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PRACTICE

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Private Circuit Services Signalling Handbook

A guide to the selection of Signalling Systems for Private Branch Networks, including a full description of all signaling systems in use within the UK, both inland and international.

For the use of BT staff only - The contents of this handbook must not under any circumstances be shownto persons or organisations outside British Telecomunications plc

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Private Circuit Services Signalling Handbook

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Private Circuit Services Signalling Handbook

Section 1 — Introduction

It is not usually possible to separate the signalling requirements for inter-PBX circuits from the transmission requirements. The Handboook therefore includes general guidance for the selection of circuits with an outline of their transmission performance. Where necessary, reference is made to other documents for more detailed information.

It has been necessary throughout this Handbook to refer to BT Telecom Instructions (TIs). Although these have been formally cancelled, in the absence of any superceding documents, the information contained in them is still relevant. In due course the majority of the information in these TIs will become available in Private Services Handbooks and ISIS documents, produced by UKCHQ/PCS3.1.

The references contained in the text are shown in Appendix 1 (TI/ISIS references).

It is particularly important where BT has a responsibility to provide and/or maintain an inter-PBX facility, that network systems are engineered to a coherent plan so that the transmission and signalling performance is predictable. It is hoped that this Handbook will contribute to that end.

Bob Mackie
Formerly BTE Business Systems
January 1986

End of Section 1

Private Circuit Services Signalling Handbook

Section 2 — Definitions

PBX (Private Branch Exchange)

For the purpose of this document, the term PBX describes any form of Call Routing Apparatus. It is traditionally split into two forms: PABX (Private Automatic Branch Exchange) and PMBX (Private Manual Branch Exchange). One or more PBXs may be located within a Branch Telecoms System.

Branch Telecommunications System

A telecoms system situated in a set of premises within the same building or a group of buildings all within 50 metres of each other and occupied by one person or persons within the same Group.

Private Circuit

A circuit for the exclusive use of one or more particular persons, provided by a Specified Public Telecoms System.

Exclusive Private Circuit

A private circuit for the exclusive use of one person or persons within the same Group. This type of circuit may be connected in tandem with other Exclusive Private Circuits and with one Bilateral Private Circuit. It may not have access to the PSTN (Public Switched Telecoms Network).

Bilateral Private Circuit

A private circuit between two Branch Telecoms Systems run by different persons who are not members of the same Group. This type of circuit may be connected in tandem with an Exclusive Private Circuit but not with another Bilateral Private Circuit nor may it have access to the PSTN.

Public Extension Circuit

A private circuit that has all the properties of an Exclusive Private Circuit or a Bilateral Private Circuit with the added facility that it may carry I/C and/or O/G PSTN calls in either direction. This type of circuit may be connected in Tandem with another Private circuit so long as the Public Extension Circuit is not extending a PSTN call.

Dependent Circuit

A private circuit for the exclusive use of one person or persons within the same group connected between a Main System and a Dependent System. The Dependent System relying for all its external services, including PSTN access, on the main system. The Dependent System may in turn be connected via Private Circuits to Subsidiary Dependent Systems which are not connected to any other Telecoms System. These in turn depend for all their external services on the main via the dependant. A dependent circuit may be connected in tandem via the Main System to another Private Circuit including a Public extension circuit.

Inter PBX Circuit

A point to point circuit by means of which PBXs may be inter connected without use of the PSTN. For the purpose of this document, Inter PBX circuits include circuits terminating on Key Systems, House Exchange Systems (HES), Key and Lamp Units (K&LU). Such a circuit may be either a Private Circuit, a Public Extension Circuit or a Dependent Circuit. This term also covers for the purpose of this document, Inter PBX circuits within a Branch Telecoms System.

Satellite PABX

A PABX without operator positions that depends upon a Main PBX for operator services but which generally has direct exchange lines for outgoing calls to the PSTN.

Subsidiary PBX

A PBX that has no Exchange Lines and so access for both incoming and outgoing PSTN calls is through a Main PBX via an Inter PBX link.

Dependent PBX

A particular form of Subsidiary working where the Dependent PBX relies for all its external services on the Main PBX including access to the PSTN for both incoming and outgoing calls via an Inter PBX link.

Inter PBX Link

A circuit between main and subsidiary and main and dependent PBX over which incoming and outgoing PSTN calls from the Main may be extended to the subsidiary or the dependent. The circuit can also carry private circuit traffic and extension to extension calls. Automatic Signalling should always be chosen for Inter PBX links to ensure through clearing to the PSTN.

Customers Private Branch Network

A telecommunication system whereby a call from an originating PBX may be routed via one or more intermediate PBXs, Tandem Switching units or sub Tandem Switching Units to the objective PBX using Inter PBX private circuits.

Private Circuit Tandem Exchange

A switching unit, normally automatic (PCATX), exclusively used for the inter connexion of Inter PBX private circuits in a private network.

Sub Tandem Exchange

A PBX which in addition to its function as a PBX is capable of providing tandem switching facilities.

Manual Signalling

A form of signalling where an electrical signal is sent to line for a short period either during the manual depression of a ring key or button or automatically on the seizure of the circuit. Traditionally a **Clear** signal on a manual signalling circuit was signified by 'ringing off', that is, applying a similar signal at the termination of the call as at its commencement. This signal is specifically excluded on manual signalling obtained automatically and is becoming obsolescent on manual signalling in general.

Automatic Signalling

A system whereby the signals necessary to set up and release a circuit are provided automatically.

End to End Signalling

A method by which signals are passed from end to end of a multi link connexion without repetition at intermediate switching points.

Link by Link Signalling

A method of signalling by which signals are passed from end to end of a multi link connexion by repetition at each intermediate switching point.

External Extension

An extension from a PBX or from a main telephone which is routed outside the Branch Telecoms System. Incoming and outgoing exchange calls can be made via an External Extension.

Out of Area Exchange Line (OOAE/L)

A line connecting a customer to the PSTN via a Public Network Exchange other than the one in whose area he is located and to which he would normally be connected.

End of Section 2

Private Circuit Services
Signalling Handbook

Section 3 — Design and Provision of Inter PBX Circuits

Initial requests for inter PBX services will be received by Marketing/Sales who will select a service with the customer using the booklet "A-Line Services. Analogue Private Circuits". They will issue an Application for Private Services Form A4217 in accordance with Ref 1 and Ref 2.

The A4217 will be processed in an Installation Division in accordance with Ref 3, Ref 4 and Ref 5, and by CPCs and UKCHQ/PCS3.1 in accordance with Ref 6.

The CWC will propose the type of signalling to be used over inter PBX circuits and the appropriate line termination facilities ie LTF figure number for each end of the circuit.

When CPC or UKCHQ/PCS3.1 design the circuit ie on circuits that involve more than one exchange area, CPC will confirm or amend the type of signalling and LTF.

It may not be possible for CWC to propose a signalling system or LTF prior to circuit design, in which case CWC should consult with CPC and if necessary await a circuit design before finally determining the signalling system and LTF.

If for technical reasons it is not possible to apply PSTN barring on an inter PBX private circuit then CWC should inform Marketing/Sales in order that service can be refused.

Line Terminating Facilities (LTF) are given in Ref 7, Engineering Performance Specifications for Private Speech Band Circuits in Ref 8, Design of Point to Point circuits in Ref 9, DC Signalling Paths on Speechband Private Circuits in Ref 10, Configurations for Cases 200 in Ref 11 and Switching within Cases 200 in Ref 12.

All new inter PBX services and PSTN access services should conform to the terms laid down in the Department of Trade and Industry's **Licence for the Running of Branch Telecommunications Systems**.

End of Section 3

Private Circuit Services Signalling Handbook

Section 4 — Transmission Terms

Throughout this document, when describing transmission circuits and Voice Frequency Signalling systems, decibel notation is used extensively. This section on transmission terms is included as a reminder of the meanings of these terms.

The Decibel

The decibel (dB) is a logarithmic unit used in telecommunication work to express power ratios. If the powers being expressed are P_1 and P_2 then:

$$\text{(dB) Decibel} = 10 \operatorname{Log}_{10} \frac{P_2}{P_1}$$

The sign associated with the number of dB indicates which power is greater; a negative sign means P_2 is less than P_1.

Where the impedance associated with P_1 and P_2 is identical the relative power is proportional to the square of the Voltage E or the current I. Hence:

$$\text{dB} = 20 \operatorname{Log}_{10} \frac{E_2}{E_1} \text{ and dB} = 20 \operatorname{Log}_{10} \frac{I_2}{I_1}$$

When measuring the relative power levels in a network in dB, since the instruments used for such measurements are usually voltmeters calibrated in dB, it is essential to ensure that both sending and terminating impedances are equal in Value. A common characteristic impedance for BT lines is 600 ohm.

Common Abbreviations

The abbreviations dBm, dBm0 and dBr are frequently used when transmission subjects are discussed. They provide a convenient shorthand to describe power levels relative to each other in a transmission path. These terms may be defined thus:

dBm Actual Level

Power expressed as dB relative to 1 milliwatt (mW) eg +10 dBm means a power level of +10 dB relative to 1 mW in an impedance of N ohm, where 1 mW in N ohm = 0dBm. No specific impedance is implied other than by the network referred to eg terminated in 600 ohms.

dBr Relative Level

This is the ratio expressed in dB of the power at a point in a line to the power at a point chosen for the purpose as the origin of the circuit. For example in Fig 1 the origin of this circuit is the 0dBr point on the 2 wire, and the other reference points along the transmission path are the power levels at these points, relative to the 0dBr point when measured at a test frequency of 800 Hz.

dBm0

This indicates the actual level of any signal in a transmission system when it is referred to a point of zero relative level. The term is used to express the levels of signalling tones, noise, mean speech levels etc. Eg 1 VF signal tones are transmitted at -10 dBm0.

Fig 1 follows

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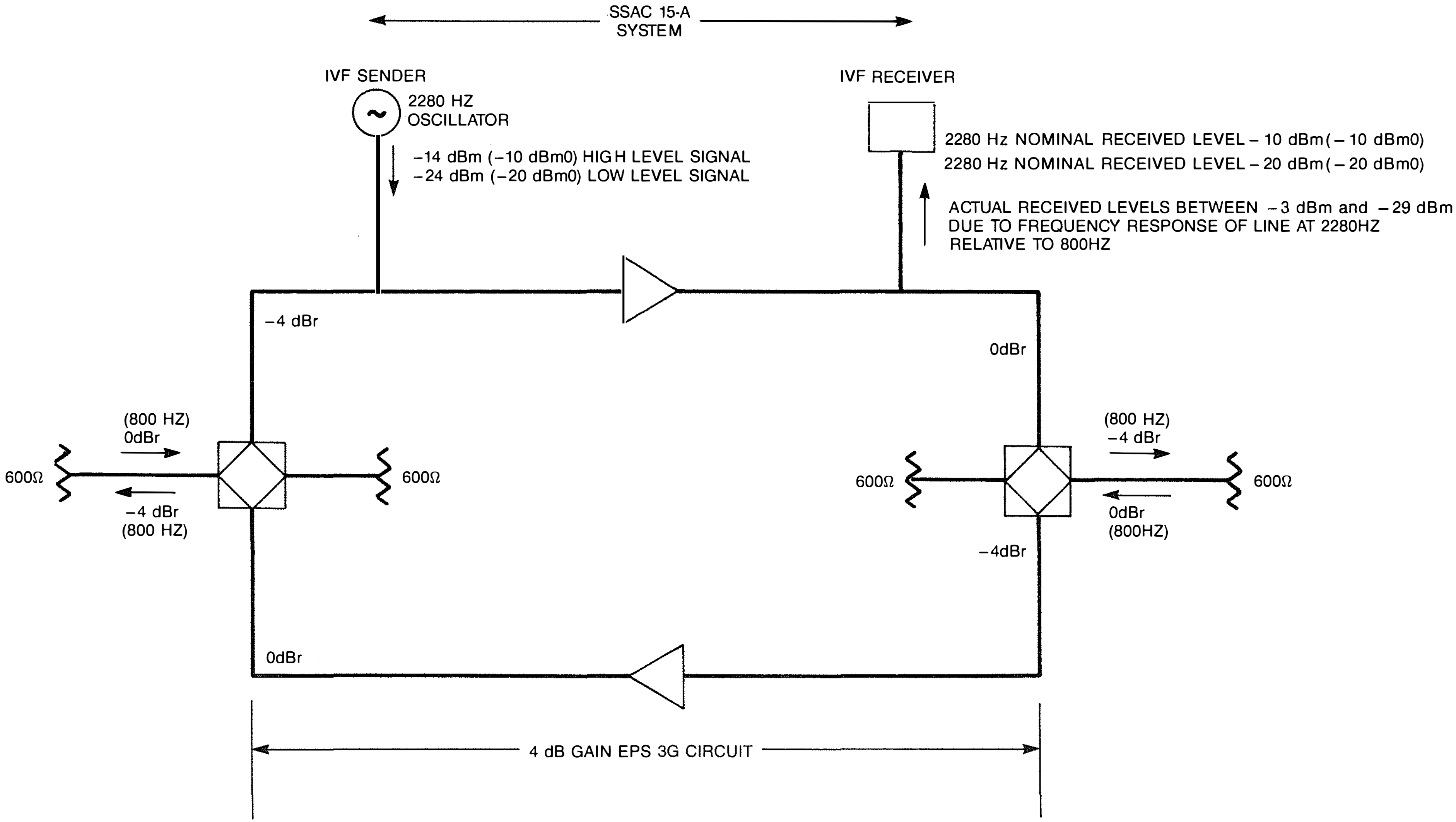

Fig 1 Typical Transmission Line Supporting a IVF Signalling System Showing Typical Power Levels as Ratio (dB) Actual (dBm) (dBmo) and Relative (dBr)

End of Section 4

Private Circuit Services
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Section 5 — Transmission Performance Inter PBX Private Circuits

Choice of Inter PBX Private Circuit

Marketing/Sales will respond to a customers request for inter PBX services by selecting a service using the booklet A Line Services.

Analogue Private Circuits

To achieve some degree of rationalization the customer is offered in the first instance a limited range of circuit types corresponding to Engineering Performance Specifications EPS1, EPS2A, EPS3J, EPS4J, EPS5J, EPS23A, EPS23B, EPS25A and EPS25B. However, the full range of EPS as described in this section and Ref 1 can be made available if required.

"A Line" Inter PBX Private Circuit Services are offered to customers under two main headings. **SpeechLine** Circuits, designed mainly for speech transmission and **KeyLine** Circuits, designed mainly for data transmission but also suitable for speech. The SpeechLine and KeyLine Suffix number coincides with the EPS Suffix number required to provide the service, eg SpeechLine 3J Tariff Class Analogue B is equivalent to EPS3J. The facilities offered to customers are summarized in Table 1.

Table 1

Summary of SpeechLine and KeyLine Facilities

Facilities	SpeechLine or KeyLine Number																
	1	2A	3A	4A 5A	3D	4D 5D	3G	4G 5G	3H	4H 5H	3J	4J 5J	3K	4K 5K	21	22A 23A 25A	22B 23B 25B
Speech only (SpeechLine Circuits)	/	/	/		/		/		/		/		/				
Speech and/or Data (KeyLine Circuits)				/		/		/		/		/		/	/	/	/
Manual Signalling	/	/													/	/	/
Automatic Signalling SSAC13 (Note 1)			/	/	/	/	/	/	/	/	/	/	/	/			
Automatic Signalling SSAC15							/	/			/	/					
Automatic Signalling in some cases	/	/															
Suitable for tandem working		/	/	/	/	/	/	/	/	/	/	/	/	/			/
Multifrequency Inter-register Signalling					/	/					/	/	/	/			

See Notes to Table on following page

Notes to Table 1

Example:

A speech circuit for tandem working using SSAC15 will be a SpeechLine 3G.

If multifrequency inter-register signalling is also required, then a SpeechLine 3J is necessary.

Note 1:

Automatic signalling SSAC13 is virtually obsolescent, and SSAC15 is the preferred 1 VF automatic signalling system.

Note 2:

Circuit numbers in the same box are similar circuits except for the performance specification. Within the same box, a higher number denotes an improved performance specification compared to a lower number. Eg a 5A is an improved specification compared to 4A, and 4A improved compared to 3A. Also 25A improved compared to 23A.

Note 3:

Preferred circuit types suffix numbers and letters are shown underlined.

Note 4:

From this table it will be seen that the choice of circuit depends on four main factors:

1. **Quality of circuit required by the customer.**
2. **Type of signalling employed.**
3. **Whether the circuit forms part of a Tandem Switched Network.**
4. **Whether the circuit is required to carry data.**

The circuit chosen is specified under Engineering Performance Specifications (EPS). The characteristics of each EPS is described in full in Ref 1. A summary of those EPS used for inter PBX circuits follows in Section 6.

End of Section 5

Private Circuit Services Signalling Handbook

Section 6 — Engineering Performance Specifications for Inter-PBX Circuits

EPS1

Presentation

2-Wire

Predominant Use

Speech quality circuits, not suitable for tandem connection.

Signalling

Manual signalling is available over any distance. Automatic signalling is normally available on circuits up to 11 km chargeable distance and may be available on circuits in excess of this distance so long as a route survey shows that the signalling limits for Signalling System DC10-A (SSDC10-A) are not exceeded. See Section 12, and so long as a dc path can be made available according to the rules given in Section 9 and Ref 1.

Advertised Performance

The maximum nominal insertion loss between customer's premises is 17 dB at 800 Hz. The actual loss depends on the routing of the circuit.

EPS2A

Presentation

2-Wire

Predominant Use

Speech quality circuits, suitable for use in switched networks where two EPS2A circuits or one EPS2A and one EPS3A circuit may be connected in tandem.

Signalling

Manual signalling is available over any distance. Automatic signalling is normally available on circuits up to 11 km chargeable distance and may be available on circuits in excess of this distance so long as a route survey shows that the signalling limits for Signalling System DC10-A (SSDC10-A) are not exceeded. See Section 12 and so long as a dc path can be made available according to the rules given in Section 9 and Ref 1.

Advertised Performance

The maximum nominal insertion loss between customer's premises will be 10 dB at 800 Hz. The actual loss depends on the routing of the circuit.

EPS2B

Presentation

2-Wire

Predominant Use

Speech quality circuits, primarily introduced for the administration networks of the Ministry of Defence (MOD). (An EPS2B circuit may also be used in a switched MOD network where two EPS2B circuits or one EPS2B and two EPS3A circuits may be connected in tandem.)

Signalling

Manual signalling is available over any distance. Automatic signalling is normally available on circuits up to 11 km chargeable distance and may be available on circuits in excess of this distance so long as a route survey shows that the signalling limits for Signalling System DC10-A (SSDC10-A) are not exceeded. See Section 12, and so long as a dc path can be made available according to the rules given in Section 9 and Ref 1.

Advertised Performance

The maximum nominal insertion loss between customer's premises will be 6 dB at 800 Hz. The actual loss depends on the routing of the circuit.

EPS3A, 3B, 3C, 3D, 3E, 3F, 3G, 3H, 3J and 3K

Presentation and Use

EPS3A (2-wire)	0 dBr Trans — −3 dBr Rec −3 dBr Rec — 0 dBr Trans	Private Networks: 2-wire presented at both ends. Used for External Extensions & 00A Exchange Lines.
EPS3A (4-wire)	0 dBr Trans —— 0 dBr Rec 0 dBr Rec —— 0 dBr Trans	
EPS3B	−4 dBr Trans —— +1 dBr Rec +1 dBr Rec — −4 dBr Trans	Private Networks: 4-wire presented at both ends. Superseded for new work by EPS3G. Used for ext extn & 00A Exchange Lines.
EPS3C	−4 dBr Trans — −7 dBr Rec +1 dBr Rec — 0 dBr Trans	Private Networks: 4-wire presented at one end, 2-wire presented at the other. Superseded for new work by EPS3H.
EPS3D	AS EPS3A (2-wire)	Private Networks equipped with multi-frequency signalling: 2-wire presented at both ends. Used for Ext Extns & 00A E/L with SSMF4.
EPS3E	AS EPS3B	Private Networks equipped with multi-frequency signalling: 4-wire presented at both ends. Superseded for new work by EPS3J. Used for Ext Extns & 00A E/L with SSMF4.
EPS3F	AS EPS3C	Private Networks equipped with multi-frequency signalling: 4-wire presented at one end, 2-wire presented at the other. Superseded for new work by EPS3K.
EPS3G	−4 dBr Trans — 0 dBr Rec 0 dBr Rec — −4 dBr Trans	Private Networks: 4-wire presented at both ends. May be used to support SSAC 15.
EPS3H	−4 dBr Trans — −4 dBr Rec 0 dBr Rec — 0 dBr Trans	Private Networks: 4-wire presented at one end, 2-wire presented at the other.
EPS3J	AS EPS3G	Private Networks equipped with multi-frequency signalling: 4-wire presented at both ends. May be used to support SSAC 15.
EPS3K	AS EPS3H	Private Networks equipped with multi-frequency signalling: 4-wire presented at one end, 2-wire present at the other.

Note: EPS3B, 3C, 3E and 3F have been superseded for new work by EPS3G, 3H, 3J and 3K respectively see Ref 2 **Introduction of Incremental Loss Plan for 4-wire Switched Speech Networks.**

Signalling

The signalling system used over an EPS3 circuit will be that of the overall network of which it is part. For networks, manual or automatic signalling is available over any distance. Circuits to EPS3D, E, F, J and K will support multi-frequency (MF) inter-register signalling. When automatic signalling is required in a circuit not forming part of a speech network then EP3G should be specified if a dc path cannot be made available (see Ref 1).

EPS4A, 4D, 4G, 4H, 4J and 4K

General Description

Circuits provided to EPS4 offer the same presentation as circuits with the same suffix in the EPS3 range but also offer a detailed performance specification equivalent to EPS23. Suitable for Data. See Ref 3 and booklet "A-Line Services".

Presentation and Use

EPS4A (2-wire)	0 dBr Trans –3 dBr Rec –3 dBr Rec 0 dBr Trans	Private Networks: 2-wire presented at both ends.
EPS4A (4-wire)	0 dBr Trans —— 0 dBr Rec 0 dBr Rec —— 0 dBr Trans	
EPS4D	AS EPS4A (2-wire)	Private Networks equipped with multi-frequency signalling: 2-wire presented at both ends.
EPS4G	–4 dBr Trans — 0 dBr Rec 0 dBr Rec — –4 dBr Trans	Private Networks: 4-wire presented at both ends. May be used to support SSAC 15.
EPS4H	–4 dBr Trans –4 dBr Rec 0 dBr Rec 0 dBr Trans	Private Networks: 4-wire presented at one end, 2-wire presented at the other.
EPS4J	AS EPS4G	Private Networks equipped with multi-frequency signalling, 4-wire presented at both ends. May be used to support SSAC 15.
EPS4K	AS EPS4H	Private Networks equipped with multi-frequency signalling, 4-wire presented at one end, 2-wire presented at the other.

Signalling

The signalling system used over an EPS4 circuit will be that of the overall network of which it is a part. For networks manual or automatic signalling is available over any distance. Circuits to EPS4D, 4J and 4K will also support multi-frequency (MF) inter-register signalling.

EPS5

General Description

Circuits provided to EPS5 offer the same presentation as circuits with the same suffix in the EPS3 range but also offer a detailed performance specification equivalent to EPS25. Suitable for Data. See Ref 3 and booklet A-Line Services.

Presentation and Use

EPS5A (2-wire)	0 dBr Trans −3 dBr Rec −3 dBr Rec 0 dBr Trans	Private Networks: 2-wire presented at both ends.
EPS5A (4-wire)	0 dBr Trans —— 0 dBr Rec 0 dBr Rec —— 0 dBr Trans	
EPS5D	AS EPS5A (2-wire)	Private Networks equipped with multi-frequency signalling: 2-wire presented at both ends.
EPS5G	−4 dBr Trans — 0 dBr Rec 0 dBr Rec — −4 dBr Trans	Private Networks: 4-wire presented at both ends. May be used to support SSAC 15.
EPS5H	−4 dBr Trans −4 dBr Rec 0 dBr Rec 0 dBr Trans	Private Networks: 4-wire presented at one end, 2-wire presented at the other.
EPS5J	AS EPS5G	Private Networks equipped with multi-frequency signalling, 4-wire presented at both ends. May be used to support SSAC 15.
EPS5K	AS EPS5H	Private Networks equipped with multi-frequency signalling, 4-wire presented at one end, 2-wire presented at the other.

Signalling

The signalling system used over an EPS5 circuit will be that of the overall network of which it is part. For networks manual or automatic signalling is available over any distance. Circuits to EPS5D, 5J and 5K will also support multi-frequency (MF) inter-register signalling.

EPS21

Presentation

2-Wire

Predominant Use

Point-to-point data, not suitable for tandem connexion. The circuit may be switched to an alternative telephone and/or PBX for use as a point-to-point speech connexion.

Signalling

Manual Signalling Only

Advertised Performance

The maximum nominal insertion loss between customer's premises will be 17 dB at 800 Hz.

EPS22A/B

Presentation

2-Wire or 4-Wire

Use

An EPS22A circuit is suitable for point-to-point data use and an EPS22B circuit is suitable for either point-to-point or tandem connected data use. In the latter case no overall performance can be specified. Both types of circuit may be switched to an alternative telephone and/or PBX for use as a speech circuit.

Signalling

Manual signalling only.

Advertised Performance

For EPS22A the maximum nominal insertion loss between customers premises at 800 Hz will be 14 dB 2-wire presented and 6 dB 4-wire presented. For EPS22B it will be 3 dB 2-wire presented and 0 dB 4-wire presented.

EPS23A/B

Presentation

An EPS23A circuit is suitable for point-to-point data use and an EPS23B circuit is suitable for either point-to-point or tandem connected data use. In the latter case no overall performance can be specified. Both types of circuit may be switched to an alternative telephone and/or PBX for use as a speech circuit.

Note: The facilities provided are identical to those provided to EPS22A/B but the circuits are of slightly higher quality.

Signalling

Manual signalling only.

Advertised Performance

For EPS23A the maximum nominal insertion loss between customer premises at 800 Hz will be 14 dB 2-wire presented and 6 dB 4-wire presented. For EPS23B it will be 3 dB 2-wire presented and 0 dB 4-wire presented.

EPS25A/B

Presentation

2-Wire or 4-Wire

Use

An EPS25A circuit is suitable for point-to-point data use and an EPS25B circuit is suitable for either point-to-point or tandem connected data use. In the latter case no overall performance can be specified. Both types of circuit may be switched to an alternative telephone and/or PBX for use as a speech circuit.

Note: The facilities offered are identical to those provided to EPS23A/B but the circuits are slightly higher quality.

Advertised Performance

For EPS25A the maximum nominal insertion loss between customers premises at 800 Hz will be 14 dB 2-wire presented and 6 dB 4-wire presented. For EPS25B it will be 3 dB 2-wire presented and 0 dB 4-wire presented.

Notes on Circuit Performance

Tolerance on Nominal Insertion Loss

The Loss at 800 Hz specified for circuits which are 4-wire routed throughout is in each case the 'nominal' loss. These circuits are designed and lined-up to this nominal loss but are subject to a ± 2 dB tolerance allowed at line-up to cover the cumulative effects of section adjustment error. The loss at 800 Hz specified for circuits which include a 2-wire routed portion is a 'maximum' nominal loss. This means that the nominal loss is dependent upon the circuit routing and can take any value up to the maximum but may in practice be less. Such circuits are also subject to a further ± 2 dB tolerance allowed at line-up.

Variation of Insertion Loss with Time

The overall insertion loss of the circuit will normally be within ± 3 dB of the nominal loss: changes of loss within this range may occur gradually or instantaneously.

Detailed Performance Data

For the detailed performance data of EPS. Eg Loss/frequency response, noise levels, Group Delay etc. See Ref 3.

End of Section 6

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Section 7 — Transmission Performance PSTN Access Circuits

7.1 Existing Arrangements

NOTE: See new Code of Practice paragraph 2.

Inter-PBX Extensions

To accord with the National Network Plan the transmission loss of an Exchange Line to a PBX must not exceed 8.5 dB. It follows that the additional loss introduced by an inter-PBX Extension may have a degrading effect upon the overall network performance. The planning rules for these circuits should therefore be strictly applied and the customer informed if any increased risk of transmission difficulty is likely. Transmission planning rules governing the provision of Inter-PBX extensions are covered in detail in Ref 1.

2-wire Circuit

Maximum permitted loss of a 2 wire circuit is 6 dB at 1600 Hz.

4-wire Circuit

2-wire presented — to be provided to EPS3A with the 2/4 wire terminating Units located at the customers premises. Nominal loss 3 dB at 800 Hz.

4-wire Presented

4-wire presented, that is, either 4-wire Switched or with the 2/4 wire terminating Units located in the PBX signalling equipment — provided to EPS3G or, where multifrequency Signalling is employed (SSMF5 or SSMF4) provide to EPS3J. Nominal loss 2w-2w 4 dB at 800 Hz.

4-wire — 2-wire

4-wire presented at one end 2-wire at the other — provide to EPS3H or where multifrequency signalling is employed provide to EPS3K. Nominal loss 2w-2w 4 dB at 800 Hz.

The transmission planning rules for any specific modern PBX will take precedence over the rules outlined above.

Inter-PBX Link

The combined loss of the longest exchange line at the Main PBX and the longest inter PBX link must not exceed 7 dB at 1600 Hz. The transmission planning rules for any specific modern PBX will take precedence.

External Extension

The exchange line transmission loss (Max 8.5 dB) and the extension transmission loss are treated as separate and independent entities. The additional loss introduced by the external extension can have a degrading effect on the overall network performance. Accordingly when the total loss between the extension telephone and the public exchange exceeds 10 dB at 1600 Hz, the customer should be advised of the increased risk of experiencing transmission difficulties. Transmission planning rules governing the provision of External Extensions are covered in detail in Ref 1.

2-wire Circuits

Maximum permitted loss 6 dB at 1600 Hz.

4-wire Circuits

To be provided to EPS3A with the 2/4 wire terminating Units located at the customers premises or to EPS3B — 4 wire presented when the 2/4 wire terminating Units are located in the line Signalling equipment. If multi-frequency Signalling (SSMF4) is employed provide to EPS3D and EPS3E respectively.

The transmission planning rules for any specific modern PBX take precedence.

Tandem Connexion of Inter-PBX Extension and an External Extension

Incoming PSTN calls may be passed over this type of connexion and unless the losses of the Exchange line, Inter-PBX Extension and External Extension are low, transmission difficulties will be experienced. The customer should be warned accordingly.

Out of Area Exchange Lines

2-wire Circuit

For an OOAEL providing direct public exchange access service to a telephone the maximum permitted loss is 10 dB at 1600 Hz. For an OOAEL serving a PBX the maximum permitted loss is 8.5 dB at 1600 Hz.

4-wire Circuit

To be provided to EPS3A, 2 wire presented, between the Remote Exchange and the Local Exchange. The local line loss must not exceed 5 dB at 1600 Hz. Where the local line exceeds this limit the circuit should be provided to EPS3A 2-wire presented at the customers premises. When the 2/4-wire terminating Units are located in the Signalling equipment, provide to EPS3B. When multifrequency Signalling (SSMF4) is employed provide to EPS3D — 2-wire presented, and to EPS3E — 4-wire presented.

7.2 New Code of Practice for Connection of Private Branch Networks to the BT Public Switched Network

In the future the responsibility for the performance of Private Branch Networks (PBN) when interconnecting with the BT Public Switched Network (PSTN) will rest with the operator of the PBN ie the customer. A Code of Practice for the planning and management of Private Branch Networks will be published in due course.

The design characteristic covered in the Code are:-

Safety
Address Structure
Call Routing
Call Control Activities
Call Progress Indication
Call Path Transmission Quality
Digital Coding and Synchronisation

The approach to transmission performance is of particular interest in the context of this Handbook and is briefly described below.

Transmission Performance

The limits for overall loss are expressed in terms of Loudness Ratings as defined in CCITT recommendation P76. These losses are arrived at by taking the Send Loudness Rating (SLR) and Receive Loudness Rating (RLR) of the extensions to an appropriate interface at the PBX concerned, and adding to them the sum of the planning losses of the interconnexions, including the local exchange line, to the serving PSTN exchange.

In addition to overall loss; matters such as delay, echo and stability, cross talk, attenuation distortion etc, are covered in the Code of Practice.

As well as meeting the transmission requirements in the Code of Practice a PBN will need to satisfy the routing restrictions of the Branch Systems General Licence.

It will be the customers responsibility to specify the quality of circuit required to meet the requirements of the Code of Practice when ordering circuits from BT; within the range of circuits BT are able to offer.

The customer will provide every District Manager responsible for PSTN connexion to the PBN, with a copy of a Compliance Certificate.

Districts will be notified when this Code of Practice comes into force and what effects, if any, it will have on existing private networks.

Until the Code of Practice comes into force the provision of Public Switched Telecoms Network (PSTN) access circuits will follow the existing arrangements as described in paragraph 1.

End of Section 7

Private Circuit Services Signalling Handbook

Section 8 — Line Terminating Facilities (LTF)

A series of simplified schematic diagrams, known as Circuit Terminating Arrangements (CTA) — see booklet **A Line Services** and Ref 1, will enable Marketing/Sales staff to identify customer requirements and describe them in a form suitable for translating into one of the Line Terminating Facilities (LTF) defined in Ref 2. Those cases that are not covered by a Standard LTF and cannot be dealt with by the local CWC should be referred to UKCHQ/PCS3.1.

End of Section 8

Private Circuit Services Signalling Handbook

Section 9 — DC Signalling Paths on Speech Band Private Circuits

Policy for Provision of a dc Signalling Path

BT cannot in any instance guarantee the availability of a dc signalling path on a speech band private circuit.

Where a dc signalling path is provided on a speech band private circuit, BT reserve the right to withdraw the facility after one year's notice has been given to the customer.

Where a dc signalling path is provided on a speech band private circuit, BT cannot in any instance guarantee the provision or maintenance of any particular value of dc resistance.

Full details of BT policy regarding the provision of dc signalling paths is contained in Ref 1.

Interpretation of Policy

NOTE 1: The resistance limits quoted in this refer to the dc loop values.

NOTE 2: If the circuit is 4-wire amplified, the dc signalling path of the amplified section consists of the phantom loop and the resistance is taken as half that of a single pair.

NOTE 3: PCM channels do not offer a continuous dc path, but an SSDC10 Signalling Unit is available for private circuits and is suitable for use with 30 channel (1st and 2nd generation) PCM systems. SSDC10 signalling cards for 24 channel and 30 channel PCM (3rd generation) systems are not available.

