Specification PTC 107

PABX
External Port
Interface Requirements

Access Standards
Telecom Corporation of New Zealand Limited
Wellington
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FIGURES

RELATED TELECOM DOCUMENTS

PTC 100	Permit to Connect : General Conditions
PTC 101	Electrical Safety Requirements for a Telecom Permit to Connect
PTC 102	Telephone Network General Interface Requirements
PTC 105	Code of Practice for Building Telecommunications Cabling
PTC 106	Code of Practice for Commercial Building Lead-ins*
PTC 108	PABX: Signalling and Supervisory Conditions
PTC 109	PABX: Transmission Requirements
PTC 202	Technical Requirements for Permission to Connect Telephone Instruments
PTC 207	General Requirements for PABX Equipment
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PTC 300	General Requirement for Network Interconnection
PTC 301	Telephone Network Interconnection
PTC 307	ISDN Network Interconnection*

* To be issued later

REFERENCE DOCUMENTS

BS 6450 Parts 1 & 2 : 1983

OTR 001 : 1988 (Published by Oftel, UK,and submitted to the British Standards Institution as a draft for BS 6450 Part 4)

FOREWORD

This Specification is one of a set of documents prepared by Telecom to cover the network interface requirements for customer premises switching systems. The general term "PABX" is used, but for the purposes of the Permit to Connect (PTC) system, this term covers all types of automatic telecommunications switching systems which are installed in customers' premises and intended to be connected to the Telecom network.

PABX requirements are divided into several different PTC Specifications to allow each aspect to develop separately without the need to re-issue the complete set when changes become necessary. It also allows cross referencing between Specifications for other equipment which needs to comply with the same or similar standards for interconnection with the network.

The purpose of these Specifications is primarily to cover the connection of privately-supplied PABX's to the Telecom PSTN, in the first instance, when PABX's are deregulated on 1 April 1989. However, deregulation of the telephone network also occurs at the same time and the simplest form of network to be provided by any operator as an alternative to the Telecom PSTN is a PABX network. These Specifications therefore also relate to interconnection of networks at the PABX level and will form the technical basis of contracts established between Telecom and PABX network suppliers or users.

This particular technical Specification describes the interface conditions required on the various ports of a PABX for interconnection with the Telecom Public Switched Telephone Network (PSTN), leased circuits and PABX's supplied by Telecom, and with switching systems or multiplex equipment supplied by other organisations. It is complementary to the general requirements Specification and the other technical Specifications that make up this set of documents covering PABX requirements.

ISDN is still at an early stage of development internationally but impacts greatly on use and future development of PABX's. For this reason it has been necessary for these Specifications to be prepared in such a way that they fully accommodate likely developments of ISDN. It is envisaged that there will be ongoing discussions with industry as development unfolds and it will be necessary to issue supplements or amendments to these Specifications in due course.

General requirements and other technical matters relating specifically to the interconnection of networks is being covered in a separate 'family' of PTC Specifications numbered in the "300" series.

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1.
SCOPE

1.1
Outline of contents

This Specification describes the external port interface requirements for customer switching systems (PABX's) intended for connection to the Telecom Public Switched Telephone Network (PSTN). The port interfaces covered are as follows:-

(1) Extension ports:
Off-premise extensions that use the Telecom Network between the PABX and the location of the extension telephone or other terminal equipment require defined interfaces. Extension port interfaces intended for connection to telephones or other terminal equipment designed to meet Telecom PTC Specifications are also included.

(2) Trunk ports:
The point of connection between the PABX equipment and the Telecom PSTN is the trunk port interface which is specified in detail in this Specification.

(3) Tie line ports:
Although tie-lines linking privately-supplied PABX's will normally form part of a private network which is only linked to the Telecom PSTN for outside calls, the tie-lines may themselves traverse the Telecom Network to reach a distant PABX. For this reason it is necessary to define the tie-line port interfaces to ensure satisfactory connection and operation.

As with other Specifications in the PTC series, an effort is also made to explain the significance behind the various requirements.

1.2
Digital signalling

(1) The PABX ports described in this Specification include both analogue and digital applications. Signalling and supervisory requirements descibed in Specification PTC 108, however, cover mainly analogue applications with only a brief reference to digital.

(2) Digital signalling is an integral part of the overall conditions at any digital interface and cannot conveniently be separated. For this reason digital signalling requirements have been incorporated in this Specification.

1.3
Compliance

The pre-requisites for the granting of a Telecom PTC for any type of switching system intended to be connected to the PSTN are compliance with the general requirements of Specification PTC 100 together with the requirements of PTC 207.

1.4
Related Specifications

The primary Specification relating to the grant of a PTC for any customer switching system is PTC 207. All PTC grants and the associated "Telepermit" labelling for such systems will be issued with PTC 207 series numbers. However, many references are made in that Specification to the related technical Specifications which include this one. To satisfy the requirements of PTC 207 it is necessary to comply with all the relevant clauses of these related Specifications.

1.5
Application of PTC

As stated in Telecom's Terms and Conditions of Telephone Service and in PTC 100, only those systems granted a PTC and bearing a "Telepermit" label may be connected to the Telecom network. However, systems supplied by Telecom and connected to the network prior to 1 April 1989 are exempted from this requirement. Following this date, all new systems supplied by Telecom will also be subject to the requirement to comply with the PTC Specifications and to bear a PTC label to indicate that this has been done.

2.
GENERAL

2.1
Mode of presentation
Those aspects of this Specification which are regarded as mandatory are printed in plain type with each paragraph formally numbered. Comments, recommendations and explanations, which are added only as indications of the means of compliance with this specification, are shown in italics. Smaller type is used, each paragraph being preceded with a "•" symbol, but without numbering.

2.2
Impact of technological changes
(1) Some clauses of this Specification may be subject to considerable change because the development of electronic switching systems is proceeding rapidly at the present time and certain requirements cannot be finalised until the CCITT has settled on firm Recommendations. Such aspects as the impact of ISDN (Integrated Services Digital Network) on the design of PABX systems and the digital interfaces with the Telecom Public Switched Telephone Network have yet to be finalised and, while good progress is being made, it is not yet possible to define some of the interconnect requirements.

(2) Current plans to deregulate the New Zealand network will also impact on the requirements for PABX systems, especially as regards transmission planning and signalling standards. Such aspects will also develop rapidly over the next year or so, and these Specifications will evolve to cover the various developments. Nevertheless, Telecom's intention is to provide the industry with the earliest possible notice of technical requirements. For this reason it may be necessary to re-issue or supplement these Specifications after publication of the initial versions .

2.3
Marketing features
This Specification does not deal with those characteristics of a switching system's design which have no direct effect on its basic telecommunications functions or on the standard of performance offered by the Telecom network. Such characteristics are regarded only as additional features of advantage to its competitive marketing. However, to clarify the
position when some aspect is not a requirement for the grant of a PTC, an explanatory note will be provided.

2.4
Related Specifications
(1) Those documents which, together with this Specification, form the main structure of the general and technical requirements for PABX systems are as follows:-

PTC 102 Telephone Network: General Interface Requirements

PTC 108 PABX: Signalling and Supervisory Conditions

PTC 109	PABX: Transmission Requirements
PTC 202	Technical Requirements for Permission to Connect Telephone Instruments
PTC 207	General Requirements for PABX Equipment
PTC 208	Requirements for Telephone Headsets*
PTC 211	Requirements for Non-Voice Equipment
PTC 212	Requirements for Automatic Answering, Calling and Recording Equipment
PTC 217	Requirements for Bandwidth Management Devices*
PTC 307	ISDN Network Interconnection*

* To be issued later

(2) Specifications relating to the interconnection of networks, including PABX networks, are as follows:-

PTC 300	General Requirement for Network Interconnection
PTC 301	Telephone Network Interconnection

(3) This Specification shall be read in conjunction with all the Specifications listed under "Related Documents".

3
DEFINITIONS

3.1
Those definitions that apply to more than one of the set of PTC Specifications dealing with PABX requirements are given in Specification PTC 207. For ease of reference those terms that are particularly significant to PABX port interfaces are dealt with in clause 3.3.

3.2
Further general definitions are given in PTC 100, PTC 101 and PTC 102.

3.3
The following terms are those used in relation to the external port interfaces of PABX systems intended for connection to the Telecom PSTN:-

Analogue circuit (trunk or extension): is a circuit carrying voice frequency signals using either one-way or two-way transmission.

Bothway circuit (trunk): is a circuit or trunk that is capable of setting up calls in either direction.

