

Please do not upload this copyright pdf document to any other website. Breach of copyright may result in a criminal conviction.

This Acrobat document was generated by me, Colin Hinson, from a document held by the Henlow Signals Museum, believed to be out of copyright. It is presented here (for free) and this pdf version of the document is my copyright in much the same way as a photograph would be. If you believe the document to be under other copyright, please contact me.

The document should have been downloaded from my website <https://blunham.com/Radar>, or any mirror site named on that site. If you downloaded it from elsewhere, please let me know (particularly if you were charged for it). You can contact me via my Genuki email page: <https://www.genuki.org.uk/big/eng/YKS/various?recipient=colin>

You may not copy the file for onward transmission of the data nor attempt to make monetary gain by the use of these files. If you want someone else to have a copy of the file, point them at the website. (<https://blunham.com/Radar>). Please do not point them at the file itself as it may move or the site may be updated.

It should be noted that most of the pages are identifiable as having been processed by me.

I put a lot of time into producing these files which is why you are met with this page when you open the file.

In order to generate this file, I need to scan the pages, split the double pages and remove any edge marks such as punch holes, clean up the pages, set the relevant pages to be all the same size and alignment. I then run Omnipage (OCR) to generate the searchable text and then generate the pdf file.

Hopefully after all that, I end up with a presentable file. If you find missing pages, pages in the wrong order, anything else wrong with the file or simply want to make a comment, please drop me a line (see above).

It is my hope that you find the file of use to you personally – I know that I would have liked to have found some of these files years ago – they would have saved me a lot of time !

Colin Hinson

In the village of Blunham, Bedfordshire.

REDIFON 
**Technical
Information**

**Instruction Manual
for
TERMINAL TELEGRAPH
TYPE TT18**

© Redifon Ltd., 1970

Redifon Limited · London · S.W.18 · England



S A F E T Y F I R S T

The operation of electronic equipment involves the use of voltages which may be sufficiently high to endanger human life. Although every practicable safety precaution has been incorporated in this equipment the following rules should be observed:—

The power should be removed completely and any high voltage capacitors in power supplies discharged manually with a shorting bar before changing valves or making internal adjustments.

Under no circumstances should any person reach within a unit for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

Under no circumstances should interlock switches be removed, short circuited or tampered with in any way by other than authorised maintenance personnel; nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

REDIFON



A Member Company of the Rediffusion Organisation

Contractors to:

British Broadcasting Corporation, Crown Agents, General Post Office, Ministry of Technology, Ministry of Defence.

Factories, Research and Development Laboratories: London, S.W.18; Aylesbury, Bucks; Crawley, Brighton and Rustington, Sussex

Communications Division

M. F., H.F., V.H.F. and SSB/ISB Transmitters
Fixed- and variable-tuned receivers for all purposes
SSB/ISB and Frequency-Shift (Simplex and Twinplex)
Converters
Frequency-Shift Keyers and Combiners
Telegraphy Error Correctors
H.F. and V.H.F. single- and multi-channel
Transmitter/Receiver Terminals
H.F. and U.H.F. Packsets
M.F. Beacons

Marine Division

A complete range of Marine Communications transmitters, receivers and ancillary equipment for all classes of vessels

The range includes:—

CW, MCW and telephony (DSB and SSB)
M.F., I.F. and H.F. Transmitters
Main, SSB and loudspeaker-watch receivers
Auto-Alarms
Auto Keyers
V.H.F. Multi-channel Transmitter/Receivers for International and Private bands; Base Stations and Systems
D.F. and LORAN Navigational Aids
Communal Aerial Amplifiers
Sound Reproduction Equipment for crew calling, public address, intercommunication and entertainment

RADAR Simulator Division

Radar Simulators and Trainers
Digital & Analogue Action Speed Tactical Teachers and Naval Tactical Trainers
Ground Controlled Approach Simulators
Fighter Control
Air Traffic Control
Gunnery and Weapon Control Simulators
Iconorama

Redifon Air Trainers Ltd., & Flight Simulator Division

Procedure Trainers
Type Trainers
Flight Simulators
Engine Trainers
Flight System Trainers
Aircraft System Trainers
Cockpit Trainers
Submarine Simulators
Power Station Simulators
Vehicle Driving Trainers
AUTOTUTOR
Automated Control Systems

Rediweld Ltd., – Glass Fibre Developments Ltd.

Fabricators in Thermoplastics and Glass Reinforced Plastics
Injection Moulders of Thermoplastic and Thermosetting materials:

The range includes.

Transport Vehicle Bodies
Aircraft Wing Tips and Engine Cowlings
Corrosion Resistant Pumps and fans
Fume Cabinets
Filter Units
Welding Torches and Associated Equipment
Laboratory Ware
Extruded Rod & Sheet

Redifon-Astrodata Ltd.

Scientific Computation Equipment (Analogue, Digital, & Hybrid Computers)

REDICOLOUR Colour Computer – fully integrated colour matching system

Data Acquisition, Telemetry & Timing Systems

Redifon Project Engineers are available for consultation on complete communications systems

REDIFON LIMITED LONDON S.W.18 ENGLAND

Telephone: 01-874 7281 (15 lines) Telex: 264029 Telegrams and Cables: Redifon London Telex

CONTENTS

- 1 INTRODUCTION**
- 2 INSTALLATION**
- 3 OPERATION**
- 4 CIRCUIT DESCRIPTION**
- 5 MAINTENANCE AND REPAIR**
- 6 COMPONENTS LIST**
- 7 CIRCUIT DIAGRAM**

1. INTRODUCTION

- 1.1 APPLICATION OF TT18
- 1.2 BRIEF DESCRIPTION OF EQUIPMENT
- 1.3 KEYING CONDITIONS, TERMINOLOGY
- 1.4 CONTROL CIRCUIT FUNCTIONS
- 1.5 SPECIFICATION
TABLE 1.1 CONTROL OUTFIT
CONNECTIONS
- 1.6 MECHANICAL DESCRIPTION
- 1.7 VENTILATION
- 1.8 PLUGS AND SOCKETS
- 1.9 CONTROL SWITCH FUNCTIONS

ILLUSTRATIONS

- FIG 1.1 TELEGRAPH TERMINAL TT18
FRONT VIEW
- FIG 1.2 BLOCK DIAGRAM OF TELEGRAPH
SYSTEM WITH TT18
- FIG 1.3 BLOCK DIAGRAM OF EQUIPMENT



Fig 1-1

TELEGRAPH TERMINAL TT18 FRONT VIEW

1. INTRODUCTION

1.1 APPLICATION OF TT18

The TT18 Telegraph Terminal provides facilities for routing low level (6-0-6 volt) teleprinter signals to and from associated TT20 (Voice Frequency Telegraph Receiver Terminal) and TT21 (Voice Frequency Telegraph Transmitter Terminal), and for control and system indication of a radio frequency transmitter.

The TT18 is primarily designed to operate with a teleprinter requiring low level signals (6-0-6 volt). A built-in high level converter allows the use of teleprinters with double current electro-magnet coils.

Manual or automatic control of "Send" or "Receive" conditions is provided.

Internal links permit a Morse key to key a transmitter for CW operation. Alternatively, a tone may be keyed via the associated TT21 transmitter.

The TT18 is constructed in the form of a drawer assembly which fits under the shaped Mount, Teleprinter Terminal (5815-99-560-6271). This mount supports the Creed 75 Teleprinter, the whole forming one compact assembly. (FIG 1.1).

A block diagram of the TT18 as part of a Telegraph Terminal is shown in Figure 1.2.

1.2 BRIEF DESCRIPTION OF EQUIPMENT

The TT18 drawer assembly is approximately $2\frac{3}{4}$ inches (7 cm) high, $9\frac{1}{4}$ inches (23.5 cm) wide and $19\frac{1}{2}$ inches (49.5 cm) deep. The assembly contains five major sub-assemblies:—

- (a) **Power Supply** which accepts 100/125V or 200/250V 48/62 Hz. This provides the DC supplies for the remainder of the equipment.
- (b) **High level converter printed circuit board**, which accepts a +6—0—6V signal on the reception line, and converts it to a high impedance current drive for a double current electro-magnet.
- (c) **Traffic Indicator printed circuit board**, which accepts traffic (+6—0—6V) signals on the reception or transmission lines, and indicates the presence of traffic by an indicator lamp.
- (d) **'Receive' printed circuit board**, which accepts signals from an associated Receiver (TT20), provides an inhibit signal to the Transmit board and mutes the TT20 below a pre-determined level.
- (e) **'Transmit' printed circuit board**, this monitors signals from the teleprinter and activates the associated Transmitter (TT21) when transmission takes place, provided it is not inhibited by the Receive circuit.

Other circuits provide for the monitoring of CW sidetone from a receiver; the control of the radio transmitter manually; and the operation of a Morse key; "Broadcast line" (relaying) operation, and operation on a "Shore" line.

1.3 KEYING CONDITIONS AND TERMINOLOGY

The terms ACTIVE and NON ACTIVE appear throughout this handbook. They may also be referred to as 'A' and 'Z' conditions, and are used to avoid confusion.

The Active condition is defined as the signal state which corresponds to the start signal of a teleprinter. When the signal corresponds to the stop signal this is "NON ACTIVE".

It is assumed that internal connections of the teleprinter receiver circuit are made so that the signal voltage is Positive for Space and Negative for Mark. When using the Creed 75 Teleprinter (Admiralty No. 12), current flows from teleprinter terminal J to G for Active condition and from G to J for Non-Active, i.e. the Active condition corresponds to Space and Non-Active to Mark in this instance. Conditions are reversed if the teleprinter internal connections are altered to the opposite sense.

1.4 CONTROL CIRCUIT FUNCTIONS

This section describes the functions of the various control circuits in the TT18 Telegraph Terminal, and associated equipment.

1.4.1. Receiver Control Circuit

In the absence of a received signal, the VF receiver may be inhibited by a pre-set control to prevent operation of the teleprinter by noise. This receiver muting function is contained within the TT20. The muting level is set by a control on the TT18.

1.4.2. Transmitter Control Circuit

- (a) In the standby or inactive condition (Z), a +18V signal is applied by the TT18 to the control circuit of the TT21. This muting voltage inhibits the output of the TT21. The pressel and key lines to the radio transmitter are open-circuited.
- (b) When transmission is initiated, (for example from the teleprinter) the +18V muting voltage is replaced by an 0V potential. This activates the TT21. At the same time the pressel and key lines are brought into circuit with the radio transmitter.
- (c) The control circuit operates on receipt of a negative-going pulse of not less than 10 ms duration. It will be held in the transmit position for approximately 3 seconds after the receipt of the last negative going pulse. Then it reverts to the standby condition.
- (d) A 'Transmit Override' push switch allows an immediate return to the standby condition at the end of a transmission.

1.4.3. Control Sequence

- (a) From the standby condition, the activation of the receiver control circuit inhibits the operation of the transmitter control circuit.
- (b) From the standby condition the activation of the transmitter control circuits either:
 - (i) Does not inhibit the receiver control circuit thus allowing a looped circuit to be established for purpose of a local record or:
 - (ii) operates a relay to disconnect the receive line and to provide a local record from the transmit line or:
 - (iii) operates as in (i) on RATT or as in (ii) on BROADCAST. Links are provided to select the required system.

1.4.4. Control Indicators

The following indicator lamps show the state of the circuits controlled by the TT18:—

Mains Supplies on	— Clear
Transmit	— Green
Receive	— Red
Traffic	— White
Remote Radio Transmitter Ready	— Yellow
Remote Radio Transmitter In use	— Red with white cross

1.5 SPECIFICATION

1.5.1. Mains Supply

100 to 125V or 200 to 250 volts 48 – 62 Hz single phase 20W. The nominal voltage can be set at the tapping points on the mains transformer. The equipment will meet the requirements of this specification with maximum supply voltage variations of $\pm 6\%$ of the nominal voltage.

1.5.2. Signalling Speed

200 baud maximum.

1.5.3. High Level Converter Input Voltage

Positive and Negative 6 ± 1 volt.

Positive voltage indicates the Z or non-active condition.

Negative voltage indicates the A or active condition. The equipment will tolerate asymmetry between the active and non-active conditions within the limits shown above.

1.5.4. Duty Cycle

Continuous.

1.5.5. Traffic Detector

The Traffic Detector is activated as described in 1.5.3. above (negative-going signals). It responds to pulses of not less than 10 ms duration.

The Traffic Indicator Lamp indicates the presence of traffic until approximately 300 ms after the last negative-going pulse.

1.5.6. Electro-magnet Converter

- (a) Input Impedance: adjustable 1 – 6 kohms.
- (b) Coil Current: adjustable 20 – 45 mA double current.
- (c) Input Sensitivity: between ± 1 and ± 3 volts.
- (d) Distortion introduced: less than 10% at 200 baud.

1.5.7. Teleprinter Calling Bell

A bell in the TT18 rings when the bell contacts close in the teleprinter.

1.5.8. Remote Transmitter Control Circuit

Maximum current rating: 2 amps at 28V DC into a resistive load.

1.5.9. Control System Compatibility

The TT18 remote radio transmitter connections and functions are compatible with the Royal Navy Control Outfit KMM and variants in accordance with Table 1.1 below:—

TABLE 1.1 Control Outfit Connections

<i>Wire Designation</i>	<i>Wire Function</i>	
M + } M2 }	Signal pair to Tx Obtained from TT21	
C +	Common	Not required
C2	-24V	
PS	Pressel line	Normally connected to Tx control circuit
S	Morse selector	
K	Morse key	
LB	Busy lamp	
LC	Lamp common	
LR	Ready lamp	Applied to TT20
R + } R2 }	Receive pair	
SU	Muting	

1.5.10. Monitoring

Monitor points are provided on the front panel for checking transmitter input, receiver output and the electro-magnet current. A headphone jack allows monitoring of an external receiver. This is located at the right-hand side near the front of the equipment.

1.5.11. Dimensions and Weight

Height	—	7 cm	(2 $\frac{3}{4}$ inches)
Width	—	23.5 cm	(9 $\frac{1}{4}$ inches)
Depth	—	49.5 cm	(19 $\frac{1}{2}$ inches)
Weight	—	8.65 kg	(19 pounds)

1.5.12. Climatic and Durability

- Operating temperature range 0 C to +55 C.
- Storage temperature range -40° to +75°C.
- The TT18 complies with DEF. 133 Table N1 for protected shipborne equipment tests 1, 2 (test A), 3 (test A), 4, 11 (test A), 12, 14 and 17.

