PUBLIC EMERGENCY TELEPHONE SYSTEM

Installation and Maintenance Manual

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NOTICE

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Contents

1. INTRODUCTION

1.1 THIS MANUAL

READ THIS FIRST!

This manual tells you how to install and maintain the emergency telephone system produced by Whiteley Electronics Ltd for use at level crossings and similar sites.

Some additional technical information is given, as well as some hints for first-line fault-finding down to printed circuit board level.

Basic technical skills and knowledge are assumed: a list of abbreviations used in this manual is given at the back.

You do not need to read all of it at once. Beside this introduction, the three most important sections are *3. Installation, 4. Testing* and *5. Maintenance*. The rest is background information or for reference.

Finally, always remember: **SAFETY IS AT STAKE.** People's lives can depend on the safe functioning of this apparatus, so it must be installed properly. If you have any questions or are unsure of anything, **ask your supervisor.**

1.2 THE EQUIPMENT

The equipment described in this manual is a public emergency telephone system for use primarily at rail/road level crossings; it is compatible with most kinds of telephone signalling system.

The telephone allows users of the crossing to contact the signalman located elsewhere, in order to supervise crossing by cattle or abnormal road vehicles or in the event of road vehicle breakdown at the crossing. The facilities and features are provided in accordance with Department of Transport requirements, as described in **Railway Construction & Operational Requirements - Level Crossings** (HMSO, 1981).

A description of the equipment's appearance is to be found in section 2. There is a full technical specification in section 6. The rest of this section gives a general overview of the equipment's features and operation.

1.2.1 Features

The equipment provides a variety of features, enabling it to be used in a wide range of installation configurations. Microprocessor technology is used in order to provide such a sophisticated range of facilities at both the signal box and the remote telephone ends. The equipment is DC-powered, the voltage being selectable.

The Public Emergency Telephone System provides not only basic telephony (speech) functions but also contact closure signalling together with extensive monitoring of the remote telephones and the interconnecting transmission link.

1.2.2 The Hardware

Normally identical sets of electronic hardware are provided at the signal box and at the remote end. The equipment differs in respect of minor variations in packaging, and by individually selectable software. The equipment at the remote end may be installed within existing signalling equipment frames and occupies the space of two standard signalling relays. The outer packaging (equipment case) is environmentally protected with a ingress rating of IP55 in accordance with BS 5420 and the circuitry is electrically isolated to the requirements of BS6301 for Network and user safety.

Up to four individual telephone line circuits may be provided at both the Signalbox and the remote end. It will be normal for only one line circuit to be equipped at the Signalbox, and either two or four line circuits to be provided at the remote end.

1.2.3 Mounting

The signal box equipment is designed to be wall-mounted, free-standing or alternatively for fitting within an equipment rack. The software, which determines whether the equipment hardware is remote or Signal box type, is selected by an internal switch.

Smaller signalboxes will have the equipment wall-mounted with a dedicated telephone instrument, larger signalboxes will have the telephone circuits extended to a telephone concentrator.

1.2.4 Transmission Circuit

In the simplest arrangement the signal box and the remote end will be connected with a physical pair of copper wires. However, the equipment is sufficiently flexible to allow either two- or four-wire physical circuits. Four-wire circuits provide a more reliable speech path. Additionally, private-wire circuits (supplied by BT or by Mercury) or point-to-point transmission links may be used. Provided the losses on the circuit are below the limits in Section 6, the distance between the two ends is unlimited.

1.2.5 Signalling System

In order to support the various facilities over a basic speech circuit, a complex data communication protocol, based upon speech-band DTMF signalling, has been developed. This is a safety system which demands security and reliability: the signalling protocol has been designed to be robust and fail-safe.

1.3 FURTHER INFORMATION

This document describes the detailed requirements for system planning and installation, together with a detailed account of the facilities, principles of operation, maintenance and fault-finding. In-depth descriptions of software and hardware designs are not provided as maintenance and repair by customer's staff will be limited to printed circuit board (PCB) level.

The statutory requirements for provision of telephone service at level crossings is under constant review by Her Majesty's Railway Inspectorate and BRB. It should therefore be noted that any changes to statutory requirements, rules and regulations or memoranda that are circulated on the subject **shall take precedence over the information contained in this manual.**

2. GENERAL DESCRIPTION

2.1 INTRODUCTION

Two types of equipment are available, one type to be installed within the signal box, the other type to be installed at the remote end. The overall equipment design is such that all the PCB cards and the cardframe systems are identical at both signal box and remote end. It is only the outer casing, which houses the equipment cardframe, that differs.

The remote equipment provides an outer casing which occupies the space envelope of two signalling relays. Holes at the rear of the casing are provided to align with standard relay fixing points. In order to accommodate extreme environmental variation, the case is sealed to BS5420 ingress protection rating IP55.

The signal box equipment is enclosed in a similar casing, which is not environmentally protected. The front cover differs in respect of labelling and cut-outs for the push-button switches to be used by the signalman.

In both instances a standard half-width Eurocard frame with motherboard and a termination PCB are installed within the casing. Both systems use identical PCB cards, and software on the microprocessor cards is also identical, but a selection switch identifies the local function as remote or signal box.

2.2 REMOTE EQUIPMENT

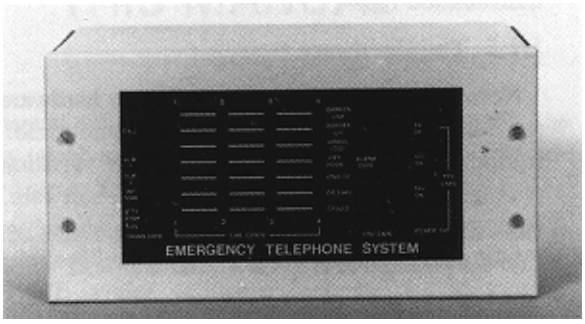
The equipment is enclosed by a substantial steel fabricated case of approximate dimensions 310mm (W) x 15198mm (D). The unit is sprayed light straw and is uniquely identified by its front panel labelling and the absence of any exposed front panel switches or controls.

2.2.1 Outer casing

At either side of the unit a gland plate, with multiple knockouts, is fitted by eight screws compressing the plates onto sealing gaskets. All incoming/outgoing cables are to be suitably glanded to maintain environmental protection.

The case, when correctly installed, is protected to BS 5420, IP55, and will normally be installed in a trackside location cabinet, or preferably in an apparatus room (if available).

Removal of the front cover will reveal the modular cardframe, which is common to both remote and signal box equipment. This arrangement is shown in Fig 3.4.



2.2.2 Terminations

Removal of the left-hand side glandplate reveals the termination PCB. All connections are made via removable terminal blocks which friction-fit to pins on this PCB.

2.2.3 Functional facilities

There are no switches or user controls exposed on the remote equipment. All major operational conditions are identified on LEDs visible through the perspex front cover. The LEDs are an aid to fault-finding and maintenance, and are supplemented by a seven-segment display which will indicate any current equipment alarms on the remote equipment.

Once the front cover is removed, two switches are exposed on the central processor unit (CPU) PCB to provide the following facilities.

a) SCAN - (bottom switch on the microprocessor PCB with seven-segment display). Operation of this switch will enable all current alarms to be displayed, in rotation, on the seven-segment display.

b) RESET - (upper switch on the microprocessor PCB with seven-segment display). Operation of this switch provides total microprocessor reset.

2.2.4 Interfaces

The remote equipment will normally connect the following equipment/interfaces.

a) Trackside/level crossing telephone - up to four independent line circuits are available depending upon the number of installed line cards.

b) Contact closure signals - up to four circuits (bi-directional) are available as one bi-directional set per line card. The signals are to be interfaced directly from the external contacts. The signal inputs are opto-coupled and power for the input circuit may be derived from the internal +12V supply via a volt-free contact on the remote equipment . Alternatively, the external equipment may supply the input circuit with a voltage in the range 12V to 50V during the active state.

c) Transmission - the transmission interface may be chosen as two-wire or four-wire. Four wire offers optimum performance.

The transmission interface is tested to conform with BS 6301 for user and network saftey. However, **it is not approved for connection to public telecommunications systems** under the Telecommunications Acts. If private wire circuits are to be rented from BT or MCL, then **Site Specific Approval** must be sought.

2.2.5 Power Supply

The remote equipment will operate on incoming DC supply rails in the range 20V to 57V DC, either floating or with either pole earthed. The internal supplies are fully isolated from the input supply. At level crossing installations this allows the unit to be powered from the crossing barrier battery if desired.

2.2.6 Earthing

The remote equipment power supply circuit comprises an isolated DC - DC convertor. Earth reference is provided from a terminal for connection to an external telecomms earth. If the incoming supply is earthed, this may be used in preference to an external earth. When used in Signalling Relay Rooms, the case **must** be isolated from the internal supplies by removing the link on the motherboard, see Fig 3.2. **The case must then be bonded to external metalwork for safety.**

2.3 SIGNAL BOX EQUIPMENT

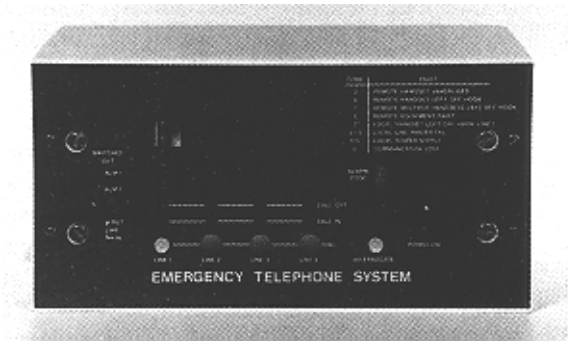
The equipment is enclosed by a casing similar to the remote equipment. The front cover and gland plate arrangement differs to suit the functional and installation requirements of the signal box equipment. The equipment should be installed in a dry environment such as the working areas of a signal box.

Frequently the signal box equipment will be wall-mounted, with an adjacent control telephone.

2.3.1 Outer casing

At both sides of the unit a gland plate is provided and is retained by eight screws. The left hand gland plate is equipped with a buzzer (equipment alarms) and a standard BT master line jack socket (for the control telephone). All incoming/ outgoing connections, with the exception of the control telephones are to be suitably glanded.

The main components of the case are shown in Fig 3.1. Blanking plugs are to be fitted into spare holes in the card frame when particular line cards are not to be installed.



2.3.2 Terminations

Terminations are as for the remote unit , but in addition, the buzzer and master line jack socket are pre-wired to the appropriate terminations.

2.3.3 Functional facilities

A number of user controls and indicators are provided for the signalman, when the system is installed in a signal box adjacent to the control telephone. In the event that the equipment is to be connected to a concentrator, provision is made for extending most of the facilities. The controls/indicators provided are as follows:

a) On each line circuit:

i) Call Button - used to initiate the calling sequence. A push button is provided to enable selective calling (if provided), and also to prevent inadvertent calling if the control telephone handset is lifted. Selective calling is only relevant to "paired" or "solo" type system configurations.

The control button on Line 1 is still used in the "all-call" configuration to maintain consistency in operation.

ii) Call In indicator - this indicator operates in sympathy with the incoming ringing signal and is also used to identify a call in progress or, if flashing, that a call has taken place whilst the signal box was unattended.

iii) Call Out indicator - this indicator illuminates when a call is established by the signalman, and has particular relevance where selective calling is used by identifying which line circuit is active.

iv) Contact Closure indicator - two indicators are provided behind an area dedicated to a label strip which identifies the location of the remote equipment. One indicator shows the status of the remote contacts, the other shows the status of signals relayed to the remote end from the signal box (if the option is not used, then the label strip should mask the indicator).

b) Interrogate

The button has two functions as follows:

i) Whilst the button is held in, any current alarms are displayed, in rotation, on the seven-segment display.

ii) During a call, any change of status at the remote end, i.e. contact closure, second caller, etc. will be identified by a special "intrusion tone". The signalman may suspend the conversation and operate the Interrogate button, whereupon the event will be transmitted to the signal box equipment.

c) Alarm display

A seven-segment which under normal circumstances shows a flashing hyphen "- ".

Under conditions of a current alarm, the highest alarm code will be permanently displayed. Operation of the Interrogate button will reveal any other lower priority pending alarms. Each alarm is displayed cyclically until the "hyphen" is reached. Release of the button returns the display to the original, most significant, alarm state.

d) Block Switch (optional)

This switch, if equipped, provides a manual means of re-routing the transmission circuitry to the emergency telephone system. Normally the circuits would be re-routed to another signal box. Provision is given to interface the activation of this mode with signalling equipment, in other words when the cabin is switched out, the telephone arrangements are switched automatically together with the block signalling and re-routed to another box which is still open.

e) Block Switch mode

A flashing indicator, "Switched Out", is provided to warn that the transmission circuits have been re-routed and that the equipment is disabled i.e. Block Switch has been operated.

f) General status indicators

A variety of indicators are provided but these only have minor relevance to the signalman. Their primary function is as a diagnostic aid for engineering purposes (refer to section 5).

g) Buzzer

The buzzer is provided to gain the attention of the signalman whenever a major system alarm is raised. The buzzer will be silenced by operating the Interrogate button and will only operate again if another alarm is raised. An external buzzer may be fitted (see section 2.3.4 d).

2.3.4 Interfaces

The signal box equipment will normally connect to the following equipment/interfaces.

a) Signal box wall-mounting telephone via the master line jack socket on the left-hand side gland plate. Alternatively, see section 2.3.6, where wired connections are made to a concentrator.

b) Contact Closure Signals - up to four circuits (bi-directional) may be supported, depending on the provision of line cards. In a basic system only one signal is provided. Conditions signalled from the remote end are provided on volt-free contacts.

c) Transmission - the same considerations apply as for the remote unit.

d) Remote calling indicator - a set of volt-free relay contacts are provided to enable the operation of supplementary bells, buzzers or indicators to operate during an incoming call.

The relay contacts may be selected to operate in sympathy with the incoming ringing sequence, or alternatively to operate continuously whilst an incoming call remains unanswered.

e) Alarms - two separate relay contacts are available to extend the normal and urgent alarm conditions. It should be noted that normally the local buzzer requires the urgent alarm relay set. If the equipment is to be used with a remote concentrator it may be necessary to extend the alarm conditions.

f) Block Switching - if the system requires to operate in block-switched mode, this may be activated by a control signal from existing equipment. To switch-out this particular equipment, a voltage is supplied to the opto-isolated input. This voltage may be in the range 12 to 50V. If the existing equipment provides a volt-free contact then the available +12V rail, normally connected to the side switch, may be used.

2.3.5 Earthing

The signal box equipment power supply circuit comprises an isolated DC - DC convertor. Earth

reference is provided from a terminal for connection to an external telecomms earth. If the incoming supply is earthed, this may be used in preference to an external earth. If the signal box equipment is installed where the signalman will operate it, **the case must be earthed for safety.** If it is installed in a Signalling Relay Room, the case **must** be isolated from the internal supplies by removing the link on the motherboard, see Fig 3.2. **The case must then be bonded to external metalwork for safety.**

2.3.6 Use with a concentrator

Whilst the facility of a simple local dedicated telephone will be more appropriate to smaller signalboxes normally found on branch lines, it customary for concentrators to be provided in larger signalboxes.

The signal box control telephone line circuit may be extended to a concentrator AUTO circuit interface. Certain configurations of the remote equipment permit more than one control circuit and these may also be extended to separate circuits on the concentrator.

When operating to a concentrator it should be noted that the signal box set-up switch, SW5 D shown in Fig 3.2, should be set up so that the front panel CALL button does not have to be operated to set-up a call to the remote end.

It is recommended that the signal box equipment be installed in the same room as the concentrator to enable analysis of alarm conditions by the operating staff. Alternatively, if the signal box equipment is installed in an apparatus room, then the urgent (major) and normal (minor) alarms should be extended to the concentrator. In this instance, operational procedures for level crossing working shall be modified so that an alarm causes a lamp to light on the concentrator front panel, requiring the signalman to caution drivers of trains.

