the TCB.

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, IC4.

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 wide band T555TR and 4.5kHz for the narrow band 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 0.7V.

The switching signal from the threshold detector is then inverted by Q7. C17 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 25W by a 5 stage broad band amplifier (Q40, Q41, Q45, 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 25W by RV253 which controls the collector voltage of Q45 and hence the gain of the broad band amplifier. The circuit utilises a power detector, D57, and a feed back loop to hold the transmitter power to 25W under conditions of varying supply voltage.

Transistor Q42 prevents the transmitter turning on when the synthesiser is out of lock.

Note: A receiver front end protection circuit, consisting of D58 and R269, detects the presence of avalanche current in the series receiver PIN diode (D56) and turns the PA power down via the out of lock transistor (Q42). The avalanche current can occur under extreme VSWR conditions. Transistor Q48 adds a small delay to the switching voltage for D56.

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.

2.5 POWER SUPPLY

2.5.1 GENERAL

Note: The T555TR 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 T555TR 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 9V regulator. A continuous 9V is applied to the audio processor and synthesiser.

2.5.3 RECEIVE

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

receive VCO
receiver
squelch control
CMOS gate in the receive audio path
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:

transmit VCO
low power transmitter stages
CMOS gates in the microphone audio and modulation paths
transmit diode in the aerial switch.

Closing the PTT switch also initiates a timer circuit around IC1 which will return the T555TR to receive after 1.5 minutes of transmission.

2.6 FREQUENCY INFORMATION

The synthesiser programming, which determines the operating frequency of the radio, is controlled by the microprocessor on the TCB. 16 data bits are presented to the synthesiser A & N lines. Refer to Table 1 in Section 5.4.3 to check the synthesiser programming data.

2.7 TRUNKING CONTROL BOARD

2.7.1 ANALOGUE INTERFACES TO THE RADIO

2.7.1.1 Received Signal Strength Indicator (RSSI)

The RSSI is an analogue DC voltage produced by a detector in the receiver. The voltage enters the PCB at SKT-3 pin 3 and is fed to PE7 of the microcomputer via R95 and C85.

2.7.1.2 Lock Detect

This analogue voltage produced on the main board is fed to the TCB at SKT-3 pin 12. The signal is then fed via IC2 to microcomputer port PA2, thus enabling the synthesiser lock status to be monitored.

2.7.1.3 FFSK (Including Modem)

The received FFSK signal enters the PCB at SKT-1 pin 2 and is AC coupled to a pre-amplifier, IC2. FFSK is then passed to the modem chip via IC14 pin 16, which results in a logic '1' at IC14 pin 15 and decoded data at IC14 pin 14.

For transmit data, the modem provides a Tx sync signal at pin 3. The transmit data which originates at microcomputer port PA3 (pin 31) is applied to the modem at pin 7. It appears as FFSK at pin 5 and leaves the PCB at SKT-1 pin 5. RV1 controls the FFSK deviation, which is set to the required level while sending a pattern of alternate '1's and '0's in test mode.

2.7.1.4 Sidetone

Audible 'pips' and 'ringing' sounds are produced from the speaker during various stages of call set-up. These are generated in the microcomputer and appear at port PA4. The signals are then passed via C50/RV2 to SKT-3 pin 4 to the radio where they are mixed into the speaker amplifier. RV2 adjusts the tone level.

2.7.2 DIGITAL INTERFACE CIRCUITS TO THE RADIO

2.7.2.1 Pressel (PTT)

This signal takes one of three forms:

(a) A 12k ohm resistance to ground from the radio to the PCB when the microphone is 'on hook', i.e. when the stud on the microphone is grounded.

(b) A short circuit to ground from the radio to the PCB when the pressel is pushed.

(c) A short circuit to ground from the PCB to the radio to command the transmitter to key during signalling.

The PTT/hook signal is fed to microcomputer port PE4 (pin 44). This port samples the analogue input and the microcomputer determines the status. Tx-CRL is driven low by Q3 to enable transmission.

2.7.2.2 Microphone Mute

This signal passes from the TCB to the radio. The microphone is muted during signalling by Q2 turning on. The microphone mute signal leaves the board at SKT-3 pin 2.

2.7.2.3 Receive Audio Mute

This signal passes from the TCB to the radio and disables received audio to the speaker.

2.7.2.4 Synthesiser Control

This is a 16-bit parallel interface from the TCB to the radio to control the synthesiser frequency. The supply voltage to the synthesiser is 9V; thus IC3 and IC4, which perform the serial-parallel conversion, also run from 9V. IC10 provides the level shifting from 5V to 9V. The synthesiser data is controlled via synchronous communications with the microcomputer. Port lines PA5, PA6 and PD2 provide the serial clock (SYC), the serial data (SYD) and the latch (SYL) respectively to IC3 and IC4. The transfer command originates at microcomputer port PD2 and is also level shifted in IC10.

2.7.2.5 PA Disable

This is a signal from the TCB to the radio which disables the transmitter. The PA will be disabled when this line goes high.

2.7.2.6 Call Button

The 'Call' button initiates call requests and is passed from the radio to the TCB. It enters the board at SKT-3 pin 1 and is applied to microcomputer port PD4 (pin 24).

2.7.2.7 AUX Button

This button is connected via SKT-3 pin 14 to microcomputer port PA7 (pin 27); its function is software definable.

2.7.2.8 Emergency

This wire is taken from SKT-3 pin 13 to the rear panel power connector pin adjacent to the ground return wire. On the TCB it is connected to microcomputer port PE3 (pin 49).

2.7.3 DIGITAL INTERFACE TO THE FRONT PANEL

2.7.3.1 Clock, Data and Enable

These lines come from ports PA5 (pin 29), PA6 (pin 28) and PD5 (pin 25) respectively of the microcomputer. The lines leave the TCB at SKT-8 pins 8, 9 and 10. The data is in serial format with a synchronous clock; the enable line is necessary to update the display.

2.7.3.2 Buttons

The front panel buttons which are used to enter the called address and clear down are connected via the front panel to SKT-8 pins 3, 6 and 7 on the TCB.

2.7.4 MICROCOMPUTER CIRCUITS

2.7.4.1 The Microcomputer (IC12)

The heart of the TCB is the MC68HC1141, which controls all radio functions via software resident in the memory devices.

2.7.4.2 Memory Devices

The RAM (IC9) is a zero power device with its own internal battery.

The EPROM (IC8) is mounted in a socket for easy software updating.

The EEPROM is resident in the microcomputer (IC12).

2.7.4.3 Miscellaneous Functions

Miscellaneous functions are:

(a) 'GO' LED

This LED indicates traffic channel allocation for a call.

(b) 'SYS' & 'TX' LED's

The 'SYS' LED is switched on when the radio is receiving valid digital information from the control channel transmitter.

The 'TX' LED is switched on during transmit key.

2.7.4.4 Test Mode

The 'test mode' pins will pull microcomputer port line PD5 low when fitted with a shorting link. When shorted together on switch-on, the TCB goes into test mode to aid servicing.

2.7.4.5 Clock Circuit

The clock is generated by an on-chip oscillator and external crystal (XTAL 1). The clock is divided by 4 within the microcomputer and appears as 'E' on pin 5.

2.7.5 MICROCOMPUTER SUPERVISORY CIRCUIT

$\overline{\text{RES}}$ is driven by a three terminal LVI chip (IC15). An internal bandgap reference and external resistors R66/R67 ensure a $\overline{\text{RESET}}$ when the 5V supply falls below 4.8V.

2.7.6 POWER SUPPLIES

The supply to the TCB from the radio is taken from both the 13.8V switched and 9V regulated supplies. 13.8V is fed to a discrete regulator in the front panel to supply the 'SYS' and 'GO' LED's and IC100. 9V is further regulated by another 78L05 (VREG1) and this supplies all other TCB hardware.

2.8 FRONT PANEL DISPLAY

Data from the TCB is presented via SKT-8 to the 14499 display driver (IC100), which controls the four 7-segment displays.

SECTION 3 ANCILLARY EQUIPMENT

3.1 T508-01/02 POWER SUPPLY

The T508 Power Supply will allow the operation of a T500 Series I or II two way radio from a 230V (nominal) 50Hz or a 115V (nominal) 60Hz mains supply. 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 5.5A (intermittent) regulated supply for the T500 Series I and II two way radios and incorporates current limiting and thermal protection.

Type Numbers:

230V Supply	.. T508-01 (previously designated T508)
115V Supply	.. T508-02 (previously designated T508/115)

3.2 T508-21/22 SWITCH MODE REGULATOR

The T508-21/22 Power Supply uses switch mode technology to control the regulation of the output voltage. This results in a power supply with a higher temperature rating, improved efficiency and greater reliability.

The T508-21/22 provides a 13.8V DC 6.5A (intermittent) regulated supply for the T500 Series I and II two way radio and incorporates current limiting and thermal protection.

Type Numbers:

230V Supply	.. T508-21
115V Supply	.. T508-22

3.3 T220-02 REMOTE SPEAKER ASSEMBLY

The T220-02 remote speaker assembly may be used with the T555TR. It comprises a heavy duty 4W 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.

3.4 T500-20 SERIAL DATA INTERFACE

This is used to interface the T555TR with an IBM* XT or AT PC (or compatible) for identity programming. Circuitry to level shift the RS232 signals is built into the interface.

*IBM is a registered trademark of International Business Machines.

SECTION 4 INSTALLATION

4.1 VEHICLE INSTALLATION

Installation instructions (IPN 409-50001-00) are packed with each radio.

CAUTION: The T555TR is suitable for negative earth installation only.

4.2 T508 POWER SUPPLY UNIT

When using the T555TR with a T508 power supply, it is essential that the RF power output is adjusted so that the station effective radiated power (ERP) from the antenna complies with the licence conditions in force.

SECTION 5 SERVICING

5.1 GENERAL

5.1.1 NOTES

If further information is required about the T555TR 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 (e.g. T555-81), 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, e.g. M555-91, Issue A.

CAUTION: SWITCH OFF IN EXPLOSIVE ENVIRONMENTS

A functioning T555TR is always active and can respond automatically to an incoming call. It is therefore advisable to switch the T555TR off with the 'On/Off' button when entering potentially hazardous areas, such as petrol stations, or when in close proximity to quarries or tunnelling works where remote controlled explosive charges may be in use.

CAUTION: CLEANING

This is a plastic based product with a secondary finish on the front panel. 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. Do not use solvent cleaners on the front panel.

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: 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, e.g. 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' (TI's) 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 POZIDRIV RECESS HEAD SCREWS

Pozidriv 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.

Pozidriv No 1 screwdrivers will fit the pozidriv screws used in the T555TR. Philips cross-head screwdrivers are not satisfactory for use on these screws.

5.2.2 DISASSEMBLY INSTRUCTIONS

Note 1: To carry out alignment procedures it is necessary to remove only the bottom cover as given in 5.2.2.1 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.

5.2.2.1 To Gain Access To The Component Side Of The Radio PCB

Place the T555TR upside down on the bench.

Remove the 4 bottom cover retaining screws.

Gently lift both ends of the bottom cover until it clears the front panel and heatsink.

Lift away the bottom cover.

Remove the front panel as instructed below (Section 5.2.2.3).

With the power removed from the radio, carefully lift off the TCB.

5.2.2.2 To Gain Access To The Track Side Of The PCB

Remove the bottom cover as in 5.2.2.1 above.

Turn the T555TR over on the bench, taking care not to bend or damage any header pins on the main PCB.

Remove the 2 top cover retaining screws.

Gently raise both ends of the top cover until it clears the front panel and heatsink.

