# TECHNICAL HANDBOOK

# AWA RT-85 CARPHONE

HANDBOOK 1LH82270

LAND AND MOBILE COMMUNICATIONS

AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED

# AWA RT-85

# CARPHONE

| BAND | TYPE No. | FREQUENCY |
|---|---|---|
| VHF(LB) | 1LM82271 | 70-85MHz |
| VHF(HB) | 1LM82272 | 148-174MHz |
| UHF(LB) | 1LM82273 | 403-420MHz |
| UHF(MB) | 1LM82274 | 450-475MHz |
| UHF(HB) | 1LM82275 | 470-500MHz |
| UHF(SHB) | 1LM82276 | 495-520MHz |

Handbook No. 1LH82270

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# RT-85 TECHNICAL HANDBOOK

## TABLE of CONTENTS

Table of Contents (cont.)

Table of Contents (cont.)

RT-85 TECHNICAL HANDBOOK

INDEX to FIGURES

# A.1 - SPECIFICATIONS

## GENERAL SPECIFICATIONS

| Band | Type Number | Frequency Range (MHz) | No. of Channels | Channel Spacing (KHz) | Maximum Channel Separation (MHz) |
|---|---|---|---|---|---|
| VHF(LB) | 1LM82271 | 70-85 | 1-64 | 30* | 3.0 |
| VHF(HB) | 1LM82272 | 148-174 | 1-64 | 30* | 5.0 |
| UHF(LB) | 1LM82273 | 403-420 | 1-64 | 25 | Tx 9.5<br>Rx 3.0 |
| UHF(MB) | 1LM82274 | 450-475 | 1-64 | 25 | Tx 9.5<br>Rx 3.0 |
| UHF(HB) | 1LM82275 | 470-500 | 1-64 | 25 | Tx 9.5<br>Rx 3.0 |
| UHF(SHB) | 1LM82276 | 495-520 | 1-64 | 25 | Tx 9.5<br>Rx 3.0 |

* 12.5KHz channel spacing available to order with channel frequencies any multiple of 6.25KHz.

Frequency Stability

+-0.0005% over -10°C to +60°C range (+25°C reference).

Voltage

13.8 V DC Negative Ground.

Primary Power Current (Approx)

| | | |
|---|---|---|
| Standby with Rx muted and display blanked: | | 350mA max. |
| Standby with display active: | | 450mA approx. |
| Receiving (3W AF output): | | 800mA max. |
| Transmitting | VHF: | 6.0A max. |
| | UHF (1.2MHz separation): | 7.5A max. |
| | UHF (9.5MHz separation): | 7.8A max. |

Operating Temperature

-10°C to +60°C.

Dimensions

| | Transceiver | Control Unit |
|---|---|---|
| Height: | 60mm | 70mm |
| Width: | 185mm | 124mm |
| Depth: | 250mm | 45mm |
| Weight: | 4.0Kg (including cradle) | 0.45Kg |

## TRANSMITTER SPECIFICATIONS

Type

Phase-locked loop synthesized exciter with Voltage Controlled Oscillator (VCO) at final output frequency, driving power amplifier with regulated power output.

RF Output

25W +-10%.

Power

12.4-16.0 V DC over normal switching bandwidth.

Power Adjustment Ranges

12-25W or 0.5-12W (range selectable from control unit).

Output Impedance

50 ohms unbalanced.

Modulation

Phase/frequency modulation.

Deviation

Does not exceed +-5KHz (+-2.5KHz for 12.5KHz channeling).

Noise Level

Less than 50dB below full deviation (EIA).

Spurious Radiation

Less than 2.5uW.

Microphone Input

Audio response from 300Hz to 2500Hz:
Within +1dB and -3dB of a 6dB/octave characteristic (with 1KHz as the 0dB reference).

Audio response at 3000Hz:
Within +1dB and -4.5dB using above reference.

Audio distortion:
Less than 3% at 1KHz with +-3KHz deviation (EIA).

Auxiliary Audio Input

Audio response from 300Hz to 2500Hz:
Within +1dB and -1dB of a flat response (with 1KHz modulating frequency and +-1KHz deviation as 0dB reference).

Audio response from 2500Hz to 3000Hz:
Within +1dB and -3dB using above reference.

Audio distortion:
Less than 3% at 1KHz with +-3KHz deviation (EIA).

## RECEIVER SPECIFICATIONS

Type

Double conversion superheterodyne. Synthesizer derived local oscillator.

Input Impedance

50 ohms.

Intermediate Frequencies

21.4MHz (first IF), 455KHz (second IF).

Sensitivity

Less than 0.35uV pd for 12dB SINAD.
Less than 0.5uV pd for 20dB quieting.

Intermodulation Response

VHF: -80dB below 12dB SINAD sensitivity (EIA method)
UHF: -72dB below SINAD sensitivity (EIA method).

Spurious Responses

Better than 85dB.

Signal-to-Noise Ratio

Better than 50dB unsquelched.
Better than 60dB squelched (EIA).

Squelch Threshold Sensitivity

Better than 0.2uV.

Modulation Acceptance Bandwidth

+-7.5KHz.

Audio Output

More than 3W.

Audio Distortion

Less than 5% at full output.

Audio Response (Loudspeaker Circuit)

Between 300Hz and 3000Hz:
Within +2dB and -8dB of a 6dB/octave de-emphasis characteristic (with 1KHz as the 0dB reference point).

Pre-Squelch Audio Output

Frequency response between 50Hz and 3000Hz:

Within +1dB and -1dB of a flat response (with 1KHz modulating frequency and +-3KHz deviation as 0dB reference).

Level:
Nominal 340mV into 10K ohm impedance at +-3KHz deviation.

Distortion:
Less than 5% at 1KHz modulating frequency and +-3KHz deviation.

Post Squelch Audio Output

310mV rms into 10K ohms.

Squelch Output Control Signal

With load impedance 10K ohms:

| | |
|---|---|
| Squelch OFF: | Greater than 4.5V dc. |
| Squelch ON: | Less than 0.5V dc. |

* The performance figures stated herein are typical of those obtained in practice, but are subject to normal production and servicing tolerances.

The manufacturer reserves the right to alter the equipment in line with future technical developments.

## A.2 - FEATURES & OPTIONS

### STANDARD FEATURES

#### 64 Channel Capacity

Channels numbered 1 to 63 plus "0" can be programmed to any frequency within the specified switching bandwidth for the unit. Any channel can be left unprogrammed, and for any channel, the transmitter and receiver may have different frequencies. The same frequency can also be used on any number of channels.

#### Synthesized TX and RX Frequencies

VHF - Any frequency multiple of 5KHz.
(Optional - multiples of 6.25KHz)
UHF - Any frequency multiple of 12.5KHz.

#### Receiver Channel Scanning

If scanning is activated by operation of the SCAN button, the receiver will step across a programmed sequence of channels at a rate of 0.2 or 0.4 sec./channel (programmable), and will stop on a channel if a carrier signal (or carrier plus CTCSS if programmed) is detected. The receiver will then monitor that channel until the received signal stops, after which scanning will resume with a hold time of 1.3 to 7.5 sec. (programmable).

#### Transmitter Power Adjustment & Switching

The output power of the transceiver may be set to one of two settings (selected from the rear of the control unit):

High - 12 to 25 watts
Low - 0.5 to 12 watts.

#### Transmitter Time-out Timer

This programmable feature allows a limited transmission period (30, 60, 90, 120, 150, 180 or 210 secs.) when the microphone PTT button is held on. After this period, the TX switches off, and an audible "beep" is sounded. If the PTT button is released, the operator is able to commence another transmission period.
Alternatively, the unit may be programmed so that the TX will not time out, making continual transmission possible.

#### Channel Busy Indicator

If the receiver noise squelch is opened, either by adjustment of the SQUELCH control or from a received carrier, the yellow BUSY LED on the control unit will light.

#### Transmit/SELCALL "CALL" Indicator

The CALL LED will light if the transmitter is activated. It will flash if a code is received by the Selective Calling Decoder, if fitted (see HARDWARE OPTIONS below).

Reversed Battery Polarity Protection

Inherent non-destructive protection prevents damage to the unit if the battery supply is reversed. However, to protect the vehicle wiring in the event of a wiring short or a battery reversal, fuses are fitted in the leads between the transceiver and the battery.

Auxiliary Connector

A 20-way flat cable connector on the transceiver allows attachment of external accessories (e.g. a printer).
Access is provided to: the switched supply, ground, RX pre- and post-squelch, squelch outputs, squelch control signal output, loudspeaker mute input, auxiliary TX audio input and PTT.
In addition, 9 pins are left uncommitted, for special user applications.

Carrier Release Time

For special applications, the unit can be programmed so that the TX carrier will hold on for 0-350msec. after release of the microphone PTT button.

Pre-terminated Installation Cables

A battery lead fitted with fuses and transceiver connector is supplied with each unit, requiring only attachment to the battery.
The aerial is supplied with connected coaxial cable and BNC plug, ready for attachment when the cable is cut to length.

Busy Transmit Inhibit

If programmed, this feature prevents transmission whenever the BUSY LED is on.

Control Unit Interchangability

The RT-85 will accept two types of control unit, viz:

the 1-4C82009 RT-80 control unit, which provides limited facilities (10 channels only, no scanning, no status)

or

the 1LC82259 RT-85 control unit, which provides all facilities of the RT-85 system.

## HARDWARE OPTIONS

### 1. CTCSS "Quietline" Encoder ST-100A (Single Tone)

Any CTCSS frequency (67Hz to 200Hz) may be set so that all transmissions have the sub-audible tone generated simultaneously with voice transmission. This is used to open the loudspeaker in special base consoles or to provide access to talk-through base stations and repeaters.

### 2. CTCSS "Quietline" Encoder/Decoder Z-281 (Programmable)

This CTCSS encoder modulates all transmitted audio signals with the required CTCSS tone, while the decoder allows all received signals to be muted until the required CTCSS tone is present on the incoming signal.
This option allows specific CTCSS encode and decode frequencies (determined when programming) to be independently selected for each RF channel. A different tone frequency may be programmed for TX and RX, and any frequency from EIA groups A or B may be selected. In addition, the unit may be programmed so that CTCSS is inhibited for specific channels. A high pass filter is included in this module to remove the CTCSS tone in the loudspeaker.

* Note: Either Option 1 or Option 2 listed above may be fitted.

### 3. SELCALL Encoder/Decoder ZX-06A

This plug-in unit allows the receiver to remain muted until a specific 5 tone code is received. At this time, the receiver unmutes (i.e. reverts to noise squelch only), an audible "beep" is sounded from the loudspeaker, and the CALL LED flashes. In addition, the 5 tone code is automatically retransmitted as a "handshake" back to the caller. If the SEND button is depressed, a 5 tone code is sent to open the loudspeaker at a specific base control point.

### 4. SELCALL Encoder/Decoder with Status/Car-to-Car Calling Facility ZX-06C

This option comprises the ZX-06A Selcall Encoder/Decoder plus the 1LK82267 Selcall Status/Car-to-Car Calling Kit.

In addition to the features of Option 3 above, this option allows either:

a status number 0 to 9 (as displayed on the control unit) to be transmitted on automatic transpond when a call is received or when the SEND button is depressed. A decoder at the base station is required to display this status number.

or

a car number (as displayed on the control unit) to be transmitted when the SEND button is depressed. This allows one car from a group of ten to call another car in the group.

* Note: Either Option 3 or Option 4 listed above may be fitted (in addition to either Option 1 or Option 2).

## PROGRAMMING FEATURES RELATED TO OPTIONS 2, 3 and 4

### A. SILENT Button and OPEN L.E.D.

If the loudspeaker is muted because Option 2, 3 or 4 is fitted, operation of the SILENT button on the control unit switches the OPEN LED on, and the receiver reverts to noise squelch only.
For special privacy applications, the SILENT button can be rendered inoperative (by programming) so that the operator is unable to open the muting on the receiver.

### B. BUSY LED Delay

This option allows a transceiver with CTCSS decoding to function so that the operator does not have to open the receiver muting before transmitting. The option is implemented so that the BUSY LED remains on for approximately 5 seconds after a carrier has been received. If Busy Transmit Inhibit (see STANDARD FEATURES above) is set, transmission will only be possible if the channel has been clear for at least 5 seconds.

### C. TX SILENT Inhibit

If "listen before sending" type operation is required, this option is implemented (during programming), so that the operator must open the receiver mute and switch the OPEN LED on before transmission is possible.

## EXTERNALLY CONNECTED OPTIONS

### 1. HS-81 Handset

The standard hand microphone is removed when this option is fitted. The operator may choose to listen through the loudspeaker or through the handset earpiece. The handset also contains a microphone and PTT switch.

### 2. Extension Cable Kit 1LK82149 / 2LK82149 (Heavy Duty)

For boot mounted installations, this kit provides cables to extend the control unit and battery connections by 4 metres.

### 3. "Transcript 85" Printer

If special computing equipment is installed at the base station, messages may be directed through the RT-85 unit to the Transcript 85, where they will be printed on metallised paper.
In addition, up to 10,000 status codes may be sent back to the base station from the printer.

### 4. Security Lock

This lock may be fitted to the mounting cradle to prevent unauthorised removal of the RT-85 transceiver from its cradle.

## A.4 - OPERATING INSTRUCTIONS

### STANDARD EQUIPMENT - NO OPTIONS FITTED

Each RT-85 Carphone is pre-programmed to suit the specific operational requirements of the user's radio system. These programmable 'software' options are permanently stored within the equipment to provide the operator with the functions and facilities previously determined. However, if necessary, the RT-85 Carphone can be re-programmed at any future time to suit subsequent changes to operational needs.

The following instructions refer to the standard RT-85 Carphone with none of the available options fitted. All operator controls referred to are located on the Control Unit.

#### POWER ON/OFF

To switch on the equipment, rotate the OFF/SQ control clockwise (downwards direction).

#### CHANNEL SELECTION

To select the desired channel, momentarily depress the UP or DOWN buttons to singularly advance or retard the previously displayed channel. The channel number is displayed with a 2-digit LED readout STATUS/CHANNEL.

If the RT-85 has been programmed for single channel only, operation of the UP and DOWN buttons for channel change is inhibited. When more than 10 channels have been programmed, depressing either the UP or DOWN buttons for more than one second will cause the stepping of channels to occur at a rate of 10 at a time.

* The STATUS/CHANNEL display will automatically switch off after 20 seconds. This feature prevents visual discomfort to the vehicle operator at night, and also preserves battery current. However, the previously selected operating channel is immediately displayed again by momentarily depressing the UP or DOWN buttons, or operating the microphone PRESS-TO-TALK button to initiate a transmission from the mobile unit.

#### RECEIVING

1. To hear incoming messages on the selected channel, adjust the VOLUME control for the desired listening level.

2. To silence unwanted noise in the absence of signals, start with the OFF/SQ control at its lowest setting (as near as possible to fully anti-clockwise i.e. upwards direction without turning off power) then, during an interval in which no signals are being received, gradually rotate the control clockwise (downwards) until received noise is silenced.