This feature may be invoked by wiring the urgent alarm to an adjacent CB circuit on the concentrator. When an alarm is raised the CB circuit will be looped, indicating a call. Alternatively, it should be noted that the microprocessor PCB has a connector to the seven-segment display drive circuit. This could be extended in multi-pair (preferably screened) cable by up to 20 metres to drive a remote display.

2.3.7 Remote Telephone Types

The remote telephones is intended to be a standard Central Battery press-to-call type.

The vandal detection system checks for a leakage current across the telephone pair, provided by a resistor across the line pair.

If the telephone is equipped with an auxiliary loop through the telephone handset the vandal detection system will monitor the telephone loop up to and including the handset.

The remote line circuit allows two types of calling, namely loop-disconnection calling, and earth-loop calling. Loop disconnection calling uses the press-to-call button to break the telephone line current momentarily to initiate a call. Earth calling uses the button to connect a third wire from the equipment to the telephone loop. This wire is connected to the internal supply of the equipment.

3. INSTALLATION

Before starting the installation, check the materials that will be taken to site. The equipment code numbers detailed in Section 7.2 will be printed on the individual cardboard cartons in which each item is packed. Take a suitable installation drawing to site so that you can amend the details for the finished drawing.

Safety: Read the saftey notes in Section 5.1 before starting work.

Important: the best place to begin the installation is at the signalbox.

Warning: observe static precautions and additional information provided in section 5.2.

3.1 SIGNALBOX EQUIPMENT INSTALLATION

First of all, establish whereabouts the equipment is to be mounted. In a basic installation a dedicated control telephone is needed and the signalbox equipment should be installed near to the telephone.

If the equipment is to be used in conjunction with a concentrator it may either be located in an apparatus room, or preferably nearby the concentrator.

3.1.1 Unpack the Signalbox equipment and establish that it is the correct item. The Signalbox equipment is identifiably different from the remote equipment in the following features.

a) Telephone Line Jack Socket on the left-hand side gland plate.

b) All perspex front panel with button holes/blanking plugs for the three line card slot positions.

c) Front panel legend - “Emergency Telephone System”, and large rectangular clear boxes for on-site labelling.

d) Alarm sounder mounted on the bottom centre of left-hand side gland.

3.1.2 Remove the perspex front panel by undoing the two smaller slotted head screws (four on early models). Carefully lift off the perspex panel.

3.1.3 If the system design requires more cards than are supplied with the basic system, install them now. Ensure the cards are located in the upper and lower

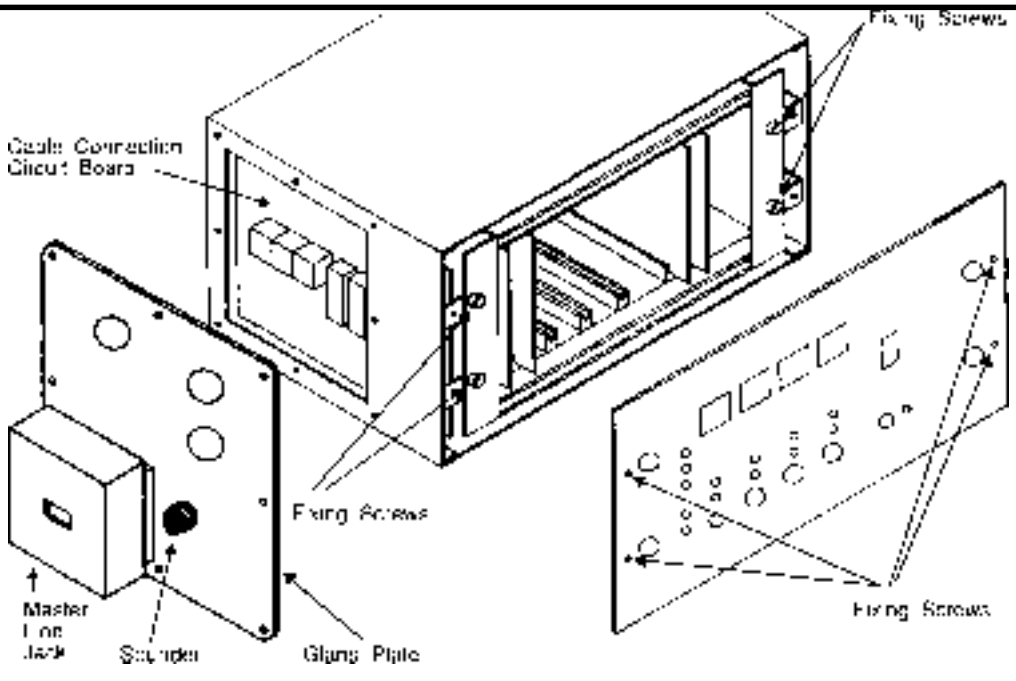


Fig 3.1 Signal Box Unit, Exploded View

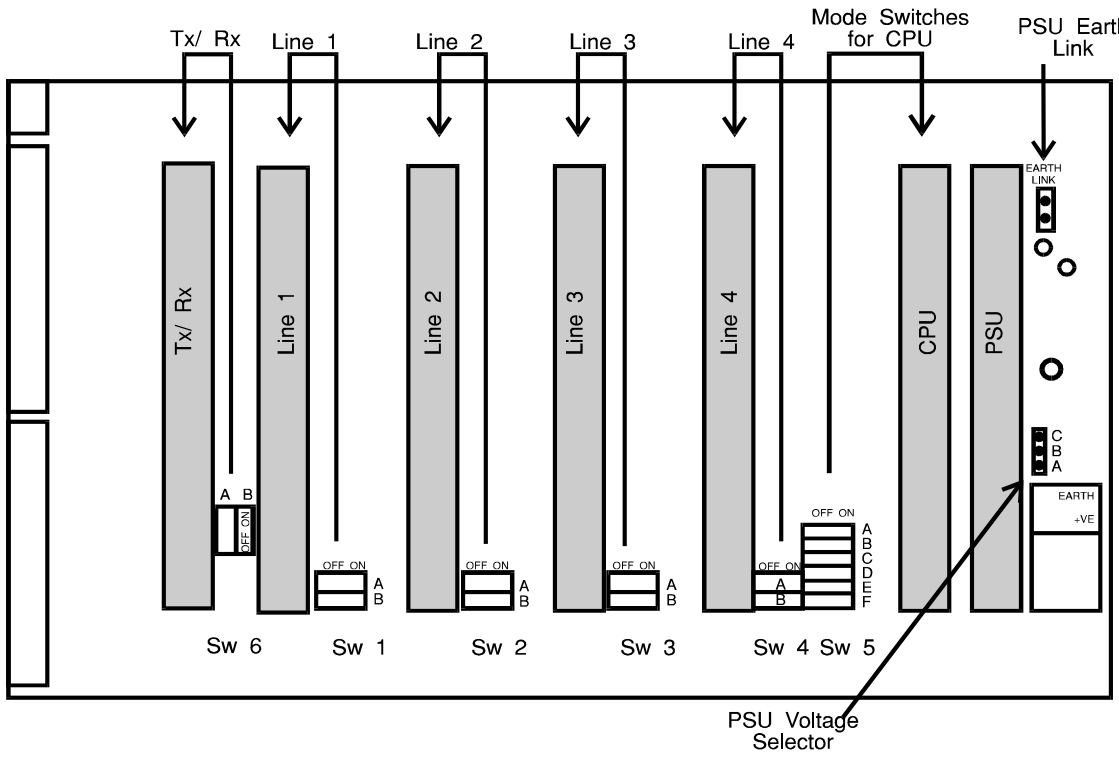


Fig 3.2 Motherboard Layout showing switch Positions

Table 3.1	**Signal box Equipment**	**Motherboard Mode Switches CPU (SW5A, B, C, D, E, F)** (* denotes factory set option)	
SWITCH	DESCRIPTION OF MODE	SWITCH TO THE LEFT (off)	SWITCH TO THE RIGHT (on)
A&B	Telemapping, i.e configuration	See table below*	See table below
C	Call relay signalling.	Contact closes * continuously during incoming ringing period	Contact operates in sympathy with incoming ringing sequence
	NB: this relay operates the external sounder. Set switch to suit desired sounder effect.		
D	Signalbox line circuit type	Concentrator	Local control telephone *
E	System software	Selects remote system	Selects signalbox system *
F	Signalbox	Terminal signalbox	Intermediate box

Table 3.1, Continued , Signal box Equipment Telemapping System Configuration
(* Denotes factory set option)

SWITCH A	SWITCH B	CONFIGURATION
OFF	OFF	Mode 2 - Paired Signalbox line 1 remote lines 1 + 2 Signalbox line 3 remote lines 3 + 4 i.e. Selective calling, appropriate to two separate individual remote systems.
OFF *	ON *	Mode 1 - All call
ON	ON	Signalbox line 1 remote lines 1,2,3 + 4
NB: Switch position not relevant		NB: Phased ringing occurs between lines 1 + 2 and 3 + 4 at remote. This is the basic system mode with normal signalbox line 1 and remote lines 1 + 2 installed.
ON	OFF	Mode 3 - Solo Signalbox line 1 remote line 1 Signalbox line 2 remote line 2 Signalbox line 3 remote line 3 Signalbox line 4 remote line 4 Reserved for future applications

guides, then insert by applying pressure to the card front edge only. Take care that LED indicators are not bent back on Line, TX and PSU cards.

3.1.4 Remove the left-hand side glandplate by undoing the six fixing screws. Note where the wires are connected. Remove the wiring to the line jack socket and sounder from the terminals.

3.1.5 With the open part of the case uppermost, remove the four large slotted-head screws, taking care to support the internal card frame. The internal cardframe should be removed entirely, but care should be taken not to damage the components on the termination PCB to the left hand side. The cardframe fixing brackets are very close to PCB components during removal.

3.1.6 The housing may be fixed to a convenient wall: four holes are provided at the rear. Use four No 8 x 1" screws to fix it, either directly to wooden structures, or using wall plugs on brick or similar walls. Use the housing as a template to mark the positions for drilling starter holes.

3.1.7 Identify the various installation cables required. As a minimum these will be as follows:

a) DC power feed - a single pair of 1mm cables with colour identification. The power supply may be from a telecomms or signalling battery source of between 20V and 57.5V DC. It is immaterial whether the battery is earth-free, positive, or negative earth. It is recommended that the feed is fused at source and should be 2A @ 24V or 1A @ 50V.

Important - do not install the source fuse until the installation is completed.

b) Transmission circuit - either a single pair or two pairs of 0.5/0.6mm cable.

c) Earth point - See 2.3.5. **Either**: connect the case metalwork to a known safety earth, **or:** remove the PSU Earth Link on the motherboard (see Fig 3.2) and connect the case to bonded metalwork.

Beyond the above basic requirements, the following may be required if determined by system planning (Section 7):

d) Contact signalling and block switching - a multi-pair 0.5/0.6mm cable. One pair for each remote contact status circuit and one pair for the block switching interface.

Table 3.2 Signal box Equipment Transmission Card Switches (SW6 A,B)
(* denotes Factory set Option)

SWITCH	DESCRIPTION OF MODE	SWITCH DOWN (off)	SWITCH UP (ON)
A	Transmission circuit arrangement	4-wire *	2-wire
B	Reserved for future use	N.A. *	N.A.

Table 3.3 Signal box Equipment Line card switches: (* denotes factory set option)

Line 1 (SW1 A, B)

Line 2 (SW2 A, B) *

Line 3 (SW3 A, B) switches set to off

Line 4 (SW4 A, B)

It is only necessary to set the switch on line card 1 at the signalbox equipment, as follows:

SW1 SWITCH	DESCRIPTION OF MODE	SWITCH TO LEFT (off)	SWITCH TO RIGHT (on)
A	Data update method	During conversation mode any status changes at the remote end are signalled by intrusion tone and to be signalled have to be triggered manually by the Interr-ogate button. *	During conversation DTMF signalling will automatically occur every 30 secs and will interrupt speech.
B	Not used	N/A *	N/A

e) External sounder - additional sounder, such as Hosiden Besson Ltd “Bedlam” may be installed as necessary. The sounder should operate from the incoming 24V/50V supply, which may be jumpered via the relay contact within the signalbox equipment.

f) Concentrator - a pair is required for each line circuit to be extended to the concentrator. The alarm circuit may also need to be extended.

NB: It is strongly recommended that the equipment is located close to the concentrator so that alarms may be observed by the signalman.

g) Additional transmission circuits to remote signalboxes, identical quantity and type as b) above (only required with block switching).

Good installation practice will use the minimum number of individual cables and it should be possible to combine at least some of the wiring described above within the same multi-pair cable.

3.1.8 Having decided upon the cabling arrangement, suitable cable glands (20mm plastic) should be obtained. The knockout holes on the gland plate should now be removed as necessary. Use the knockouts nearest the wall, i.e. away from the line jack socket.

3.1.9 If the equipment is to be used with a concentrator, the line jack socket should be removed.

3.1.10 Cabling can start now. It may be useful to secure the gland plate, with glanded cables, onto the wall-mounted case by a couple of the fixing screws. Leave sufficient cable unclipped to allow the gland plate to be removed and provide clear access to within the case.

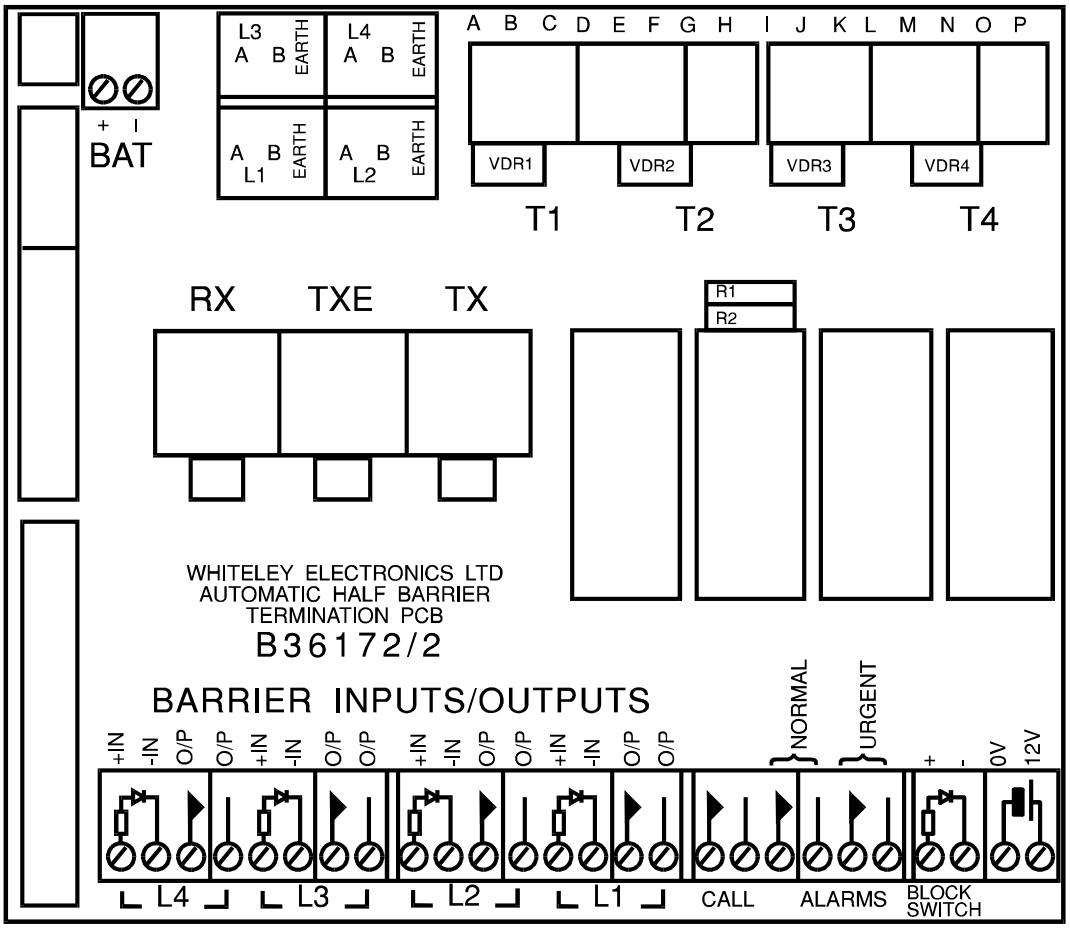


Fig 3.3 Cable Connection Circuit Board

3.1.11 With the cardframe outside the case it is easier to see the individual programming switches. All of the switches are located on the motherboard and are labelled SW1 to SW6. The switch positions are identified in Fig 3.2.