5.2.2.3 To Remove The Front Panel

Remove the microphone cord relief grommet from its seat.

Unplug the microphone.

Remove the bottom and top covers as instructed above.

Slide the front panel forward.

It is not necessary to remove the knob - it may be left in place.

5.2.2.4 To Gain Access To The PA Components

To gain access to the PA, remove the screws retaining the two PA cavity lids.

Remove the component side lid towards the right hand side of the PCB (as viewed from the front of the set) so that it clears the power supply feedthrough capacitor.

5.2.2.5 Speaker Removal/Refitting

The speaker in the T555TR is held in place with four "push-on fix" spring clips (IPN 357-00010-09, Spire No. SFP 3253) which may cause problems when the speaker is removed.

To remove the speaker, cut the spring clips off the plastic locating pegs with wire cutters. Do not attempt to prise off the spring clips as this will damage the pegs.

Fit four new clips when refitting the speaker.

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 REASSEMBLY

Reassembly is carried out in the reverse order of the above.

Replace the PA covers.

Replace the TCB carefully, ensuring that all header pins are located in the bottom entry sockets. The plastic pillar will click into place, securely locking the TCB in place.

Slide on the front panel.

Fit the top cover:

Gently press the cover into position, taking care to position the rim at the rear of the cover into the heatsink groove. Ensure that the rim of the front panel fits into the groove round the front of the top cover.

Replace the two "Taptite" screws at the rear of the cover.

Fit the bottom cover:

Invert the T555TR.

Gently press the cover into position, taking care to position the rim at the rear of the cover into the heatsink groove. 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.

Replace the two "Taptite" screws at the rear of the cover and the two "Plastite" screws at the front of the cover.

Plug the microphone back in and reseat the cord relief grommet.

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 LEADED 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 CHIP COMPONENT REMOVAL/REPLACEMENT

Note 1: **The following procedure applies only to chip capacitors, resistors and transistors. Do not attempt to remove surface mount IC's by hand with a soldering iron. These devices must be serviced only with appropriate desoldering equipment or by an Approved Tait Dealer.**

Note 2: The temperature of the soldering iron must be maintained at 320-370°C (600-700°F) and a low temperature solder should be used.

5.3.3.1 Component Removal

1. Place the soldering iron tip directly on the component in order to melt the solder and glue as shown in Figure 2. Remove the component with tweezers or long nose pliers.

2. Completely remove the old solder from the 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.

5.3.3.2 Replacement

1. After a component has been removed and the PCB pattern cleaned, apply a small amount of solder on the PC pattern and allow to cool, as shown in Figure 3.

2. Insert the new components and apply the soldering iron tip to the PC pattern as shown in Figure 4 (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.

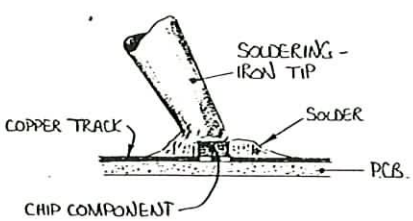


Figure 2

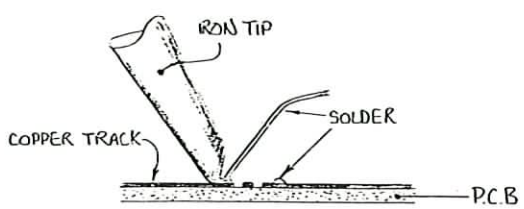


Figure 3

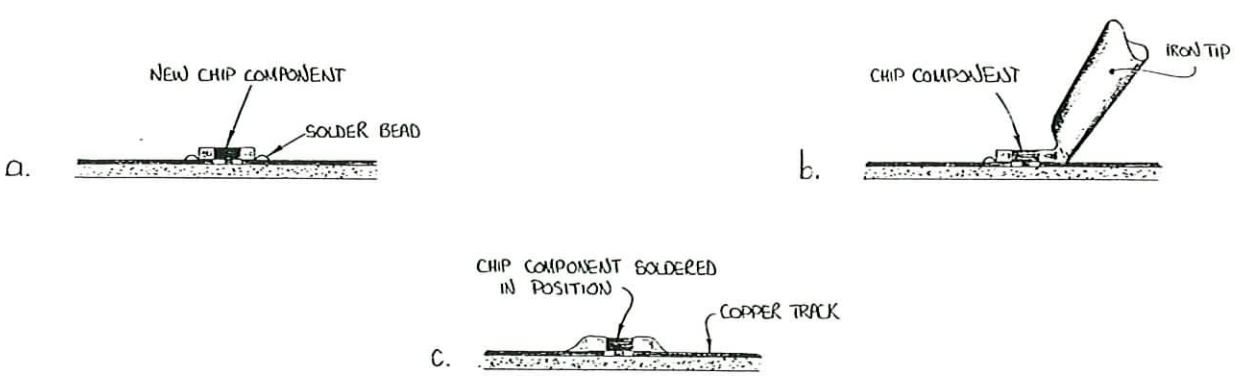


Figure 4

5.3.4 COMPONENT REMOVAL FROM PTH PCB's

The two satisfactory methods of removing components from PTH PCB's are detailed below.

Note: The first method requires the use of a desoldering station, e.g. Philips SBC 314 or Pace MBT-100E.

5.3.4.1 Desoldering Iron Method

Place the tip over the lead and, as the solder starts to melt, move the tip in a circular motion.

Start the suction and continue the movement until 3 or 4 circles have been completed.

Remove the tip while continuing suction to ensure that all solder is removed from the joint, then stop the suction.

Before pulling the lead out, ensure it is not stuck to the plating.

If the lead is still not free, resolder the joint and try again.

Note: The desoldering iron does not usually have enough heat to desolder leads from the ground plane. Additional heat may be applied by holding a soldering iron on the tip of the desoldering iron (this may require some additional help).

5.3.4.2 Component Cutting Method

Cut the leads on the component side of the PCB.

Heat the solder joint sufficiently to allow easy removal of the lead by drawing it out from the component side: do not use undue force.

Fill the hole with solder and then clear with solderwick.

5.3.5 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.

5.3.5.1 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 or nut, as this will fracture the device.

5.3.5.2 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.

5.3.6 MICROPROCESSOR REPLACEMENT

The microprocessor (IC12) is factory programmed and permanently bonded to the PCB. If this device fails, the trunking logic PCB must be replaced.

5.4 SETTING UP

Note: The T555TR software enables a "test mode" function which allows ease of service without requiring interaction with a trunking system. The purpose of this test mode is to enable the normal radio functions to be set up. However, a trunking test set (e.g. Marconi TF2960) or Schlumberger 4040/4041 system is required to test the trunking signalling protocols.

It is recommended that the serviced radio is field tested by the serviceman on the customer's trunking system before being returned to the customer.

5.4.1 TEST EQUIPMENT REQUIRED

1. Multimeter (e.g. AVO Model 8)
2. DC electronic voltmeter (e.g. Tech TE65)
3. RF power meter 50 ohm, 30W FSD usable to 520MHz with 5 & 30W elements (e.g. Bird Model 6154 or 611).
4. Power supply - output adjustable between 9 & 16V DC with a capacity of at least 8A.
5. Modulation meter (e.g. Sayrosa 252)
6. Sinad meter (e.g. Helper Instruments Sinadder)
7. UHF signal generator. Good quality FM 50 ohm. Useable from 0.1µV (-127dBm) to 200mV (0dBm) pd. (e.g. 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 (e.g. HP 204C/D)
11. Tone box: Audio amplifier, with about 1.5W output, to drive a small speaker which can be coupled to the T555TR 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
(e.g. Weinschel 40-40-33 30dB 150W, plus Coline 1200 85 20dB 1W)
16. RF diode probe (e.g. Coline M12DM modular RF detector probe)

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 T555TR should be as short as practical and fitted with a 'mating' BNC 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.

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.

5.4.3 CHANNEL PROGRAMMING

Note: VCO operation is restricted to a 6MHz switching range on receive and transmit within the band 400 to 520MHz. Do not programme frequencies outside these limits.

The switching range is defined as the change in frequency for a loop voltage of between 2 and 6.5V.

To check that the synthesiser is programmed correctly, refer to Table 1.

A logic level 1 on the pins listed adds that frequency increment to the total VCO frequency.

A logic level 0 on the pin means that it is not added.

Table 1

Frequency Increment MHz	Code	Pin No. IC8 (MC14152)	Connector
409.6	N9	20	SKT-3, pin 5
204.8	N8	19	SKT-3, pin 6
102.4	N7	18	SKT-3, pin 7
51.2	N6	17	SKT-3, pin 8
25.6	N5	16	SKT-3, pin 9
12.8	N4	15	SKT-3, pin 10
6.4	N3	14	SKT-4, pin 6
3.2	N2	13	SKT-4, pin 7
1.6	N1	12	SKT-4, pin 8
0.8	N0	11	SKT-4, pin 9
0.4	A5	10	SKT-4, pin 10
0.2	A4	25	SKT-4, pin 1
0.1	A3	24	SKT-4, pin 2
0.05	A2	22	SKT-4, pin 4
0.025	A1	21	SKT-4, pin 5
0.0125	A0	22	SKT-4, pin 3

5.4.4 TEST MODE

5.4.4.1 General

The test facility enables the TCB to emulate a multichannel radio, utilising the frequencies reserved for trunking. On transmit the TCB emits a stream of 1's and 0's to set the data modulation rate.

5.4.4.2 To Enter Test Mode

Switch the radio off.

Remove the bottom cover (refer to Section 5.2.2).

Place a temporary short across the two pins labelled "TEST MODE".

Switch the radio on.

The last channel number to be entered while in "test mode" (before power down) will be displayed; the dash (-) in the leftmost display position indicates the radio is in "test mode".

Remove the short.

Note: When in "test mode", connect the aerial socket to a dummy load to prevent interference with trunking systems and avoid testing on channels in use locally.

5.4.4.3 Function Selection

Use the digit entry buttons to set up the desired function number from the list below:

modem control:	10	continuous zeros (1800Hz tone)
	11	continuous ones (1200Hz tone)
	12	preamble (alternating 1200/1800Hz)
	13	modem Tx off
mute control:	20	mute the receive audio
	21	unmute the receive audio
	22	mute the microphone audio
	23	unmute the microphone audio
PA control:	30	inhibit the PA
	31	enable the PA
RSSI threshold set up:	61	set up L1 threshold value
	62	set up L2 threshold value
	63	display RSSI level (averaged)
	64	display L1 threshold value
	65	display L2 threshold value
special functions:	99	display/modify channel number entry

Press the AUX button to execute the function.

For radio control functions, an "A" will appear in the display to indicate that the number is valid and that the function has been executed.

To set an RSSI threshold value:

Apply a signal to the radio at the threshold level.

Select the required function.

Two dashes will appear in the display while averaging of the RSSI signal is taking place.

When averaging is complete, the result is displayed (in decimal, full scale = 255) and stored in the radio's database. The database checksum is automatically updated.

Function 63 displays the averaged RSSI level and also indicates when the threshold values have been exceeded. The leftmost decimal point lights when L1 is exceeded, the rightmost when L2 is exceeded.

5.4.4.4 Channel Selection

Use the digit entry buttons to set up the desired one, two or three digit channel number.

Press the CALL button to execute the channel change. A dash will appear in the display to indicate that the channel number is valid and that the channel change has been executed.

The radio can be incremented to the next channel by grounding the "EMERGENCY" line (available on the power connector). Channel incrementing starts from the last programmed channel. When the highest valid channel is reached, the radio will reset to the lowest valid channel at the next increment.