Channel associated signalling: is any signalling system where the signalling information is directly identified with the associated voice channel of the transmission system being used.

Collision calls (double seizure): is an incoming call and outgoing call occurring simultaneously on the same bothway trunk such that neither takes precedence over the other.

Digital circuit (trunk or extension): is a circuit transmitting signals in digital form in both directions between a terminal device and a switching point, or between two switching points, and is the combination of two unidirectional digital channels.

- *A digital channel is defined by the ITU-T, Volume 10, as a one-way 64 kb/s digital path. Thus two such channels are required for two-way communication.*

Digital trunk interface (DTI): is an interface for a 2048 kb/s A-Law digital system having the characteristics of an "Interface A" as defined in ITU-T, Recommendation Q. 512, clause 2.1.

- *Reference also ITU-T, Recommendations G. 703, G. 704 and G. 705.*

Direct dialling in (DDI): is the facility to allow incoming calls from the Public Exchange to be switched directly to a specified extension without PABX operator assistance.

- *Also known sometimes as " Direct in-dial", or "DID" overseas.*

Encoding laws (A-law and μ-law): are two alternative methods of encoding samples of analogue signals into a binary form for pulse code modulation.

- *Reference ITU-T, Recommendation G. 711.*
- *The method universally adopted by Telecom is A-law.*

Earth start: is the facility whereby a PABX seizes the main exchange equipment by means of an earth on the -ve lead of the connecting trunk, usually accompanied by a loop condition.

- *For "earth start" PABX's the idle condition from the main exchange is -50 V on the -ve lead and open circuit on the +ve lead of the PABX trunk.*

Fast guard: is a d.c. condition applied to a PABX trunk, immediately it is seized by the main exchange, as a "busy" condition to prevent any attempts by the PABX to seize it during silent periods of the ringing cadence.

Key telephone system (KTS): is the simplest form of customer switching system which usually makes use of multi-button telephone sets to provide direct selection of specific central office trunks or extensions.

- *Such systems are classed as "PABX" systems for PTC purposes.*
- *Earlier versions of KTS were known by Telecom as 'interphone' systems.*

Line signals: are supervisory signals such as 'seize', 'clear', etc. passed over a line between switching devices and which do not contain any information concerning the route or destination of a call.

Loop start: is the facility whereby a PABX seizes the main exchange equipment by means of a loop condition on the connecting trunk.

- *For "loop start" PABX's the idle condition from the main exchange is -50 V on the -ve lead and earth on the +ve lead of the PABX trunk.*

Numeric signals/routing information: are signals of numeric nature, transmitted by a telephone or switching device, which contain route and destination information necessary for the connection of a call.

- *The most usual information is the Directory number of the called party, but trunk or tie line access digits are also included within this definition.*

Press-to-talk: is a term used in association with VHF land mobile radio systems whereby the radio transmitter is "triggered" by a button on the telephone handset whenever the user speaks.

- *Some modern systems use voice-operated switches to avoid the need for press-to-talk operation.*

Ring return earth: is the condition where ringing voltage is applied to one lead of a line in series with the exchange battery and the circuit is completed via an earth on the other lead (return lead).

Ring return battery: is the condition where ringing voltage is applied to one lead of a line in series with earth and the circuit is completed via the exchange battery to earth on the other lead (return lead).

• *Telecom main exchanges normally use the "ring return battery" convention while the most common PABX convention for extensions is "ring return earth".*

Timeout (or release timeout): is the time taken for exchange switching equipment to be fully restored to the idle condition following release of an exchange line by a customer.

• *The "timeout" period for main exchange equipment is typically 4 seconds, but it can vary between 0 and 20 seconds.*

Unguarded interval: is any period of time during which equipment, which is in the process of being seized or released, is not guarded against seizure by another call.

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4
TYPES OF EXTERNAL PORT INTERFACES

4.1
General requirements

(1) To facilitate the location of faults and the definition of responsibilities for fault clearance, provision shall be made for the isolation of individual ports of the system from the associated building cabling.

(2) The provision of such isolation points may be either within the equipment or as part of the installation practice.

4.2
Analogue ports

(1) This Specification defines the external interfaces which shall be provided on the following ports of PABX's intended for connection to the Telecom PSTN:-

(a) Analogue extensions designated for use with telephones complying with the requirements of Specification PTC 202.

• *Extension ports designated for use with system-dependent telephones are regarded as an integral part of the PABX system and as such their connection is regarded as a marketing feature.*

(b) Analogue CO trunks.

• *All Telecom central offices are capable of terminating analogue trunks, but not necessarily digital trunks. This may change in the future.*

(c) Analogue tie trunks.

• *The provision of tie trunks is not mandatory and is regarded as a marketing feature.*

• *Internal interfaces are not part of the formal PTC requirements. Some are however defined by Telecom within a PTC Specification to assist those suppliers who wish to achieve maximum compatibility with Telecom supplied equipment.*

(2) Analogue extension ports designated for use with telephones to Specification PTC 202 shall terminate on a standard Telecom socket as described in Specification PTC 102, clause 10.3.

(3) Analogue CO trunks of key telephone systems (KTS) may terminate on a plug to BS 6312 : 1985. Connection to the public exchange is then via a standard Telecom socket as described in Specification PTC 102, clause 10.3.

4.3
Digital ports

(1) Conversion of the Telecom network from analogue to digital is now well advanced and it is therefore desirable that PABX's are supplied with the capability of terminating all external port interfaces in digital form. This applies primarily to central office trunks,

but it may also apply to off-premise extensions and tie trunks where they are required to traverse the Telecom network to reach a separate location.

(2) The standard interface for use on digital tie and CO trunks shall be a digital trunk interface (DTI), i.e. 2048 kb/s interface to ITU-T, Recommendation G. 703. Telecom normally makes standard use of the
75 ohm coaxial option, however, consideration may be given to use of the
120 ohm screened balanced pair option in certain cases.

4.4
Proprietary extension ports

(1) Extension ports intended solely for association with proprietary or system-dependent terminal equipment may be digital or analogue and are subject only to the following restrictions:-

(a) Signal limitation and electrical safety where any Telecom facilities are used.

(b) If connected to the PSTN then the overall transmission performance characteristics shall be no worse than those of the combination of a standard Telecom telephone and Central Office line (ref. Specification PTC 109, clause 5.5).

- *This applies whether the port is analogue or digital.*

(2) The supplier is free to define any interface which is wholly within an installation and does not relate in any way to the Telecom network or to the use of terminal equipment complying with Telecom PTC requirements.

5
2-WIRE ANALOGUE EXTENSIONS

5.1
General

This Section only applies where the extension ports are intended for use with telephone instruments or other terminal equipment to Specifications PTC 202, 211 or 212.

• *There are no formal requirements where ports are intended for exclusive use with 'system-dependent' devices, or where ports are totally barred access to or from the Telecom PSTN.*

5.2
Voltage/current relationships

(1) All analogue extension ports and associated extension cabling, intended for interfacing with terminal equipment that complies with Specification PTC 202, are required to be such that the minimum values of current and voltage at the terminal equipment terminals are 25 mA and 10V respectively.

• *It is recommended that the open circuit voltage at terminal equipment terminals be not less than 50V in order to achieve these results.*

• *10 V at the terminal equipment is achieved by use of a current of 25 mA through a 400 ? device.*

(2) The supplier shall be responsible for advising the customer of the limitations in length of extension cable over which a telephone, or other terminal equipment complying with Specification PTC 202, will operate satisfactorily when connected to an extension port.

• *The major factor in limiting operation is the resistance of the extension cable pair and its effect on the seizure of equipment when a call is initiated.*

• *Suppliers should note that 0.4 mm diameter conductors are commonly used for building cabling in New Zealand. The loop resistance is thus of the order of 300 ?/km.*

(3) Although not mandatory, the normal convention for analogue extension ports is negative battery on one leg and earth on the other, as for PSTN lines (ref. PTC 102).

• *This convention enables PABX extension ports to be connected to telephones off premises via the Telecom network.*

• *Extension connected to separate premises are often routed via circuits derived on PCM or fibre systems and are interfaced via signalling adaptors. For correct operation, connection to such adaptors requires that the PABX port is referenced to earth.*

(4) If PABX extension ports are not referenced to earth as described in (3) above, the cost of any modification to enable connection to a Telecom supplied signalling adaptor associated with a derived circuit, may be charged to the customer or PABX suppliers.

5.3
Call set-up
Detailed checks shall be made on all ports connected to the Telecom network for any transients produced during the call set-up phase. Information on such transients shall be provided in sufficient detail that their impact on any part of the Telecom network may be determined.