It is now important to set correctly the particular characteristics of this installation. Check the settings of each switch against Tables 3.1, 3.2 and 3.3, even though some of the switches will have been pre-set to the required position in the factory.

From the factory pre-set switch positions it will be noted that the default system has the following characteristics:

a) The software selected is for the signalbox.

b) The system operates in ALL CALL configuration,

i.e. signalbox line circuit 1 controls all four line circuits at the remote end with phased ringing between 1 + 2 and 3 + 4.

c) The incoming call repeater relay operates continuously whilst the control telephone rings and may thus operate an additional sounder.

d) The system is set to operate a local control telephone and thus to call the remote telephones the CALL button has to be operated after lifting the control telephone's handset.

e) The block switching mode is inhibited.

f) The physical transmission circuit is selected as four-wire.

g) Auto update is not enabled and thus any changes in status at the remote will be indicated, during conversation, by the intrusion tone. The signalman has to operate "Interrogate" to trigger a data transfer exchange (DTMF tones).

h) Power supply link

When using a 50V power supply, set the link to B-C. For 24V operation set the link to A-B.

Table 3.4 Signal box Equipment External Terminal Allocations

CIRCUIT REFERENCE	TERMINAL LETTER	CONNECTION
T1 Two wire circuit	A & B	Circuit pair to remote equipment. (or to intermediate box in the case of a distant signalbox.
	C & D	Circuit pair to main box (only used in block switching). This pair is not used at the main box.
T2 600R termination and changeover circuit	E & F	Input - relay contacts either provide 600R load or route to G & H
	G & H	Output
N.B. Maintains hybrid stability ina blocked-switched two-wire system		
T3 4-wire output (transmit) circuit.	I + J	Circuit pair to remote equipment (or to intermediate box in the case of the distant signalbox).
	K + L	Circuit pair to output (four-wire) from distant signalbox.
T4 4-wire input (receive) circuit.	M + N	Circuit pair from remote equipment (or from intermediate box in the case of the distant signalbox.
	O + P	circuit pair routing to distant signalbox.

3.1.12 Before re-fitting the cardframe within the case familiarise yourself with the termination card arrangement. This is also clearly detailed in fig 3.3.

3.1.13 Re-fit the cardframe, taking care not to damage the components on the termination PCB.

3.1.14 Fit the label strip to the inside of the perspex front panel, by means of self-adhesive tape. Ensure the apertures align with the barrier status indicators,and that the label has been marked with the location of each remote telephone.

3.1.15 Wiring the various circuits

The termination PCB is shown in fig 3.3 and provides all external interfaces. It should be noted that the equipment is designed to comply with BS6301 (Network and User electrical safety) in that all transmission circuits are isolated from the rest of the equipment. NB: Isolation voltage checks are conducted at 3.5kV RMS. To preserve this isolation, it is essential that transmission circuits do not share the same multi-pair cable as local connections.

The termination card is split into a number of areas, as follows:

a) DC power input - a two-way terminal block to the top left of the card. The incoming DC power terminations are clearly labelled positive and negative.

b) Local line circuits - to the middle left of the top of the termination card. All four circuits are provided on individual three-way terminal blocks. In the signalbox equipment the line jack unit will have been pre-wired to line circuit 1. The remaining line circuits are only used in the alternative configuration modes. Line circuit wiring may be extended to a remote concentrator.

The earth connection is not used in any configuration of the signalbox equipment and leakage loop testing is not applied.

c) Transmission circuits - all of the transmission circuits are isolated from all other circuits to conform with BS6301 (Network and User electrical safety). In order to maintain isolation if the transmission path is provided by a direct connection to a public telephone network you should not mix the transmission circuit pairs with any of the other circuits used for this system in the same cable.

d) Contact inputs/outputs - these terminals are located to the lower left-hand portion of the termination PCB. All outputs are volt-free contacts and all inputs are via opto-isolators (volt-free). The opto-isolators require a DC drive voltage to operate, and are polarised.

The relay contact outputs are identified by the legend "Out" and are associated with each of the line circuits, i.e. L1 to L4. The opto-isolator inputs are identified by the legends " + IN " and " - IN " and require a voltage of correct polarity in the range 12V DC to 50V DC.

The bi-directional signalling is associated with the line card provision. Hence in the standard equipment, with only line Card 1 installed, only one output/input associated with L1 is available.

e) External call sounder - a pair of terminals are located to the middle of the lower row and are labelled "CALL". These terminals are connected to a normally-open volt-free contact set which closes during an incoming call and remains closed until it is answered.

f) Equipment alarms - further to the right on the bottom row of terminals, four terminals are provided above the legend "ALARMS". One pair is labelled "Normal", the other pair labelled "Urgent".

The latter pair will be connected to the buzzer via the +12V supply. The "Urgent" alarm contacts are connected fail-safe so that the circuit closes in the event of total power failure. The buzzer may be disconnected and the circuit can be extended to an external fault-logging device.

The "Normal" alarm contacts are not normally used. These contacts additionally indicate non-urgent faults such as a handset being left off-hook at the remote end.

g) Block switch - this pair of terminals is located to the bottom right of the termination PCB. The terminals connect through to an opto-isolated input and are thus polarised, identified by the "+" & "-" legends. When selected (by software control switch), a voltage (between 12 and 50V DC) will cause the unit to re-route the transmission circuits to a distant box, and cause the "Switched Out" front panel indicator to flash.

h) Local Supply - the equipment operates from a locally-generated 12V supply which is suitably regulated down to a 5V rail for the microprocessor. All internal relays operate from this 12V supply, which is capable of supporting an additional (external) 100mA load.

The lower far right terminals provide this 12V supply, which is reserved for operating the local buzzer and/or the manual block switch.

3.1.15 In order to assist with the system wiring, further details are provided in Figs 3.6 to 3.8.

3.1.16 Once the wiring is completed, the gland plate should be replaced, taking care not to trap the wires.

3.1.17 If the equipment is to be installed and tested at the same time, then refer now to section 4.2, Testing Signal box Equipment.

If not, then ensure all cards are located correctly and replace the front panel assembly. The signalbox installation is now complete.

3.1.18 Special Note: If the equipment is to be installed and tested at the same time, power up the signal box equipment, and test it locally, before travelling to the remote site to commence installation.

3.2 REMOTE EQUIPMENT INSTALLATION

First of all it is useful to establish whereabouts the equipment is to be mounted. The equipment is designed to mount within signal equipment racking practice and will normally be installed in a trackside location cabinet or in a nearby apparatus room. For reliable operation of the vandal-detection feature, it is recommended that the equipment is installedsuch that the total loop resistance of the connected telephones is less than 1000 ohms.

3.2.1 Unpack the remote site equipment and establish that it is the correct item. The remote equipment is identifiably different to the Signalbox equipment in the following features.

a) Steel front with perspex window with no holes.

b) Gland plates with rubber seal gaskets.

3.2.2 The dismantling procedure is similar to that for the signal box equipment in 3.1.1 to 3.1.5. However, there are no wires to remove.

3.2.3 The housing may now be fixed to the signal equipment frame; it requires the same space as two relays. Additional clearance should be given to allow for cable entries.

3.2.4 Identify the various installation cables required. As a minimum, these will be as follows:

a) DC power feed - a single pair of 1mm cables with colour identification. The power supply may be from a telecomms or signalling battery source of between 22V and 57.5V DC. It is immaterial whether the

Table 3.5 Remote Equipment Motherboard Switch Settings CPU (SW5A, B, C, D, E, F)
(* denotes Factory set Option)

SWITCH	DESCRIPTION OF MODE	SWITCH TO THE LEFT (off)	SWITCH TO THE RIGHT (on)
A	Intrusion tone, on barrier change	Enable *	Disable
B	Test mode	Normal *	Test mode enable
C	Call relay signalling.	Contact closes * continuously during incoming ringingperiod.	Contact operates in sympathy with incoming ringing sequence
	NB: this relay operates the external sounder. Set switch to suit desired sounder effect.		
D	Busy tone	Engaged tone is provided to a second caller	Second caller receives ringing tone until signalman answers *
E	System software	Selects remote system *	Selects signalbox system
F	Auto update	Auto update enabled i.e. any change of status results in automatic DTMF transmission.	Auto update disabled. Signalman has to * operate Interrogate button manually.

battery is earth-free, positive, or negative earth. It is recommended that the feed is fused at source and should be 2A @ 24V or 1A @ 50V. At level crossings, the crossing barrier battery may be used.

Important: do not install the source fuse until the installation is completed.

b) Transmission circuit - either a single pair or two pairs of 0.5/0.6mm cable.

c) Earth point - See 2.2.5. **Either**: connect the case metalwork to a known safety earth, **or:** remove the PSU Earth Link on the motherboard (see Fig 3.2) and connect the case to bonded metalwork.

d) Telephone circuits - each line circuit will be extended to the remote telephones.

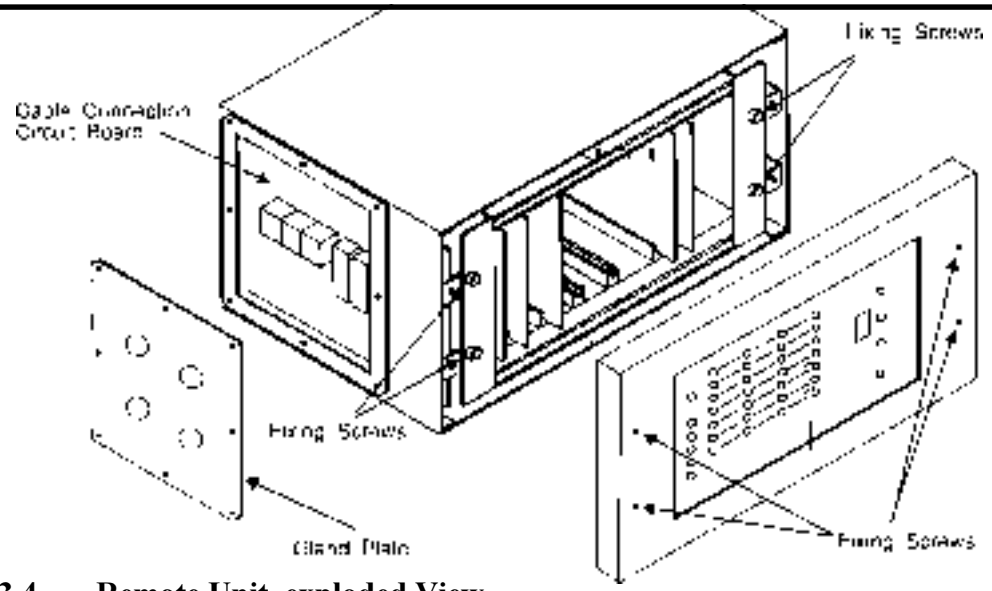


Fig 3.4 Remote Unit, exploded View

Table 3.6 Remote Equipment Transmission Card Switches (SW6 A,B)
(* denotes Factory Set Option)

SWITCH	DESCRIPTION OF MODE	SWITCH DOWN (off)	SWITCH UP (ON)
A	Transmission circuit arrangement	4-wire *	2-wire
B	Reserved for future use	N.A. *	N.A.

Table 3.7 Remote Equipment Line card switches:

Line 1 (SW1 A, B)
Line 2 (SW2 A, B) *
Line 3 (SW3 A, B) switches set to off
Line 4 (SW4 A, B)

It is necessary to set the switches on each line card according to the installation arrangement.:

SW1 SWITCH	DESCRIPTION OF MODE	SWITCH TO LEFT (off)	SWITCH TO RIGHT (on)
A	Call method	Loop disconnect calling* (2-wire)	Earth loop calling (3-wire)
B	Not used	N/A *	N/A

Table 3.8 Remote Equipment External Terminal Allocations

CIRCUIT REFERENCE	TERMINAL LETTER	CONNECTION
T1 Two wire circuit	A & B	Circuit pair to signal box equipment.
	C & D	Not used.
T2 600R termination and changeover circuit	E & F	Input - relay contacts either provide 600R load or route to G & H. (not normally used).
	G & H	Output (not normally used).
T3 4-wire output (transmit)	I & J	Circuit pair to signal box equipment.
	K & L	Not used.
T4 4-wire input (receive) circuit	M & N	Circuit pair from signal box equipment.
	O & P	Not used

From the above basic requirements, the following may be required as determined by system planning (Section 7):

e) Contact status signalling - a multi-pair 0.5/0.6mm cable. One pair for each barrier circuit.

Good installation practice means that the minimum number of glands (20mm plastic) should be obtained. The knockout holes on the gland plate should now be removed as appropriate.

3.2.5 Cable installation can start now. It may be useful to secure the gland plate, with glanded cables, onto the case by a couple of the fixing screws.

Leave sufficient cable unclipped to allow the gland plate to be removed and provide clear access to within the case.

3.2.6 With the cardframe outside the case it is easier to see the individual programming switches. All of the switches are located on the motherboard and are labelled SW1 to SW6. The switch positions are identified in Fig 3.2.

It is now important to set correctly the particular characteristics of this installation. Check the settings of each switch against Tables 3.1, 3.2 and 3.3, even though some of the switches will have been pre-set to the required position in the factory.

Factory Set Options

From the factory pre-set switch positions it will be noted that the default system has the following characteristics:

a) The software selected is for the remote end.

b) Test mode is disabled.

c) The incoming call repeater relay operates continuously whilst any of the remote telephones ring and may thus operate an additional sounder.

d) If a call is already in progress from one of the remote telephones, a second caller attempting to use another remote telephone will receive ring tone until the signalbox answers the second call.

e) Power supply link

When using a 50V power supply, set the link to B-C. For 24V operation set the link to A-B.

The arrangement is somewhat complex in order to cope with a variety of circuit configurations, both 2-wire and 4-wire. The switch settings are detailed in Table 3.6.

3.2.7 Before re-fitting the cardframe within the case familiarise yourself with the termination card arrangement. This is also clearly detailed in Fig 3.3.

3.2.8 Re-fit the cardframe, taking care not to damage the components on the termination PCB.

3.2.9 Wiring the various circuits.

The termination PCB is shown in Fig 3.3 and provides all external interfaces. It should be noted that the equipment is designed to conform to BS6301 (Network and User electrical safety) in that all transmission circuits are isolated from the rest of the equipment. NB: Isolation voltage checks are conducted at 3.5kV RMS.

The termination card is split into a number of areas, as follows:

a) DC power input - a two-way terminal block to the top left of the card. The incoming DC power terminations are clearly labelled positive and negative.

b) Local line circuits - to middle left of the top of the termination card. All four circuits are provided on individual three-way terminal blocks. Each remote telephone will normally use its own dedicated line circuit, and up to four line circuits are available depending upon the installed configuration. Terminals A & B provide the normal two-wire (loop-disconnection calling) circuit. The earth terminal is required for 3-wire connections (earth calling).

c) Transmission Circuits - all of the transmission circuits are isolated from all other circuits to conform with BS6301 (Network and User electrical safety). In order to maintain isolation if the transmission path is provided by a direct connection to a public telephone network you should not mix the transmission circuit pairs with any of the other circuits used for this system in the same cable.

d) Barrier inputs/outputs - these terminals are located to the lower left-hand portion of the termination PCB. All outputs are volt-free contacts and all inputs are via opto-isolators (volt-free). The opto-isolators require a DC drive voltage to operate and are polarised.

The relay contact outputs are identified by the legend “CALL” and are associated with each line circuit, i.e. L1 to L4. The opto-isolator inputs are identified by the legends

“+ IN” and “- IN” and require a voltage of correct polarity in the range 12 to 50V DC.