5.4.4.5 Power Up State

In test mode the radio powers up in the following state:

- modem Tx off (13)
- receive audio unmuted (21)
- microphone audio unmuted (23)
- PA enabled (31)
- receive mode (PTT released)
- display showing channel number, with a dash in the leftmost display position (the last channel number entry in "test mode" at power down will be displayed on the next power up in "test mode")

5.4.4.6 General

An invalid number selection is indicated by a "UA2" message in the display.

The microphone pressel functions as per normal radio operation. The 'TX' LED indicates that the radio is in transmit mode but does not necessarily mean that it is transmitting (e.g. the PA could be inhibited).

The 'SYS' LED indicates the synthesiser lock status, and is on whenever the synthesiser is out of lock.

The 'GO' LED indicates the squelch status and is on whenever a signal is detected on the selected channel.

5.5 VCO ALIGNMENT

Connect the T555TR to a dummy RF load.

Remove the RF shield cover to gain access to TP3.

Plug a UHF frequency counter onto radio test plug TP3:

Connect:-	centre pin	to	ground
	left pin	to	Rx VCO
	right pin	to	Tx VCO

Enter "test mode" as described in Section 5.4.4.2.

Monitor the loop voltage (TP2) with a high impedance voltmeter (0-10V range).

Select the highest channel frequency.

1. Receive Mode

   Adjust CV190 for >5.8V and <6.1V at radio TP2.

   Check that the frequency is:

   highest Rx frequency - 21.4MHz

2. Transmit Mode (PTT switch closed)

   Adjust CV232 for >5.8V and <6.1V at radio TP2.

   Check that the frequency is:

   highest Tx frequency

Note: A loop voltage of less than 0.6V or more than 7.5V indicates the synthesiser 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.

5.6.1 STANDARD FREQUENCY REFERENCE

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

Select the channel with the lowest frequency.

Adjust L30 for the correct VCO frequency.

Check the frequency on receive and transmit.

Replace the RF shield cover and solder the four locating tabs.

5.6.2 TCXO

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

Select the channel with the lowest frequency.

Adjust RV3 on the TCB for the correct VCO frequency.

Check the frequency on receive and transmit.

Replace the RF shield cover and solder the four locating tabs.

5.7 TRANSMITTER ADJUSTMENTS

5.7.1 ALIGNMENT

Note: In this and following Sections, measurements are given which differ for wide band and narrow band sets. In these cases the figures for wide band sets are given first followed by figures for the narrow band versions in square brackets [ ].

Connect a power meter to the aerial socket.

Set RV253 (power control) fully clockwise (viewed from component side).

Enter "test mode" as described in Section 5.4.4.2.

Close the PTT switch.

Adjust CV269 for maximum power.

Adjust CV284 for maximum power.

Adjust CV269 & CV284 for similar power and transmit current on the highest and lowest channel frequencies.

Adjust RV253 to reduce the output power to 25W.

Adjust CV284 to reduce the transmitter current for best efficiency.

Readjust RV253 for 25W if necessary.

Check that the transmit current does not exceed 6.0A for 25W output, with 13.8V at the set.

Check the output power across the frequency band.

5.7.2 MODULATION ADJUSTMENT (SPEECH)

Connect the T555TR 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 -30dBm (25mV 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.

5.7.3 MODULATION ADJUSTMENT (SIGNALLING)

Select the middle channel.

Disconnect the audio generator and enable "Preamble" from the modem as described in Section 5.4.4.3.

Mute the microphone as described in Section 5.4.4.3.

Set the data deviation to ±1.5kHz via RV1 on the TCB.

Check the lowest and highest channels to ensure that the deviation is between ±1.3kHz and ±1.7kHz.

5.7.4 RF POWER ADJUSTMENTS

Note: To comply with licence requirements when used in a fixed station role with the T508 power supply unit (e.g. as a despatcher), the T555TR should have the RF power output reduced.

Connect a power meter to the aerial socket.

Set RV256 (power control) to adjust the RF power output to the required level.

For use with the T508 power supply unit, the RF power output should be adjusted to the level required to achieve the correct rating (ERP) as permitted in the relevant licence document for the installation, allowing for antenna gain and feeder/connector losses.

Do **not** adjust the RF power output level for less than 5W.

5.8 RECEIVER ADJUSTMENTS

5.8.1 RF ALIGNMENT

Adjust RV149 fully clockwise.

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

Select the middle frequency channel.

Set the signal generator to the required receive frequency.

Connect a sinad meter across the speaker terminals.

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

Tune CV110, CV106, CV105, CV104 and CV100 for best sinad while reducing the signal generator output level to maintain approximately 12dB sinad.

Repeat the above tuning.

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

Check that the signal generator output does not exceed -117dBm [-116dBm] for 12dB sinad.

Monitor the RSSI voltage at PL-3 pin 3.

With an input level of -94dBm, use RV157 to set the RSSI voltage to 2.0 ±0.2V on the middle channel.

Measure and note the RSSI voltage levels across the frequency band and check they are within 900mV of each other. If not, select the channel with the lowest reading and adjust the level (by tuning CV100, CV104 & CV106) to a value halfway between the current low reading and the highest level noted earlier.

Note: Do not adjust CV105 as its tuning is very coarse.

Recheck the RSSI levels across the band as before and repeat the above adjustment procedure if necessary.

Select the middle channel and adjust the RF input level for 12dB sinad.

Adjust RV147 until the mute closes and then carefully readjust RV147 until the mute just opens.

Check that the mute opens at 10dB ±3dB sinad. If not, repeat the above procedure.

Note: Sensitivity will degrade towards -115dBm [-114dBm] (worst case) as the channel separation extends to 6MHz.

5.8.2 RSSI ALIGNMENT

Complete the receiver alignment as instructed in Section 5.8.1.

Select the middle channel.

Enter the L1 and L2 levels as described in Section 5.4.4.3.

Set the L1 threshold level with an input signal of -108dBm.

Set the L2 threshold level with an input signal of -94dBm.

Check the L levels as follows:

Enter "63" on the display and push "AUX": the average RSSI level will be displayed.

When the RSSI level exceeds L1, the leftmost decimal point will light.

When the L2 level is exceeded, the rightmost decimal point will light.

Ensure that the L2 level is reached with a signal generator input of -94dBm ±6dB across the band.

5.8.3 IF ALIGNMENT

Note: **The Intermediate Frequency Section has been accurately aligned during manufacture and should not be adjusted unless repairs have been carried out, or there is clear evidence of malfunction.**

To obtain the best performance from the IF, the receiver pass band must be swept. Alignment of L21 and L23 for best 12dB sinad sensitivity may result in high audio distortion or poor mute performance.

The following IF sweep procedure assumes the front end alignment has been completed (see Section 5.8.1).

Set up the test equipment as in Diagram 2.

Set the signal generator to give an unmodulated 'on channel' signal.

Connect the audio oscillator to externally modulate the signal generator with a sine or triangular waveform to approximately ±15kHz deviation at a rate of about 10Hz.

Connect the audio oscillator output to the oscilloscope (DC coupled).

Connect the second oscilloscope input (AC coupled) via a 10:1 scope probe to pin 5 IC7 of the T555TR (R124).

Set the oscilloscope to 'X-Y' display and adjust the signal generator output level so that the IF is not limiting (this should be less than -100dBm).

Remove the RF shield cover.

Adjust L21 and L23 for minimum ripple and slope. Maximise the width and amplitude.

At an RF input level of -115dBm, the amplitude at the centre of the sweep should be approximately:

wide band	-	5-10mV rms
narrow band	-	10-15mV rms

Replace the RF shield cover and solder the four locating tabs.

5.9 RADIO 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 a fault can be readily pinpointed.

5.9.2 RECEIVER PERFORMANCE TESTS

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

5.9.2.1 Squelch

Select the middle channel.

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.

Slowly increase the signal generator output level until the squelch gate 'opens'; this should be less than 8dB sinad.

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 3.7V across 4 ohms at +13.8V supply.

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

The distortion should not exceed 5%.

5.9.2.3 To Check The VCO Injection To The Mixer

Desolder the four locating tabs and remove the RF shield cover.

Connect a DC EVM to the junction of R109/C111 via a 33k ohm isolating resistor at the probe tip.

Short the junction of C198/L27 to ground using the metallic end of a WT11 tuning tool.

Check that the EVM reads approximately 1.5V DC.

Remove the short and note the increase in EVM reading.

The EVM reading should increase by more than 0.1V. Insufficient injection will result in poor receiver sensitivity.

Replace the RF shield cover and resolder the four locating tabs.

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 on the receive frequency. (Couple a 21.4MHz 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 -127dBm.

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

The signal generator output should not be greater than -117dBm [-116dBm] and is typically -119dBm [-118dBm], for single channel use or two channels separated by less than 2MHz. As the channel separation extends towards 6MHz, the sinad sensitivity will degrade towards -115dBm [-114dBm].

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 [25dB] for single channel use or two channels separated by less than 3MHz. As the channel separation extends towards 6MHz, the signal + noise to noise ratio will degrade towards 27dB [22dB].

5.9.2.6 To Check The Ultimate Signal To Noise Ratio

Note: A good quality low noise RF signal generator should be used for this check (e.g. 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 IC2.

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 IC2.

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 T555TR 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 T555TR 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 16V.

Above 13.8V the RF power output should not increase by more than 2W.

At 10.8V the RF power output should be more than 10W.

5.9.3.4 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 SYNTHESISER 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 R220 (6.5V) and L53 (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 Synthesiser 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 synthesiser (IC 8):

(Under normal operating conditions the loop voltage is between 2.0 and 6.1V 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 Q26/Q30 and TP2.

(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 $f_{prescaler} = f_{VCO}/64$

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 synthesiser (pin 1) is more than 500mV pp.

5.9.4.3 To Check The VCO Output Frequency Stability

If the synthesiser 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 The Transmitter Switch-On

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

(a) that, if the synthesiser is locked, the lock detect output (IC8, pin2) is high;

(This output pulses low if the synthesiser is out of lock.)

(b) that the voltages are as shown in the Circuit Diagram (Q25, Q42).

5.9.4.5 Microphonics

If the set shows a high level of microphonics:

(a) check that all components inside the VCO box are flush mounted to the PCB, paying special attention to the trimmer capacitors and the inductors at the bottom side. (Resoldering may be attempted, but a solvent cleaner must never be used inside the VCO box.)

(b) Remove any excess solder where the VCO box touches the PCB.

(c) Ensure that all screws are securely tightened.