• *The call setup phase exists from the time of off-hook detection through to the establishment of a stable speech path when the call is answered.*

5.4
Call release
On all calls to or from the PSTN the following conditions shall apply:-

(a) The public exchange equipment shall be released when the PABX extension clears, with appropriate exchange line guarding from the PABX until the public exchange equipment restores to the idle condition.

• *There are some exceptions to this requirement, notably in the areas of emergency "111" calls and where Telecom is dealing with malicious call complaints on behalf of a customer. In such cases, the network equipment may hold a call originated within a PABX.*

(b) Neither party shall be able to prevent the other from releasing and being able to establish or receive another call.

(c) On outgoing tie-line calls to Telecom-supplied systems, the PABX equipment and tie-line circuits shall be released when the PABX extension clears, with appropriate tie-line guarding while the distant PABX equipment restores to idle.

• *Calls on tie-lines to other non-Telecom PABX's are not subject to this requirement as this is then regarded as a marketing feature.*

5.5
Applied Voltage Protection
(1) It is desirable that any terminations of the extension port are able to withstand, without permanent damage, the application of a direct earth, or positive or negative 50 V battery referenced to earth.

(2) It should also be possible to directly short the output of the port for indefinite periods with no permanent damage.

• *Such conditions can result from cable faults within the extension reticulation.*

• *This requirement is not mandatory, but is a recommended marketing feature.*

6
ANALOGUE CENTRAL OFFICE TRUNKS (2-WIRE)

6.1
General requirements
Specification PTC 102 defines the general requirements for equipment terminated on any line connected to the Telecom PSTN. These requirements apply also to the connection of any PABX to the Telecom network and, except where there is a conflict with this Specification, all PABX equipment shall comply with Specification PTC 102.

6.2
Loop/earth start
(1) The Telecom PSTN is normally set up for "loop start" but optional "earth start" facilities can be arranged for PABX systems where requested by a customer. The provision of earth start involves the use of modified or special purpose central office equipment whereby the normal A-leg earth is disconnected in the idle state, leaving only battery on the B-leg.

(2) Reversal of this condition or the presence of an earth on the the A-leg indicates that the central office end of the trunk is not free to accept any new outgoing call from the PABX.

6.3
Voltage/current relationship
In the seized condition the voltage/current relationship of all 2 - wire analogue trunk ports shall be within the limits given in Specification
PTC 102 clause 4.2.3 and shown in Fig. 2 of that Specification.

6.4
Call start and clear
(1) For satisfactory interworking it is important that PABX's connected to the Telecom PSTN comply with the signalling protocol detailed in this Section. While many signals referred to are however only subject to strong recommendation, the "answer" signal from a PABX (ref. clause 6.11) is a mandatory requirement for all calls from the Telecom PSTN.

• *The timing of calls, and consequently the associated charging, is dependent upon receipt of an answer signal from the customer when an incoming call is received.*

• *See also Specification PTC 207, clause 1.1 (3).*

(2) During the dynamic call start or clear periods the trunk shall be in either one of the following two possible stable d.c. states:-

(a) Seized: For loop and earth start trunks the seized condition shall be as detailed in 6.3 above.

(b) Idle: In the idle state the PABX trunk termination shall offer a d.c. resistance greater than 50 k?.

• *The d.c. resistance offered to a public exchange in the 'clear' or 'idle' condition must be sufficiently high to ensure the proper release of calls. Specification PTC 102 clause 4.2.2 states that the current in the idle condition shall not exceed 1 mA which equates to 50 k? on a very short line. However it is preferred that the resistance be in the order of 100 k? to provide an adequate operational margin.*

6.5
Clear forward
On some types of public exchange, Telecom offers a 'clear forward' facility on CO trunks for calls terminating at the PABX. This is provided by means of an 800 - 1,100 ms break on the idle positive lead (i.e. the lead that is positive when in the idle condition).

• *In the future this may be changed to the idle negative lead.*

6.6
Fast guard
The "fast guard" signal comprises immediate application of a line polarity reversal from the idle condition on a trunk at the main exchange. It is mandatory that any PABX shall respond satisfactorily to this condition with a recognition time of 10 - 25 ms.

• *Due to the presence of silent periods of up to 2 seconds in ringing cadence from the main exchange there is the risk of a PABX trying to seize a trunk for an outgoing call while in receipt of an incoming ring. This may result in a "collision call" with unsatisfactory results. To avoid this collision of calls the "fast guard" condition is applied at the main exchange as soon as ringing is applied to the PABX trunk to provide a continuous indication to the PABX that the trunk has been seized for an incoming call.*

• *This fast guard is accomplished by connecting the central office ring return earth to the A-leg.*

• *The fast guard facility may be omitted from key telephone systems.*

6.7
Idle circuit termination
Termination of lines connected to the Telecom PSTN is described in Specification PTC 102 Section 10. Trunks terminating on PABX's shall provide a termination equivalent to a 1.8 µF capacitor in series with a resistor of 5 k? or greater in the idle condition.

• *This is to facilitate line testing by Telecom Network Control.*

• *Non-standard terminations may result in the detection of an apparent fault leading to either a maintenance visit or disconnection of the "faulty" line pending repair.*

6.8
Initial audio connection
Where a PABX uses decadic signalling to the public exchange, effective control of the audio path during the call set-up phase shall ensure the following:-

(a) The PABX shall prevent any DTMF signals from extension terminal devices from "spilling" into the Telecom network during any sender operation, and thereby causing faulty address signalling.

• *The majority of exchanges in the Telecom network will accept both decadic and DTMF signalling. Therefore, "spillover" of DTMF signals may be accepted by the Telecom network and result in unnecessary false routing of calls with resulting inconvenience to both customer and Telecom.*

(b) Effective audio path provision following completion of DTMF sending even if the answer reversal is not received.

• *It is recommended that all PABX's support DTMF signalling to the main exchange as there can be no guarantee for the future that decadic signalling will continue to be accepted.*

6.9
Re-seizing faulty trunks
Any automatic attempts to re-seize a trunk, diagnosed as faulty by customer switching equipment, shall not be made at intervals of less than 3 minutes.

• *See also Specification PTC 207, clause 5.13.*

6.10
Power failure
In the event of a failure in the supply of power to any customer switching equipment, provision shall be made for the handling of traffic incoming to the customer (see also Specification PTC 207, clause 5.11). This may be carried out by use of the following means, however, any other suitable

methods proposed by a supplier will also be considered at the time of application:-

(a) For earth and loop start trunks, the system may be by-passed such that incoming calls are answered on a suitable telephone instrument. This by-pass arrangement may either be an integral part of the system design or an installation feature added by the installer.

(b) For DDI lines, trunks should be back-busied from the PABX to the main exchange such that the caller receives an indication that they are not available for traffic. This will minimise the number of repeat attempt calls during the time that the power is off.

6.11
Metering pulses
Other than for an answering reversal, which is applied in most situations, Telecom main exchange equipment does not provide for any form of metering pulses to be sent to line.

• *Some administrations provide facilities for meters on customers' lines for registering calls. Such meters may be operated by pulses from the main exchange equipment which indicate the charging distance and duration of calls. Telecom, however, uses a centralised message recording system which is quite separate from the customer's line and therefore does not provide meter pulses.*

6.12
Direct dialling in (DDI) trunks

(1) DDI is defined in Specification PTC 207 along with the general requirements for its application.

(2) It is necessary that line feeding arrangements on PABX DDI trunks are designed to withstand the extreme currents that may occur when a full earth or -50 V is applied to either or both wires of the 2-wire trunk.

• *On some Telecom main exchanges, only decadic DDI address signalling is available. It is therefore recommended that PABX DDI interfaces be capable of accommodating both decadic and DTMF address signalling.*

• *On some recently installed main exchanges the seize condition to the PABX on a DDI call is earth on -ve lead and -50 V on +ve lead instead of the normal loop condition. It is therefore recommended that PABX equipment is designed to cater for this possibility. Efforts are being made to revert to loop calling in future designs but modification of equipment now installed may not be practical.*

6.13
Line signalling protocol

6.13.1
The line signalling protocol for earth/loop start trunks is given in tables 6.13 (1) to (4), to which the following notes apply:-

• *The term "line signalling" used here refers to seizing, ringing, releasing etc. and does not include "numeric signalling" or the sending of routing information required for the setting up of a call. Although reference is made to numeric signalling in some tables, these are covered in more detail in Specification PTC 108.*

Note 1: The polarity reversal on seize provides the "fast guard" facility.