The bi-directional signalling is associated with the line card provision. Hence in the standard equipment, with only line card 1 installed, only one output/input associated with L1 is available. Only the IN connections will be used in normal systems.

e) External call sounder - a pair of terminals are located to the middle of the lower row and are labelled “CALL”. These terminals are connected to a normally-open volt-free contact set, which closes during an incoming call and remains closed until it is answered. This feature will not normally be used.

f) Equipment alarms - further to the right on the bottom row of terminals, four terminals are provided above the legend “ALARMS”. One pair is labelled “Normal”, the other pair labelled “Urgent”. These circuits are not normally connected at this end of the installation.

g) Block switch - not used.

h) Local Supply - the equipment operates from a locally generated 12V supply, which is suitably regulated down to a 5V rails for the microprocessor. All internal relays operate from this 12V supply, which is reserved for local use.

3.2.10 In order to assist with the system wiring, further details are provided in Figs 3.7 to 3.10.

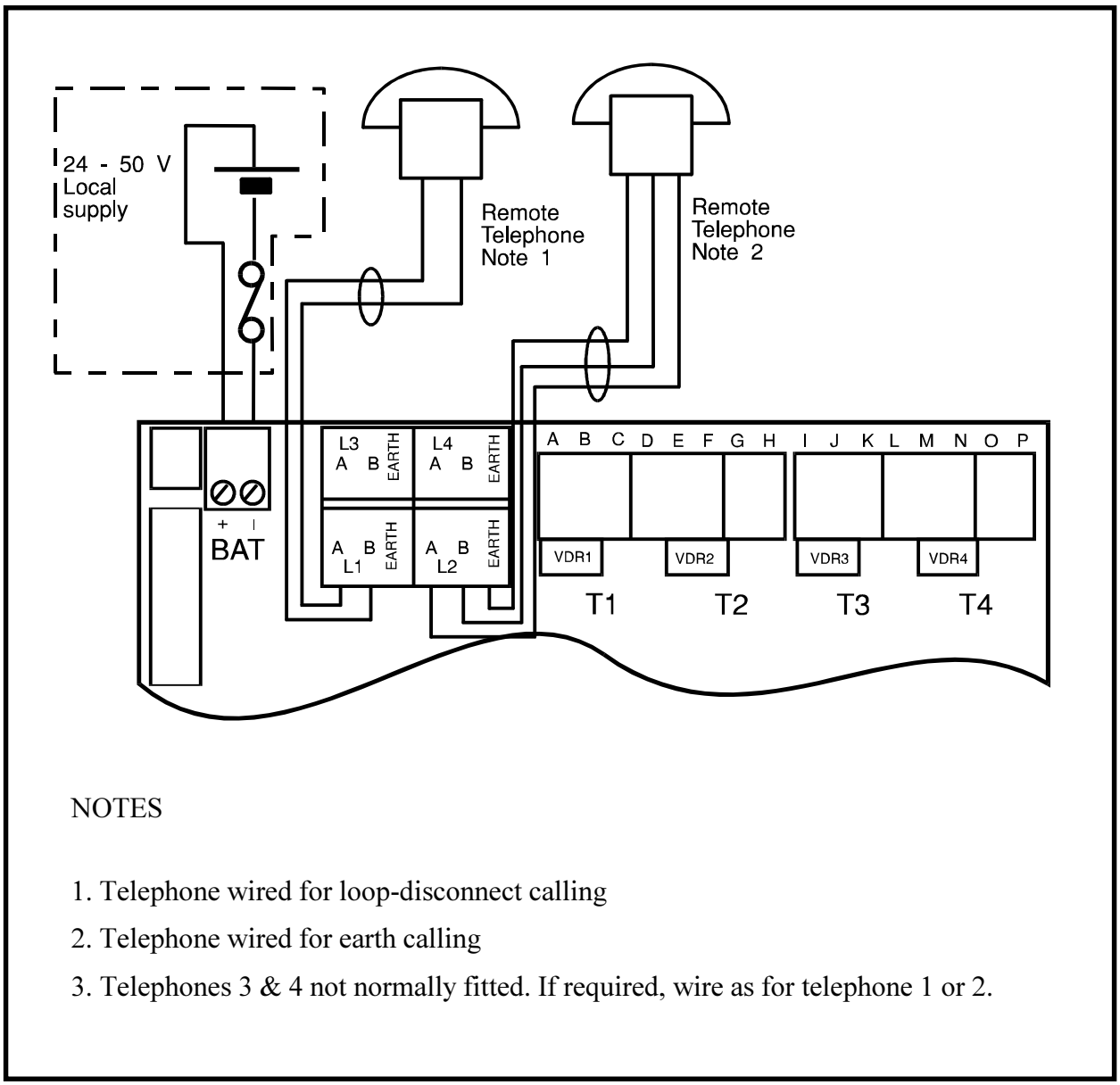
3.2.11 Once the wiring is completed, the gland plate should be replaced, taking care not to trap the wires and that the sealing gasket is correctly seated.

3.2.12 If the equipment is to be installed and tested at the same time, refer now to section 4.3, Testing Remote Equipment.

If not, then ensure all cards are located correctly and replace the front panel assembly. The remote end installation is now complete.

3.3 Wiring Diagrams

The following pages contain wiring diagrams to assist with the installation.



NOTES

1. Telephone wired for loop-disconnect calling
2. Telephone wired for earth calling
3. Telephones 3 & 4 not normally fitted. If required, wire as for telephone 1 or 2.