1.5.13. Interchangeability

All units are electrically and mechanically interchangeable.

1.6 MECHANICAL DESCRIPTION

The Teleprinter Terminal TT18 is constructed in the form of a drawer assembly to fit under the table-shaped Mount, Teleprinter Terminal (5815-99-560-6271). This supports the Creed 75 Teleprinter. Six rollers—three on each side of the TT18—engage in channels in the Mount. The rollers are staggered for easy installation. Spring-loaded catches on the Mount secure the TT18 by engaging the spindles of the two front rollers.

1.7 VENTILATION

Natural Air. The top and underside covers of the unit are slotted to allow air to circulate.

1.8 PLUGS AND SOCKETS

All inter-unit (Figure 1.2) and supply cables are connected via Pattern 104 (e.g. Smart and Brown type SB104) connector plugs at the rear.

1.9 CONTROL SWITCH FUNCTIONS

This section describes the facilities provided by the control switches on the front panel of the TT18 unit. Figure 1.2 shows the relationship of the units in the system.

1.9.1 Radio/shore

This is switch SB in the circuit diagram, Figure 7.1.

This two-position switch enables the teleprinter to operate with either the ship's VF Telegraph and Radio

Equipment, or with the VF Telegraph Equipment which terminates the shore lines. With the switch in the 'Shore' position, incoming and outgoing signals from the teleprinter are switched to a separate outlet from the TT18. Radio transmitter operation is inhibited, and no circuits of the TT18 are employed except the High Level Converter.

1.9.2 Morse/RATT/Broadcast (Switch SC)

- Morse*
The teleprinter is disconnected and the Morse key may be linked for CW (DC) keying of the radio transmitter, or for tone keying via the VF Telegraph transmitter.
- RATT*
Automatic or Manual RATT facilities are available.
- Broadcast*
The input and output connections of the VF equipment are available for cross-connection to similar equipments. This facility allows an incoming signal on another circuit to be 'Relayed'.
The teleprinter connected to the receiving TT18 provides local copy. The transmit contacts of both teleprinters are disconnected from the VF equipment. The teleprinter connected to the transmitting TT18 is held in the Z (non-active) condition.

1.9.3 Tx On/Off Switch (SF)

In the 'off' position, the keying and pressel control lines to the Radio transmitter are disconnected.

1.9.4 Tx/Auto/Rx Switch (SE)

- In the 'Tx' position, the equipment will remain in the transmit state in any keying conditions, except that switching to transmit when receiving will not take effect until the end of the received signal.
- In the 'Rx' position, the equipment remains in the receive state, and the transmitter is inhibited.
- The centre position, 'Auto', gives the automatic changeover. The Tx and Rx positions give manual changeover.

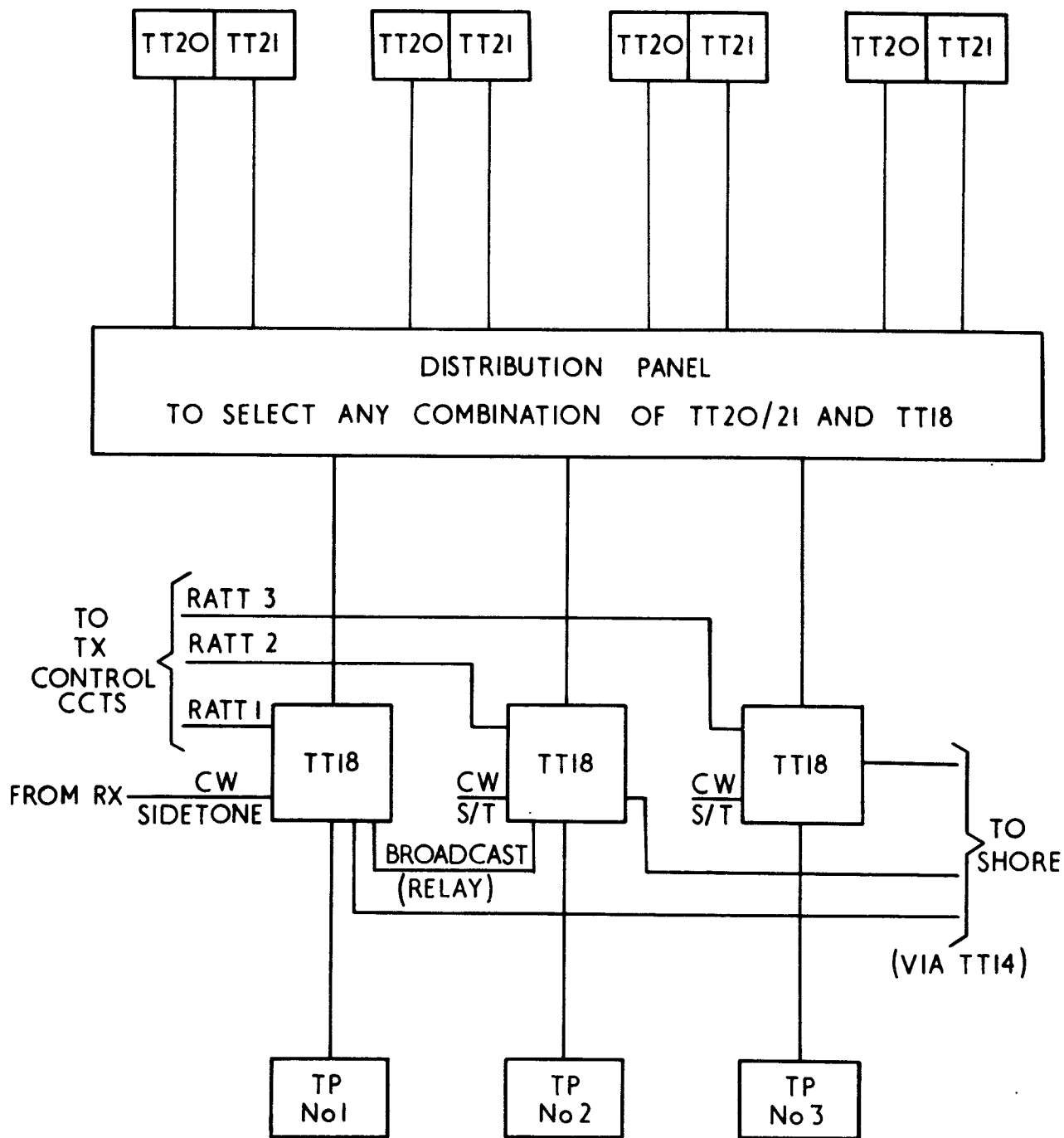
1.9.5 Mains On/Off (Switch SA)

This controls the mains supply to the TT18 and an AC supply socket for the teleprinter.

1.9.6 Tx Override Push-button (Switch SD)

This push-button allows the circuits to revert to 'Receive' at the end of a transmitting period without waiting for the 3 second delay.





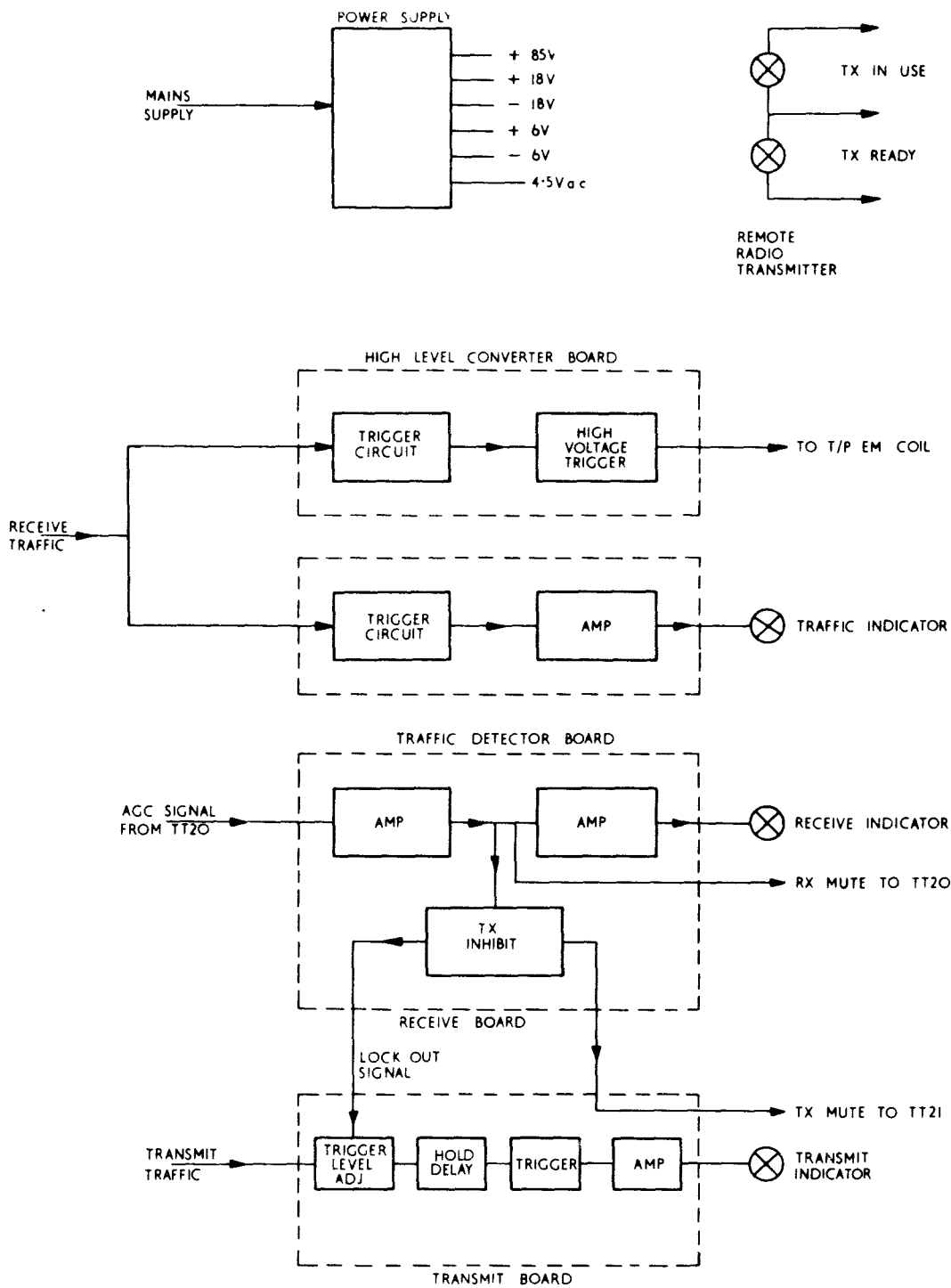


Fig 1-3

BLOCK DIAGRAM OF EQUIPMENT

2. INSTALLATION

2.1 INTRODUCTION

2.2 INSTALLATION INSTRUCTIONS

2.3 SETTING TO WORK

TABLE 2.1 POWER SUPPLY VOLTAGES

TABLE 2.2 SCHEDULE OF PLUG AND SOCKET CONNECTIONS

TABLE 2.3 SCHEDULE OF PLC CONNECTIONS

TABLE 2.4 LINK FUNCTIONS

FIGURES

2.1 TELEPRINTER MOUNT FIXING CENTRES

2.2 TELEPRINTER INTERNAL CONNECTIONS

2.3 REAR VIEWS OF EQUIPMENT

2.4 TOP AND UNDERSIDE VIEWS OF EQUIPMENT.

2.5 FRONT AND SIDE VIEWS OF EQUIPMENT.

2. INSTALLATION

2.1 INTRODUCTION

This chapter describes the siting and setting to work of the TT18 as part of an automatic switching VF Telegraph Terminal, in conjunction with a local teleprinter, a TT20 and TT21.

Equipments required for the tests in this chapter are:

- A multimeter (multirange volts-ohms-amps meter e.g. AVO meter Model 8).
- A general purpose oscilloscope, sensitivity 100 mV/cm, response DC to 100 kHz maximum.

2.2 INSTALLATION INSTRUCTIONS

2.2.1 Siting

- The choice of site for the TT18 is governed by the installation requirements for the associated teleprinter and/or auto-tape sender. Note. An equipment configuration may be employed which permits transmission either from a teleprinter or from an auto-tape sender.
- The TT18 with a teleprinter and the VF channelling equipment form an integrated and automatic telegraph terminal.
- The equipment should be sited in a clean, dry location away from sources of heat.
- Adequate operating space is necessary for efficient traffic handling.
- Sufficient clearance should be left at the rear of the teleprinter/TT18 assembly for easy access to connections, plugs and sockets.

2.2.2 Installing the Teleprinter Mount

Bolt the Mount in position using six $\frac{1}{4}$ inch bolts. Before passing the bolts through the slots in the feet of the shock mounts, place the six mount-clamps (provided separately) in position over the slots. This will locate the bolts and clamp the feet.

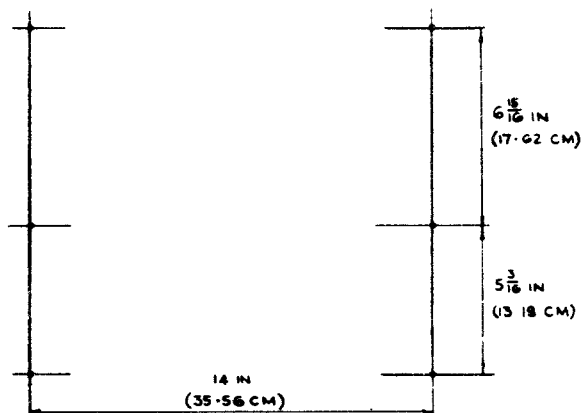


Fig. 2-1 Teleprinter Mount Fixing Centres

Dimensions between fixing hole centres are given in Fig. 2.1 (Below).

2.2.3 Connecting Equipment

- The cables, plugs and sockets may now be fitted. Sufficient slack should be left in the cables connecting the TT18 to allow it to be drawn forward in the mount with cables remaining connected. Cable to U.K. Defence Specification DEF. 10 Type 3C and 12C is recommended.
- Plug and Socket connections are shown in Table 2.2 at the end of this chapter, which also shows the functions of the wires. Table 2.3 lists the connections from plug PLC to the associated TT20 and TT21 equipments. The rear view of equipment with its plugs and sockets is shown in Fig. 2.3.
- If using the Creed type 75 teleprinter the internal connections to the Send/Receive and Mark/Space contacts must conform to Figure 2.2 (Below).