Note 2: "Ringing" is fully detailed in Specification PTC 102

Note 3: Timeout of public exchange equipment, prior to reverting to the idle condition (or "release acknowledge"), is typically 4 seconds but it can vary between 0 and 20 seconds.

• *It is recommended that PABXs provide an outgoing call guard timer programmable between 1 and 6 seconds. During this time the trunk should be able to receive new incoming calls.*

Note 4: If the PABX extension continues to hold after the timeout period, then the "hold" becomes the "seize" condition of Table 6.13 (2) and a new outgoing call is initiated.

Note 5: This reversal of polarity is provided by the vast majority of Telecom public exchanges. However, since a few older types of equipment do not provide this facility, PABX systems shall be capable of operating normally without it.

Note 6: The trunk shall guard against outgoing calls for 500 ms after release by the calling party, before reverting to the idle condition.

Table 6.13 (1): Incoming calls to loop start PABXs

PABX <-- CO

Signal	Direction	PABX Interface	Exchange Interface Idle -ve Lead	Idle +ve Lead
Idle		Open Circuit	-50 V	Earth
Seize (Note 1)	<--	Open Circuit	Earth	-50 V
Ringing (Note 2)	<--	Open Circuit	Earth (with ringing)	-50 V
Answer	-->	Loop	-50 V	Earth
Calling Party Release first (Notes 3 & 4)	<--	Loop	-50 V	Earth (or 800 - 1100 ms break - ref. clause 6.5)
Called Party Release first (Note 3)	-->	Open Circuit	-50 V	Earth
Called Party Re-answer (before calling party release or timeout) (Note 3)	-->	Loop	-50 V	Earth
Both Parties Release together (Note 3)	<-->	Open Circuit	-50 V	Earth

Table 6.13 (2): Outgoing calls from loop start PABX's

PABX --> CO

Signal	Direction	PABX Interface	Exchange Interface Idle -ve Lead	Idle +ve Lead
Idle		Open Circuit	-50 V	Earth
Seize	-->	Loop	-50 V	Earth
Seize Acknowledge	<--	Loop	-50 V (Dial tone)	Earth
(Signalling)	-->	DTMF or Decadic	-50 V	Earth
Answer	<--	Loop	Earth	-50 V (Note 1)
Calling Party Release first	-->	Open Circuit	Earth then -50 V	-50 V Earth (Note 2)
Called Party Release first (Notes 3 & 4)	<--	Loop	-50 V	Earth
Called Party Re-answer (before calling party release or timeout) (Note 3)	<--	Loop	Earth	-50 V
Both Parties Release together (Note 3)	<-->	Open Circuit	-50 V	Earth

Table 6.13 (3): Incoming calls to earth start PABX's

PABX <-- CO

Signal	PABX Direction	Exchange Interface	Idle -ve Lead	Idle +ve Lead
Idle		Open Circuit	-50 V	Open Circuit
Seize (Note 1)	<--	Open Circuit	Earth	-50 V
Ringing (Note 2)	<--	Open Circuit	Earth (with ringing)	-50 V
Answer	-->	Loop	-50 V	Earth
Calling Party Release first (Note 3)	<--	Loop	-50 V	Open Circuit
Called Party Release first (Note 3)	-->	Open Circuit	-50 V	Earth
Release Acknowledge (Idle)	<--	Open Circuit	-50 V	Open Circuit
Both Parties Release together (Idle)	<-->	Open Circuit	-50 V	Open Circuit

Table 6.13 (4): Outgoing calls from earth start PABX's

PABX --> CO

Signal	Direction	PABX Interface	Exchange Interface Idle -ve Lead	Idle +ve Lead
Idle		Open Circuit	-50 V	Open Circuit
Seize	-->	Earth on -ve Idle with Loop	-50 V	Open Circuit
Seize Acknowledge	<--	Loop	-50 V (Dial tone)	Earth
(Signalling)	-->	DTMF or Decadic	-50 V	Earth
Answer	<--	Loop	Earth	-50 V (Note 2)
Calling Party Release first	-->	Open Circuit	Earth or -50 V	-50 V or Earth
Release Acknowledge	<--	Open Circuit	-50 V	Open Circuit
Called Party Release first (Note 1)	<--	Loop	-50 V	Earth then Open Circuit
Called Party Re-answer within timeout period (Note 1)	<--	Loop	Earth	-50 V (Note 2)
Both Parties Release together (Note 1)	<-->	Open Circuit	-50 V	Open Circuit

6.13.2
The line signalling protocol for DDI trunks is given in tables 6.13 (5) to (7), to which the following notes apply:-

Note 1: Recognition of the seizure signal shall take place within 150 mS.

Note 2: The PABX should be ready to receive DTMF or decadic signals within 500 ms from application of the seize signal.

Note 3: A minimum 500 ms delay is required between seizure and signalling.

Note 4: > 9 k? loop for crossbar main exchange equipment.
> 20 k? loop for pre - 1988 SPC digital main exchange equipment.
> 50 k? loop for post - 1988 SPC digital main exchange equipment.

Note 5: Control of audio path during call set-up is essential (ref. clause 6.8).

Table 6.13 (5): Incoming Calls to DDI PABXs
(using 2-wire both-way analogue trunks)

CO --> PABX

Signal	Direction	Exchange Interface	PABX Interface Idle -ve Lead	PABX Interface Idle +ve Lead
Idle		Idle -ve Lead -50 V Idle +ve Lead Earth	-50 V	Earth
Seize	-->	Loop (Notes 1 & 3)	-50 V	Earth
(Signalling)	-->	DTMF or Decadic (Note 2)	-50 V	Earth
Answer	<--	Loop (Note 5)	Earth	-50 V
Calling Party Release first	-->	High resistance Loop (Note 4)	Earth	-50 V
Release Acknowledge (Idle)	<--	High resistance Loop (Note 4)	-50 V	Earth
Called Party Release first	<--	Loop (Note 5)	-50 V	Earth
Release Acknowledge (then to Idle)	-->	High resistance Loop (Note 4)	-50 V	Earth
Both Parties Release together (then to Idle)	<-->	High resistance Loop (Note 4)	-50 V	Earth

Table 6.13 (6): Outgoing calls from DDI PABXs
(using 2-wire both-way analogue trunks)

PABX --> CO

Signal	Direction	PABX Interface	Exchange Interface Idle -ve Lead	Idle +ve Lead
Idle		Idle -ve Lead -50 V Idle +ve Lead Earth	-50 V	Earth
Seize	-->	Loop	-50 V	Earth
Seize Acknowledge	<--	Loop	-50 V + Dial Tone	Earth
(Signalling)	-->	DTMF or Decadic (Note 3)	-50 V	Earth
Answer	<--	Loop	Earth	-50 V
Calling Party Release first	-->	> 20 k? Loop	Earth	-50 V
Release Acknowledge (Idle)	<--	> 20 k? Loop	-50 V	Earth
Called Party Release first	<--	Loop	-50 V	Earth
Re-answer	<--	Loop	Earth	-50 V
Release Acknowledge (then to Idle)	-->	> 20 k? Loop	-50 V	Earth
Both Parties Release together (then to Idle)	<-->	> 20 k? Loop	-50 V	Earth

Table 6.13 (7): Incoming Calls to DDI PABXs
(using 2-wire unidirectional crossbar analogue trunks)

CO --> PABX

Signal	Direction	Exchange Interface	PABX Interface Idle -ve Lead	PABX Interface Idle +ve Lead
Idle		> 9 k? Loop	-50 V	Earth
Seize	-->	Loop (Note 1)	-50 V	Earth
(Signalling)	-->	DTMF or Decadic (Note 2)	-50 V	Earth
Answer	<--	Loop	Earth	-50 V
Calling Party Release first	-->	> 9 k? Loop	Earth	-50 V
Release Acknowledge (Idle)	<--	> 9 k? Loop	-50 V	Earth
Called Party Release first	<--	Loop	-50 V	Earth
Release Acknowledge (Idle)	-->	> 9 k? Loop	-50 V	Earth
Both Parties Release together	<-->	> 9 k? Loop	-50 V	Earth

7
DIGITAL CENTRAL OFFICE TRUNKS

7.1
General interface requirement (layer 1)

(1) The standard digital interface for PABX trunks to the main exchange shall be 2048 kb/s, with A- Law encoding, to ITU-T Recommendations G. 703, G. 704, G. 705, G. 711, G. 732 and G. 823 and shall normally incorporate the 75 ? coaxial termination option.