General Conditions

Where a customer asks, either at the outset or after the circuit has been provided, for the use of a dc signalling path, incorporating if necessary the phantom of a physical circuit, it may, where technically possible, be made available without additional cost to the customer provided that the policy appropriate to the length of the circuit as given in the paragraphs below is applied and that the customer is warned of the appropriate conditions.

Circuits up to 11 km Chargeable Length

Policy

The request should normally be acceded to unless exceptional inconveniences to BT is foreseen.

Conditions

The dc resistance of such a path must be assumed to be at least 3800 ohm and the customer advised accordingly. In practice, the actual resistance may be less than this value dependent upon line plant used. Circuits confined to one exchange Area may be assumed to be at least 2000 ohm.

Circuits Between 11 and 40 km Chargeable Length

Policy

The decision to provide a dc path for circuits of chargeable length 11 km to 40 km will depend upon the availability of suitable line plant.

It is not possible to set down a cut-off figure above which no circuits are provided with a dc path. Each circuit must be considered individually by the circuit designer, who should investigate the availability of line plant over the route proposed for the circuit, taking into account:-

(a) the likely recovery of obsolete cables,

(b) the anticipated introduction of PCM which may decrease the availability of dc paths,

(c) the need to keep available a reserve of pairs to enable existing dc path circuits to be maintained,

(d) the high cost of 1 VF signalling, which may be required if a dc path is not available.

It is of primary importance that the deliberation should cover not only the present situation but also proposed or anticipated future changes to plant availability which may occur during the circuits expected life.

Conditions

The dc resistance of such a path must be assumed to be at least 3800 ohm but is likely to be in excess of this value, possibly reaching 10 000 ohm.

Circuits Over 40 km Chargeable Length

Policy

All requests for a dc path should be refused except in very exceptional circumstances such as where the customer is awaiting the delivery of a CONFIRMED ORDER for VF signalling equipment. This policy will also apply when using Signalling Units F5A for the routing of a private circuit on a PCM system.

Conditions

The dc resistance of such a circuit cannot be estimated in advance of provision of the circuit but must be assumed to be greater than 6000 ohms.

Automatic Signalling on Inter PBX Circuits

For network design and planning costing purposes, customers or their consultants are advised that for automatic signalling, SSDC10 signalling should be assumed for circuits under 11 km radial length and that 1 VF signalling — SSAC15 or SSAC13, should be used for circuits 11 km and over. However, at the network assessment stage, the customer is advised to check on the availability of dc signalling paths for the 11 km and over routes, that meet the limits for SSDC10 signalling, before the signalling equipment is ordered.

Since the implementation stage of a network and the procurement of signalling equipment may take a year or more, it is important that the type of lineplant and therefore the signalling system that is to be used is formally confirmed with the customer. If there is any doubt about the availability of dc paths then CWC and the customer should be advised that 1 VF signalling will be necessary. Equally, however, once a dc path has been confirmed care should be taken to ensure its continued availability for network implementation.

30 Channel PCM (1st Generation) Routing

The Signalling Unit F5A has been developed for SSDC10 signalling over 1st generation 30 channel PCM systems. The facilities offered by the Signalling Unit F5A are Phantom signalling, transmission gain up to 9.2 dB in 0.5 dB steps, pulse regeneration, 4-wire test points and links, line current limiting resistors (1000 ohm in each phantom) and access to time slot 16. The Signalling Unit F5A is not suitable for use on 24 channel or on 2nd generation 30 channel PCM systems nor on PCM routes which terminate on a System X exchange (analogue — digital groups). If an analogue — analogue 1st generation 30 channel system is planned for retermination onto a System X exchange within 3 years, then the use of the Signalling Unit F5A should be avoided in such cases. Inband signalling will have to be used at the outset of the circuit design and the customer advised accordingly.

NOTE 1: When using the Signalling Unit F5A on a private circuit the SSDC10 signalling path resistance limit will be 3800 ohm, the pulsing limit will be reduced from 42000 μF ohm to 18000 μF ohm.

NOTE 2: 1000 ohm line current limiting resistors are fitted in the Signalling Unit F5A in series with both signalling legs. The resistors should be strapped out, if the signalling path resistance is greater than 1800 ohm.

30 Channel PCM (2nd Generation) Routing

A Signalling Unit F5/1 is available for SSDC10 signalling over 2nd generation 30 channel PCM systems. The facilities offered are similar to those for the Signalling Unit F5A described above.

End of Section 9

Private Circuit Services Signalling Handbook

Section 10 — Manual Inter PBX Signalling Systems

Definition of Manual Inter PBX Signalling

A method whereby control information on the progress of a call is conveyed from one PBX to another, usually, but not exclusively, under the control of an operator

It is a form of signalling where an electrical signal is sent to line for a short period either during the manual depression of a **ring** key or button, or automatically on the seizure of the circuit. Traditionally a **clear** signal on a manual signalling circuit is signified by **ringing off,** that is, applying a similar signal at the termination of the call as at its commencement. This signal is specifically excluded on manual signalling obtained automatically [M/BB (auto)] in order to prevent confusion to the operator.

Address information cannot be transmitted over a Manual Circuit so its use is very restricted. In general one or other of the standard automatic signalling systems should be chosen in preference.

Manual Signalling as Preferred System

There are certain circumstances when Manual Signalling may be the preferred system. One example would be on international circuits where it may be the only system mutually recognised by the two countries concerned. Another might be where alternative speech/data is required and the complications presented by switching automatic signalling circuits presents an obstacle (see Section 20 on Alternative Speech/Data). In addition manual signalling is common on the older PBXs, particularly PMBXs. The first choice for manual signalling should be Manual Balanced Battery (M/BB) and the second choice should be Manual Alternating Current (M/AC).

Manual Signalling should never be provided on PSTN access circuits since through clearing to the PSTN is required on such circuits. It should also be avoided when the circuit forms part of a tandem network due to difficulties arising from lack of through clearing.

10.1 Manual Balanced Battery Signalling (M/BB)

This is the application of similar dc potentials, typically −24 volt or −50 volt to the A and B wires of a 2-wire circuit or each wire of the phantoms of a 4-wire circuit via the centre tap of the line transformer. The arrangement for one end of such a circuit is shown in Fig 2. The distance over which Balanced Battery Signalling can be employed depends on:-

- Signalling voltage.
- Sensitivity of receiving device.
- Total resistance of signalling path.

10.2 Manual Alternating Current Signalling (M/AC or G/AC)

This is the application of a low frequency ac ringing current 17, 25 or 50 Hz to the A and B wires of a 2-wire circuit or the phantoms of a 4-wire circuit. The ringing current flows round a signalling loop formed at the distant end by a low frequency ac detector, or the bell circuit of a telephone. A typical arrangement is shown in Fig 3.

10.3 Manual Signalling Conversion

M/AC and M/BB both require physical circuits when used exclusively. The signalling limits when they are used in this way are shown in Section 15.4 and 15.6. When inter PBX circuits are routed over physical line plant that exceeds the M/AC or M/BB limits then signalling repeaters or signalling converters can be used. The converters are of two basic types:-

(a) Those that convert M/AC to M/BB or M/BB to M/AC. This type of converter, generally, will also serve as a signalling repeater usually in a M/BB to M/BB configuration.

(b) Those that convert M/AC or M/BB to **in band** voice frequency (VF) signalling. The VF signals will be amplified by any amplifiers in the circuit and therefore only two converters will be required in any length of circuit.

When inter PBX circuits are routed over channels in frequency division multiplex (FDM) or pulse code modulation (PCM) systems, M/AC or M/BB to **in band** VF signalling converters may be used. Only two converters will normally be required in any circuit. There are also available PCM signalling Units for M/BB and M/AC.

When signalling converters or signalling repeaters are used there is no practical signalling limit for M/AC or M/BB.

Restrictions on Manual Signalling

Manual signalling is not permitted on any circuit which has access to the Public Switched Telephone Network (PSTN). On private networks automatic signalling is preferred (Ref 1) and before manual signalling is utilized it is essential that any networking implications involved in the provision of a circuit and its associated signalling, are investigated before the signalling system is determined.

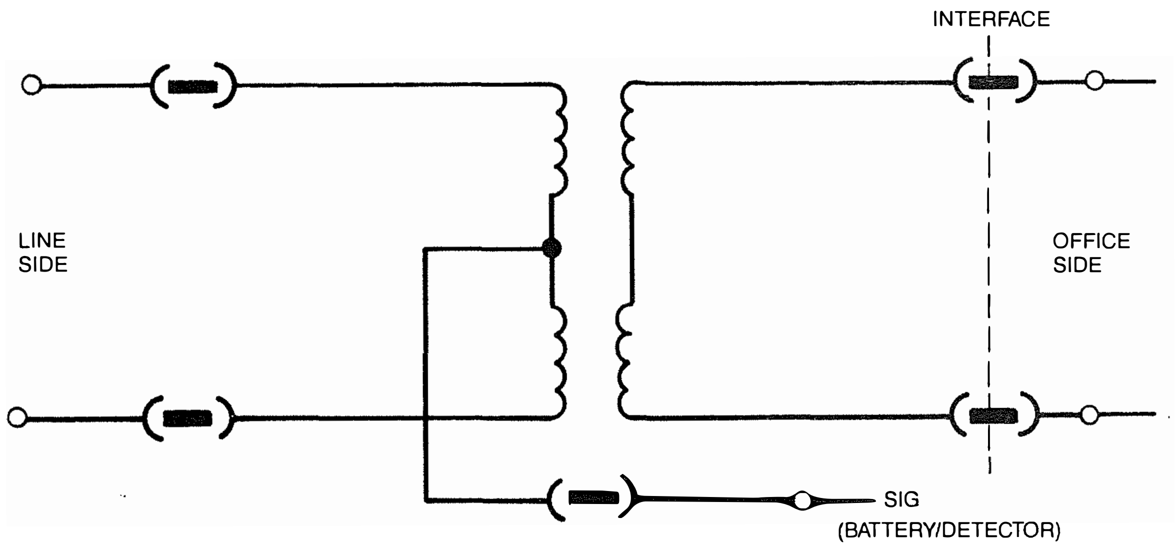


Fig. 1 a) Balanced Battery Signalling on a 2-Wire Circuit

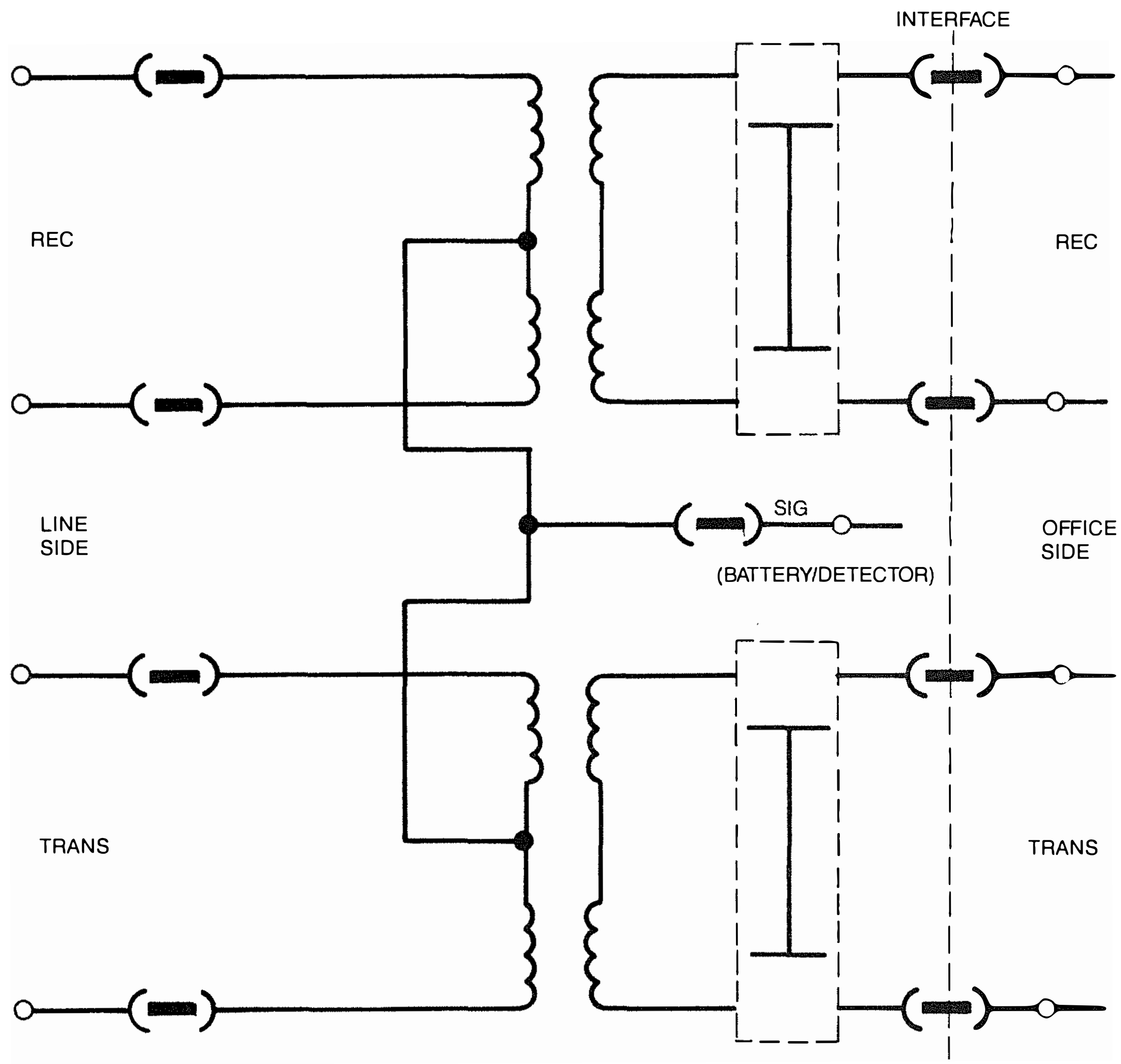


Fig. 2 b) Balanced Battery Signalling on a 4-Wire Circuit

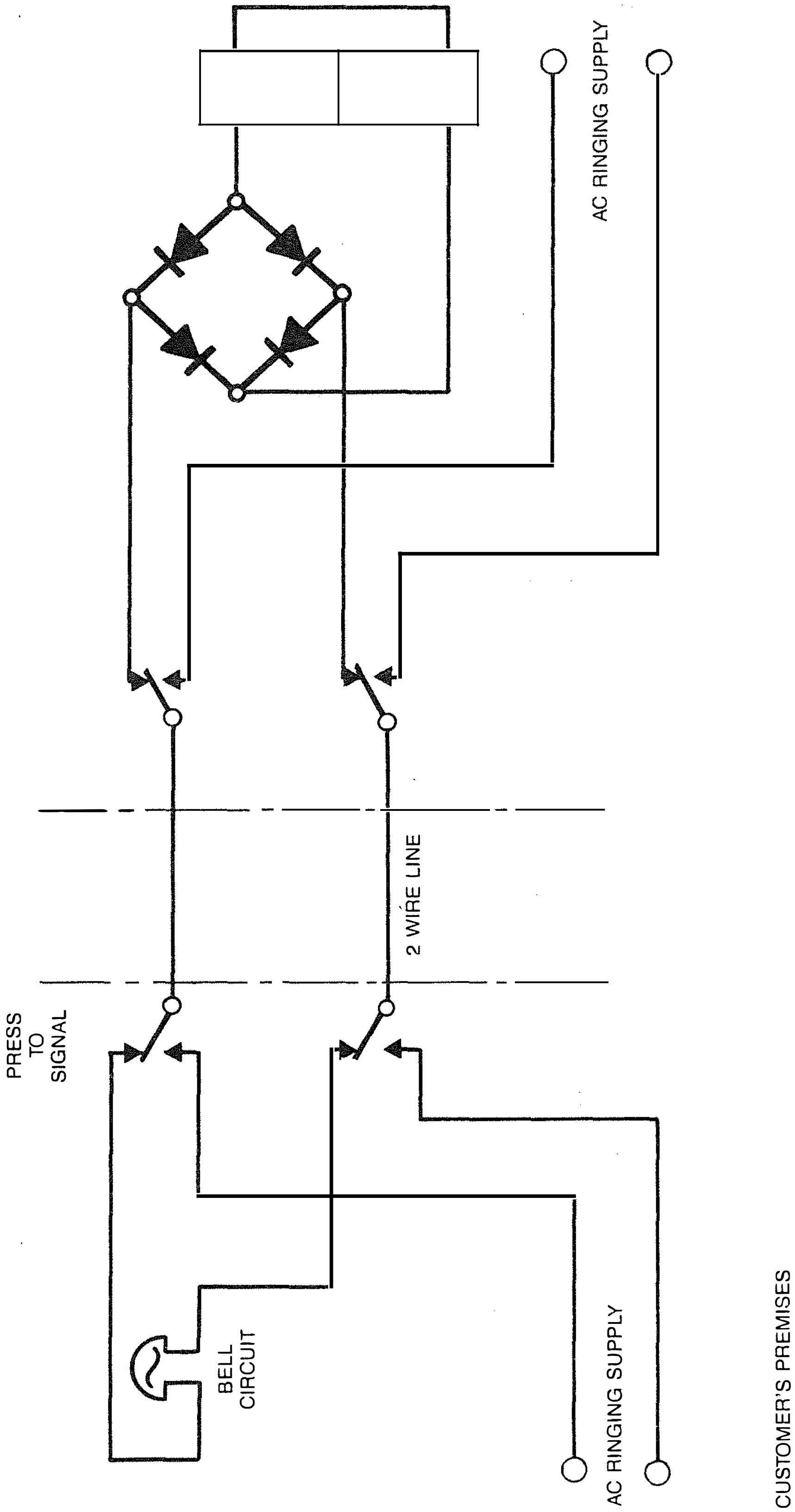


Fig. 3 25HZ Signalling

Signalling Over a DC Metallic Path

This form of manual signalling as its title suggests uses dc techniques (or very low frequency ac signals). The use of this method is restricted to those circuits or sections having a dc metallic path and the signalling systems are given above in order of preference.

Reference should be made to Section 9 regarding the policy for provision of a dc signalling path. Where a dc metallic path is not available over the entire length of the circuit due to the type of line plant employed it becomes necessary to use a signalling method that provides conversion from dc/25 Hz to a tone within the speech band that can be passed over HF (PCM and FDM) channels.

End of Section 10

Private Circuit Services Signalling Handbook

Section 11 — Manual Signalling Conversion Units

11.1 Types of Conversion Units

The signalling conversion units that are currently available comprise two basic types:-

(a) Those providing conversion from one manual (dc/25 Hz) signalling condition to another manual (dc/25 Hz) signalling condition. Unit Signalling No. 7 and Signalling Units No. 28 and 48 are of this type. These units also provide transmission bridge facilities. It is possible using one signalling unit to signal between two telephones and provide the necessary transmitter feed current. In this configuration the calling telephone would signal 'B' wire earth to the signalling unit and the remote telephone would be called using 25 Hz from the signalling unit to ring the telephone bell. Where the signalling resistance between each telephone and the signalling unit exceed the signalling limits it becomes necessary to utilise two signalling units. In this configuration the signal conditions on the local (ie customer) side of each unit will again be 'B' wire earth **in** and 25 Hz **out**, but the signalling between the two conversion units will be effected by means of bothway balanced battery.

(b) Those units providing conversion from a dc/25 Hz signalling condition to an **in-band** signal suitable for transmission over HF (pcm or fdm) channels. Units Signalling No. 18 and Signalling Units No. 27 and 47 are of this type.

Unit Signalling No. 7 (US 7)

This unit is now obsolescent and is being superseded by the Signalling Units No. 28 and 48 (see this section). Two US 7s are contained on a Panel Signalling No. 7, which is Pre-51 type equipment practice.

Signalling Facilities

The US 7 provides the conversion from dc or 25 Hz signalling on the local side of the unit to balanced battery signalling on the line side. (See also Ref 1). The US 7 can be interworked with a Signalling Unit No. 27 or No. 28, or 48, or a Unit Signalling No. 18.

Signalling Unit No. 28A (SU 28A)

The Signalling Unit No. 28A (Ref 2) is the 62-type replacement for the obsolescent Unit Signalling No. 7.

Signalling Facilities

The SU 28A provides for the conversion of any one manual (dc/25 Hz) signalling condition to another manual (dc/25 Hz) signalling condition.

The strapping arrangements necessary to provide the various signalling configuration are detailed in diagram RP/RPW 7151. The SU No. 28A has the facility to provide transmitter feed current in one or both directions of transmission. The SU 28A can be interworked with either a SU 28 (A or B), a SU 27 (A or B), SU 47A or 48A or a US 7.

Signalling Unit No. 28B (SU 28B)

The Signalling Unit No. 28B is a manufacturers alternative to the SU 28A and provides the same facilities. The strapping arrangements necessary to provide the various signalling configurations are detailed in diagram RP/RPW 7750 sheets 2 and 3 and the block schematic is RP/RPW 7750. The SU 28B can be interworked with either a SU 27 (A or B), SU 28 (A or B), SU 47A or 48A, or a US 7.

Signalling Unit No. 48A

This signalling unit will supersede the Signalling Units No. 28A and 28B. It provides the same facilities as the Signalling Units 28A and 28B but its performance is in line with the SU 28B. The unit is described in diagram RP/RPW 9815 and specification RC 6655.

500/20 Hz Converters

500/20 Hz signalling units (eg Units Signalling No. 18) provide the conversion of manual dc signalling to a 500 Hz tone interrupted twenty times a second and in the reverse direction of transmission, conversion of a 500/20 Hz tone from a remote signalling unit to dc signalling or 25 Hz.

Units Signalling No. 18 (US 18)

These signalling units are now obsolescent and should not be used on new work. The US 18 is not compatible with the Signalling Unit 27A or B. (Ref 3 refers.)

Signalling Unit No. 27A (SU 27A)

The Signalling Unit No. 27A is a 62-type 2280 Hz in-band to dc/25 Hz converter. The SU 27A consists of a 2280 Hz transmitter and receiver and a Relay Unit No. 24A (refer to Ref. 4).

Signalling Facilities

The SU 27A provides the conversion of manual signalling (dc/ 25 Hz) to 2280 Hz tone in the transmit direction and the conversion of a 2280 Hz tone to a manual (dc/25 Hz) signalling condition in the opposite direction of transmission. The strapping arrangements necessary to provide the various signalling configurations are detailed in diagram RP/RPW 7149 and the block schematic shown in RP/RPW 7061. The SU 27A has the facility to provide a battery feed to a telephone on the local side when used in conjunction with B-wire earth signalling from the telephone.

The 2280 Hz signal is transmitted to line at a level of -13 ± 1 dBmO. The receive unit requires a minimum 800 Hz test level of -12 dBr for satisfactory operation. The setting-up of an SU 27A to meet these requirements is detailed in Ref 4.

Signalling Unit No. 27B (SU 27B)

The Signalling Unit No. 27B is a manufacturers alternative to the SU 27A and is pin compatible providing the same facilities. The SU No. 27B can be interworked with a SU 27 (A or B), SU 28 (A or B) or a US 7. The strapping arrangements necessary to provide the various signalling configurations are detailed in diagram RP/RPW 7783 and the block schematic shown in RP/RPW 7749.

Signalling Unit No. 47A

This signalling unit will supersede the Signalling Units No. 27A and 27B. It provides the same facilities as the Signalling Units 27A and 27B but its performance is in line with the SU 27B. The unit is described in diagram RP/RPW 9814.

Table 1

Signalling Units Available in 62-Type Equipment Practice for Use with 62-Type 30 Channel PCM

PCM Sig Unit Code	Spec RC	Facilities	Application
30A	6667	2-wire or 4-wire Bothway adjustable gain, Signalling Options. (i) Balanced Battery (ii) Ringing 17/25 Hz (iii) 'B' wire earth in 17/25 Hz out (iv) 'B' wire earth in reversal out Signalling path is via 2-wire, 4-wire phantoms on separate wires GEC Private Venture (PV) design	London Overlay Network, National Private Circuit digital Network (NPCDN)
G8/1	8045	TEP1 (E) Equivalent of SU 30A GEC private venture design	NPCDN

11.2 Signalling Limits Using Manual Converters

Signalling Voltage

The effective signalling voltage is the minimum supply voltage less the likely difference in earth potential between signalling units. Under severe electrical storm conditions this difference may be several hundred volts for the duration of several minutes but under normal conditions it is unlikely to exceed a few volts. In practice an allowance of six volts should be made and this covers all but the most exceptional conditions.

Thus the signalling voltages actually available are:-

50 volt nominal (45 volt minimum at the equipment) — 39 volt. (Allowing for difference in earth potential.)

24 volt nominal (21 volts minimum at the equipment) — 15 volt.

20.5 volt nominal supply at customer premises (Local Power Unit) eg Power Unit No. 103B.

(When the signalling unit and terminal signalling equipment share a common earth as at a customers premises, the earth voltage difference will be zero.)

Sensitivity of Receiving Device

For the type of signalling unit available (see para 11.1) the *test operate* figures for the relays concerned are listed in Table 2. A tolerance of 30 Per Cent should be added to these figures to allow for loss of sensitivity due to ageing.

Table 2

Operate Current for Different Signalling Unit Types

Signalling Unit Type		Nominal Operating Current
3000 Type	Sleeve Relay Set Key and Lamp Unit Panel Signalling No. 7 Unit Signalling No. 18	6 mA
23 Type Relay	Signalling Unit No. 27A Signalling Unit No. 28A	16 mA
HALL Effect Relay	Signalling Unit No. 27B Signalling Unit No. 28B Signalling Unit No. 47A/48A	7.5 mA 10.0 mA

NOTE: The values are the nominal operate current when two windings of the relay is in the signalling path. For 'B' leg earth signalling only one winding of the relay are employed, therefore the sensitivity is halved and the nominal operate current is doubled.

Total Resistance of Signalling Path

This consists of the sum of the following:-

(a) The resistance of the line signalling path determined from the loop conductor resistance as shown in Table 3 and figure 1.

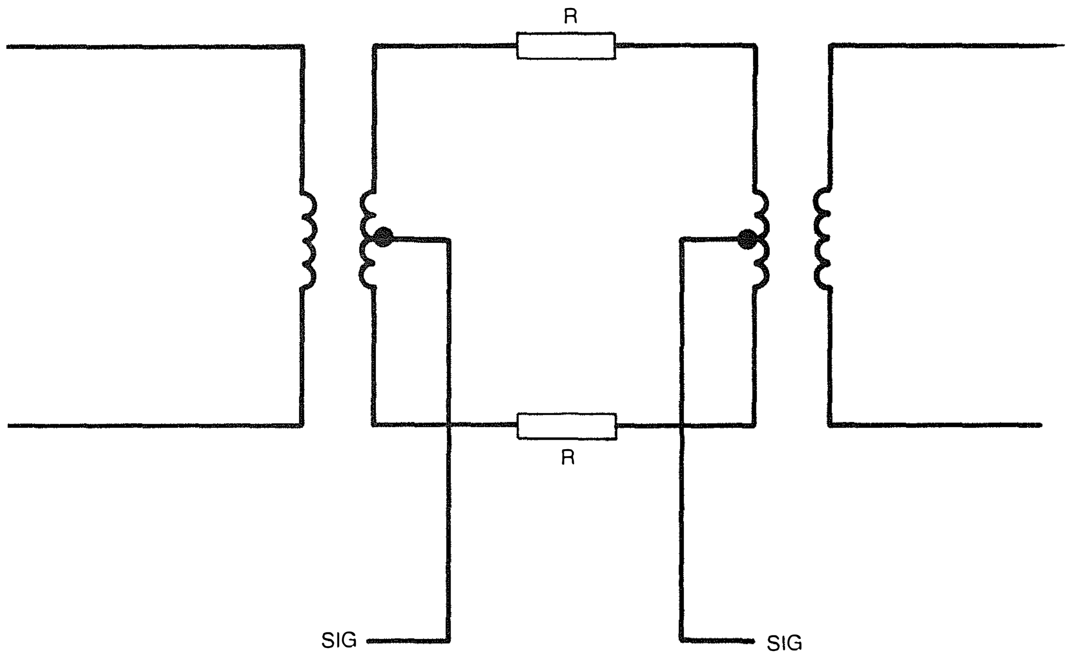


Fig 1 Signalling Path Resistance

Line Signalling Path Resistance =

$$\frac{1}{\frac{1}{R} + \frac{1}{R}} = \frac{R \times R}{R + R} = \frac{R^2}{2R} = \frac{R}{2}$$

$$\text{but } R = \frac{\text{Loop Resistance}}{2}$$

Therefore Line Signalling Path Resistance =

$\frac{\text{Loop Resistance}}{4}$ for a 2-wire circuit

Table 3

Determination of Line Signalling Path Resistance for Balanced Battery Working

Circuit Routing	Signalling Path Resistance
2-Wire	$\frac{\text{Loop Resistance of Pair}}{4}$
4-Wire	$\frac{\text{Loop Resistance of Pair}}{8}$

(b) The resistance of the line transformers calculated in a similar way to the line signalling resistance above. In practice this can be neglected as it is small in comparison to the line signalling resistance.

(c) The protective resistor at the sending end.

NOTE: The protective resistors values (Rp) are as follows:-

3000 type relay Rp = 200 ohm

23 type relay Rp = 1000 ohm or (500 ohm if modified in accordance with Table 5)

HALL Effect relay Rp = 50 ohm

(d) The resistance of the signalling unit receiving relay, allowing for manufacturing tolerances and increase in resistance due to high temperature after prolonged operation are values given in Table 4.

Table 4

Receive Relay Sensitivity

Signalling Unit Type		Relay Resistance
3000 Type Relay	Sleeve Relay Set Key and Lamp Unit Panel Signalling No. 7 Unit Signalling No. 18	(1000) 1100 ohm
23 Type Relay	Signalling Unit No. 27A Signalling Unit No. 28A	(185 + 185) 222 + 222 = 444 ohm
HALL Effect Relay	Signalling Unit No. 27B Signalling Unit No. 28B Signalling Unit No. 47A Signalling Unit No. 48A	(200 + 50* + 200 + 50*) 240 + 50* + 240 + 50* = 580 ohm

*Thermistors in series with Relay

NOTE: Figures in brackets denote relay resistance before allowing manufacturing tolerances and increase in resistance due to high temperature.

Manual Balanced Battery Signalling Limits

The signalling limits for balanced battery working between signalling units are given in Table 5. This table also includes the limits for balanced battery signalling between a private circuit signalling unit and a PMBX which uses a 3000 type relay.

Table 5

DC Signalling Path Resistance Limits for Balanced Battery Signalling

Signalling Unit	Nominal Signalling Voltage (V)	Balanced Battery Signalling Path Resistance Limit (Ohm)				
		SU No. 28A	Addtl 1 k ohm Resistor Fitted†	SU 28B	3000 Type Relay (US No. 7/PBX)	SU 47A/48A
Signalling Unit No. 27/28A	50 24 20.5 ϕ	550 — —	1050 — 80	1580 — 470	1350 — 380	1305 74
Signalling Unit No. 27/28B	50 24 20.5 ϕ	1580 — 470	1580 225 550	3220 770 1370	3120 670 1270	3800 1600
Unit Signalling No. 7/18	50 24	1350	1350	3120	3760	3572 495
SU 47A/48A	50 24	1305 74		3800 1600	3572 495	3572 495

eg A SU No. 27A working at a nominal voltage of 50 V using balance battery signalling working to a US No. 7. The dc signalling path resistance = 1350 ohm.

† To improve the sensitivity of the SU No. 28A a Resistor Coil No. 35A 1 k ohm may be fitted between pins TSA 18 and 26 on Unit N2 of the SU No. 28A.

ϕ Refer to Ref. 2 & 4.

Table 6

**25 Hz Bothway
DC Loop Resistance Limit Between Signalling Units**

A End Sig Unit	Nominal Signalling Voltage (V)	25 Hz Bothway Loop Resistance (ohm) B End Sig Unit			
		SU 28A	SU 28B	3000 Type Relay (US No. 7)	SU
Signalling Unit No. 27/28A	50	1500	1500	1500 †	1500
Signalling Unit No. 27/28B	50	1500	2400	1500 †	
Unit Signalling No. 7/18	50	1500	1500	—	1500
Signalling Unit No. 47A/48A	50	1500	2400	1500	2400

† Unit Signalling No. 7

Phantom Signalling Paths

On 4-wire circuits requiring a phantom signalling path, the following arrangements should be made. At the end of the circuit nearest to the circuit control, the ‘A’ Signalling wire will be connected to the phantom of the transmit pair and the ‘B’ Signalling wire to the phantom of the receive pair. At the other end of the circuit, the ‘A’ Signalling wire will be connected to the phantom of the receive pair and the ‘B’ Signalling wire to the phantom of the transmit pair. This is to ensure that the ‘A’ Signalling wire at each end is connected to the same phantom and likewise for the ‘B’ wire refer to Figure 2. The reversal should be identified by paper sleeves in accordance with Ref. 5.