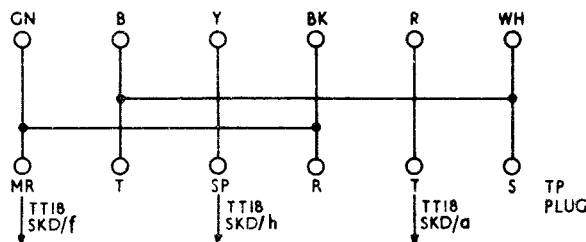


Fig. 2-2 Teleprinter Internal Connections

2.2.4 Securing the Teleprinter

Before securing the teleprinter, ensure that the spark quench unit is connected in parallel with the electro-magnet coil. In the Creed 75 teleprinter, this unit consists of a 330 ohm resistor in series with a 0.5 mfd capacitor.

2.3 SETTING TO WORK

2.3.1 Introduction

If the equipment is being set to work for the first time, the following actions should be carried out:—

- The taps on the mains transformer and mains voltage label must be set to conform with the local mains supply voltage.
- The power supply should be checked to ensure that it is delivering the correct voltage to the remainder of the equipment.
- The links should be set to conform to the installation requirements.
- The equipment should be operated briefly in conjunction with a TT20; a TT21; and a teleprinter; or whichever combination of equipment forms the installation.

2.3.2 Mains Transformer Taps and Links

Before installing the TT18, check that the mains taps on the power supply transformer are set to the local mains supply voltage. Proceed as follows:—

- (a) Remove the covers from the top and underside of the equipment.
- (b) Check that the correct fuses and indicator lamps are fitted.

For operation with 200–250V, FS1–2 are 250 mA. For operation with 100–125V, FS1–2 are 500 mA. FS3 and FS4 are selected to suit the teleprinter. (As the TT18 may be used with various teleprinter types, fuselinks FS3 and FS4 are not supplied with the TT18). Lamp types and values are shown in Chapter 6, Components.

- (c) Ensure that the taps of the mains transformers T_1 and T_2 are set to within 5V of the local mains supply voltage. To gain access to the taps, unscrew the four 4BA screws securing the rear panel of the unit. Draw the panel clear. Take care not to damage the internal wiring to the plugs and sockets. Remove the transformer terminal cover. Nominal voltage for the taps are indicated on the top-side of the transformers.
- (d) Adjust the 'turn over' voltage indicator label on the rear panel to show the appropriate voltage range.
- (e) Replace the rear panel and transformer terminal cover. Fig. 2.3 shows the rear of the equipment with the rear panel raised to gain access to transformer taps. The panel which shows tapping connections for each transformer can be sighted by the equipment top cover. The top view of the equipment is shown in Fig. 2.4.
- (f) During tests and adjustments, it may be necessary to alter some of the link connections. If so, it may be convenient to remove the link and make a temporary connection using short test leads with a crocodile clip at each end.
- (g) Set the links for the service required, referring to Table 2.4 for link functions. Fig. 2.4 (top) shows the physical position of the links. The connecting plugs and sockets appear at the top of the picture. The central single printed board labelled 'PB6' carries links LKD, LKE, LKF, LKA and LKB, reading from left to right around the lower edges of the printed board. LKC is located on the lower edge of PB4, the central of the three lower printed boards.

2.3.3 Power Supply Check

Before setting the TT18 to work, apply the correct mains supply leaving all plugs and sockets disconnected except for the mains supply. Set the mains switch SA 'ON', and check the power supply voltages to the rest of the equipment. These should be:—

Table 2.1 Power Supply Voltages (to chassis)

+18V	($\pm 0.25V$)	Pin 10 of PB1
–18V	($\pm 0.25V$)	Pin 9 of PB1
+6.8V	($\pm 0.4V$)	Pin 1 of PB2
–6.8V	($\pm 0.4V$)	Pin 4 of PB2
+85V	($\pm 15V$)	Pin b of LKD
4.5V AC	($\pm 0.25V$)	across Pins 17 and 18 of T2.

For these tests, use a multimeter (e.g. Avometer Model 8). To gain access to PB1 and PB2 (Power supply printed boards), remove the equipment. PB1 is located just above the equipment control panel. PB2 is the small printed board above and to the right of PB1.

With the mains switched 'on', check that:—

- (a) ILP1 'Mains' Indicator is on.
- (b) Set SE (Tx/AUTO/Rx) to Tx, check that 'Tx' indicator lights.

2.3.4 Circuit Checks

Switch off equipment. Remove the mains socket and install the equipment in the teleprinter mount. Set the links as detailed in Table 2.4. Replace the covers. Connect all plugs and sockets. Connect all ancillary equipments, e.g. TT20, TT21 teleprinter, morse key.

Do not connect the TT20 to the radio receiver line at this stage. The TT21 may be connected to the radio transmitter line. Ensure that the TT20 and TT21 have been checked, and are working properly in accordance with Section 2.3 'Overall Operational Tests' of the TT20/TT21 Handbooks.

(a) Receive Circuits Check

Set the FSK Test Set and TDMS keying into the TT20 (Section 2.2.3 of TT20 handbook). Set the TT18 controls as follows:—

SC — MORSE/RATT/BROADCAST to RATT.

SE — TX/AUTO/RX to AUTO.

SB — RADIO/SHORE to RADIO.

SF — TX/ON/OFF to TX OFF.

(See Fig. 2.5 for Front Panel layout).

Check that the teleprinter correctly prints at least two lines of a test message.

Check that the 'RX' indicator is lit.

Check that the 'Traffic' indicator is lit.

With the oscilloscope check that reversals are present at the RX test socket TS3 (TS2 common) on the front panel.

(b) E/M Coil Current Check

With the TT20 signal removed and with SC set to MORSE (this represents a continuous active signal), check the electromagnet coil current by connecting the Multimeter across TS4/5 (TS5 +ve). The 100 ohm resistor across TS4/5, with the multimeter set to the 10V DC range will give 100 mA f.s.d. Check

that the E.M current reading is within the limits specified for the teleprinter in use. If the current requires adjustment, adjust RV14 on the front right side of the equipment (see Fig. 2.5). Set SC to RATT.

(c) *Set Receiver Muting*

Connect the TT20 into a radio receiver circuit which has no signal on it (i.e. noise and interference only). With switch conditions as above, adjust the Rx MUTING Control very slowly in a clockwise direction until the teleprinter just stops chattering. The Rx Muting control is positioned at the front L.H. side of the equipment. See Fig. 2.5.

(d) *Transmit Circuits Check*

With conditions as above, send a test signal from the local teleprinter and check that:-

- (i) The TT21 is keyed (refer to TT21 front panel meter).
- (ii) The TRAFFIC indicator lights if LKF/a - c is connected.
- (iii) The Tx indicator is lit.

Check the level of keying signals at TS1 with the oscilloscope. When the test message is finished, immediately press the Tx OVERRIDE button at left (Fig. 2.5). The TT18 should revert instantly to the receive condition.

(e) *Radio Transmitter Check*

With conditions as above, set switch SF (Tx ON/OFF) to ON. Send a test message. Check that:-

- (i) The radio transmitter is transmitting the keying signal.
- (ii) All indicators (except Rx) are lit.
(NOTE. The Rx lamp will be lit if a local record is obtained round the loop.)

(f) *Morse sidetone check*

Plug a pair of headphones into JKA at right (Fig. 2.5). Check that keying signals can be heard from the radio receiver audio output circuit.

Finally: disconnect all test gear and test links; connect the correct links; and reconnect the equipment into the system ready for operation.

Table 2.2. Schedule of Plug and Socket Connections

<i>Plug/Socket Letter</i>	<i>No. of Pins</i>	<i>Function</i>	<i>Pin Connections</i>
PLA	3	A.C. (115/230V) Mains Input	(a) Line (b) Neutral (c) Earth
SKA	3	A.C. Mains Supply to Teleprinter	(a) Line (b) Neutral (c) Earth
SKB	3	Morse Key Connector	(a) Blank (b) Line (c) Chassis
JKA	2	Headphone Jack	Tip and Sleeve
PLB	12	To Radio Transmitter Control Circuits	(a) Lamp 'Busy' LB (b) Lamp Common LC (c) Lamp Ready LR (d) Common Line (e) Morse Switch Line (may be used to enable Tx) (f) Morse Key Line (g) Pressel Line (Press-to-talk) (h) External Keying Circuit (j) (k) (l) (m) spare

Table 2.2 Schedule of Plug and Socket Connections (Continued)

<i>Plug/Socket Letter</i>	<i>No. of Pins</i>	<i>Function</i>	<i>Pin Connections</i>
PLC	12	To TT21 From TT20	(a) RECEIVE line (+6-0-6V from TT20) (b) Chassis (c) Spare (d) TRANSMIT line (+6-0-6V) to TT21 (e) Chassis (f) SENSE KEYING line from TT21 (g) VF Transmitter muting line to TT21 (h) AGC line from TT20 (j) Muting line to TT20 (k) } CW sidetone input (l) } from radio receiver (m) Spare
SKD	12	To Teleprinter	(a) Line from T/P to VF transmit circuits (+6-0-6V) (b) Chassis (c) Spare (d) Line to T/P from VF receive circuits (6-0-6V) (e) Chassis (f) +6V to T/P contacts (g) E/M Coil (h) -6V to T/P contacts (j) E/M Coil (k) To Bell contact (l) To Bell contact (m) Spare
SKE	12	To Shore Line and Broadcast Circuits	(a) Line to T/P from SHORE VF receive circuit (+6-0-6V) (b) Common (c) Spare (d) Line from T/P to SHORE VF transmit circuits (+6-0-6V) (e) Common (f) Transmit line from BROADCAST circuit to TT21 (+6-0-6V) (g) Common (h) Receive line to BROADCAST circuit from TT20 (j) Common (k) (l) (m) Spare

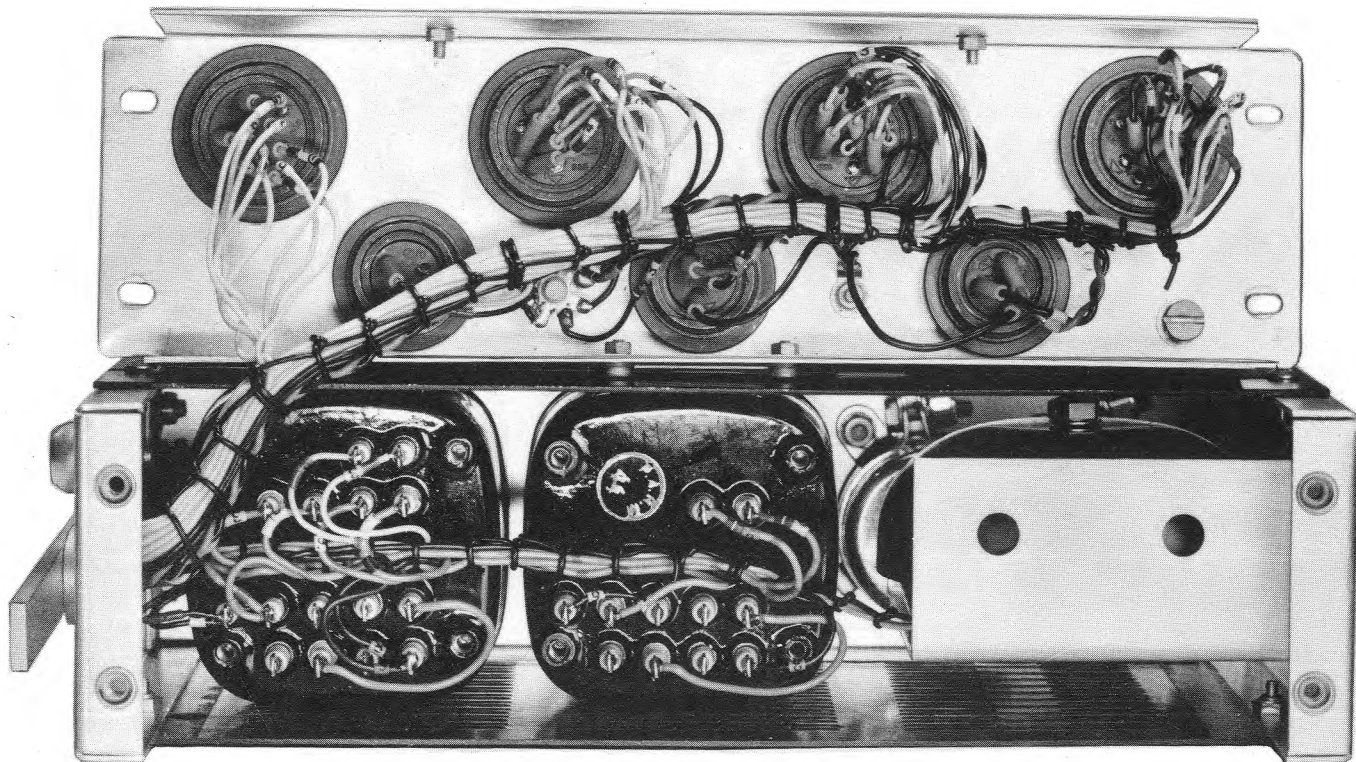
Table 2.3 Schedule of PLC Connections

<i>Pin Letter</i>	<i>Function of Line</i>	<i>Equipment Connections</i>
a	RECEIVE line (+6-0-6V) from TT20	Connect to SKTA pin 7 in TT20
b	Chassis	Connect to SKTA pin 8 in TT20 (Chassis)
c	Spare	
d	TRANSMIT line (+6-0-6V) to TT21	Connect to SKTA pin 7 in TT21
e	Chassis	Connect to SKTA pin 8 in TT21 (Chassis)
f	SENSE KEYING line from TT21	Connect to SKTA pin 1 in TT21. Ensure Linkboard LKE in TT21 connections correct.
g	TRANSMITTER MUTING line to TT21	Connect to TT20 SKTA pin 13. Ensure Linkboard LKA in TT20 connections correct.
j	MUTING line to TT20	Connect to TT20 SKTA pin 1. Ensure Linkboard LKA in TT20 connections correct.
k	CW sidetone from Radio Receiver	Connect to Radio Receiver Audio Line.
l	CW sidetone from Radio Receiver	Connect to Radio Receiver Audio Line.
m	Spare	