Fig 3.5 Remote Unit Local Wiring Diagram

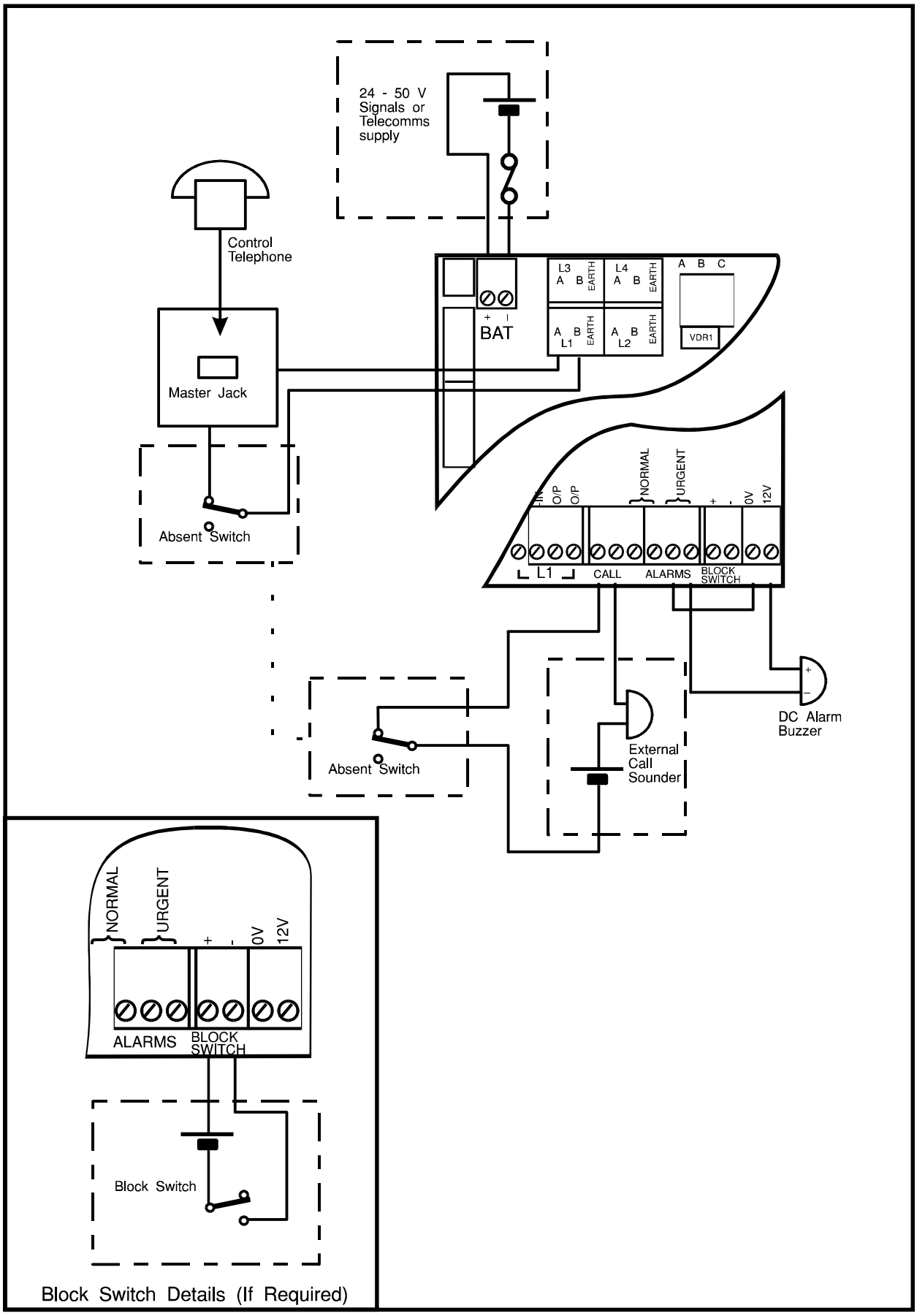


Fig 3.6 Signal Box Local Wiring Diagram

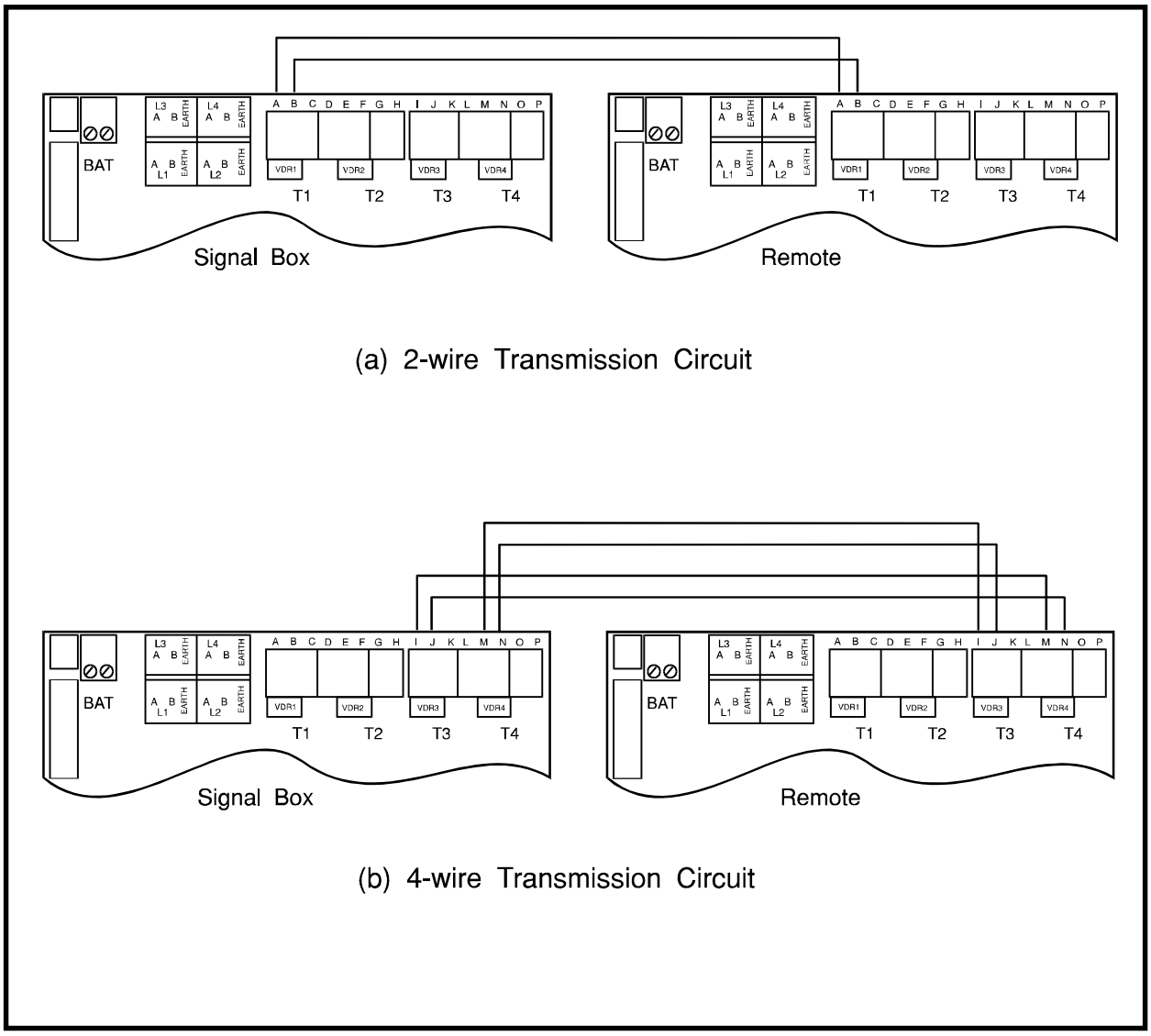


Fig 3.7 Transmission Circuit Wiring without Block Switching

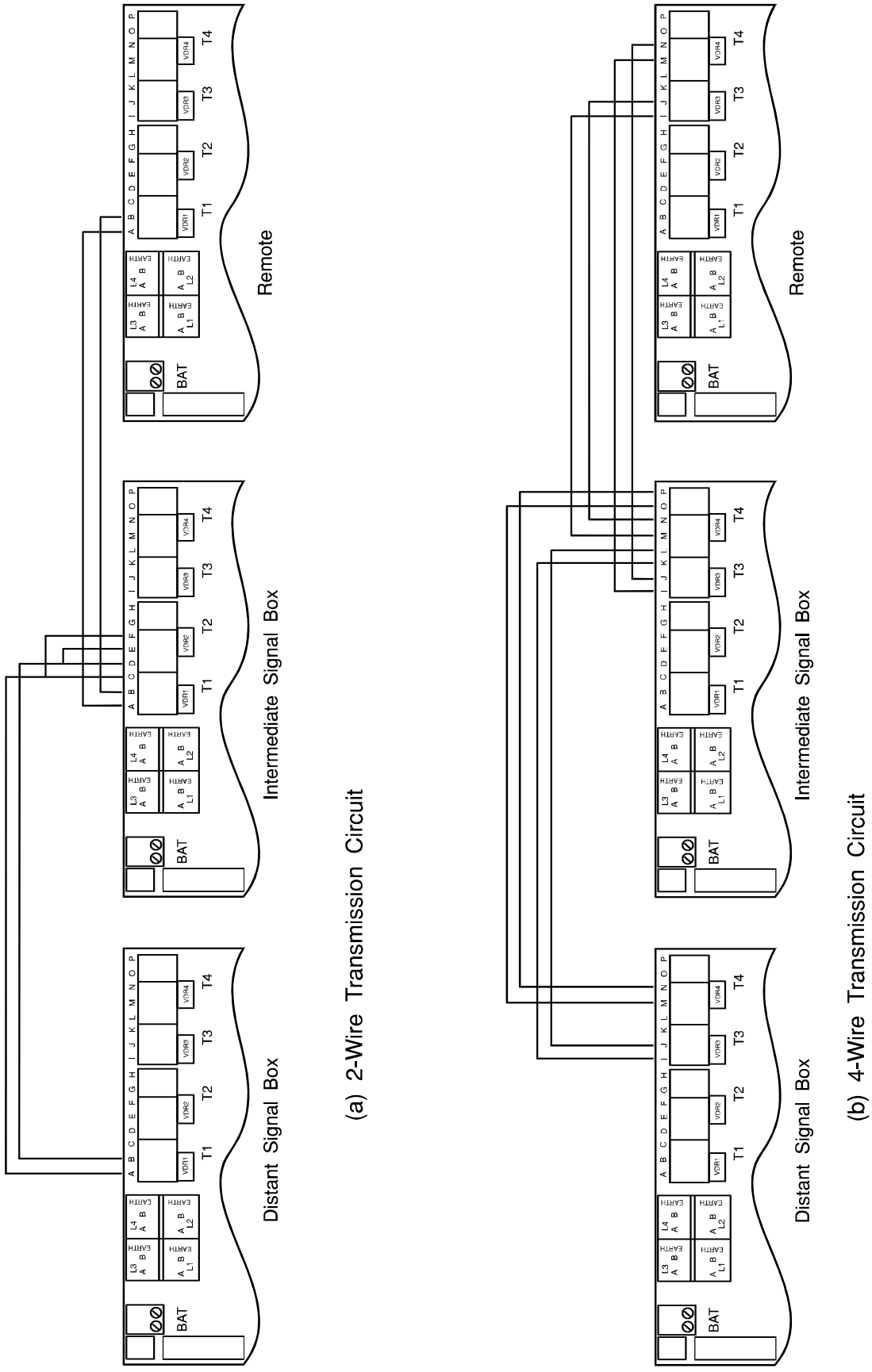
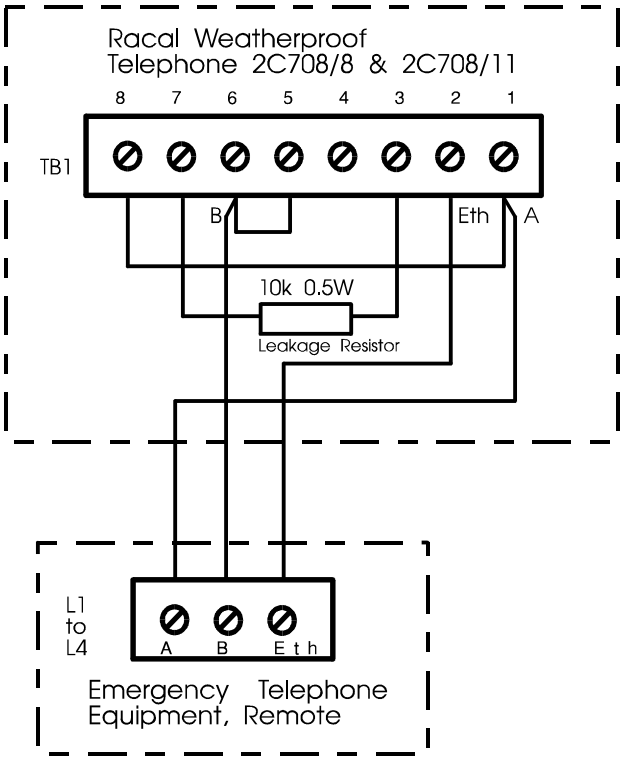
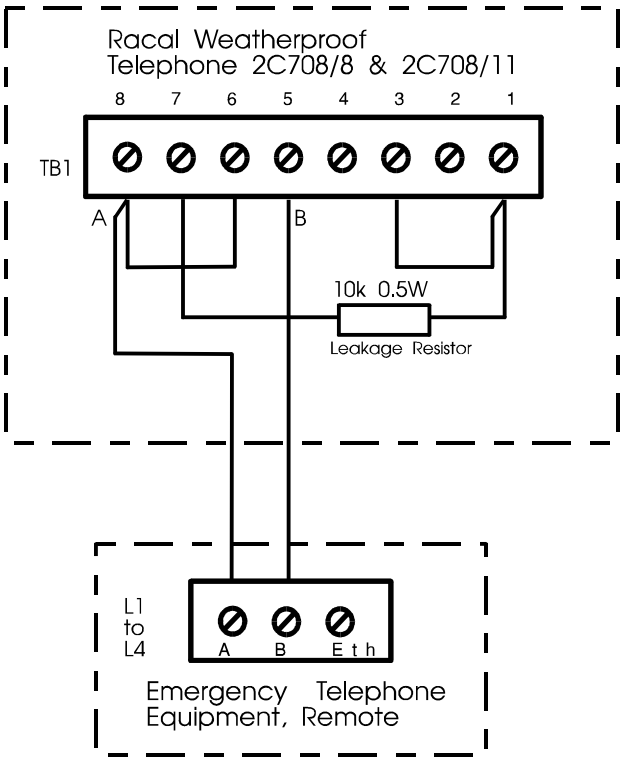


Fig 3.8 Transmission Circuit Wiring with Block Switching

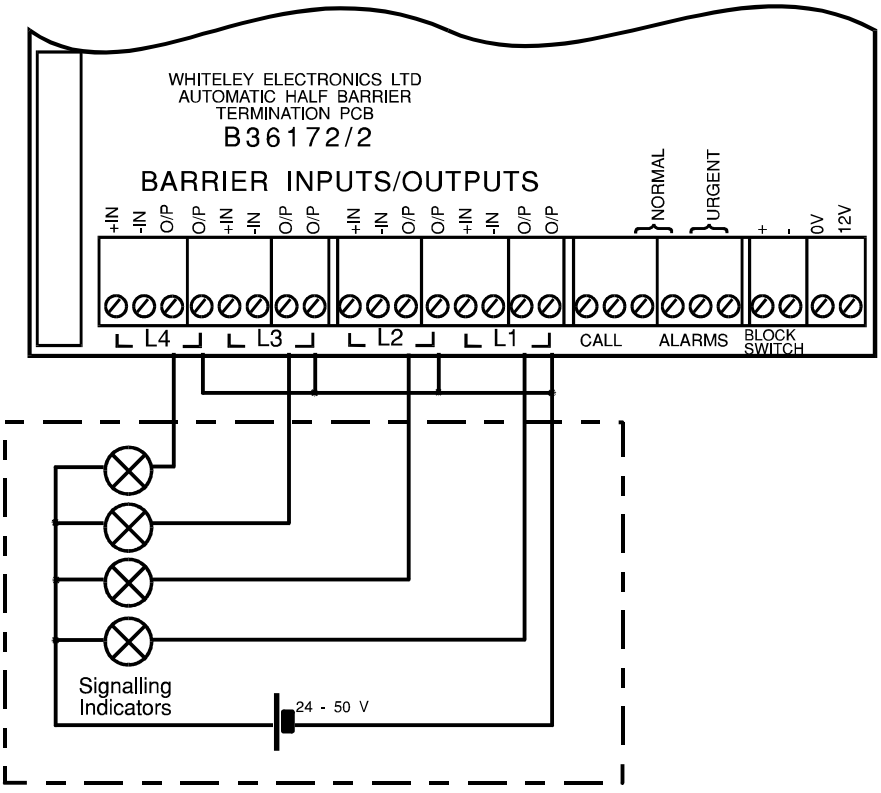


Telephone Wired for Earth Calling

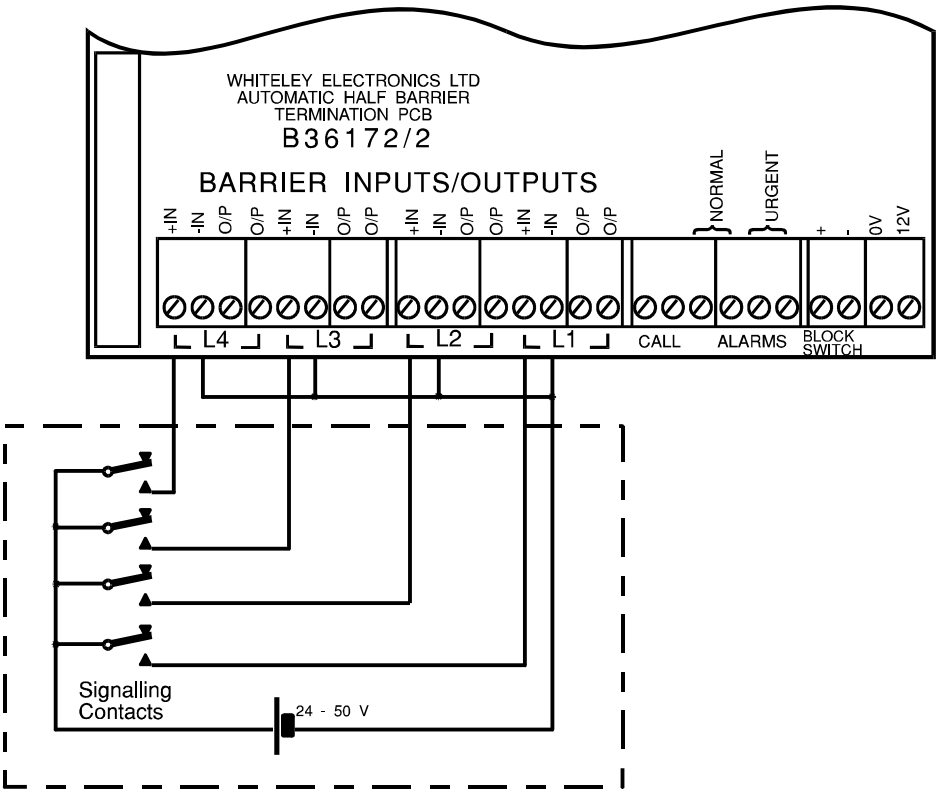


Telephone Wired for Loop Disconnect Calling

Fig 3.9 Wiring of Racal Telephones



(a) Signal Box Wiring (typical)



(b) Remote End Wiring (typical)

Fig 3.10 Wiring of Contact Indicators

4. TESTING

4.1 PRELIMINARY

It is possible for one person to install and test the system. However, in these circumstances the signal box equipment will be installed and immediately powered. Only limited checks can be performed on the signal box equipment without a connected remote system; these will be visible checks on the front panel LED status.

Following the installation and powering of the signal box equipment the remote equipment will be installed on site and powered. Testing will be undertaken from the remote end, with basic assistance from the signalman.

Testing will be speeded up by having staff at both ends of the installation. This will enable a more complete check of the functions at the signal box end.

4.2 SIGNAL BOX EQUIPMENT

4.2.1 Power-up checks

(remote transmission circuit not connected)

Check the polarity and fuse ratings of the main power feed and if correct then insert the fuse to apply power.

Confirm the following observations:

a) Incoming DC indicator is illuminated.

b) +5V, +12V and -60V internal supply rail indicators are illuminated.

c) The buzzer sounds and alarm code “C” is displayed (i.e. communication lost with remote end, as transmission circuit is not connected).

d) DTMF LINE OUT indicator flashes, but DTMF LINE IN does not illuminate.

Operate the Interrogate button to silence the buzzer, continue to hold down the button (interrogating) to see if any other alarms are present. No other alarms should be indicated and the display should scan directly to the hyphen symbol.

Release the button and confirm that the “C” alarm is displayed (as the remote communication has not yet been established).

4.2.2 Partial Completion

The signal box equipment is now partially tested. Further tests will be conducted in conjunction with the remote equipment, when assistance will be required to check responses within the signal box.

Before leaving the signal box ensure that the transmission circuits are connected and that the signalman has been familiarised with the equipment.

4.3 REMOTE EQUIPMENT

Before commencing it is assumed that the early tests at the signal box in 4.2.1 above have been undertaken and that the transmission circuit is connected.

4.3.1 Power-up checks

Check the polarity and fuse ratings of the main power feed and if correct then insert the fuse to apply power.

Confirm the following observations:

a) Incoming DC indicator is illuminated.

b) +5V, +12V and -60V internal supply rail indicators are illuminated.

c) At power-up the alarm code indicator displays “C” for a short period of time

(this may not be observed if you are unable to see the equipment immediately after power-up). The display should return to a hyphen once communication is established with the signal box.

d) The DTMF TX and RX indicators are illuminate alternately.

e) The “Vandal loop” indicators of the attached line circuits are illuminated i.e. OK.

Observe the alarm code indicator for at least 30 seconds after power-up. Any problems with the line circuits will be identified at this time, as follows:

Alarm codes 0, 1, 2, 3 indicate faults on the vandal loop circuits of lines 1, 2, 3, 4 respectively. This may be an open circuit line connection, or an incorrectly modified telephone.

Alarm code 8, 9, 0, 1 (lower case, little 0 and 1) indicate a continuous off-hook condition from lines 1 to 4 respectively. This may be a short circuit line connection, or an incorrectly modified telephone.

4.3.2 Functional tests

The following is a full test of the system. It is essential to obtain assistance within the signal box. All observations may be confirmed using the system to communicate with the signal box.

Use Table 4.1 to record the results of each test. A successful result should be indicated by a tick.

4.3.2.1 Line Circuits

a) Lift the telephone handset and confirm that dial tone is provided.

b) Operate the CALL button and confirm that a ringing tone response is provided.

c) Establish conversation with the signal box (NB: DTMF tones will be heard). Confirm speech quality and signal level. Ask the signal box to observe the special intrusion (warning) tone when you clear the call, and then to ring you back.

d) Confirm that the telephone rings properly.

e) Answer the call and establish conversation, again confirm quality. Ask the signal box to clear the call and confirm that dial tone is returned.

f) Keep the handset "off-hook" (without operating the CALL button); after 30 seconds the NU tone will be heard. Wait five seconds. Operate the CALL button, ring tone will be heard, establish speech with the signal box and confirm that the "off-hook" alarm code 6 was raised at the signal box.

g) Clear the call to the signal box by replacing the handset. Disconnect the telephone from line for at least 35 seconds or disconnect the leakage resistor in the telephone. Reconnect it and establish conversation with the signal box. Check that alarm code 0 (vandal alarm) was raised at the signal box.

h) Establish a CALL to the signal box, but when ringing tone starts, replace the telephone handset. Establish that the CALL has been latched, i.e. continues to ring at the signal box.

NOTES

1. All four line circuits are shown, although normally only two line circuits will be equipped.
2. If more than two line circuits are equipped, and depending on the mode configuration, a test shall be conducted to confirm originating caller identity.

4.3.2.2 Line circuit interaction tests

These tests are determined by system configuration. In mode 1 (ALL CALL) the tests shall he conducted between all installed line circuits. In mode 2 (Paired) the tests shall be conducted between the line circuits on each pair only. In mode 3 (Solo) the tests are not relevant.

Use Table 4.1 to record the results of each test. A successful result should be indicated by a tick.

The normal level crossing is installed as mode 1 (ALL CALL) and thus these test shall be undertaken between all installed line circuits.

a) Lift the telephone handset, do not operate the CALL button. NU tone will be received after 30 seconds.

b) Leave the telephone off-hook on this phone and go to each other connected phone to confirm that a call may be established.

c) The signal box should now establish a call and ringing tone should be confirmed at all other remote phones.

d) Repeat the above procedure until all remote phones have been tested, such that if only one telephone remains on hook, calls may still be received.

e) Leave a second telephone off-hook: until NU tone is received and confirm that the signal box receives a buzzer warning and alarm code 1 is raised.

f) Replace all remote telephone handsets.

g) Establish a call on one of the remote telephones and leave the phone off-hook in conversation.

h) Go to another remote telephone and establish a CALL.Confirm that ringing tone is heard, that the signal box receives the intrusion (warning) tone. (**NB:** The signal box will replace the control telephone handset after the intrusion tone). Confirm that the signal box phone rings back immediately and that the second call is established.

4.3.2.3 Transmission Circuit Tests

Disconnect the transmission circuit for a period of one minute. Reconnect and confirm that the loss of communication alarm was received at both ends of the equipment. On four-wire circuits, disconnect the transmit and receive circuits separately, and then together.