* In areas of very weak or fluctuating signals, it may be necessary to temporarily return the OFF/SQ control to its lowest setting in order to improve the intelligibility of the incoming signal.

Unless the CTCSS (Quietline) Encoder/Decoder and/or Selcall options are fitted, the SILENT button and OPEN LED indicator have no significance, and their operation is inhibited.

The BUSY LED is illuminated whenever a signal is being received on the channel, or when the OFF/SQ control is set to its lowest point (receiver noise audible).

## TRANSMITTING

1. If the set has been pre-programmed so that transmission is inhibited when the BUSY LED is illuminated, transmission will not be possible if the channel is occupied or if SQUELCH is open, in which case a short audio beep will be heard.

2. Wait for a short interval after the BUSY LED is extinguished, and then press the button on the side of the microphone and speak into the microphone at normal conversational level, from a distance of approximately 10 cm. While this PRESS-TO-TALK (PTT) button is operated, the CALL LED is illuminated. (A pulse tone of short duration will be heard in the loudspeaker if the transmitter is not being activated when the PTT button is operated).

3. Release the PTT button immediately after finished speaking, otherwise the reply message will not be heard.

4. It is normal for any continuous transmission to be automatically limited to a preset period of between 0-210 seconds (usually 60 seconds) to curtail lengthy transmissions on the operating channels.

   At the expiration of this preset time period, the operator will hear a tone signal to indicate that his transmitter has automatically switched off. The PTT button must then be released and re-operated before transmission can be continued.

5. When the exchange of messages has been completed, return the microphone to its holder.

## EQUIPMENT FITTED with ADDITIONAL PROGRAMMABLE OPTIONS and HARDWARE OPTIONS

## CHANNEL SCANNING (RECEIVE)

Pre-determined frequency channels are automatically scanned sequentially in the order decided at time of programming of your equipment.

The operating channel selected manually prior to engaging the SCAN button becomes the 'priority' or 'home-reverting' channel.

When an incoming signal is detected, the automatic scanning action stops until that channel is clear. Scanning will resume after a pre-determined delay (normally 5 seconds) after the channel clears. Alternatively, scanning can be resumed from a busy channel by depressing the UP button once, which causes the next channel to be selected.

The SCAN LED indicator will glow when scanning is operating and the CHANNEL display will indicate the frequency channels being scanned.

A two-beep tone alarm will be heard when a signal is detected on the 'priority' or 'home' channel to indicate that particular channel has been activated.

## SCANNING OPERATION (TRANSMIT MODE)

If the microphone PTT button is operated during the scanning mode, this will cause the scanning functions to stop, a single-beep tone alarm will be heard from the loudspeaker, and the 'priority' or 'home' channel will be immediately displayed. Transmission on this channel will not occur however, until the microphone PTT button is released and then re-activated. Scanning action will not be resumed until the SCAN button is again operated manually.

## OPERATING with CTCSS 'Quietline' ENCODER ST-100A

This option allows a sub-audible preset tone to be injected automatically into all transmissions made from the vehicle. No special operator action is required, and the system is operated as for the standard configuration.

## OPERATING with CTCSS 'Quietline' ENCODER/DECODER Z-281

With this option installed, a vehicle operator can choose to listen only to those messages specifically intended for his network. This is done by depressing the SILENT button to its on position, i.e. when the channel OPEN LED indicator is not lit. In this position, all signals present on the channel, other than those containing the correct Quietline tone, are silenced. However, it is normally arranged for transmissions from the mobile also to be inhibited when operating in SILENT mode.

When transmission is required the equipment can be operated as for the standard system by again depressing the SILENT button. This action will also illuminate the OPEN LED indicator and all messages on the channel will then be heard.

## OPERATING WITH STANDARD Selcall DECODER/ENCODER ZX-06A

### Receiving Calls

By virtue of this option, the vehicle operator can choose to listen only to those messages specifically directed to him (SILENT mode), or he can listen to all messages on the channel (OPEN channel). In either case, an alert that the base operator is directing a specific call to his vehicle is given by means of a 2-second burst of audio beep tone from the loudspeaker, accompanied by continuous flashing of the red CALL indicator. Should the vehicle operator fail to respond to the call, every succeeding attempt by the base operator to contact the vehicle will produce the audio beep alert tone. (The CALL indicator will continue to flash throughout this period).

### Transmitting a Vehicle Address Code

When fitted, this facility enables the vehicle operator to transmit his vehicle address code to the base station by momentarily depressing the SEND button. However, this transmission can only occur when the BUSY indicator is not alight (i.e. the channel is clear), and the SILENT button is in the OPEN channel position.

## OPERATING WITH Selcall DECODER/ENCODER ZX-06C INCLUDING CAR-TO-CAR CALLING FACILITY

### Receiving Calls

Operation is the same as described above under "OPERATING WITH STANDARD Selcall DECODER/ENCODER ZX-06A".

### Calling a Selected Mobile (or Base Station)

Momentarily depress the SEND button. This will cause the 2-digit STATUS/CHANNEL readout to display only the left-hand digit, which can be altered to suit the number required corresponding to the vehicle (or base station) to be called. The displayed number is altered by depressing the UP and DOWN buttons until the required number is displayed. Then, again depress the SEND button to transmit the selected address code.

Note, however, transmission can only occur when the BUSY indicator is not alight (i.e. the channel is clear), and the SILENT button is in the OPEN channel position.

## OPERATING WITH Selcall DECODER/ENCODER ZX-06C INCLUDING STATUS CALLING FACILITY

### Receiving Calls

Operation is the same as described above under "OPERATING WITH STANDARD Selcall DECODER/ENCODER ZX-06A".

### Transmitting a Status Code to the Base Station

Momentarily depress the SEND/STATUS button. This will cause the 2-digit STATUS/CHANNEL readout to display only the left-hand digit, which can be altered to suit the number required corresponding to the status code to be transmitted simultaneously with the vehicle's identification address code. The displayed number is altered by depressing the UP and DOWN buttons until the required number is displayed.

The selected status code may then be manually transmitted by the vehicle operator by again depressing the SEND/STATUS button. Alternatively, the selected status code will be automatically transmitted on the next occasion this vehicle is selectively called, or interrogated by the base operator.

It is normal operating procedure to have allocated one code number, usually '0', to represent a 'no status' condition. This number should then be the last code to be entered if a 'no status' condition is to be reported when the vehicle is next 'polled' by the base operator.

Note also that manual transmission of a status condition can only occur when the BUSY indicator is not alight (i.e. the channel is clear), and the SILENT button is in the OPEN channel position.

## OPERATING WITH TELEPHONE HANDSET HS-81

This option makes no operative difference to the equipment, except that the loudspeaker can be switched on or off by means of a switch on the handset mounting cradle. At all times received audio can be heard via the handset earpiece.

## A.5 - THEORY of OPERATION

The following description refers to Fig. A-1 (page A.5 - 3).

### SYNTHESIZER

Both the transmitter and receiver operating frequencies are controlled from a master oscillator by a dual Phase Locked Loop (PLL) synthesizer.

The main PLL is set to frequency by programmable dividers directed from the central microprocessor. The microprocessor first sets the receive frequency, and then when the PTT button is operated, it sets the transmit frequency.

For reception, the main PLL generates the first mixer injection frequency directly, while for transmission, the main PLL injects the required frequency into a mixer inside the transmitter PLL.

Two reference frequencies, separately divided from the master oscillator are fed into the Phase Detector (PD) in each PLL. The output of each PD is filtered and used to control the output frequency of separate Voltage Controlled Oscillators (VCOs).

In the main PLL, the VCO output, divided in the Prescaler (PRESCA) and Programmable Divider (PROG DIV), is compared with the reference frequency in the PD, thus establishing the main PLL frequency.

In the TX PLL, the VCO output is mixed with the main PLL output, divided and compared with the TX reference frequency in the TX PD to establish the TX output frequency.

### TRANSMITTER

Transmitter modulation is achieved by processing the transmitter reference frequency through a Phase Modulator (MOD). Microphone audio signals are amplified, differentiated, clipped and integrated in the Instantaneous Deviation Control (IDC) circuits before being fed to the Phase Modulator.

The TX VCO output is amplified and fed into the 3-stage Power Amplifier (PA AMP). It is then fed to the antenna terminal via a PIN diode antenna switch (ANT SW), to switch TX and RX, followed by a Low Pass Filter (LPF), to eliminate harmonics.

The PA AMP output is detected and fed back into an automatic power control circuit to stabilise the TX output over a wide battery voltage range.

### RECEIVER

The RT-85 contains a double conversion superheterodyne receiver with 21.4MHz first IF and 455KHz second IF.

Signals received from the antenna are fed from the ANT SW into an RF amplifier, with front-end selectivity achieved using critically coupled bandpass filters. Signals are converted to 21.4MHz in the first mixer, using the synthesizer output as the local oscillator.

A narrow band crystal filter provides selectivity prior to amplification and mixing to 455KHz, where ceramic resonators provide the final selectivity filtering. A quadrature detector produces audio output which is gated by the noise squelch circuitry before being amplified up to the level required to drive the loudspeaker.

## MICROCOMPUTER and EPROM

A 4-bit single chip CMOS microcomputer is used to control the frequency synthesizer and logic functions of the unit. The channeling and programming information for the individual unit is stored in an ultra-violet Erasable Programmable Read Only Memory (EPROM), which is programmed in a separate device prior to being plugged into the RT-85.

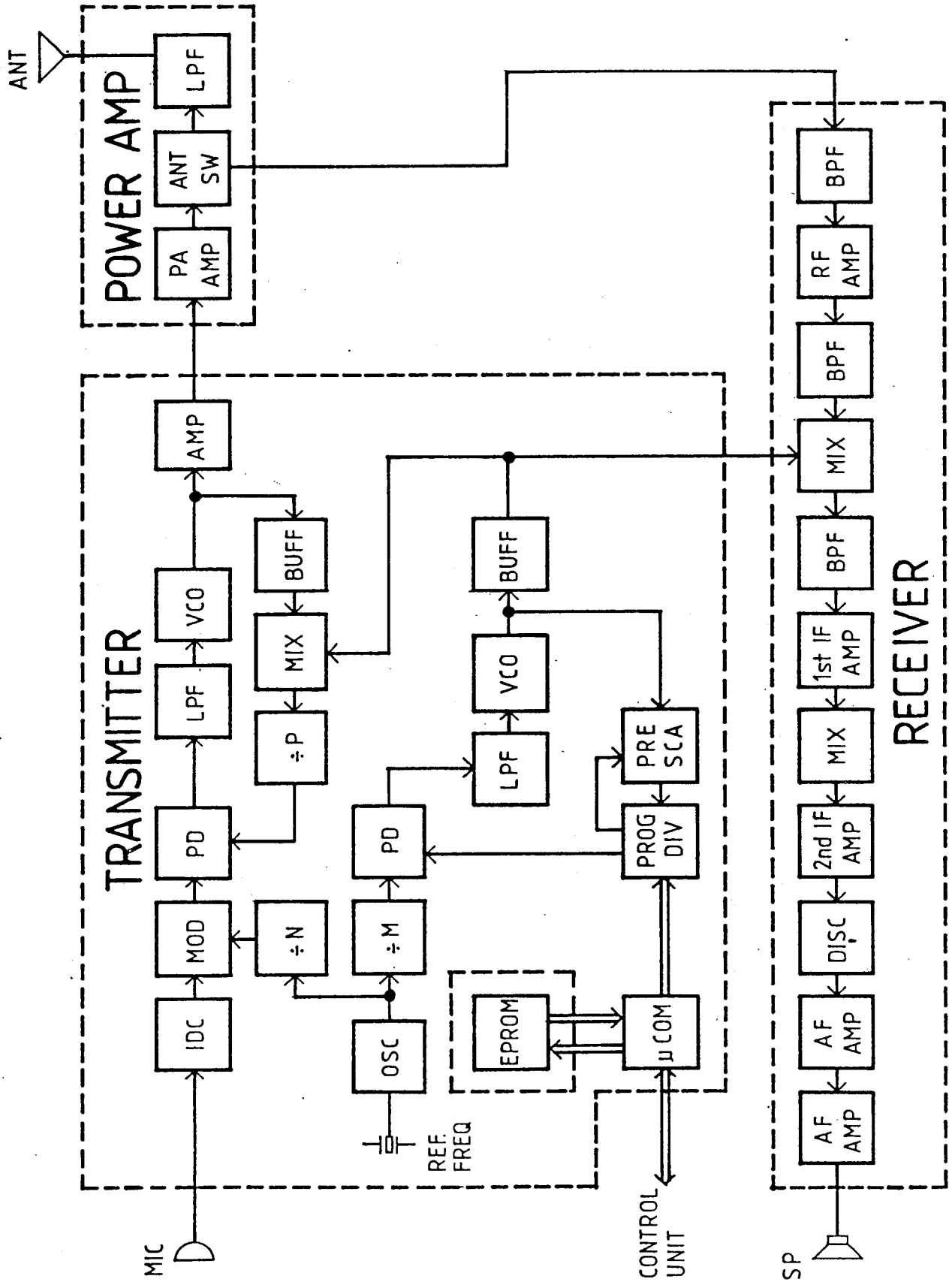



Fig. A-1 RT-85 Transceiver Block Diagram

# B.1 - TRANSMITTER ASSEMBLY

## IDENTIFICATION

| Band | Frequency | PCB No. | Circuit Drawing |
|---|---|---|---|
| VHF(LB) | 70-85MHz | TX-081 | 82271-1-02 |
| VHF(HB) | 148-174MHz | TX-153 | 82272-1-02 |
| UHF(LB) | 403-420MHz | TX-404(A) | 82273-1-02 |
| UHF(MB) | 450-475MHz | TX-404(B) | 82273-1-02 |
| UHF(HB) | 470-500MHz | TX-404(C) | 82273-1-02 |
| UHF(SHB) | 495-520MHz | TX-404(D) | 82273-1-02 |

## GENERAL DESCRIPTION

The transmitter assembly is a printed circuit board which mounts on the upper side of the diecast RT-85 transceiver frame. It contains the:

- Central microprocessor;
- Master frequency oscillator;
- Main frequency synthesizer;
- IDC transmitter audio circuits;
- Phase modulator;
- Transmitter phase locked loop;
- Exciter output amplifier; and
- DC power regulators.

In addition, the programming EPROM module plugs onto the transmitter assembly.

## CIRCUIT DESCRIPTION

### CENTRAL MICROPROCESSOR

IC901 acts as the central processor and controller for the RT-85. It is a 4-bit CMOS mask programmed microcomputer, packaged in a single 42 pin chip containing 2048 bytes of ROM and 140x4 bits of RAM. The microcomputer is run by a 400KHz ceramic resonator clock on pins 17 & 18.

The current consumption is low: 17mA being drawn during normal operation. When the transceiver is switched off from the control unit, only 1.2mA is required to retain the microprocessor memory. Thus the unit will "remember" the last used channel, even when switched off.

D402 regulates the dc supply for IC901 and is powered through D403 only when the control unit is on, otherwise the hold-on current is supplied through D404.