- *It is recommended that coaxial test access facilities are provided to enable the 2048 kb/s digital stream to be easily monitored during servicing or fault-finding.*

- *75 ? coaxial termination is the existing standard interface method adopted by Telecom. Consideration, however, may also be given for use of 120 ? balanced pair terminations in certain situations.*

- *Requirements for equipment using other processing methods to increase the available capacity of 2048 kb/s digital links, including use of flexible multiplex, are covered separately in Specification PTC 217.*

- *Examples of such processing methods are ADPCM, CVSD, packetised voice systems etc.*

- *Some of the limitations for use of such equipment when linking PABX's are covered in Specification PTC 109, Section 7.*

(2) The 2048 kb/s digital interface consists of two unidirectional ports. For the purposes of this Specification they are designated the "send" port and the "receive" port as indicated in Fig. 1. These ports shall comply with ITU-T, Recommendation G. 703 as follows:-

(a) The digital signal at the send port shall comply with the requirements of G.703, para. 6 for an output port, unless otherwise stated.

(b) The digital signal presented to the receive port shall comply with the requirements of G. 703, para. 6, for an input port.

(3) Earth connections shall be as follows:-

(a) The outer conductor of the send port shall be directly connected to earth as shown in Fig. 2 (a).

(b) The outer conductor of the receive port should be connected to earth through a 100 nF, 100 V capacitor as shown in Fig. 2 (b).

(c) Provision shall be made at the receive port to facilitate the future use of a direct earth (see Fig. 2 (c)) instead of the 100 nF capacitor described in (b).

- *"Earth" used in this context should be the quietest available earth.*

7.2
Frame structure
(1) The allocation of bits 1 to 8 of the frame shall be as detailed for national use in ITU-T Recommendation G.704.

(2) Although not a mandatory requirement, Telecom normally uses bits 3 and 8 in the frame "not containing frame alignment signal" as follows:-

(a) Bit 3 is used for alarm indications, where

0 = normal condition
1 = alarm condition

(b) Bit 8 is used for the remote loopback facility, where

1 = normal
0 = loopback

• *When the remote loopback command is received at the distant terminal, that terminal loops back the 2048 kb/s stream except for the remote loopback command bit which it returns as logic 1. If the remote loopback command is received back at the initiating terminal, the command is ignored. These features provide double protection against the formation of a "closed loop".*

• *It is recommended that bits 4-8 inclusive are all accessible, even if not used initially. This may be to the mutual benefit of both the PABX customer and Telecom at a later date.*

• *PABX suppliers are invited to consider the provision of compatible loopback facilities for their equipment in order to ease the problem of fault location.*

• *Local loopback facilities should also be provided.*

7.3
Synchronisation
(1) For satisfactory interworking of digital systems in any network it is necessary that they be synchronised with each other. Failure to do so may produce signal errors which will result in distortion to the user.

(2) Telecom has an established synchronisation hierarchy for it's PSTN whereby all interworking component digital systems in the network are synchronised with one master source. This master clock has an accuracy of ±1 part in 10^{11}.

(3) PABX's connected digitally to the Telecom network shall conform to the following synchronisation hierarchy:-

(a) Systems shall be capable of being synchronised to a nominated (primary) 2048 kb/s link from the main exchange (see Fig. 3).

(b) Failure of the primary link should result in the equipment being synchronised to a nominated standby (secondary) 2048 kb/s link, if available.

• *It is recommended that systems free run within 50 ppm of the nominal 2048 kb/s frequency on their own internal clock system, if all links with the Telecom network fail or are not available for any reason.*

7.4

Jitter and wander

(1) Jitter and wander are in fact similar phenomena occurring at different frequencies and it is necessary to exercise control to avoid excessive accumulation in any digital network. Failure to do so can result in errors and slips in the transmission of digital signals and a degradation of digitally encoded analogue information.

• *Reference ITU-T, Recommendation G. 823.*

(2) For any 2048 kb/s digital interface between a PABX and the PSTN, jitter and wander performance is specified as follows:-

(a) Jitter and wander tolerance of an input interface, which is the ability of equipment to accept phase deviations on incoming signals without introducing slip or errors, shall comply with the limits shown in the mask shown in Fig. 4.

(b) Relative Time Interval Error (TIE) of an output interface, over the period 'S' seconds shall not exceed the following limits:-

	(100 S) ns + $^1/_8$ UI	for values of S < 10
or	1000 ns	for values of S = 10

where UI = 488 ns (for 2048 kb/s)

• *"UI" is an abbreviation for "unit interval", which has a unique value for each separate digital bit rate.*

(c) Where the networks are independently synchronised (e.g. where the PABX network is plesiochronous) the relative TIE may eventually exceed the jitter and wander tolerance and slip will then occur. The long term mean controlled slip under these circumstances shall not exceed one slip in 70 days.

• *Reference ITU-T, Recommendations G. 811 and Q. 512 clauses 3.2 and 5.2.*

7.5
Alarm and fault conditions

7.5.1
(1) The fundamental characteristics, fault conditions, etc., together with the alarm facilities of any 2048 kb/s digital stream interconnecting a PABX with the Telecom PSTN, shall conform to ITU-T, Recommendation G. 732.

(2) The bit error rate (BER) of the digital signal incoming to the Telecom PSTN shall be less than 1 part in 10^7 in order to deactivate Telecom's BER alarms.

(3) It is strongly recommended that adequate alarm facilities are provided for the interconnecting bit stream, particularly alarm indications to the end under the control of Telecom. This indication is desirable so that adequate service protection to Telecom customers can be provided. Reciprocal arrangements can also be made so that any alarm supervision of the link is to the mutual benefit of both parties.

(4) Details of such alarm arrangements and associated service protection responsibilities shall be clearly defined in any application for connection of a PABX to the Telecom PSTN.

7.5.2
Telecom alarms
Following is a list of alarm indications monitored by Telecom. This information is reported automatically to the main exchange software:-

(a) Loss of Frame Alignment (LOF):
This is an indication that the received pattern (if any) does not contain the Frame Alignment word.

(b) Loss of Multiframe Alignment (LOMF):
This is an indication that the received pattern (if any) does not contain the Multiframe Alignment word.

(c) Frame Pattern Error (FPE):
This alarm indicates that a threshold bit error rate of ±1 part in 10^3 has been exceeded.

(d) PCM Loss (PCML):
This is an alarm which indicates a complete loss of incoming signal.

(e) Alarm Indication Signal (AIS):
This is an indication that the received pattern contains all digit '1's.

(f) Remote Frame Alarm (RFA):
This is a signal forwarded in the send direction of a digital link, in response to the LOF signal, indicating to the remote equipment that the receive path has been disrupted. Conversely, an alarm is activated by the local equipment when a Remote Frame Alarm signal is received

from the remote equipment.
(g) Remote Multiframe Alarm (RMFA):
This is a signal forwarded in the send direction of a digital link, in response to the LOMF signal, indicating to the remote equipment that the receive path has been disrupted. Conversely, an alarm is activated by the local equipment when a Remote Frame Multiframe Alarm signal is received from the remote equipment.

(h) Frame Alignment Memory Error (FAME):
This alarm indicates a bit error in the frame alignment memory.

7.6
Signalling (layer 2)

7.6.1
General

(1) Telecom has adopted channel associated signalling as described in ITU-T, Recommendation G 704. The bit allocation of time slot 16 shall be as given in Table 7 of that Recommendation.

(2) The following Tables 7.6(1) - 7.6(6) all detail channel associated signalling protocols at a PABX digital trunk interface (DTI). The line signalling shown uses two signalling channels in each direction of transmission per speech circuit. These signalling channels are referred to as 'A_f' and 'B_f' for the direction of call set-up (forward direction) and, A_b and B_b for the backward direction.

(3) Telecom does not support the CCITT R2 MFC line signalling protocol for PABX signalling. Instead, decadic signalling, using time slot 16, and DTMF signalling within the voice channel are used.

(4) For satisfactory interworking it is important that PABX's connected to the Telecom PSTN comply with the signalling protocol detailed in this Section. While most signals referred to are only subject however to strong recommendation, the "answer" signal from a PABX is a mandatory requirement for all calls from the Telecom PSTN.

• *The timing of calls, and consequently the associated charging, is dependent upon receipt of an answer signal from the customer when an incoming call is received.*

(5) The make/break bit toggling for decadic address signalling over digital systems follows the normal cadence of decadic signalling.

(6) Following release of a call from a PABX, timeout of the main exchange equipment prior to reverting to the idle condition is typically 4 seconds, but it can vary between 0 and 20 seconds.