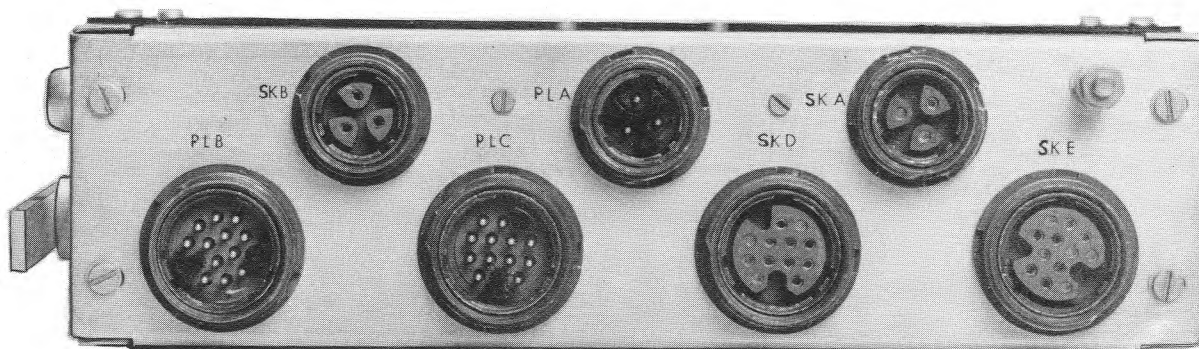
Table 2.4 Link Functions

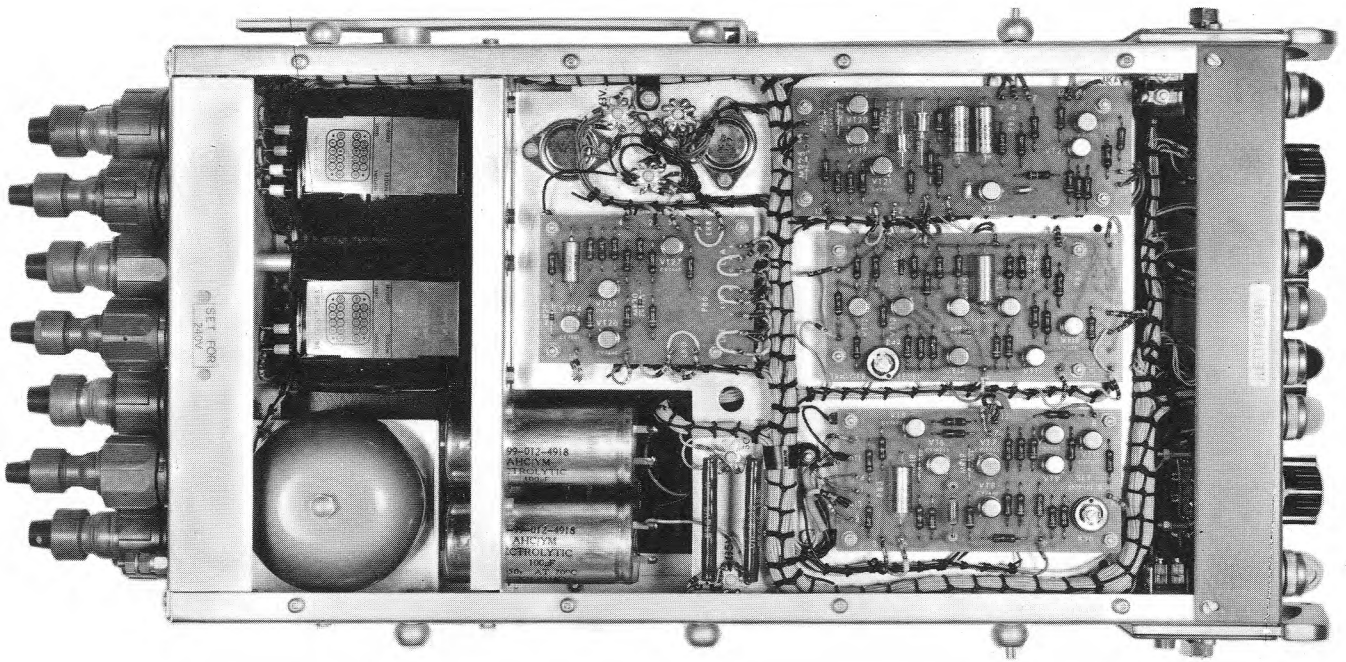
- LKA** *Join a to c for tone keying. The Morse key line PLB(f) is connected to common when the radio transmitter is keyed.
Join a to b when direct keying of the radio transmitter is required in which case the external morse key circuit is routed to PLB(h)*
- LKB** *Morse Keying Function, Pressel Line Selector
Join a to b to connect the pressel line to common when using tone keying.*
- LKC** *Morse Keying Function, TT21 Muting Selector
This is used to select Muting when using Morse.
Join a to c if tone keying is being used.
Join a to b if direct keying is being used, in which case the TT21 is muted continuously when SC (Morse/RATT/Broadcast Selector) is turned to position 1 (Morse).*
- LKD** *High Level Converter Selector
LKE routes the +6-0-6 receive signal into the high level converter PB3.
LKD connects the +85V supply to the output transistors.
Both LKD and LKE must be connected (a to b in both cases) if the high level converter is to be used.*
- LKF** *Local Record Selector
The local receive teleprinter line, the BROADCAST receive line (SKE Pin H) and the traffic indicator may be operated in three ways:-
A—RLC not operated when transmitting. The Receive teleprinter line, the BROADCAST receive line and the traffic indicator are connected to the receive line from the TT20.
B—RLC operated when transmitting. The traffic indicator and local teleprinter (connected to SKD) in position 2 (RATT) of function switch gets the transmitted keying on the receive line. With the function switch in position 3 (BROADCAST) the local teleprinter is inhibited and the broadcast line and traffic indicator get the transmitted signal.
C—RLC Not operated on RATT (A) but operated on BROADCAST (B) above.
Leave all connections of LKF open for A
Join a to c for B above
Join a to b for C above*





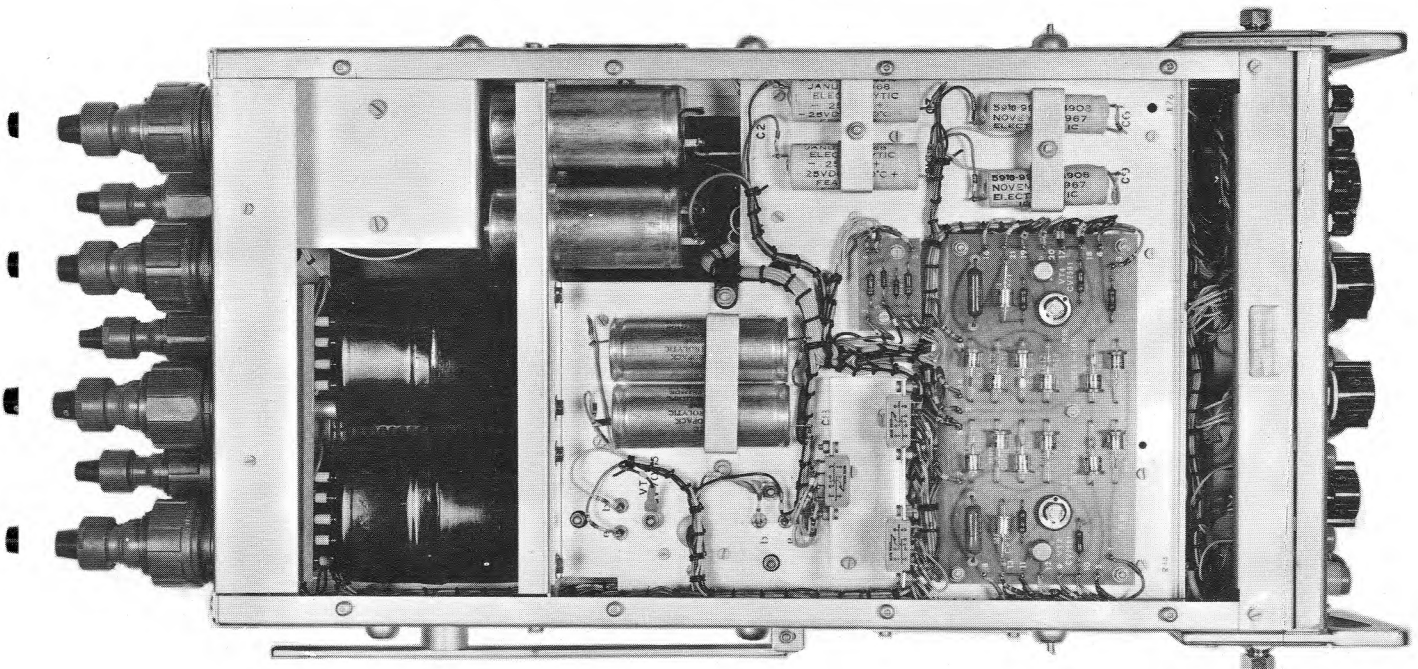
Panel Raised

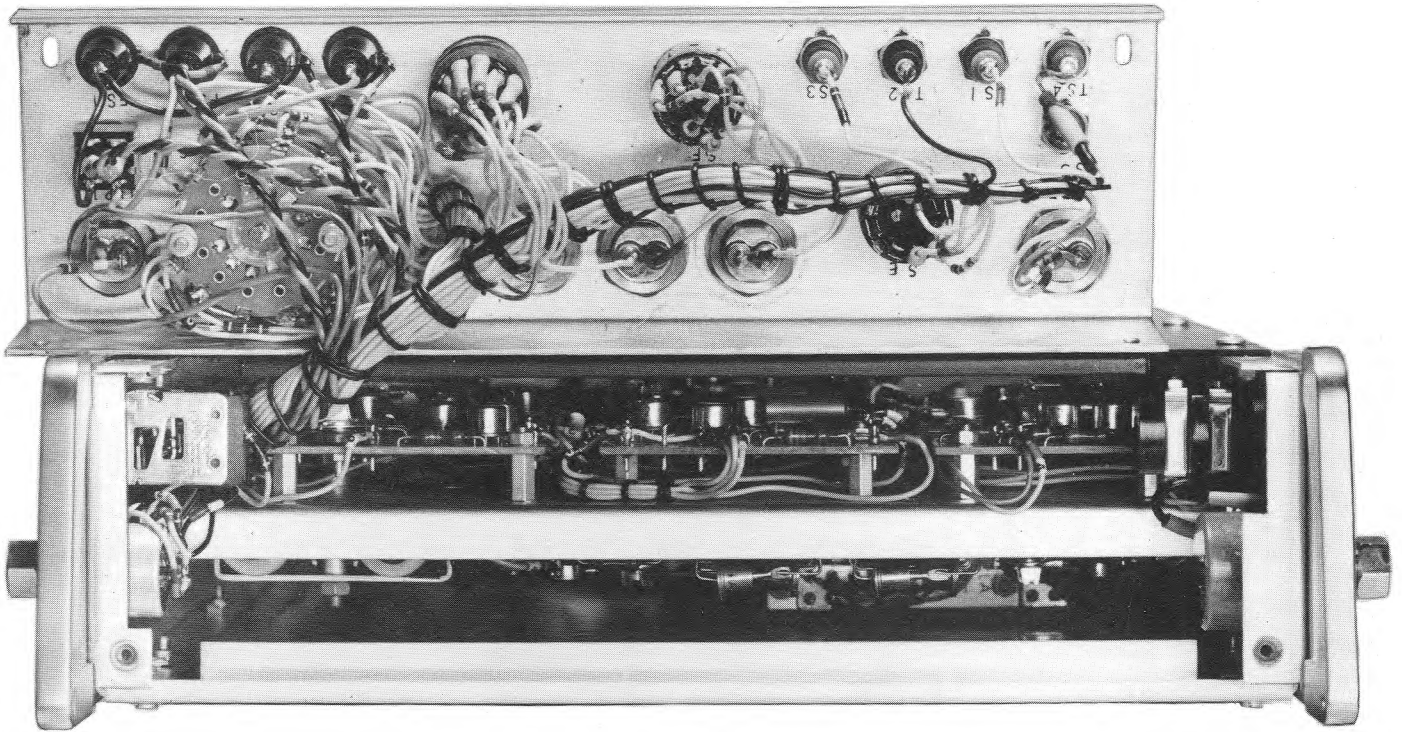




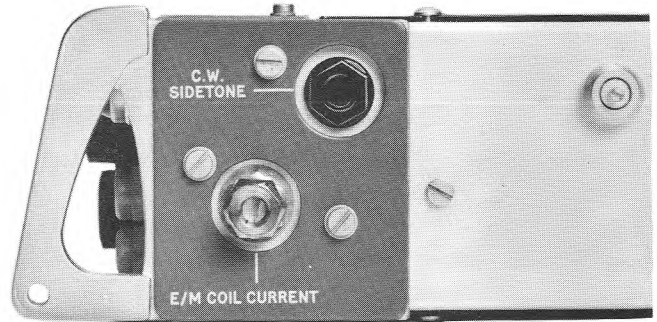
Top

Underside





Left-hand Side



Right-hand Side



3. OPERATION

3.1 DESCRIPTION OF FRONT PANEL CONTROLS

3.2 OPERATION OF EQUIPMENT

3. OPERATION

3.1 DESCRIPTION OF FRONT PANEL CONTROLS AND FACILITIES

Fig. 2.5 shows the front panel layout. The controls and indicators carry out the following functions:—

- (a) **Switch SA—MAINS SWITCH**
Applies mains to the TT18 and the local teleprinter.
- (b) **Switch SB—RADIO/SHORE**
In *SHORE* position selects separate Shore transmit and receive lines which are connected to the local teleprinter. In *RADIO* position, disconnects the Shore line and switches the local teleprinter to main equipment.
Note: When switched to *SHORE*, the main equipment and associated TT20/21 will still operate via the *BROADCAST* and *MORSE* positions of SC except that no local record would be available.
- (c) **Switch SC—MORSE/RATT/BROADCAST**
In the *MORSE* position, selects the Morse keying and control circuits. Morse operation may be either Tone keying via the TT21, or direct keying of the transmitter.
In the *RATT* position, the local teleprinter is switched through to the TT20, TT21 and TT18 control circuits. This is the normal operating position.
In the *BROADCAST* position the local teleprinter TX contacts are disconnected. The transmit, receive and traffic indicator lines are switched through to the Broadcast circuits.
- (d) **Switch SD—TX OVERRIDE PUSH-BUTTON**
Pressing this button at the end of a transmitted message will eliminate the 3-second delay, and cause the circuit to revert instantly to the receive condition.
- (e) **Switch SE—TX/AUTO/RX**
In the *AUTO* position automatic changeover between TX and RX is provided. 3 seconds after the end of a transmission the TT21 transmitter output is inhibited and the RX circuit of the TT18 will detect any signal above the muting threshold level. If a signal is received the TT21 remains inhibited. If a transmission takes place when no signal is being received the TT21 transmitter is activated. In the *TX* position the equipment remains in the transmit condition irrespective of the keying condition. If the equipment is switched to TX when the transmitter is inhibited by receive traffic the equipment will not switch to the TX state until the receive signal ends. The *TX* position may be used for testing the TT21 or radio transmitter.