4.3.2.4 Contact status indications

Individual installations may vary by the way in which contact status indications are applied. Obviously an indication circuit used to show the level crossing "barrier down" condition is best proved by observing the operation of indicators at the signal box. An equipment alarm

TABLE 4.1 **TEST CHECK SHEET**

4.3.2.1	**Line Circuit tests**	1	2	3	4
a)	Dial Tone	( )	( )	( )	( )
b)	Make Call	( )	( )	( )	( )
c)	Speech Quality	( )	( )	( )	( )
d)	Ringing	( )	( )	( )	( )
e)	Answer Call	( )	( )	( )	( )
f)	Off-hook Alarm	( )	( )	( )	( )
g)	Vandal Alarm	( )	( )	( )	( )
h)	Call Latching	( )	( )	( )	( )
4.3.2.2	**Line Interaction Tests**				
a)	1 phone off-hook - NU tone	( )	( )	( )	( )
b)	Call with phone off-hook	( )	( )	( )	( )
c)	Ring with phone off-hook	( )	( )	( )	( )
d)	Multiple phones off-hook	( )	( )	( )	( )
e)	Two off-hook alarm	( )	( )	( )	( )
h)	Second Call	( )	( )	( )	( )
4.3.2.3	**Transmission Circuit Tests**	( )	( )	( )	( )
4.3.2.3	**Contact Signalling Tests**				
a)	Signalling Works	( )	( )	( )	( )
b)	Signalling during Conversation	( )	( )	( )	( )
4.4.5	**Signal Box Completion**				
a)	No Alarms	( )	( )	( )	( )
b)	Cover fitted OK	( )	( )	( )	( )
c)	Instructions displayed	( )	( )	( )	( )
d)	Staff informed	( )	( )	( )	( )

signal may have to be simulated by some means which does not interfere with equipment operation.

a) Confirm the operation of contact signalling.

b) Confirm the operation of contact signalling during conversation mode, i.e. that the intrusion (warning) tone is produced and that clearing the signalman's phone or operating the Interrogate button provides the update of contact signalling status.

NOTES

1. Signalling may be subjected to a maximum 1.6 seconds switching delay.

2. Signalling is provided in the signal box to remote direction but this is reserved for future applications.

4.3.2.5 Site Checks

Before leaving the remote site ensure that there are no alarms showing on the seven-segment indicator. The front cover should be secured correctly to ensure an environmental seal.

The site should be inspected to ensure that all telephones are suitably labelled in accordance with the statutory requirements.

4.4 COMPLETION AT THE SIGNAL BOX

Completion tests at the signal box will depend on the specific installation. The following facilities should be tested if installed:

4.4.1 Absent switch

The "Absent" switch will normally disconnect the control telephone to disable the ringing signal whilst the signal box is unattended. In some instances the switch will route the line circuit to a telephone answering device which provides an automatic announcement to a caller during the absent period. Confirm the operation of the Absent switch.

4.4.2 Block switch

The block switch causes the transmission circuit to be re-routed. The switch should not be operated during a call. In order to test a system with a block switching arrangement it will be necessary to repeat the tests at each signal box to which the system is capable of working.

The block switch function will suppress communication failure alarms on the signal box equipment which is disconnected. It should be noted that a special alarm code " ? " is provided to identify certain installation faults on the block transmission circuit changeover. This alarm code identifies that DTMF tones are being received, when they are not expected.

Confirm the operation of the block switch and repeat the commissioning test to all other interconnected signal boxes.

4.4.3 Alarm buzzer

The alarm buzzer will sound for any "Urgent" alarm and will be silenced when the alarm is acknowledged by the Interrogate button.

4.4.4 External call signal

Additional call sounders may be installed (particularly where confusion may arise between the sounds generated by other telephones in the signal box).

If an absent switch is also installed, then the external call sounder will also have to be disabled by the absent switch. Confirm operation of the sounder as either in sympathy with an incoming ringing signal, or continuously during the ringing sequence, as required.

4.4.5 Completion

a) Ensure that no equipment alarms are raised.

b) Ensure that the cover is correctly fitted.

c) Ensure that the "Instructions for use" are clearly displayed.

d) Ensure that the signal box staff are fully conversant with the operation of the equipment.

5. MAINTENANCE

Maintenance on faulty equipment will confined to be diagnosing problems at PCB level only. This section therefore provides sufficient information to locate such faults and to provide guidelines on fault-finding to external plant and transmission circuits.

5.1 SAFETY NOTES

5.1.1 Ringing voltage and high voltage DC (60V) exceed the EEC low voltage directive and are dangerous voltages.

5.1.2 Within the railway environment "ground potential rise" can occur. Before working on transmission and telephone line interface, check with a voltmeter.

5.1.3 Check for voltage difference between signalling frames and feeding battery. Ensure integrity of signalling apparatus.

5.1.4 Make sure there is a safe earth on all equipment, or it is bonded to structural metalwork, whichever is appropriate.

5.1.5 Under fault conditions, certain pcb components can get hot. In particular: DC-DC convertor components, and loop-feed resistors on line cards.

5.1.6 When removing cards from the frame, they may release suddenly. Ensure you are standing correctly and do not fall. Also be cautious of sharp edges of component leads on circuit boards.

5.1.7 DC voltage will be retained for a short time in electrolytic capacitors of the power supply unit.

5.1.8 Electronic components contain hazardous substances, in particular Beryllium Oxide. Do not open or touch broken components. Dispose of safely.

5.1.9 Observe the procedures in the BR Track Safety Handbook when working on, or about, the trackside.

5.2 EQUIPMENT SELF-DIAGNOSTICS

The most significant aid to fault-finding are the various indications provided on the front panel. It is therefore possible to undertake fault analysis by asking a signalman to describe the front panel indications before attending site with the most appropriate spares.

5.2.1 Alarm codes - signal box

Alarm codes are indicated on a seven-segment display (CPU card). The highest priority alarm will be displayed normally; secondary alarms may be revealed by operating the Interrogate button and allowing the codes to cycle until the hyphen is reached. See Table 5.2 for a more detailed explanation.

Like the Remote equipment, the signal box equipment is provided with numerous indicators to aid fault diagnosis. In order to avoid possible confusion to the signalman, a number of the indicators are masked by the front panel. The following indicators are visible through the front panel:

5.2.2 Front panel indicators - signal box

Working from left (transmission card) to right (power supply and ringer card), we note:

a) SWITCHED OUT. This indicator will flash to warn the signalman that the equipment is inactive due to block switching.

b) ALARM 1. Non-urgent alarm (as remote equipment).

c) ALARM 2. Urgent alarm (as remote equipment).

d) DTMF TX LINE OUT. When illuminated, the signal box equipment is transmitting data to the remote equipment.

e) DTMF RX LINE IN. When illuminated the signal box equipment is receiving DTMF data from the remote equipment. The DTMF RX indicator should

Table 5.1 Signal Box Equipment Alarm Codes

Alarm Code		Condition	Comments
(Urgent)		Microprocessor watchdog alarm, or failure of the 5V rail.	a) Check the front panel 5V rail indicator; if extinguished replace the PSU. b) Operate the reset switch on the CPU card.If this does not resolve the fault, replace theCPU card.
(Urgent)		EPROM memory fault, checksum mismatch.	Operate the CPU reset button. If this fails to clear the fault then replace the CPU card.
(Urgent)		RAM fault, walking code error.	Operate the CPU reset button. If this fails to clear the fault then replace the CPU card.
(Urgent)		Communication failure.	Check the DTMF TX and RX indicators. If TX is not operating, the fault may be on the transmission card.If the RX indicator is not operating, then the fault will be (a) on the transmission TX or RX circuit, (b) at the remote equipment, or (c) on the signalbox transmission card.
(Urgent)		60V internal DC rail.	Failure may be in the following areas: (a) on the PSU (DC-DC converter) card, or (b) excessive current to a line card.
(Urgent)		12V internal DC rail from the DC-DC converter is low.	Failure may be in the following areas: (a) on the PSU card, (b) on a line card, (c) on the transmission card, or (d) on the CPU card.
(Urgent)		Failure of remote equipment.	Attend remote site and analyse its local alarm code indicator.
(Urgent)		remote telephone vandalised.	Attend remote site and analyse alarm code to identify affected line circuit. Fault may be (a) break in line circuit, or (b) damage or vandalism to handset cordage.
(Urgent)		Multiple off-hook conditions at remote.	Generally this will not be caused by engineering faults. The signalman must caution all trains and the site must be attended by operational staff to replace handsets.
(Urgent)		Ringer failure.	After six rings in sequence, ringing voltage remains low. (a) Check line circuit for short circuits. (b) Replace PSU card (possible failure of ringing generator).
(Non-urgent)		Remote telephone off-hook.	Generally this will not be caused by engineering faults. Site must be attended by operational staff to replace handset on hook.
(Urgent)		Control telephone left off-hook.	Signalman must check that the telephone handset is securely on-hook.
		DTMF tones received when block switched out.	Something wrong with the wiring of the transmission circuits.

always show a response to a DTMF transmission. ie the TX and RX indicators should follow, a flicker on RX follows a flicker on TX. It will be noted that DTMF activity is suspended once a call is established. Indicators a) to e) are part of the transmission card.

f) BARRIER O/P. This indicator may be displayed to the signalman by providing an aperture in the line card reference label. NB: It may not be appropriate for the signalman to see this indicator. When illuminated the relay output contact is closed and signifies that a voltage condition has been provided to this particular line circuit at the remote equipment.

g) BARRIER I/P. This indicator is again optionally displayed to the signalman according to the labelling arrangement. The indicator operates when a voltage is applied to the barrier input terminals at the signal box equipment. This particular signalling facility is reserved for future use.

h) CALL IN. This indicator operates when a call is received from the equipment.

i) CALL OUT. This indicator operates when a call is made to the equipment.

Indicators (f) to (i) are provided for each installed line circuit. In the basic single control telephone installation, only one line circuit (line card 1) will be provided unless additional barrier signalling capacity is required.

j) POWER ON. The presence of the external power supply is indicated.

This indicator is part of the power supply and ringer card. Indicators for the various power supply rails and telephone line status are provided internally in the same relative positions as the remote equipment. It should be noted that the "Vandal Loop" and "Call" indicators are not relevant to the signal box equipment. The "Call" indicator is substituted by the "switched out" indicator.

5.2.3 Alarm Codes -Remote

Alarm codes are indicated on a seven-segment display (CPU card). The highest priority alarm will normally be displayed. Secondary alarms may be revealed by operating the Interrogate button and allowing the codes to cycle until the hyphen is reached. See Table 5.3 for a more detailed explanation.

5.2.7 Front panel displays - Remote

Working from left (transmission card) to right (PSU card), we have:

a) CALL. This indicator will operate when any of the remote telephones has ringing current applied. The "Ring OK" and "CALL IN" indicators will also operate on the appropriate line.

b) ALARM 1. This indicator operates to signify a non-urgent alarm status, typically one telephone off-hook timeout.

c) ALARM 2. This indicator operates to signify an urgent alarm pending. The alarm type may be read off the seven-segment display, and secondary alarms may be revealed by operating the Interrogate button.

d) INT. TONE (Intrusion tone). This indicator operates whilst the intrusion tone is applied to the speech path.

e) DTMF TX. This indicator operates whenever the equipment is transmitting DTMF tones to the signal box. By observing the operation of TX together with RX, useful diagnosis of the transmission circuit performance may be undertaken.

f) DTMF RX. This indicator shows when DTMF tones are received from the signal box. The remote equipment, when functioning correctly, will always reply (Tx) immediately to a valid DTMF (RX) reception.

The indicators (a) to (f) above are fitted to the transmission card.

g) BARRIER O/P. This indicator reflects the status of the signalling relay (for this particular line card). This is a control signal to the barrier, and at present has no operational use (i.e. reserved for future use). When the indicator is "on" the relay contacts are closed.

h) BARRIER I/P. This indicator reflects the status of the signalling condition from the barrier. When the indicator is "on" a voltage feed to the relevant line card input (I/P+, I/P-) has been provided by the barrier.

i) VANDAL LOOP. The telephone line leakage current test circuit causes this indicator to extinguish when current flow is broken, i.e. due to an open circuit line as a result of damage to the line circuit or to the handset test loop. An appropriate alarm on the seven-segment display will also be raised.

j) OFF-HOOK. This indicator operates whenever the attached telephone's handset is lifted from its cradle. A line short-circuited would also cause the indicator to operate.

k) RING OK. This indicator will operate in sympathy with ringing sequence applied to each line circuit. Failure of the ringing generator, or short circuit line conditions, will inhibit the operation of this indicator. A general (urgent) alarm is raised after six successive failures of the ringing sequence and is automatically reset after six successful rings.

If a ringing failure alarm has been raised, it will be necessary to allow the telephones to ring six bursts

Table 5.2 Remote Equipment Alarm Codes

Alarm Code	Condition	Comments
(Urgent) 	Microprocessor watchdog	a) Check the front panel 5V rail indicator; if extinguished replace the PSU. b) Operate the reset switch on the CPU card. If this does not resolve the fault, replace the CPU card.
(Urgent) 	EPROM memory fault, checksum mismatch.	Operate the CPU reset button. If this fails to clear the fault then replace the CPU card.
(Urgent) 	RAM fault, walking code error.	Operate the CPU reset button. If this fails to clear the fault then replace the CPU card.
(Urgent) 	Communication lost with. signalbox.	Check the DTMF TX and RX indicators. If RX is not operating, the fault may be (a) on the transmission card, (b) at the signalbox or (c) on the line circuit. NB: the TX circuit will not operate if RX signals are not received. If RX is operating but TX is inactive then the fault may be on the transmission card.
(Urgent) 	60V internal DC rail.	Failure may be in the following areas: (a) on the PSU (DC-DC converter) card, or (b) excessive current to a line card.
(Urgent) 	12V internal DC rail from the DC-DC converter is low.	Failure may be in the following areas: (a) on the PSU card, (b) on a line card, (c) on the transmission card, or (d) on the CPU card.
(Urgent) 	Line circuits 1, 2, 3 or 4 respectively vandalised (loss of leakage loop)	The leakage loop is connected via the CALL switch and the handset cord of the signal post telephone. Check the line circuit to the telephone. The line card may be tested by applying a 10K resistor across the line terminals.
	Line circuits 1, 2, 3 or 4 respectively have ringer failure.	Check ringing functions to each telephone. The fault may be indicated on one line circuit only but this may still be caused by total failure of the ringing generator on the PSU card. A loop short on a particular line will only cause ringer failure when the ringer is activated. A loop short will also cause an off-hook timeout alarm.
	Off-hook timeout on line circuits 1, 2, 3 or 4 respectively.	Normally this is not an engineering fault. However, a loop short-circuit will cause the alarm to be raised.

(sequences) to clear the alarm indication when the fault has been cleared.

l) CALL IN. Whenever a call is established by the remote equipment, this indicator will operate.

m) CALL OUT. Whenever a call has been established by the signal box, this indicator will operate.

Indicators (g) to (m) are provided on each installed line card and reflect the status condition specific to each individual line circuit.

n) 5V OK. This indicator should light permanently, confirming the presence of the microprocessor power supply.

o) 12V OK. This indicator should light permanently, confirming the presence of the power supply to the transmission, relay and line card circuits.

p) 60V OK. This indicator should light permanently, confirming the presence of the power supply to the telephone line loop feeder bridge and ringing generator.

q) POWER. This indicator shows the presence of the incoming 24/50V DC supply. If the indicator fails, the fault is likely to be external to the equipment.

Indicators (n) to (q) are part of the power supply and ringer PCB.

5.3 GENERAL WORKING PRACTICES

5.3.1 Static-sensitive devices

When printed circuit boards are handled during replacement, anti-static wrist straps should be employed, earthed on the cardframe metalwork. All printed circuit boards in this apparatus contain components which are static-sensitive. Avoid touching the PCB tracks and if possible handle by the card edges. Always keep the cards in anti-static protective bubble bags when not installed in the equipment.

5.3.2 Removal and replacement of cards

Always remove power at the incoming supply fuse before removing or inserting cards into the frame. Failure to do so will result in damage (latch-up) of certain PCB components. Removing a card from its motherboard edge connector will require some force. Components at the card fronts should not be used to assist removal. Two holes (upper & lower) are provided on the front edge: a hook or piece of insulated wire (threaded through the hole) should be used to pull out the card. When inserting a card, ensure it is fully located home into the motherboard connector.

IMPORTANT - Always ensure that the correct card is inserted into the correct slot. Each card is polarised to prevent this, but forcing an incorrect card into a slot will damage the edge connector.

5.4 FAULT-FINDING ON THE TRANSMISSION CIRCUITS

A physical (unwetted) two- or four-wire transmission circuit will normally be used. This may be supplemented by point-to-point PCM links interfaced as two- or four-wire E & M circuits (as appropriate).

The signal transmitted by the signal box equipment may be distinguished from the signal transmitted by the remote equipment by the number of tones in a given packet or burst. NB: four tones from the signal box, five tones from the AHB.