• *It is recommended that PABXs provide an outgoing call guard timer programmable between 1 and 6 seconds. During this time the trunk should be able to receive new incoming calls.*

7.6.2
Description of signalling terms used
The following clauses describe the terms use in Tables 7.6 (1) to (6) and detail any deviation from CCITT Recommendations Q. 422 and Q. 424:-

(a) Idle:
In the idle state the originating end sends $A_f = 1$, $B_f = 0$. This results in the terminating end returning $A_b = 1$, $B_b = 0$, provided that all equipment at the terminating end is idle. The circuit is only idle if the originating end recognises $A_b = 1$, $B_b = 0$ in response to $A_f = 1$, $B_f = 0$.

(b) Release to Idle (on both-way trunks):
When released, the end which acted as the terminating end must maintain the signalling code $A_b = 1$, $B_b = 0$ for at least 100 ms to ensure that the signal is recognised at the originating end, after which the circuit becomes idle.

(c) Seize:
Seizure from the originating end only occurs when the terminating end is in the 'idle' condition (i.e. $A_b = 1$, $B_b = 0$) and this condition is recognised by the originating end. Seizure consists of changing A_f from 1 to 0 to give $A_f = 0$, $B_f = 0$.

• *The originating end must maintain this condition until it receives a seize acknowledge signal from the terminating end. During this period the trunk, at the originating end, will be blocked to further outgoing calls.*

(d) Seize Acknowledge
Seize Acknowledge ($A_b = 1$, $B_b = 1$) is returned from the terminating end to the originating end in response to a seize signal from the originating end. However, this shall only occur when all equipment associated with receiving the address information is ready to receive it.

• *After receipt of the seize acknowledge signal the originating end can proceed to forward address information immediately (further delay will cause the address information receivers at the terminating end to be unnecessarily held).*

• *If the seize acknowledge signal is not received at the originating end within 800 ms from sending the seize signal, then the originating end should not proceed to send address information but should either return disconnect tone to the calling party (while continuing to monitor for seize acknowledge signal) or reattempt to establish a call set-up.*

• *If the seize acknowledge signal is returned after the 800 ms timeout , the originating end should send a clear forward signal ($A_f = 1$, $B_f = 0$) to the terminating end in order to release the trunk for further calls.*

• *Telecom terminations, at present, return the seize acknowledge signal within a period ranging from 114 ms to 1438 ms (average 222 ms) following receipt of a seize signal. On calls outgoing from the*

Telecom termination, the address information is forwarded after 800 ms regardless of whether a seize acknowledge signal is received or not. Further development is being considered by Telecom.

(e) Address Signalling:
Decadic address signalling is incorporated within channel 16 and DTMF address signalling in the voice channel of the channel associated structure. Address signalling may commence immediately upon receipt of the seize acknowledge signal, but should not proceed if the seizure acknowledgement signal has not been recognised.

• *Requirements for decadic and DTMF address signalling in the Telecom PSTN are described in Specifications PTC 102, Section 5 and PTC 108, Section 5.*

(f) Answer:
The off-hook condition of the called party causes the terminating end to send $A_b = 0$, $B_b = 1$ to the originating end as an answer signal.

(g) Called Party Release (Clear Back):
The release condition from the called party causes the terminating end to send $A_b = 1$, $B_b = 1$ (clear back) to the originating end. When this is recognised, the originating end responds with $A_f = 1$, $B_f = 0$ (clear forward) causing the terminating end to further respond after 100 ms with $A_b = 1$, $B_b = 0$ (release to idle).

(h) Calling Party Release (Clear Forward):
When the calling party clears, the originating end sends $A_f = 1$, $B_f = 0$ (clear forward) to the terminating end.

• *The originating end should not restore to idle until recognition of a clear back signal from the terminating end.*

• *On connections that originate from the Telecom PSTN the clear forward signal (in response to clear back) is sent either:-*

(a) immediately the calling party is cleared, or

(b) if the calling party does not clear within 5 seconds of the clear back signal.

7.6.3
Direct dial-in (DDI) trunks

The signalling protocol adopted by Telecom for use on DDI trunks is as shown in Tables 7.6(1) and 7.6(2). This protocol basically follows the digital version of Signalling System R 2 as described in ITU-T, Recommendation Q. 421, with the addition that time slot 16 is used for address signalling.

Table 7.6(1):
Incoming Calls to PABX via Direct Dial In (DDI) Trunks (CO --> PABX)

Signal	Direction	2 Bit Signal ------> Forward A_f	B_f	<------ Backward A_b	B_b
Idle		1	0	1	0
Seize	--->	0	0	1	0
Seize Acknowledge	<---	0	0	1	1
Decadic Signalling: Break	--->	1	0	1	1
Make	--->	0	0	1	1
Answer	<---	0	0	0	1
Called Party Release First	<---	0	0	1	1
Calling Party Release First	--->	1	0	0	1
Called Party Release After Calling Party (then to Idle)	<---	1	0	1	0
Calling Party Release After Called Party (then to Idle)	--->	1	0	1	1
Both Parties Release together (then to idle)	<--->	1	0	1	1
Release to Idle		1	0	1	0
Blocking	<---	1	0	1	1

Table 7.6(2)

Outgoing Calls from PABX via Direct Dial In (DDI)
(PABX --> CO)

Signal	Direction	2 Bit Signal ------> Forward A_f	B_f	<------ Backward A_b	B_b
Idle		1	0	1	0
Seize	--->	0	0	1	0
Seize Acknowledge	<---	0	0	1	1
Decadic Signalling: Break	--->	1	0	1	1
Make	--->	0	0	1	1
Answer	<---	0	0	0	1
Called Party Release First	<---	0	0	1	1
Calling Party Release First	--->	1	0	0	1
Called Party Release After Calling Party (then to Idle)	<---	1	0	1	0
Calling Party Release After Called Party (then to Idle)	--->	1	0	1	1
Both Parties Releases together (then to Idle)	<--->	1	0	1	1
Release to Idle		1	0	1	0
Blocking	<---	(Not currently supported by Telecom main exchanges)			

7.6.4 Telecom protocol

An alternative Telecom version of signalling protocol used on some local PCM systems, whether originating from main exchange DTI or multiplex equipment, is shown in tables 7.6(3) - 7.6(6) following. This protocol is proprietary to Telecom but is available for any PABX supplier wishing to support it.

Table 7.6(3)

Incoming Calls to PABX (Loop Start Equivalent)

CO --> PABX

Signal	Direction	2 Bit Signal ------> Forward A_f	B_f	<------ Backward A_b	B_b
Idle		1	0	1	0
Ringing:	--->	0	0 or 1	1	0
Fast Guard Rev.	--->	1 or 0	1	1	0
Answer (Note 1)	<---	1	1 or 0	0	0
	or	0	1 or 0		
Answer Acknowledge	--->	1	1	0	0
Calling Party Release (for approx. 800 ms --- Note 2)	--->	0	0	0 or 1	0
Called Party Release (then to Idle - see clause 7.6.1 (6))	<---	1	1	1	0
	or	0	0		
Called Party Re-answer (before Calling Party Release or timeout - see clause 7.6.1(6))	<---	1	1	0	0
Both Parties Release together (then to Idle - see clause 7.6.1(6))	<--->	0	0	1	0
Release to Idle	--->	1	0	1	0
Forward Blocking	--->	1	1	1	0
Backward Blocking	<---	1	0	1	1

Note 1: In the stable "busy" state the A_f bit is "1".

Note 2: "Calling Party Release" is not always available on Telecom main exchanges or PCM systems.

Table 7.6(4)
Outgoing Calls from PABX (Loop Start Equivalent)
PABX --> CO

Signal	Direction	2 Bit Signal ------>		<-----	
		A_f	B_f	A_b	B_b
Idle		1	0	1	0
Seize	--->	0	0	1	0
Seize Acknowledge (Note 1)	<---	0	0	1	1
Decadic Signalling: Break	--->	1	0	1	1
(Note 2) Make	--->	0	0	1	1
Answer	<---	0	0	0	1
Calling Party Release	--->	1	0	0 or 1	1
Called Party Release	<---	0	0	1	1
Called Party Re-answer (before Calling Party Release or timeout - see clause 7.6.1(6))	<---	0	0	0	1
Release Acknowledge (Idle)	<---	1	0	1	0
Both Parties Release together (then to Idle - see clause 7.6.1(6))	<--->	1	0	1	1
Release to Idle	<---	1	0	1	0
Forward Blocking	--->	1	1	1	0
Backward Blocking	<---	1	0	1	1

Note 1: "Seize Acknowledge" is only realised when "in band" dial tone is present on the associated voice channel.