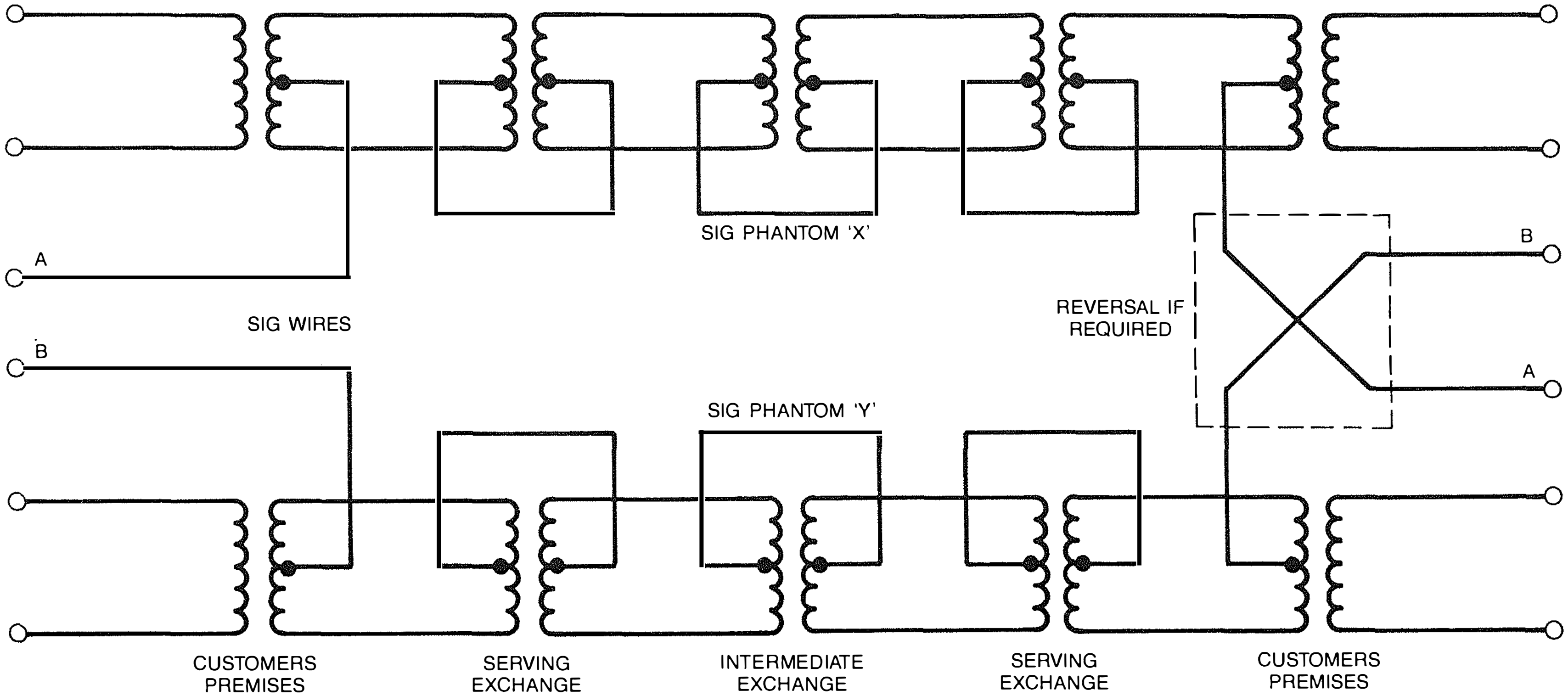


Fig. 2 Signalling Over Derived Phantoms

7-MCS664

End of Section 11

Private Circuit Services Signalling Handbook

Section 12 — Automatic Inter-PBX Signalling Systems

Definition of Automatic Inter-PBX Signalling

Automatic Inter-PBX Signalling is a method whereby control information on the progress of a call is conveyed from one PBX to another. The information takes the form of *Line Signalling* eg Idle, Seizure, Answer, Hold and Clear. Line Signalling Systems must also be capable where necessary of carrying *Address* and *Supplementary Services* information. *Address* information is the information necessary to route the call to its destination. *Supplementary* information is information required after the call is set up to call in additional facilities eg Call transfer, Three party etc.

12.1 Automatic Balanced Battery (A/BB)

Balanced battery is generally used in both directions. Dialling is not available with this system. To call a distant PBX, similar or balanced DC potentials are applied automatically to the A and B wire of the line or phantom. When the distant end answers balanced battery is returned to the originating end automatically to provide an answer supervisory. When either end clears, the balanced battery is removed automatically from the circuit by the PBX which clears first and the distant end receives a clear supervisory. The system requires a physical signalling path and cannot be used with manual signalling converters eg SU27A 28A. Whilst still in use on some older PBXs this signalling system is no longer provided on modern PBXs.

12.2 Loop Signalling (Loop)

This is an automatic signalling system in which a low resistance path is automatically applied across the A and B wire of a circuit or phantom to give a call signal which is detected by a battery and earth backed double coil relay or electronic equivalent at the distant end. An automatic answer signal is normally given from the distant end by a reversal of the battery and earth condition. When loop signalling is applied in both directions, a clear signal from either end is given by reverting to a normal battery and earth condition through a double coil relay. Dialling can be used with loop signalling by disconnection and reconnection of the loop normally at the rate of 10 pulses per second with a 66⅔ break to 33⅓ make ratio. Loop signalling is generally used in both directions. Whilst this system is still provided on some modern PBXs, Signalling System DC10A is preferred over physical signalling paths.

12.3 A Wire Earth Signalling (A/WE)

An earth is automatically applied to one wire of the pair or phantom to call the distant end. An earth is automatically applied to the other wire of the pair as an answer signal from the distant end. Removal of the earth at either end constitutes a clear signal. A/WE is generally used in both directions. Dialling can be used with earth signalling by disconnection of the earth and reconnection of the earth from the wire of the pair, normally at 10 pulses per second with a 66⅔ break to 33⅓ make ratio. Although it is technically feasible to get bothway dialling, in practice it is generally applied in one direction only. The use of A/WE signalling is now discouraged because of the noise it can induce into other cable pairs. Modern PBXs are not normally provided with this signalling system.

12.4 Signalling System DC10 (SSDC10)

SSDC10 is the generic title for a family of line signalling systems based on the Single Commutation Double-Current method of signalling. Individual SSDC10 signalling systems differ in signal code only, each variant designated by a suffix letter. These are:-

SSDC10-A Inter-PBX line signalling with 10 pps

SSDC10-B Inter-PBX line signalling for use with SSMF5 inter-register signalling

SSDC10-C Long external extension signalling

At present only SSDC10-A has been defined and is generally available.

12.4.1 Single Commutation Double Current Signalling (SCDC & SSDC10-A

12.4.1.1 Signalling System DC10-A (SSDC10-A)

System DC10-A (SSDC10-A) provides bothway working over audio line plant where a metallic path can be provided end to end. Over 2-wire inter-PBX circuits the signalling path is provided by the speech pair. On 4-wire inter-PBX circuits the signalling path is derived from the phantoms of the Receive and Transmit pairs. The system operates by regulating the direction of line current — Commutation — to achieve recognisable signals over long lines. The use of line current reversals counters the effect of high line Capacitance x Resistance (CR) values. SSDC10-A is the preferred method of inter-PBX signalling where a metallic signal path is available. It is described in detail in British Telecommunications Requirements (BTR) 1183 Sections 1 and 2.

Characteristics of Signalling Path

To ensure the satisfactory recognition of signals, particularly 10 pps digits the line characteristics must fall within the following limits:-

(a) Signalling path loop resistance. 0-3.8 kohms.

(b) Signalling path CR value. 0-42,000 microfarad ohm. The CR value is obtained by multiplying the sum of the capacitances (UF) of all sections of the signalling path by the sum of the resistances (ohms) of all sections. The sum of capacitances shall include the capacitance of cables assessed with reference to cable mutual electro-static capacitance values.

(c) Signalling path insulation resistance is greater than 100 kohm.

It can be assumed that these limits are met on BT lines when the two ends of the circuit are within 11 km radial distance although it will always be necessary to survey the route concerned.

NOTE: 30 channel PCM (1st Generation). When a PCM link forms part of the route, SSDC10-A may be provided by using a SSDC10-A to PCM Converter-Signalling Unit No. 5A or F5/1. When using this converter the signalling path resistance limits will be 3800 ohm and the pulsing limit is reduced from 42,000 microfarad ohm to 18,000 microfarad ohm. See also Section 9 *DC Signalling paths on speech band private circuits*.

Transmission

Circuits to EPS1, EPS2 or EPS3 may be used depending on the transmission quality required, so long as the dc signal limits described above are met.

Signalling Conditions

In the idle condition each end of the circuit presents a resistance loop — 280 ohm nominal — to line. A calling signal is signified by the application of an earth on the A wire via a resistance Ra and a -50 volt nominal battery on the B wire via a resistance Rb. The answer signal from the distant end is an earthed loop. A clear back is the removal of the earth leaving the line looped. A clear forward is the application of an earth on the B wire via a resistance Rc and a -50 volt battery on the A wire via a resistance Rd. When the PBX is ready to receive calls this condition at the calling end reverts to resistance loop, ie the idle state. Dialled pulses take the form of line current reversals, that is, during the break pulse an earth is connected to the B wire and a negative battery to the A wire. See Table 1 for signal code.

Resistance Ra, Rb, Rc and Rd are each within the range 300-760 ohm. To meet the balance to earth requirements $Ra = Rb$ and $Rc = Rd$. To ensure that the loop currents are approximately equal $Ra + Rb$ ohm $=$ $Rc + Rd$ ohm.

Fig. 1 and 2 show typical SSDC10-A outgoing and incoming elements.

Transfer of Address Information

Address information is sent as digit signals which are either applied to the signalling path as 10 pps of negative battery A wire, earth B wire or as Multifrequency signal code eg SSMF4 or SSMF5 basic code only.

Signalling Code SSDC10-A and SCDC

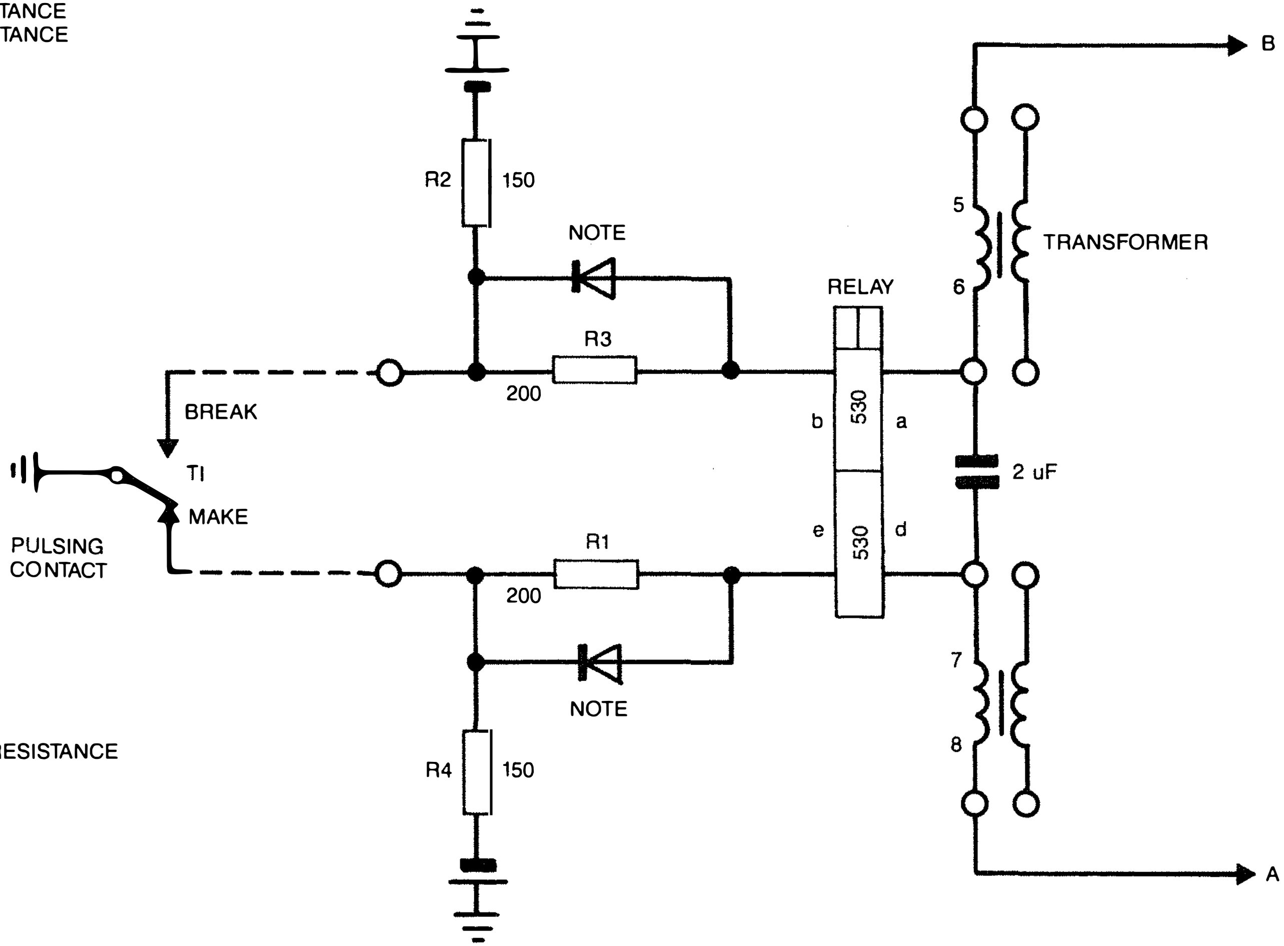
The signalling code for SSDC10-A and SCDC is shown in Table 1. The signal sending durations are continuous unless otherwise specified. Only signals with durations given in the table are sent to line. All signals sent give a true indication of the state of the PBX. Note that SCDC Signal Code does not include the optional signals.

Table 1

Signal	Outgoing PBX	Incoming PBX
Idle	Loop	Loop
Seizing	Earth A wire — Negative battery B wire	—
Forward Hold	Earth A wire — Negative battery B wire	—
Delayed-Dialling (Optional) Note	—	Earth A and B
Proceed-to-Send (Optional) Note	—	Loop
Digit Signals 1-0	Negative battery A wire — Earth B wire pulses corresponding to Digit Signal sent	—
Answer	—	Earth A and B
Backward Hold	—	Earth A and B
Clear Forward	Negative battery A wire — Earth B wire for longer than 300 ms	—
Clear Back	—	Loop for longer than 300 ms
Forward Auxiliary Signal Signal (Optional) Note	Negative battery A wire — Earth B wire for period of 45-135 ms	—
Backward Auxiliary Signal (Optional) Note	—	Loop for a period of 45-135 ms

Note: Not included in SCDC Signalling Code.

Ra = R1 + RELAY COIL RESISTANCE
Rb = R2 + RELAY COIL RESISTANCE
Rc = R3 + RELAY COIL RESISTANCE
Rd = R4 + RELAY COIL RESISTANCE



NOTE:- DIODE FORWARD RESISTANCE
50 OHMS APPROX

Fig. 1 SSDC10-A Typical Outgoing Element

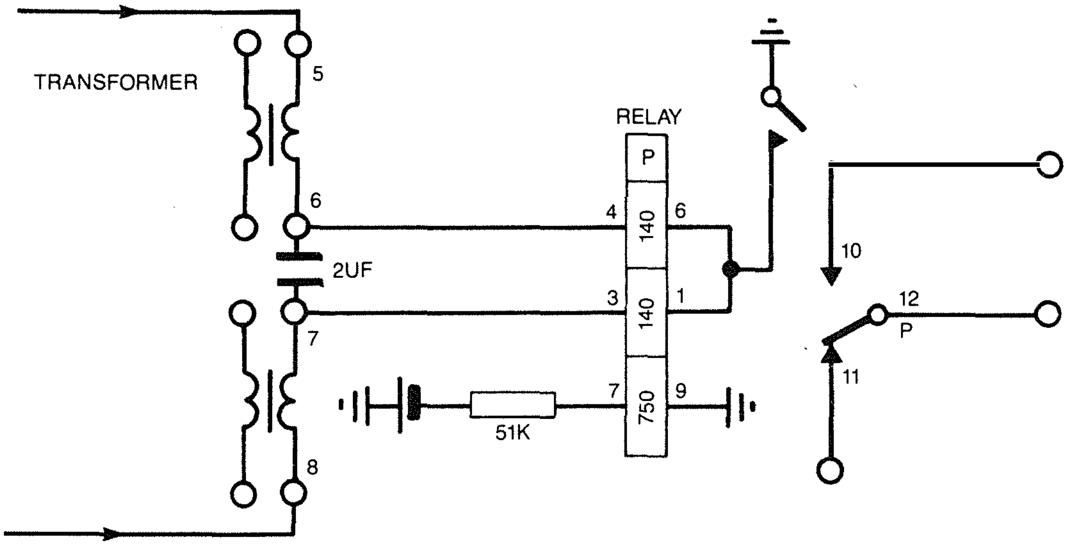


Fig. 2 SSDC10-A Typical Incoming Element

12.4.1.2 SCDC

SCDC signalling system is the forerunner of SSDC10-A and has been superseded by it. The signalling conditions are indentical to SSDC10-A and the signal code is shown in Table 1. SCDC differs from SSDC10-A in two respects:

(a) SCDC does not provide for the optional signals shown in Table 1.

(b) The line characteristics limits quoted in Ref 1 for SCDC of 4.4 kohm loop resistance and CR of 76,000 microfarad ohm have been standardised with SSDC10-A at 3.8 kohm and 42,000 microfarad ohm.

12.5 Signalling System DC5 (SSDC5)

SSDC5 is the generic title for a family of line signalling systems which are based on the E and M Method of signalling. Individual SSDC5 signalling systems differ in signal code only, each variant designated by a suffix letter. These are:-

SSDC5-A Inter-PBX line signalling with 10 pps.

SSDC5-B Inter-PBX line signalling for use with SSMF5 inter-register signalling

SSDC5-C Long external extension signalling

SSDC5-D Inter-PBX line signalling on International circuits with 10 pps or MF inter-register signalling

At present only SSDC5-A has been defined and is generally available on PBXs, but SSDC5-D can be provided using a SSDC5-A/SSDC5-D Signalling converter (Signalling Unit No. 46A). This is described in Section 17. SSDC5-B and SSDC5-D have been developed by certain PBX supplies by transposing the protocol from SSAC15-B and SSAC15-D.

12.5.1 Signalling System DC5-A (SSDC5-A)

This signalling system is used for signalling between a PBX and co-sited equipment. The system operates over two discrete signalling wires which are electrically separated from the associated speech circuit. The two signalling wires are designated E and M. Signals are sent on the M wire and received on the E wire. For this reason the system is often referred to as E and M signalling. SSDC5-A is described in detail in British Telecommunications Requirements (BTR) 1182 Sections 1 and 2.

Signal Path Limits

Since the system is unbalanced in character it is necessary to apply strict limits to the E and M wires to prevent radiated interference with other circuits.

(a) The system is designated such that neither E or M wires carry a current of more than 25 mA.

(b) To ensure adequate wetting of any relay contacts in the signal path the E and M wires carry a minimum current of 5 mA in the active state.

(c) The dc resistance limit for both signal wires is 25 ohm which is equivalent to 275 metre of 0.5 mm cable. If precautions are taken to minimise the interference caused ie by using a dedicated cable for the signal wires, the dc resistance can be increased to 300 ohm.

(d) The Earth-on condition applied to the M wire or received on the E wire is presented via a nominal 1200 ohm resistance in parallel with a capacitance of 1 microfarad. This network acts as a noise suppression filter and spark quench.

Signalling Conditions Sending

Signals are sent as either Earth-on Condition or Earth-off Condition applied to the M wire via a noise suppression filter network as described above.

Signalling Conditions Receiving

Signals are received as either Earth-on or Earth-off condition received on the E wire. An Earth via a resistance of up to 1500 ohm in parallel with a capacitance of 1 microfarad is recognised as an Earth-on condition. An earth via a resistance of greater than 400 kohm in parallel with a capacitance of 1 microfarad is accepted as an Earth-off condition.

Signal Code

The Signal Code for SSDC5-A is shown in Table 2.

Transfer of Address Information

As well as 10 pps signalling SSDC5-A will also support Multifrequency Code Signalling eg SSMF4 and SSMF5 (basic code).

Applications

SSDC5-A essentially provides signalling between two co-sited systems. The two main applications are:-

(a) signalling between a PBX and the *out band* signal path on a derived channel of Channel Translating Equipment (CTE), and

(b) signalling between a PBX or a derived channel on a CTE and a signalling converter to provide *in band* signalling appropriate to the transmission path provided, eg SSDC5-A/SSAC15 and SSDC5-A/SSDC10-A.

Signalling Code SSDC5-A

The signalling code for SSDC5-A is shown in Table 2. The signal sending duration are continuous unless otherwise specified. Only signals with durations given in the table are sent to line.

Table 2

Signal	Signalling Conditions	
	Outgoing PBX	**Incoming PBX**
Idle	Earth-Off M wire Earth-Off E wire	Earth-Off E wire Earth-Off M wire
Seizing	Earth-On M wire Earth-Off E wire	Earth-On E wire Earth-Off M wire
Hold	Earth-On M wire Earth-Off E wire	Earth-On E wire Earth-Off M wire
Delay Dialling (Optional)	Earth-On M wire Earth-On E wire	Earth-On E wire Earth-On M wire
Proceed to send (Optional)	Earth-On M wire Earth-Off E wire	Earth-On E wire Earth-Off M wire
Digit Pulse	Earth-Off M wire in step with break pulse Earth-Off E wire	Earth-Off E wire in step with break pulse Earth-Off M wire
Answer	Earth-On M wire Earth-On E wire	Earth-On E wire Earth-On M wire
Clear Forward	Earth-Off M wire Earth-On E wire	Earth-Off E wire Earth-On M wire
Clear Back	Earth-Off M wire Earth-Off E wire	Earth-Off E wire Earth-Off M wire
Forward Auxiliary Signal (Optional)	Earth-Off M wire for a period of 45-135 ms Earth-On E wire	Earth-Off E wire for a period of 35-150 ms Earth-On M wire
Backward Auxiliary Signal (Optional)	Earth-On M wire Earth-Off E wire for a period of 35-150 ms	Earth-On E wire Earth-Off M wire for a period of 45-135 ms

12.5.2 Out-of-Band Signalling Incorporating SSDC5 (E & M)

The arrangements for a circuit using out-of-band signalling between two PBXs is shown in Fig. 3. Other circuit configurations are shown in Ref 2. The signalling conditions at the circuit interface are SSDC5; the transmitted signal from the PBX appears on the M wire and is reproduced at the distant end of the circuit, by the CTE, as a signal on the E wire. (For this reason out-of-band signalling is often called E & M signalling.)

The signalling between the PBX and the CTE is designated SSDC5.

On the hf side of the CTE, 3825 Hz is used as the out-of-band signalling frequency for each channel. This frequency is generated within the CTE and is injected into the transmission path, via a static relay before the channel modulator and therefore appears in the group band as a signal at a frequency equal to the channel carrier frequency minus 3825 Hz. The static relay is under the control of the earth ON or earth OFF condition applied to the M wire via a noise suppression filter. The line signalling condition is represented by the presence of a signalling tone. Strapping arrangments within the CTE allow the system to work in either the Tone ON Idle or Tone OFF Idle state: Tone ON Idle should normally be adopted.

At the distant end of the group the signalling receiver in the CTE detects the presence or absence of the signalling tone and applies an *earth on* or *earth off* condition, via the Noise Suppression Filter (NSF) and the E wire to the PBX relay set.

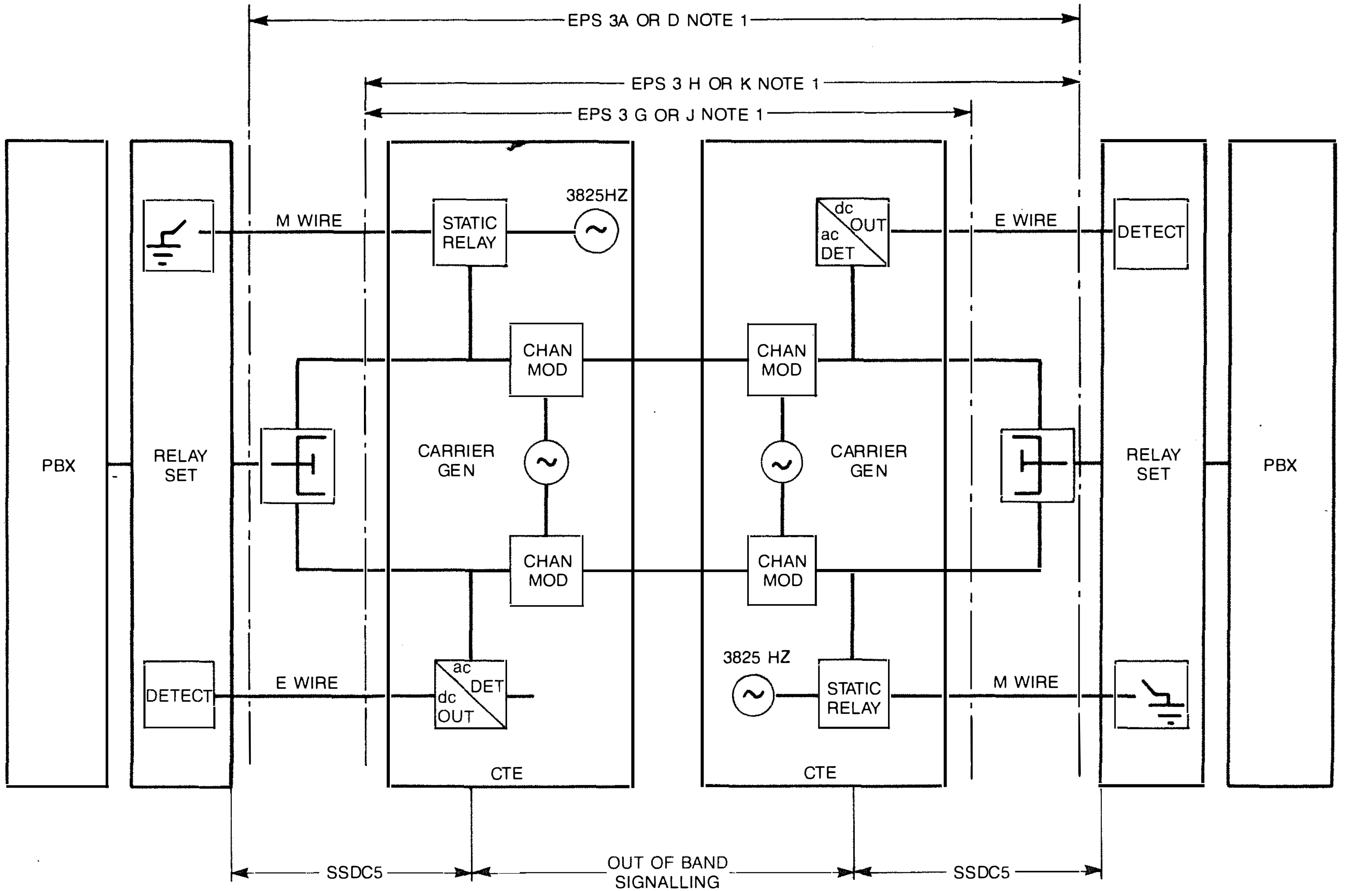
Channel filters operating over the normal speech band range of 300-3400 Hz ensure that the signal frequency at 3825 Hz remains *out-of-band*.

When an overall circuit consists of two channels from private groups connected in tandem the signalling wires are cross-connected ie the E-wire and M-wire of the receive are connected to the M-wire and E-wire of the transmit channel respectively. Each channel of a BT provided private group has the capacity for out-of-band signalling. However, it should not be provided on channel 12 of a private group not forming part of a private supergroup, because this group may be routed via Through group Filters in the BT HF fdm network and the response of such filters is likely to give rise to unacceptable losses at the 3825 Hz signalling frequency. All 60-channels of a private supergroup may be equipped with out-of-band signalling.

If the out-of-band capability is not required on a particular channel of a private group (eg the channel is being used for data transmission) then out-of-band signalling may be provided for channel 12 by means of the spare signalling capacity of the other channel. Failing this signalling may be provided by employing SSA15-A (in-band). Spare signalling capacity on a data circuit may also be used to extend dc alarm conditions (see Ref 2).

Signalling Limits

The 3825 Hz tone is transmitted at a power level of -20 dBmO. The power level of this continuous signal is chosen to conform to the transmission loading requirements of British Telecoms HF line plant and CCITT Recommendations Q15.



NOTE 1. EQUIVALENT EPS4, AND 5 CAN BE USED

Fig. 3 Typical PBX-PBX Connexion Utilising SSDC5 & Out-of-Band Signalling

12.5.3 SSDC5-A to a Signalling Converter

In certain cases it is necessary to provide a signalling converter external to the PBX concerned, typical examples are:

- Where the PBX is not equipped with the full range of inter-PBX signalling systems but does have a SSDC5-A inter-PBX port. See Fig. 4
- Where the PBX has no spare capacity for the signalling system required but does have a spare SSDC5-A port, there may be strong cost grounds for providing the signalling facility using a signalling converter.
- For extending the signalling path of a derived channel on CTE over an autio section to a distant PBX. See Fig. 5.

The range of signalling convertors available is described in section 17 of this document.

Figs 4 and 5 follow

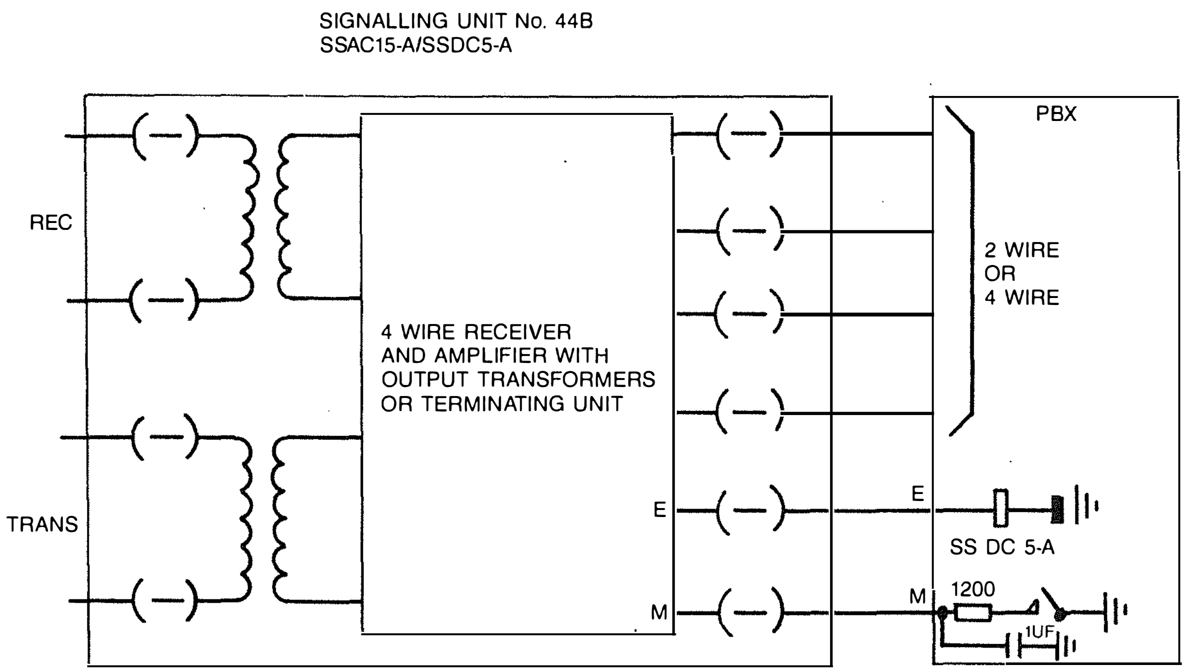


Fig. 4 SSDC5-A to a Signalling Convertor Typical Arrangement

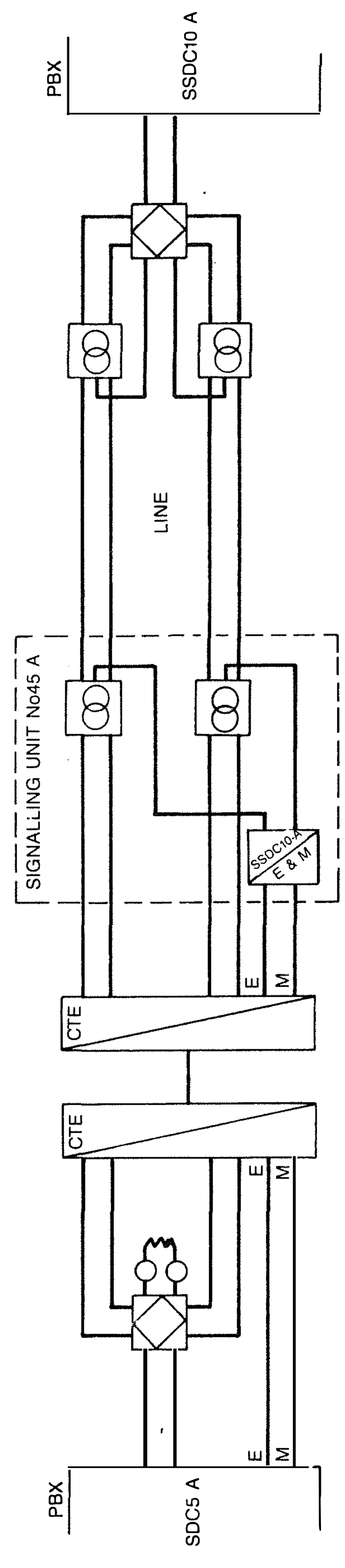


Fig. 5 Extending a Channel on a Private Group Over an Audio Section using an SSDC5-A/SSDC10-A Convertor

12.6 Signalling System AC15 (SSAC15)

SSAC15 is the generic title for a family of line signalling systems which are based on a single voice frequency (1 vf) method of signalling. Individual SSAC15 signalling systems differ in signalling code only, each variant designated by a suffix letter. A brief description of each type follows:-

- SSAC15-A. Provides line signalling and 10 pps pulsing between PBXs within a private network based on the line signalling part of CCITT signalling system R1. The system is intended to signal address information at 10 pps but may be used to support multi-frequency inter-Register signalling (SSMF5) basic code only.
- SSAC15-B. This is a British Telecom version of the CEPT signalling System L1. It provides the line signalling support for multi-frequency inter-register signalling (SSMF5) both basic code and supplementary services, between PBXs in a private network.
- SSAC15-C. Provides line signalling and 10 pps pulsing on long external extensions off a PBX and for Out-of-Area exchange line (OOAE/L) terminating on a telephone. This system is the BT version of CEPT signalling System L2. It is described in Section 16.
- SSAC15-D. This is the British Telecom version of the CEPT signalling System L1. It is primarily intended for use between PBXs in different countries via international leased lines, but may be used inland. This system is intended to signal address information at 10 pps but may be used to support multi-frequency inter-Register signalling.
- SSAC15-E. Provides line signalling on long Out-of-Area exchange line (OOAE/L) which terminate on a PBX or other call routing apparatus. This system is described in Section 19.

The essential common features which each of these Systems share are:-

- The signalling system is inserted in the Transmit and Receive pairs of a 4-wire transmission path.
- Uses a single frequency of 2280 Hz.
- The signal frequency is transmitted to line at two standard levels. -10 dBmO (high level) and -20 dBmO (low level).
- The signal receiver has the same sensitivity in each case, ie it will accept signal levels in the range -3 dBm and -29 dBm.
- There is no limit on line length.