When the unit is switched on, after approximately 100ms, Q405 pulls pin 15 of IC901 low, resetting the microprocessor. In the power down mode, pin 15 of IC901 is held high by R408.

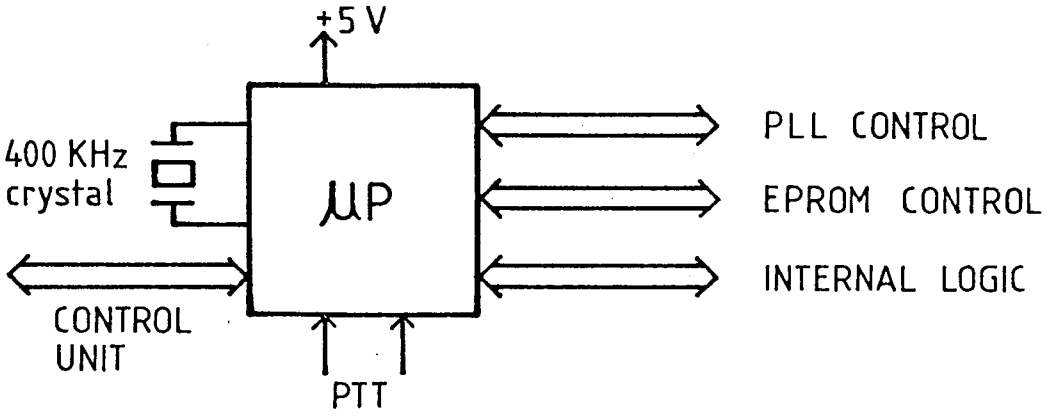



Fig. B-1 Central Microprocessor Controls

## Control Unit

When reset, the microprocessor checks the control unit lines DSP0, DSP1, DSP2 & DSP3, and if any of these are low, it assumes that an RT-80 type control unit is fitted. In this situation, DSP0/3 become inputs for channel selection, and $\overline{\text{DSPSTBH}}$ & $\overline{\text{DSPSTBL}}$ become inputs for $\overline{\text{SEND}}$ & $\overline{\text{SILENT}}$.

If any of DSP0/3 are high, they become outputs for commanding the RT-85 control unit switches and displays, and $\overline{\text{DSPSTBH}}$ and $\overline{\text{DSPSTBL}}$ become display strobe outputs.

The microprocessor controls the display and switch functions of the control unit by multiplexing on DSP0/3, $\overline{\text{DSPSTBH}}$, $\overline{\text{DSPSTBL}}$ & $\overline{\text{SWRTN}}$, and remembers all the settings last entered.

## Internal Logic

The microprocessor carries out conditional logic tests on a number of signals:

### Microprocessor Inputs:

| Pin | Signal | Function |
|---|---|---|
| 5 | TSQ/MON | Indicates whether CTCSS or Selcall decoding has occurred. |
| 4 | SQ SIGNAL | Indicates operation of noise squelch. |
| 6 | | Indicates main PLL out of lock. |

Microprocessor Outputs:

| Pin | Signal | Function |
|---|---|---|
| 28 | $\overline{\text{BUSY}}$ | Switches BUSY LED. |
| 29 | STATUS STROBE | Pulses status number into Selcall/Status option. |
| 9 | $\overline{\text{SILENT}}$ | Switches Selcall decoder to silent mode. |
| 8 | $\overline{\text{SEND CNT}}$ | Causes Selcall encoder to send code (Status version only). |
| 3 | AUDIO OUT | "Beep" tones sent to speaker amplifier. |
| 2 | TX TM | Switches CTCSS encoder on during transmission. |
| 12 | DEPOW | Switches TX PA to low power setting. |
| 13 | | Switches transmitter on. |
| 39 | AUX STB | Strobe for AUX data (CTCSS). |
| 5 | | Audio enable (low). |
| 6 | | Audio mute & TX inhibit (low). |

PTT Inputs:

Note that these interrupt inputs override all other commands.

| Pin | Signal | Function |
|---|---|---|
| 30 | $\overline{\text{PTT}}$ | PTT input from control unit. |
| 31 | $\overline{\text{ADRS TX}}$ | PTT input from Selcall or auxiliary connector. |

## EPROM and PLL Control

This major function of the microprocessor ensures that the correct frequency is generated by the frequency synthesizer and that the unit shuts down during abnormal operation.

## MASTER FREQUENCY OSCILLATOR

Q701 and X701 form a high-stability crystal oscillator running at 5.12MHz (VHF) or 12.8MHz (UHF) and is designed to maintain frequency within 5 ppm from -10°C to +60°C. Both transmit and receive frequencies are maintained by this oscillator.

The channel incremental frequency (5KHz for VHF and 12.5KHz for UHF) is derived in IC701 by dividing by 1024 after amplification in Q703.

The transmit reference is achieved by dividing the oscillator output in IC702:

| | | |
|---|---|---|
| VHF | (divide by 4) | 1.28MHz |
| UHF | (divide by 8) | 1.6MHz. |

## MAIN FREQUENCY SYNTHESIZER

The following description refers to Fig. B-2 (page B.1 - 5) and the circuit diagrams following this section.

The frequency synthesizer comprises an EPROM IC951, shift register IC902, programmable divider/phase detector IC701, prescaler IC703 and voltage controlled oscillator Q707.

### EPROM and Shift Register

When a new channel is selected, or the unit switches to transmit or receive, the synthesizer reads information from the EPROM and sets the appropriate frequency in the main PLL.

Firstly, IC901 sends 6 bits of data from pins 32/37 into IC952 where they are latched to IC951 pins 1/6 by a clock pulse into IC952 pin 9. Another 5 bits of data from IC901 pins 32/36 appear on IC951 pins 7, 8, 19, 22 & 23. The full 11 bit address A0/A10 is latched into IC951 when it is enabled by a pulse from IC901 pin 37.

The 8 bit memory at this address (up to 2048 different addresses are possible) appears at inputs P0/P7 of IC902, and is latched into pin 9 of this shift register by a positive pulse from IC901 pin 40. The 8 bits are then sent serially out of IC902 pin 3 to IC701 in response to negative clock pulses generated by IC901 pin 42, each clock pulse pushing another bit into IC701.

The above process occurs 3 times for each new frequency, sending 24 bits of data into IC701.

### Programmable Dividers, Prescaler and Phase Detector

The serial data out of IC902 is clocked into a 17 bit shift register inside IC701, with the first 7 bits of the 24 data bits being discarded. On receipt of a positive pulse from IC902 pin 41 into IC701 pin 1, the contents of the shift register are transferred into a 17 bit latch inside IC701.

The 17 bits output from this latch are used to program two counters: 7 bits program the "divide by a" counter (where "a" can be set between 1 and 128), while the remaining 10 bits program the "divide by n" counter (where "n" can be set between 1 and 1024).

Both counters count pulses from the output of a two-modulus prescaler IC703, which divides its input frequency by 63 (32 for VHF(LB)) when IC703 pin 6 is high, or alternatively by 64 (33 for VHF(LB)) when IC703 pin 6 is low.

After "a" pulses out of the prescaler, the "divide by a" counter output switches high, which changes the prescaler from dividing by 64 (33) to dividing by 63 (32). Meanwhile, the "divide by n" counter has been counting, and after "n" pulses, both counters are reset to zero, IC703 pin 6 switches low, a negative pulse is output to the phase detector, and the cycle starts again.

The phase detector compares the repetition rate of its input pulses against a reference frequency, which is the master oscillator frequency divided by 1024. IC701 pin 11 produces a dc signal at a level dependent on the difference between the reference frequency and the output pulse frequency of the "divide by n" counter. If the phase detector is out of lock, IC701 pin 10 switches low to alert the microprocessor.

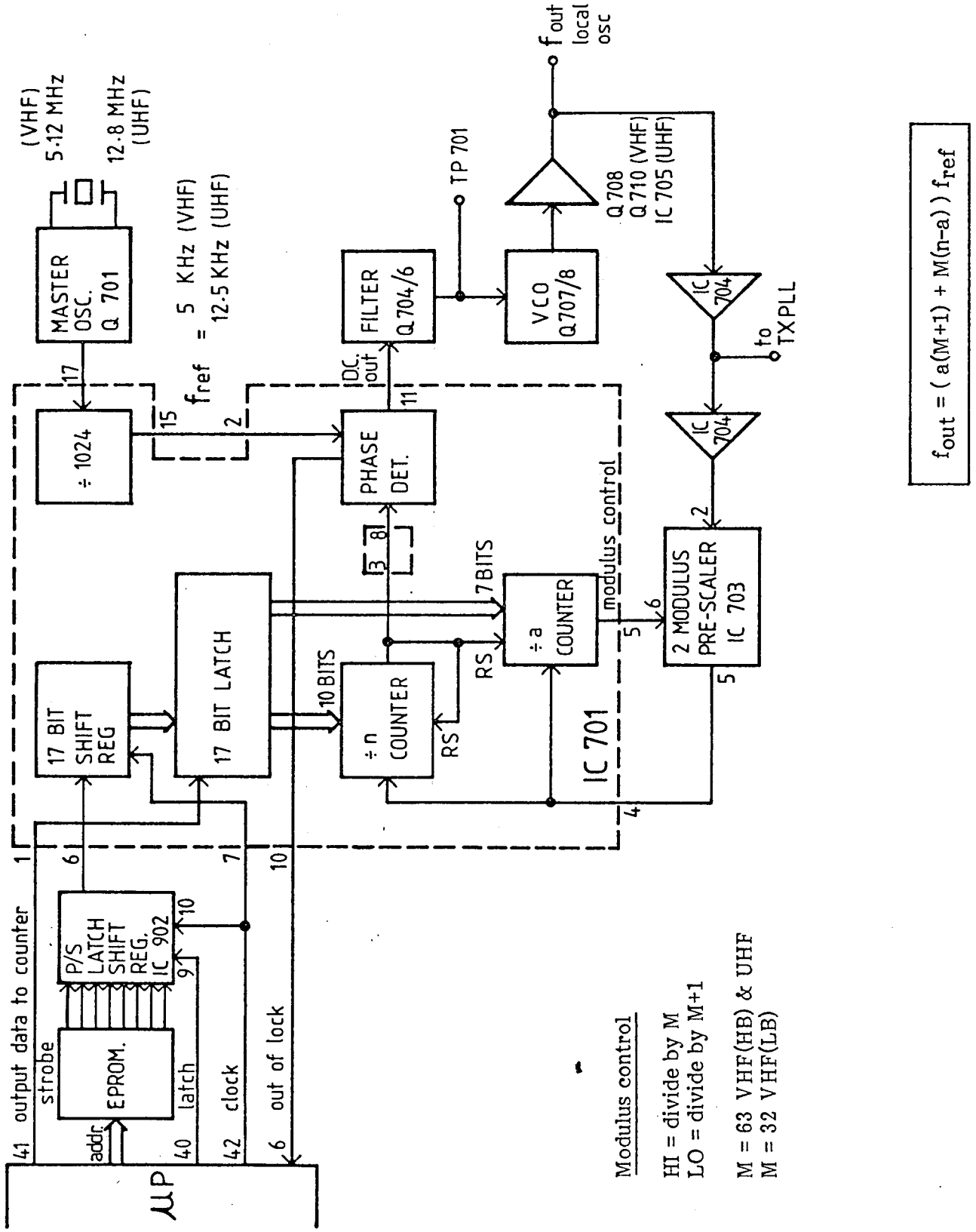



Fig. B-2 Main Frequency Synthesizer

Voltage Controlled Oscillator and Buffers

The phase detector output IC701 pin 11, is amplified in Q704, Q705 & Q706 and then used to bias a varicap diode D702. The capacitance of this diode determines the oscillating frequency of a Colpitts oscillator Q707. The output of this oscillator is the local oscillator frequency of the receiver, and is amplified and buffered in Q709 and IC705 (Q710 for VHF), before being fed to the receiver mixer via J365.

During transmission, this output is again buffered in IC704 and fed to the TX PLL. In addition, IC704 provides an output back to the prescaler IC703 to complete the main PLL.

## TRANSMITTER AUDIO CIRCUIT and PHASE MODULATOR

The IDC amplifier IC701 amplifies the microphone signal with 6dB/octave pre-emphasis (C112, R112). This signal is peak clipped to limit deviation, -6dB/octave de-emphasis is applied and frequencies above 3KHz are removed in a low pass filter L103, L104. RV101 sets limiting deviation, while RV102 sets microphone gain.

The auxiliary input level is set by RV103 and this signal is amplified in Q104, with no pre-emphasis being applied. Q103 buffers the audio signal before it is fed to the phase modulator. Two (three for UHF) coupled inductors L101, L102 (L105 for UHF) are tuned by varactor diodes D101, D102 (D110 UHF) to phase modulate the output of IC702. This signal is then buffered and amplified in Q101 and Q102.

## TRANSMITTER PHASE LOCKED LOOP

The following description refers to Fig. B-3 (page B.1 - 7) and the circuit diagrams following this section

D108 is a double balanced mixer which converts the exciter output frequency down to the TX IF frequency of 20.48MHz (VHF) or 19.2MHz (UHF). During transmission, the main synthesizer generates the required frequency for this conversion.

IC106 is a fixed divider (by 16 for VHF, by 12 for UHF) and its output frequency is the same as the phase modulator output frequency (1.28MHz (VHF), 1,6MHz (UHF)). IC103 is a phase detector which compares the phase differece between its two inputs and produces a dc output at TP101 proportional to this difference. This dc signal controls the VCO Q108 with varicap D104 setting the actual exciter output frequency. This is buffered in Q109 and IC104, before being amplified by Q112 (VHF) or IC105 (UHF) to a level suitable for injection into the double balanced mixer.

## EXCITER OUTPUT and OUT OF LOCK PROTECTION

The output of IC104 is amplified in Q110 (VHF) or Q110, Q112 & Q113 (UHF) to the required exciter output power level: i.e. 20-40mW (VHF) or 0.4-1.2W (UHF).

When the TX PLL is in lock, IC102 pin 13 is low, but if the TX PLL is out of lock, pin 13 has positive pulses which switch on Q111, removing base bias from Q110 and thus inhibiting transmitter output. Q111 can also be switched on through D107 by a high signal out of IC706 pin 8, indicating that the main PLL is out of lock.