Note 2: DTMF signalling within the associated voice channel is also supported.

Table 7.6(5)

Incoming Calls to PABX (Earth Start Equivalent)

CO --> PABX

Signal	Direction	2 Bit Signal ------> Forward A_f	B_f	<------ Backward A_b	B_b
Idle		1	0	1	0
Fast Guard Rev.	--->	1 or 0	1	1	0
Ringing: (ring)	--->	0	1 or 0	1	0
Answer (Note 1)	<---	1	1 or 0	0	0
	or	0	1 or 0		
Answer Acknowledge	--->	1	1	0	0
Calling Party Release (for approx 800 ms --- Note 2)	--->	0	0	0 or 1	0
Called Party Release (then to Idle - see clause 7.6.1(6))	<---	1	1	1	0
	or	0	0		
Release Acknowledge (Idle)	--->	1	0	1	0
Both Parties Release together (then to Idle - see clause 7.6.1(6))	<--->	0	0	1	0
Release to Idle	--->	1	0	1	0
Forward Blocking	--->	1	1	1	0
Backward Blocking	<---	1	0	1	1

Note 1: In the stable "busy" state the A_f bit is "1".

Note 2: "Calling Party Release" is not always available on Telecom main exchanges or PCM systems.

Table 7.6(6):

Outgoing Calls from PABX (Earth Start Equivalent)

PABX --> CO

		2 Bit Signal			
		------>		<------	
Signal	Direction	A_f	B_f	A_b	B_b
Idle		1	0	1	0
Seize	--->	0	0	1	0
Seize Acknowledge (Note 1)	<---	0	0	1	1
Decadic Signalling: Break	--->	1	0	1	1
(Note 2) Make	--->	0	0	1	1
Answer	<---	0	0	0	1
Calling Party Release	--->	1	0	1 or 0	1
Called Party Release First	<---	1 or 0	0	1	1
Called Party Re-answer (before Calling Party Release or timeout - see clause 7.6.1(6))	<---	0	0	0	1
Release Acknowledge (Idle)	<---	1	0	1	0
Both Parties Release together (then to Idle)	<--->	1	0	1	1
Release to Idle	--->	1	0	1	0
Forward Blocking	--->	1	1	1	0
Backward Blocking	<---	1	0	1	1

Note 1: "Seize Acknowledge" is only realised when "in band" dial tone is present on the associated voice channel.

Note 2: DTMF signalling within the associated voice channel is also supported.

7.7

Blocking and Unblocking Procedures

(1) Blocking of outgoing calls on individual trunks shall occur when a signal $A_b = 1$, $B_b = 1$ appears on a trunk from the distant end. The trunk shall revert to idle upon recognition of an idle signal ($A_b = 1$, $B_b = 0$) from the distant end.

- *Blocking may be used when fault conditions are indicated.*

- *Additional examples of signals that are can function as blocking signals are seize acknowledge, called party release, etc.*

(2) In order to prevent permanent blocking the local terminal shall maintain the idle condition when a blocking signal is received from the distant terminal.

(3) On recognition of a Remote Alarm signal from the distant end, the local terminal shall prevent outgoing calls on all channels of a 2048 kb/s link until such time as the Remote Alarm signal has cleared.

- *Upon recognition of a Remote Alarm indication the Telecom termination blocks all channels and ignores individual channel blocking signals from the distant end until such time as the Remote Alarm is restored. When the Remote Alarm is restored the Telecom termination will act on channel blocking signals on individual channels.*

- *Furthermore, upon recognition of a Remote Alarm, the Telecom termination retains current call states on individual channels for a period of 8 seconds. After 8 seconds the Telecom termination restores each channel to idle ($A_f = 1$, $B_f = 0$) but channels remain blocked to further outgoing calls until the Remote Alarm has cleared. Link restoration within 8 seconds results in the resumption of calls in the state of progress at which they were at the instant of Remote alarm recognition.*

- *Call state retention will be effective only if the distant end similarly maintains call states for the 8 second period. If the distant end reverts to an idle signal on channels immediately after a Remote Alarm has been recognised, the Telecom termination will recognise that when the Remote Alarm has been cleared and also return to idle without maintaining the current call states.*

- *At present, Telecom main exchange equipment does not provide the channel blocking signal on individual channels toward the distant end. However, this facility is under consideration and may be introduced in due course.*

7.8

Collision calls

(1) A collision call, or double seizure, is the condition when a bothway trunk is simultaneously seized from both ends. This phenomena results in both terminals forwarding the seize signal ($A_f = 0$, $B_f = 0$), and also receiving that same signal instead of a seize acknowledge signal ($A_b = 1$, $B_b = 1$). In such situations, the connection shall either:-

(a) be released at both ends and Disconnect Tone sent to the calling party, or,

(b) a repeat attempt made to set up the call.

(2) On recognition of a collision call condition, equipment at both ends must maintain the seized state for a minimum of 100 ms, after which time a clear forward signal shall be sent. After sending the clear forward signal for a minimum of 100 ms each end may then restore to the idle condition.

7.9
Order of trunk circuit selection

(1) In order to minimise the incidence of collision calls, it is recommended that channel selection within a 2048 kb/s link at each end should begin in the opposite order. This is known as "linear selection".

- *For "linear selection" the main exchange normally commences at channel 1 and proceeds to channel 30. A higher numbered channel is only selected if there are no lower numbered channels available. It is recommended that at the PABX end, selection is reversed commencing at channel 30 and proceeding to channel 1.*

(2) Under heavy traffic conditions, however, "linear selection" places undue demands on the processor at the main exchange. In this case "circular selection" is preferred.

- *"Circular selection" is a process where the next channel selected by the main exchange is the one higher in number to the previous one selected. At the PABX end, selection is the one lower in number to the prvious one selected.*

- *This method is only employed where traffic conditions are high enough to cause problems with processor overload. For light traffic,"linear selection" is still preferred. The matter should be discussed with the local Telecom Manager prior to the commissioning of a PABX.*

8
ANALOGUE TIE LINES

8.1
General

(1) This Section applies in all cases where the tie line port interfaces with the Telecom network for interconnection with a remote PABX, using analogue voice communication.

(2) Where two or more PABX's are networked together and none of them have been supplied by Telecom then the choice of line signalling method and the protocol used are regarded as marketing features. However, since there can be no guarantee that any particular type of connection is readily available between the required localities, the choice of signalling method may be restricted. It is therefore recommended that early discussions be held with the local Telecom Manager to establish:-

(a) the facilities readily available, and

(b) the possibilities of augmentation and costs involved, if necessary.

• *Although no guarantee can be given, in general 2-wire physical cable pairs can usually be provided between locations in the same urban district but not between remote districts. Increasingly, 2-wire or 4-wire E & M facilities may be readily provided between most locations due to the penetration of digital (PCM) systems and fibre-optic cables throughout the network.*

• *The option of digital ties is also recommended for consideration wherever digital facilities are, or can be made available (see Section 9).*

(3) Where networking of PABX's includes the use of a system supplied by Telecom then the line signalling protocol used shall conform to this Specification.

8.2
Decadic signalling ties (2-wire)

(1) Between non-Telecom PABX's the only Telecom requirement for interfaces of 2-wire tie line ports using decadic (loop disconnect) signalling is that any voltage applied is limited to ELV as defined in Specification
PTC 101.

• *The line signalling method and protocol for this application of tie lines are regarded as marketing features.*

(2) If one or more of the PABX's involved in a network has been supplied by Telecom then the line signalling protocol shall conform to Tables 6.13 (6) and (7).

(3) Transmission requirements and limits are covered separately in Specification PTC 109.

8.3
E & M Signalling (UK Type SSDC5)

(1) Port interfaces using two separate signalling wires (E & M signalling) may consist of a 2-wire or 4-wire voice path as required. The two signalling wires necessary for channel associated signalling are designated S1 and S2. A channel fail (CF) wire may also be required where transmission equipment is associated with the interface. A typical arrangement is shown in Fig. 5. All signalling voltages are d.c.

• *It is recommended for this type of signalling that the cable distance between equipment on each side of the interface be as short as possible, ideally not more than 300 metres.*

(2) Signal send conditions:
The signalling conditions to be applied to the signal originating (M) wire shall be "earth on" and "earth off", defined as follows:-

"Earth on" -- the equivalent of an earth condition applied via a switching resistance of up to 100 ? together with, either:-

(a) a noise suppression filter, consisting of a 1200 ? ± 5 % series resistor with a 1 µF ± 10 % capacitor connected between the signalling wire and the signalling earth (see Fig 5), or

(b) a series 1200 ? ± 5% resistor.