- (f) **Switch SF—TX ON/TX OFF**
In the *OFF* position, the pressel, morse key, and morse key switch line are inhibited, preventing operation of the radio transmitter. This position is used for testing any terminal equipment in the transmitting mode without enabling the RF transmitter. In the *ON* position, the RF transmitter is energised. This is the normal operating condition.
- (g) **Indicator MAINS**
Shows when mains supply is applied to the power unit in the TT18.
- (h) **Indicator TRAFFIC**
The *TRAFFIC* lamp is on whenever either a signal is being received via the Terminal Telegraph Receiver or a local record is being obtained from the TX line. On shore operation, as the signal is fed directly to the shore output lines the *TRAFFIC* lamp is not in operation.
- (i) **Indicator TX READY**
Shows when the RF TX is switched on and is connected into circuit.
- (j) **Indicator TX IN USE**
Shows when the RF TX is in use.
- (k) **Indicator TX**
Shows when the TT18 is switched to the transmit mode and the VF TX is activated.
- (l) **Indicator RX**
Shows when the TT18 is switched to the receive mode and the VF RX is activated.
Additional items on the Front Panel are:—
 - Mains fuses (2).
 - Teleprinter mains fuses (2).
 - Electromagnet coil current monitor (See Chapter 2 for Setting Up) (2 sockets, TS4 TS5).
 - Receive and Transmit keying test points (TS3, TS1 with TS2 (black) common).

3.2 Operation of Equipment

Once the links (see 2.3.2) have been set and the equipment 'set to work' correctly, no further attention by the operator should be necessary. However, frequent checks should be made of the passage of traffic (ILP4), and the operation of the other indicators.



4. CIRCUIT DESCRIPTION

- 4.1 POWER SUPPLIES**
- 4.2 HIGH LEVEL CONVERTER**
- 4.3 TRAFFIC INDICATOR**
- 4.4 RECEIVER SUB-SECTION
TABLE 4-1 TRUTH TABLE**
- 4.5 TRANSMITTER SUB-SECTION**
- 4.6 ADDITIONAL CIRCUITS**

4. CIRCUIT DESCRIPTION

This chapter describes the operation of the various circuits within the equipment. Reference should be made to Chapter 7, Circuit Diagram.

4.1 POWER SUPPLIES

- (a) Three main power supplies are required by the TT18:—
 1. +85V for operating the high level converter.
 2. +18V for the remaining circuits.
 3. -18V for the remaining circuits.Three additional supplies are provided:—
 4. 4.5V a.c. for operating the bell.
 5. +6V low current supply for bias circuits.
 6. -6V low current supply for bias circuits.
- (b) The +85V supply is derived from a mains transformer (T1) and a bridge rectifier (MR1-4). The capacitors C1 and C2 (100 mfd) provide smoothing, with R1 (22 ohms).
- (c) The remaining supplies are derived from the second mains transformer T2. One secondary supplies the bridge rectifier assembly MR5-8. C5 (500 mfd) is the main smoothing capacitor. The resistor R3 (47 ohms) acts as a source resistor for the shunt regulator circuit VT1, VT2, C7 (250 mfd) is the final smoothing capacitor.
- (d) In operation the voltage across C7 is applied to the base of VT2 via the attenuator R4, R5 (set +18V) R6 and MR9, the latter a zener diode.
- (e) VT2 is an emitter follower, which drives the base of VT1. If the 18V tends to drop, then VT2 base volts and hence VT1 base volts will drop. This will cause VT1 to take less current and this acts to oppose changes of voltage on the +18V line. An additional capacitor C6 (100 mfd) reduces ripple on the circuit by making use of VT1's gain.
- (f) The negative 18 volt line contains an identical rectifier and regulator circuit, except for the value of R8 (100 ohms).
- (g) The 6 volt bias lines are derived from a separate printed board (PB2), which carries two zener diodes MR15, MR16 and their associated voltage dropping resistors.

4.2 HIGH LEVEL CONVERTER

- (a) The High Level Converter board PB3 accepts input signals on the Receive line to the teleprinter at the nominal 6-0-6V level and converts these signals to the current pulses necessary to operate the electromagnet of the teleprinter.
- (b) The input signal passes via link LKE to the base of VT11, which operates as an emitter follower. The base input circuit of VT11 includes the potentiometer RV36. This is used to set the High Level converter input impedance.
- (c) The emitter output of VT11 is directly coupled to the base of VT10, which operates as a trigger circuit in conjunction with VT9. The collectors of these two

transistors are cross coupled via R28, R32. Each drives the base of the opposite transistor, so that when one is turned 'hard on', the other transistor will be biased off.

- (d) The collector of VT10 is directly connected to emitter follower VT8. This stage is directly connected to the base of VT7, which is one half of the high level converter amplifier. VT7 together with VT6 form a long-tailed pair trigger circuit. The feedback is taken from the collector of VT7 to the base of VT6 via the directly connected emitter follower VT5. As in para 4.2(c), the alteration of VT7 base potential will cause one transistor of the pair to switch from 'hard on' to 'biased off'.
- (e) VT6/7 collector circuit is returned to the +85V line, and the transistors drive the teleprinter electromagnet via RV14 which sets the magnet operating current. R19 and R21 (100 ohm each) fix the maximum coil current available. TS4 and 5 across R19 allow the magnet current to be monitored.
- (f) Diodes MR18/19, R22, R23 and C11 form a suppression circuit to limit voltage spikes when the electromagnet is being operated. The cathodes of the diodes MR18/19 are held at approximately +70V. The collector of each transistor is clamped at this potential when the Transistor is switched off.

4.3 TRAFFIC INDICATOR

- (a) The Traffic Indicator circuit on printed board PB6, accepts negative-going 6 volt traffic signals at pin 1. These traffic signals are indicated when the equipment is in the receiving mode. The input signal is applied through diode MR29, R89 to the base of VT24. VT24 forms one half of a long-tailed pair circuit, and is normally held non-conducting by the voltage drop developed across the common emitter resistor R91 by VT25.
- (b) VT25 operating characteristics are set by the base bias resistors R93 and R94. VT26 is an n-p-n transistor which forms a trigger circuit with VT24 and VT25, VT26 and VT25 are being held conducting in the non-traffic condition. On receipt of a negative going traffic signal, VT24 conducts causing VT25 to start to turn off. The change of collector voltage of VT25 causes VT26 to turn off, and the increase in VT26 collector voltage, coupled to VT25 base via R95 and MR30 causes VT25 to become turned 'hard off'. This change in collector potential of VT26 is connected directly to amplifier VT27. This operates as a common emitter amplifier and drives the traffic indicator light ILP4 in its collector circuit.

4.4 RECEIVER SUB-SECTION

- (a) The receiver sub-section printed circuit board in the TT18 (PB5) accepts the AGC line input from the

TT20 VF telegraph receiver terminal at pin 5. It uses this signal:—

1. to control the transmit board via the 'inhibit Tx' line, pin 3 on the receiver board;
 2. to generate a muting signal to inhibit the TT20 output in the absence of received signals; and
 3. to operate a 'Rx' lamp when signals are received by the TT20.
- (b) The AGC signal at pin 5 on the receive printed board is at chassis potential with no signals at the TT20, and moves positively when a telegraph signal is received by the TT20. This DC signal is smoothed by C13, R75 and C14, before being applied to one input of an integrated circuit amplifier VX1. This DC amplifier has overall feedback applied by R79, C15 and C16 being used to achieve stable operation (non inverting).
- (c) The preset control, 'Rx muting', R76 is used to set the operating level of the amplifier. The output potential, pin 6 of VX1 is normally negative which causes the p-n-p amplifier VT22 to be turned hard on. In the quiescent state, the junction of R81, R82 in the collector circuit of VT22 is thus positive. This positive potential:—
1. Passes to the TT20 via pin 13 and SC(d) to mute the TT20 VF telegraph receiver terminal output (See Chapter 4.0 of TT20 handbook).
 2. Maintains VT23 in the cut-off state. Note that VT23 is a p-n-p transistor. The 'Rx' indicator lamp in VT23 collector circuit is extinguished.
 3. Applies a positive bias to the base of VT19, turning VT19 hard on (saturated), with its collector at a low potential.
- (d) On receipt of a positive-going AGC signal (see TT20

handbook Chapter 4.0), the transistor VT22 is turned off and its collector falls to chassis potential. This turns on VT23, causing the 'Rx lamp' to light, and the positive muting voltage disappears from the 'Rx Muting line' at pin 13 (and connections 2 and 3 on SC(d)). This output voltage is now slightly negative and activates the output circuit of the TT20 telegraph receiver terminal

- (e) In the quiescent condition with no incoming signal to the TT20, VT19 base is at a slight positive potential as mentioned above and the transistor is saturated with its collector almost at chassis potential.
- (f) Similarly, the companion transistor VT20 is off, by virtue of its low base potential. Again, in the quiescent or no-signal state on both transmit and receive paths, a positive voltage appears on pin 4, causing VT21 to be turned 'hard on', its collector settling at a low potential. With VT19 on and VT20 off, their combined collector potential will be approx. 0.75V, which back biases the diode MR25 in the 'Tx Inhibit' line (pin 3).
- (g) On receipt of a negative signal on the muting line VT19 is turned off and the combined collector voltage of VT19 and 20 rises and MR25 is forward biased. This inhibits the operation of the transmit circuit (see Section 4.5 below).
- (h) As for the muting signal, a 'transmit signal' is derived from the transmit printed circuit board, via pin 4 on the receive board. This signal is positive with no transmit signal and is slightly negative when transmitting. VT21 is an inverting amplifier causing VT20 to be cut off when there is no transmit signal and saturated when transmitting. Thus the potential of the combined collectors of VT19/20 will follow table 4-1 below, depending on signalling conditions:—

Table 4.1 Truth Table

<i>Condition</i>	<i>VT19/20 Collector</i>	<i>Effect</i>
Quiescent	Low	Both transmitter and receiver can operate. Receiver muted.
Receiving	High	Transmitter inhibited.
Transmitting	Low	Receiver muted.
Transmitting with received signal available.	Low	Receiver operating.

4.5 TRANSMITTER SUB-SECTION

- (a) The transmitter sub-section printed circuit board in the TT18 (PB4) accepts the control signals from the receive sub-section board and keying signals from the TT21 input circuit. It uses these signals to:—
1. Operate relay circuits, which energise the transmitter.
 2. Activate the TT21.
 3. Operate a 'Tx' lamp (ILP2) to indicate the passage of traffic.
- (b) The first stage is a p-n-p direct coupled emitter follower VT12. The input signal at pin 1 is selected by SE and is either the keying signal from the TT21, or positive or negative 6.0V. The latter voltages are used for system testing and represent the receive and send conditions respectively. The exact current from the emitter follower is set by R43 'Set Trigger Level'. R43 is used to adjust the trigger levels to be equally spaced about OV.
- (c) The second stage, VT13, has its emitter voltage fixed by R48 and zener diode MR20. When there is a negative input to pin 1 on board PB4, VT13 is biased off and the collector potential is at the positive supply voltage. When the input to pin 1 is positive the base voltage on VT13 becomes positive with respect to the emitter voltage and the collector voltage drops close to the emitter voltage, as set by MR20. However, if an inhibit signal is applied from the Rx board to the base of VT13 due to a 'Receiving, Transmitter Inhibited' condition, then VT13 is biased hard on regardless of any subsequent input condition to the transmit board.
- (d) VT14 is an emitter follower which supplies a low impedance charging path for the time delay circuit R51/C12. Diode MR21 is forward biased when C12 is charging and reverse biased when C12 is discharging, thus allowing a rapid charge and slow discharge rate.
- VT15, 16 and 17 constitute a trigger circuit. When the voltage on VT15 base becomes more positive than voltage on VT6 base set by R54 and R55, the emitter

voltage rises, VT16 starts to turn off and the collector voltage rises. VT17 starts to turn off and its collector voltage drops, MR22 becomes forward biased and hence VT16 base voltage is reduced, turning VT16 further off. This action ends with VT15 on, and VT16 and VT17 off. The output voltage at VT17 collector is near OV for negative inputs to PB4 and at +18V for positive inputs. This collector voltage is used to mute or activate the Transmitter Terminal Telegraph. The +18V output mutes the Transmitter.

- (e) VT17 collector potential also controls the voltage to one input of the Tx inhibit circuit so that in the Tx condition a slightly negative voltage appears at pin 7. This has the effect of locking the Tx inhibit circuit to allow transmission to continue whether or not received signals are present.
- (f) The VT17 collector is directly connected to the base of VT18, an emitter follower, which operates the transmitter control relays and the 'Tx' indicator lamp ILP2. The positive voltage at VT17 collector is also used to mute the output of the TT21, joining (a) and (b) on LKC, and selecting SC position 1 will cause the transmitter (and receiver via switch SC(d)) to be muted.
- (g) VT18 current causes RLA, RLC (if selected by the link board LKF and SCh) and the lamp ILP2 to operate.

4.6 ADDITIONAL CIRCUITS

- (a) Additional switch and indicator circuits are provided in the TT18 to allow control and indication of the radio transmitter. ILP5 and ILP6 are the radio transmitter 'IN USE' and 'READY' indicator lamps, the operating voltage (24V) being derived from the radio transmitter control circuits.
- (b) The switch SC select the Morse keying function which may be preset for either external tone or CW keying. In the OFF position the Tx ON/OFF switch SF breaks the pressel, morse switch and morse key lines.