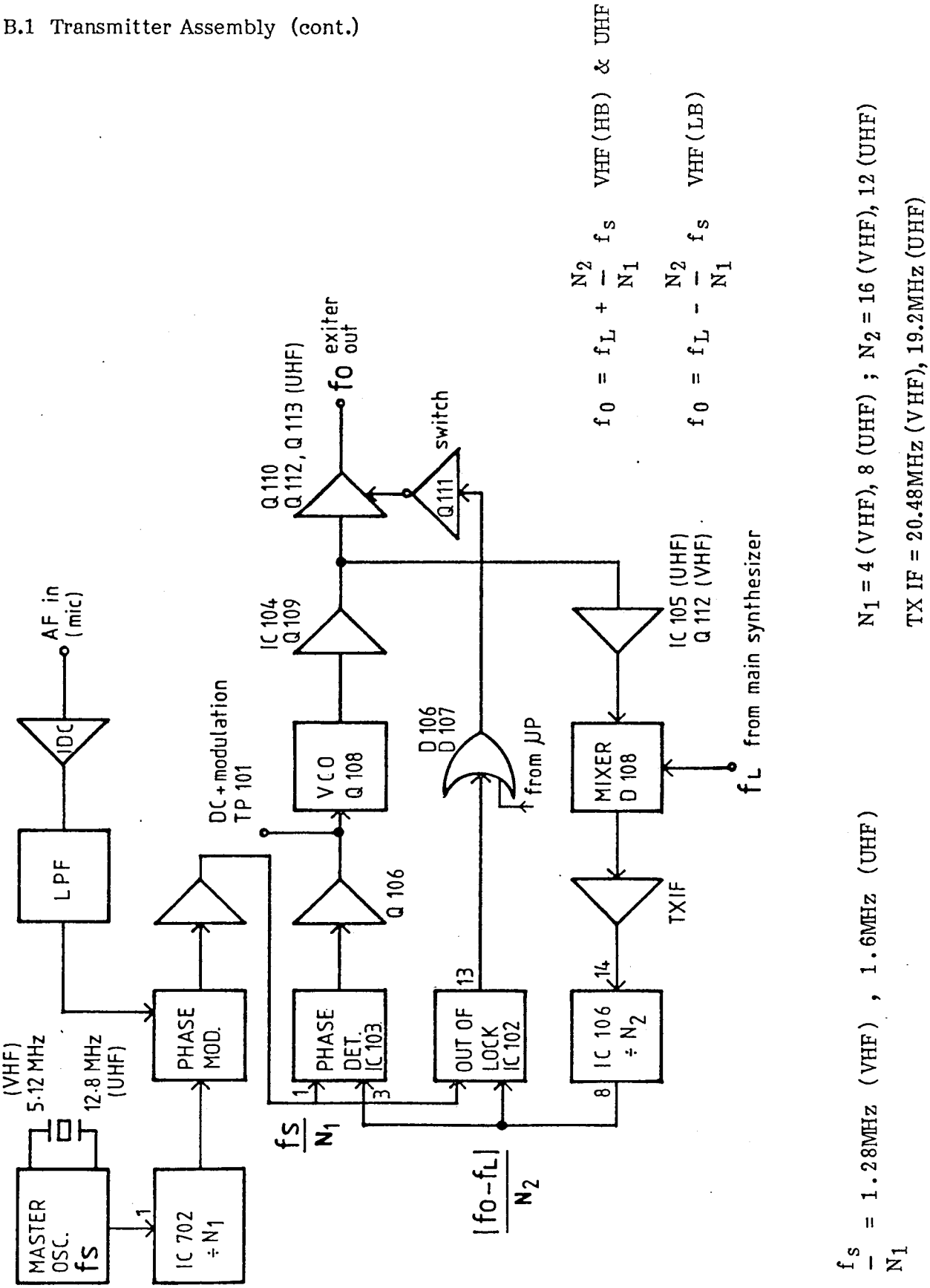



Fig. B-3 Transmit Phase Locked Loop

## DC POWER REGULATORS

The transmitter assembly contains the following dc regulators:

5 V for the microcomputer: D402;

main 5 V supply: IC402 (three terminal regulator); and

8 V supplies: IC401.

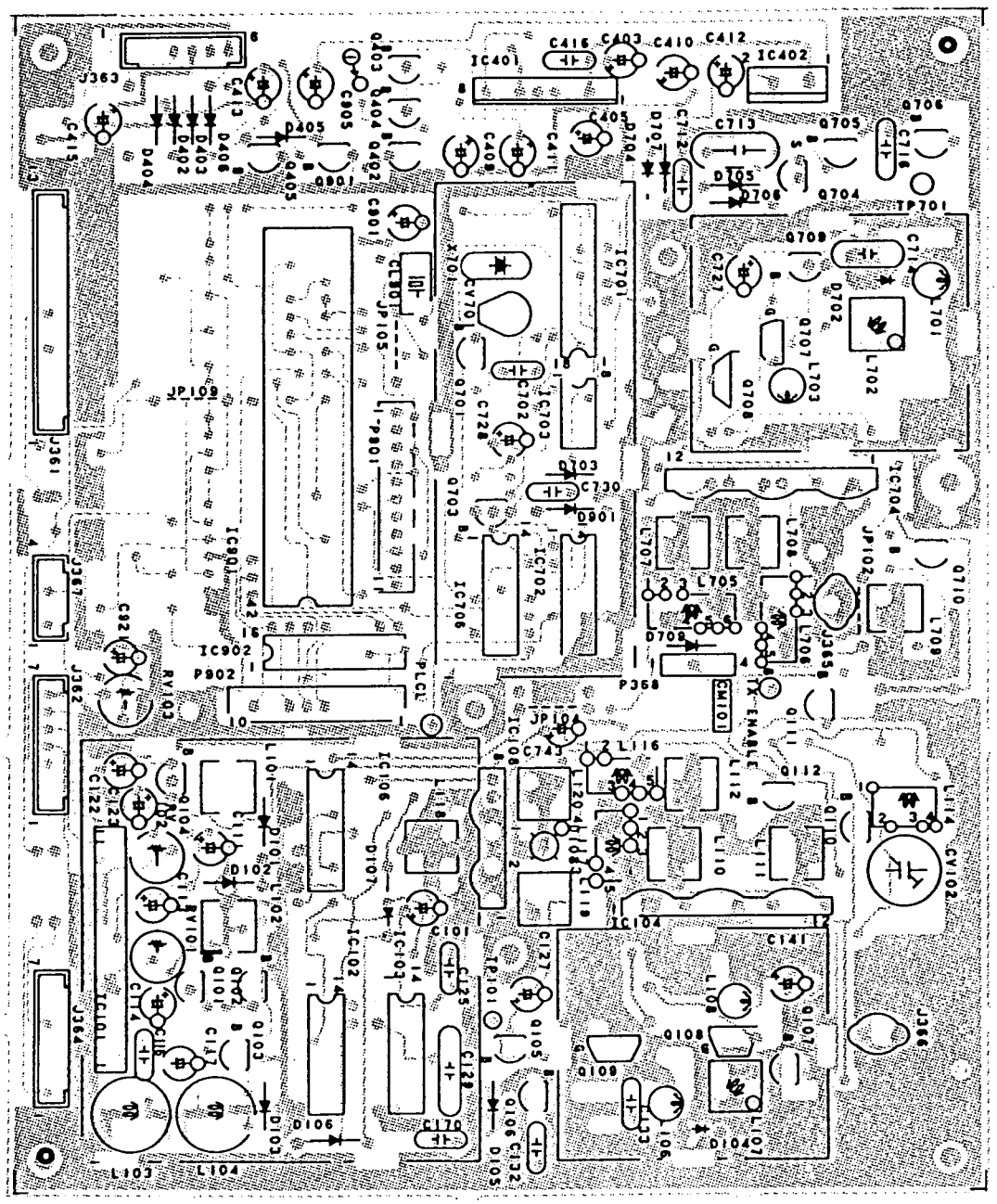
IC401 has three outputs:

C8 V common 8 V which is on whenever the +B supply is on;

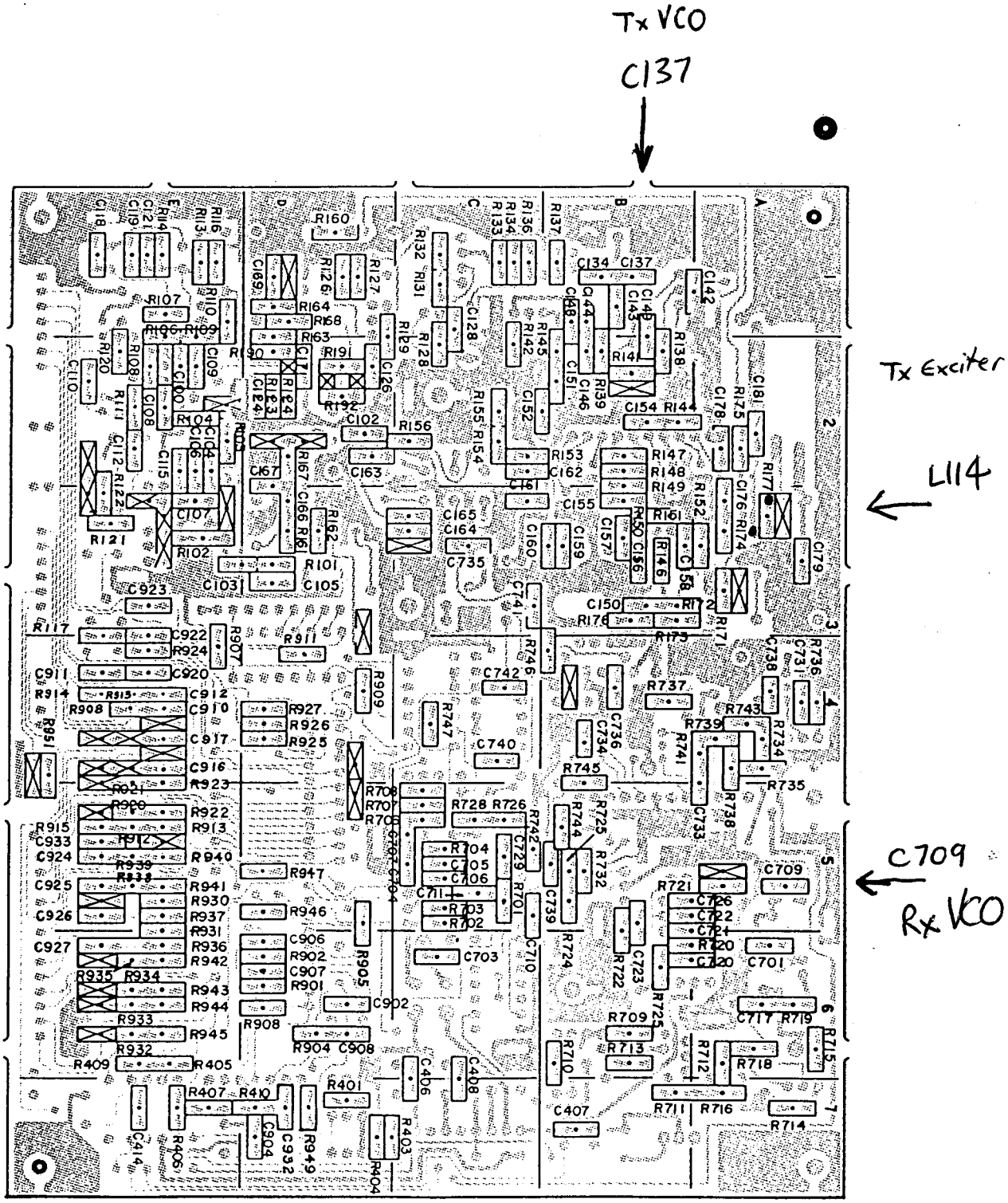
R8 V on during receive periods; and

T8 V on when the unit is transmitting.

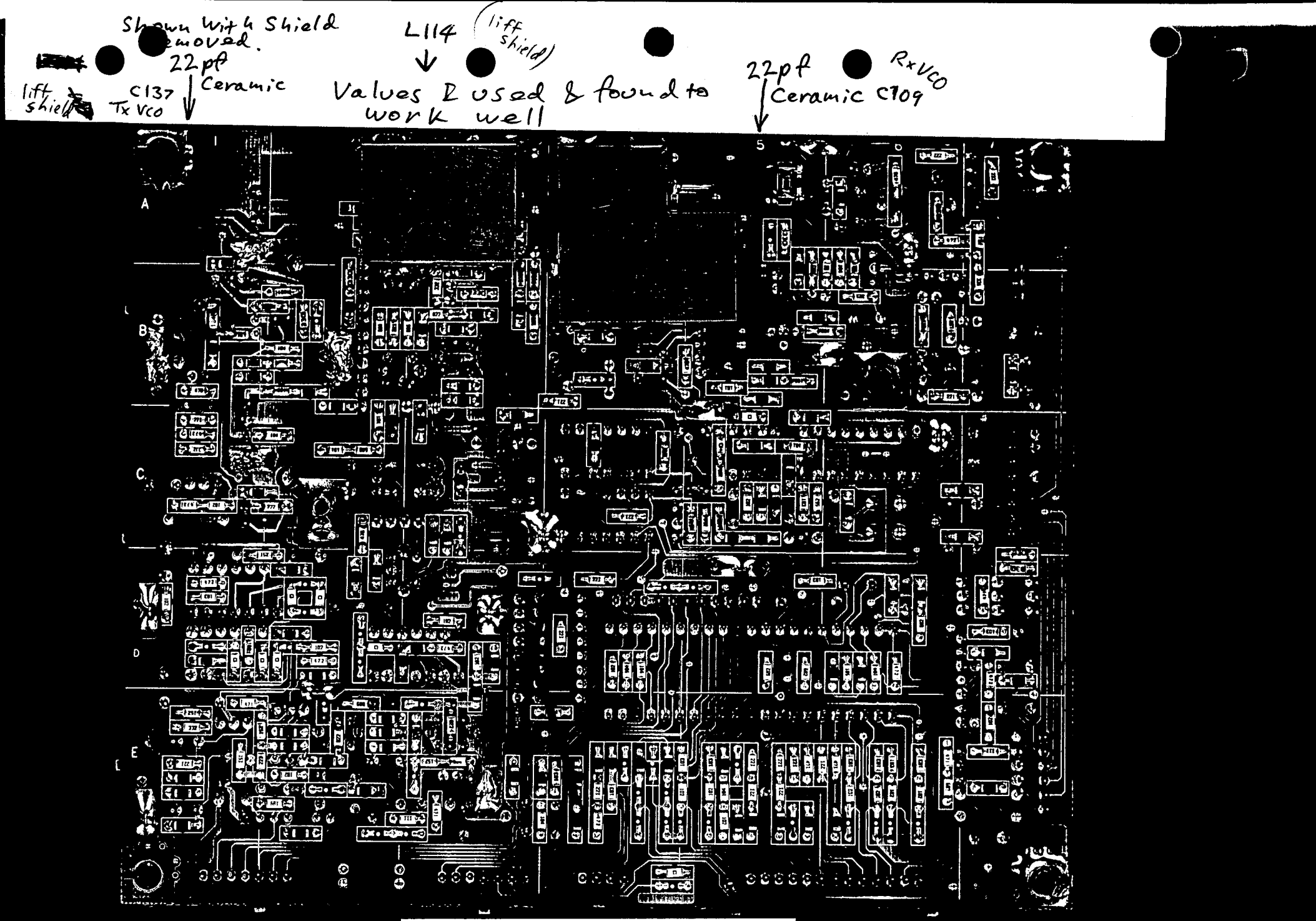
IC901 pin 13 switches low for transmission, switching Q402 off and causing Q403 and Q404 to conduct, changing IC401 from receive to transmit. Q404 clamps R8 V off, ensuring a fast switchover to transmit.