"Earth off" -- removal of the "earth on" condition leaving a residual resistance to earth greater than 500 k?.

These signalling conditions may be accompanied by a potential between -60 V and +3 V via a resistance of not less than 200 k?.

(3) Signal receive conditions:

(a) The signalling conditions to be detected on the signal receiving (E) wire shall be "earth on" and "earth off", defined as follows:-

"Earth on" -- a resistive earth of less than 1500 ?.
"Earth off" -- a resistive earth greater than 400 k?.

Recognition of the "earth on" and "earth off" signals must be capable of tolerating the presence on the signal receive wire of a potential between -60 V and +3 V via a resistance of not less than 150 k?.

(b) The signal receiving equipment shall present a substantially non-reactive impedance. If necessary, the receiving circuit shall be quenched to prevent damage or interference to the Telecom signal sending equipment or the interface wires. The potential presented by the signal receiving equipment shall be negative and be within the limits of 0 and 60 V.

(c) The impedance presented to the interface by the receiving equipment shall be such that the current flow resulting from the application of a zero resistance earth directly to the receiving equipment does not exceed 25 mA and the current flow resulting from a similar application of an earth via a 1500 ? resistance exceeds 5 mA.

(4) Signalling protocol:
The following table details the line signalling protocol for E&M type signalling:-

Table 8.3 E &M Type Line Signalling Protocol

SIGNAL		ORIGINATING TK. CCT.		TERMINATING TK. CCT.	
	Direction	'M' Lead	'E' Lead	'M' Lead	'E' Lead
Idle	--------> <--------	Earth Off	Earth Off	Earth Off	Earth Off
Connect (Seize)	-------->	Earth On	Earth Off	Earth Off	Earth On
Delay Dial	<-------	Earth On	Earth On	Earth On	Earth On
Proceed to Send (Note 1)	<-------	Earth On	Earth Off	Earth Off	Earth On
Address	------->	Earth On/Off	Earth Off	Earth Off	Earth On/Off
Answer	<-------	Earth On	Earth On	Earth On	Earth On
Calling Party Release	------->	Earth Off	Earth On or Earth Off	Earth On or Earth Off	Earth Off
Called Party Release	<-------	Earth On	Earth Off	Earth Off	Earth On

Note 1: To ensure interworking with Telecom PABX's various options shall be provided as detailed below. The above table shows only the "Delay Dial/Proceed to Send" option.

(5) Seize protocols:
The following programmable options shall be provided to ensure correct inter-register signalling between different Telecom PABX's:-

(a) Delay dial/proceed to send.

(b) A programmable pre-sending pause between 500 and 3000 ms between seizure and the sending of address information.

(c) "Wink start" where the idle "earth off" signal is maintained by the called PABX until the register is attached, at which time an "earth on" signal of 140 to 290 mS is applied by the called PABX. The "off hook" to "on hook" transition (start dial) must not occur until 210 mS after the connect signal is received.

- *The option of in circuit dial tone from the seized PABX is also recommended.*

(6) Address information:

DTMF signalling of address information within the voice band is supported by Telecom PABX's.

- *On systems installed to date by Telecom no "end of address" signal is provided on DTMF signalling. Unless suppliers can ensure that their PABX's can operate satisfactorily without this signal it is recommended that DTMF not be used.*

9
DIGITAL TIE LINES

9.1
General interface requirement

(1) The Telecom digital network supports, for general use, 2048 kb/s A-Law conforming to ITU-T Recommendation G. 703. Any interface between the network and PABX's at this level shall conform to this Recommendation and shall incorporate the 75 ? coaxial termination option.

• *It is recommended that coaxial test access facilities are provided to enable the 2048 kb/s digital stream to be easily monitored during servicing or fault-finding.*

(2) Interface requirements shall be in accordance with the requirements of clause 7.1.

9.2
Frame structure

(1) Where networking of PABX's includes the use of a system supplied by Telecom the frame structure shall be as stated in clause 7.2.

(2) Where the PABX network does not include a Telecom-supplied PABX then the frame structure can be regarded as a marketing feature.

• *While not mandatory in all cases it is nevertheless recommended that the frame structure conform to ITU-T Recommendation G. 704 as detailed for national use.*

9.3
Synchronisation

All digital PABX networks that are connected to the Telecom PSTN shall be synchronised in accordance with clause 7.3.

9.4
General characteristics

The fundamental characteristics, fault conditions, etc. together with alarm facilities of any 2048 kb/s digital interface involving interworking with Telecom shall conform to ITU-T, Recommendation G. 732. It is also essential that adequate alarm facilities are provided where the remote PABX has been supplied by Telecom.

9.5
Line signalling

(1) Where the PABX network does not include a Telecom PABX then the signalling protocol is regarded as a marketing feature.

(2) There is at present no standard Telecom signalling system for digital interworking of PABX's. There are however three commonly used systems. Therefore, where a Telecom-supplied PABX is included in the network the signalling protocol used will probably be one of the following:-

(a) Channel associated signalling in accordance with ITU-T Recommendation G.704.

(b) Digital private network signalling system (DPNSS) as detailed in British Telecom Specifications BTR 188 and BTR 189.

(c) CCITT No. 7 signalling system to ITU-T, Recommendation Q. 710.

(3) It is recommended that discussions be held with the local Telecom Manager to ensure signalling compatibility with any existing Telecom-supplied PABX.

9.6
Future standards

(1) ISDN development is still proceeding internationally and is closely related to the networking of PABX's and interconnection with national networks. Definite standards are being evolved and are to be incorporated by the CCITT in the Blue Book, due for release in 1989.

(2) Network interworking and service capabilities relating to ISDN will be covered in the CCITT Blue Book 'I' Series Recommendations.

(3) Signalling protocols relating to ISDN will be incorporated in the CCITT Blue Book 'Q' Series Recommendations.

(4) The whole question of ISDN is subject to continuing study by Telecom and PTC Specifications will be issued as follows:-

Telecom ISDN Interfaces	- PTC 130 Series
ISDN Terminal Devices	- PTC 230 Series
ISDN Network Interconnection	- PTC 307

10
OPERATORS CONSOLE

10.1
General
The general facilities and method of operation of a PABX operator's console are regarded as marketing features and therefore, apart from transmission requirements stated in PTC 109, are not subject to any restrictions.

10.2
Operator's headset
Requirements for operator's headsets for use in the Telecom PSTN are being covered in Specification PTC 208.

11
MOBILE RADIO ACCESS

11.1
General facilities

(1) Access to VHF land mobile radio facilities is normally available to PABX customers via a relay set in the main exchange. This access is provided by means of a dedicated trunk circuit and is activated either by an extension on the PABX dialling a VHF access code, or by a mobile operator's telephone hard wired to the trunk, going "off-hook".

(2) Incoming access from a mobile unit via the VHF relay set in the main exchange is normally provided direct to the mobile operator's telephone or to a monitoring loudspeaker connected to the trunk.

• *Consideration is being given to a method of mobiles accessing PABX extensions directly by use of DTMF signalling through the VHF interface.*

11.2
VHF trunk conditions

(1) If the VHF relay set in the main exchange is in use then busy tone will be received on the trunk if access is attempted from the PABX. At the same time the normal idle d.c. conditions are removed. This shall not be interpreted by the PABX as a fault condition.

(2) If the relay set is free then the line polarity on the trunk is reversed at the main exchange in response to a loop from the PABX.

(3) On an incoming call from a mobile the line polarity on the trunk is reversed at the main exchange.

(4) Any monitoring loudspeaker connected to a trunk shall have a high impedance input circuit and it shall be activated by the reversal of line polarity from the main exchange.

11.3
Trigger conditions

(1) Press-to-talk systems are activated by application of a balanced earth condition from the VHF operator's telephone or extension telephone when the 'talk' button is depressed. This condition triggers the VHF transmitter.

(2) Non press-to-talk systems are activated by the loop condition from the calling telephone.

(3) Calls from the Telecom PSTN shall not be capable of accessing the mobile radio facilities directly via a PABX. Such calls shall be answered in the first instance by the PABX operator, and then they may be extended in the normal way.

• *This facility is regarded as an interconnection of networks and, in this case difficulty may be experienced with transmission quality. It is important therefore that the call be answered at the access point.*

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12
PAGING

In general paging within a PABX is regarded as a marketing feature. However, any paging device which can in any way be connected to the Telecom PSTN via the PABX shall conform to the overall requirements of Specification PTC 202.

END OF SPECIFICATION PTC 107