The inter-PBX versions of SSAC15 ie SSAC15-A, SSAC15-B and SSAC15-D are described in this section. All these systems employ both-way working.

12.6.1 Signalling System AC15-A (SSAC15-A)

System Description

SSAC15-A is a continuous tone type in-band signalling system for the link by link transmission of supervisory signals and 10 pps digits between PBXs in a private network. It uses a single frequency of 2280 Hz in each direction of a 4-wire transmission path, the presence or absence of this frequency indicates a specific signal dependent upon when it occurs in the signalling sequence and in certain cases on its duration. When the circuit is idle low level signalling tone is continuously present in both directions. It is sometimes described as a *tone on idle* system. SSAC15-A is described in detail in British Telecommunications Network Requirements (BTNR) 181 Sections 1 and 2. The system is based on the line signalling part of CCITT signalling system R1 modified to meet the requirements for sending and receiving signals of CEPT line signalling System L1.

Application

SSAC15-A is the preferred method of inter-PBX signalling on inland circuits over a transmission path which contains an HF Section, either fdm or pcm. And where 10 pps pulsing or SSMF4 or SSMF5 basic code only is employed.

Transmission Requirements

Inland Inter-PBX Circuits

The signalling system is connected in a 4 wire mode and is situated at the 0 dBr point in the Receive path and the −4 dBr point in the Transmit path of a BT EPS3G circuit. The performance at 2280 Hz of such a circuit will ensure that signal tone received levels are within the sensitivity range (−3 dBm to −29 dBm) of the SSAC15-A Signal Receiver. When Multifrequency signalling is used, either SSMF4 or SSMF5, an EPS3J circuit should be chosen to give the required response to MF signals. Either a physical audio circuit or a circuit including an HF section (fdm or pcm) is suitable. There is no limit on line length.

International Leased Lines

SSAC15-A may occasionally be provided on International lines either with 10 pps, CEPT System L1 MFPB (SSMF4) or CEPT L1 MFC Inter-register signalling (SSMF5). The type of circuit provided shall be mutually agreed between the parties concerned but should be to the standard of CCITT Recommendation G171 and M1010 to M1060. International circuits are normally presented 4 wire at 0 dBr at each end, so care should be taken to ensure that the 2280 Hz received signal tone level is within the sensitivity range of the signal receiver (−3 dBm to −29 dBm). Requests for this service should be referred to BT International/IBI 4.3.2.

Outline of Operation

Idle

In the idle state the PBXs at each end of the inter-PBX circuit apply an 'idle signal' to indicate they are free to accept incoming calls. This takes the form of a continuous low level (−20 dBmO) 2280 Hz tone in both directions of transmission. The power level for this continuous signal is chosen to conform to the transmission loading requirements of British Telecommunications HF line plant and CCITT Recommendations Q15.

Seize

When the inter-PBX circuit is selected by the PBX for an outgoing call, the PBX appplies a seizing signal to the signalling path. The seizure signal is the removal of the 2280 Hz tone in the forward direction — Tone Off. On recognition of the seizure signal the PBX at the incoming end busies the circuit against outgoing calls and prepares to receive routing information. A transmission path is established between the incoming and outgoing ends to enable the return of supervisory tones to the caller. At the same time the caller is prevented from hearing the 2280 Hz signalling tone which is returned from the distant end until an answer condition is received.

Holding

The continued receipt of the seizing signal — Tone Off — is accepted by the incoming PBX as a hold signal.

Digit Pulses

10 pps pulses are transmitted as pulses of tone-on during the break period. These pulses of tone are transmitted at high level (−10 dBmO) to ensure proper operation in the presence of noise.

Delayed Dialling and Proceed to Send (Optional)

Where the facility is provided to delay the sending of digit impulses until the incoming PBX is ready to accept them, a delay dialling signal is returned by the incoming PBX immediately on recognition of a seizure signal. The signal is tone-off in the baclward direction. When the incoming PBX is ready to accept digit pulses, tone is reconnected in the backward direction to give a Proceed-to-Send signal. The initial portion of this tone-on signal, as with all tone-on signals, is augmented by 10 dB to ensure proper operation in the face of noise.

Answer

When the called party answers the incoming PBX applies an answer signal, or tone-off, to the signalling path.

Clear Down

On clear down, each PBX applies the appropriate clear signal to the signalling path. The incoming PBX applies a clear back signal, tone-on in the backward direction, and the outgoing PBX applies a clear forward signal, tone-on in the forward direction. The initial portion of each tone-on signal is sent at high level (– 10 dBmO) to ensure proper operation in the presence of noise, and then reverts to low level (– 20 dBmO) for the idle state. Each PBX bars access to the inter-PBX circuit until both clear forward and clear back signals have been exchanged.

Auxiliary Signals (Optional)

Forward and backward auxiliary signals are defined but are only provided when required to exploit additional facilities between interconnected PBXs. An auxiliary signal is a tone-on pulse, at high level (– 10 dBm) for a period of 45-135 ms.

Signalling Code SSAC15-A

The signalling code for SSAC15-A is shown in Table 3. The signal sending durations are continuous unless otherwise specified. Only signals with durations given in the table are sent to line.

Table 3

Signal	Outgoing PBX	Incoming PBX
Idle	Tone-On	Tone-On
Seizing	Tone-Off	—
Forward Hold	Tone-Off	—
Delay Dialling (Optional)	—	Tone-Off
Proceed-to-Send (Optional)	—	Tone-On
Digit Signals 1-0	Tone-On Pulses corresponding to Digit Signal sent	—
Answer	—	Tone-Off
Backward Hold	—	Tone-Off
Clear Forward	Tone-On for longer than 300 ms	—
Clear Back	—	Tone-On for longer than 300 ms
Forward Auxiliary Signal (Optional)	Tone-On for a period of 45-135 ms	—
Backward Auxiliary Signal (Optional)	—	Tone-On for a period of 45-135 ms

NOTE: High level Tone-on is sent for the duration of the signal or for a minimum of 300 ms (which ever is shorter) and for a maximum of 550 ms after which it is reduced to low level.

Transfer of Address Information

Address information is sent as digit signals which are either applied as 10 pps pulses or as multifrequency code eg SSMF4 or SSMF5 basic code only.

12.6.2 Signalling System AC15-B (SSAC15-B)

System Description

SSAC15-B is a continuous tone type in-band signalling system for the link by link transmission of supervisory signals and the line signalling support for multifrequency inter-Register signals between PBXs in a private network. It uses a single frequency of 2280 Hz in each direction of a 4-wire transmission path, the presence or absence of this frequency indicates a specific signal dependant upon when it occurs in the signalling sequence and in certain cases on its duration. When the circuit is in the idle condition, low level signalling tone is continuously present in both directions. it is sometimes described as a *tone-on-idle* system. SSAC15-B is described in detail in British Telecom Network Requirements (BTNR) 181 Sections 1 and 3. It is a BT version of CEPT signalling System L1. CEPT Recommendation T/CS49-01.

Application

SSAC15-B is the preferred method of inter-PBX signalling on inland circuits over any 4 wire presented transmission path whether HF or physical and where SSMF5 inter-register signalling is employed.

Transmission Requirements

Inland Inter-PBX Circuits

The signalling system is connected in a 4 wire mode and is situated at the 0 dBr point in the Receive path and the −4 dBr point in the Transmit path of a BT EPS 3J circuit. The response at 2280 Hz of such a circuit will ensure that signal tone received levels are within the sensitivity range (−3 dBm to −29 dBm) of the SSAC15-B Receiver. SSMF5 signal frequencies will be correctly recognised when 6 such circuits are connected in tandem in a 4 wire switched private network. Either a physical audio circuit or a circuit including an HF section (fdm or pcm) is suitable. There is no limit on line length.

Transmission Requirements

International Leased Lines

SSAC15-B may be used on international lines which employ System L1 multifrequency Signalling (SSMF5). The type of circuit provided shall be mutually agreed between the parties concerned but should be to the standard of CCITT Recommendation G171 and M1010 to M1060. International circuits are normally presented 4 wire at 0 dBr at each end, so care should be taken to ensure that the 2280 Hz received signal tone level is within the sensitivity range of the signal receiver (−3 dBm to −29 dBm). Requests for this service should be referred to BT International/IBI 4.3.2.

Outline Operation

Idle

In the idle state, the PBXs at each end of the inter-PBX circuit applies an 'idle signal' to indicate they are free to accept incoming calls. This takes the form of a continuous low level (−20 dBmO) 2280 Hz tone in both directions of transmission. The power level for this continuous signal is chosen to conform to the transmission loading requirements of British Telecommunications HF line plant and CCITT Recommendations Q15.

Seize

When the inter-PBX circuit is selected by the PBX for an outgoing call, the PBX applies a seizing signal to the signalling path. The seizure signal is the removal of the 2280 Hz tone in the forward direction — Tone Off. On recognition of the seizure signal the PBX at the incoming end busies the circuit against outgoing calls and prepares to receive information. A transmission path is established between the incoming and outgoing ends to provide for mf inter-Register Signalling. At the same time the caller is prevented from hearing the 2280 Hz signalling tone which is returned from the distant end until a seizing acknowledgement or proceed-to-send signal is received.

Holding

The continued receipt of the seizing signal — Tone Off — is accepted by the incoming PBX as a hold signal.

Seizing Acknowledgement or Proceed-to-Send

Depending on the capacity of the incoming PBX, recognition of the Seizing Signal will initiate either a Seizing Acknowledgement or a Proceed to Send procedure. As the Seizing Acknowledgement and Proceed to Send Signals are electrically identical the meaning of the signal must be mutually agreed between the parties involved.

Seizing Acknowledgement

When the incoming PBX recognises the Seizing Signal it returns a Seizing Acknowledgement signal — Tone off in the backward direction. The sending of this signal does not imply that the incoming PBX is ready to receive address information. Provision is made by the outgoing PBX to introduce a pre-Sending pause as necessary.

Proceed to Send

When the incoming PBX recognises the Seizing signal it maintains the idle signal until it is ready to receive address information, it then applies a Proceed to Send signal — Tone Off in the backward direction.

Transfer of Address Information

Address Information is sent as multifrequency inter-register signals. Signalling System MF5 (SSMF5) both Basic Code and Supplementary Services. See Section 13:2 of this document and BTR 1184.

Answer

When the called party answers, the incoming PBX applies an Answer signal to the signalling path. A pulse of tone-on of 45-135 ms duration. This pulse of tone is sent at high level (– 10 dBmO) to ensure proper operation in the presence of line noise.

Clear Down

On clear down, each PBX applies the appropriate clear signal to the signalling path. The incoming PBX applies a clear back signal, tone-on in the backward direction, and the outgoing PBX applies a clear forward signal, tone-on in the forward direction. The initial portion of each tone-on signal is sent at high level (– 10 dBmO) to ensure proper operation in the presence of noise, and then reverts to low level (– 20 dBmO) for the idle state. Each PBX bars access to the inter-PBX circuit until both clear forward and clear back signals have been exchanged.

Time-Out on non-Receipt of Address Information

When address information is not received after receipt of a SEIZING SIGNAL the PABX shall time out and disassociate the inter-PABX circuit from any common equipment. Under these conditions the PABX shall:-

- Apply a CLEAR BACK SIGNAL
- Bar access to the inter-PABX circuit for outgoing calls until a CLEAR FORWARD SIGNAL is received.

Forward and Backward Recall Signals (Optional)

These signals are used to re-associate mf signalling equipment when a PBX wishes to cause another PBX to prepare to receive further address or facility information.

Forward Service Request Recall

The forward recall signal is sent by the originating PBX to re-associate common equipment at the destination PBX. The recall signal is a pulse of tone-on of 45-135 ms duration sent at high level (– 10 dBmO) to ensure proper operation in the presence of noise.

Backward Service Request Recall

The backward recall signal is sent by the destination PBX to re-associate common equipment at the originating PBX. The recall signal is a pulse of tone-on of 45-135 ms duration sent at high level (– 10 dBmO) to ensure proper operation in the presence of noise.

Forward Link Recall

The forward link recall signal is sent to recall common equipment in an adjacent transit PBX. The recall signal is a double pulse of tone-on, 45-135 ms on, 30-70 ms off, 45-135 ms on, sent in the forward direction at high level (– 10 dBmO).

Backward Link Recall

The backward link recall signal is sent to recall common equipment in an adjacent transit PBX. The recall signal is a double pulse of tone-on, 45-135 ms on, 30-70 ms off, 45-135 ms on, sent in the backward direction at high level (– 10 dBmO).

Signalling Code SSAC15-B

The signalling code for SSAC15-B is shown in Table 4. The signal sending durations are continuous unless otherwise specified. Only signals with durations given in the table are sent to line.

Table 4

Signal	Outgoing PBX	Incoming PBX
Idle	Tone-On	Tone-On
Seizing	Tone-Off	—
Forward Hold	Tone-Off	—
Seizing Acknowledg-ment or Proceed-to-Send	—	Tone-Off
Address Information	Mf inter-register signailing (SSMF5). See Section 13.2 and BTR 1184.	
Answer	—	Signal Tone-On Pulse for 45-135 ms
Backward Hold	—	Tone-Off
Clear Forward	Tone-On	—
Clear Back	—	Tone-On
Forward Service Request Recall (Optional)	Single Tone-On Pulse for 45-135 ms	—
Backward Service Request Recall (Optional)	—	Single Tone-On Pulse fpr 45-135 ms
Forward Link Recall (Optional)	Double Tone-On Pulse for 45-135 ms on, 30-70 ms off, 45-135 ms on.	—
Backward Link Recall (Optional)	—	Double Tone-On Pulse for 45-135 ms on, 30-70 ms off, 45-135 ms on.

NOTE: High level Tone-On is sent for the duration of the Signal or for a minimum of 300 ms (whichever is shorter) and for a maximum of
550 ms after which is it reduced to low level.

12.6.3 Signalling System AC15-D (SSAC15-D)

System Description

SSAC15-D is a continuous tone type in band Signalling System for the link by link transmission of supervisory signals and 10 pps pulses between PBXs. It may also support CEPT system L1 multifrequency push-button signalling (SSMF4). SSAC15-D is used on International inter-PBX Circuits and meets the requirements of CEPT line signalling system L1. It may also be used on inland inter-PBX circuits where appropriate. It uses a single frequency of 2280 Hz in each direction of a 4-wire transmission path, the presence or absence of this frequency indicates a specific signal depending upon when it occurs in the signalling sequence and in certain cases on its duration. When the circuit is idle low level signalling tone is continuously present in both directions. The system may be described as a *tone-on-idle* system. SSAC15-D is described in detail in British Telecoms Network Requirements (BTNR) 181 Sections 1 and 5 and also CEPT Recommendation T/CS49-01.

Application

SSAC15-D is the preferred method of inter-PBX signalling on international circuits where 10 pps pulsing is employed.

Transmission Requirements

International Leased Lines

SSAC15-D is normally provided on international lines, usually with 10 pps but it may also support CEPT System L1 MFPB (SSMF4) or CEPT System L1 MFC (SSMF5). The type of circuit provided shall be mutually agreed between the parties concerned but should be to the standard of CCITT Recommendation G171 and M1010 to M1060. International circuits are normally presented 4-wire at 0 dBr at each end, so care should be taken to ensure that the 2280 Hz received signal tone level is within the sensitivity range of the signal receiver (– 3 dBm to – 29 dBm). Requests for this service should be referred to
BT International/IBI 4.3.2.

Inland Inter-PBX Circuits

The signalling system is connected in a 4-wire mode and is situated at the 0 dBr point in the receive path and the – 4 dBr point in the Transmit path of a BT EPS3G circuit. The performance at 2280 Hz of such a circuit will ensure that signal tone received levels are within the sensitivity range of the SSAC15-D Signal Receiver. When multifrequency signalling is used, either SSMF4 or SSMF5 an EPS3J circuit should be chosen to give the required response to MF signals. Either a physical audio circuit or a circuit including an HF section (fdm or pcm) is suitable. There is no limit on line length.

Outline Operation

Idle

In the idle state, the PBXs at each end of the inter-PBX circuit applies an *idle signal* to indicate they are free to accept incoming calls. This takes the form of a continuous low level (– 20 dBmO) 2280 Hz tone in both directions of transmission. The power level for this continuous signal is chosen to conform to the transmission loading requirements of British Telecommunications HF line plant and CCITT Recommendations Q15.

Seize

When the inter-PBX circuit is selected by the PBX for an outgoing call, the PBX applies a seizing signal to the signalling path. The seizure signal is the removal of the 2280 Hz tone in the forward direction — Tone-Off. On recognition of the seizure signal the PBX at the incoming end busies the circuit against outgoing calls and prepares to receive information. A transmission path is established between the incoming and outgoing ends to provide for Mf inter-Register Signalling. At the same time the caller is prevented from hearing the 2280 Hz signalling tone which is returned from the distant end until a seizing acknowledgement or proceed-to-send signal is received.

Holding

The continued receipt of the seizing signal — Tone-Off — is accepted by the incoming PBX as a hold signal.

Seizing Acknowledgement or Proceed-to-Send

Depending on the capacity of the incoming PBX, recognition of the Seizing Signal will initiate either a Seizing Acknowledgement or a Proceed-to-Send procedure. As the Seizing Acknowledgement and Proceed-to-Send signals are electrically identical the meaning of the signal must be mutually agreed between the parties involved.

Seizing Acknowledgement

When the incoming PBX recognises the Seizing Signal it returns a Seizing Acknowledgement signal — Tone-Off in the backward direction. The sending of this signal does not imply that the incoming PBX is ready to receive address information. Provision is made by the outgoing PBX to introduce a pre-sending pause as necessary.

Proceed to Send

When the incoming PBX recognises the Seizing signal it maintains the idle signal until it is ready to receive address information, it then applies a Proceed-to-Send signal — Tone-Off in the backward direction.

Transfer of Address Information

Address information is sent as digit signals which are either applied as 10 pps pulses or as multifrequency signals, CEPT System L1 MFPB (SSMF4) or CEPT System MFC (SSMF5).

Answer (Optional)

Where the facility is provided and when the called party answers the incoming PBX sends an Answer signal on the signalling path. A pulse of tone-on of 45-135 ms duration. This pulse of tone is sent at high level (−10 dBmO) to ensure proper operation in the presence of line noise.

Some PBXs do not use the answer signal. Others require it for correct operation. Where the answer signal is required by the outgoing PBX but the incoming PBX is unable to provide it, the signal must be artificially generated at the outgoing PBX. However the signal may be generated at the incoming PBX by arrangement between the parties involved. It can be assumed that all BT provided and/or maintained PBXs require an answer signal, either from the distant end or generated locally.

A genuine answer-signal will be necessary where calls are established end-to-end using multifrequency inter-register signalling (SSMF5).

Clear Down

On clear down, each PBX applies the appropriate clear signal to the signalling path. The incoming PBX applies a clear back signal, tone-on in the backward direction, and the outgoing PBX applies a clear forward signal, tone-on in the forward direction. The initial portion of each tone-on signal is sent at high level (– 10 dBmO) to ensure proper operation in the presence of noise, and then reverts to low level (– 20 dBmO) for the idle state. Each PBX bars access to the inter-PBX circuit until both clear forward and clear back signals have been exchanged.

Clear Back Prior to Answer

An electrical signal identical to Clear-Back may be received prior to the Answer Signal to indicate either:-

- Completion of a time-out in the incoming PBX.
- That the called extension is engaged or conjestion has been encountered.

Some PBXs will return Busy Tone to the caller on receipt of this signal.

The procedure is not provided where calls are established end to end by multifrequency inter-register signalling (SSMF5).

Time-Out on Non-Receipt of Address Information

When address information is not received after receipt of a SEIZING SIGNAL the PABX shall time-out and disassociate the inter-PBX circuit from any common equipment. Under these conditions the PABX shall:-

- Apply a CLEAR BACK SIGNAL
- Bar access to the inter-PABX circuit for outgoing calls until a CLEAR FORWARD SIGNAL is received.

NOTE: Clear-back on non-receipt of address information is inhibited when the incoming PBX is a PMBX. In some cases a clear back signal is sent if no answer is received from the PMBX console within a time-out period.

Forward and backward Recall Signals (Optional)

These signals are used to re-associate mf signalling equipment when a PBX wishes to cause another PBX to prepare to receive further address or facility information.

Forward Service Request Call

The Forward recall signal is sent by the originating PBX to re-associate common equipment at the destination PBX. The recall signal is a pulse of tone-on of 45-135 ms duration sent at high level (– 10 dBmO) to ensure proper operation in the presence of noise.

Backward Service Request Call

The backward recall signal is sent by the destination PBX to re-associate common equipment at the originating PBX. The recall signal is a pulse of tone-on of 45-135 ms duration sent at high level (– 10 dBmO) to ensure proper operation in the presence of noise.

Forward Link Recall

The Forward Link Recall signal is sent to recall common equipment in an adjacent transit PBX. The recall signal is a double pulse of tone-on, 45-135 ms on, 30-70 ms off, 45-135 ms on, sent in the forward direction at high level (– 10 dBmO).

Backward Link Recall

The Backward Link Recall signal is sent to recall common equipment in an adjacent transit PBX. The recall signal is a double pulse of tone-on, 45-135 ms on, 30-70 ms off, 45-135 ms on, sent in the backward direction at high level (– 10 dBmO).

Signalling Code SSAC15-D

The signalling code for SSAC15-D is shown in Table 5. The signal sending durations are continuous unless otherwise specified. Only signals with durations given in the table are sent to line.

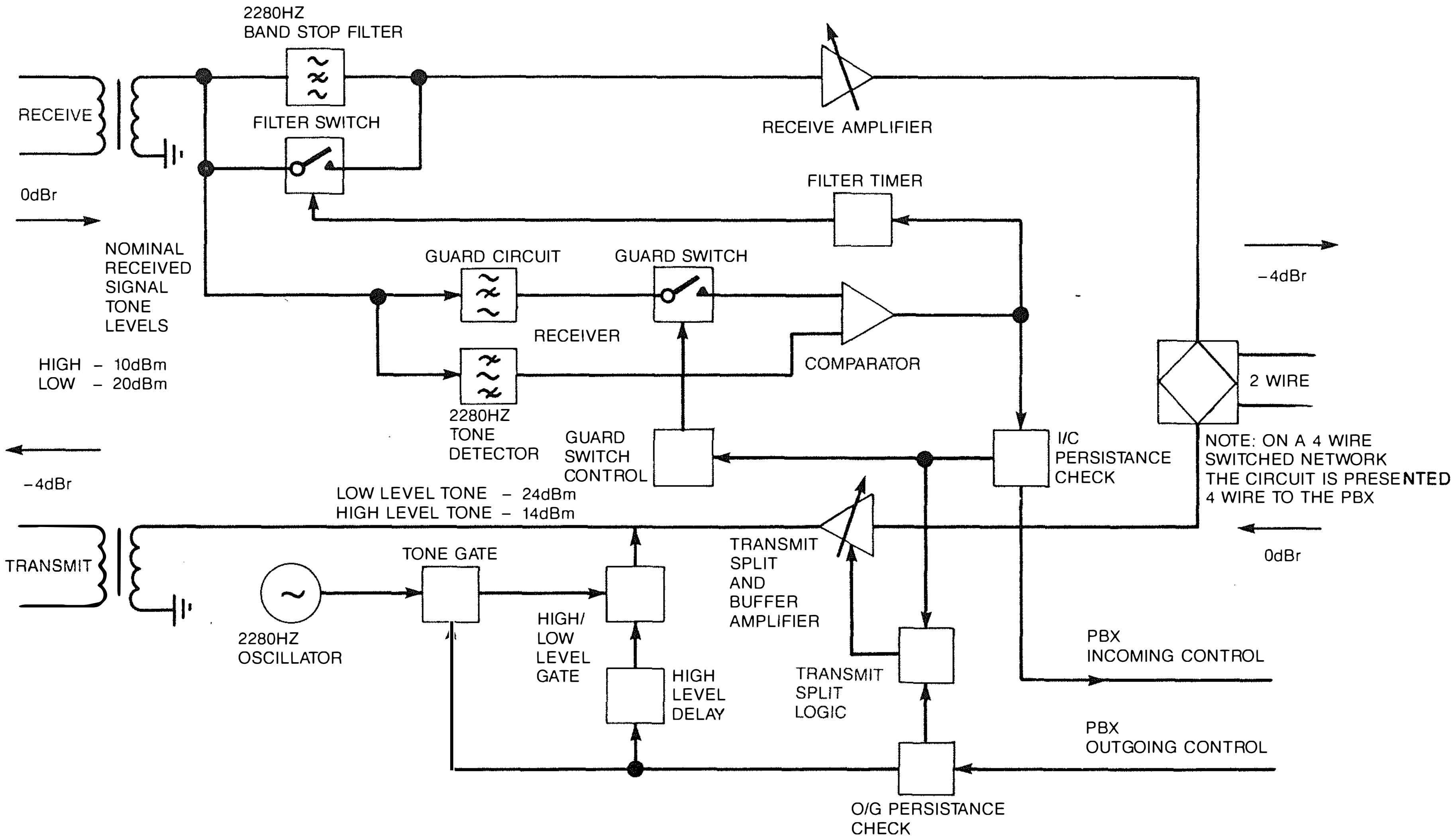
Table 5 follows

Table 5

Signal	Outgoing PBX	Incoming PBX
Idle	Tone-On	Tone-On
Seizing	Tone-Off	—
Forward Hold	Tone-Off	—
Seizing Acknowledge-ment or Proceed-to-Send	—	Tone-Off
Digit Signals 1-0	Tone-On pulses corresponding to digit signal sent	—
Answer (Optional)	—	Signal Tone-On Pulse for 45-135 ms
Backward Hold	—	Tone-Off
Clear Forward	Tone-On	—
Clear Back	—	Tone-On
Forward Service Request Recall (Optional)	Single Tone-On Pulse for 45-135 ms	—
Backward Service Request Recall (Optional)	—	Single Tone-On Pulse for 45-135 ms
Forward Link Recall (Optional)	Double Tone-On Pulse for 45-135 ms on, 30-70 ms off, 45-135 ms on	—
Backward Link Recall (Optional)	—	Double Tone-On Pulse for 45-135 ms on, 30-70 ms off, 45-135 ms on

NOTE: High level Tone-On is sent for the duration of the signal or for a mimimum of 300 ms (whichever is shorter) and for a maximum of 550 ms after which it is reduced to low level.

Fig. 6 follows



MCS668

Fig. 6 SSAC15-A, SSAC15-B, SSAC15-D Typical PBX Interface

12.6.4 SSAC15 System Features

The techniques for detecting and sending signals are similar for all the inter-PBX versions of SSAC15, ie SSAC15-A. SSAC15-B and SSAC15-D. A typical PBX SSAC15 line interface arrangement is shown in Fig. 6.

2280 Hz Receiver

2280 Hz signal tone detected on the Receive path is accepted by the Receiver if it is within the frequency range 2280 Hz ± 15 Hz and is rejected if it is outside the frequency range2280 Hz ± 75 Hz. The sensitivity of the Receiver is such that incoming signal levels between −3 dBm and −29 dBm are accepted and a signal level of −39 dBm or below is rejected.

Assuming an EPS3G circuit ie with a 4 dB gain at 800 Hz, the nominal received levels are −10 dBm, with high level tone sent at −14 dBm (−10 dBmO) and −20 dBm, with low level tones sent at −24 dBm (−20 dBmO). The extended acceptance range of the Receiver takes account of the frequency/attenuation response of the line at 2280 Hz.

The Receiver has two modes of operation:

Guarded Mode

On the receipt of the first 225 ms (approx) of signal frequency the Receiver will accept only a narrow band of frequencies and the guard circuit is operative. The signal frequency is compared with all other frequencies that are present. A signal frequency is accepted only if the power level at 2280 Hz exceeds the power level at accompanying guard frequencies by an amount shown in Table 6.

Accompanying Frequency (Hz)	500	750	1000	1250	1500	1750	2000	3000
Total power level of signalling tone (2280 Hz ± 75) above accompanying frequencies (dB)	7	10	12	12	12	11	7	9

The guard ratio is chosen to meet two requirements. These are:-

- Speech and impulsive noise frequencies containing a 2280 Hz component will not give a false signal indication.
- A genuine 2280 Hz signal is not prevented from being recognised by normally accpetable levels of background noise. Typically the acceptance band of the receiver in the narrow band state is 2280 Hz ± 45 Hz.

Unguarded Mode

Should the Tone-On signal persist for longer than 225 ms (approx) the receiver will switch to the unguarded mode. In this condition the guard circuit is inhibited and the effective band width of the receiver is increased to 2280 Hz ± 1000 Hz approximately. The guard circuit is removed so that the receiver can hold to low level tone accompanied by normal background noise or supervisory signals, eg: Ring Tone, NUT etc. The increased bandwidth gives a measure of protection against short term line disconnections.

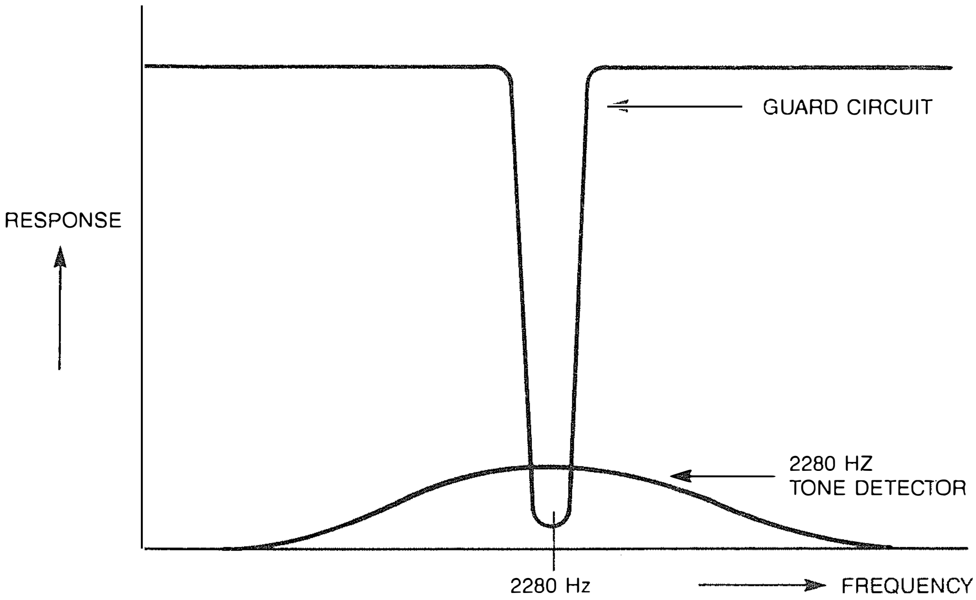


Fig. 7 Frequency Response of SSAC15 Receiver

Incoming Signal Persistence Checks

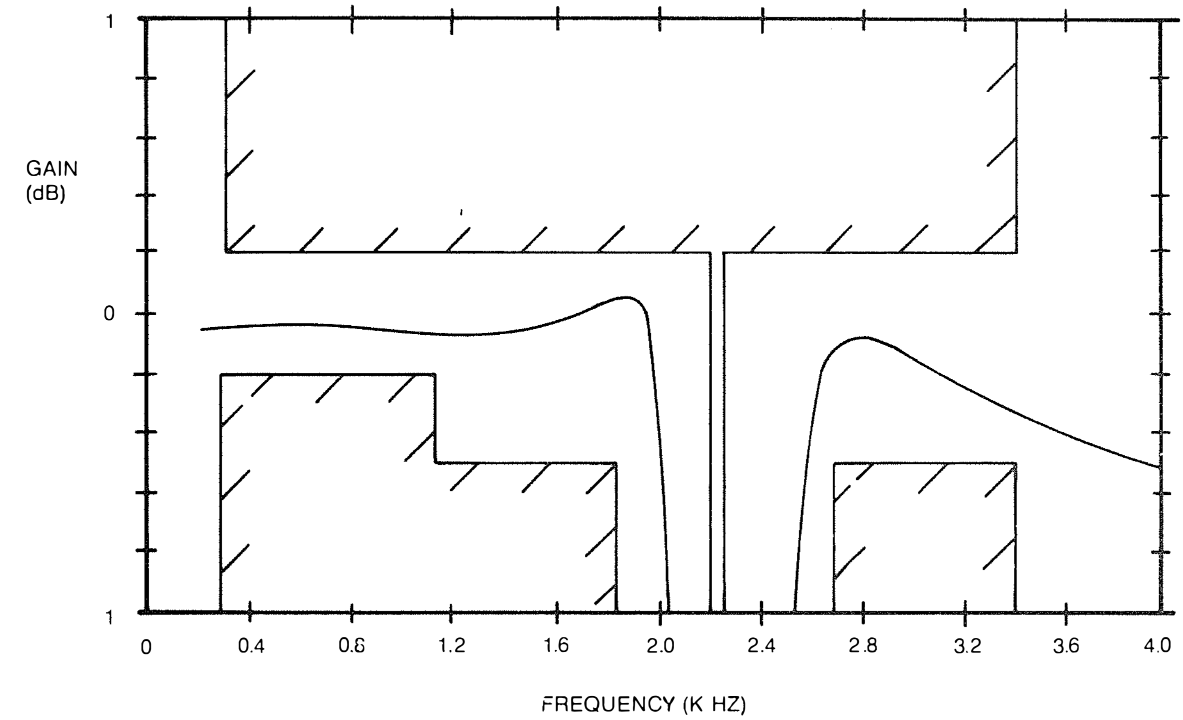
All incoming tone-off and tone-on signals from line are subject to persistence checks. This is to guard against false signal simulation due to short line disconnections and signal tone spill over. All tone-on signals are subject to a recognition time of approximately 30 ms. Tone-off signals are subject to a recognition time of approximately 40 ms if the previous tone-on condition persists for 300 ms or longer. If the previous tone-on condition is shorter than 300 ms the tone-off persistence check is 10 ms. This is to allow for the recognition of the full range of valid 10 pps make pulses.