5.10 TRUNKING CONTROL BOARD FAULT FINDING

5.10.1 GENERAL

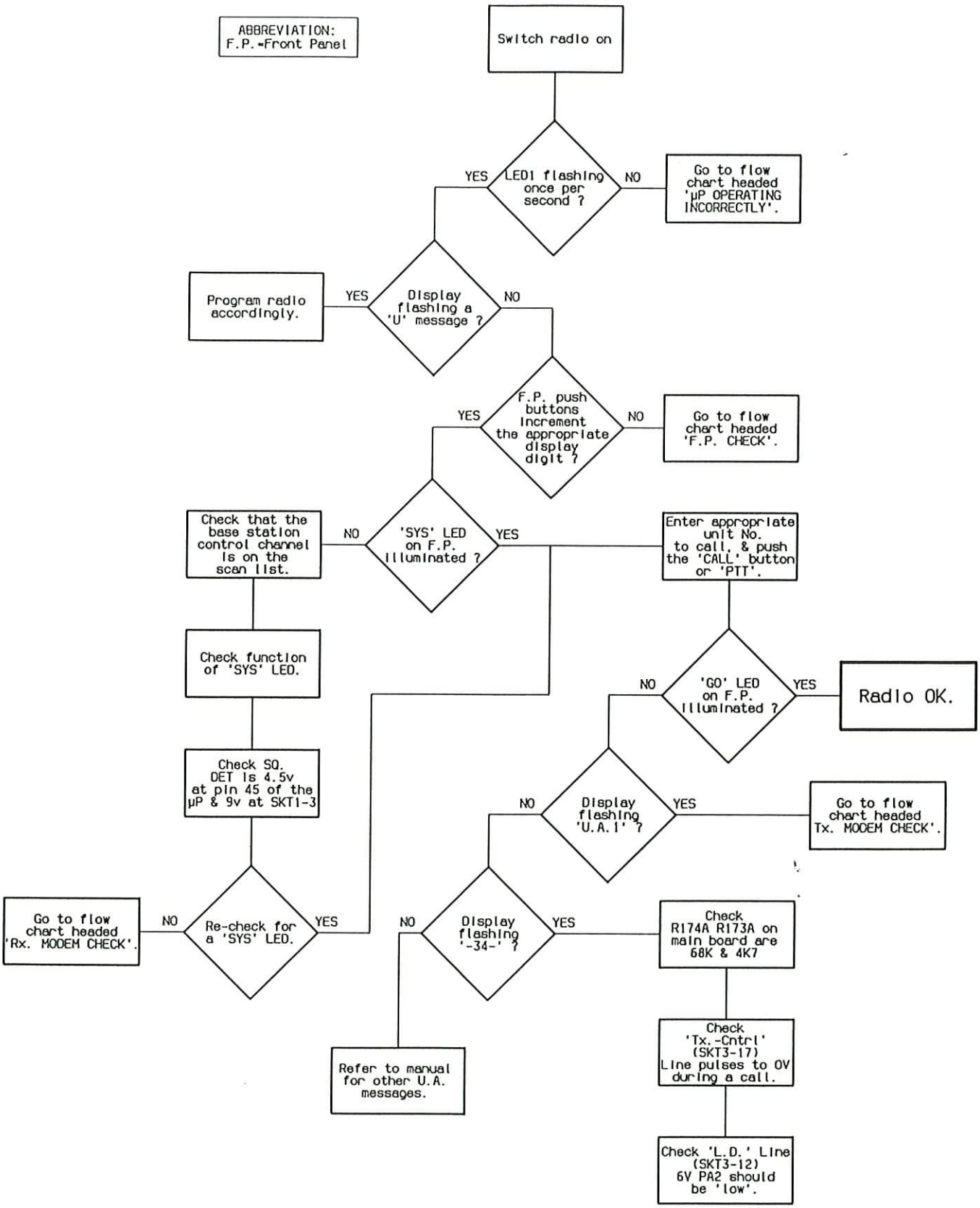
Five flow charts are provided in this Section as an aid to fault finding the TCB. The aim of these charts is to enable simple faults to be traced quickly to a certain area of the board.

If there is a regular fault that requires replacement of the TCB, please contact the Product Support Group at Tait Electronics Ltd.

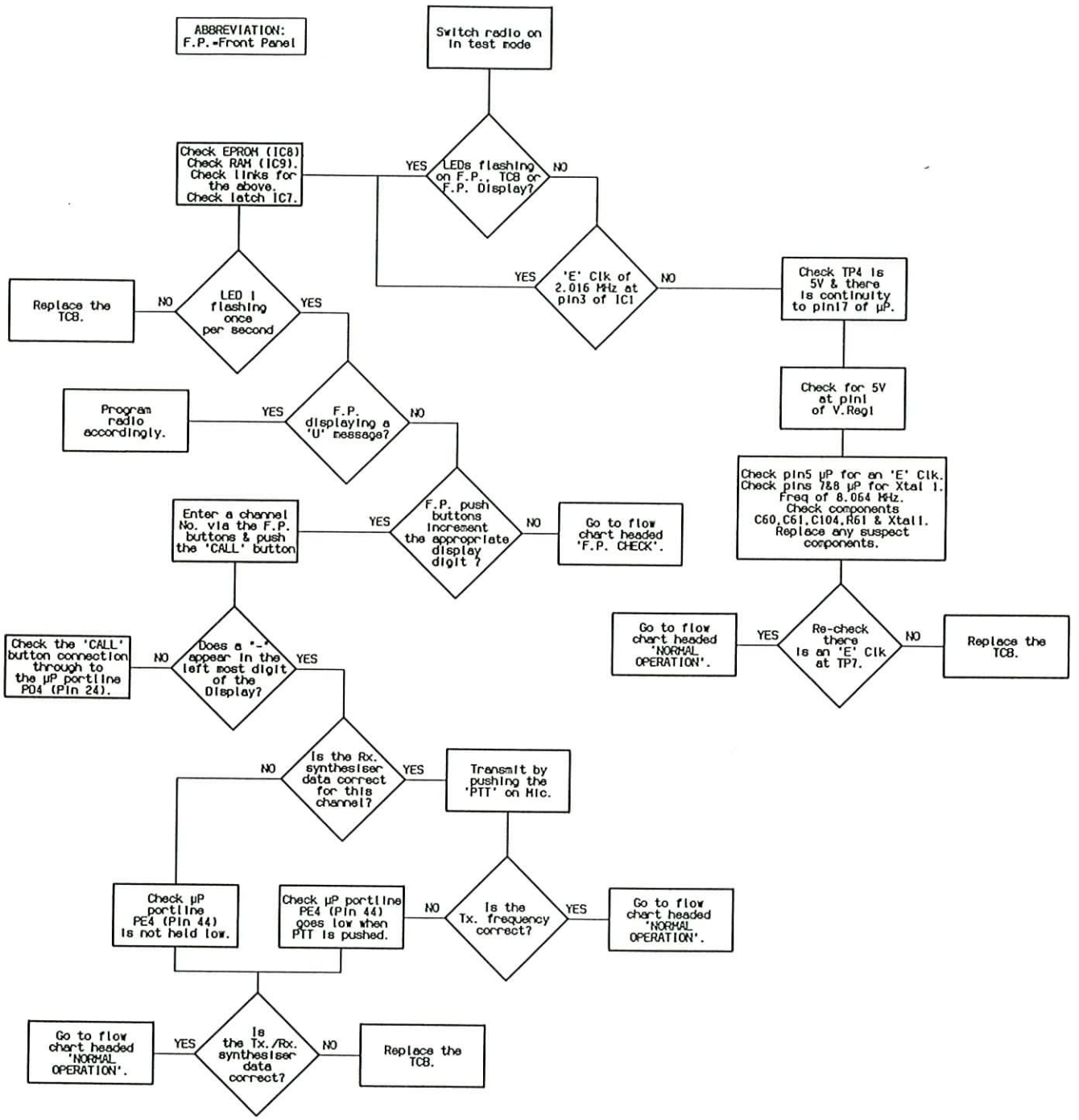
Start the fault finding by referring to Section 5.10.2, "Normal Operation", referring thereafter to the other flow charts as directed (removal of the radio covers is described in Section 5.2).

Note: When servicing is complete, always check that the "radio personality" is correct for the user. A before and after check of the "radio personality" is recommended.