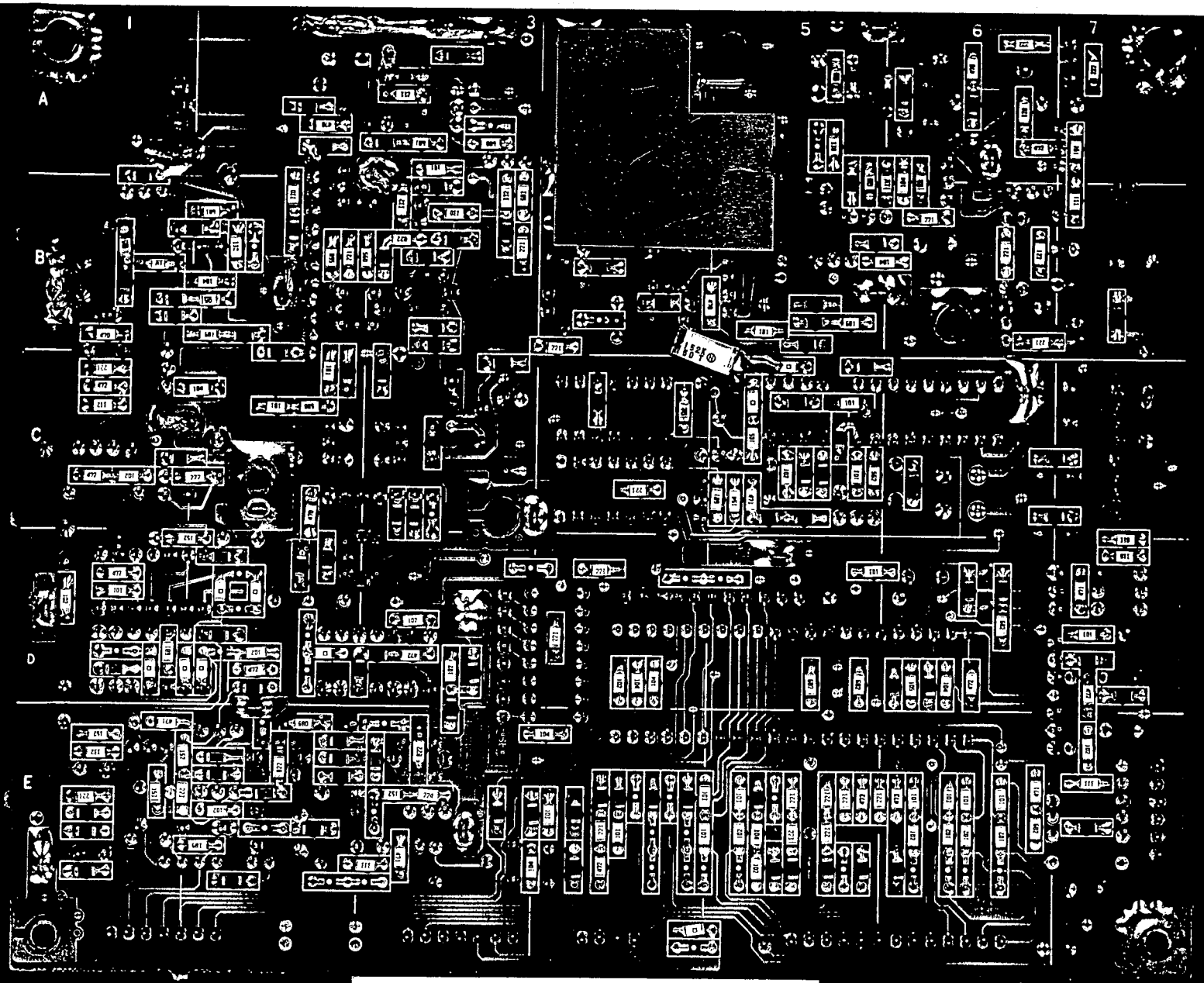

TX-081 TOP SIDE



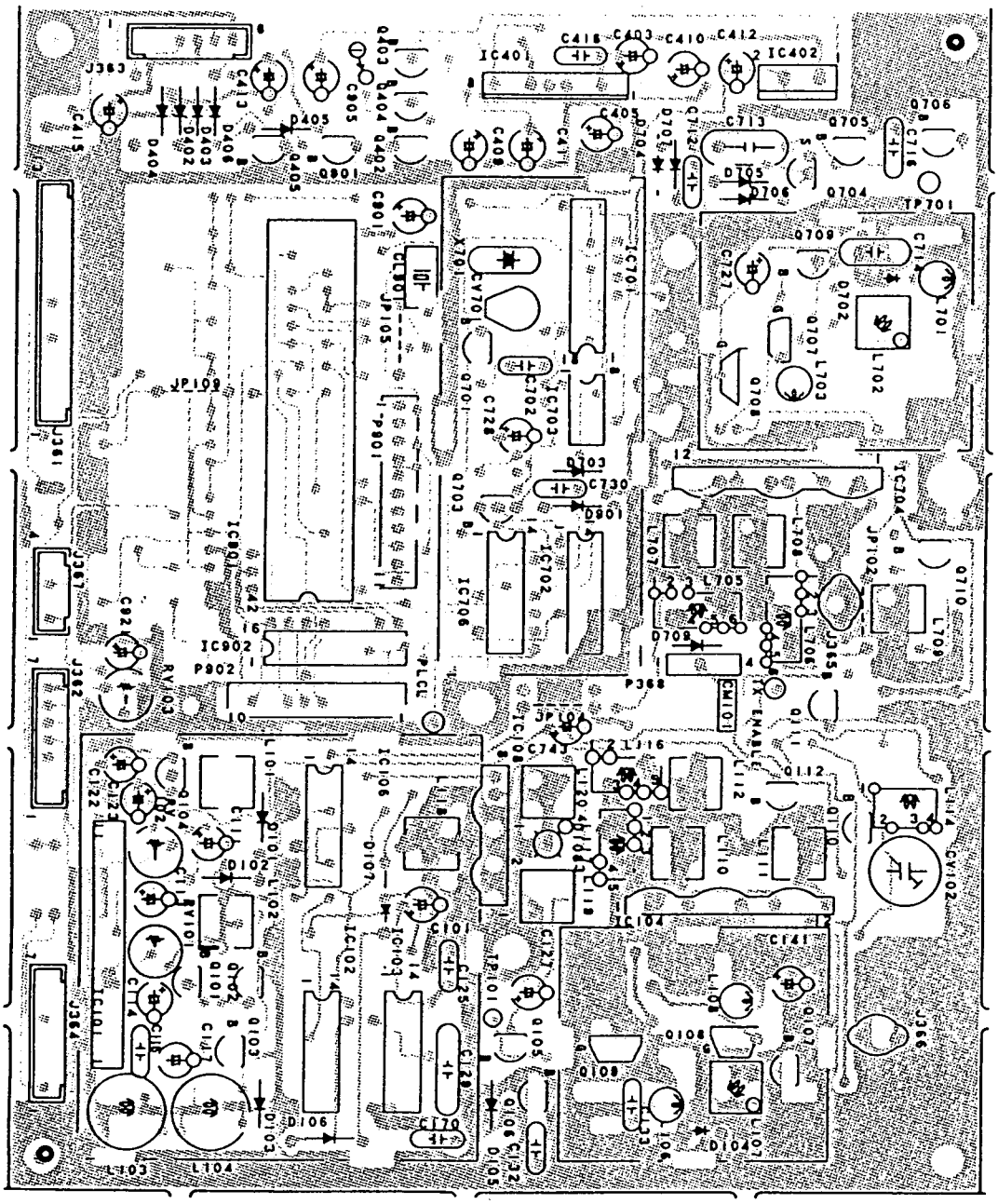

TX-081 BOTTOM SIDE



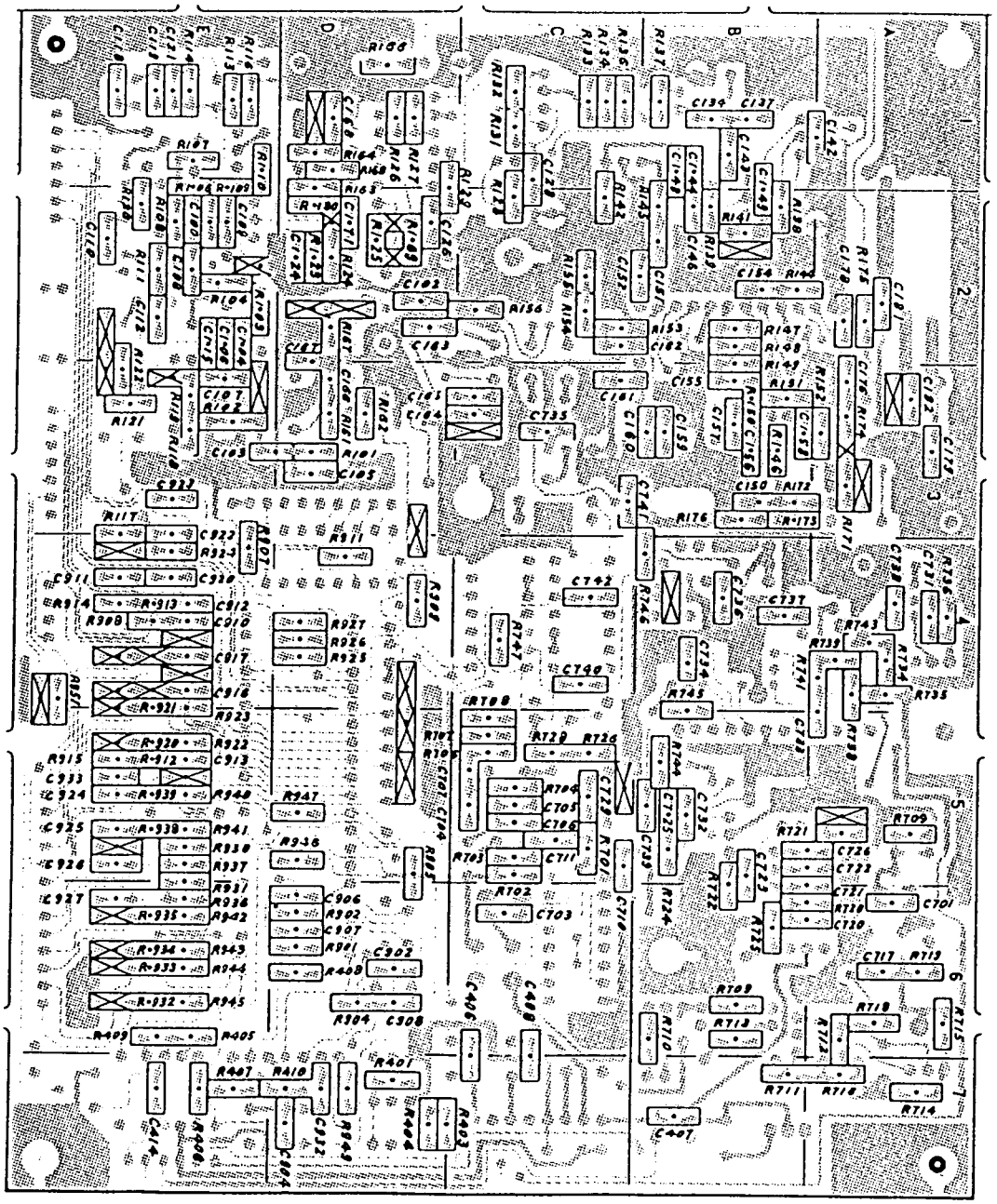

**6m MODIFIED RT85 VCO**



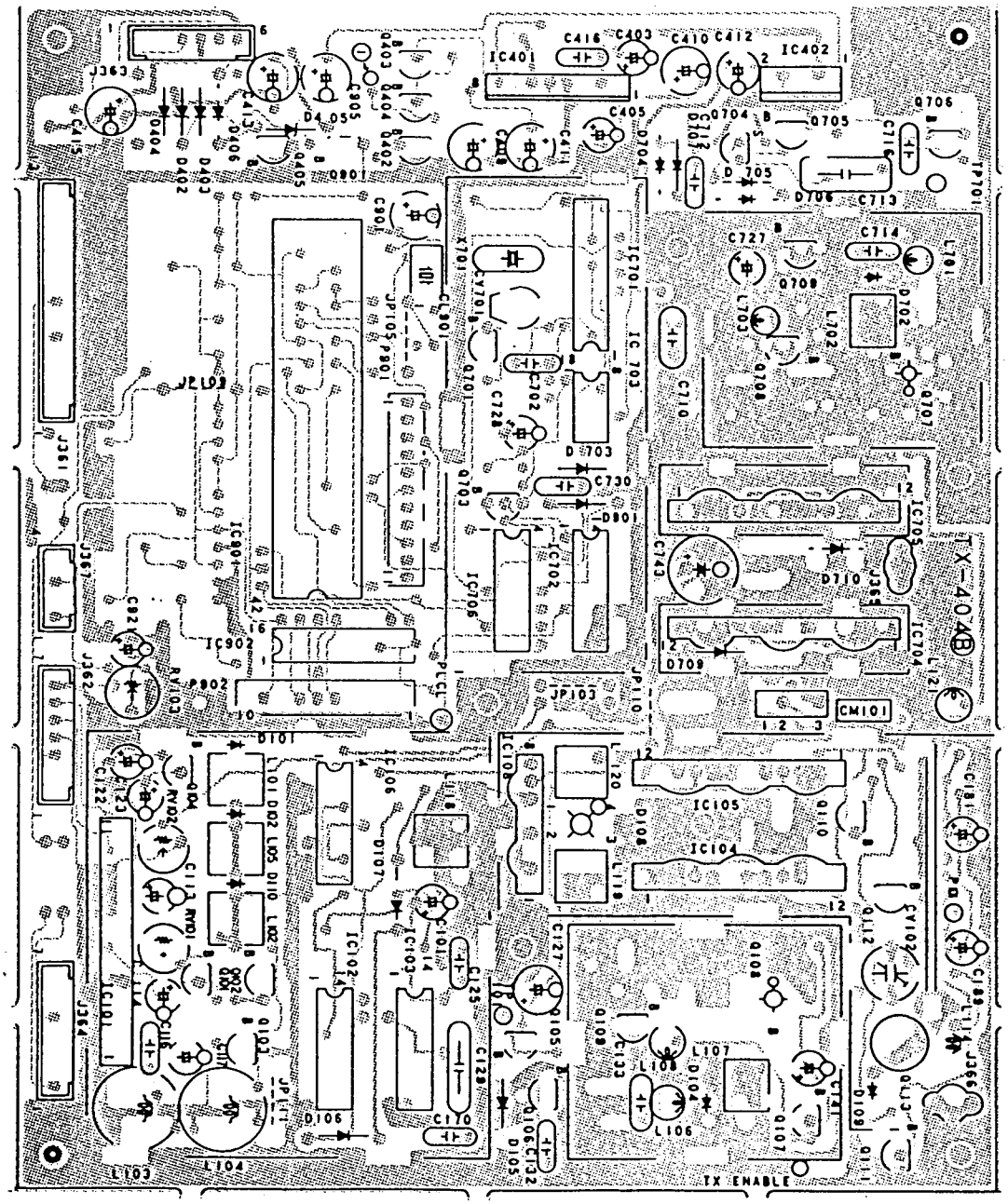
**UNMODIFIED RT85 VCO**



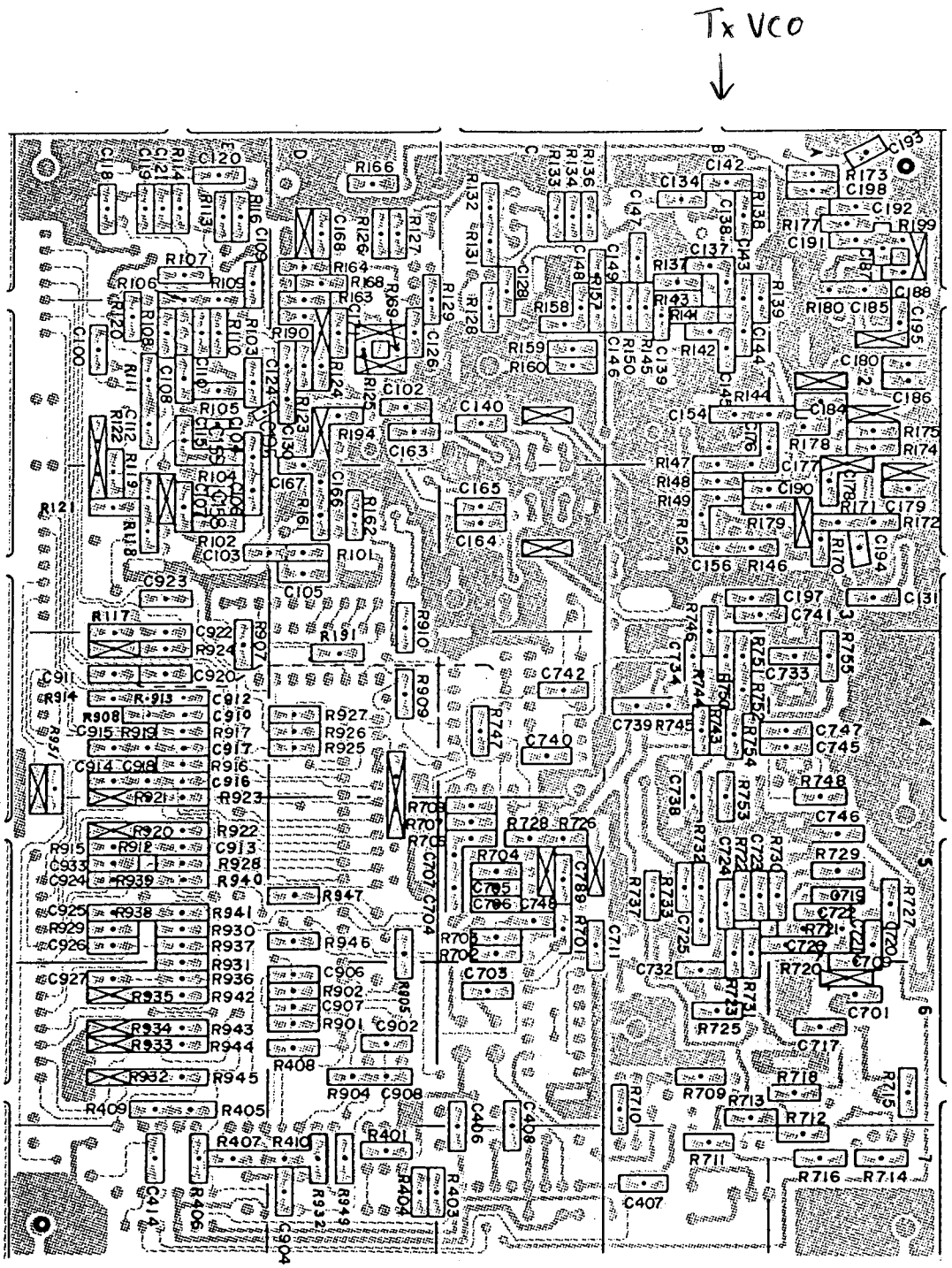
TX-153 TOP SIDE



TX-153 BOTTOM SIDE




TX-404 TOP SIDE




TX-404 BOTTOM SIDE

## B.2 - RECEIVER ASSEMBLY

### IDENTIFICATION

| Band | Frequency | PCB No. | Circuit Drawing |
|---|---|---|---|
| VHF(LB) | 70-85MHz | RX-081 | 82271-1-01 |
| VHF(HB) | 148-174MHz | RX-154 | 82272-1-01 |
| UHF(LB) | 403-420MHz | RX-404(A) | 82273-1-01 |
| UHF(MB) | 450-475MHz | RX-404(B) | 82273-1-01 |
| UHF(HB) | 470-500MHz | RX-404(C) | 82273-1-01 |
| UHF(SHB) | 495-520MHz | RX-404(D) | 82273-1-01 |

### GENERAL DESCRIPTION

The receiver assembly is a printed circuit board which mounts on the lower side of the diecast RT-85 transceiver frame. It contains the:

- RF amplifier and front end filters;
- Local oscillator amplifier and filter;
- First mixer and 21.4MHz IF;
- Integrated second oscillator, mixer, 455KHz IF and discriminator;
- Noise amplifier and squelch amplifiers;
- Audio gate and switches;
- Speaker amplifier; and
- DC input relay.

### CIRCUIT DESCRIPTION

#### FRONT END, MIXER and FIRST IF

Front end selectivity is achieved by the use of bandpass filters L201, L202, L204, L205 & L206 (also L203 for UHF).

D201 and D202 clip high amplitude input signals before they reach the RF amplifier Q201 (and Q202 for UHF). The local oscillator signal from the main frequency synthesizer is fed into the source of Q202 (VHF), Q203 (UHF) after filtering and amplification by Q203 (VHF), Q204 (UHF).

FL251 is a monolithic crystal bandpass filter which filters the 21.4MHz IF signal prior to amplification in Q251.

#### SECOND IF and DISCRIMINATOR

IC251 forms the second mixer , crystal oscillator at 20.945MHz and 455KHz IF amplifier. FL252 and FL253 are 455KHz ceramic filters, and L252 tunes the quadrature detector which has its output at IC251 pin 13.