Receiver Path Split

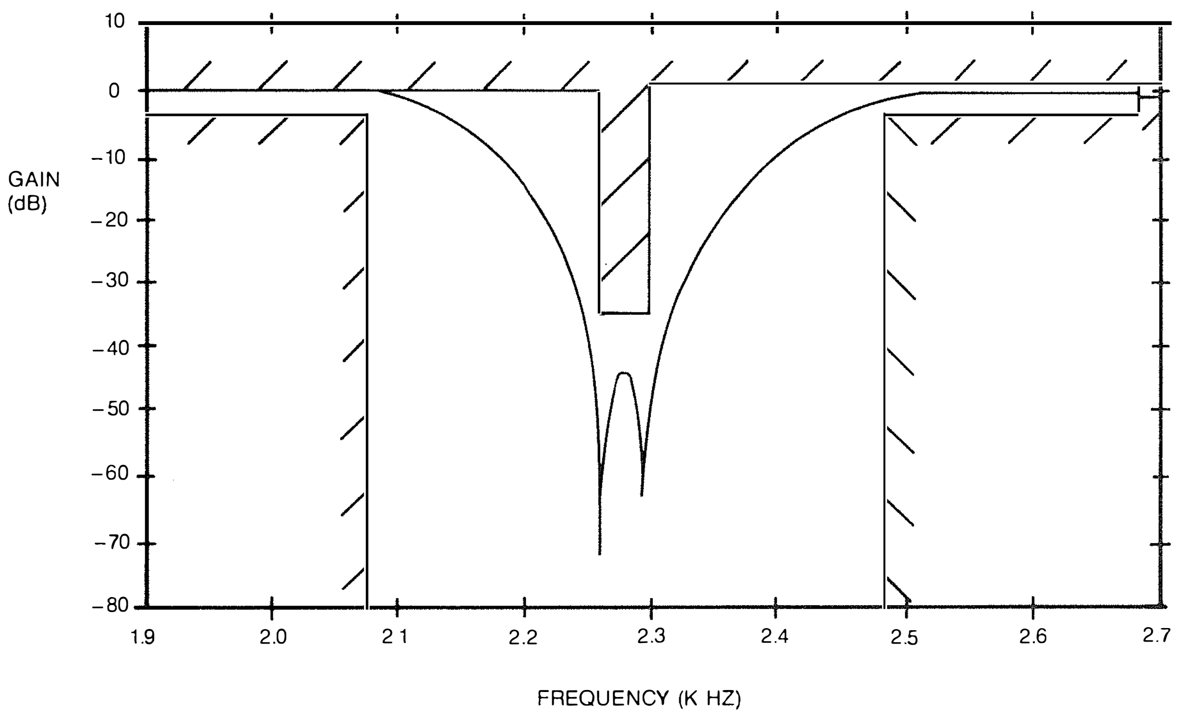
During the process of a call the calling party must be prevented from hearing 2280 Hz signal tone from the distant end. Also spill over of signal tone into preceding links must be avoided or at least limited to a few milli-seconds. This is arranged by ensuring that all the time 2280 Hz signal tone is being received, the receive path is split from the calling end. In the case of SSAC15-A, 2280 Hz tone is received until the called party answers, but whilst waiting for an answer the calling party must be able to hear supervisory tones eg Ring tone, Engaged tone, etc. This is achieved by inserting a 2280 Hz Band Stop filter in the receive path as shown in Fig. 6. This filter is activated all the time 2280 Hz signal tone is present. It operates over a narrow band of frequencies, 2280 Hz ± 15 Hz, and so does not interfere significantly with the reception of supervisory tones and conjestion announcements, whilst at the same time preventing the caller hearing the signal tone.

A typical response curve of a SSAC15-A Receive path band stop filter is shown in Fig. 8.

a) PASSBAND RESPONSE



b) STOPBAND RESPONSE



NOTE: PLOT SHOWS TYPICAL VALUE. THE SHADED AREA SHOWS FILTER ATTENUATION LIMITS.

Fig 8 SSAC15-A Receive Path 2280 Hz Band Stop Filter Response

Sender 2280 Hz Oscillator and Tone Gate

The 2280 Hz oscillator transmits signal tone to line within the frequency limits 2280 Hz ± 5 Hz. In the idle state signal tone is transmitted at low level −24 dBm (−20 dBmO at a −4 dBr point in the transmission path). When the circuit is seized or when sending 10 pps make pulses, the tone gate is turned off and signal tone is prevented from being sent to line (tone-off condition). When an outgoing clear signal or a pulsed signal eg 10 pps break pulse, is to be transmitted the tone gate is turned on and signal tone is sent to line. This tone is sent at high level −14 dBm (−10 dBmO at a −4 dBr point in the transmission path) for a period of 300-550 ms or for the duration of the pulse, whichever is shorter, and then reverts to low level tone, −24 dBm. These tone levels are chosen to conform to the short term and long term transmission loading requirements of British Telecoms HF line plant and CCITT Recommendation Q15. The initial portion of each tone-on signal, and the whole of a pulsed signal is sent at high level to ensure that the signals are received and recognised by the distant Signal Receiver in the face of normally acceptable levels of line noise, both random and impulsive.

Transmit Path Isolation

It is necessary to protect line signals from mutilation by the effects of near end switching transients. It is therefore arranged that the transmit path is split in such a way that the tone-on and tone-off signals are isolated from the PBX during critical times in the signalling process.

Idle Condition

The transmit path remains split in both directions during the idle state.

Outgoing Seizure

The transmit path remains split until 75-160 ms after tone-off has been sent.

Outgoing 10 pps Pulsing

The transmit path is split just prior to the first tone-on pulse and remains split until 75-160 ms after the last tone-on has been sent.

Incoming Seizure

The transmit path remains split until 350-750 ms after receipt of tone-off.

Outgoing Answer

The transmit path is split just prior to the tone-off being sent and remains split for 75-160 ms.

Outgoing Clear

The transmit path is split just prior to the tone-on signal being sent and remains split for 350-750 ms

Incoming Clear following Outgoing Clear

The transmit path is split within 250 ms of the receipt of tone-on and remains split during the idle state.

12.7 Signalling System AC13 (SSAC13)

System Description

SSAC13 is an automatic IVF signalling system for the link by link transmission of supervisory signals and 10 pps pulses between PBXs. It uses a single frequency of 2280 Hz in each direction of the transmission path. The system is designed essentially to be inserted in the 2-wire section of the transmission path, signals cannot therefore be passed simultaneously in both directions. Discrimination between signals is effected by signal duration and the point at which the signal occurs in the progress of the call. Provision of SSAC13 in the 4-wire path is available on some PBXs, for example at a PCATX where 4-wire switching is provided.

Application

SSAC13 was the first UK inter-PBX signalling system to enable automatic signalling to be provided over HF line plant. Since 1979 SSAC13 has been largely superseded for new work by SSAC15-A and may be considered, to some extent, an obsolescent system. However under some circumstances it is still provided on certain types of installation:

- At existing BT Strowger PBXs where spare rack capacity exists for SSAC13 equipment, when the appropriate SSAC13 equipment is available from Stores and when SSAC13 equipment is available at the distant PBX.
- At new or existing BT non-Strowger PBXs where external factors preclude the use of SSAC15-A and an SSAC13 interface is available at the PBX. A typical external factor is a new PBX interworking with an existing PBX at which SSAC13 equipment is already installed.
- Between non-BT PBXs by mutual agreement between the parties concerned.

Transmission Requirements

SSAC13 was originally designed to operate over an EPS2A circuit, that is a circuit with a maximum nominal insertion loss of 10 dB at 800 Hz. The SSAC13 2280 Hz send level was adjusted to ensure that the received level was -23 dBm or higher (the maximum sensitivity of the SSAC13 Receiver is -26 dBm but an allowance must be made for the $\pm$ 3 dB variation of insertion loss with time). This has resulted in some circuits carrying higher signal levels than those recommended to conform to the loading requirements of BT HF line plant and CCITT Recommendation Q15. The position now is that all new circuits shall be provided to the following standards:

- 2-wire connected SSAC13 — Provide the circuit to EPS3G and provide appropriate LTF to convert 4-wire to 2-wire. The system is situated at the 0 dBr send point in the 2-wire path and the 2280 Hz send level is standardised at -10 dBmO (-10 dBm at a 0 dBr point). If the circuit is carrying Multifrequency signals, either SSMF4 or SSMF5 on EP3J should be provided to give the required response to mf signals.

- 4-wire connected SSAC13. The signalling system is situated at the 0 dBr point in the Receive path and the −4 dBr point in the Transmit path of an EPS3G circuit. The 2280 Hz send level is standardised at −10 dBmO (−14 dBm at a −4 dBr point). When multifrequency signalling is employed, either SSMF4 or SSMF5 an EPS3J circuit should be chosen to give the required response to mf signals.

Either a physical audio circuit or a circuit including an hf section (fdm or pcm) is suitable. There is no limit on line length.

SSAC13 on Older PBXs

For the older type of PBX, using SSAC13 equipment to BT Diagram SA 8299, or private manufacturer equivalent, a description of the system is contained in Ref 3 and the line up procedure for 2280 Hz signals is described in Ref 4.

Outline Operation

Idle

In the idle state the PBXs at either end of the circuit presents a continuous tone-off condition to line. In this state both PBXs are free to accept incoming calls.

Seize

When the inter-PBX circuit is selected by the PBX for an outgoing call the PBX applies a Seizing signal to the Signalling path. This is the application of a single pulse of 2280 Hz tone for a period of 57 ± 4 ms. On recognition of the seizure signal the PBX at the incoming end busies the circuit against outgoing calls and prepares to receive information. A transmission path is established between the incoming and outgoing ends.

Digit Pulses

10 pps pulses are transmitted as pulses of tone-on of 57 ± 4 ms duration signifying a dial break pulse.

Line Splitting awaiting an Answer Signal

At the incoming PBX, if the SSAC13 is connected in the 2-wire path, the receipt of a 10 pps pulse will result in the 2-wire path being *chopped*, that is disconnected for 35 ms every second. This is to ensure that the 2280 Hz Receiver is isolated from continuous tone eg NUT and near end noise for a short period to ensure response to a Clear forward signal. This transmission path 'chopping' is not required on a 4-wire connected SSAC13.

Answer

When the called party answers, the incoming PBX applies an Answer signal to line. A pulse of tone for 265 ± 65 ms. This answer signal is repeated until an Answer acknowledge signal is received from the outgoing PBX. The period between repeated answer signals is 275 ± 75 ms. This procedure is to ensure reliable operation of the system should an interfering signal inhibit the 2280 Hz Receiver during the first transmission of the Answer signal.

Answer Acknowledge

On recognition of an Answer signal the outgoing PBX will transmit an Answer Acknowledge signal, a pulse of tone for 57 ± 4 ms.

Clear Back

When the called party clears a Clear Back signal is sent from the incoming PBX, a pulse of tone for 265 ± 65 ms. This clear back signal is repeated until a Clear Back acknowledge signal is received from the outgoing PBX. The period between repeated Clear Back signals is 275 ± 75 ms. This procedure is to ensure reliable operation of the system should an interfering signal inhibit the 2280 Hz Receiver during the first transmission of the Clear Back signal. The PBX bars access to the inter-PBX circuit until a Clear Forward signal has been received and a Release Guard signal has been sent.

Clear Back Acknowledge

On recognition of a Clear Back signal the outgoing PBX will transmit a Clear Back acknowledge, a pulse of tone for 57 ± 4 ms.

Clear Forward

When the calling party clears a Clear Forward signal is sent from the outgoing PBX, a pulse of tone for 1200 ms minimum. The Clear Forward must be long enough to pass through the 35 ms *window* in the one second line 'chopping' sequence at the incoming end. The Clear Forward signal is repeated until a Clear Back or Release Guard signal is received from the incoming PBX. The period between repeated Clear Forward signals is 300-600 ms. This procedure is to ensure reliable operation of the system should an interfering signal inhibit the 2280 Hz Receiver during the first transmission of the Clear Forward signal. The outgoing PBX bars access to the inter-PBX circuit until a Clear Back signal has been received and a Release Guard signal has been recognised and has terminated.

Release Guard

When the incoming PBX has sent a Clear Back signal and has received a Clear Forward signal a Release Guard signal is transmitted, a pulse of tone for 650 ms minimum. Until this signal has been completed both incoming and outgoing PBXs bar access to the inter-PBX circuit. The Release Guard signal covers the period necessary for each PBX to clear the connexion.

Forward Operator Recall

An originating operator may recall the distant operator(s) on a link by link basis by momentary operation of the ring or recall key. This will result in a pulse of tone of 100-150 ms duration being transmitted to line. At the distant end the supervisory lamp on the operators' console will flash. This facility is not necessarily provided on modern PBXs which have the SSAC13 signalling capability. The operating manual or facility schedule for the PBX concerned should be consulted.

Backward Busy

When the PBX de-activates an SSAC13 circuit for any reason eg so that maintenance may be carried out on auxiliary equipment associated with the SSAC13 line interface, a continuous 2280 Hz tone is sent to line. When the SSAC13 circuit is re-activated the continuous tone is terminated.

At the distant PBX access to the inter-PBX circuit is barred whilst the continuous 2280 Hz tone is being received. The ability to send Backward Busy signal is not necessarily available on all modern PBXs which have the SSAC13 signalling capability. The operating manual or facility schedule for the PBX concerned should be consulted.

Transfer of Address Information

Address information is sent as digit signals which are either applied as 10 pps pulses of 57 ± 4 ms duration or as Multifrequency Code eg SSMF4 or SSMF5 basic code only.

Signalling Code SSAC13

Table 7

Signal	Duration (ms)
Seize	57 ± 4
Pulses	57 ± 4
Answer	265 ± 65
Answer Acknowledge	57 ± 4
Period between repeated answer signals	275 ± 75
Clear Back	265 ± 65
Clear back acknowledge	57 ± 4
Period between repeated clear back signals	275 ± 75
Clear Forward	1200 minimum
Period between repeated clear forward signals	300-600
Release guard	650 minimum
Forward operator recall	100-150
Backward busy	continuous

NOTE 1: All signals are transmitted to line at −10 dBmO.

NOTE 2: Supervisory tones are repeated until an acknowledgement is returned. This is to ensure reliable operation of the system should an interfering signal inhibit the 2280 Hz Receiver during the first transmission.

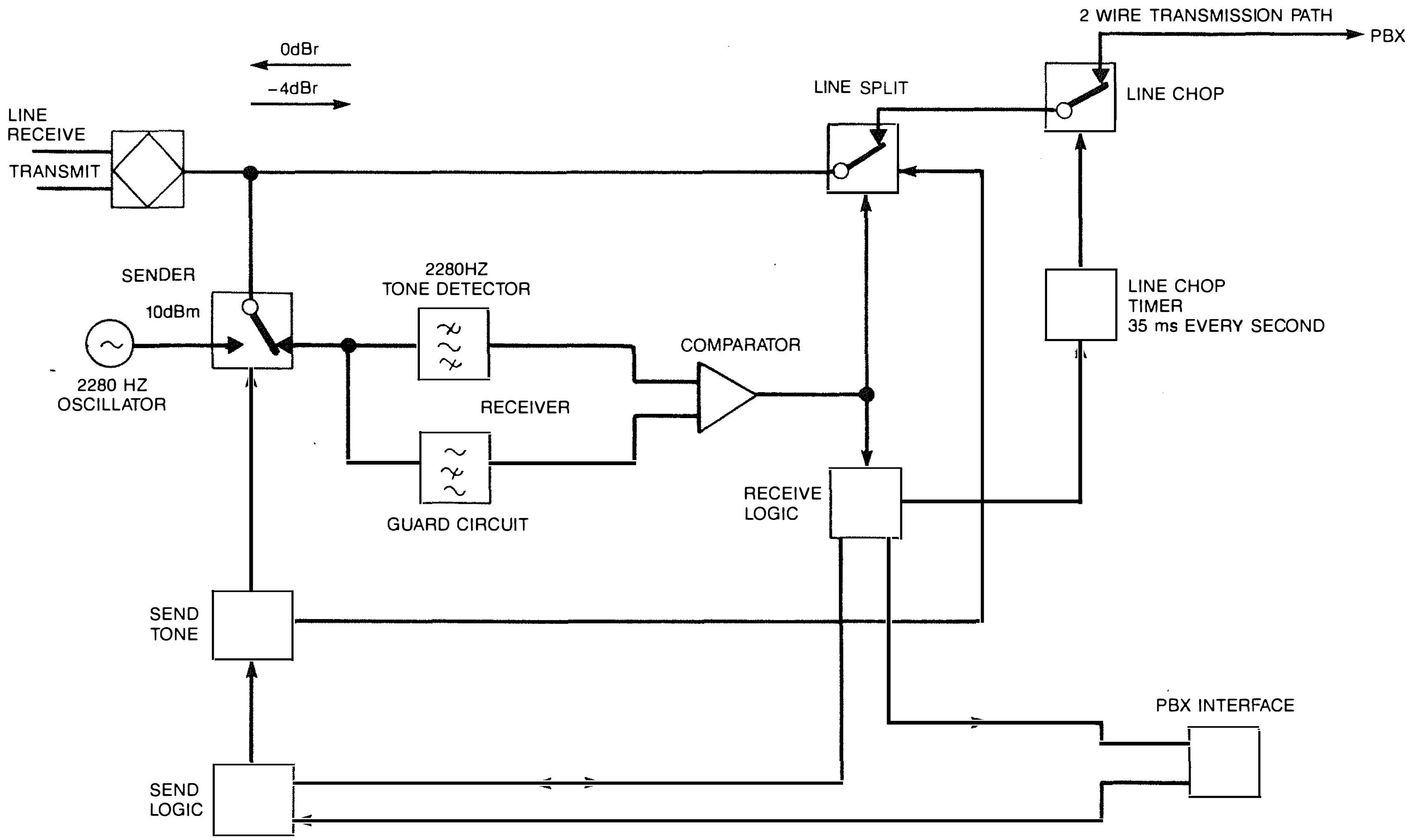


Fig. 9 SSAC13 Typical PBX 2 Wire Interface

SSAC13 System Features

A typical 2-wire SSAC13 line interface arrangement is shown in Fig. 9

2280 Hz Receiver

Two types of Receiver will be encountered in practice:

- Those Receivers associated with the older type of PBX using SSAC13 equipment to BT Diagram SA 8229, or private manufacturers equivalent.
- On some modern PBXs Receivers designed to meet the same general requirements as the SSAC15-A Receiver in its guarded mode.

Type 1 Older PBXs

2280 Hz signal tone detected on the 2-wire transmission path, if 2-wire connected and on the Receive path, if 4-wire connected, is accepted by the Receiver if it is within the frequency range 2280 Hz ± 25 Hz and is rejected if it is outside the frequency range 2280 Hz ± 75 Hz. The sensitivity of the Receiver is such that incoming signal levels between −3 dBm and −26 dBm are accepted, and a signal level of −33 dBm or below, is rejected.

Assuming an EPS3G circuit ie with a 4 dB gain at 800 Hz, the nominal received levels are −10 dBmO, that is −14 dBm at a −4 dBr point on the 2-wire path. The extended acceptance range of the Receiver takes account of the frequency/attenuation response of the line at 2280 Hz.

The Receiver is guarded against operation to spurious signals. The signal frequency is compared with all other frequencies that are present; a signal frequency is accepted only if the power level at
2280 Hz exceeds the power level at accompanying guard frequencies by an amount between 10 dB and 20 dB. The guard ratio is chosen to meet two requirements. These are that:

- Speech and impulsive noise frequencies containing a 2280 Hz component will not give a false signal indication.

and

- A genuine 2280 Hz signal is not prevented from being recognised by normally acceptable levels of background noise.

Type 2 Modern PBXs

2280 Hz signal tone detected on the 2-wire transmission path, if 2-wire connected and on the receive path, if 4-wire connected, is accepted by the Receiver if it is within the frequency range 2280 Hz ± 15 Hz and is rejected if it is outside the frequency range 2280 Hz ±75 Hz. The sensitivity of the Receiver is such that incoming signal levels between −3 dBm and −29 dBm are accepted and a signal levels between −39 dBm or below is rejected.

Assuming an EPS3G circuit ie with a 4 dB gain at 800 Hz, the nominal received levels are −10 dBmO, that is −14 dBm at a −4 dBr point of the 2-wire patch. The extended acceptance range of the Receiver takes account of the frequency/attenuation response of the line at 2280 Hz.

The Receiver is guarded against operation to spurious signals. The signal frequency is compared with all other frequencies that are present. A signal frequency is accepted only if the power level at 2280 Hz exceeds the power level of accompanying guard frequencies by an amount shown in Table 8.

Table 8

Accompanying Frequency (Hz)	500	750	1000	1250	1500	1750	2000	3000
Total power level of signalling tone (2280 Hz ± 75) above accompanying frequencies (dB)	7	10	12	12	12	11	7	9

The guard ratio is chosen to meet two requirements. These are that:

- Speech and impulsive noise frequencies containing a 2280 Hz component will not give a false signal indication, and
- A genuine 2280 Hz signal is not prevented from being recognised by normally acceptable levels of background noise.

Incoming Signal Persistence Check

All incoming 2280 Hz signals from line are subject to a persistence check to guard against false signal simulation due to tone spill over. This recognition time is in excess of 30 ms and less than 53 ms depending on the specific realisation. These times ensure that permitted spill over times of 30 ms are not recognised and genuine signals of 57 ± 4 ms are recognised.

Line Split

On 2-wire connected SSAC13 the 2-wire transmission path is split during both sending and receiving signals to prevent spill over, greater than 30 ms, into proceeding and succeeding links and also to prevent the signal being mutilated by near end noise. It also prevents the calling or called party hearing the signal tone. On 4-wire connected SSAC13 the transmit path is split when a signal tone is sent to prevent mutilation of the signal by near end noise. The Receive path is split on receipt of signal tone to prevent spill over into proceeding and succeeding links. It also prevents the calling and called party hearing signal tone.

Line Chopping Awaiting an Answer Signal

At the incoming PBX, if the SSAC13 is connected in the 2-wire path, the receipt of a 10 pps pulse will result in the 2-wire path being *chopped*, that is disconnected for 35 ms every second. This will ensure that the Receiver is isolated from continuous tone, eg NUT and near end noise, for a short period to allow a Clear Forward signal to be effective. When an Answer signal is received from the incoming PBX, the chopping ceases. This transmission path *chopping* is not required on a 4-wire connected SSAC13.

Sender 2280 Hz Oscillator

On older PBXs with SSAC13 equipment to BT Diagram SA 8299, or manufacturers equivalent, the signal tone is sent to line within the frequency limits of 2280 Hz ± 6 Hz. The Sender output level is normally set to − 10 dBm, but as the older SSAC13 circuits were often routed over EPS2A circuits, that is a circuit with a nominal maximum loss of 10 dB at 800 Hz, the sender output could be adjusted in 1 dB steps to ensure the received level at 2280 Hz was − 23 dBm or higher. A description of this system is contained in Ref 3 and the line up procedure for 2280 Hz signals is described in Ref 4. Because this arrangement could result in some circuits carrying higher signal levels than those recommended to conform to loading requirements for BT hf line plant and CCITT Recommendation Q15, the standard practice now is to provide SSAC13 on EP3G circuits, or better.

On modern PBXs the signal tone is transmitted to line within the frequency limits 2880 Hz ± 5 Hz and the sender output level is standardised at − 10 dBmO ie − 10 dBm at the 0 dBr point on a 2-wire circuit, and—14 dBm at the − 4 dBr point on the transmit path of a 4-wire circuit.

End of Section 12

Private Circuit Services Signalling Handbook

Section 13 — Signalling Systems for Fast Call Set Up and Integrated Services Networks

13.1 Digital Private Network Signalling System No. 1 (DPNSS1)

13.1.1 General Description

DPNSS1 is a common channel digital signalling system which provides fast call set up between PBXs and enables the supplementary facilities on individual PBXs in a network to be made available on a network wide basis. See Fig 1 and 2.

It provides error free data links between the Central Processing Unit (CPU) of Stored Program Control (SPC) interconnected PBXs as shown in Fig 3. Signals are sent on these links from one CPU to another to set up calls and request supplementary services. As the system employs common channel signalling and since the signalling channel is separated from the traffic channels, messages can be sent at any time without interference to speech or data.

The system is especially suitable for digital PBXs since transmission and signalling between PBXs over a digital inter-PBX link, requires no conversion.

DPNSS1 is described in British Telecoms Network Requirements BTNR188.

Interworking via a Gateway PBX with public network signalling systems or with other private network signalling systems is described in detail in British Telecoms Network Requirements BTNR189.

DPNSS1 is based on an interpretation of part of the International Organisation for Standards (ISO) Reference Model for Open Systems Interconnection (OSI). For DPNSS1 the ISO reference model is presented as shown in Fig 4. The system is considered on three levels.

Level 1 Physical Media for Interconnection

This is the transmission medium over which the DPNSS1 messages are carried. It is either:-

a. Channel 16 of a 30 channel pulse code modulation system (PCM) ie utilizing a 2048 kbit/s digital transmission system or

b. Where the traffic is too low to justify the use of a 2048 kbit/s digital link an alternative means of carrying DPNSS1 signalling may be employed. An additional private circuit, dedicated to signalling is provided to carry DPNSS1 in the form of either:-

- A 64 kbit/s digital circuit with rate adaption to 2400, 4800 or 9600 bit/s.
- An analogue 4-wire circuit terminated with modems operating at 2400, 4800 or 9600 bit/s.
- An analogue 2-wire circuit terminated with modems operating at 1200, 2400, 4800 or 9600 bit/s.

NOTE: The customer must specify the speed and modem type.

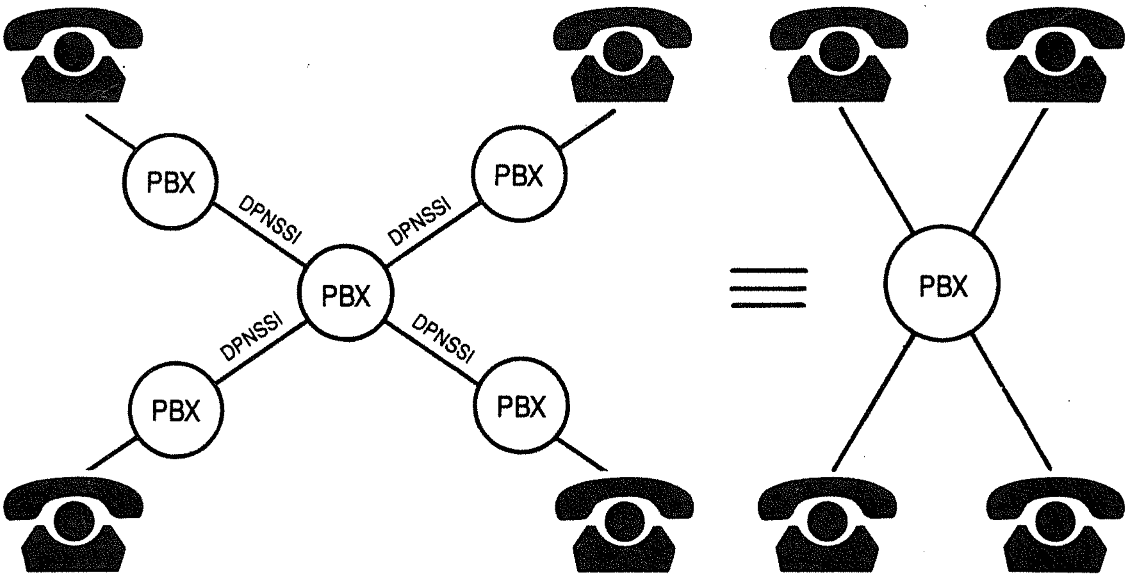


Fig 1 With DPNSS1 a Private Network with many PBXs can appear to the extension user as one PBX.

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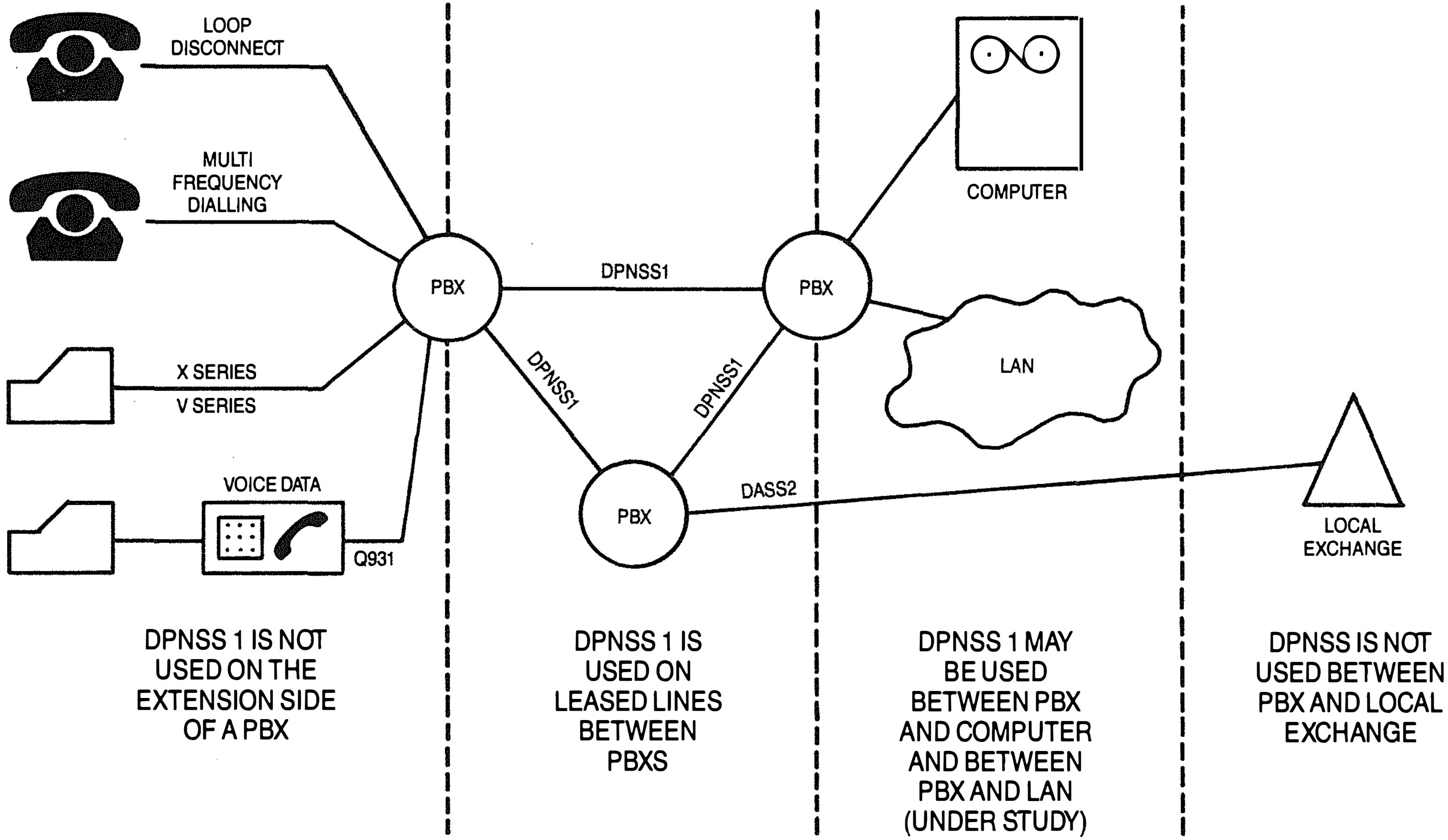
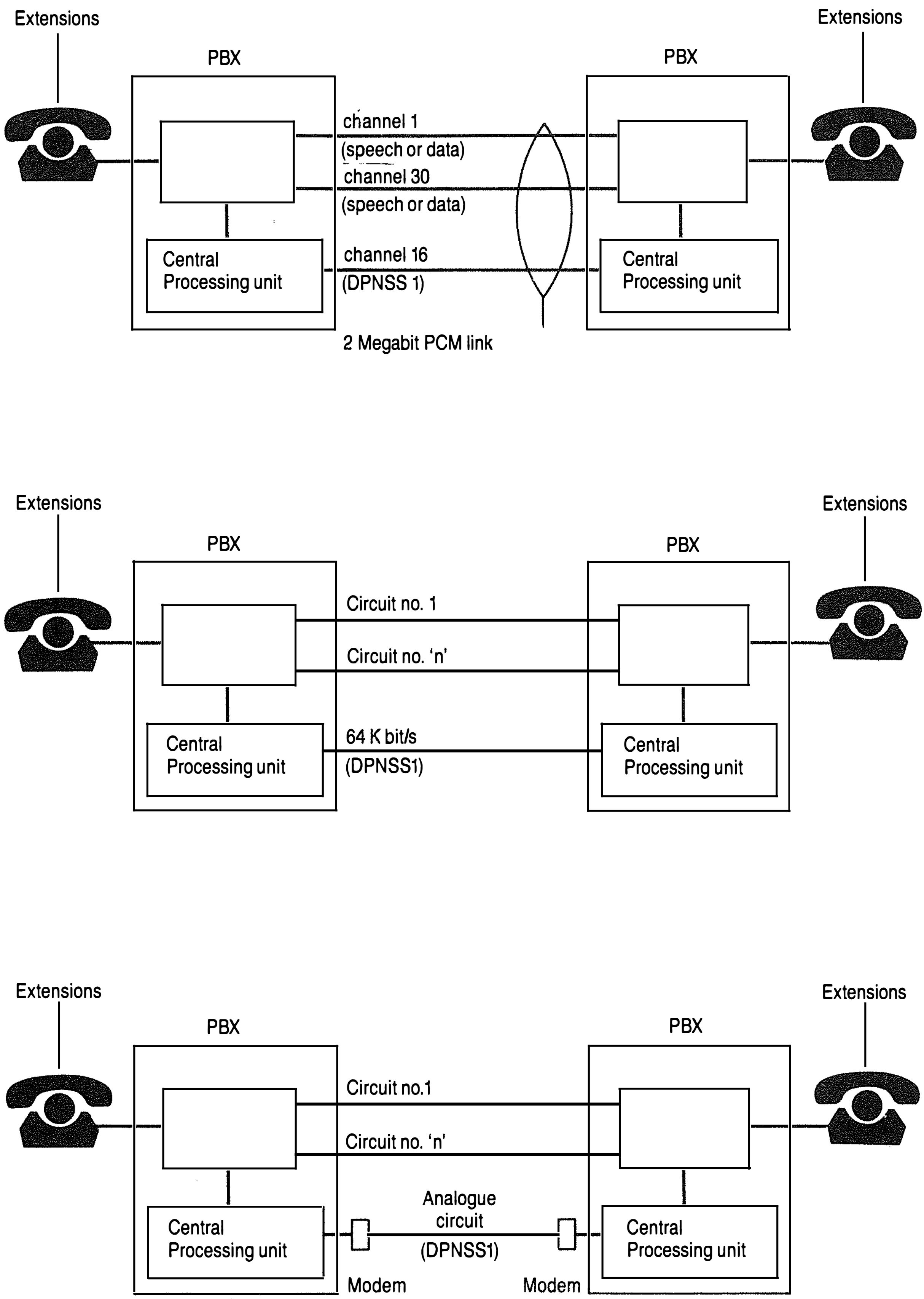


Fig 2 Where can DPNSS 1 be Used



Section 13 Fig 3 Three Methods of Realizing a DPNSS1 Link

Peer to Peer Protocol Inter Relation

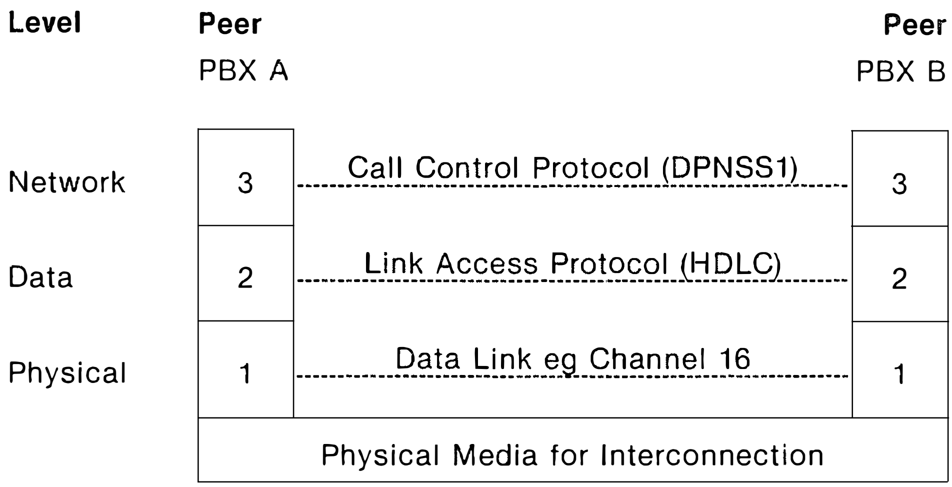


Fig 4 ISO Reference Model

Level 2 Link Access Protocol (LAP)

To ensure reliable error-free transfer of DPNSS1 messages between PBXs, they are carried along the signalling channel in accordance with the internationally recommended High Level Data Link Control (HDLC) protocol. Fig 5 shows an HDLC frame carrying a DPNSS1 message.