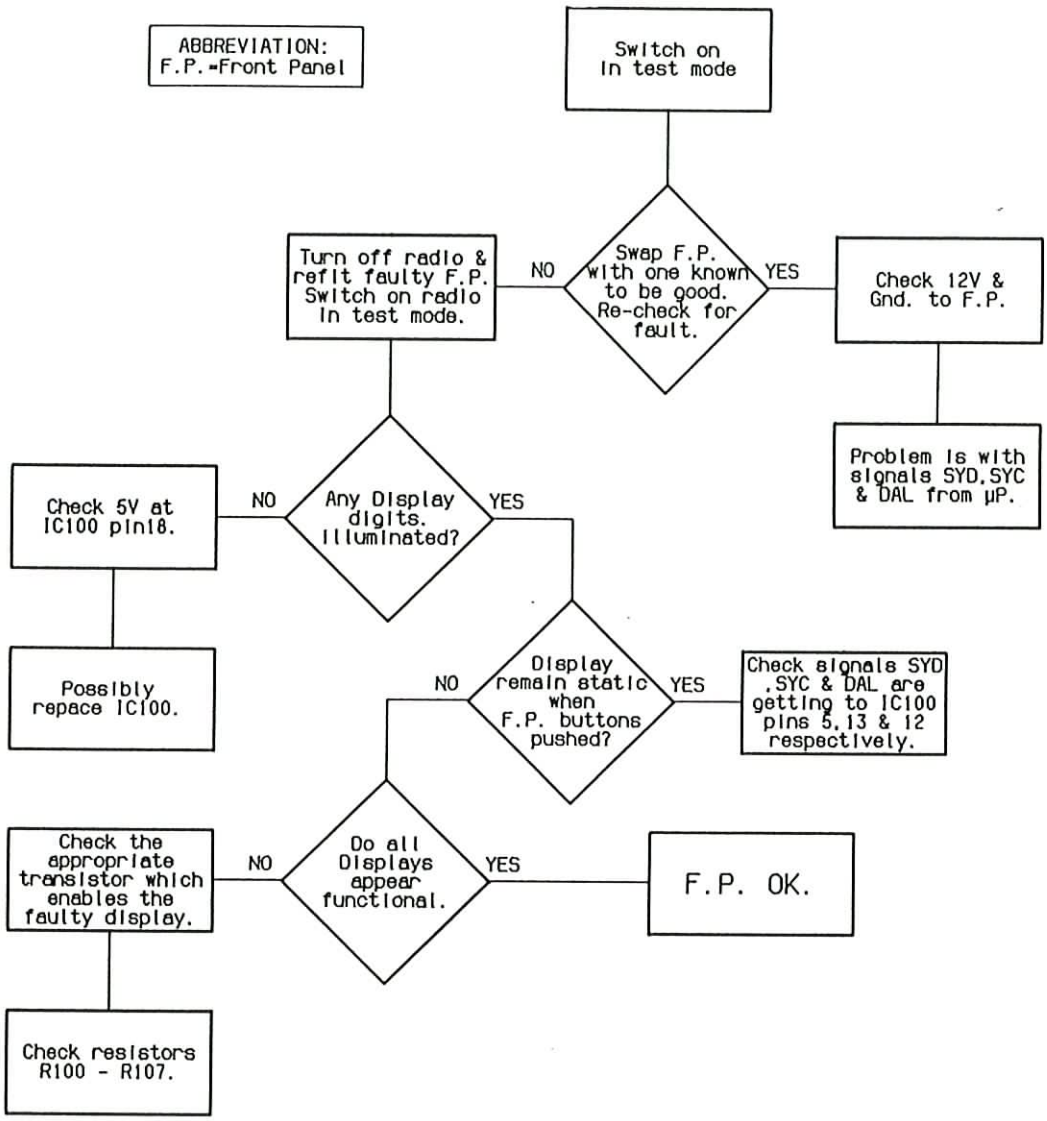
5.10.2 NORMAL OPERATION



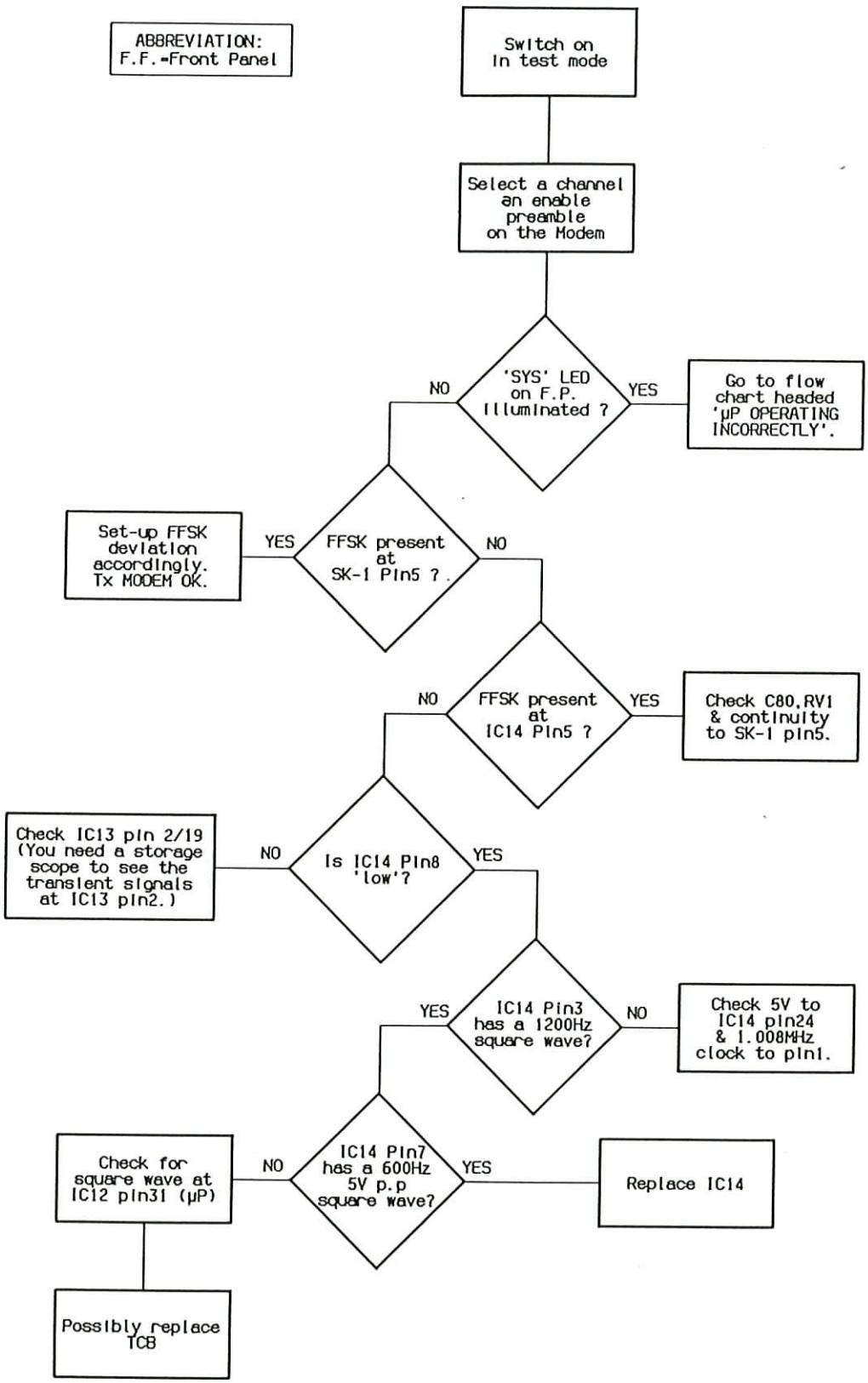
5.10.3 MICROPROCESSOR OPERATING INCORRECTLY