A lineman's test telephone in high impedance monitor mode (10K ohm) may be used to check out the transmission circuits. A continuously repeated sequence of DTMF tones will be heard from alternate ands of the circuit.

5.5 SPECIAL TEST ROUTINE ON REMOTE EQUIPMENT

This test is specially prepared for factory testing, but may also be used if a system is under test "off site", e.g. in a workshop. The test mode is invoked by setting motherboard switch SW5B in the ON position before power up. The contact status signalling inputs are to be connected via switches which will activate the input opto-isolators. The contact inputs have the following effect in the "on" state:

Contact 1 - enables direct speech path from line 1 (remote) to signal box line 1.

Contact 2 - enables a DTMF tone signal (code increments at each subsequent operation of the switch).

Contact 3 - enables the intrusion tone signal.

Contact 4 - enables sequence operation of the DTMF and intrusion tones (DTMF is 80 milliseconds on, 80 milliseconds off. Intrusion tone in normal sequence). NB: when the switch is off, DTMF and intrusion tones are enabled as a continuous tone.

The seven-segment display will indicate the received DTMF code.

5.6 CIRCUIT DIAGRAMS

Circuit diagrams and descriptions are not provided as fault diagnosis shall be to card level only. However, if required, copies may be ordered from the manufacturers at the address below.

5.7 REPAIR OF FAULTY CARDS

The Equipment is covered by a twelve month warranty. Items are to be returned to

Whiteley Electronics
Victoria Street
MANSFIELD
Notts
NG18 5RW
Phone: 0623 421300

In order to assist in fault diagnosis, details of the problems encountered should be sent with the returned equipment.

British Rail customers have a Stores Return Procedure which must be followed for the return of faulty material.

6. TECHNICAL SPECIFICATION

6.1 REMOTE EQUIPMENT

6.1.1 Local Telephone Circuits

a) Maximum number of line circuits = 4.

b) Maximum number of telephones wired in parallel per line circuit = limited so that the combined REN does not exceed 2. It shall be normal installation practice to connect only one telephone per line circuit.

c) Calling arrangement = Earth leg recall or loop break (Selectable for each line card).

d) Dial tone = 350Hz + 440Hz , as per BS6305 App C2 (international standard).

e) Ringing tone = 400Hz + 440Hz (0.2s on, 0.2s off, 0.2s on, 2.0s off).

f) Engaged tone = 400Hz (0.375s on, 0.375s off).

g) NU tone = 400Hz continuous (applied if handset left off-hook 30 seconds).

h) Intrusion tone = 400Hz (0.2s on, 0.2s off, 0.2s on, 0.2s off, 0.2s on, 2.0s off).

i) Maximum DC loop resistance = 1,000 ohms.

j) Feeding voltage = 60V (positive earth).

k) Ringing voltage = 120V peak-peak (commutating), 40V RMS 25Hz.

l) Impedance = 600 ohms resistive.

m) Leakage test current (handset monitor) = 6mA nominal (2mA to 8mA).

n) Off-hook detection = loop current greater than 15mA.

6.1.2 Contact status signalling

a) Bi-directional signalling, one circuit in each direction (send/receive) provided per line card. (NB: a matching line card required at the signalbox).

b) Input = opto-isolated, voltage 12V to 50V required to activate.

c) Output = voltage-free relay contact 100V DC @ 300mA, 30V DC @ 1A (resistive).

d) Response time = 1.6 seconds during quiescent (idle) state.

6.1.3 Power supply

a) Input voltage range 20V to 57.5V DC

b) Current (with all cards fitted) = 425mA (for 24V systems), 250mA (for 50V systems).

NB: Current ratings are typical for a fully-loaded system, under quiescent (idle) conditions, and may be used to determine battery back-up period.

c) Fuse rating (external) = 2A (for 24V systems), 1A (for 50V systems)

6.1.4 Transmission

a) Signalling: DTMF 5 digit sequence (fifth digit is checksum of the four previous digits).

Mean one minute power level to line -13dBm.

b) Impedance = 600 ohms resistive.

c) Return loss = better than 15dB between 300Hz and 3.4kHz.

d) Balance return loss = better than 65dB to earth.

e)Maximum attenuation of transmission path = 20 dB.

6.1.5 System self-tests

a) Processor self-test (watchdog).

b) Processor EPROM checksum.

c) Processor RAM (write/read test).

d) Loss of communication from Signalbox.

e) Various power supply condition tests.

f) Leakage loop test to each remote telephone.

g) Ringer voltage test to remote telephone line terminals.

h) Off-hook timeouts on each remote telephone.

6.1.6 Timing

Maximum no valid RX data timeout in idle mode before auto reset = 30 seconds.

Maximum no valid RX data timeout in call mode, with auto update enabled, before reset warning = 2 minutes.

Maximum no valid RX data timeout in call mode, with auto update disabled, before reset warning = 10 minutes.

Intrusion (warning) tone duration before full reset = 30 seconds.

Vandal Alarm detect timer = 30 seconds.

Off-hook Alarm detect timer = 30 seconds.

Maximum consecutive invalid RX data frames before reset = 3 off.

Maximum consecutive ringing detector failures before alarm = 6 off.

Maximum consecutive successful ring detections to clear alarm = 6 off.

Line status (loop) debounce time = 41 milliseconds.

Ring detector debounce time = 41 milliseconds.

SCAN/UPDATE debounce time = 41 milliseconds.

Contact input = 410 milliseconds.

PSU under-voltage detector = 410 milliseconds.

6.1.7 Environmental

a) Ingress Rating to BS 54520, IP 55.

b) Temperature: -20 to +50 Celsius.

6.2 SIGNALBOX EQUIPMENT

6.2.1 Local telephone circuits

a) Maximum number of line circuits = 4.

b) Maximum number of telephones wired in parallel per line circuit = limited so that the combined REN does not exceed 2. It shall be normal installation practice to connect only one telephone per line circuit and line 1 will be used for the control telephone.

c) Calling arrangement = Call button on equipment front panel or off-hook (concentrator mode).

d) Dial tone = 350Hz + 440Hz continuous (new international standard).

e) Ringing tone = 450Hz + 440Hz (0.4s on, 0.2s off, 0.4s on, 2.0s off).

f) Engaged tone = 400Hz (0.375s on, 0.375s off).

g) NU tone = 400Hz continuous.

h) Intrusion tone = 400Hz (0.2s on, 0.2 s off, 0.2s on, 0.2s off, 0.2s on, 2s off).

i) Maximum DC loop resistance = 1,000 ohms.

i) Feeding voltage = 60V (positive earth).

k) Ringing voltage = 120V peak-peak (commutating), 40V RMS 25Hz.

l) Impedance = 600 ohms resistive.

m) Loop trip current = greater than 15mA.

n) Line is equipped with a Master Line Jack Socket. Bell wire is to be switched by Absent Switch,

o) Concentrators are to be used with an AUTO type interface.

6.2.2 Contact signalling

a) Bi-directional signalling, one circuit in each direction (send/receive) provided per line card. (NB: matching line card required at the signalbox).

b) Typical input: opto-isolated, voltage 12V to 50V required to activate.

c) Output: voltage-free relay contact 100V DC @ 300mA, 30V @ 1A (resistive).

d) Response time = 1.6 seconds during quiescent (idle) state.

6.2.3 Power supply

a) Input voltage range 20V to 57.5V DC (range

selection on motherboard).

b) Typical current (with all cards fitted) = 425mA (24V systems), 250mA (50V systems).

c) Fuse rating (external) 2A (24V systems), 1A (50V systems).

6.2.4 Transmission

a) Signalling = DTMF 4 digit code (4th digit is checksum of previous three).

b) Average signalling cycle time = 1.6 seconds.

c) Impedance = 600 ohms resistive.

d) Return loss = better than 15dB between 300Hz and 3.4kHz.

e) Balance return loss = better than 65dB to earth.

f)Maximum attenuation of transmission path = 20 dB.

6.2.5 System self-tests

a) Processor self-test (watchdog).

b) Processor EPROM checksum.

c) Processor RAM (read/write test).

d) Loss of communication with remote.

e) Ringer voltage test to signalbox telephone lines.

f) Off-hook timeout line 1 in manual mode.

6.2.6 Timing

Maximum TX re-tries on receipt of an individual RX frame before reset = 6 off.

Maximum number of valid RX data timeout before re-transmission = 1049 milliseconds.

Call mode auto-update interval (when selected) = 30 seconds.

Line 1 off-hook timeout (Manual mode, does not apply to concentrators) = 30 seconds.

Maximum consecutive ringing detector failures before ringer alarm = 6 off.

Maximum consecutive successful ringing detections before clearing alarm = 6 off.

Maximum duration of received DTMF tone when blocked out before raising alarm code ? = 40 milli-seconds.

Line (loop) status debounce time = 41 milliseconds.

Ringing detector debounce time = 41 milliseconds.

Interrogate switch debounce time = 41 milliseconds.

Contact input debounce time = 4l0 milliseconds.

PSU under-voltage detector debounce time = 410 milliseconds.

6.1.7 Environmental

Temperature: -20 to +50 Celsius.

7. SYSTEM PLANNING

The equipment hardware is designed to be universal and it is therefore necessary to define at an early stage the actual equipment needed and how the equipment is to be configured.

The signal box equipment is supplied with only one line card, and the remote equipment with two line cards as standard. So the first consideration is the quantity of line cards required, . The requirement for contact status signalling also influences the quantity of line cards needed. Generally, other variations of site requirement will only affect wiring and the setting of switches within the equipment.

7.1.1 System configurations

A standard level crossing system requires two telephones, one at either side of the level crossing. Each telephone is to be connected to its own line card within the remote equipment. Consequently for the standard level crossing installation the two line cards, as supplied, are adequate.

With this arrangement only one line card is required at the signal box for the signalman's control telephone. If contact-status signalling is required, then only one switching circuit is provided and will map from line circuit 1 at the remote end to the signalman's line circuit 1 at the signal box.

If two signalling circuits are required then an additional line card is required at the signal box end, and any further increase in signalling circuits will require a pro-rata increase in line cards at each equipment end.

The above situation is the most common arrangement. However, the equipment is versatile and accommodates a number of telephone configurations, as follows:

a) All call

In this arrangement only one signal box line circuit is required to support speech. At the remote end up to the maximum of four line circuits may be installed. A remote installation of four telephones with individual line circuits may be provided. Any call from the remote telephones is routed to signal box line circuit 1. If the Signalman calls the remote end, all telephones ring. (N.B. phased ringing on lines 1 & 2 against lines 3 & 4).

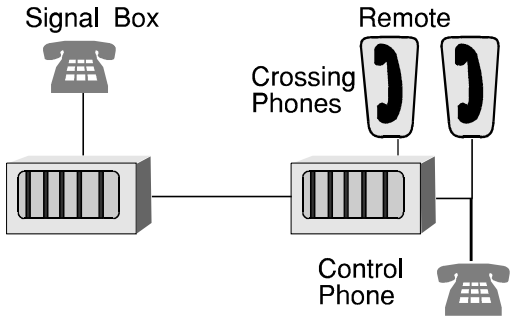


Fig 7.1 Typical Application, All Call

Level Crossing, 2 remote circuits.

b) Paired

In this arrangement two line circuit cards are required at the signal box. The line cards at the remote end are split into two groups (Circuit 1 + 2 and Circuits 3 + 4) which may be called selectively. Signal box line circuit 1 operates remote line circuits 1 + 2. Signal box line circuit 3 operates remote line circuits 3 + 4.

This arrangement is particularly relevant to two closely located level crossings which may share a common set of remote equipment. Provision is made to identify the calling parties, and to ensure that the signalman communicates with only one remote line at a time.

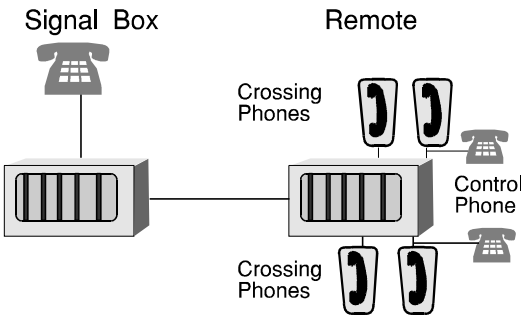


Fig 7.2 Typical Application, paired.

2 level crossings, 4 remote circuits.

c) Soloed

In this arrangement all four signal box line cards, and all four remote line cards may be installed. The arrangement allows signal box line 1 to work to remote line 1, signal box line 2 to remote line 2 etc, in other words each remote line circuit is identified independently at the signal box equipment.

This arrangement could be applied to an Auto-Half Barrier Level crossing and a number of occupation crossings. In order to provide the required number of telephones at the AHB, crossing telephones would be connected in parallel to a common line circuit.

In all instances contact-status signalling in both directions is always provided and the line circuit at the remote equipment end maps directly to the same line circuit at the signal box. Consequently, if four signals are required, then four line circuits are to be fitted to each set of equipment.

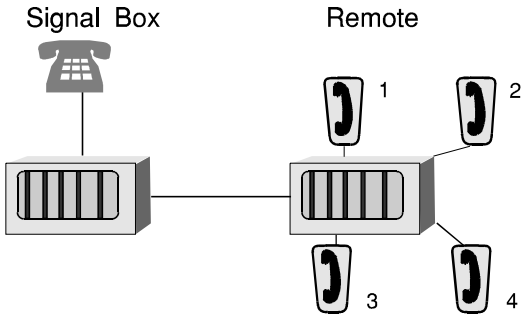


Fig 7.3 Typical Application, Soloed

4 separate remote telephones

These various system configurations are selected by means of DIL switches on the motherboards of the remote and signl box equipments.

NB: if remote line cards are to be provided, but without telephones, then arrangements are to be made to simulate the leakage current test by fitting a 10K ohm 0.5W resistor across the line pair.

7.1.2 Block switching

It is possible to re-route the transmission paths and pass control over the particular remote end to another signal box.

It is therefore necessary to investigate the arrangements for a particular installation, which may result in the need for a second, but identical, set of signal box equipment. The arrangements for achieving block switching automatically by signalling equipment should be investigated.

7.1.3 Remote telephones

For British Railways applications, the remote telephones shall be a standard approved CB type to BR specification BR1672. The telephones are to be installed and labelled in accordance with Telecomm Installation Instruction TII 9018.

The telephone has a pre-wired loop through the telephone handset and this loop is provided on the terminals. The loop is to be used as part of the remote equipment's telephone vandal detection system in which a small DC leakage current is tested around the telephone loop. The telephone circuit up to and including the handset is thus monitored.

Other applications may use an alternative CB telephone. The vandal detection leakage current must be simulated by adding a resistor across the line pair. A standard loop-disconnect dialling telephone may also be used, although the digit buttons will have no function. A DTMF telephone is unsuitable as the tones may interfere with the line signalling.

The remote line circuit allows two types of calling, namely loop-disconnection calling, and earth-loop calling.

When only one telephone is to be installed per line circuit the loop-break system of calling is preferred, as wiring is simpler, needing only one pair. Earth-loop calling may be necessary if older telephones or parallel-connected telephones are to be used with the equipment.

Details of the telephone wiring arrangement are shown in Fig 3.5. It will be noted that a resistor (supplied with the remote equipment) has to be installed across the terminals at each telephone, in order to set the test leakage current.

A switch is located on the motherboard, adjacent to each line card, to select whether earth or loop-disconnect calling is required. The equipment is normally supplied with the switches set for loop-disconnect calling.

7.1.4 Line transmission

The emergency telephone system requires either a two- or four-wire voiceband transmission channel. DC signalling is not required and the line transmission circuits are to be unwetted (without DC). This should be specified to the network provider if private circuits are to be rented from BT or MCL.

Best performance in respect of distance may be achieved with a two-pair (four-wire) physical interconnection between the remote and signal box equipment.

It should be noted that a similar transmission arrangement should be available between the intermediate and the distant signal boxes, in the event of a block switching requirement.

To connect a remote system via a point-to-point PCM circuit, in which case a four-wire E & M type interface will be appropriate; the E & M signalling circuits are not used.