5. MAINTENANCE AND REPAIR

- 5.1 ROUTINE MAINTENANCE**
- 5.2 EQUIPMENT REQUIRED FOR TESTS**
- 5.3 PRELIMINARY SETTING AND POWER SUPPLY CHECK**
- 5.4 HIGH LEVEL CONVERTER**
- 5.5 RECEIVE CIRCUIT**
- 5.6 TRANSMIT CIRCUIT**
- 5.7 TRANSMIT INHIBIT CIRCUIT**
- 5.8 TRAFFIC CIRCUIT**
- 5.9 BELL**
- 5.10 TRANSMITTER CONTROL CIRCUITS**
- 5.11 RECEIVE AND TRANSMIT LINES**
- 5.12 CONTINUITY CHECKS**
- 5.13 FINAL PROCEDURE**

FIGURES

- FIG. 5.1 POWER SUPPLY BOARD PB1 COMPONENT LAYOUT**
- FIG. 5.2 POWER SUPPLY BOARD PB2 COMPONENT LAYOUT**
- FIG. 5.3 HIGH LEVEL CONVERTER BOARD PB3 COMPONENT LAYOUT**
- FIG. 5.4 RECEIVER BOARD PB5 COMPONENT LAYOUT**
- FIG. 5.5 TRANSMITTER BOARD PB4 COMPONENT LAYOUT**
- FIG. 5.6 TRAFFIC INDICATOR BOARD PB6 COMPONENT LAYOUT**

5. MAINTENANCE AND REPAIR

5.1 ROUTINE MAINTENANCE

The TT18 should be checked weekly to ensure that all lamps and facilities function correctly. The equipment should not be unplugged or covers removed if it is functioning normally. Should a fault develop, the symptoms should be noted and an attempt made to deduce which part of the circuit, or which printed board is at fault. The following sequence gives check tests for each main facility. In the event of a fault, the appropriate test may be selected from 5.4-5.12 to locate the fault.

5.2 EQUIPMENT REQUIRED FOR TESTS

- (a) Multimeter, e.g. AVO 8 (2 required).
- (b) Potentiometer 2.5 kohm Lin, e.g. Colvern type 1106.
- (c) Resistor, 100 ohm 0.5W $\pm 2\%$ e.g. Electrosil TR5.
- (d) Resistor 10 kohm 0.5W $\pm 2\%$ e.g. Electrosil TR5.
- (e) Stop-watch
- (f) Mains cable fitted with 3-way brass socket Pattern 104 or Mk. 4, orientation 0.
- (g) Free plugs and sockets, Brass Pattern 104 or MK4.
 - PLB: 12-way socket orientation 1
 - PLC: 12-way socket orientation 0
 - SKD: 12-way plug orientation 0
 - SKE: 12-way plug orientation 1

Refer to Figure 7.1 for the circuit of all printed board assemblies.

5.3 PRELIMINARY SETTING AND POWER SUPPLY CHECK

- (a) Fit fuses and pilot lamps.

Note Pilot lamps are 18V for: TRAFFIC; TX; and RX, and 28V for: MAINS; TX READY; and TX in USE.
- (b) Connect links as follows:-

LKA: a-c	LKD: a-b
LKB: a-b	LKE: a-b
LKC: a-c	LKF: No link
- (c) Check that T1 and T2 are correctly connected for operation on the mains supply, and that the mains voltage label has been adjusted to show the corresponding voltage. See Chapter 2.0 for method of gaining access to transformer taps.
- (d) Connect mains cable to PLA and free connectors to PLB, PLC, SKD, SKE. Connect a 10 kohm resistor across PLC/G to B.
- (e) Set switches as follows:-

SA: ON	SC: RATT
SB: RADIO	SE: AUTO
SF: TX OFF	

- (f) Set R36 fully anti-clockwise, and lock.
- (g) Set supply voltages.

By means of R5 on PB1, adjust the voltage at the + 18V common tag with respect to chassis, to + 18V $\pm 0.1V$.

By means of R10 on PB1, adjust the voltage at the - 18V common tag with respect to chassis to - 18V $\pm 0.1V$.

Record voltage at SKD/f. LIMIT: + 6.8 \pm 0.4V.

Record voltage at SKD/h. LIMIT: - 6.8 \pm 0.4V.

Record voltage at LKD. LIMIT: + 85 to + 105.

See Fig. 5.1 for Power Supply Board Layout PB1, and Fig. 5.2 for the 6.0V regulator section of the power supply circuit.

5.4 HIGH LEVEL CONVERTER

See Fig. 5.3 for High Level Converter Board Layout PB3.

- (a) Connect a 2.5k potentiometer across SKD/f to h, and connect wiper to SKD/d.

Connect 100 ohm resistor in series with multimeter (set to 100 mA d.c. range) across SKD/j to g.
- (b) Trigger Levels. Record the input at SKD/d required to change the direction of the current in the 100 ohm load. LIMIT + 2 \pm 1V and - 2 \pm 1V.
- (c) Set R14 fully clockwise. Record output current. LIMIT: must be greater than 45 mA.
- (d) Set R14 fully anti-clockwise. Record output current. LIMIT: must be less than 20 mA.
- (e) Adjust input to reverse output current and record output current. LIMIT: must be less than 20 mA.
- (f) Set R14 fully clockwise and record output current. LIMIT: must be greater than 45 mA.
- (g) Adjust R14 to give output current of 45 mA and lock R14.
- (h) Measure voltage across TS.4 to TS.5 (E/M COIL) on the front panel. LIMIT: 4.5 \pm 0.3V.

5.5 RECEIVE CIRCUIT

See Fig. 5.4 for Receive Board Layout PB5.

- (a) Set R76 fully anti-clockwise and disconnect 2.5k potentiometer wiper from SKD/d and connect to PLC/h.

Set input at PLC/h to about -1V
- (b) Slowly increase input volts (positively), and record the input voltage required to turn the RX circuit on. This is indicated by the RX lamp coming on. LIMIT: 0 to + 0.3V.
- (c) Record the output voltage at PLC/j LIMIT: - 0.8 \pm 0.2V.

- (d) Switch SC to B'CAST. Check that the output is unchanged. Switch SC to MORSE. Record the output voltage. LIMIT: $+ 6.8V \pm 0.4V$.
- (e) Switch SC to RATT. Switch SB to SHORE. Record the output voltage at PLC j. LIMIT: $+ 6.8V \pm 0.4V$. Switch SB to RADIO.
- (f) Slowly decrease input volts and record the input voltage required to turn the RX circuit off. This is indicated by the RX lamp going off. LIMIT: $0 \pm 0.2V$.
- (g) Record the output voltage at PLC j. LIMIT: $+ 6.5 \pm 0.5V$.
- (h) Set input to $- 1.0V$. Adjust R76 slowly clockwise until the RX lamp goes off. Lock R76 in this position.

5.6 TRANSMIT CIRCUIT

See Fig. 5.5 for Transmit Board Layout.

- (a) Disconnect 2.5k potentiometer wiper from PLC/h and connect to PLC/f. Set R43 on PB4 to approximately mid-position.

- (b) Trigger Levels.

Note When measuring or adjusting trigger levels on the TX circuit, keep the TX Override button at the left-hand side of the unit depressed. This is to avoid confusion arising from the time delay in this circuit. The input signal level must be changed slowly.

Note the input levels required to switch the TX circuit on and off, as indicated by the voltage change at PLC/g. Adjust R43 until the trigger levels are equally spaced about 0V. Lock R43. Record the trigger levels as finally set. LIMIT: $+ 2V \pm 1V$, $- 2V \pm 1V$.

- (c) Switch SE to RX. Record the output at PLC g. LIMIT: $+ 18 \pm 0.5V$. Check TX lamp is off.
- (d) Switch SC to MORSE and to B'CAST. Check that the output at PLC g does not change from the figure obtained in Paragraph (c).
- (e) Disconnect LKC a-c and link LKÇ a-b. Check that the output at PLC g is as in Paragraph (c) for SC at RATT and B'CAST. Record the output at PLC/g with SC at MORSE. LIMIT: 0 to $+ 0.5V$.
- (f) Switch SE to TX and SC to RATT. Record the output at PLC/g. LIMIT: $- 0.5$ to $+ 0.5V$. Check that the TX lamp is on.
- (g) Time Delay. Starting with SE at TX, switch to RX. Check the time delay between switching to RX and the time the TX lamp goes off. LIMIT: 3 - 1 sec.
- (h) Starting with SE at TX, switch to RX and immediately press push-button SD, TX Override. Check that the TX lamp goes off immediately on closing SD without the delay measured in Paragraph (g).

5.7 TRANSMIT INHIBIT CIRCUIT

Disconnect 2.5k potentiometer wiper from PLC/f and switch SE to RX. Link SKD/h to PLC/h, switch SE to AUTO and check that the RX lamp is on and the TX lamp is off. Link SKD h to PLC/f and check that the RX lamp is on and the TX lamp is off. Remove the input from PLC h and check that the RX lamp is off and the TX lamp is on. Re-connect the input to PLC/h and check that the RX lamp is on and the TX lamp is also on.

5.8 TRAFFIC CIRCUIT

For layout of traffic indicator board see Fig. 5.6. Remove the connection between SKD/h to PLC/f and between SKD f to PLC h. Link SKD/h to PLC/a and check that the TRAFFIC lamp is ON. Remove the input from PLC a and check that the TRAFFIC lamp is OFF.

5.9 BELL

Link SKD k to l and check that the bell rings. Remove link SKD k to l.

5.10 TRANSMITTER CONTROL CIRCUITS

- (a) Connect PLB b to chassis. Apply $+ 18V$ to PLB/a and check that the TX IN USE lamp is on. Apply $+ 18V$ to PLB/c and check that the TX READY lamp is on.
- (b) Switch SC to MORSE and switch SE to TX, SF to TX OFF. Check PLB/e to d: open circuit. Check PLB/f to d: open circuit. Check PLB/g to d: open circuit.
- (c) Switch SF to TX ON. Check PLB/e to d: continuity; check PLB f to d: continuity; check PLB/g to d: continuity.
- (d) Disconnect LKA/a-c and link LKA/a-b. Check PLB f to h: open circuit. Link SKB/b to c. Check PLB f to h: continuity. Check PLB/f to d: open circuit. Disconnect SKB/b to c.
- (e) Disconnect LKB a-b. Check PLB/g to d: open circuit. Switch SC to RATT. Check PLB/f to d: continuity. Check PLB g to d: continuity. Switch SC to B'CAST. Check PLB/f to d: continuity. Check PLB g to d: continuity.
- (f) Switch SE to RX. Check PLB/f to d: open circuit. Check PLB g to d: open circuit.

5.11 RECEIVE AND TRANSMIT LINES

- (a) Switch SC to MORSE and switch SE to TX. Connect SKD/h to PLC a and to SKD/a. Check output at SKD/d is $+ 6.8 \pm 0.4V$. Check for no output at SKE/h. Check output at PLC/d is $+ 6.8 \pm 0.4 V$. Check for no output at SKE/d. Check output at TS3 (RX) is $+ 6.8 \pm 0.4V$. Check output at TS1 (TX) is $- 6.8 \pm 0.4V$.

- (b) Connect SKB/b to c. Check output at PLC/d is $-6.8 \pm 0.4V$. Disconnect SKB/b to c.
- (c) Switch SC to RATT. Check output at PLC/d is $-6.8 \pm 0.4V$. Check output at SKD/d is $-6.8 \pm 0.4V$. Check for no output at SKE/h.
- (d) Switch SC to B'CAST. Check output at SKE/h is $-6.8 \pm 0.5V$. Check output at SKD/d is $-6.8 \pm 0.5V$. Check for no output at PLC/d.
- (e) Connect SKD/h to SKE/f. Check output at PLC/d is $-6.8 \pm 0.5V$.
- (f) Disconnect SKD/h to PLC/a. Link LKF/a to b. Check output at SKD/d is $+6.8 \pm 0.5V$. Check output at SKE/h is $-6.8 \pm 0.5V$.
- (g) Switch SC to RATT. Check for no output at SKD/d.
- (h) Link LKF/a to c. Check output at SKD/d is $-6.8 \pm 0.5V$.

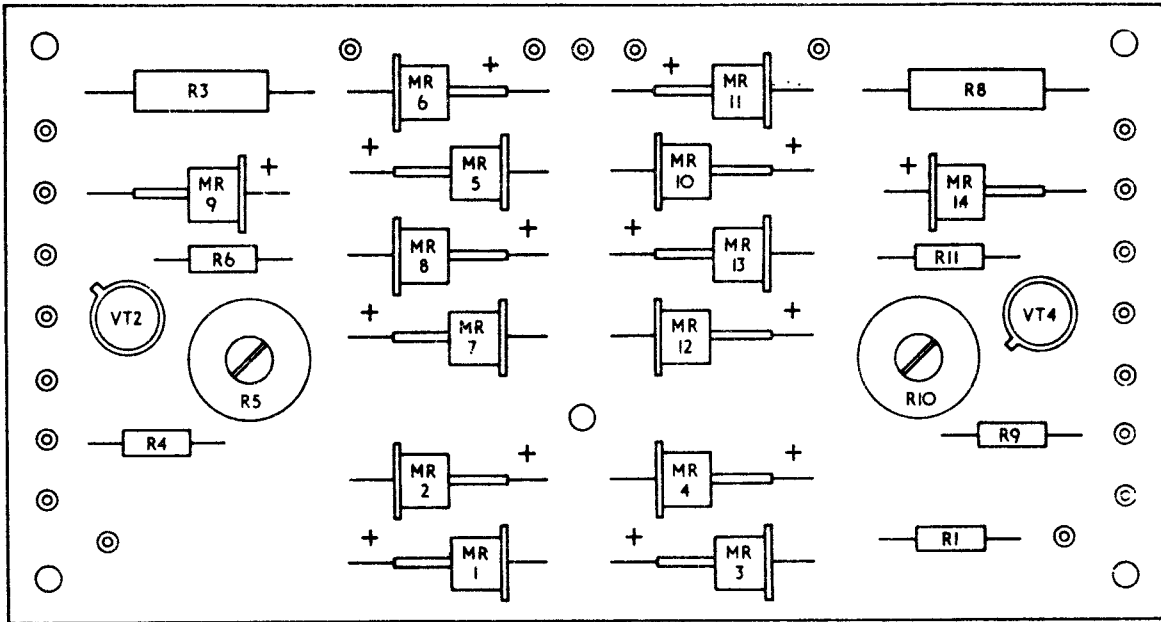
- (i) Switch SB to SHORE. Check output at SKE/d is $-6.8 \pm 0.5V$. Check output at PLC/d is $+6.8 \pm 0.5V$. Check for continuity between SKD/d and SKE/a.

5.12 CONTINUITY CHECKS

- (a) Check for continuity between chassis and the following points:—
SKD/b and e. SKE/b, e, g and j. PLC/b and e: TS2.
- (b) Check for continuity between the following points:—
PLC/k and one contact on JKA. PLC/L and the other contact on JKA.