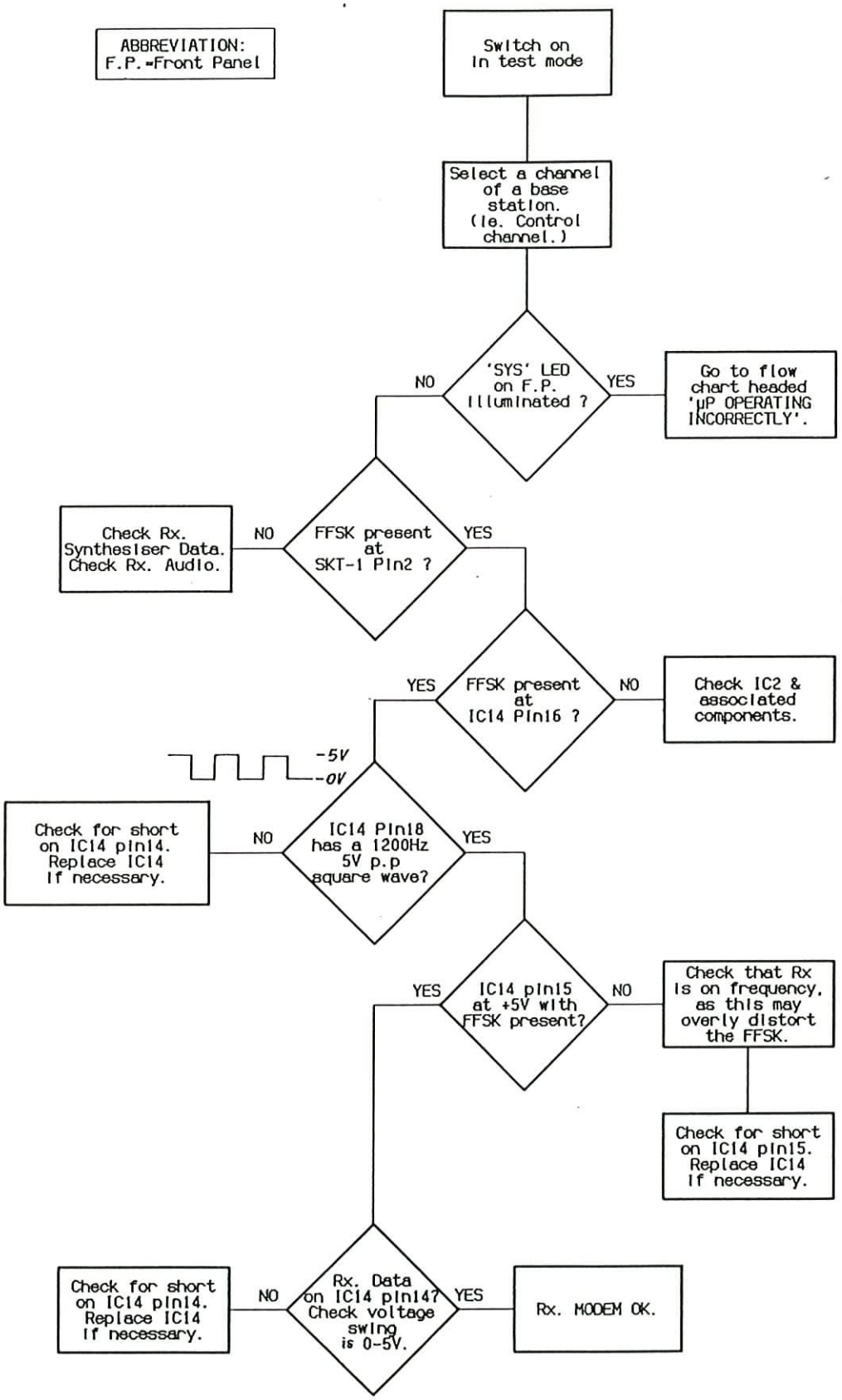
5.10.4 FRONT PANEL CHECK



5.10.5 TX MODEM CHECK



5.10.6 RX MODEM CHECK



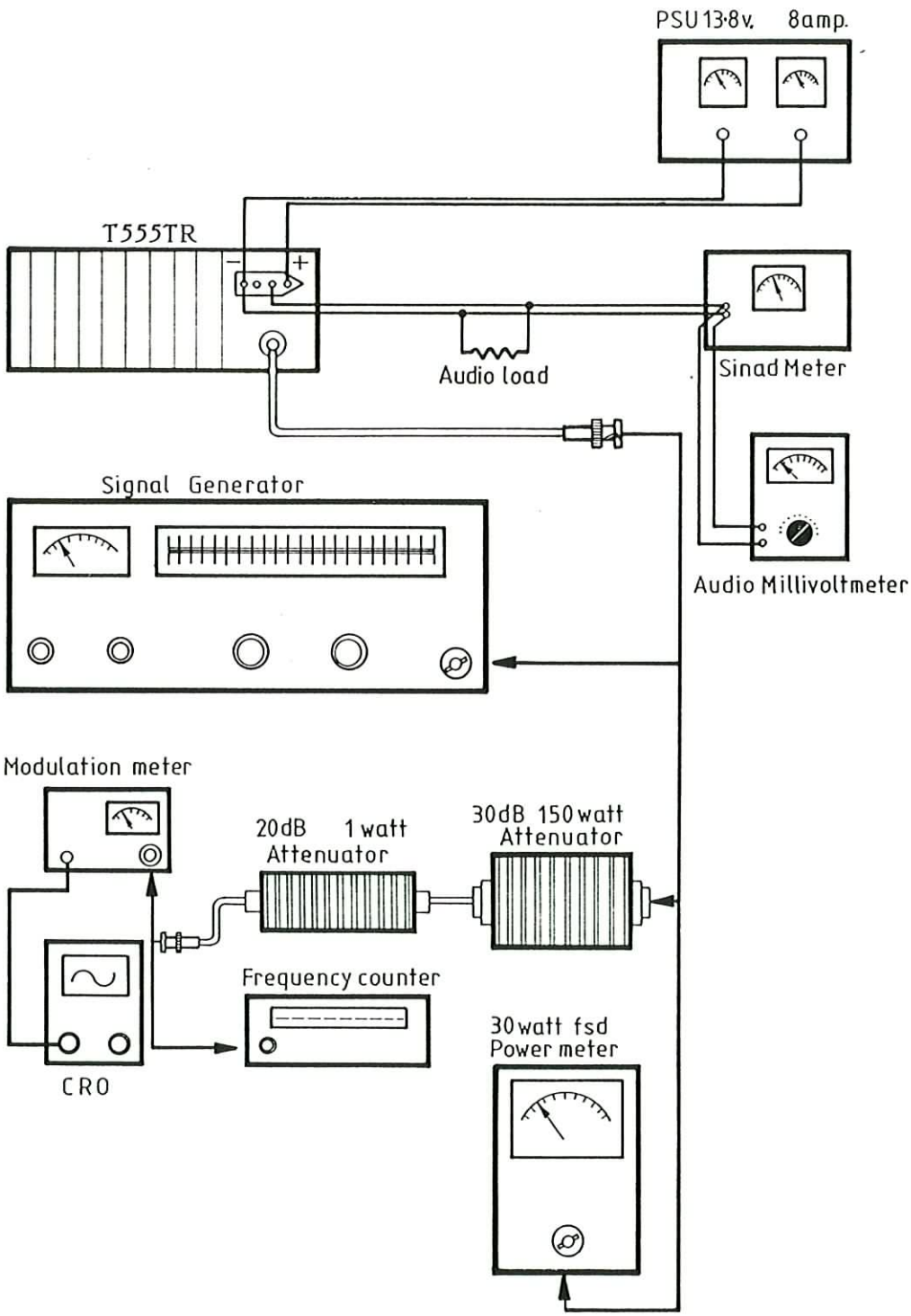


Diagram 1 Suggested Test Equipment Set-Up

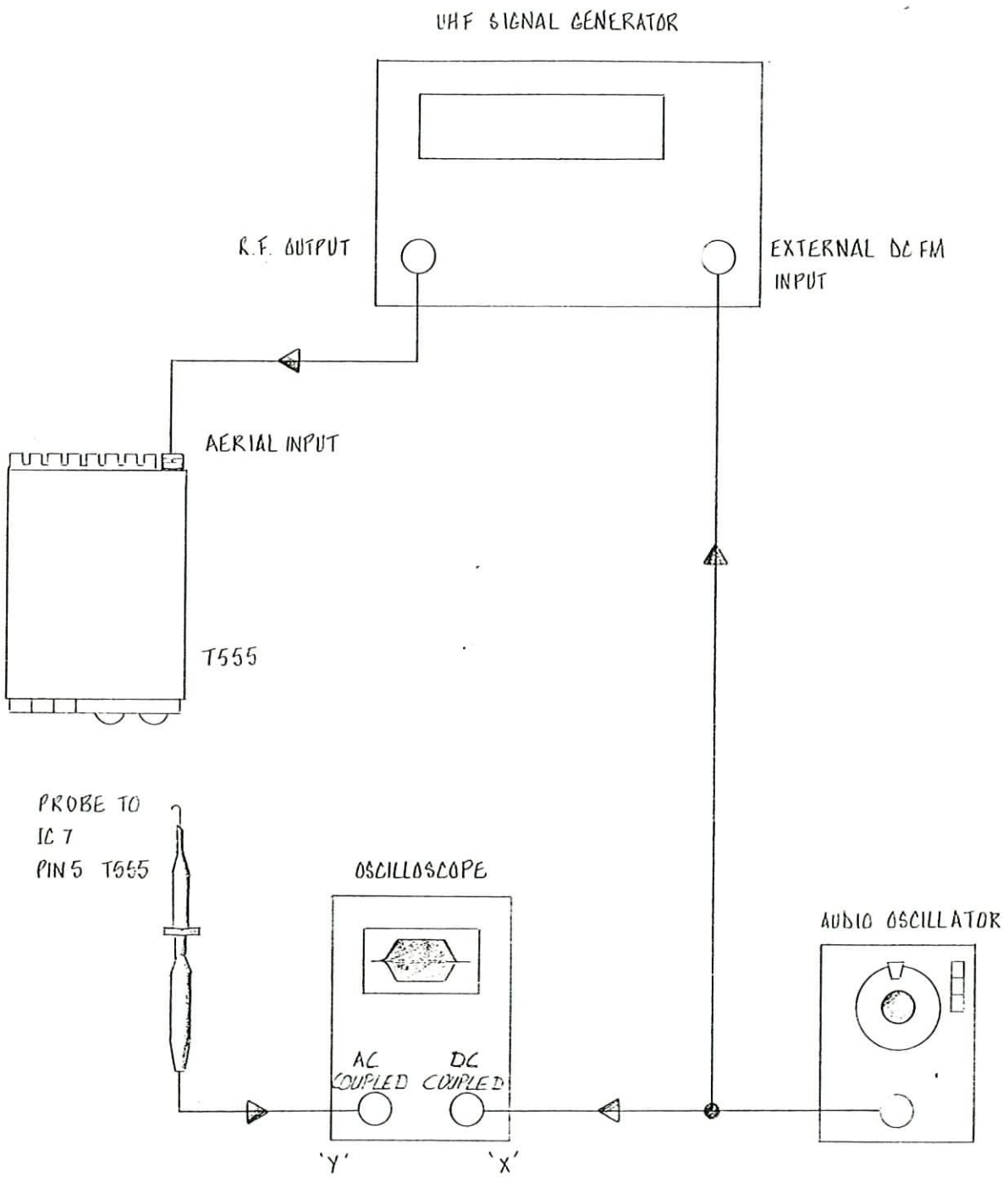


Diagram 2 IF Alignment Test Set-Up

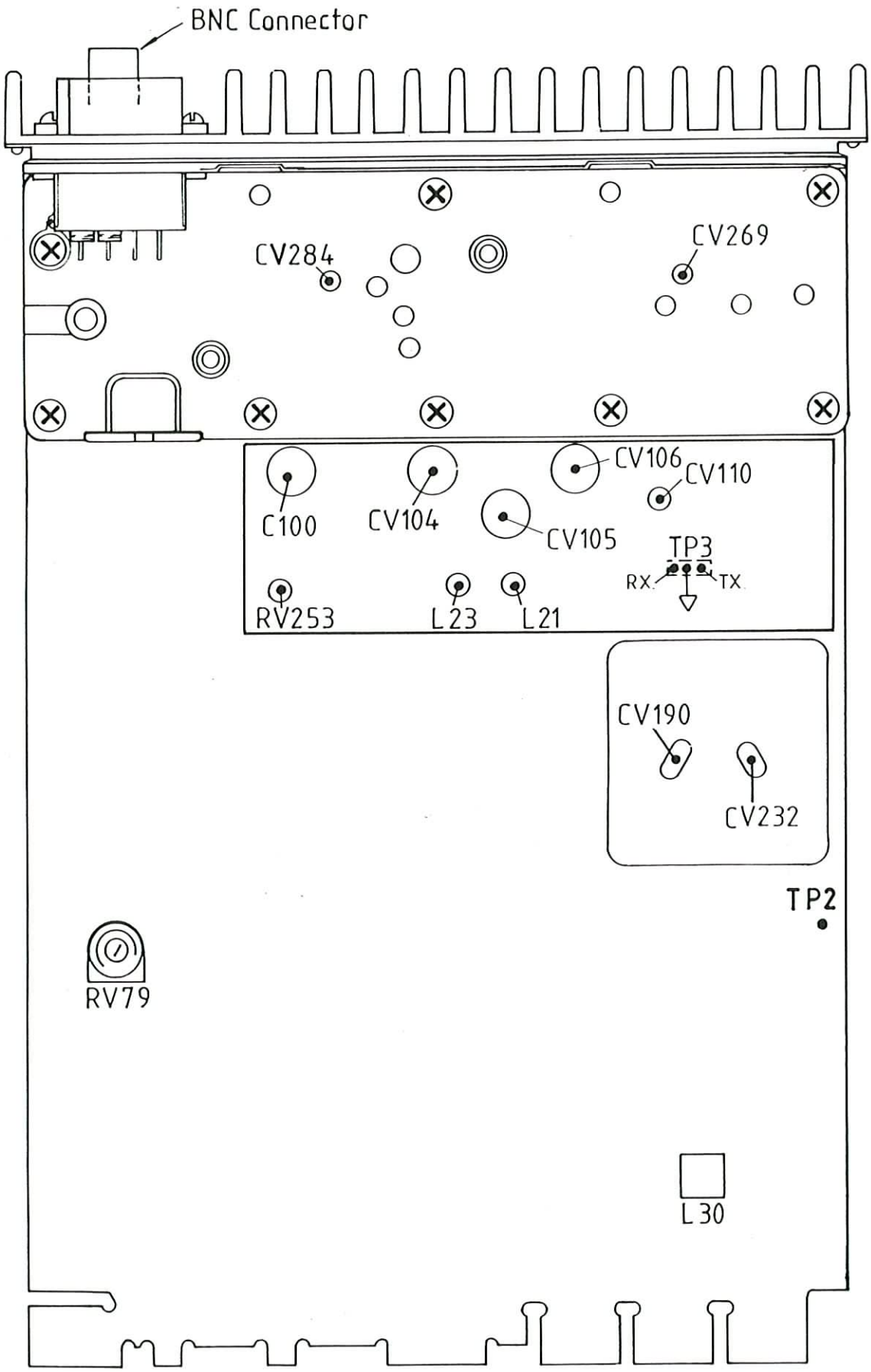


Diagram 3 T555TR Tuning Points

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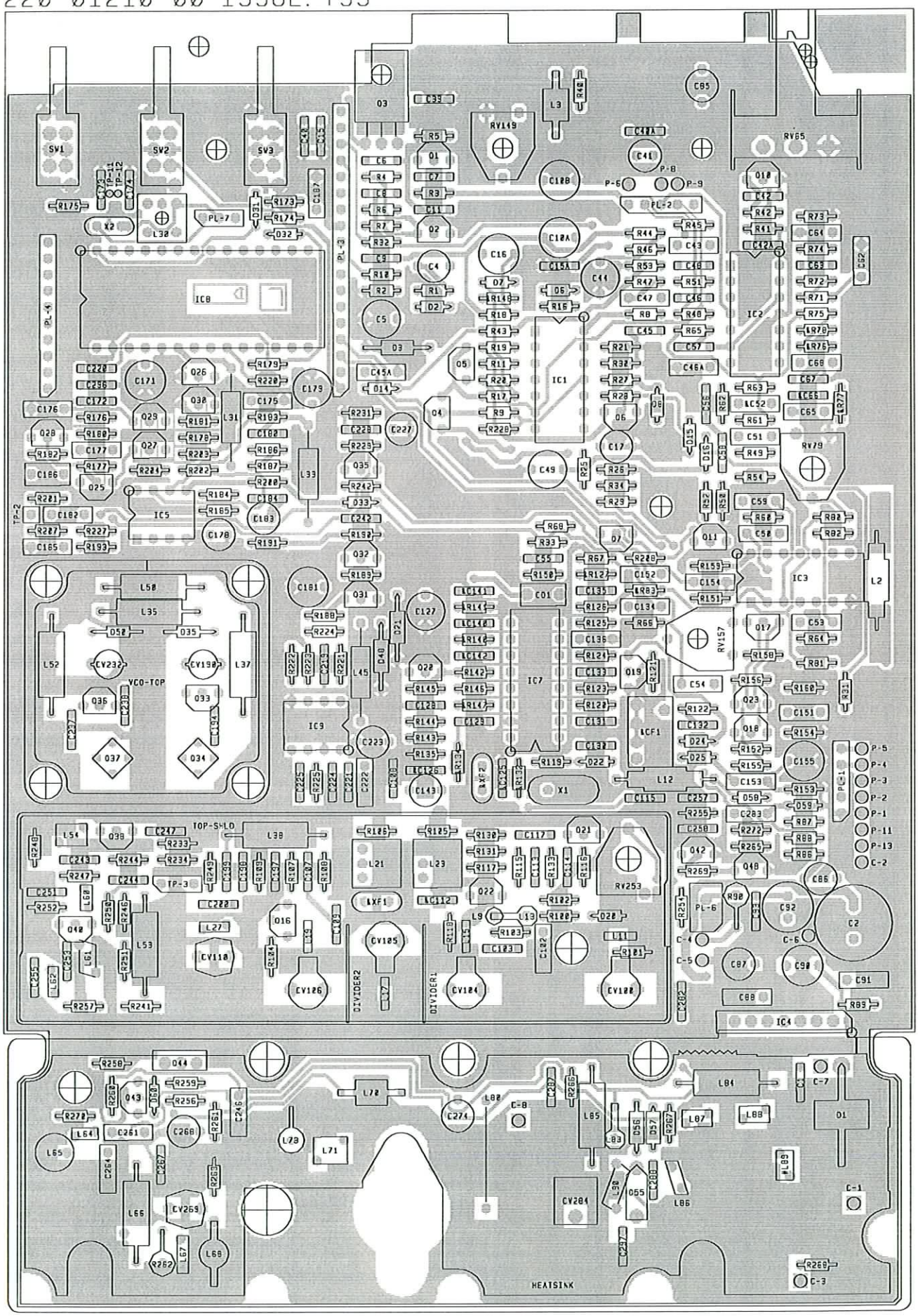

DIAGRAM 4 - T555TR PCB LAYOUT - TOP SIDE.