NOISE SQUELCH and AUDIO GATE

L254 and L255 form a band pass filter at approximately 60KHz, and discriminator noise of this frequency is amplified in IC251 (pin 10 in, pin 11 out) and Q252.

With no carrier, IF noise is rectified in D252 and D253 to increase voltage on IC251 pin 12. Depending on the setting of the squelch control, this voltage switches the output of the inverting amplifier IC251 (pin 12 in, pin 13 out) low, which shuts the audio gate Q259 off.

In the presence of carrier, the noise out of Q252 drops switching IC251 pin 13 high. Audio gate Q259 switches high under this condition if either TSQ/MON is low or TSQ SIG J358 pin 3 is high. In addition, IC251 pin 14 will switch low causing the SQ signal (J359 pin 3) to switch high.

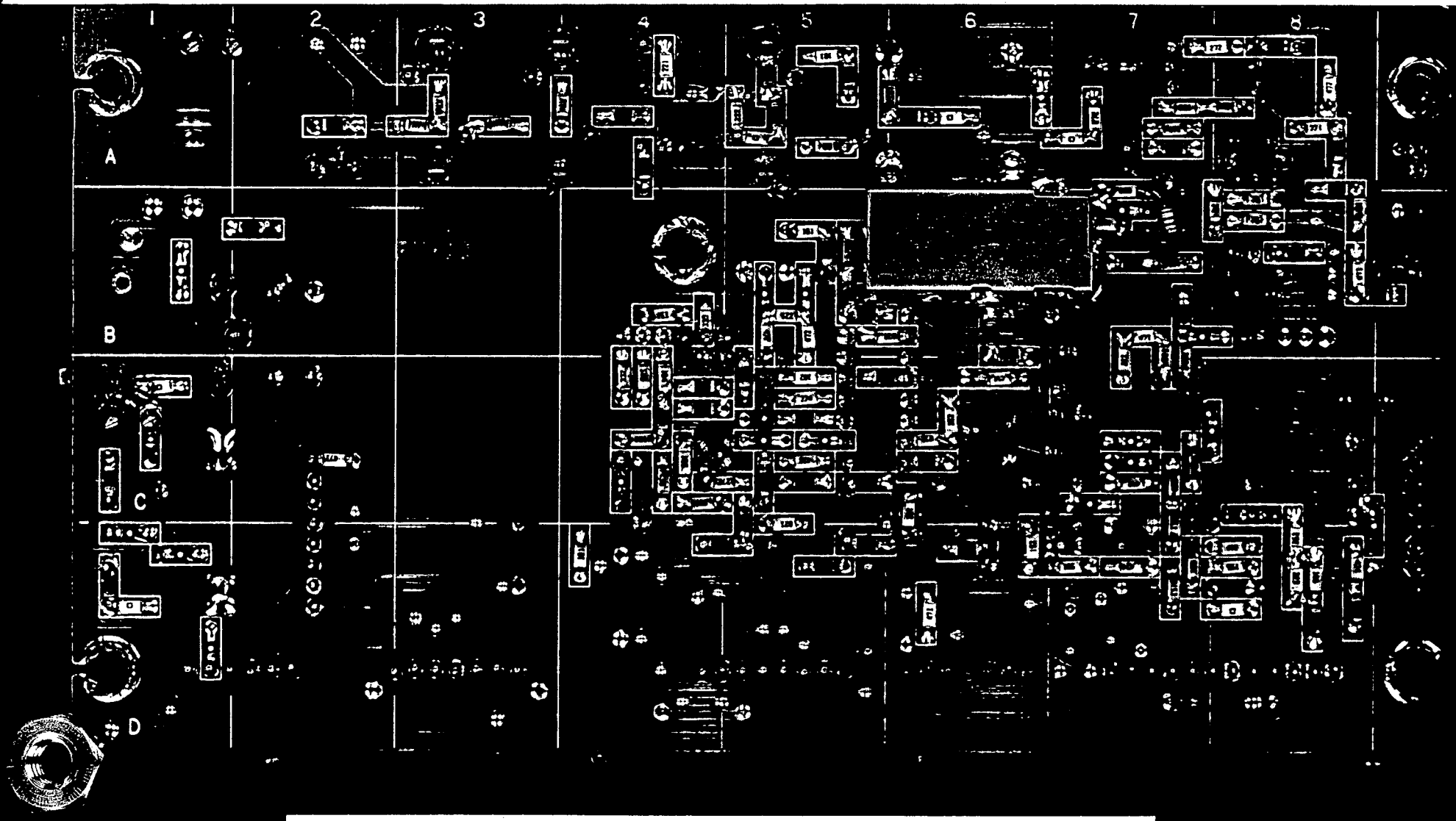
Noise out of Q252 is also rectified by D256, and if there is a sudden large increase in noise (e.g. carrier switched off), then C271 causes Q253 and in turn Q254 to pulse on quickly, discharging C266. This greatly reduces the noise tail heard in the speaker when the carrier is switched off. However, for weak and fading signals, Q253 does not turn on, so the full length noise tail as determined by C266 will be heard.

SPEAKER AMPLIFIER

IC252 is an audio power amplifier capable of delivering 3 watts into a 4 ohm load. The signal out of the audio gate Q259 is directed through the volume control and then into IC252. ALARM OUT (J353 pin 4) and BEEP (J357 pin 4) allow injection of tones from the microprocessor and the Selcall decoder into the loudspeaker.

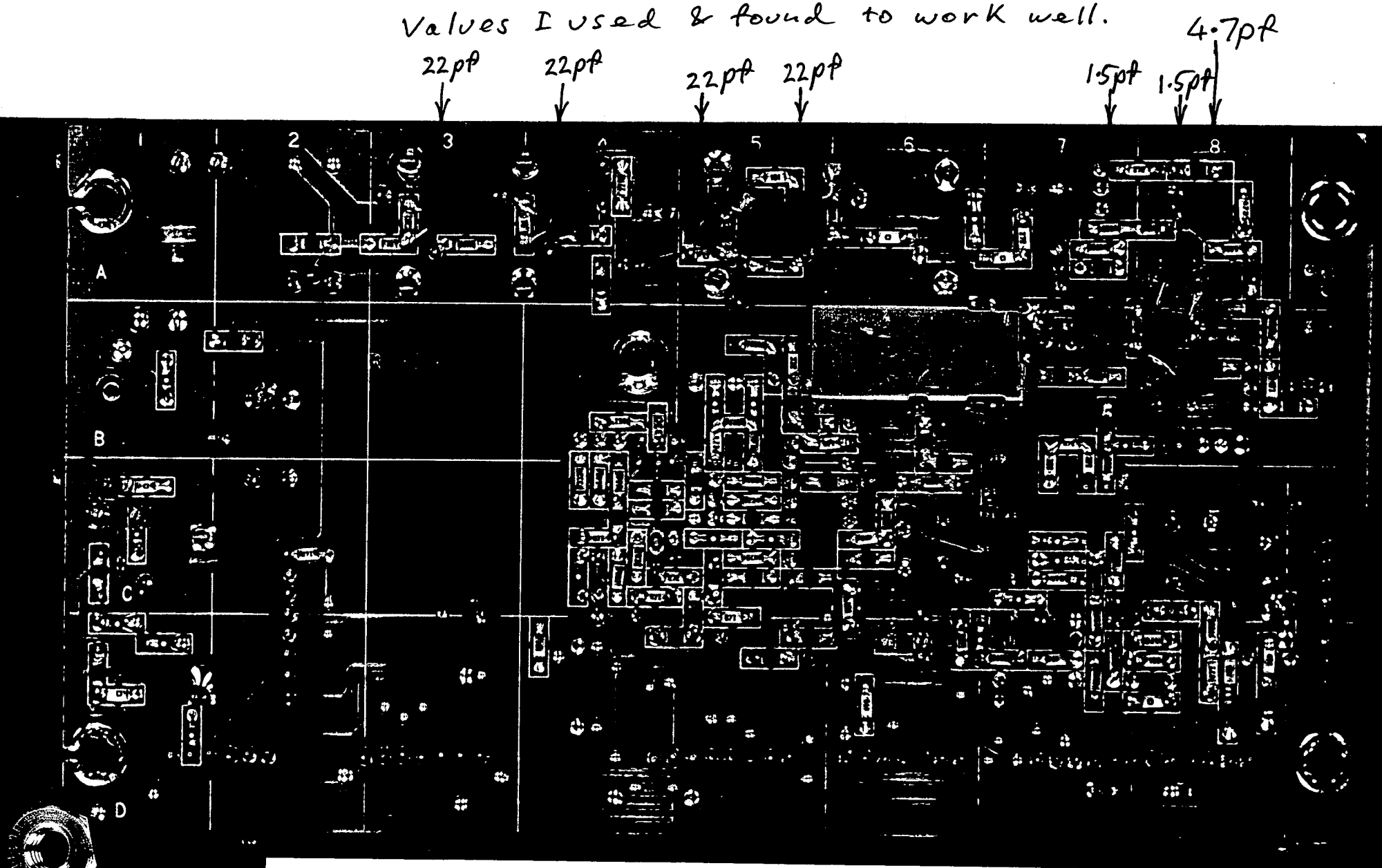
DC INPUT RELAY

K201 is a relay which is energised whenever the POWER (L) rail is switched from the control unit. The relay contact supplies dc to both transmitter and receiver. L256 with C292 and C293 form a low pass filter which reduces battery noise entering the transceiver.