The DPNSS1 HDLC frame (level 2) follows the same pattern as used in the *Digital Access Signalling System No. 2 (DASS2).* This system is used to provide digital signalling between an Integrated Services PBX (ISPBX) and the Integrated Services Digital Network (ISDN).

The DPNSS1 signal is compelled at level 2 in that each frame is repeated until it is acknowledged by a responding frame in the opposite direction.

On a 2048 kbit/s transmission system each of the 30 traffic channels and up to 30 virtual channels (supplementary services messages not relating to a real traffic channel) are supported by discrete Link Access Protocols (LAPs). Frames from each LAP are interleaved on time slot 16.

On a transmission system that uses a common channel through a modem, a number of traffic and virtual channels are supported by discrete LAPs. Frames for each LAP are interleaved on the common channel.

The information in each section of the frame is assembled in a series of 8 bits called octets. Fig 6 shows a typical arrangement for a DPNSS1 message in the Information Field (level 3).

The first two octets of the frame, known as the address field, give the number of the traffic channel to which the message relates. This enables the receiving PBX to associate the message with the appropriate channel.

Some supplementary services use messages which are not related to real traffic channels. These are known as Virtual Calls and enable information to be passed between PBXs without wastefully using a traffic channel.

The third octet of the frame — the Control Field — indicates whether the frame contains a DPNSS1 message or perhaps an acknowledgement. The control field also carries a serial number to enable the loss of a frame to be detected. The receiving PBX acknowledges each frame which contains a message by returning its serial number to the sending PBX.

Frames are repeated until acknowledged.

The next 45 octets, known as the Information Field, contain the DPNSS1 message (level 3).

The last two octets of the frame contain a frame check sequence. The information in this field enables the receiving PBX to detect any corruptions to the frame that may have occurred during transmission. Frames containing errors are not acknowledged and will therefore be repeated.

Adjacent frames are separated by a unique 8 bit pattern, referred to as a Flag. When there are no messages, continuous flags are transmitted.

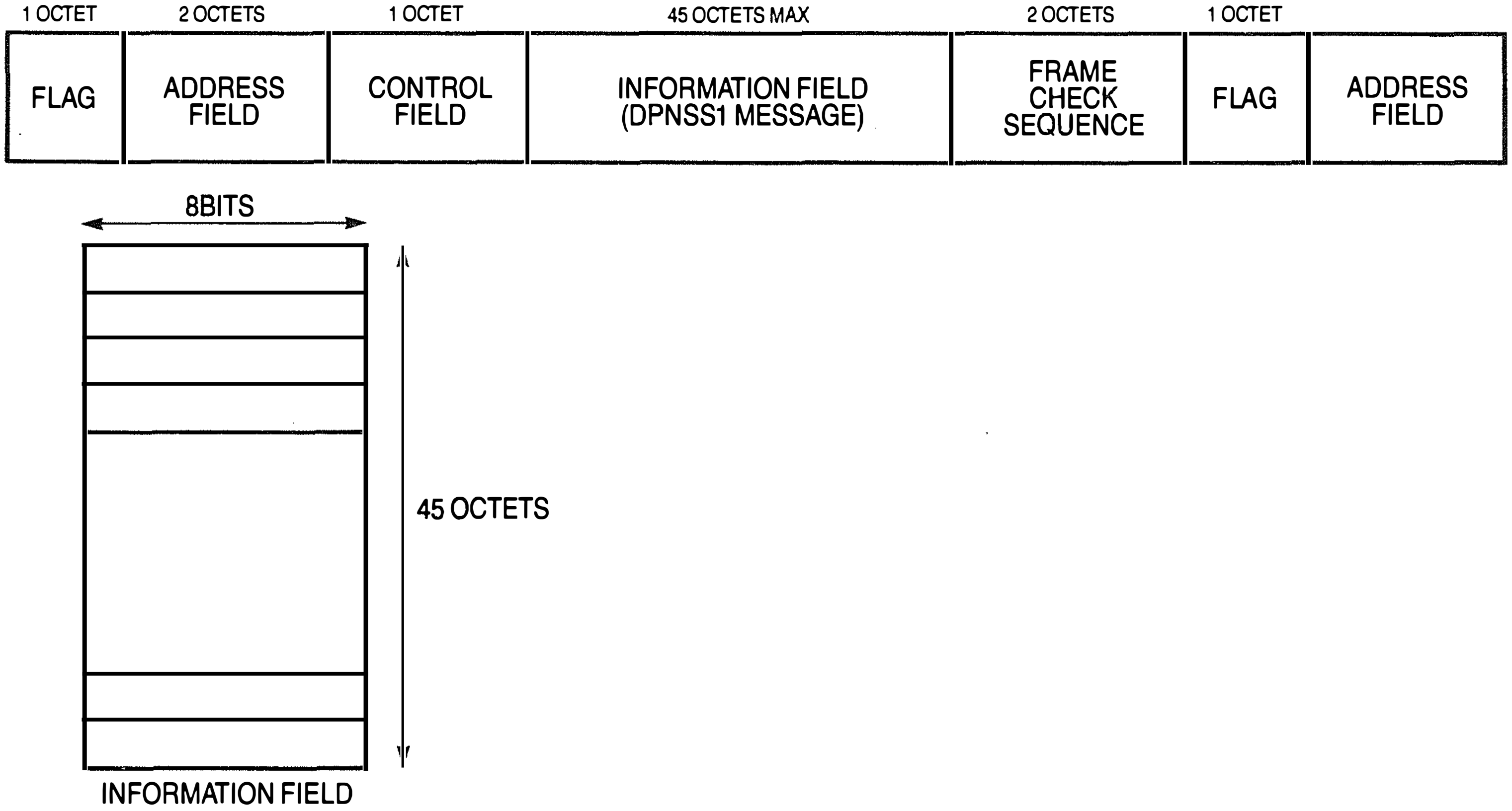


Fig 5 Transporting DPNSS1 Messages

DPNSS1 Message Format

45 OCTETS MAXIMUM
FIRST OCTET DEFINES TYPE OF MESSAGE
REMAINING OCTETS CONVEY INFORMATION FORMATTED AS DEFINED BY THE MESSAGE TYPE
EXAMPLE - INITIAL SERVICE REQUEST MESSAGE

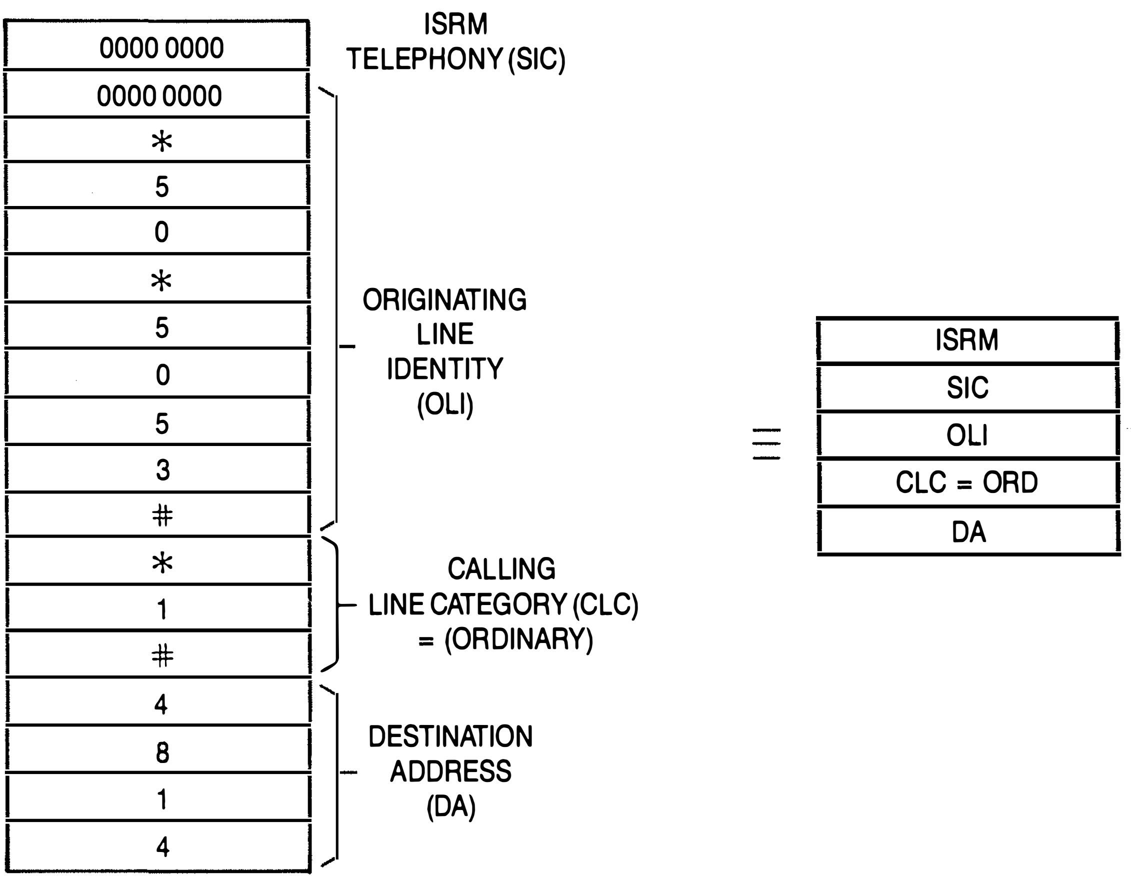


Fig 6 DPNSS1 Message Format Information Field

Level 3 Call Control Protocol (DPNSS1)

The DPNSS1 message is contained in the information field of the HDLC frame and can occupy up to 45 octets of information. Fig 6 shows an example.

A typical DPNSS1 message will contain all the necessary information to establish a call across a private network, plus the type of calling party, such as ordinary extension or operator, and telephone number. Supplementary service requests may also be included in the message in the form of supplementary information strings. Table 1 shows the 19 supplementary services specified in BTNR188. Some supplementary services involve dialogue between the PBXs.

Supplementary services are optional and a network may well contain PBXs of different capability. PBXs of lesser capability will receive information strings that are unrecognized. Some of these strings will be essential and if not understood will result in the receiving PBX sending an appropriate backward message. Some are unimportant and can be ignored. DPNSS1 includes procedures for handling unrecognized supplementary information strings. See Fig 7.

The provision of supplementary services is optional. If a service is provided the PBX shall comply with the BTNR requirements dependent on the function being performed by the PBX in the network eg End, transit etc.

The customer and the supplier must have a common view of what is required. BTNR documents contain compliance sheets to assist in specifying.

Table 1 Services Available with DPNSS1

DPNSS1 is published in British Telecoms Network Requirements No. 188 which currently (Issue 3) specifies a Simple Telephone Call plus the following supplementary services.

- Circuit Switched Data Call
- Swap Voice/Data
- Call Back When Free
- Executive Intrusion
- Diversion
- Hold
- Three Party
- Call Offer
- Call Waiting
- Bearer Service Selection
- Route Optimisation
- Extension Status
- Controlled Diversion
- Redirection
- Series Call
- Three Party Takeover
- Night Service
- Centralised Operator
- Non Specified Information

The Simple Telephone Call is a mandatory requirement of a PBX that supports DPNSS1; the supplementary services are optional however and the range provided is subject to agreement between a customer and his PBX supplier.

PBX facilities are constantly evolving and DPNSS1 has been designed for future growth. As the range of facilities offered by PBXs continues to grow so too will the list of DPNSS1 supplementary services. The following services are currently under study for inclusion in later issues of BTNR 188;

- Conference
- Priority Breakdown
- Call Back When Next Used
- Do Not Disturb
- Maintenance
- End-to-End Signalling via DASS 2
- PBX-LAN Interworking
- PBX-Computer Interworking
- Remote Registration of Diversion
- Operator Registration of Do Not Disturb
- ISO Network Services
- Loop Avoidance
- Forced Release
- Sub-Multiplexing
- Super Multiplexing

THERE ARE TWO ASPECTS

1 The role being performed by the PBX that receives the unrecognised string
ie END PBX (E)
TRANSIT PBX (T)
BRANCHING PBX (B)

2 The importance placed on the string by the PBX that sent it
ie IGNORE IF NOT UNDERSTOOD (1)
IGNORE BUT TELL ME IF NOT UNDERSTOOD (0)
STOP PROCESSING THE CALL IF NOT UNDERSTOOD (M)

THIS GIVES 27 COMBINATIONS
EACH COMBINATION IS ALLOCATED AN 1A 5 CHARACTER WHICH IS USED AS A SUFFIX OF THE STRING IDENTIFIER

*
3
9
F
*
1
2
3
*

SUPPLEMENTARY INFORMATION STRING DVG-R. DIVERTING ON NO-REPLY MAY BE IGNORED AT TRANSIT AND END PBXs BUT IS MANDATORY AT BRANCHING PBX.

Fig 7 Handling Unrecognised Supplementary Information Strings

13.1.2 Outline of Operation

DPNSS1 provides the signalling capability to establish simple telephony and data calls plus a wide range of supplementary services.

The range of supplementary services provided by a PBX is optional and depends upon customer requirements. PBXs of differing capabilities will be encountered and the procedures specified in BTNR 188 take this into account.

DPNSS1 is capable of interworking, via a gateway PBX, with the following signalling systems:

— Private Network

SSAC15-A	
SSDC5—A	Simple Call only
SSDC10-A	

SSMF5 — Supplementary Services to SSMF5 capability

— Public Network

Loop Disconnect	(PSTN)
DASS 2	(ISDN)

Interworking details are given in BTNR 189.

NOTE: The fact that a signalling system is not listed here does not imply that an interworking facility cannot be achieved with that signalling system.

Signals are conveyed between PBXs within addressed messages. DPNSS1 works on a link by link basis with each message being passed to the adjacent PBX, which either acts upon it or repeats it to the next PBX dependent upon the message type and content.

The message types, formats and contents are detailed in section 4 of BTNR 188.

A connection may be established between two PBXs for

- a simple telephony or data call
- a supplementary service
- passing supplementary information

The procedure for all of the above is essentially the same although with some supplementary services the connection may be for signalling only ie a virtual call.

A principle of DPNSS1 is to gain maximum utilisation of the inter-PBX channels by holding a connection for the shortest possible time. To this end simple calls encountering busy etc, and certain Supplementary Service requests are immediately released by a backward clearing message.

This message may contain the state of destination and if appropriate an acknowledgement signal to supplementary service signal and if necessary additional supplementary information.

Detailed signalling procedures are given in Section 5 and subsequent sections of BTNR 188. The following paragraphs give a brief outline of call establishment.

A call is initiated by the originating PBX sending a message containing the following to the adjacent PBX:

- Type of service required eg telephony or data.
- Data rate and adaption method if appropriate.
- Calling Line Category eg ordinary extension, operator PSTN etc.
- The Originating Line Identity if available. eg Extension number.
- Supplementary service request or information if appropriate.
- The required destination address.

On receipt of this message the responding PBX either:

- Routes the call to an extension within the PBX
- or routes the call to the next PBX and repeats the message, modified as necessary.

If the required outgoing route is not DPNSS1 the Gateway PBX must provide the conversion between the different signalling systems.

On receipt of the above message the terminating PBX will check the calling and called parties for compatibility and the state of the called terminal.

If the call is unacceptable or if the called party is busy etc, the connection will be released by the terminating PBX sending a backward clearing message.

This message will contain a signal indicating the reason for clearing.

If the incoming call can be accepted an acknowledgement message will be returned and the connection will be maintained awaiting further signalling.

The acknowledgement message will contain the following information:

- Called Line Category eg ordinary extension, PSTN encountered etc.
- The Called Line Identity if available.
- State of destination eg busy, free if known.
- Supplementary Service request or information if appropriate.

When the called terminal is answered the terminating PBX sends a call connected message (answer) which is repeated by each transit PBX, back to the originating PBX.

A recall message is provided to enable supplementary service requests that require a second call via the exisitng channel to be made during an established call.

This message may be used in either the forward or the backward direction.

In the forward direction the recall may be used both before and after answer.

An end-to-end message is provided to enable supplementary service signalling between the originating and terminating PBXs.

Intermediate transit PBXs repeat the message without acting upon it.

A link by link message is provided to enable supplementary signalling between adjacent PBXs.

At the end of the call the connection is released by an interchange of clearing messages. Clearing can be initiated from either end. The call is released on a link by link basis.

13.1.3 Glossary of Terms

Introduction

The purpose of this paragraph is to bring together, for reference purposes, all of the abbreviations and Mnemonics used in connection with DPNSS 1 signalling. Also included, for clarification purposes, are definitions of some terms, in order to remove any ambiguity in their interpretations.

ACK	Acknowledgement
AD	Add-on
—RQ	Request
—V	Validation
—O	Added-On
ADPCM	Adaptive Differential Pulse Code Modulation
AIS	Alarm Indication Signal
BEL	'Bell' IA5 character
BSS	Bearer Service Selection
BT	British Telecom
BTNR	British Telecom Network Requirement
BTR	British Telecom Requirement
CAN	'Cancel' IA5 character
CBC	Call Back Complete
CBWF	Call Back When Free
—R	Request
—FN	Free Notification
—CSUI	Call Set Up Immediate
—CSUD	Call Set Up Delayed
—C	Cancel Request
CCITT	The International Telegraph and Telephone Consultative Committee
CC	Clearing Cause
—AB	Access Barred
—ACK	Acknowledgement
—AI	Address Incomplete
—BY	Busy
—CNR	DTE Controlled Not Ready
—CON	Congestion
—CT	Call Termination
—FNR	Facility Not Registered
—ICB	Incoming Calls Barred
—INC	Service Incompatible
—MNU	Message Not Understood
—NT	Network Termination
—NU	Number Unobtainable
—REJ	Reject
—SI	Subscriber Incompatible
—SNU	Signal Not Understood
—SOS	Subscriber Out of Service
—SNV	Signal Not Valid
—STU	Service Temporarily Unavailable
—SU	Service Unavailable
—TRFD	Service Unavailable
—UNR	Transferred
CCM	DTE Uncontrolled Not Ready
CDIV	Call Connected Message
CEPT	Controlled Diversion
	European Conference of Postal and Telecommunications Administrations.

CIM	Clear Indication Message
CLC	Calling/Called Line Category
—ORD	Ordinary extension
—DEC	10 pps (Decadic)
—MF5	Signalling System Multifrequency No. 5
—PSTN	Public Switched Telephone Network
—OP	Operator
—NET	Network
CLI	Called Line Identity (Network Identity)
CO	Call Offer
COC	Connected Call
COS	Class of Service
CRM	Clear Request Message
CUG	Closed User Group
CW	Call Waiting
D+AR	Data Rate and Adaption Method
DA	Destination Address
DASS	Digital Access Signalling System
DC(1->4)	'Device Control' IA5 Character
DDI	Direct Dialling In
DEL	'Delete' IA5 Character
DIV	Diversion
—BY	Bypass
—V	Validation
—FM	Follow Me
—CI	Cancellation Immediate
—CR	Cancellation on Ring Tone No Reply
—CB	Cancellation on Busy
—CA	Cancellation All
DPNSS1	Digital Private Network Signalling System No. 1
DTE	Data Terminal Equipment
DVD	Diverted
—I	Immediate
—B	On Busy
—R	On Ring Tone No Reply
DVG	Diverting
—I	Immediate
—B	On Busy
—R	On Ring Tone No Reply
DVT	Divert
—I	Immediate
—B	On Busy
—R	On Ring Tone No Reply
ECMA	European Computer Manufacturers Association
EEM(C)	End to End Message (Complete)
EEM(I)	End to End Message (Incomplete)
EI	Executive Intrusion
—PVR	Prior Validation Request
—R	Request
—I	Intruded
EM	'End of Medium' IA5 Character
ENQ	Enquiry Call
ESC	'Escape' IA5 Character
ESRA	ECMA Standard for Rate Adaptation
EST	Extension Status Call
FE(0->5)	'Format Effectors' IA5 Characters

HDG	Holding
HDLC	High Level Data Link Control
Hold REQ	Hold Request
IA5	International Alphabet No. 5
ICL	Intrusion Capability Level
IG	Ignored
—SNU	Signal Not Understood
IPL	Intrusion Protection Level
—R	Request
IS(1->4)	'Information Separator' IA5 Character
ISDN	Integrated Services Digital Network
ISO	International Organisation for Standardisation
ISRM(C)	Initial Service Request Message (Complete)
ISRM(I)	Initial Service Request Message(Incomplete)
LAP	Link Access Protocol/Procedure
Link	A Transmission facility directly connecting two PBXs
LLM(C)	Link by Link Message (Complete)
LLM(I)	Link by Link Message (Incomplete)
LLRM	Link by Link Reject Message
LSB	Least Significant Bit
MF5	Signalling System Multifrequency Number 5
MSB	Most Significant Bit
MSD	Message Sequence Diagram
NAM	Number Acknowledge Message
NIM	Network Indication Messaage
NS	Night Service
—DA	Deactivated
—DVD	Diverted
—DVG	Diverting
—DVT	Divert
—N	Notification
—RDVD	Rediverted
—RDVG	Rediverting
—RDVT	Redivert
NSI	Non Specified Information
NUL	'Null' IA5 Character
OLI	Originating Line Identity
OSI	Open System Interconnection
Path	A Series of Channels used by a Call
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
PSTN	Public Switched Telephone Network
RA	Rate Adaption
RC	Rejection Cause (For Rejection Cause Qualifier. See Clearing Cause)
RCF	Redirecting on Call Failure
RDG	Redirecting
RECON	Reconnected
REJ	Rejected
RM(C)	Recall Message (Complete)
RM(I)	Recall Message (Incomplete)
RO	Ring Out
ROP	Route Optimisation
—CON	Connection
—CSU	Call Set Up
—R	Request

RR	Recall
—SNU	—Signal Not Understood
RRM	Recall Rejection Message
RTI	Routing Information
SABMR	Set Asynchronous Balanced Mode Restricted
SCE	Single Channel Enquiry
SCIM	Single Channel Clear Indication Message
SCRM	Single Channel Clear Request Message
SDL	Functional Specification and Description Language
SER	Series Call
—C	Cancellation
—E	Established
—R	Request
SF2	CEPT Services and Facilities Handbook Section III PABX
SHTL	Shuttle
SI	Signal Invalid
SIC	Service Indicator Code
SIM-A	Simulated Answer
SM	Swap Message
SNU	Signal Not Understood
SO	'Shift Out' IA5 Character
SOD	State of Destination
—B	Busy
—F	Free
SP	'Space' IA5 Character
SPL	Split
SPM	Subscribers Private Meter
SSRM(C)	Subsequent Services Request Message (Complete)
SSRM(I)	Subsequent Service Request Message (Incomplete)
SU	Service Unavailable
SUB	'Substitute Character' IA5 Character
Supplementary Information	— Contains all relevant information necessary to be communicated from one PBX to another on a call.
Supplementary Service	— used to provide facilities and/or information above that of a Simple Call
SW-R	Swap — Rejected
SW-V	Swap — Validation
TA	Terminal Adapter
TC(1->10)	'Transmission Control' IA5 Character
TOV	Three-party Takeover
—R	Request
—V	Validation
TRFD	Transferred
TWP	Two Party
UA	Unnumbered Acknowledgement
UDC	User Data Control
UI(C)	Unnumbered Information (Command)
UI(R)	Unnumbered Information (Response)
Virtual Call	A call using a signalling channel with no associated traffic channel.

13.1.4 DPNSS1 Messages

DPNSS Messages are exchanged on a link-by-link basis in the network. A Message from an originating PBX will always be sent to an adjacent PBX for action or forwarding, as appropriate. Whether the receiving PBX acts on, or forwards the Message to one of its adjacent PBXs depends on the type and contents of the Message.

A single Message may contain several information packets, each uniquely defined. An information packet comprises several Information Fields within a Message.

Normally signalling information is exchanged on behalf of *real* calls (ie calls using traffic channels). Signalling information is also exchanged when certain supplementary services, such as call back when free, are used. When signalling information is exchanged, without involving a traffic channel, the exchange is called a *virtual call*.

Table 2 lists the DPNSS Messages and gives their uses.

Table 2 DPNSS Messages and Their Uses

Abbreviation	Name	Use
ISRM(C)	Initial Service Request Message (Complete)	Used to establish a new real or virtual call. It defines at least the call type and destination address. It may also contain such things as calling line identity.
ISRM(I)	Initial Service Request Message (Incomplete)	Used instead of ISRM(C) when: ● ISRM(C) does not contain all the information required. ● The information is not available at the time ISRM(C) is sent.
RM(C)	Recall Message (Complete)	May be used to establish a second call via the same traffic channel an existing real or virtual call is using.
RM(I)	Recall Message (Incomplete)	Used instead of RM(C) when RM(C) does not contain all the information required.
SSRM(C)	Subsequent Service Request Message (Complete)	Used to: ● Send additional information not included in a preceding ISRM(I), or SSRM(I). ● Indicate the end of selection.

Table 2 DPNSS Messages and Their Uses (Cont'd)

Abbreviation	Name	Use
SSRM(I)	Subsequent Service Request (Incomplete)	Used to send additional selection information not included in a preceding ISRM(I), or SSRM(I).
NAM	Number Acknowledge Message	Used to indicate: ● Successful establishment on simple calls. ● All digits have been received in certain interworking situations.
CCM	Call Connected Message	Indicates to the originating PBX that the call has been connected. (Answered)
CRM	Clear Request Message	Initiates a clearing sequence, with the reason for clearing (eg busy).
CIM	Clear Indication	Used to acknowledge CRM.
RRM	Recall Rejection Message	Used to indicate the failure of a recall request.
SM	Swap Message	Used on transit call only, to request a change from the current service mode to a new mode eg from voice mode to data mode, or vice-versa.
EEM(C)	End-to-End Message (Complete)	Used to: ● Carry information betwen originating, terminating and branching PBXs after completion of the routing phase. Such information can be sent in either direction — forward or backward. ● Indicate completion of an end-to-end sequence which started with EEM(I).

Table 2 DPNSS Messages and Their Uses (Cont'd)

Abbreviation	Name	Use
EEM(I)	End-to-End Message (Incomplete)	Used instead of EEM(I) when EEM(C) does not contain all the information required.
LLM(C)	Link-by-Link Message (Complete)	Used only after completion of the routing phase to: • Carry information between adjacent PBXs, or • Indicate the completion of a link-by-link sequence which started with LLM(I).
LLM(I)	Link-by-Link Message (Incomplete)	Used instead of LLM(C) when LLM(C) does not contain all the information required.
LLRM	Link-by-Link Reject Message	Used to reject an unrecognised link-by-link message.
SCRM	Single Channel Clear Request Message	Used to initiate the clearing sequence for one of the calls on a traffic channel carrying 2 calls. In the case of a transit PBX, SCRM is then repeated to the next link.
SCIM	Single Channel Clear Indication Message	Used to acknowledge SCRM.

13.1.5 DPNSS1 Signalling Procedures (Level 3)

A full description of the signalling sequences for a Simple Telephony Call and for the supplementary services listed in Table 1 is given in BTNR 188.

The Simple Telephony Call is a mandatory requirement of a PBX that supports DPNSS1. The supplementary services are optional however and the range provided is subject to agreement between the customer and his PBX supplier.

Three signalling sequences are described in this handbook; a Simple Telephony Call and, as an example of a supplementary service, the Hold service within DPNSS1. Finally, to demonstrate the ability of the system to set up a data connexion, the circuit Switched Data Call within DPNSS1.

13.1.5.1 Simple Telephony Call within DPNSS1

13.1.5.1.1 Definition

The Simple Telephony Call provides the facilities for establishing a Telephony connection between any two DPNSS1 Network extensions without the need for operator assistance. A Simple Call does not involve any Supplementary Service requests.

13.1.5.1.2 Description

This Section only deals with a Simple Call which originates and terminates at user extensions within a DPNSS1 network.

NOTE: The physical characteristics of the traffic channels with which DPNSS1 is associated are not strictly part of the definition of DPNSS1. However, in order to ease the problems of ensuring that PBXs from different manufacturers can interwork satisfactorily this Section recommends preferred implementations of traffic channels.

The preferred implementations are as follows:

Digital Traffic Channels

The preferred method of carrying traffic in a DPNSS1 network is in timeslots 1 to 15 and 17 to 31 of a 2048 kbit/s digital transmission system, in accordance with CCITT Recommendation G732.

Smaller PBXs may not generate enough traffic on a given route to justify the provision of a 2048 kbit/s digital transmission system; these PBXs may use an alternative means of providing one or more 64 kbit/s channels, but a means of determining the boundaries between successive octets will be needed to allow the successful transmission of encoded speech.

When speech is carried in a 64 kbit/s digital traffic channel it shall be encoded using A/Law, as described in CCITT Recommendation G771.

Analogue Traffic Channels

It is recognised that in the early stages of introducing DPNSS1 it may not be economic to provide digital bearers, particularly for smaller PBXs. DPNSS1 signalling may be carried on analogue bearers, as described in para 13.1.1 of Section 13; the associated traffic channels may also use analogue bearers. This document does not define the characteristics of those analogue bearers.

13.1.5.1.3 Outline of Operation

The signalling procedures are dealt with in two parts:

- Call Set-Up
- Call Clear Down

The general sequences for a successful call including variations to cover call failure conditions are given in paragraphs .3.1 and .3.2.

13.1.5.1.3.1 Call Set-Up

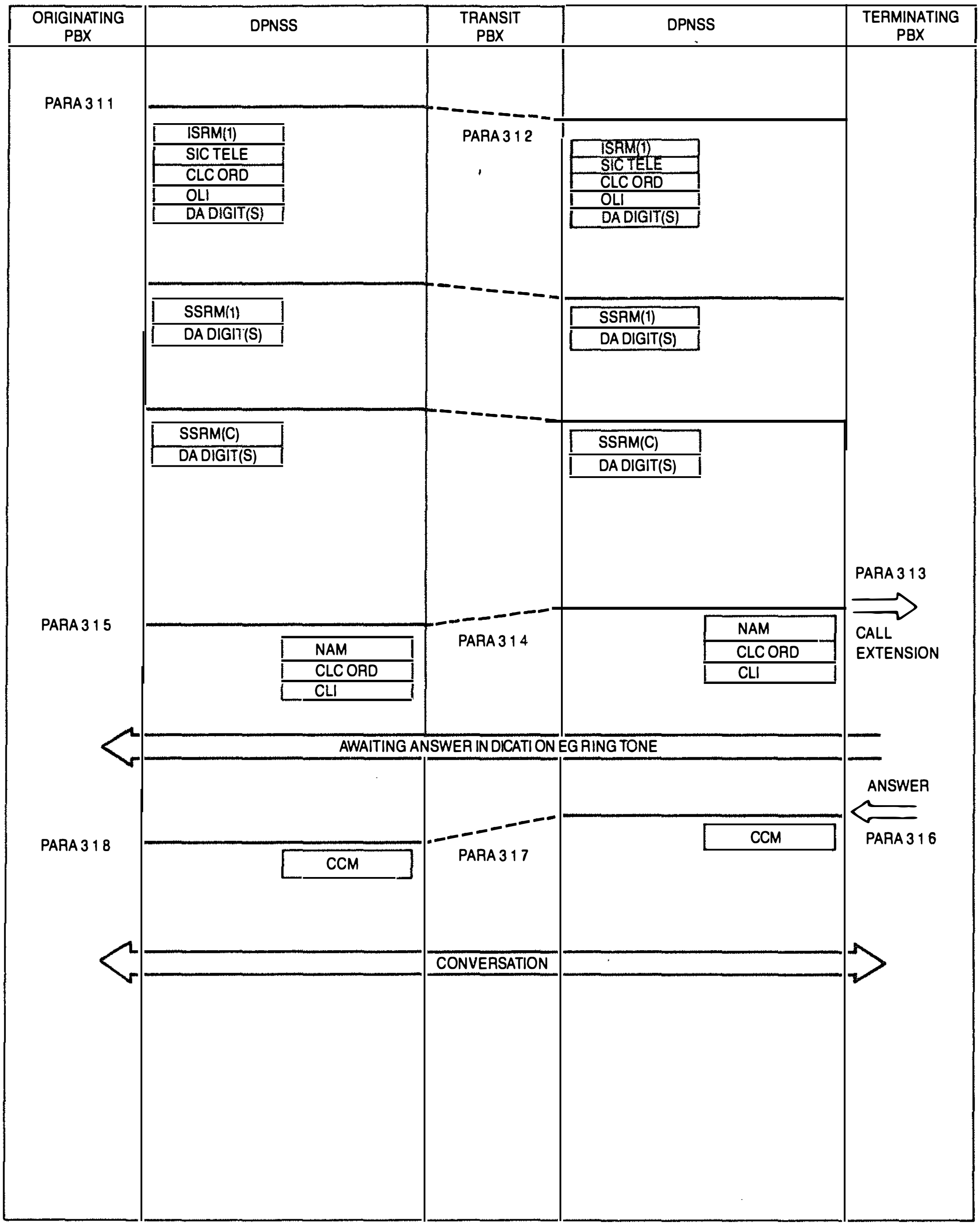


Fig 1

Notes on Call Set Up

3.1.1 When a Simple Call is originated, and digit analysis indicates a DPNSS 1 route within a Private Network a transmission channel is reserved and an Initial Service Request Message (ISRM) is sent on the signalling channel.