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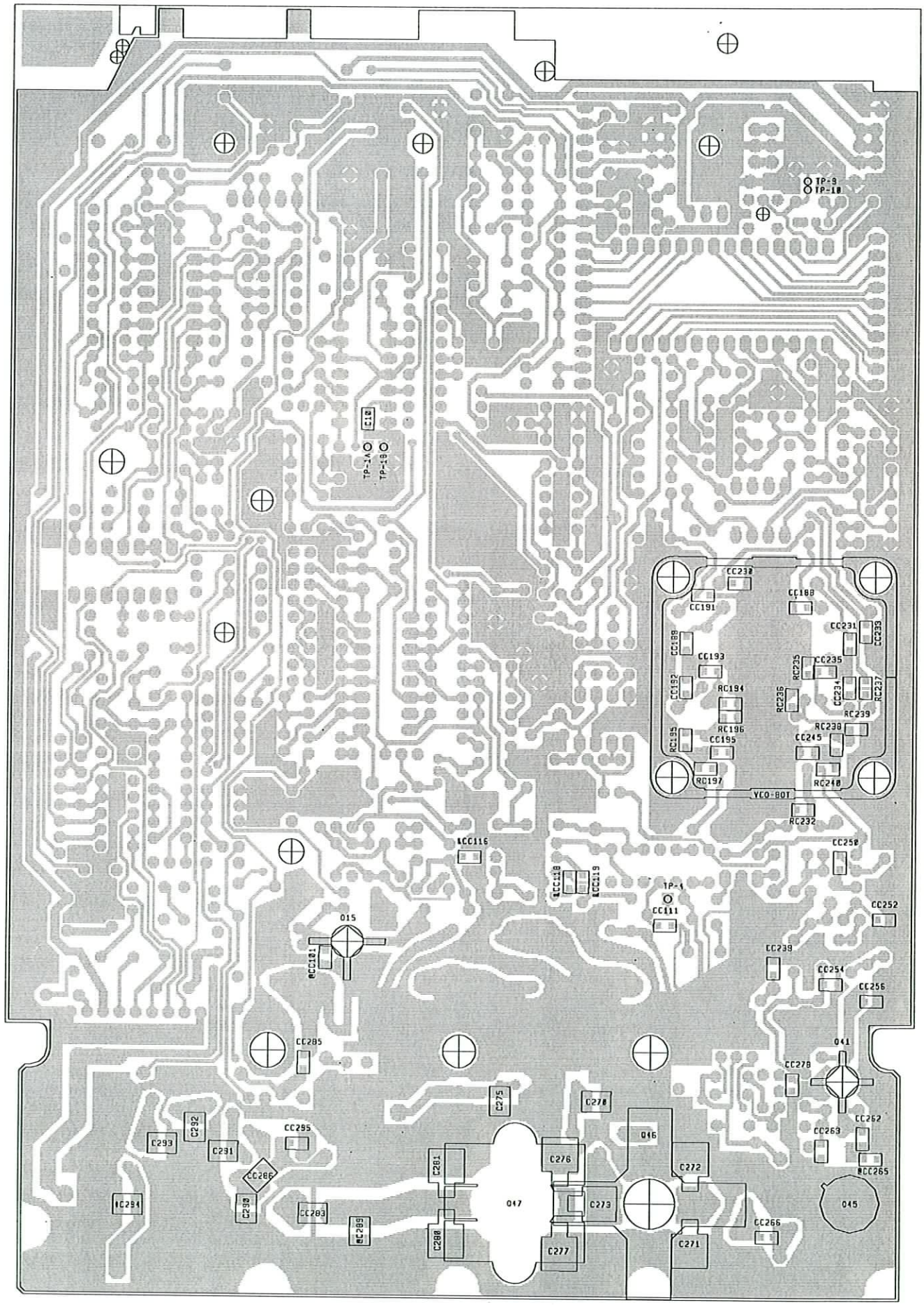


DIAGRAM 5 - T555TR PCB LAYOUT - BOTTOM SIDE.

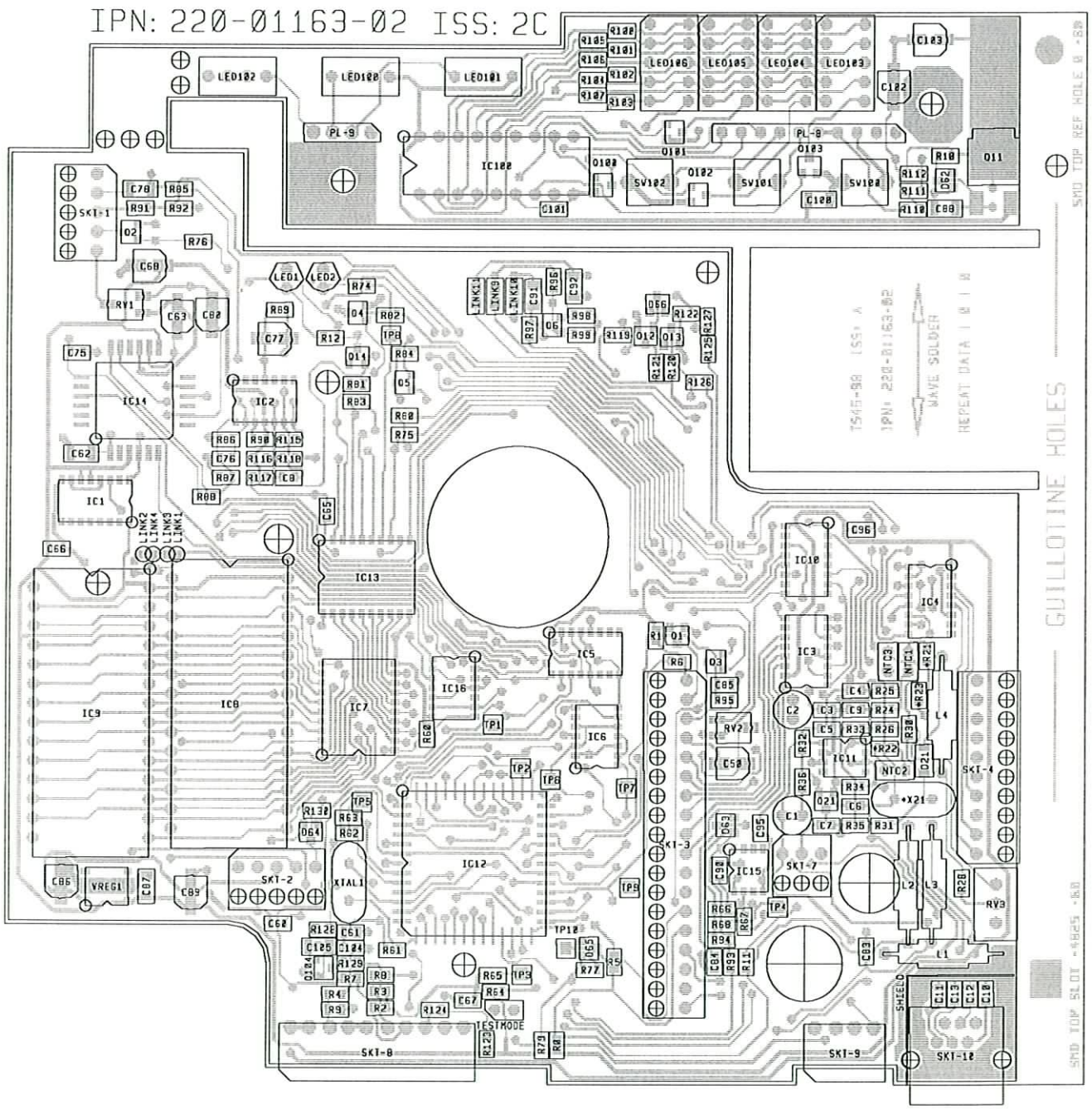


DIAGRAM 6 - TRUNKING CONTROL/DISPLAY PCB LAYOUT - TOP SIDE.

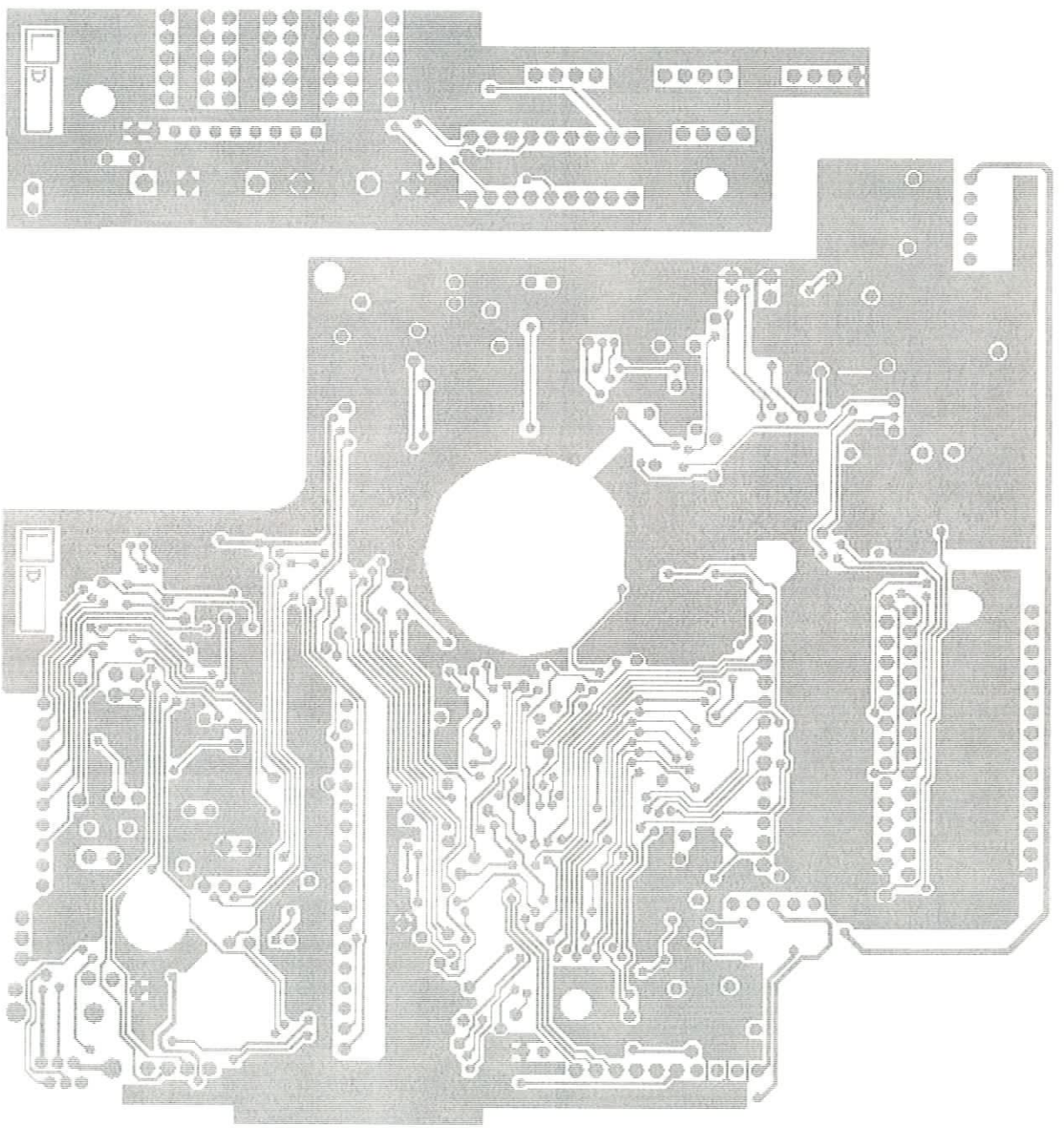


DIAGRAM 7 - TRUNKING CONTROL/DISPLAY PCB LAYOUT - BOTTOM SIDE.