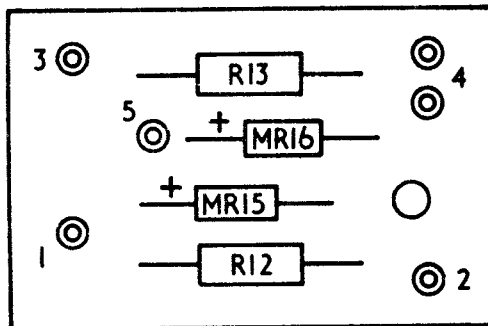
5.13 FINAL PROCEDURE

- (a) Connect links as required for operation
- (b) Remove all test connections.



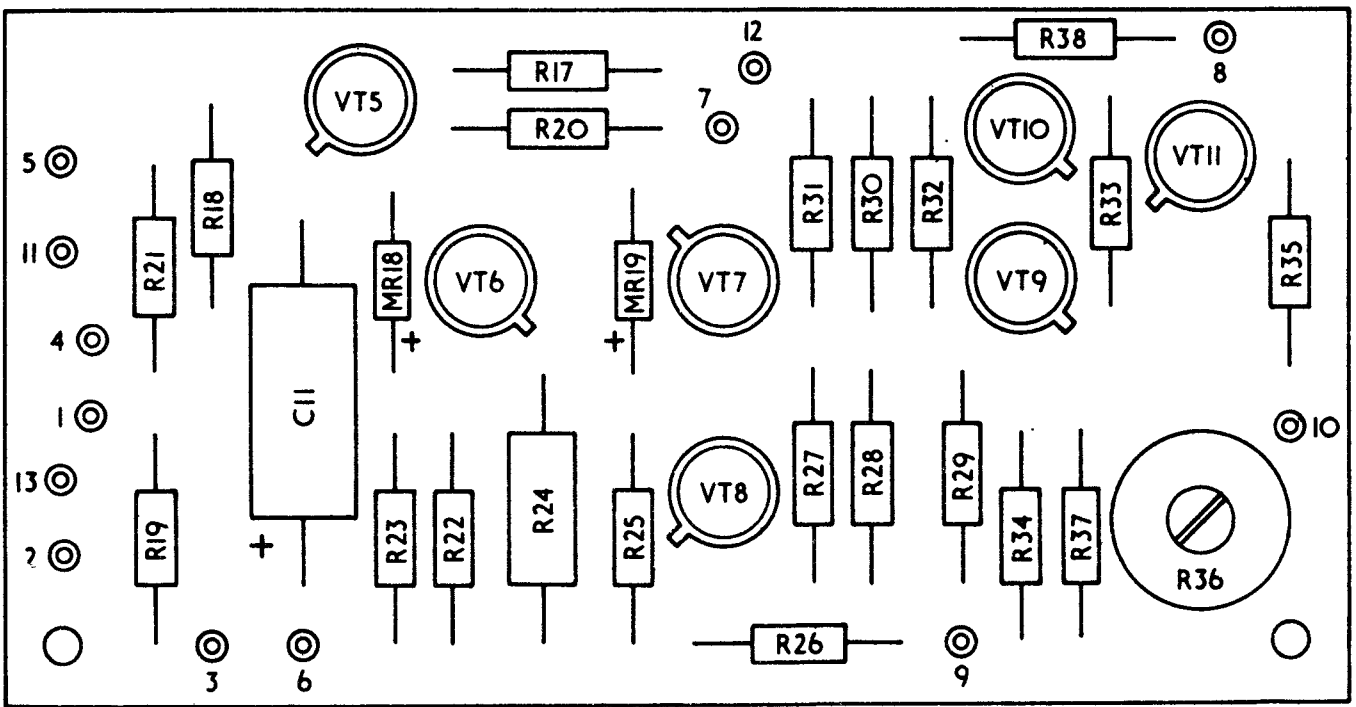
POWER SUPPLY BOARD PB1 COMPONENT LAYOUT

Fig 5-1



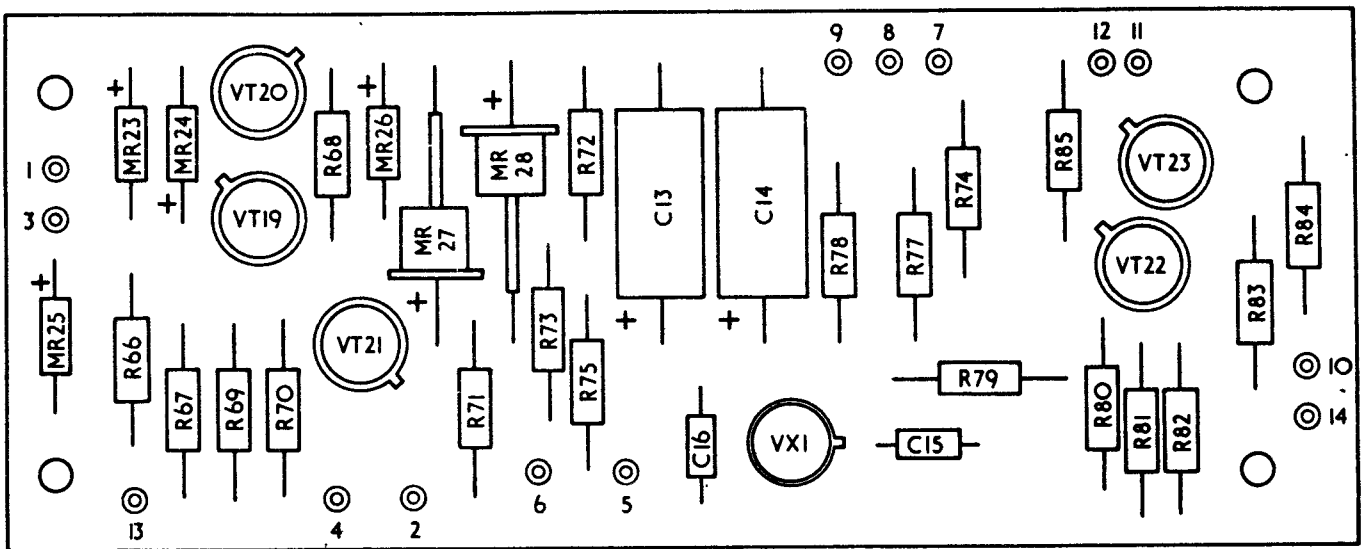
POWER SUPPLY BOARD PB2

COMPONENT LAYOUT Fig 5-2



HIGH LEVEL CONVERTER BOARD PB3 COMPONENT LAYOUT

Fig 5-3



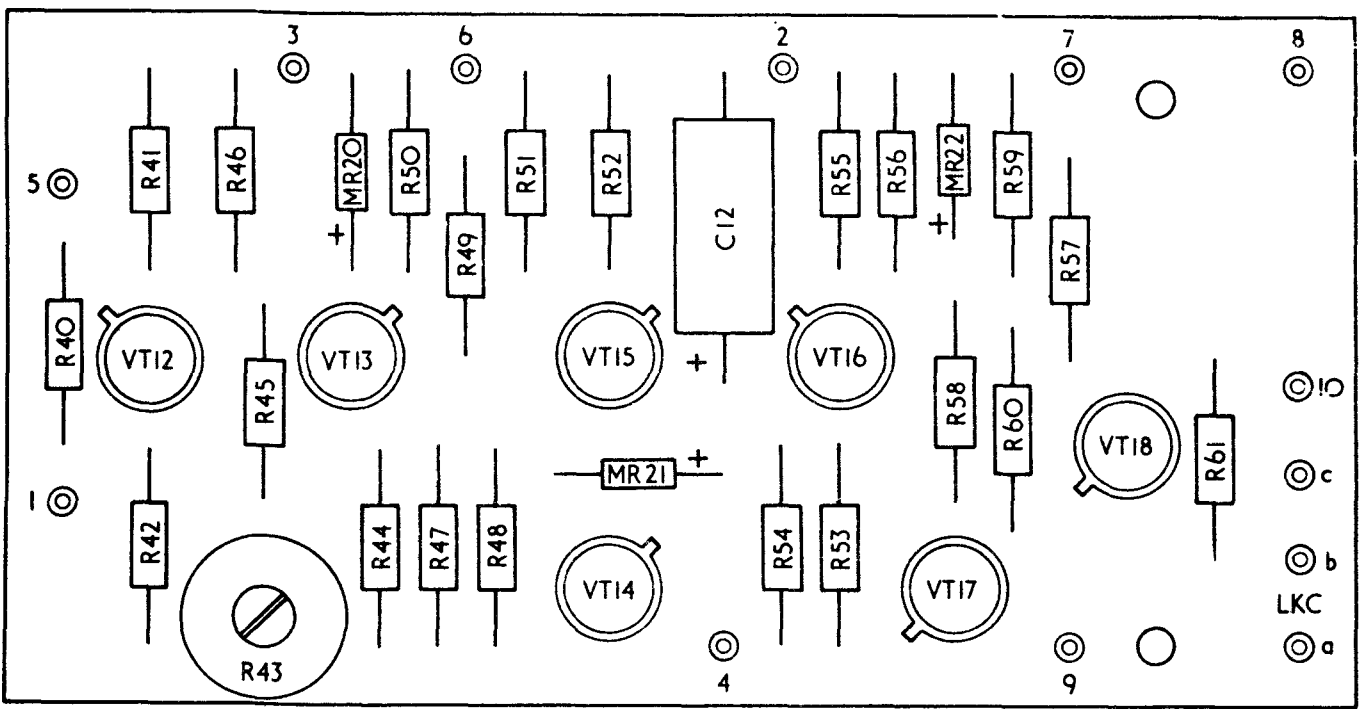


Fig 5-5

TRANSMITTER BOARD PB4 COMPONENT LAYOUT

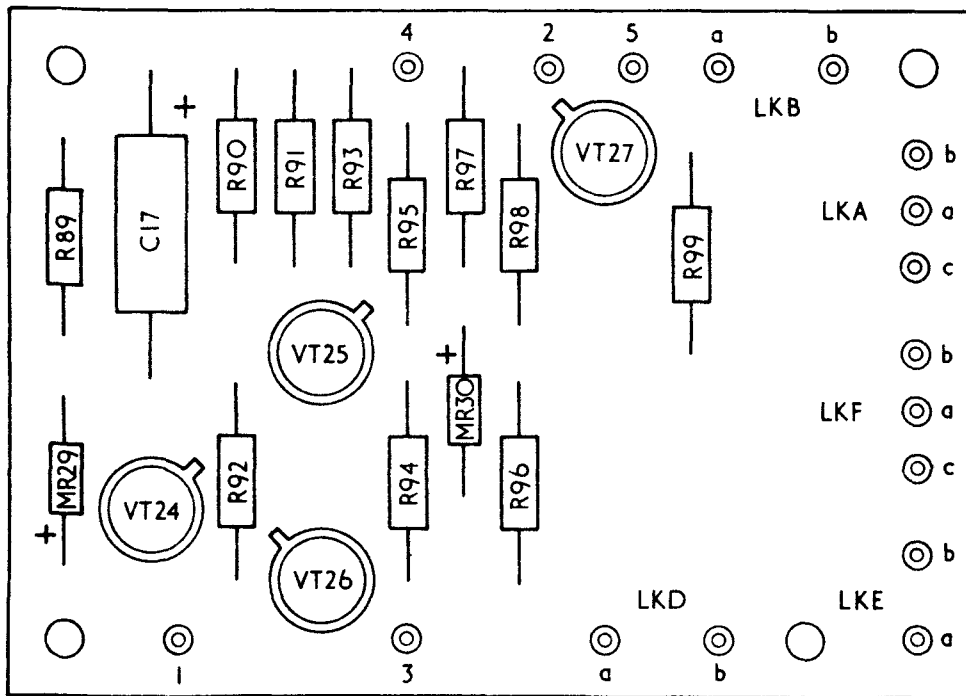


Fig 5-6

TRAFFIC INDICATOR BOARD PB6 COMPONENT LAYOUT

6. COMPONENTS LIST

6.1 COMPONENTS LIST FOR TERMINAL TELEGRAPH TT18

6.1 COMPONENTS LIST FOR TERMINAL TELEGRAPH TT18

CCT Ref.	Value	Tolerance	Rating	Description	Manufacturer and Part Number
	Ohms	%	Watt		
R1	22	2	1/2	Resistor	Electrosil Type TR5
R3	47	5	6	"	Welwyn Type W22
R4	22	2	1/2	"	Electrosil Type TR5
R5	250				
	lin. var.	20	1/4	"	Plessey pre-set Type G Mark 5A
R6	100	2	1/2	"	Electrosil Type TR5
R8	100	5	6	"	Welwyn Type W22
R9	22	2	1/2	"	Electrosil Type TR5
R10	250	20	1/4	"	Plessey pre-set Type G Mark 5A
	lin. var.				
R11	100	2	1/2	"	Electrosil Type TR5
R12	680	2	1/2	"	Electrosil Type TR5
R13	680	2	1/2	"	Electrosil Type TR5
R14	5K	5	1/2	"	Reliance Type MWT-090
	lin. var.				5/8" spindle with slot
R15	1.2K	2	12	"	Welwyn Type W24
R16	1.2K	2	12	"	Welwyn Type W24
R17	10K	2	1/2	"	Electrosil Type TR5
R18	10K	2	1/2	"	Electrosil Type TR5
R19	100	2	1/2	"	Electrosil Type TR5
R20	1K	2	1/2	"	Electrosil Type TR5
R21	100	2	1/2	"	Electrosil Type TR5
R22	33K	2	1/2	"	Electrosil Type TR5
R23	10K	2	1/2	"	Electrosil Type TR5
R24	47	5	2 1/2	"	Welwyn Type W21
R25	470	2	1/2	"	Electrosil Type TR5
R26	1K	2	1/2	"	Electrosil Type TR5
R27	220	2	1/2	"	Electrosil Type TR5
R28	3.3K	2	1/2	"	Electrosil Type TR5
R29	47K	2	1/2	"	Electrosil Type TR5
R30	1.2K	2	1/2	"	Electrosil Type TR5
R31	1.2K	2	1/2	"	Electrosil Type TR5
R32	3.3K	2	1/2	"	Electrosil Type TR5
R33	1.2K	2	1/2	"	Electrosil Type TR5
R34	3.3K	2	1/2	"	Electrosil Type TR5
R35	2.2K	2	1/2	"	Electrosil Type TR5
R36	5K	20	1/4	"	Plessey Type 404/8/00405/012
	lin. vari.				
R37	1K	2	1/2	"	Electrosil Type TR5
R38	220	2	1/2	"	Electrosil Type TR5
R40	4.7K	2	1/2	"	Electrosil Type TR5
R41	1K	2	1/2	"	Electrosil Type TR5
R42	1.8K	2	1/2	"	Electrosil Type TR5
R43	1K	20	1/4	"	Plessey Type 404/8/00405/010
	lin. var.				
R44	3.3K	2	1/2	"	Electrosil Type TR5
R45	5.6K	2	1/2	"	Electrosil Type TR5
R46	560	2	1/2	"	Electrosil Type TR5
R47	1K	2	1/2	"	Electrosil Type TR5
R48	1K	2	1/2	"	Electrosil Type TR5
R49	4.7K	2	1/2	"	Electrosil Type TR5
R50	1K	2	1/2	"	Electrosil Type TR5
R51	120K	2	1/2	"	Electrosil Type TR5
R52	5.6K	2	1/2	"	Electrosil Type TR5
R53	3.3K	2	1/2	"	Electrosil Type TR5
R54	3.9K	2	1/2	"	Electrosil Type TR5
R55	10K	2	1/2	"	Electrosil Type TR5
R56	10K	2	1/2	"	Electrosil Type TR5
R57	4.7K	2	1/2	"	Electrosil Type TR5
R58	1.5K	2	1/2	"	Electrosil Type TR5
R59	1.2K	2	1/2	"	Electrosil Type TR5
R60	1K	2	1/2	"	Electrosil Type TR5
R61	270	2	1/2	"	Electrosil Type TR5
R62					NOT USED
to					
R65					
R66	2.7K	2	1/2	"	Electrosil Type TR5
R67	6.8K	2	1/2	"	Electrosil Type TR5
R68	4.7K	2	1/2	"	Electrosil Type TR5
R69	6.8K	2	1/2	"	Electrosil Type TR5
R71	120	2	1/2	"	Electrosil Type TR5
R72	4.7K	2	1/2	"	Electrosil Type TR5
R73	220	2	1/2	"	Electrosil Type TR5
R74	1.5K	2	1/2	"	Electrosil Type TR5
R75	2.7K	2	1/2	"	Electrosil Type TR5
R76	1K	20	1/4	"	Plessey Type 404/8/00341/004
	lin. var.				
R77	2.7K	2	1/2	"	Electrosil Type TR5