The ISRM contains a Service Indicator Code (SIC), Calling Line Category (CLC), the Originating Line Identity (OLI) and the Destination Address (DA). Whenever possible an ISRM (complete) should be used. However, where the possibility of interworking with a slower speed signalling system exists, which could result in excessive post dialling delays, the ISRM (incomplete) may be used together with one or more Subsequent Service request Messages (SSRMs) to send the remaining address information.

If the end of selection is recognised by the originating PBX (eg register timeout) before a Number Acknowledge Message (NAM) is received, then an SSRM(C) is used to indicate the end of selection information.

In order that any supervisory indications or announcements are returned to the originating user the transmission path should be connected through as soon as possible.

ISRM(I) may also be used when the sending PBX does not determine end of dialling by caller.

3.1.2 On receipt of:

— an ISRM(C)
— an ISRM(I)
— an ISRM(I) and some or all SSRMs

with a Destination Address indicating an outgoing DPNSS1 route with sufficient digits to route the call forward, then a traffic channel is reserved on the outgoing route. An ISRM (complete or incomplete) is sent on the outgoing signalling channel. In the case of the ISRM(I) this will be followed by SSRMs.

If onward routing is not via the first-choice route, a NIM would be sent back to the originating PBX containing a signal RTI (Routing Information) indicating the type of onward routing, eg Alternative Route.

This information may be used to invoke Route Optimisation, display information etc to the caller.

The transmission path should be connected through as soon as possible to enable any supervisory indications or announcements to be returned to the originating user

In the event of the following call failure conditions:

- Service Incompatible
- Number Unobtainable
- Address Incomplete
- Congestion
- Access Barred

A CRM should be sent containing the appropriate Clearing Cause and a CIM should be expected in response.

3.1.3 On receipt of an ISRM(C) or an ISRM(I) and any SSRMs, and if the Destination Address identifies a user extension which is free, and the connection is allowed, then the extension should be called, the Awaiting Answer Indication returned in the traffic channel and a Number Acknowledge Message (NAM) containing the Called Line Category and Called Line Identity returned in the signalling channel.

If a NAM is returned prior to receipt of an SSRM(C) then further SSRMs shall be ignored.

In the event of the following call failure conditions:

- Number Unobtainable
- Address Incomplete
- Subscriber Incompatible
- Congestion
- Busy
- Subscriber Out of Service
- Incoming Calls Barred

a CRM should be sent containing the appropriate Clearing Cause and a CIM should be expected in response.

3.1.4 On receipt of a NAM from the succeeding PBX, the Transit PBX should send a NAM to the preceding PBX. Alternatively if a CRM is received from the succeeding PBX then a CIM should be sent in response and a CRM returned to the preceding PBX and a CIM expected in response. However, if the CRM from the succeeding PBX indicates congestion in the Clearing Cause then the Transit PBX may attempt to alternatively route the call.

3.1.5 Receipt of a NAM containing no supplementary information other than CLC and CLI indicates a successful routing and that the Awaiting Answer Indication is being returned in the traffic channel. No further SSRM(I) or SSRM(C) should be sent as part of this selection sequence.

In the case of call failure within the private network a CRM with the appropriate Clearing Cause will be used to drop the call back to the Originating PBX from which an appropriate Call Failure Indication will be given to the originating user. A CIM will be sent in response to a CRM.

3.1.6 On receipt of an answer signal a Call Connected Message (CCM) should be returned in the signalling channel. When the extension answering the call has a CLI different from the one given in the NAM, the CLI of the new extension may be given in the Indication Field of the CCM.

3.1.7 The CCM will be relayed backwards at any DPNSS1 Transit PBXs.

3.1.8 On receipt of a CCM an Answer Indication will be sent to the Originating Network Terminal if appropriate.

13.1.5.1.3.2 Call Clear Down

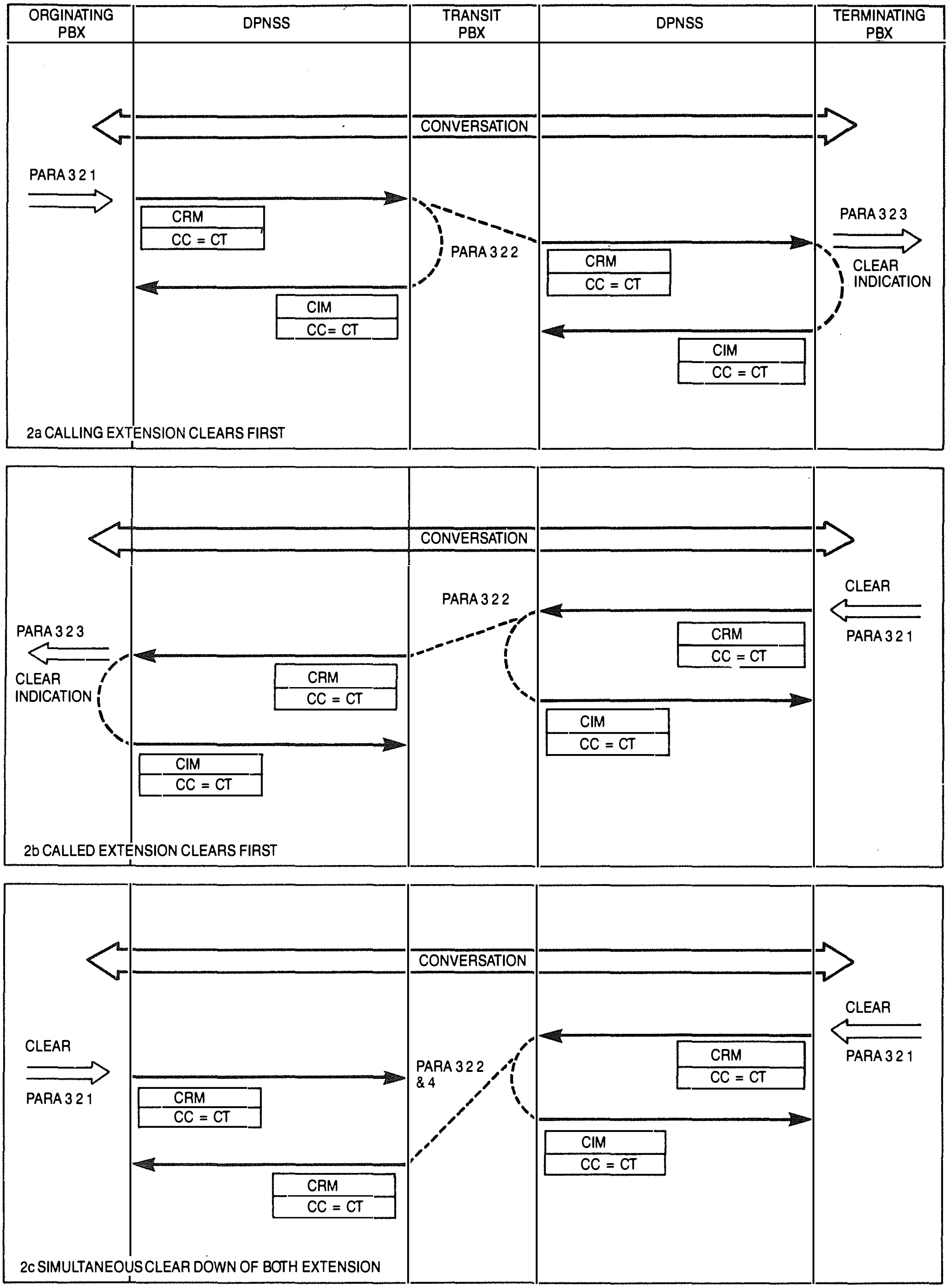


Fig 2

Notes On Call Clear Down

3.2.1 DPNSS1 uses a symmetrical clearing sequence. Therefore, when a clear signal is received from an Originating or Terminating Network Terminal the switch path should be disconnected and released and a Clear Request Message (CRM) sent on the Outgoing or Incoming channel and a Clear Indication Message (CIM) expected in response.

3.2.2 DPNSS1 uses a link by link clearing sequence. Therefore, when a CRM is received on an Incoming or Outgoing signalling channel the switch path should be disconnected and released followed by a CIM being sent in response and CRM being relayed on.

3.2.3 When a CRM is received on an Incoming or Outgoing signalling channel the switch path should be disconnected and released followed by a CIM being returned and an appropriate Clear Indication being sent to the extension.

3.2.4 As both ends of a DPNSS1 call can initiate the clearing sequence CRMs may cross. Since the group and type codes for CRM and CIM are identical, both ends will deduce that the received message is a CIM. However, the contents of the received message may not match the contents of the transmitted CRM (eg the clearing causes may differ); thus, if a CRM has been sent then a received CRM/CIM shall always be treated as a valid response regardless of the contents of the Clearing Cause and Indication Fields.

13.1.5.2 Hold Service Within DPNSS 1

13.1.5.2.1 Definition

The Hold Supplementary Service permits an extension user to hold an existing call to a second party, either for privacy reasons or in order to make use of another Supplementary Service such as establishing an enquiry call or answering a waiting call.

13.1.5.2.2 Description

This Supplementary Service permits a user to place an existing call into a suspended state, with the possibility of a holding indication being given to the held extension. The user may at any time reconnect to the held call, removing any holding indication.

This Supplementary Service enables a holding indication (eg music, silence etc) to be applied locally to the held party.

This Supplementary Service offers the possibility of preventing certain types of party being placed on Hold.

This Supplementary Service offers the possibility of preventing both parties having Hold invoked at the same time, thus avoiding possible confusion to users.

If a user who has a call on Hold clears, calling signal may be applied to that extension and the held call reconnected on answer. Some designs of PBX may permit a holding extension to clear and not be called immediately.

While a call is on Hold user may perform various actions such as establishing an enquiry call (Three Party Service Invocation) or answering a waiting call.

13.1.5.2.3 Outline of Operation

The Hold Supplementary Service is implemented using the signal sequences given in paragraph .3.1

13.1.5.2.3.1 Hold Service

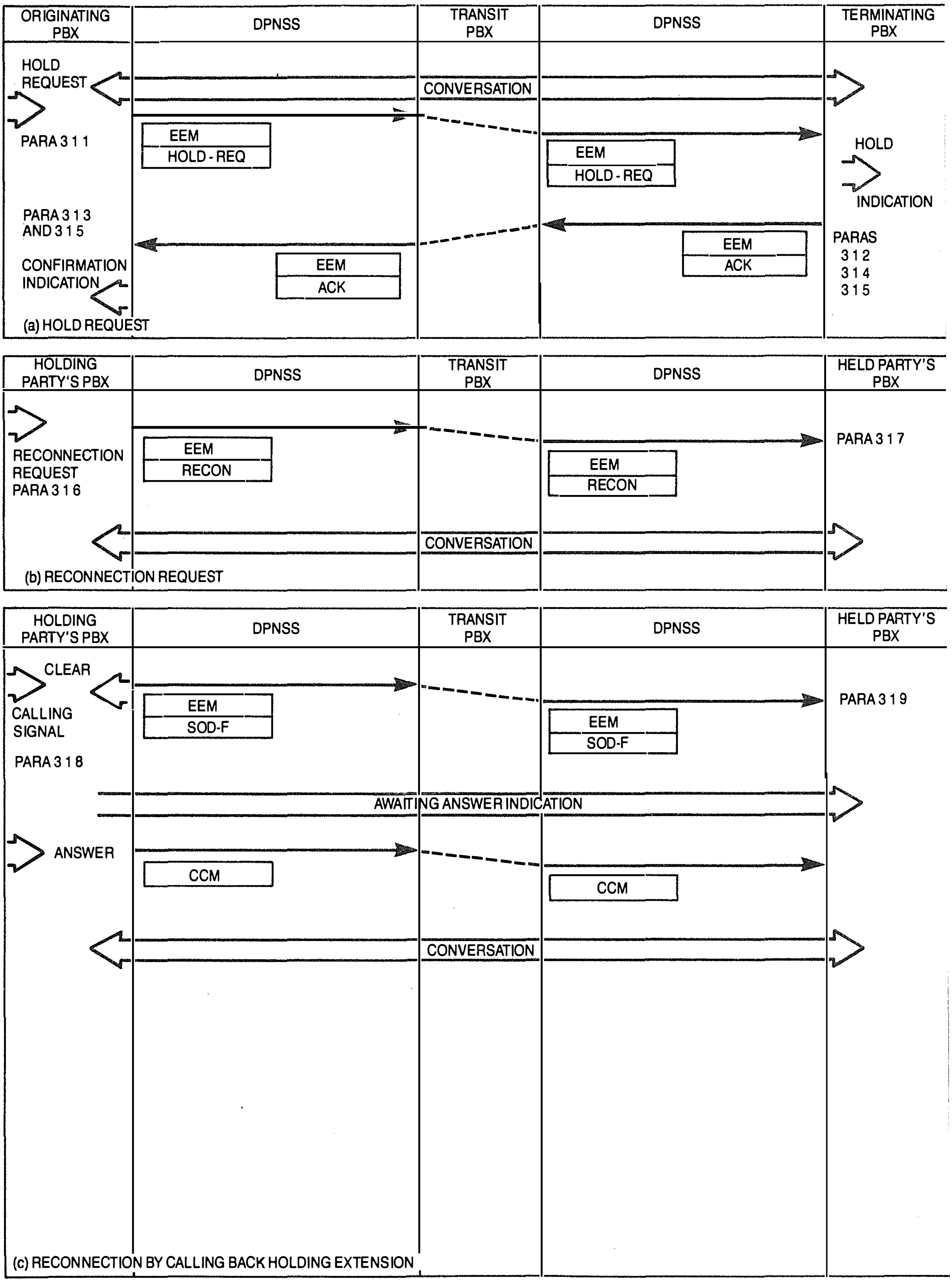


Fig 1

Notes On Hold Service

3.1.1 Either party of a call in the conversation state may request hold. An EEM containing Hold Request (HOLD-REQ) is sent to the other party's PBX.

3.1.2 On receipt of the Hold request the other party's PBX checks that the extension can be placed on Hold, and if so disconnects the traffic path, applies holding indication, and returns an EEM containing Acknowledge.

The Hold request may be rejected by returning an EEM containing Reject (REJ) for one of the following reasons:

- The other extension is of a type which is not permitted to be placed on Hold.
- The other extension is already holding the call or has made a Hold request.

3.1.3 On receipt of an EEM containing Acknowledge (ACK), the requesting extension's PBX disconnects the extension's traffic channel and gives an appropriate indication (eg dial tone) to show that the Hold request was successful.

On receipt of an EEM containing Reject (REJ) the requesting extension's PBX rejects the Hold request.

If the target PBX does not support the Hold service it replies with an EEM containing Signal Not Understood (SNU). In this case the requesting extension's PBX may still proceed as if the Hold request had been successful, although there is no protection from the other extension putting the call on local Hold.

3.1.4 Any subsequent Hold request by the held extension can be rejected by its own PBX without the need for DPNSS1 signalling.

3.1.5 If the held extension subsequently clears, or if the holding extension requests termination of the held call, the clear down sequences for a Simple Call (13.1.5.1) apply.

3.1.6 If the holding user requests reconnection, the traffic channel is reconnected and an EEM containing Reconnected (RECON) is sent to the held extension's PBX.

3.1.7 On receipt of an EEM containing RECON, the held extension's PBX reconnects the traffic channel and removes holding indication.

3.1.8 If the holding extension clears, its PBX may apply calling signal either immediately or after a delay. When calling signal is applied, awaiting answer indication is applied to the held traffic channel and an EEM containing State of Destination — Free (SOD-F) is sent to the held extension's PBX.

3.1.9 On receipt of an EEM containing SOD-F, the held extension's PBX reconnects the traffic channel and removes holding indication. The call then behaves as a simple call awaiting answer.

13.1.5.3 Circuit Switched Data Calls Within DPNSS1

13.1.5.3.1 Definition

The DPNSS1 Circuit Switched Data Calls provide facilities for establishing connections between any DPNSS1 network terminals having compatible data communications capabilities.

13.1.5.3.2 Description

General

This subsection only deals with simple Data Calls which originate and terminate at terminals connected to a PBX in a DPNSS1 network.

NOTE: For recommendations on the physical characteristics of traffic channels see Simple Telephony Call.

Each PBX along the call path should choose a suitable path based on the Service Indicator Code. NOTE: If *Flow Control* is indicated in the SIC, the selected path must not be analogue.

A Data Call shall be non-interruptible for the duration of the call at every PBX along its path.

Interconnection of different terminal types is possible providing they operate in the same mode and at the same speed.

eg It is possible to interconnect an X21 (isochronous) Data Terminal Equipment (DTE) with an X21 bis (isochronous) DTE operating at 2400 bit/s.

Rate Adaption

In order that a variety of data transmision speeds can be catered for and transported within the standard 64 kbit/s traffic channels a standard rate adaption method is proposed for use with DPNSS1.

The rate adaption requirements recommended for DPNSS1 are specified in the ECMA standard — RATE ADAPTION FOR THE SUPPORT OF SYNCHRONOUS AND ASYNCHRONOUS EQUIPMENT USING THE V SERIES TYPE INTERFACES ON AN ISDN. (TC24/84/132.)

Use of Analogue Traffic Channels for Data

Data may be carried on analogue traffic channels by means of Modems. The information in the SIC can be used by a PBX to determine the speed and type of Modem required; such a Modem may be selected from a Modem pool and switched into the channel when required.

In the transit situations where the incoming route is digital and the outgoing route is analogue (or vice-versa) the information in the SIC can additionally be used to determine the type of rate adaption and interface conversion equipment required; again such equipment may be selected from a pool and switched into the channel as required. The SIC shall be repeated without change.

In transit situations where both incoming and outgoing routes are analogue no modem switching, rate adaption or interface conversion equipment are required. The SIC should be repeated to the next link unchanged.

Note: Customers should ensure that all modems used for data calls are compatible on the line side; this is a network-wide requirement.

13.1.5.3.3 Outline of Operation

A message sequence for a generalised Circuit Switched Data Call is described in paragraph.3. 1

Other message sequences for the commonly used circuit switched data terminal interfaces referenced in the ECMA Rate Adaption draft standard are described in BTNR 188.

The cleardown sequences shall be as shown for a Simple Telephony Call (13.1.5.1).

13.1.5.3.3.1 Generalised Circuit Switched Data Call

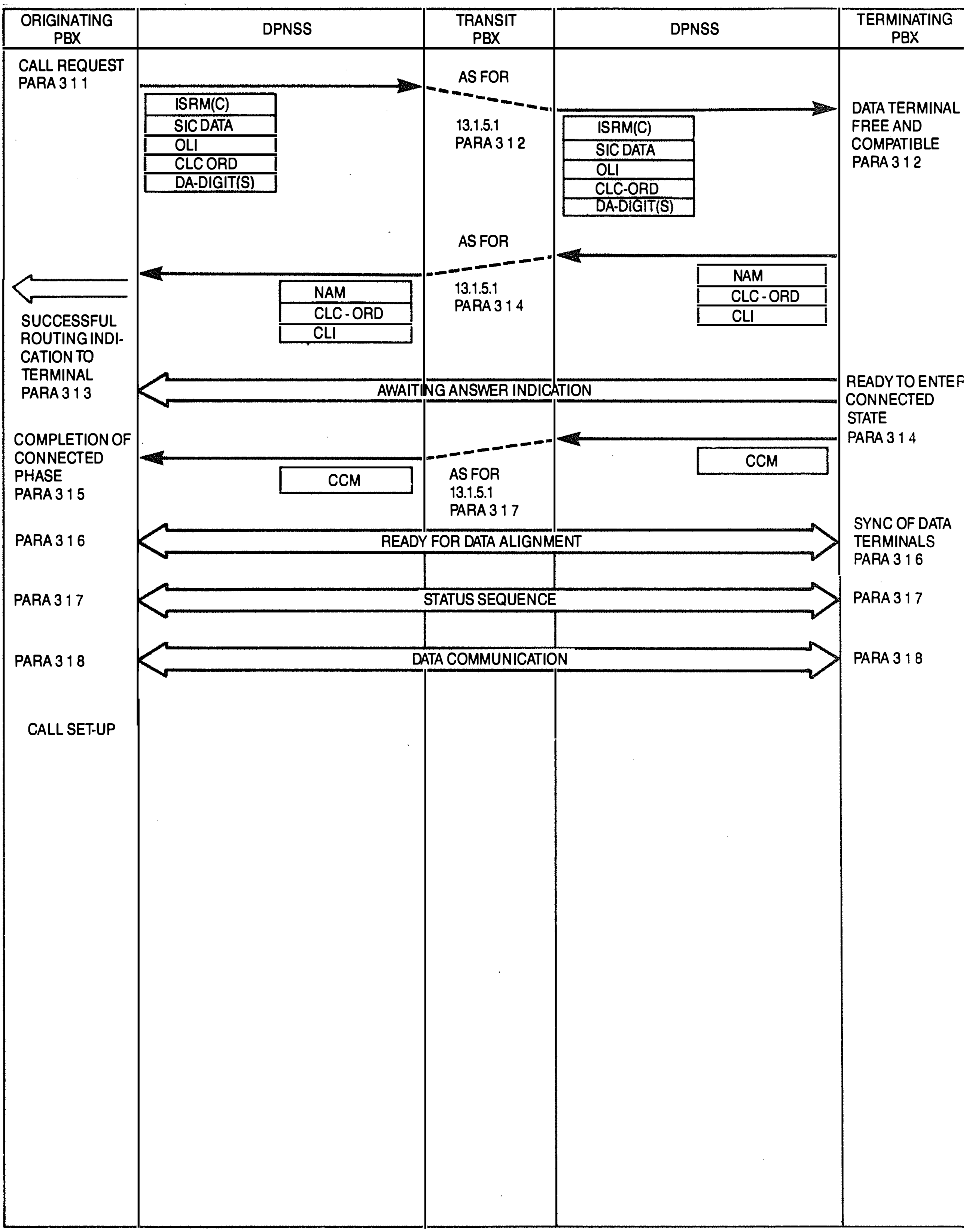


Fig 1

Notes on Generalised Circuit Switched Data Call

3.1.1 The first message on all Circuit Switched Data Calls is an ISRM. This message contains a Service Indicator Code (SIC), Calling Line Category (CLC), Destination Address (DA) and if available the Originating Line Identity (OLI).

The SIC indicates the method of rate adaptation used for the data communication phase, the source rate of the data and also whether it is isochronous or anisochronous.

The destination address may have been provided by the data terminal or from a separate keypad, or it may have been a predetermined number stored within the PBX.

3.1.2 On receipt of an ISRM the action at the DPNSS1 terminating PBX is dependent upon the type of Network Terminal identified by the Destination Address.

If the Destination Address identifies a data terminal which is free and the connection is allowed and the terminal is compatible with the service indicated in the ISRM SIC, then the call should be presented to the terminal. If the call is accepted then a NAM containing the Called Line Identity (CLI) and its Called Line Category (CLC) should be returned in the signalling channel.

In the event of the following call failure conditions a CRM should be sent containing the appropriate clearing cause:

— Number Unobtainable
— Address Incomplete
— Subscriber Incompatible
— Congestion
— Busy
— Subscriber Out of Service
— Incoming Calls Barred
— DTE Controlled not ready
— DTE Uncontrolled not ready

3.1.3 Receipt of a NAM containing no Supplementary Service Information other than CLC and CLI indicates a successful routing and an appropriate indication can be given to the Originating Network Terminal.

In the case of a call failure a CRM with the appropriate clearing cause will be used to drop the call back to the Originating DPNSS1 PBX from which an appropriate call failure indication will be given to the Originating Data Terminal. A CIM will be sent in response to this CRM.

If the CRM from the succeeding PBX indicates congestion in the clearing cause then a transit PBX could attempt to route the call via an alternative route.

3.1.4 When the terminating DPNSS1 PBX is ready to enter the connected state a Call Connected Message (CCM) will be sent on the signalling channel. This will normally follow the sending of the DCE-provided information to the data terminal.

3.1.5 Receipt of a CCM indicates completion of the connection phases.

3.1.6 At this point the Originating and Terminating PBXs should attempt to synchronise the data terminals via the traffic channel. Further details of this process are in ECMA draft standard TC24/84/132.

3.1.7 Some rate adaptation methods will provide a status channel for use with certain types of isochronous data terminals (eg X21 and X21 bis); see also ECMA draft standard TC24/84/132.

3.1.8 Once the two terminal PBXs have achieved synchronisation and the terminals have exchanged status, if appropriate, then the data communication phase can be entered allowing free interchange of data at the appropriate mode (ie isochronous or anisochronous); see also ECMA draft standard TC24/84/132.

13.1.6 Interworking Between DPNSS1 and Other Signalling Systems

DPNSS1 is capable of inter-working via a Gateway PBX with the following signalling systems:

- Private Network

  SSAC15-A
  SSDC5-A 10PPS Simple Calls only.
  SSDC10-A

  SSMF5 — Supplementary services to SSMF5 capability.

- Public Network

  Loop disconnect 10PPS (PSTN)
  DASS2 (ISDN)

Detailed information on inter-working is given in British Telecom Network Requirement BTNR189.

A typical DPNSS1 private network, inter-working with other signalling systems is shown in Fig 8.

Inter-working between DPNSS1 and signalling systems other than those listed here may be possible. Their exclusion does not imply that an inter-working facility cannot be achieved.

Gateway PBX Requirements

The signalling procedures for the other sigalling systems are unaffected by inter-working with DPNSS1.

The Simple Telephony Call is a mandatory requirement of a Gateway PBX supporting DPNSS1 inter-working. The supplementary services are optional however and the range provided is subject to agreement between the customer and his PBX supplier.

Requirements for the PSTN

The requirements for both the electrical conditions and signalling protocols for the PSTN are shown in BTR1151 Section 1 and BTR1161 Sections 1 and 2.

Requirements for DASS2

Not yet issued.

Requirements for Inter-PBX signalling at 10PPS

The requirements for SSAC15-A, SSDC5-A and SSDC10-A, electrical conditions and signalling protocols are described in Section 12 of this document.

Requirements for SSMF5

The requirements for electrical conditions and signalling protocol for SSMF5 is described in Section 13.2 of this handbook.

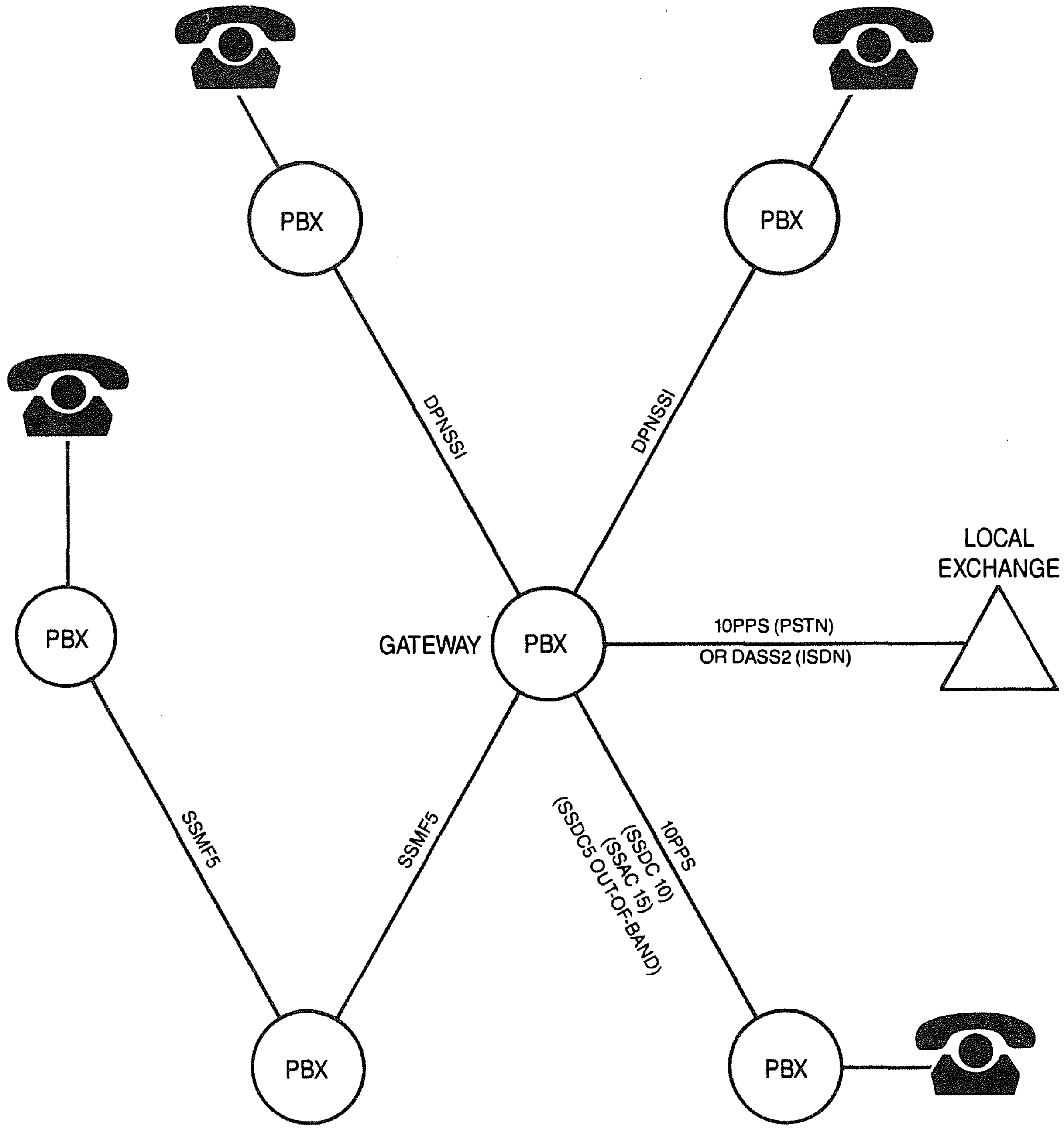


Fig 8 DPNSS1 Inter-working with Other Private Circuit Signalling Systems and with the PSTN with a Gateway PBX

DPNSS1 Signalling Procedures Inter-Working with Other Signalling Systems

A full description of the signalling sequences for Simple Telephony Calls for both PSTN (excluding DASS2) and other inter-PBX signalling systems (10PPS only) are given in BTNR189.

At the time of publication of this handbook, inter-working with SSMF5 and DASS2, the description of a Circuit Switched Data Call and all supplementary services have not yet been defined. The supplementary services under study for inclusion in later issues of BTNR189 are:-

- Swap
- Call back when free
- Executive intrusion
- Diversion
- Hold
- Three party
- Call offer
- Call waiting

The signalling sequences for a Simple Telephony Call to the PSTN and for a Simple Telephony Call to another inter-PBX signalling system, is described in the following sub-section.

13.1.6.1 Interworking with the Public Switched Telephone Network (PSTN)

Definition

A simple telephony call interworking with the PSTN provides the facilities for establishing a telephony connection between a DPNSS1 extension and a PSTN telephony terminal without the need for private network operator assistance. A simple call does not involve any supplementary service requests.

Description

This paragraph deals only with a simple automatic telephony call between an extension within a DPNSS1 private network and a telephony terminal within the PSTN.

Outline of Operation

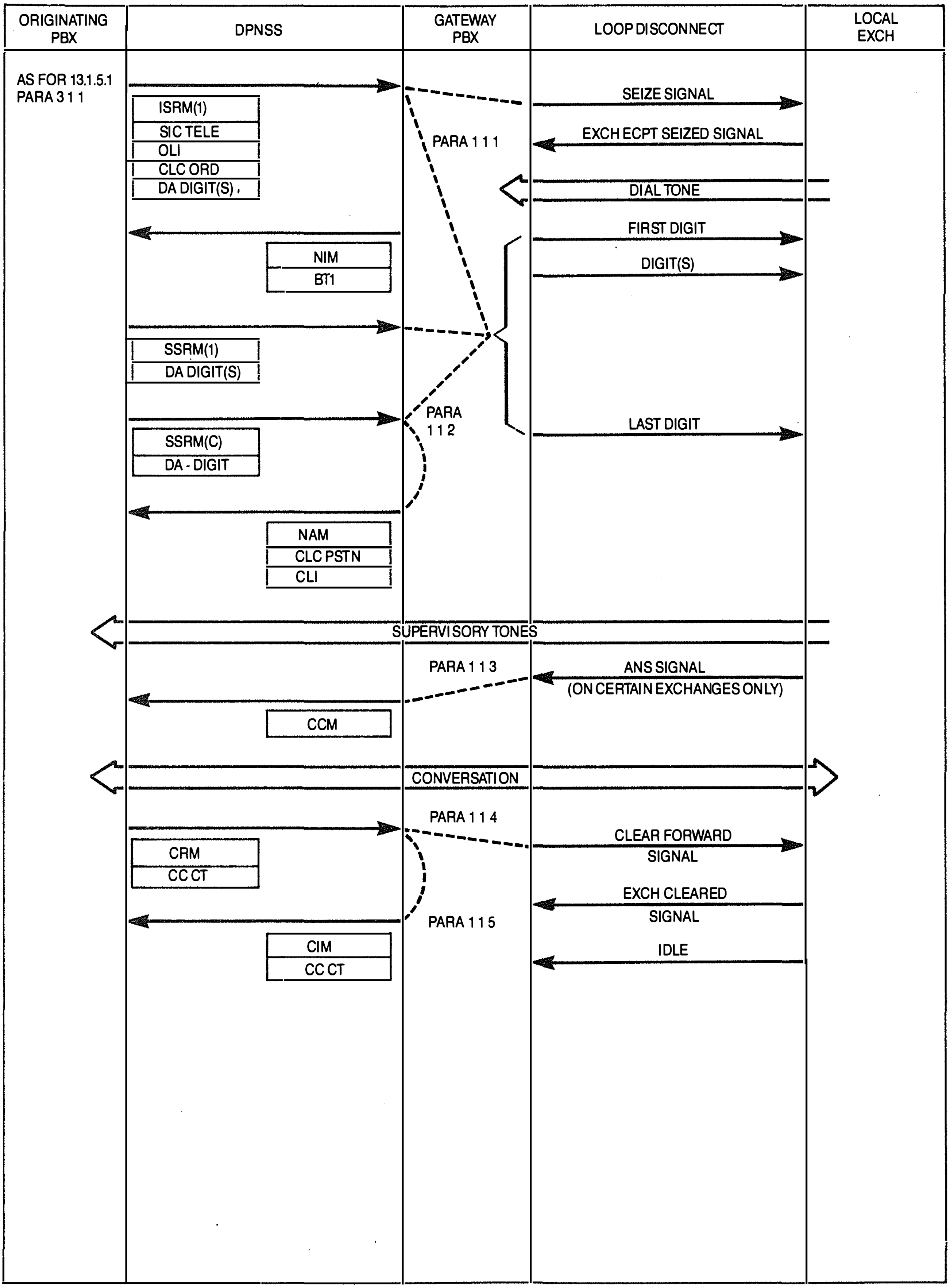
The signalling procedures are divided into three parts:

- A simple call from a DPNSS1 extension to the PSTN
- A simple call from the PSTN (DDI) to a DPNSS1 extension.
- A simple call from the PSTN (non-DDI) to a DPNSS1 extension.