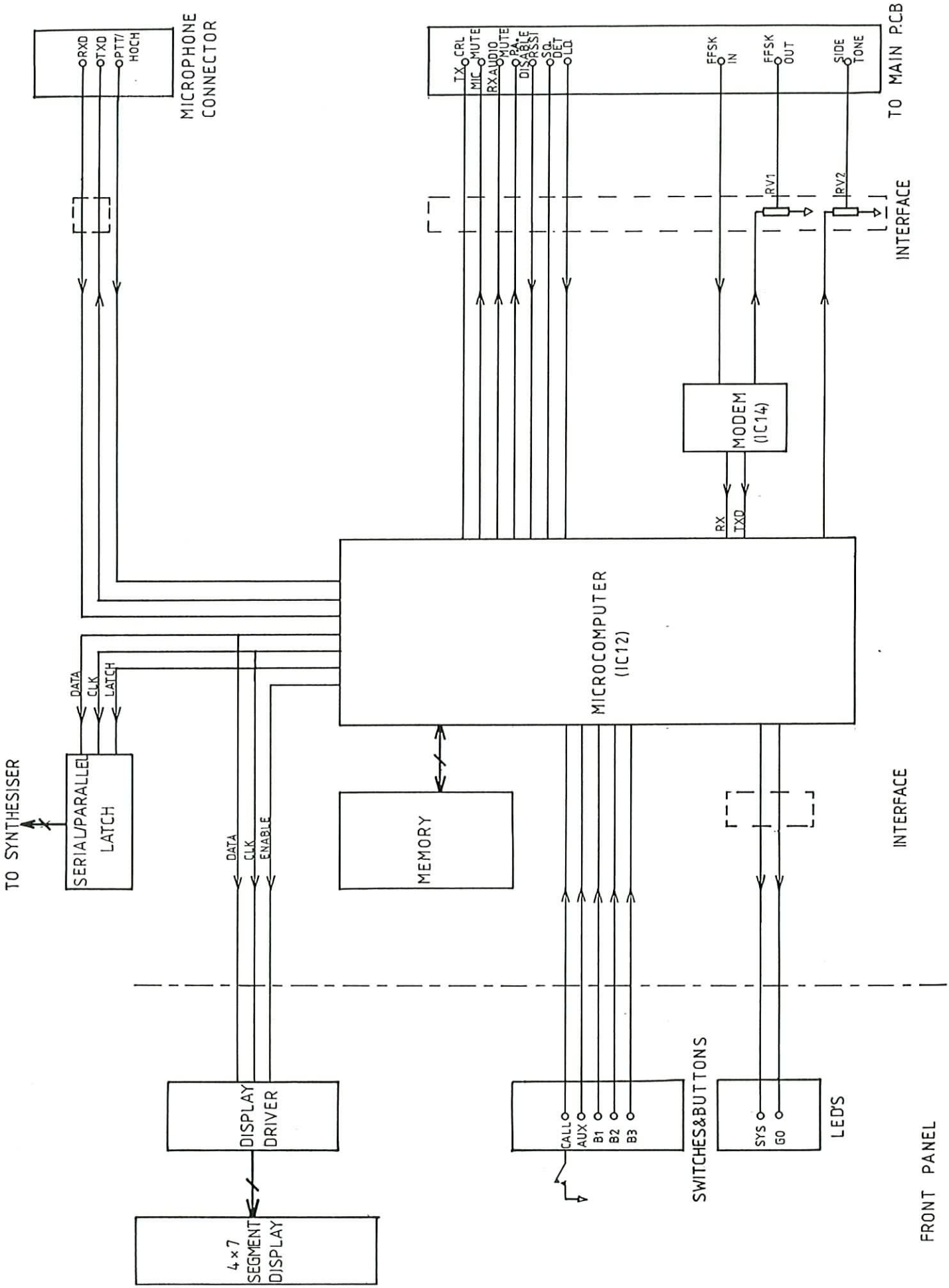
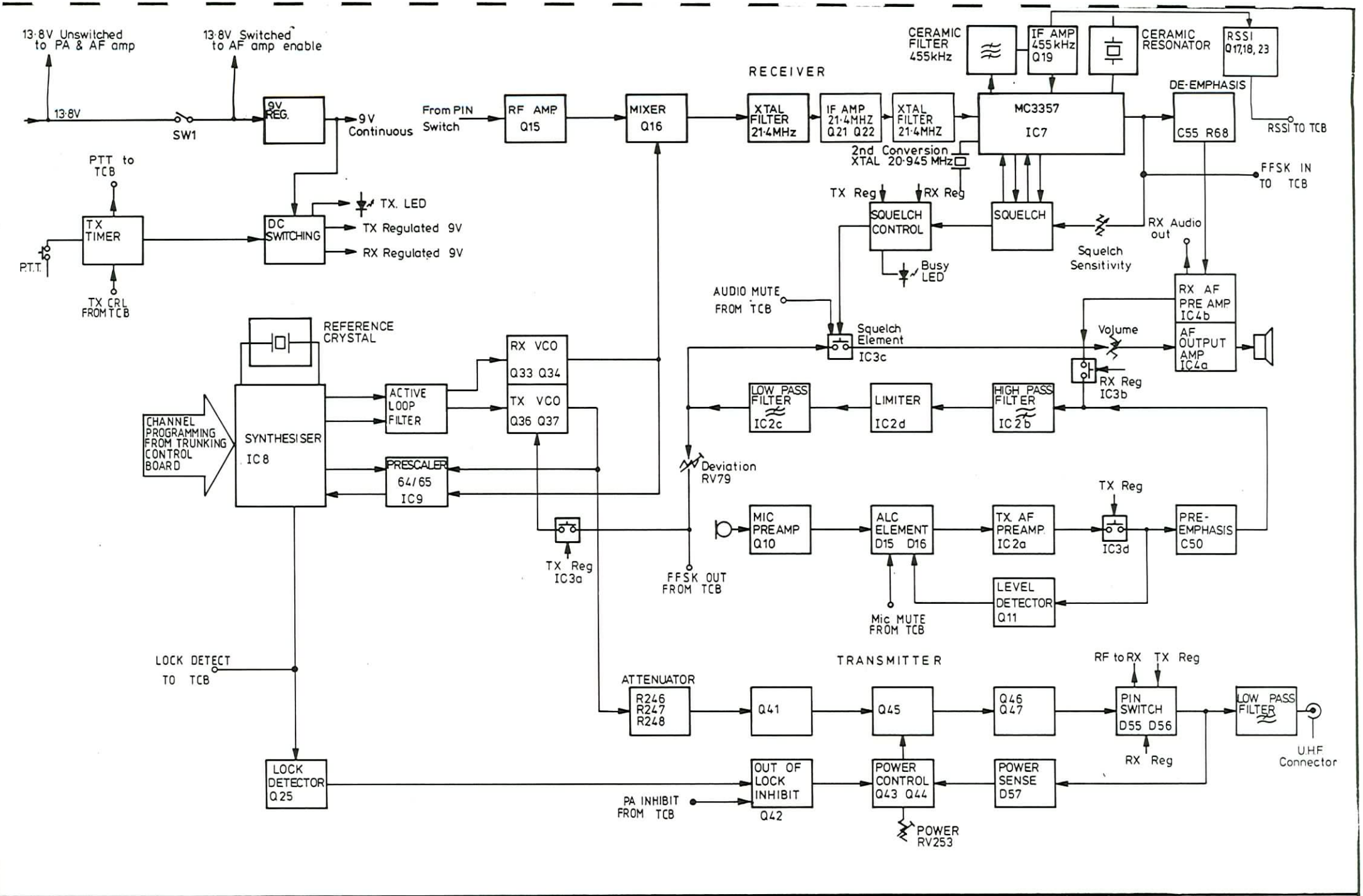


Diagram 8 Trunking Control Board Block Diagram



ISSUE	AMENDMENTS	DRN.	CHKD	APVD	DATE
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ISSUE	AMENDMENTS	DRN.	CHKD	APVD	DATE

BLOCK DIAGRAM T555TR

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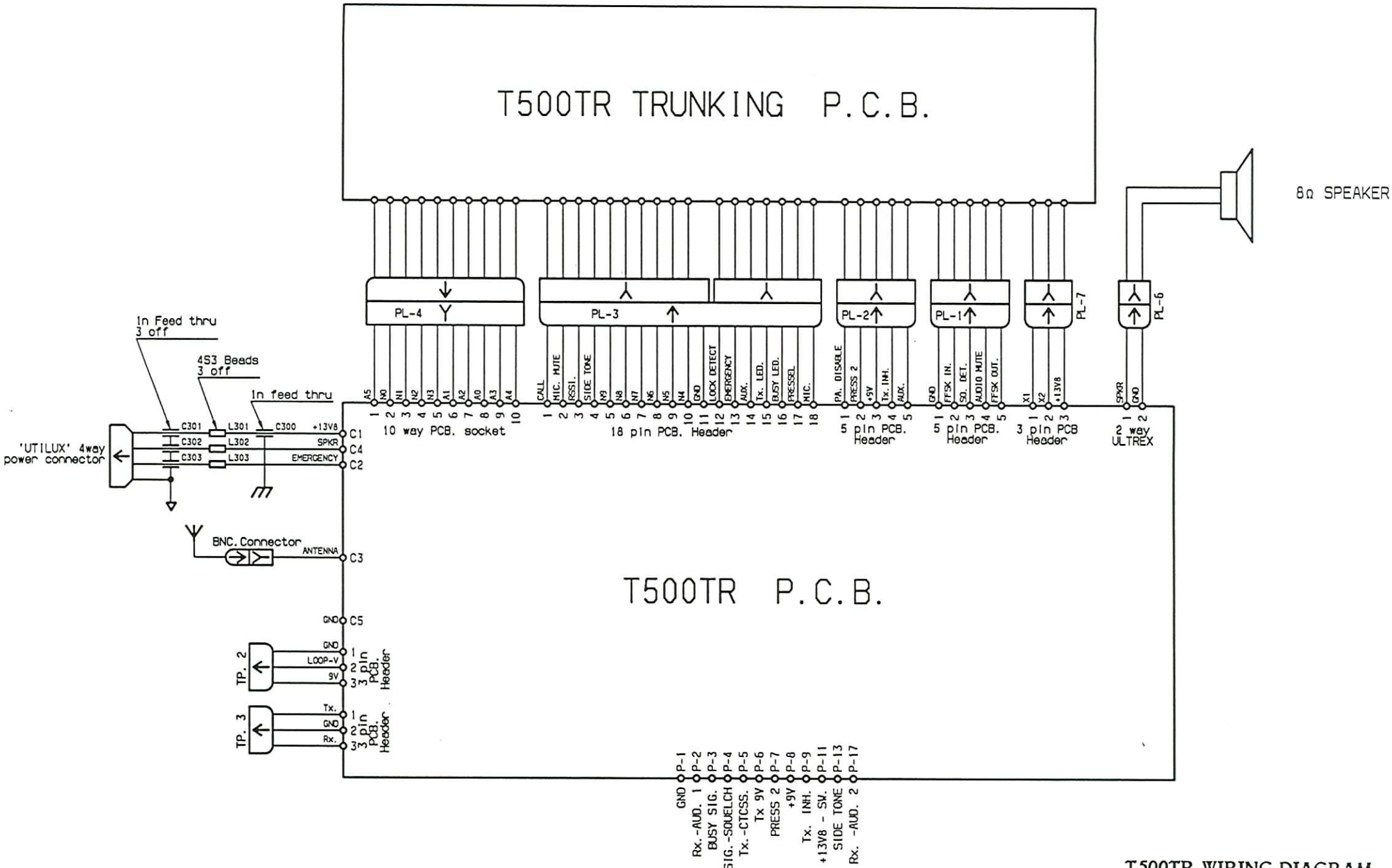
ISSUE A

DO NOT SCALE OFF DRAWING



T500TR WIRING DIAGRAM
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ISSUE B