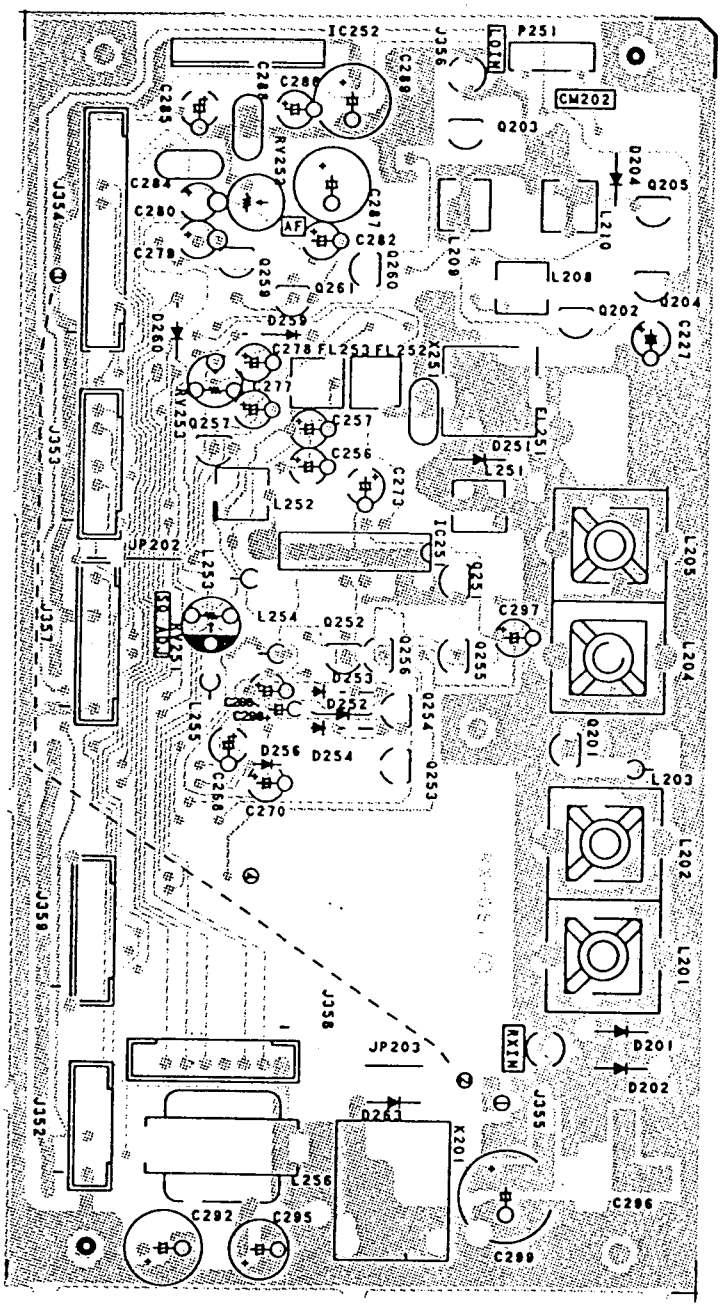



**UNMODIFIED RT85 Rx**

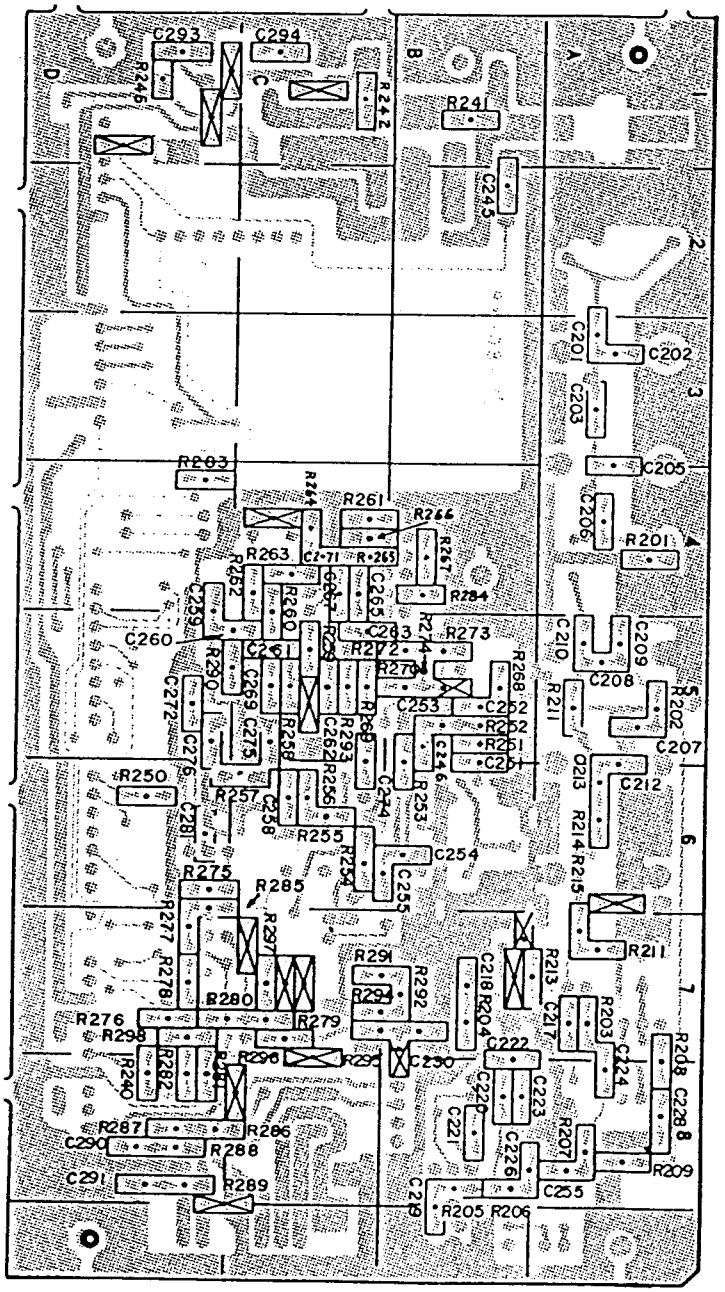
Values I used & found to work well.




**6m MODIFIED RT85 Rx**




RX-081 TOP SIDE




RX-081 BOTTOM SIDE

## B.3 - POWER AMPLIFIER ASSEMBLY

### IDENTIFICATION

| Band | Frequency | PCB No. | Circuit Drawing |
|---|---|---|---|
| VHF(LB) | 70-85MHz | PA-081 | 82271-1-02 |
| VHF(HB) | 148-174MHz | PA-1544 | 82272-1-02 |
| UHF(LB) | 403-420MHz | PA-429(A) | 82273-1-02 |
| UHF(MB) | 450-475MHz | PA-429(B) | 82273-1-02 |
| UHF(HB) | 470-500MHz | PA-429(C) | 82273-1-02 |
| UHF(SHB) | 495-520MHz | PA-429(D) | 82273-1-02 |

### GENERAL DESCRIPTION

The power amplifier is a printed circuit board which mounts within a compartment on the top side of the diecast transceiver frame. Power transistors bolt to the frame, which is shaped to provide maximum efficiency as a heat sink.

The power amplifier contains a:

- three stage power amplifier;
- solid state TX/RX changeover switch;
- PA power detector and regulator; and
- antenna low pass filter.

### CIRCUIT DESCRIPTION

The circuit diagram of the Power Amplifier assembly is on the Transmitter Assembly circuit diagram (see Section B.1).

### POWER AMPLIFIER CIRCUIT

Q501, Q502 and Q503 make up a three stage amplifier with sufficient gain to provide the specified output power with the minimum dc input voltage. The amplifier gain can be cut by reducing the dc voltage on the collector of Q501. The exciter output is used to drive this amplifier.

### TX/RX ANTENNA SWITCH

When the unit is receiving, signals from the antenna pass through C519 and L511 to the receiver. D501 and D503 are not in conduction, and thus do not load the receiver signal.

When transmitting, dc from the T8 V supply passes through R512, L510, D501, L511 & D503, causing the two diodes to conduct. The transmitter power passes through D501 to the antenna, while rf voltage to the receiver is clamped by D503.

## PA POWER DETECTOR and REGULATOR

The rf voltage out of the transmitter is coupled to D504 via C539 and an inductive pick-up loop. The rectified dc into the base of Q506 is compared with the reference voltage at the base of Q505, and as these two transistors form a differential amplifier, Q505 collector current amplified in Q504 adjusts the voltage at the collector of Q501. Thus the rf output power will adjust to maintain a constant voltage at the base of Q506.

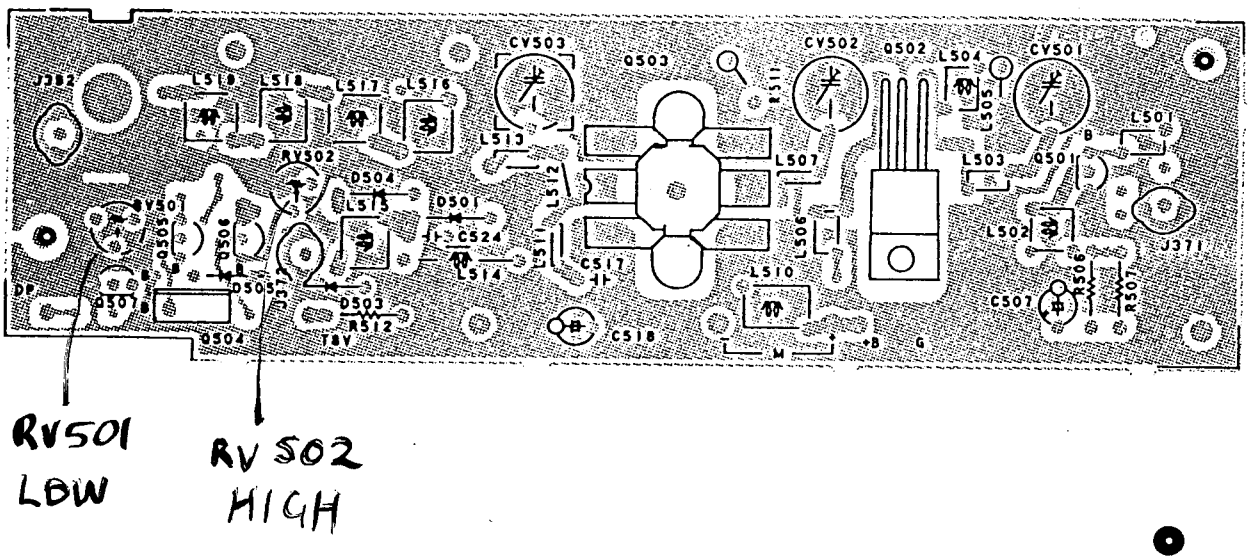
RV502 allows the output power to be preset between 12 and 25 watts. The reference at the base of Q505 can have two settings:

Normal: voltage divided from TV8 by R517, D505 & R518; or

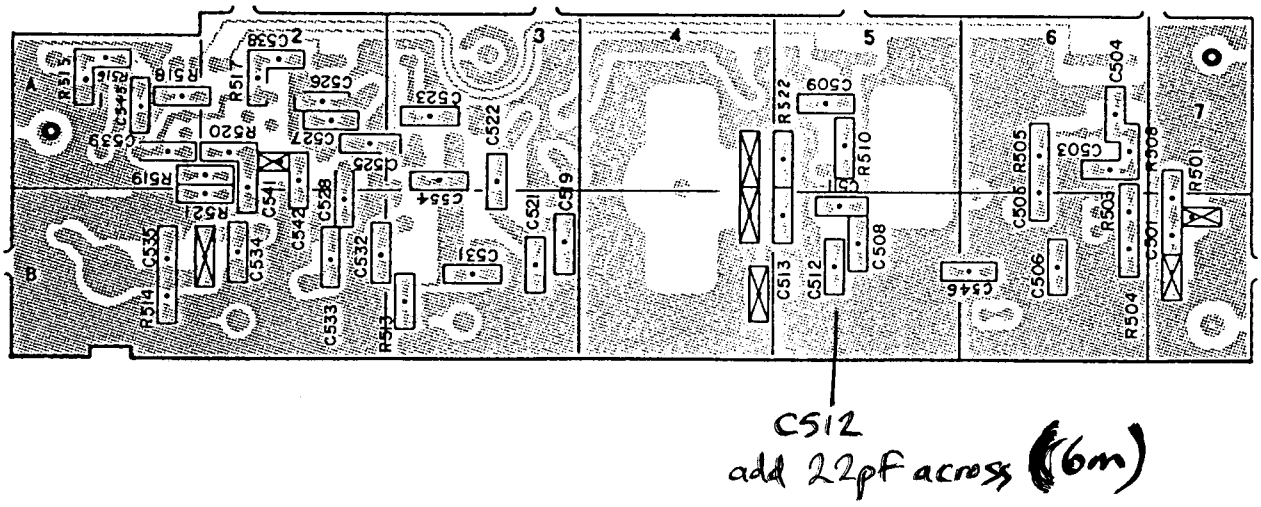
Depower: Q507 conducts and RV501 sets new reference for an output power of 1 to 12 watts.

## ANTENNA LOW PASS FILTER

L512/L515 form a low pass filter which supresses harmonics of the transmitter output frequency.




PA-081 TOP SIDE




PA-081 BOTTOM SIDE

## B.4 - ADAPTOR ASSEMBLY

The adaptor printed circuit board is identified by No. AD-43.

The circuit diagram of the Adaptor Assembly is on the Receiver Assembly circuit diagram (see Section B.2).

The adaptor board is mounted across the rear of the transceiver. It provides interconnection between the transmitter, receiver, CTCSS, Selcall, control unit and the auxiliary connector.