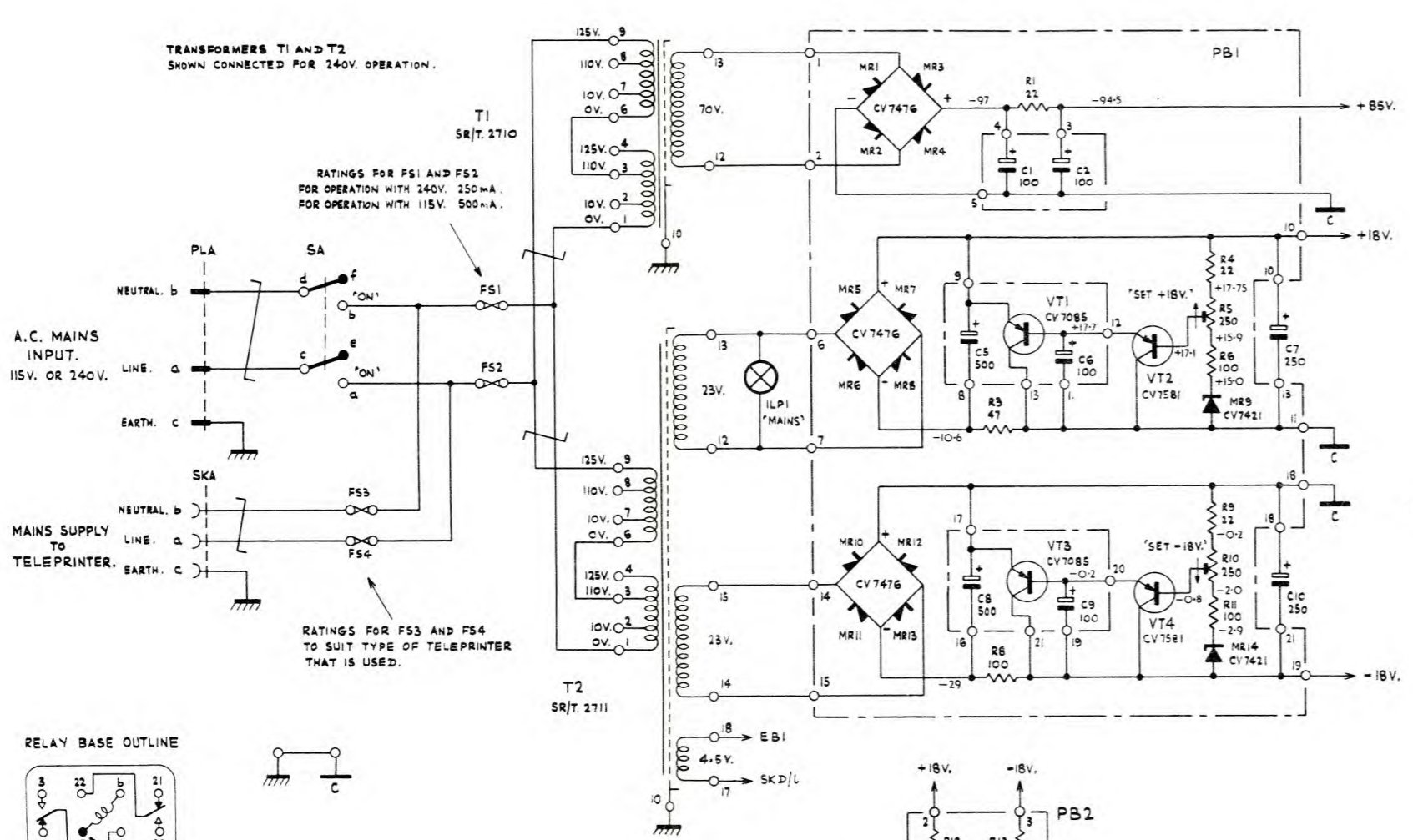
CCT Ref.	Value	Tolerance	Rating	Description	Manufacturer and Part Number
	Ohms	%	Watt		
R78	680K	2	½	Resistor	Electrosil Type TR5
R79	470K	2	½	"	Electrosil Type TR5
R80	4.7K	2	½	"	Electrosil Type TR5
R81	680	2	½	"	Electrosil Type TR5
R82	1.5K	2	½	"	Electrosil Type TR5
R83	10K	2	½	"	Electrosil Type TR5
R84	270	2	½	"	Electrosil Type TR5
R85	220	2	½	"	Electrosil Type TR5
R89	5.6K	2	½	"	Electrosil Type TR5
R90	12K	2	½	"	Electrosil Type TR5
R91	5.6K	2	½	"	Electrosil Type TR5
R92	3.3K	2	½	"	Electrosil Type TR5
R93	22K	2	½	"	Electrosil Type TR5
R94	22K	2	½	"	Electrosil Type TR5
R95	22K	2	½	"	Electrosil Type TR5
R96	3.9K	2	½	"	Electrosil Type TR5
R97	1K	2	½	"	Electrosil Type TR5
R98	10K	2	½	"	Electrosil Type TR5
R99	270	2	½	"	Electrosil Type TR5
	Micro Farads		dc V		
C1	100		350	Capacitors	C.C.L. Ltd. Type EP54S Elec.
C2	100		350	"	C.C.L. Ltd. Type EP54S Elec.
C5	500		50	"	C.C.L. Ltd. Type DG52S Elec.
C6	100		25	"	C.C.L. Ltd. Type WE53S Elec.
C7	250		25	"	C.C.L. Ltd. Type DE5QS Elec.
C8	500		50	"	C.C.L. Ltd. Type DG52S Elec.
C9	100		25	"	C.C.L. Ltd. Type WE53S Elec.
C10	250		25	"	C.C.L. Ltd. Type DE50S Elec.
C11	47	20%	35	"	Union Carbide Type K47J35S Tant
C12	47	20%	35	"	Union Carbide Type K47J35S Tant
C13	47	20%	35	"	Union Carbide Type K47J35S Tant
C14	47	20%	35	"	Union Carbide Type K47J35S Tant
C15	10pF	± 2pF	125	"	G.E.C. Type PF/AA/G Polystyrene
C16	10pF	± 2pF	125	"	G.E.C. Type PF/AA/G Polystyrene
C17	10	20%	35	"	Union Carbide Type K10J35S Tant
MR1				Diodes	CV.7476
MR2				"	CV.7476
MR3				"	CV.7476
MR4				"	CV.7476
MR5				"	CV.7476
MR6				"	CV.7476
MR7				"	CV.7476
MR8				"	CV.7476
MR9				"	CV.7421
MR10				"	CV.7476
MR11				"	CV.7476
MR12				"	CV.7476
MR13				"	CV.7476
MR14				"	CV.7421
MR15				"	CV.7103
MR16				"	CV.7103
MR18				"	CV.7368
MR19				"	CV.7368
MR20				"	CV.7103
MR21				"	CV.7368
MR22				"	CV.7368
MR23				"	CV.7368
MR24				"	CV.7368
MR25				"	CV.7368
MR26				"	CV.7368
MR27				"	CV.7421
MR28				"	CV.7421
MR29				"	CV.7368
MR30				"	CV.7368
VT1				Transistors	CV.7085
VT2				"	CV.7581
VT3				"	CV.7085
VT4				"	CV.7581
VT5				"	CV.7440
VT6				"	CV.10253
VT7				"	CV.10253
VT8				"	CV.7440
VT9				"	CV.7440
VT10				"	CV.7440

CCT Ref.	Value	Tolerance	Rating	Description	Manufacturer and Part Number
VT11				Transistors	CV.7440
VT12				"	CV.7581
VT13				"	CV.7440
VT14				"	CV.7440
VT15				"	CV.7440
VT16				"	CV.7440
VT17				"	CV.7581
VT18				"	CV.7581
VT19				"	CV.7440
VT20				"	CV.7440
VT21				"	CV.7440
VT22				"	CV.7581
VT23				"	CV.7581
VT24				"	CV.7581
VT25				"	CV.7581
VT26				"	CV.7440
VT27				"	CV.7440
VX1				Integrated Circuit	Fairchild Type MA709C
T1				Power Transformers	To Specification SR/T.2710
T2				"	To Specification SR/T.2711
SA			2A 250V a.c.	Switches	Painton Type 22/10/0201/00 Lever op.
SB				Switches	To Specification 3/OP.9464/S Rotary
SC					To Specification OP/9463/M Rotary
SD					Honeywell Type 2PB12-T Push-Button
SE					To Specification 2/OP.9464/S Rotary
SF					To Specification 1/OP.9464/S Rotary
JKA				Jack Socket	Brookhirst-Igranic Type P72
FS1			250 mA	Fuselinks, Anti Surge for 240V op.	K.E.Beswick Type TDC.134
			500 mA	Fuselinks, Anti Surge for 115V op.	K.E.Beswick Type TDC.134
FS2			250 mA	Fuselinks, Anti Surge for 240V op.	K.E.Beswick Type TDC.134
			500 mA	Fuselinks, Anti Surge for 115V op.	K.E.Beswick Type TDC.134
FS3					
FS4	To suit type of teleprinter that is used.				
1LP1	0.04A		28V	Lamp Mains	Atlas-Thorn Type L.1004
1LP2	0.04A		18V	Lamp "Tx"	Atlas-Thorn Type L.1125
1LP3	0.04A		18V	Lamp "Rx"	Atlas-Thorn Type L.1125
1LP4	0.04A		18V	Lamp "Traffic"	Atlas-Thorn Type L.1125
1LP5	0.04A		28V	Lamp Tx in use	Atlas-Thorn Type L.1004
1LP6	0.04A		28V	Lamp Tx Ready	Atlas-Thorn Type L.1004
RLA				Relay	Hellermann Deutsch Type HDD1-S-M2-E-02
RLB				Relay	Hellermann Deutsch Type HDD1-S-M2-E-02
RLC				Relay	Hellermann Deutsch Type HDD1-S-M2-E-02
EB1			4-6V	Electric Bell	Gents Type 392 (Tropical Finish)
TS1				Test Sockets (4mm dia.)	Belling Lee Type L.1717 (Red)
TS2				"	Belling Lee Type L.1717 (Black)
TS3				"	Belling Lee Type L.1717 (Red)
TS4				"	Belling Lee Type L.1717 (Red)
TS5				"	Belling Lee Type L.1717 (Red)
PLA	3 pole			Plugs	Smart & Brown Type SB.104-T4-BS-3PXO/RF
PLB	12 pole			"	Smart & Brown Type SB.104-T4-BM-12PX1/RF
PLC	12 pole			"	Smart & Brown Type SB.104-T41BM-12PXO/RF
SKA	3 pole			Sockets	Smart & Brown Type SB.104-T4-BS-3SXO/RF
SKB	3 pole			"	Smart & Brown Type SB.104-T4-BS-3SX1/RF
SKD	12 pole			"	Smart & Brown Type SB.104-T4-BM-12SXO/RF
SKE	12 pole			"	Smart & Brown Type SB.104-T4-BM-12SX1/RF

7. CIRCUIT DIAGRAM

FIGURE 7.1 – TT18 CIRCUIT DIAGRAM

Note that this circuit diagram is annotated with voltages.



RELAY BASE OUTLINE

BLUE BEAD

ROTARY SWITCHES

SB	
POS.	FUNCTION
1	RADIO
2	SHORE

SC	
POS.	FUNCTION
1	MORSE
2	RA
3	BROADCAST

SE	
POS.	FUNCTION
1	TX.
2	AUTO
3	RX.

SF	
POS.	FUNCTION
1	TX. ON
2	TX. OFF

LINKING ARRANGEMENTS

LKA LKB LKC	CONDITION		LKA	LKB	LKC
	MORSE	FOR DIRECT KEYING OF TX. LINK AS FOLLOWS	A TO B	NO LINK	A TO B
	FOR V.F. KEYING, LINK AS FOLLOWS	A TO C	A TO B	A TO C	

LKD LKE	CONDITION		LKD	LKE
	HIGH LEVEL CONVERTER	FOR USE WITH HIGH LEVEL TP. LINK AS FOLLOWS	A TO B	A TO B
	FOR USE WITH LOW LEVEL TP. LINK AS FOLLOWS	NO LINK	NO LINK	

LKF	CONDITION		LINK
	IF NO TX. SIDETONE IS AVAILABLE ON BROADCAST	A TO B	
	IF NO TX. SIDETONE IS AVAILABLE ON ANY SERVICE	A TO C	
	IF SIDETONE IS AVAILABLE ON ALL SERVICES	NO LINK	

MORSE KEY