The transmission interface is tested to conform with BS 6301 for user and network saftey. However, it is **not approved for connection to public telecommunications systems** under the Telecommunications Acts. If private wire circuits are to be used, rented from BT or MCL, then **Site Specific Approval** must be sought.

It should be noted that the transmission circuits are to be **unwetted**, ie no DC . This is important if BT private wire circuits are rented, where DC wetting is generally used.

7.1.5 Power supply

Both the remote and signal box equipment include an isolated DC-to-DC converter which operates with input voltages in the range 20V to 57.5V DC. The power supply should have a current availability of 2A @ 22V or 1A @ 57.5V. The remote equipment may be operated from a level crossing barrier battery if required.

The power supplies for both sets of equipment should be battery-backed to ensure operation during power failure.

7.1.6 Special requirement and alarms

The local arrangements and interfaces should be investigated with particular attention to the following details.

a) Is a concentrator provided in the signal box ?

NB: Auto type interface will be required.

b) Railway operating requirements state that the calling signal should be distinctive. Either use a control telephone with a distinctive ringer or install an additional sounder.

c) Are the alarms to be extended to any other equipment ?

7.2 EQUIPMENT LIST

For British Rail customers, all major parts have BR Catalogue numbers for ordering via the National Stores. Please consult Catmaster lists for these items.

7.2.1 Signal box equipment (A33899)

When ordering please state the code number A33899, which will automatically include the following items:

a) 1 off Outer case with perspex front panel and BT line jack socket pre-wired to line card 1.

b) 1 off Cardframe, motherboard and termination PCB.

c) 1 off Line card (A33838)

d) 1 off TX/RX card (A33837)

e) 1 off CPU card (A33839)

f) 1 off Power supply and ringer card (A33898)

7.2.2 Remote equipment (A33900)

When ordering please state the code number A33900, which automatically includes the following items:

a) 1 off Outer case with perspex front panel (environmentally sealed)

b) 1 off Cardframe, motherboard and termination PCB.

c) 2 off Line cards (A33838)

d) 1 off TX/RX card (A33837)

e) 1 off CPU card (A33839)

f) 1 off Power supply and ringer card (A33898)

7.2.3 Options

a) Additional line cards

Additional line cards are required under the following circumstances:

i) More than two remote telephones are needed.

ii) The configuration requires signal box control of more than one remote site.

iii) Contact status signalling requiring more than one control circuit.

The line card is identical for both remote and signal box equipment and is ordered using the code A33838.

b) Secondary signal box equipment (Block switching)

Equipment to be located at both the intermediate and main signal boxes will generally be identical.

7.2.4 Recommended spares

As a minimum each maintenance area should permanently retain at least two spares of each of the card types used within the equipment.

The following list details the minimum recommended spares:

a) Line Card A33838 - 2% of field base (minimum 2 off)

b) CPU Card A33839 - 4% of field base (minimum 2 off)

c) TX/RX Card A33837 - 2% of field base (minimum 2 off)

d) Power Supply Card A33898 - 4% of field base (minimum 2 off)

e) Termination Card A33902 - 1% of field base (minimum 2 off)

f) Motherboard A33901 - 1% of field base (minimum 1 off)

NB: Field base = total accumulated quantities in use within both remote and signal box equipments.

7.2.5 Consumable spares

a) Fuses

b) Switches (complete with button cap)

c) Screw terminals

d) Surge Arrestors

e) Switch blanking caps

f) Spare labels

g) Additional leakage resistors for telephones.

A set of consumable spares may be ordered using the code A34172. One set is required to cover each field base of 50-off systems per annum, one set minimum.

7.2.6 Recommended test and maintenance equipment

a) Digital/analogue multimeter - essential.

Comment - a digital voltmeter will provide the desired accuracy for checking power rails.

b) Eurocard extender - desirable.

Comment - only required for detailed analysis of conditions or faults within active system cards. This item may be ordered separately as item code A34173.

c) DTMF Digicount/printer - desirable.

Comment - data communication dialogue may be checked if transmission problems are encountered.

d) Transmission set - occasional.

Comment - if transmission difficulties are encountered, attenuation, frequency and noise performance of physical pairs may be analysed.

e) Lineman's test telephone - desirable.

Comment - line circuits may be checked before roadside telephones are installed. Local communication for engineering/maintenance purposes may be established to the signal box.

7.2.7 Special tools

No special tools are needed, only the standard types of screwdrivers. It should be noted that wood screws or other fixing devices will be required if wall-mounting of the equipment is desired in a signal box and if the remote equipment is to be mounted in an equipment rack or trackside location cabinet.

7.2.8 Ancillary equipment

a) Weatherproof telephones.

b) Statutory labels for level crossing locations, etc.

c) Wall-mounting telephone for signal box.

d) Cable gland (plastic, 20mm, fixing to suit cabling requirements).

7.2.9 Special labelling

It is necessary to provide individual labelling on the label strip provided with the signal box equipment.

The self-adhesive label is to be fitted by self-adhesive tape onto the rear of the perspex front panel. The label has two round apertures which are to be aligned with the contact status LED indicators for each line circuit. If the indicators are not required, or particular line cards are not to be installed, then an alternative label without holes should be used.

IMPORTANT - The location of each remote telephone associated with a given line card at the signal box must be clearly identified.

It may be useful to prepare the label strip before visiting the site to commence installation. It is recommended that the individual line cards at the remote end be identified by means of self-adhesive label tape.

8. SIGNALLING PROTOCOL

In order to provide a very reliable and noise-immune data transmission technique, DTMF signalling is used. The signalbox equipment will always be the "master" and the remote equipment the "slave". The signalbox will send a coded DTMF tone sequence to the remote end, which will, upon receipt, immediately reply with its own coded DTMF tone response. The remote equipment will never generate its own tones except in response to receipt of a valid incoming tone sequence request from the signalbox equipment.

After a call set-up, i.e. once a speech path is established, the system may operate in one of two alternative modes, namely:

a) **Auto update mode** (not normally used)

The signalbox equipment will suspend the normal 1.6 second poll cycle and change to a 30 second poll cycle in which a DTMF tone sequence, and response from the remote equipment, will be encountered every 30 seconds. This has the disadvantage of being a distraction to normal conversation. The advantage is that any changes in status at the remote end are updated automatically every 30 seconds.

b) **Manual update mode** (normal mode)

In this mode of operation the 1.6 second poll cycle is stopped once the speech path is established. Any changes in status at the remote end are indicated by the intrusion (warning) tone. If the signalbox Scan/ Update button is operated, a single poll cycle is triggered and the new data is passed to the signalbox equipment.

In this mode a poll is automatically generated after 10 minutes, just in case the signalman has not cleared the call by replacing his telephone handset.

8.1 DTMF TO BINARY CONVERSION

Table 8.1 shows the conversions from the DTMF tones to binary code.

8.2 SIGNAL BOX TO REMOTE TONE SEQUENCE

In the tone sequence (packet) four tones are generated with 80ms tone, 80ms silence etc.

a) **Tone 1**

B3 - Barrier 4	Input at signalbox maps
B2 - Barrier 3	to relay output at remote.
B1 - Barrier 2	Bit set = remote relay
B0 - Barrier 1	active

b) **Tone 2**

B3 - Ring line 4	Instructs remote
B2 - Ring line 3	equipment to apply
B1 - Ring line 2	ringing while bit is
B0 - Ring line 1	set.

c) **Tone 3**

B3 - Speech line 4	Enable speech path
B2 - Speech line 3	to the respective
B1 - Speech line 2	remote line circuits
B0 - Speech line 1	while bit is set.

d) **Tone 4** (Checksum)

The tone is determined by the binary calculation

Tone 4 (B2, B2, B1, B0) = 0 - (Tone 1 + Tone 2 + Tone 3).

Table 8.1 DTMF to Binary conversion

DTMF code	(MSB) B3	B2	B1	(LSB) B0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*	1	0	1	1
#	1	1	0	0
A	1	1	0	1
B	1	1	1	0
C	1	1	1	1
D	0	0	0	0

The above table may be used to convert logical signal states to the resulting transmission tones.

8.3 REMOTE TO SIGNALBOX REPLY

In the tone sequence (packet) five tones are generated with 80ms tone, 80ms silence etc.

a) **Tone 1**

B3 - Barrier 4
B2 - Barrier 3
B1 - Barrier 2
B0 - Barrier 1

Input at remote is transmitted to output relay at signal box Bit set = SB relay active.

b) **Tone 2**

B3 - Line 4 calling
B2 - Line 3 calling
B1 - Line 2 calling
B0 - Line 1 calling

Bit set = calling SB.

c) **Tone 3**

B3 - Line 4 answering
B2 - Line 3 answering
B1 - Line 2 answering
B0 - Line 1 answering

Bit set = remote telephone answers SB call.

d) **Tone 4**

B3 - Single off-hook timeout alarm
B2 - Multiple off-hook timeout alarm
B1 - Vandal alarm
B0 - Equipment fault including remote ringer fail

NB: If no alarms are present, DTMF code D is transmitted.

e) **Tone 5** (Checksum)

Tone 5 (B3, B2, B1, B0) = 0 - (Tone 1 + Tone 2 + Tone 3 + Tone 4)

9. OPERATING INSTRUCTIONS

9.1 INTRODUCTION

The equipment installed is an intelligent, microprocessor-controlled, telephone system for communication with the public (such as drivers of vehicles) at sites such as unattended Automatic Half-Barrier Level Crossings.

The equipment allows calls to be established by the public or by the signalman operator and to be answered by either party as appropriate. Furthermore, contact status signals may be conveyed for the purpose of monitoring the remote signal equipment. The equipment also provides extensive indication of the telephone equipment activity and status at the remote end.

A simplified set of operating instructions is available on a laminated card for display in the signal box.

9.2 OPERATION

9.2.1 Incoming call

a) An incoming call will be identified by the ringing, or tone sounder, on the associated control telephone. (In some signalboxes additional warning sounders may be installed). Additionally the "Call In" indicator flashes in sympathy with the ringing signal.

b) The call is answered by lifting the telephone handset. A short delay, together with some signalling tones on the line, will be noticed before the caller's voice is heard. The signalman is advised to await completion of the tone sequence before answering the caller.

c) Whilst the call is in progress the indicator labelled "called" will remain illuminated, thereby identifying the location of the caller.

d) If the caller replaces his telephone handset the "intrusion" tone (three pips repeated) will be heard. The control telephone handset may be either replaced on hook, or the status of the remote equipment may be established by operation of the Interrogate button. If the "intrusion" tone was the result of the remote caller replacing his handset, then dial tone will be returned to the control telephone, which should now be replaced on its rest, unless required to make another call.

The "Call In" indicator extinguishes after operation of Interrogate and the hearing dial tone, or when the control telephone handset is replaced.

9.2.2 Incoming call (Absent service)

a) Any incoming calls received whilst the signalbox is closed will be indicated by the flashing "called" indicator. Upon re-opening the signalbox and setting the absent switch to "OFF", any calls during the "absent" period will be indicated by the telephone ringing.

When the telephone is answered, dial tone will be heard if the remote caller is no longer present. Under these circumstances caution the driver of the next (first) train in accordance with operating instructions.

9.2.3 Calling the remote telephones

a) Lift the control telephone handset and wait for dial tone.

b) Operate the CALL push button under the label of the required crossing. NB: one, two, three or four buttons may be provided according to the installation. Each remote location will be labelled, above the individual CALL switches.

c) Ringing tone will be heard; await answer by the distant party.

d) Upon answer, signalling tones will be heard. Wait until the tones have stopped before speaking.

9.2.4 The intrusion/update tone

A special tone is provided, which consists of three rapid pips followed by a short delay, followed by three more rapid pips, continuously repeated.

If this tone is heard at any time, it means that an event has occurred at the remote end. The occurrence may be any of the following:

a) Party at remote end has replaced his/her telephone handset.

b) Another party at this or another site is trying to call you.

c) Contacts are changing status.

d) Equipment failure at remote end.

Simply ask your existing caller to clear down and replace your own control telephone handset. The telephone will ring again if another caller is trying to contact you. Alternatively, if you wish to maintain the call but

find out what has occurred at the AHB, simply operate the Interrogate button, whereupon signalling tones will be heard. If the event is a change of contact status or an equipment alarm, then this will be relayed to the appropriate indicator. If another caller is attempting to reach you, then the appropriate "Call In" indicator will flash and you should advise your existing caller to clear down; you can then replace the control telephone handset. The new call will ring through in the normal manner.

9.2.5 Equipment alarms

Extensive self-monitoring is provided by the equipment. Any problem of an important nature will be indicated by a continuous buzzer. The buzzer may be silenced by operating the Interrogate button.

A seven-segment LED display is provided to detail the associated problem. Normally the display will flash a "hyphen" (short horizontal middle dash) to indicate that everything is OK.

If an alarm is raised this will flash as a letter or numeral on the display. Sometimes more than one alarm may be raised and multiple alarms may be displayed by holding in the Interrogate button until the hyphen appears.

The possible alarm states are detailed in table 9.1, on the next page.

When contacting maintenance about a fault, reveal all alarm conditions by operating the Interrogate button and detail the faults. The engineer may then diagnose whether the fault is at the remote end or at the signalbox.

9.2.6 Block switching

Remote telephone systems may sometimes be operated either by an intermediate or by a distant signalbox. The changeover sequence will normally be carried out automatically by operating the block switch provided for the signals. When a control telephone is switched out by the Block Switch, this will be indicated by a flashing indicator, "Switched Out", to the upper left-hand part of the control panel.

If manual block switching is required, then a normal telephone call should be established between the two signalboxes. Control is by means of a switch on the side of the equipment at the intermediate signalbox.

IMPORTANT: Before leaving the signalbox, ensure that the "Switched Out" indicator is flashing and that the distant box is in control of the telephone. Upon returning and re-opening the signalbox, ensure that the indicator is extinguished.

9.2.7 Contact status

Sometimes the equipment will be used to relay the status of the contacts at the remote equipment. An indicator is located behind the location label box areas on the front panel. Occasionally one of the indicators may be used to raise an alarm condition. You may note the indicator changing state as level crossing barriers operate. The indicators provided are subject to small delays in operation and will not be updated during a call unless the Interrogate button is operated after the intrusion tone. Caution should therefore be given to the interpretation of these signals.

Fig 9.1 Alarm Indications

Displayed symbol	Meaning	Action
	AHB telephone vandalised or failed	Contact maintenance.Caution next train and
	Multiple AHB telephone off-hook	request driver to replace handsets.
	Signalbox ringer fail	Contact maintenance.
	AHB telephone handset left off-hook.	Advise maintenance if situation persists. Ask next caller to check all handsets and replace on rests.
	Signalbox control telephone left off hook.	Check that handset is properly on its rest.
	Power supply at signalbox.	Contact maintenance.
	Communication lost with remote system.	Contact maintenance.
	Local processor failure	Contact maintenance

10. ABBREVIATIONS USED IN THIS MANUAL

A	Amps
AC	Alternating current
AHB	Automatic half-barrier ie level crossing
AUTO	Automatic
BR	British Rail
BRB	British Railways Board
BS	British Standard
BT	British Telecom
CB	Central battery
dB	Decibels
DC	Direct current
DIL	Dual In-line
DTMF	Dual-tone, multi-frequency (also known as Touch-Tone)
HMRI	Her Majesty's Railway Inspectorate
HMSO	Her Majesty's Stationery Office
Hz	Hertz, cycles per second
I/P	Input
LB	Local battery
LSB	Least significant bit
mA	Milliamps
MCL	Mercury Communications Ltd
ms	milliseconds
MSB	Most significant bit
N.A.	Not appropriate
O/P	Output
PCB	Printed circuit board
PCM	Pulse code modulation
PSU	Power supply unit
PW	Private wire, private circuit
R	ohms
REN	Ringer equivalent number
RMS	Root-mean-square value
RX	Receive, receiver
s	Seconds
TX	Transmit, transmitter, transmission
V	Volts

INDEX

F

H

I

L

M

O

P

R

S

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