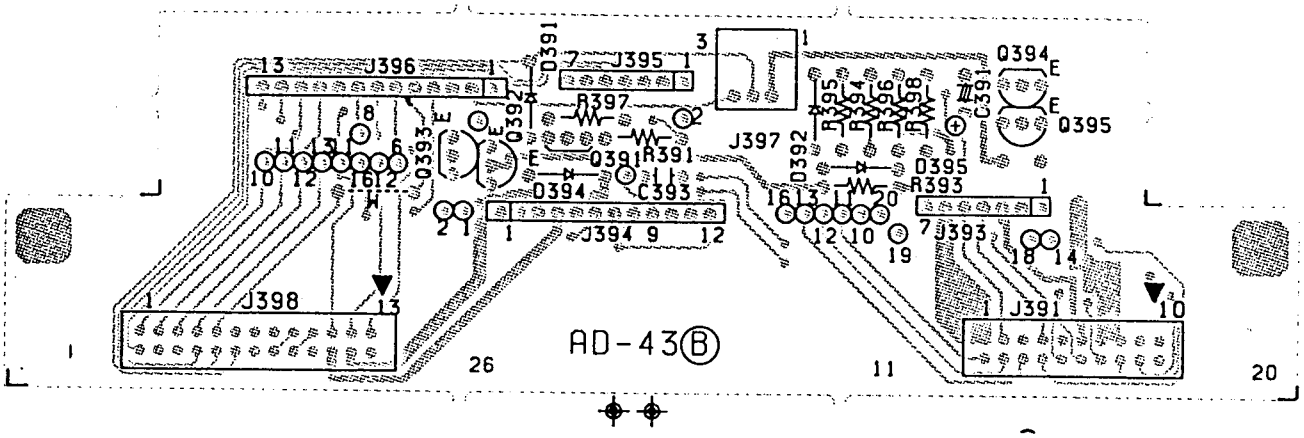
### AUDIO MUTE

Under normal conditions, Q394 conducts due to base current through R394, R395 & R398, and Q355 is cut off.

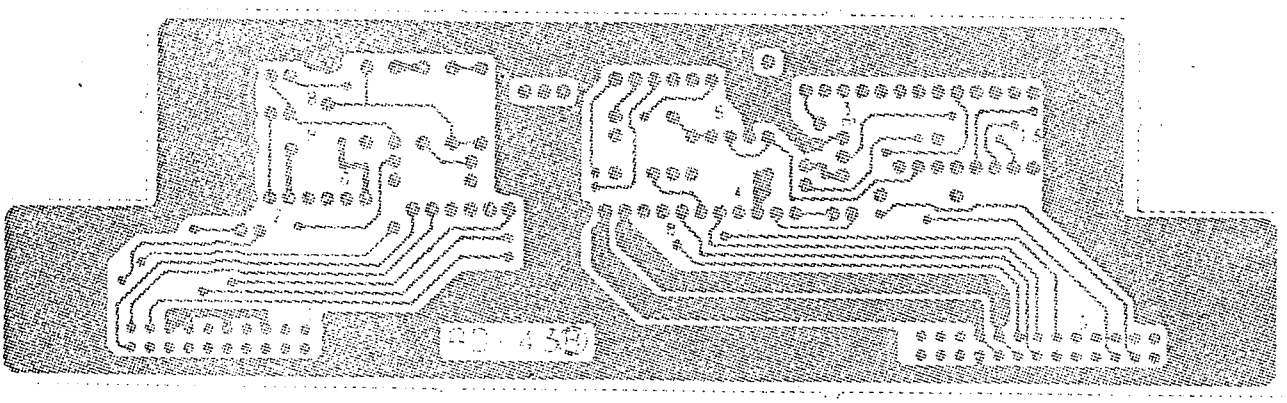
If J391 pin 15 is grounded, C391 is immediately discharged through D392, Q394 switches off, and Q395 conducts, switching off the receive audio. When J391 pin 15 switches high, the audio signal is held off for approximately 150ms due to the time constant C391, R395 and R394.

### LED DRIVERS

Q391 and Q393 sink current to switch on the control unit CALL and BUSY LEDs. The CALL LED can also be switched on from the Selcall unit via D391.




AD-43 TOP SIDE



AD-43 BOTTOM SIDE

## B.5 - CONTROL UNIT

The RT-85 control unit is identified by No. 1LC82259. The description below refers to circuit diagram 82259-1-01, which follows this section.

The control unit is housed in a moulded polycarbonate case with integrally moulded buttons forming the front face. A red acrylic lens covers the display window and supports the other LED indicators. Two edge mounted rotary knobs provide volume and squelch control.

Inside the box are two parallel mounted printed circuit boards on which are all the electronic components. Connection to the transceiver is made through a 26-way flat cable. Terminals at the rear of the case allow connection to the loudspeaker, handset and depower switch.

### PCB CX-09

This circuit board provides interfacing between the flat cable to the transceiver, external connections P303/P313 and the volume and squelch controls.

IC301 amplifies the low level microphone signal to a high level suitable for transmission through the flat cable to the TX exciter.

IC302 is a 5 V regulator powering the switch and display circuitry.

### PCB CX-10

The second PCB mounts the the six switches SW301/SW305, the channel display (IC316), the BUSY, CALL, SCAN, & OPEN LEDs and the associated decode/driver circuits.

#### Switch Multiplexing

IC313 is a BCD-to-decimal decoder which allows only one of its outputs to switch high at any time depending on the BCD code applied to its inputs A, B, C & D.

The central microprocessor sets up continually changing BCD codes, and IC313 sends momentary high pulses to one side of each switch in turn. If any switch is closed, its pulse will be transferred through D316 and inverter IC313 to the SWITCH RTN conductor back to the microprocessor, thus registering a switch closure.

In addition, two outputs from IC313 set two latches in IC314, which in turn drive the SCAN and OPEN LEDs, thus controlling these LEDs from the microprocessor. Another output from IC313 (pin 4) is a common reset for the two LED latches.

| DSP3 | DSP2 | DSP1 | DSP0 | Display Number | Switch/Latch |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | CHANNEL UP |
| 0 | 0 | 0 | 1 | 1 | CHANNEL DOWN |
| 0 | 0 | 1 | 0 | 2 | SILENT |
| 0 | 0 | 1 | 1 | 3 | |
| 0 | 1 | 0 | 0 | 4 | STATUS/SEND |
| 0 | 1 | 0 | 1 | 5 | |
| 0 | 1 | 1 | 0 | 6 | Depower |
| 0 | 1 | 1 | 1 | 7 | |
| 1 | 0 | 0 | 0 | 8 | SCAN |
| 1 | 0 | 0 | 1 | 9 | |
| 1 | 0 | 1 | 0 | Blank | SCAN LED on |
| 1 | 0 | 1 | 1 | Blank | |
| 1 | 1 | 0 | 0 | Blank | OPEN LED on |
| 1 | 1 | 0 | 1 | Blank | |
| 1 | 1 | 1 | 0 | Blank | LEDs off |
| 1 | 1 | 1 | 1 | Blank | |

| DSP3 | DSP2 | DSP1 | DSP0 | Inputs |
|---|---|---|---|---|
| A | C | B | D | IC313 |
| D | C | B | A | IC311 & IC312 |

Display Multiplexing

To set a particular display number, the microprocessor sets the appropriate BCD code on lines DSP0/DSP3, and then sends a negative pulse on the appropriate strobe line $\overline{\text{DSP STBL}}$ or $\overline{\text{DSP STBH}}$. To blank the display, a binary number above 9 is sent from the microprocessor.

Fig. B-4 (page B.5 - 3) shows the interconnection of the control unit display and switches.

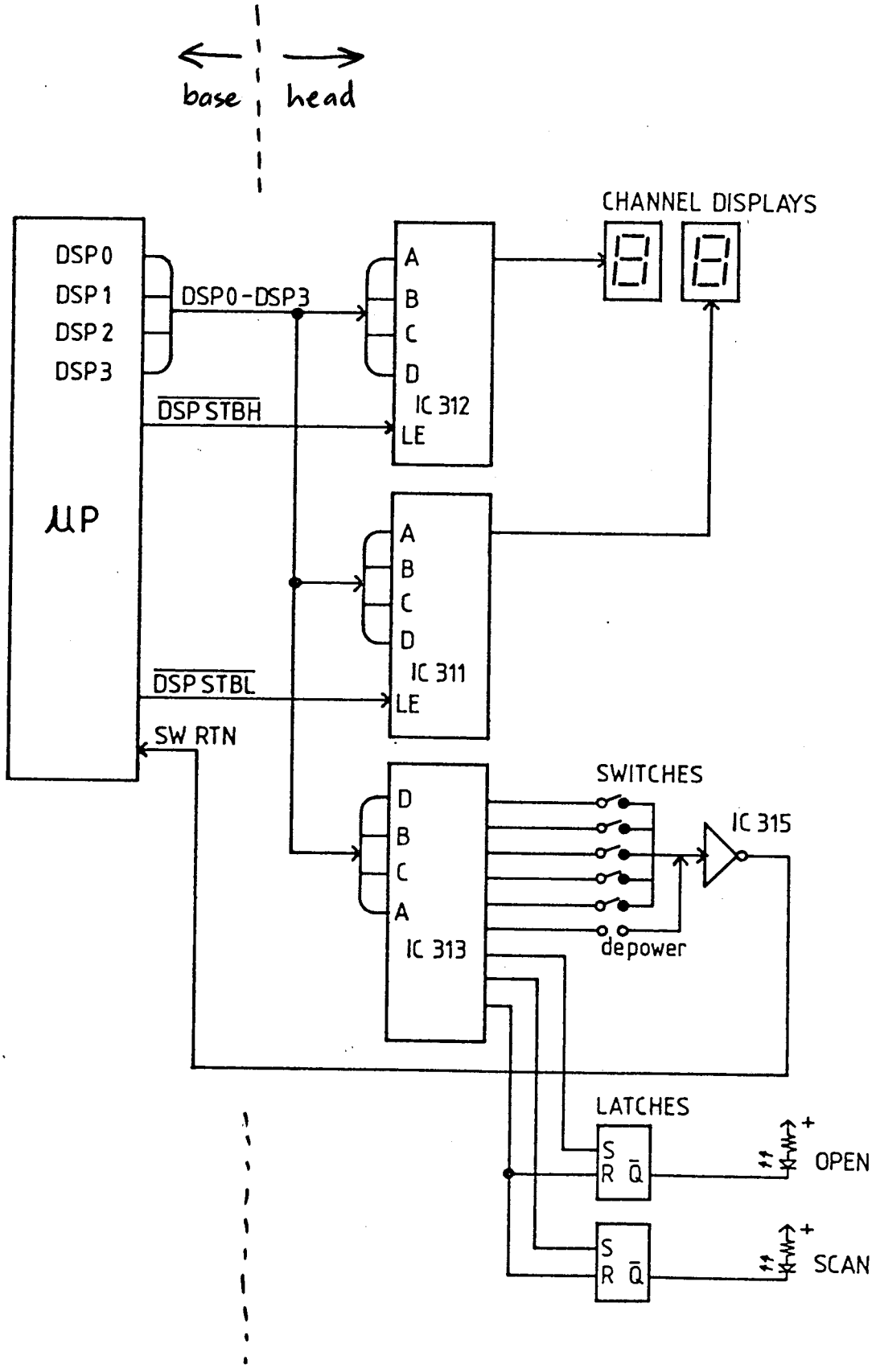
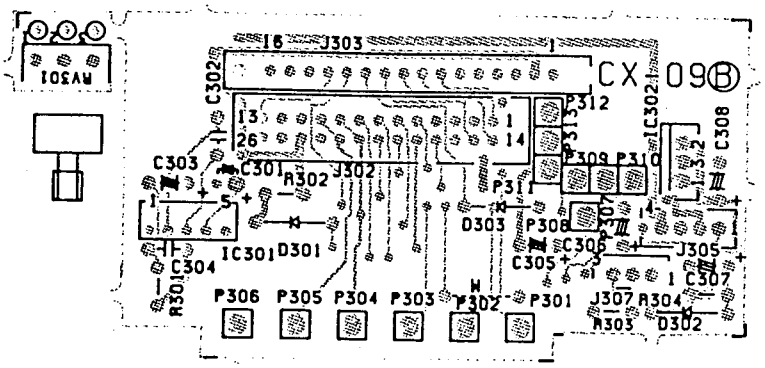
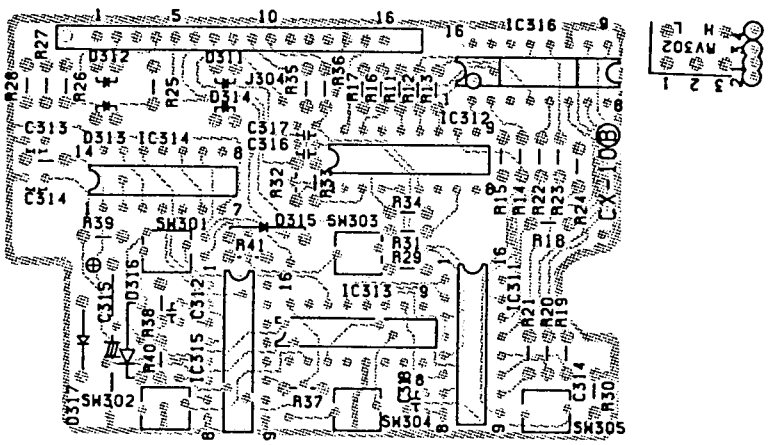
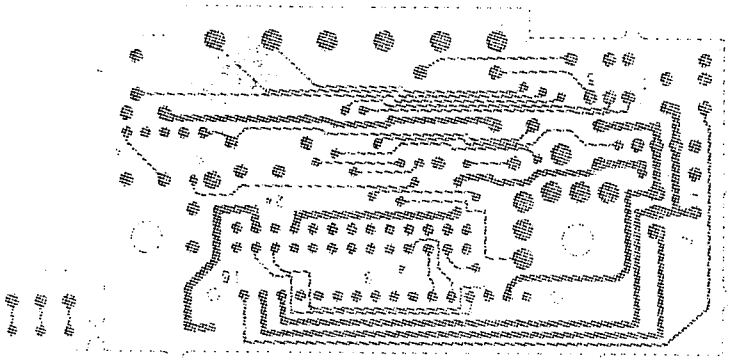


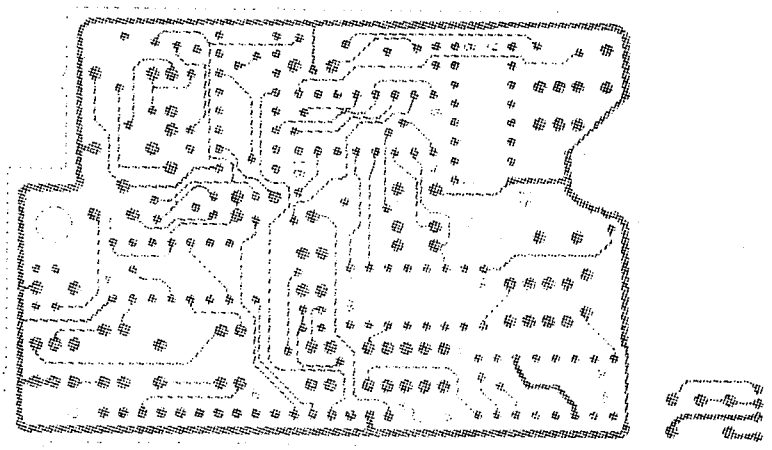

Fig. B-4 Control Unit Display/Switch Interconnection




CX-09/10 TOP SIDE





CX-09/10 BOTTOM SIDE