The general sequences for a successful call including variations to cover call failure conditions are given in paragraphs 13.1.6.1.1 to 13.1.6.1.3.

The signalling procedures on the PSTN line are specified in BTR 1151 for outgoing and Incoming Non-DDI calls and BTR 1161 for Incoming DDI calls.

13.1.6.1.1 Simple Call From a DPNSS Extension to the PSTN



Notes on Simple Call From DPNSS Extension to the PSTN

1.1.1 When the destinaion address within an ISRM(C) or ISRM(I) plus one or more SSRMs identifies an outgoing PSTN route, the gateway PBX selects a free PSTN line, sends a seizing signal to the local exchange, and returns a NIM with Routing Information (RTI) PSTN to the Originating PBX.

The local exchange will return an *Exchange Equipment Seized Signal* followed by dial tone. The dial tone will normally be blocked at the gateway PBX.

After allowing a suitable pre-sending pause, the gateway PBX will send the PSTN destination address to the PSTN digit by digit in accordance with BTR 1151.

The transmission path should be connected through as soon as possible thus enabling the caller to hear any supervisory tones returned from the PSTN.

In the event of all PSTN lines from the gateway PBX being busy the call will be cleared by sending a CRM with a clearing cause indicating congestion and a CIM should be expected in response.

1.1.2 As the Gateway PBX will not normally know the number length, end of selection may be indicated either by receipt of an ISRM(C) or SSRM(C) or by expiry of a time-out started on receipt of each ISRM(I) or SSRM(I). When End of Selection occurs and subject to an outgoing line having been successfully seized a NAM will be returned. This NAM should contain the CLC and optionally the CLI indicating the Trunk Number.

A time out shall be started after sending the NAM (eg 60 secs) unless it is known that the trunk provides Answer or SPM.

1.1.3 When an answer signal is received from the PSTN a CCM shall be sent on the DPNSS1 signalling channel.

Where no answer signal is available but SPM signals are available the first meter pulse may be used to generate a CCM.

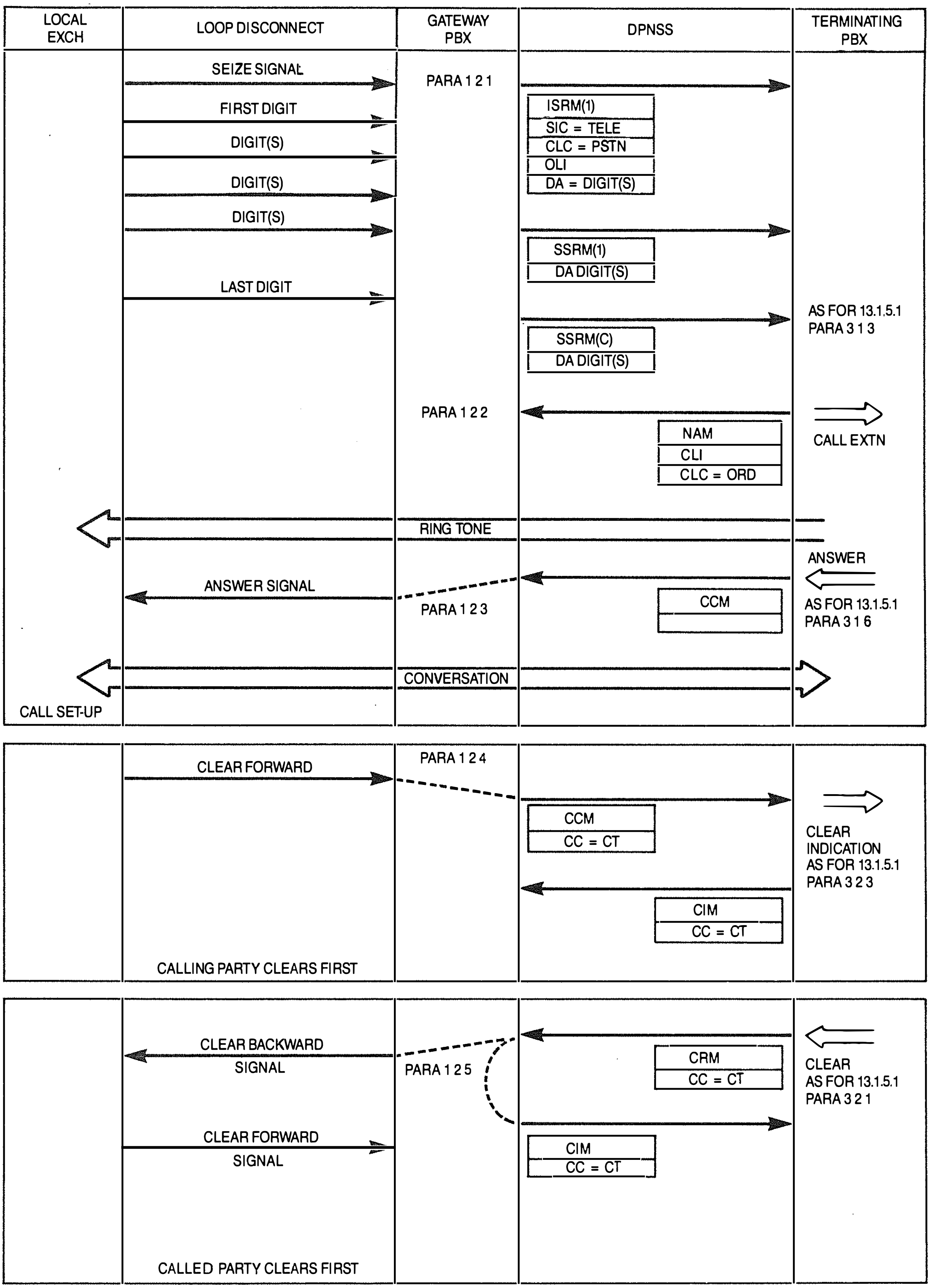
If neither an answer signal nor SPM is available the CCM will be sent following expiry of the NAM time out. Where this occurs the CCM will contain the Supplementary Information String SIM-A.

1.1.4 The handling of periodic meter pulses will be covered in a later issue of BTNR189.

1.1.5 Normally the clearing of outgoing PSTN calls is under the control of the originating party.

However in the case where the PSTN provides a clear back signal the Gateway PBX, on receipt of this signal, may initiate clearing the call through the DPNSS1 network in the backward direction in the normal way.

13.1.6.1.2 Simple Call From the PSTN (DDI) to a DPNSS Extension



Notes on Simple Call from the PSTN(DDI) to a DPNSS Extended

1.2.1 When an incoming call arrives and digit analysis indicates a DPNSS1 route within a private network, a transmission channel is reserved and an ISRM is sent on the signalling channel.

The ISRM contains the Service Indicator Code (SIC) Calling Line Category (CLC), Destination Address and optionally the Originating Line Identity (OLI) indicating the trunk number.

Whenever possible an ISRM(C) should be used. However where the possibility of interworking with a slower speed signalling system exists, or the gateway does not know the number length (either of which could result in excessive post dialling delays) an ISRM(I) may be used together with one or more SSRMs to send the remaining destination address digits. If the end-of-selection is recognised by the gateway PBX (eg register time-out) before a NAM is received, then an SSRM(C) is used to indicate the end of selection information.

In order that any supervisory indications or verbal announcements may be heard by the caller the transmission path should be switched through as soon as possible.

1.2.2 Receipt of a NAM containing no Supplementary Information other than CLC and CLI indicates a successful routing, and that the awaiting answer indication is being returned in the traffic channel. No further SSRM(I) or SSRM(C) should be sent as part of this selection sequence.

In the case of call failure within the DPNSS network a CRM with the appropriate clearing cause will be used to drop the call back to the gateway PBX from which an appropriate call failure tone will be applied to the incoming line. When a CRM is received, a CIM will be sent in response.

1.2.3 On receipt of a CCM the gateway PBX applies an answer signal to the incoming line in accordance with the relevant signalling BTNR.

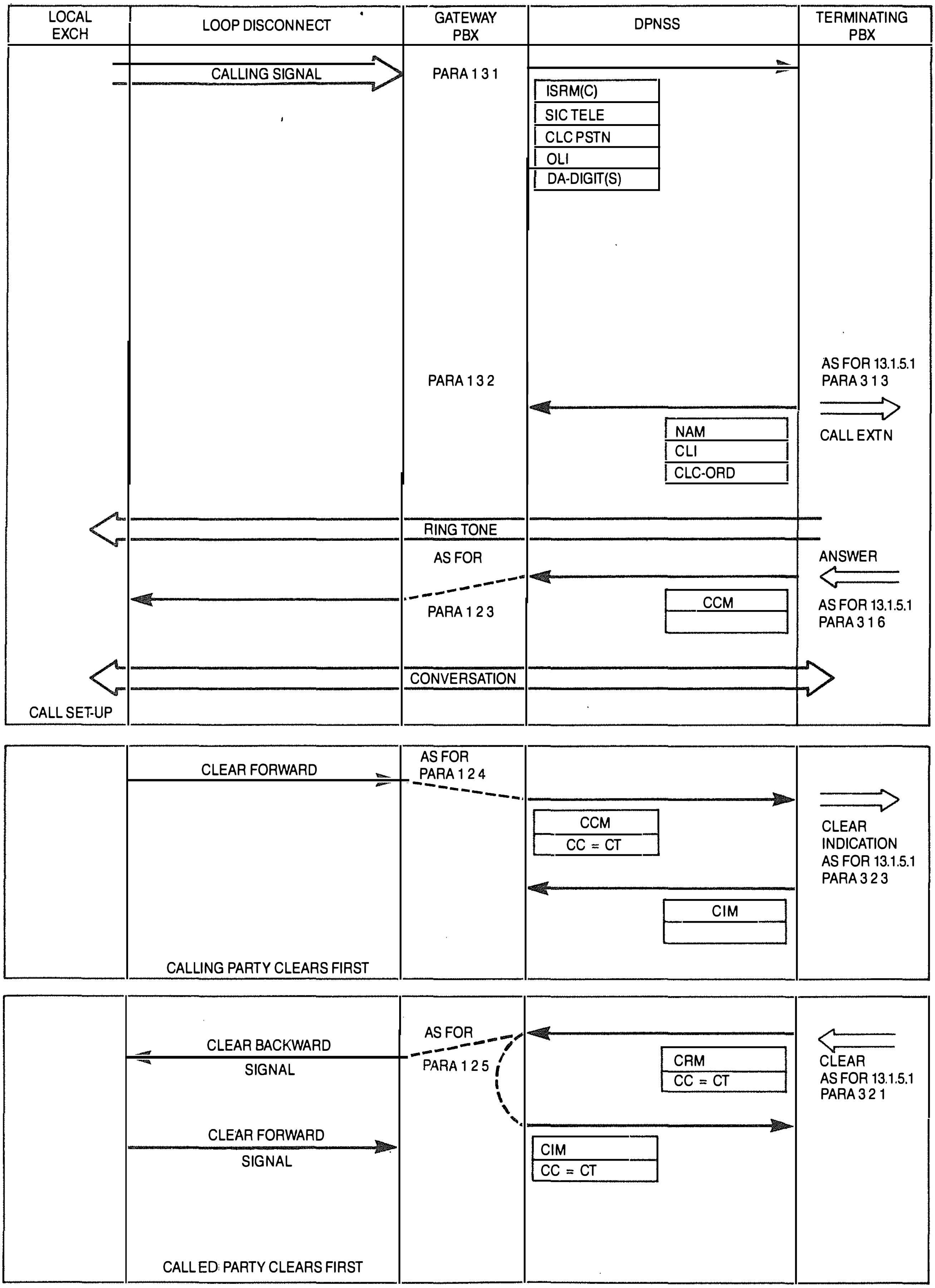
1.2.4 On receipt of a Clear Forward Signal, the gateway PBX shall release the switched path and send a CRM in the signalling channel containing a clearing cause call termination.

A CIM should be expected in response.

1.2.5 On receipt of a CRM the switched path should be released, a CIM returned and a Clear Back Signal applied to the incoming line.

The clearing sequence shall be in accordance with the relevant signalling BTNR.

13.1.6.1.3 Simple Call From the PSTN (Non DDI) to a DPNSS1 Extension



Notes on Simple Call from PSTN(Non-DDI) to a DPNSS Extension

1.3.1 When Calling signal is received on an incoming trunk allocated to Non-DDI facilities, the Gateway PBX determines whether the extension is local (ie ON PBX) or to an extension on another PBX. If the extension is ON PBX, no DPNSS1 is involved. If the extension is on another PBX a call is made as in paragraph 1.2.1.

Once all the routing digits have been sent the transmission path should be switched through as soon as possible to allow through transmission of supervisory indications.

1.3.2 Receipt of a NAM containing no Supplementary Information other than CLC and CLI indicates a successful routing, and that the awaiting answer indication is being returned in the traffic channel. No further SSRM(I) or SSRM(C) should be sent as part of this selection sequence.

In the case of call failure within the DPNSS network a CRM with the appropriate clearing cause will be used to drop the call back to the Gateway PBX. The Gateway PBX will then either redirect the call to an extension within itself, or use the appropriate Supplementary Service to route the call to another extension within the private network.

13.1.6.2 Interworking with a 10PPS Private Network

Definition

A simple telephony call interworking with a 10PPS Private Network provides the facilities for establishing a telephony connection between a DPNSS1 extension and a 10PPS private network telephony terminal without the need for operator assistance.

A simple telephony call does not involve any supplementary service requests.

Description

This paragraph deals only with a simple automatic telephony call between an extension within a DPNSS1 part of a private network and a telephony terminal within a 10PPS part of a private network.

Outline of Operation

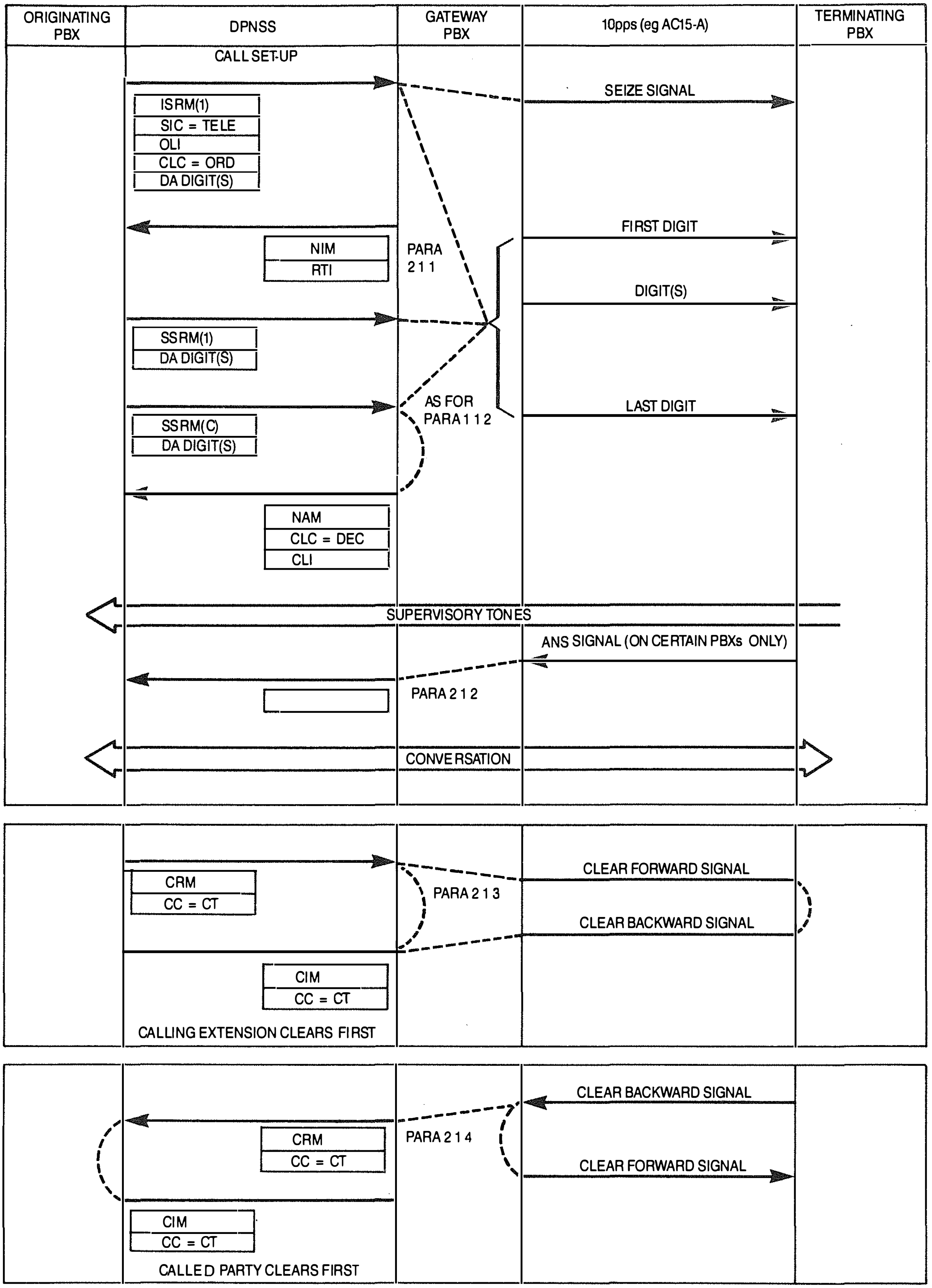
The Signalling procedures are divided into two parts;

- A simple call from a DPNSS1 extension to a 10PPS private circuit
- A simple call from a 10PPS private circuit to a DPNSS1 extension.

The general sequences for a successful call including variations to cover call failure conditions are given in paragraphs 13.1.6.2.1 and 13.1.6.2.2.

The signalling procedures on the 10PPS line are specified for SSAC15-A, SSDC5-A and SSDC10-A in Section 12 of this document.

13.1.6.2.1 Simple Call From a DPNSS Extension to the PSTN



Notes on Simple Call from DPNSS Extension to a 10pps Private Circuit

2.1.1 When the destination address within an ISRM identifies an outgoing 10PPS route, the gateway PBX selects a free circuit and sends a Seizing Signal to the next PBX.

After allowing a suitable pre-sending pause, the gateway PBX sends the destination address via the 10PPS circuit digit by digit in accordance with the relevant signalling system.

A NIM should be sent as soon as possible with Routing Information (RTI) that the call is being made to a 10PPS route.

The transmission path should be connected through as soon as possible thus enabling the caller to hear any supervisory tones returned from the 10PPS part of the private network.

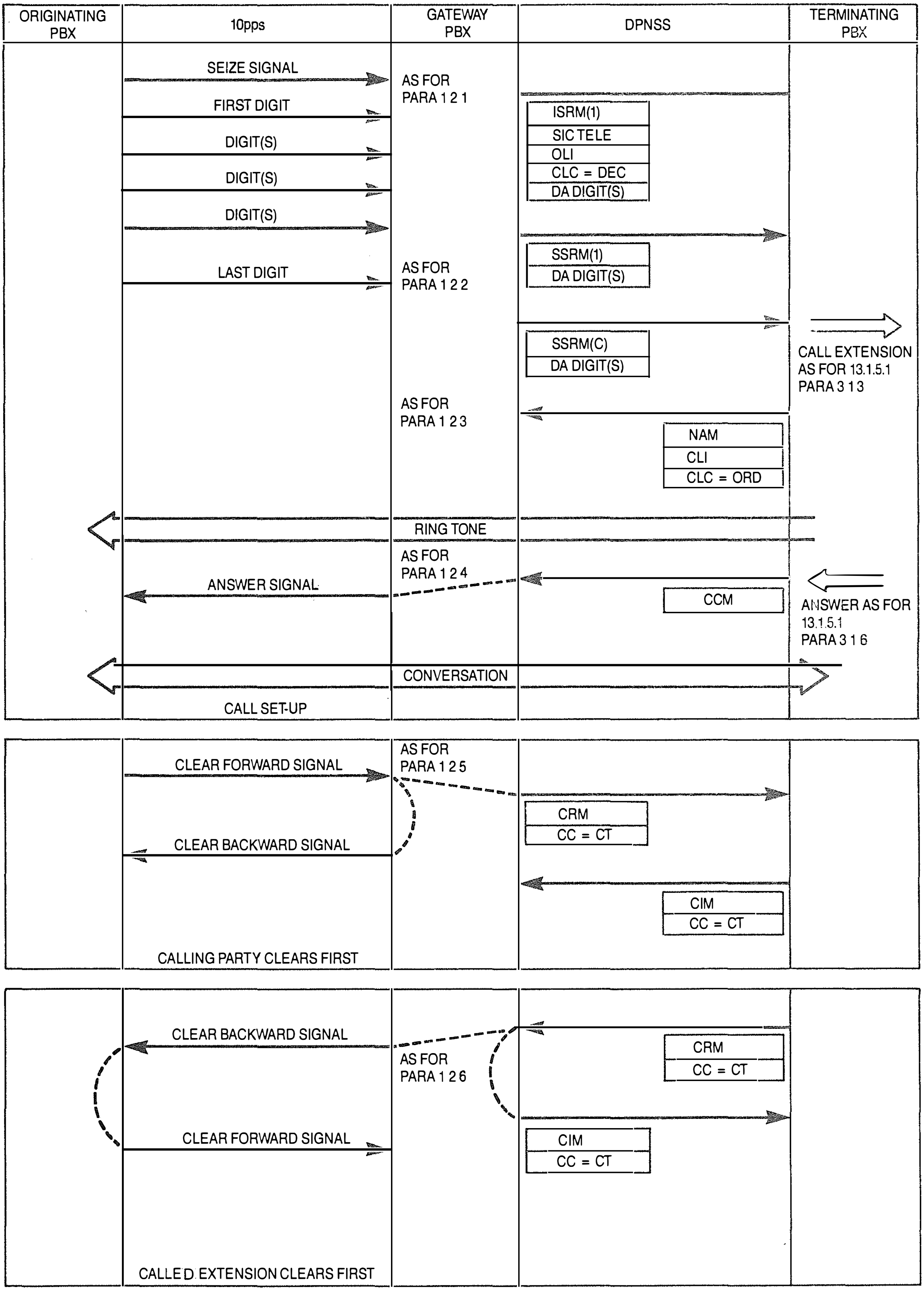
In the event of all circuits on the required route from the gateway PBX being busy the call will be cleared by sending a CRM with a clearing cause indicating congestion. A CIM should be expected in response.

2.1.2 When an answer signal is received from the 10PPS network a CCM shall be sent on the DPNSS1 signalling channel. As some 10PPS lines or call types may not provide an answer signal the CCM will be sent on expiry of the NAM timeout. Where this occurs the CCM will contain the Supplementary Information String SIM-A.

2.1.3 On receipt of a CRM the switch path should be released, a CIM returned and a Clear Forward Signal applied to the outgoing line. The clearing sequence on the 10PPS line shall be in accordance with the relevant signalling system.

2.1.4 On receipt of a Clear Backward signal the gateway PBX shall release the switched path and send a CRM in the signalling channel. A CIM should be expected in response.

13.1.6.2.2 Simple Call From A 10PPS Private Circuit to a DPNSS Extension



13.2 Signalling System Multi-Frequency No. 5 (SSMF5)

13.2.1 General System Description

SSMF5 is a multi-frequency analogue inter-PBX signalling system that provides fast call set up between PBXs and enables the supplementary services on individual PBXs to be made available on a network wide basis. See fig 9.

The system provides for the transmission of address, call management and supplementary service information between the Central Processing Units (CPU) of Stored Program Control (SPC) inter-connected PBXs as shown in fig 10. The signals are transmitted over the traffic channel allocated to the call.

SSMF5 requires the support of a line signalling system suitable for the purpose, such as SSAC15-B to provide supervisory signals, seizure, answer, clear, recall etc.

SSMF5 works on an end to end basis and is only associated with the line when required to pass information between registers. The system handles routing and call management information for both simple call set up and supplementary services. With the exception of certain signals in the backward direction, which may be sent in pulsed form, SSMF5 is a compelled system thus providing a secure means of exchanging information.

Twelve frequencies are used; these are divided into upper and lower band for signalling in the forward and backward direction respectively. Because different frequency bands are used in each direction the system may be used on 2-wire or 4-wire circuits. Selecting any 2-out of-6 frequencies for simultaneous transmission produces fifteen discrete combinations for signalling purposes.

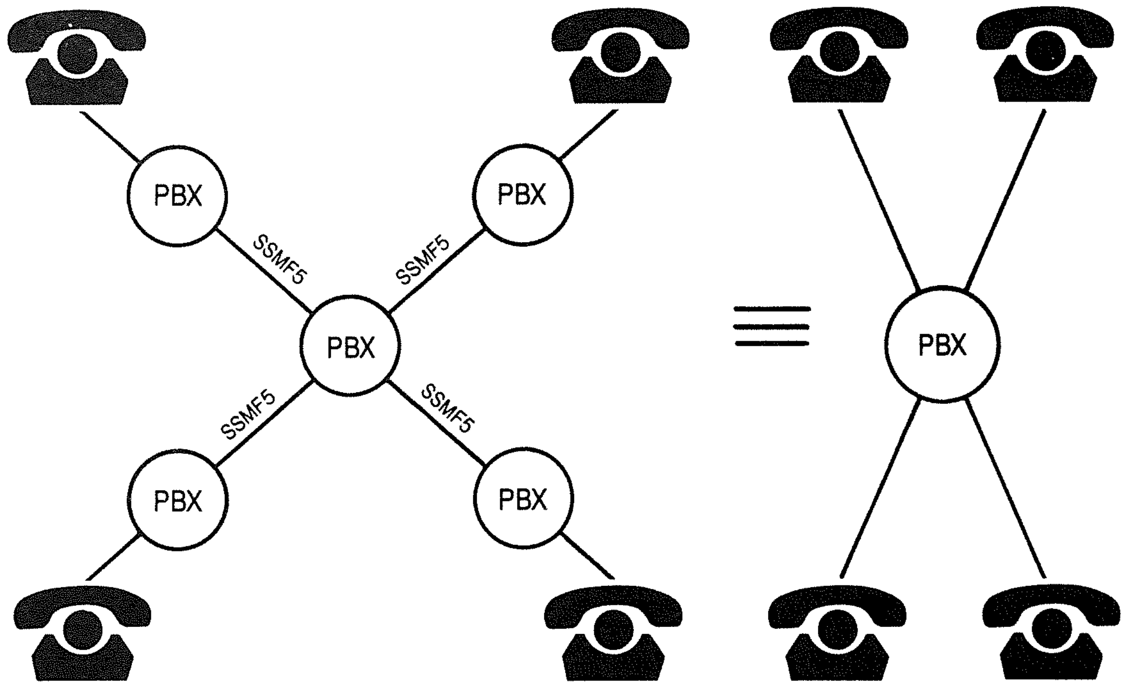
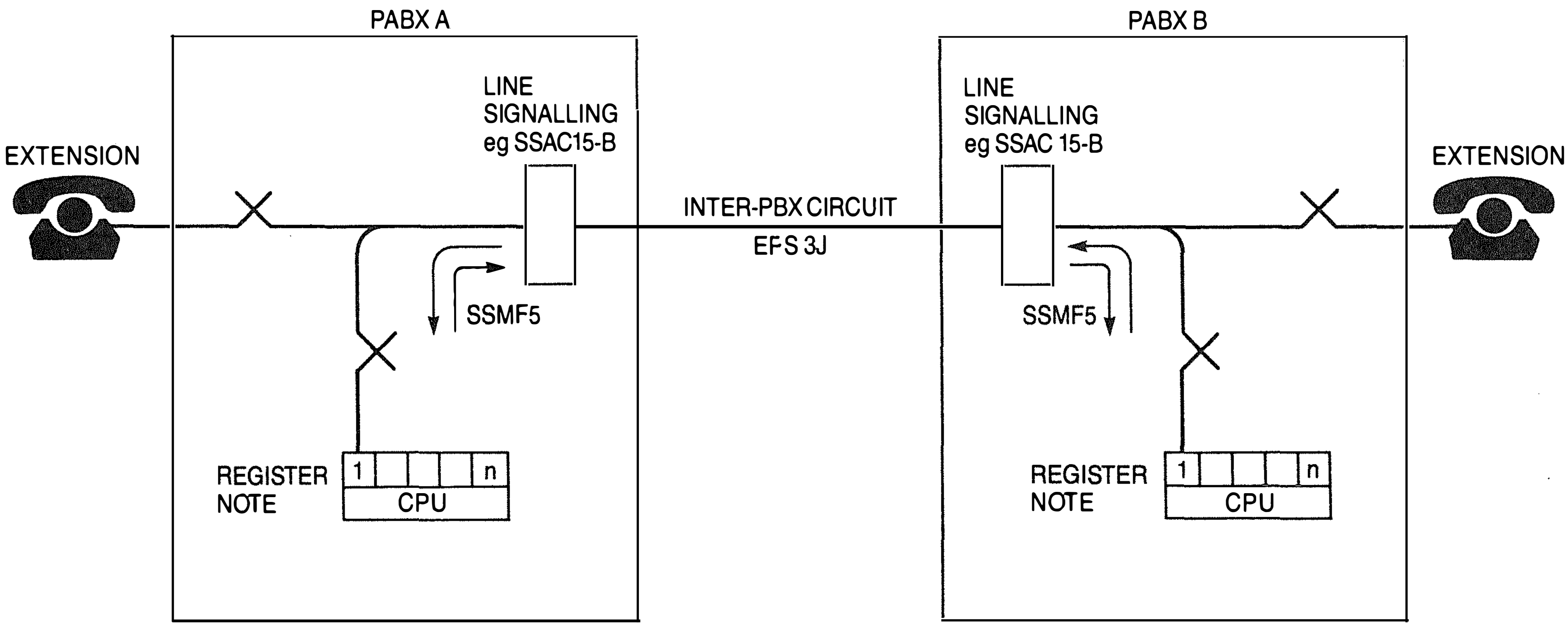


Fig 9 With SSMF5 a Private Network with Many PBXs can Appear to the Extension User as One PBX

MCS783



NOTE: The MFC Senders & Receivers are contained in the Registers associated with the CPU.

Fig. 10 SSMF5 Between PBX's

To increase the capacity of the signalling system the information to be exchanged is arranged into a number of groups in each direction of transmission. Information contained in each group is allotted one of the fifteen combinations of two frequencies, thus each combination may have more than one meaning during the call. Certain signals contained in a group are used to change from one group to another. Forward signalling groups are designated Groups I, II, III etc and backward signalling Groups A, B, C etc.

The range of supplementary services provided by a PABX is optional and depends upon customer requirements and PABX capability. In a given private network, PABXs of differing capability will be encountered and the procedures specified for SSMF5 take this into account. During the initial set-up of the call, an interchange of terminal status information takes place between originating and terminating PABXs. This enables certain subsequent supplementary service demands either from the interconnected terminals or from a third party, to be processed locally without recourse to inter-PABX signalling.

Where a supplementary service demand requires inter-PABX signalling, the request is handled by the responding PABX on an accept or reject basis, depending upon the availability of the service at that PABX.

PABXs that do not provide any supplementary services but require SSMF5 signalling capability for fast call set-up and for private network compatibility reasons, can utilise a subset of SSMF5 signalling procedures referred to as basic. The basic subset provides, as a minimum, the necessary repertoire of signals to establish an extension-to-extension call, with an optional procedure to provide locally applied supervisory tones and limited class of service information.

The SSMF5 system is based on the Multi-frequency Code (MFC) part of CCITT R2 and has been harmonized to form CEPT L1 MFC Signalling Recommendations T/CS 49-07 and T/CS 49-08. SSMF5 is described in detail in British Telecom Network Requirements BTNR 184.

13.2.2 Multi-Frequency Code Signalling

Outline of Operation

Fifteen discrete signals are available in each direction of transmission. Apart from certain signals which may be sent in pulsed form all signal inter-changes are in a compelled mode.

Signals are formed in a 2-out of-6 code using a high band of frequencies (1380 Hz-1980 Hz) for forward signalling and a low band of frequencies (540 Hz-1150 Hz) for backward signalling. See Table 3.

The sending levels are chosen so that the total signal energy does not exceed the limit for the transmission loading requirements of British Telecom HF line plant and CCITT Recommendation Q15.

The compelled mode of working ensures that backward signals are of short duration. However, the removal of a forward signal is dependant on a backward signal and hence any delay between recognition of a backward signal and removal of the forward signal is kept to a minimum.

A received signal is checked for persistence, for a discrete 2 and 2 only frequency condition, and for being within the frequency and level acceptance limits.

The levels of the individual frequencies which constitute a SSMF5 signal vary with the transmission media over which the signals are received. Group delay distortion, non-linear distortion products and the possibility of line path interruptions may also influence the received signal.

A valid forward signal is acknowledged with an appropriate backward signal. A valid backward signal is acknowledged by complying with the request contained in the signal and in the case of compelled signalling by removal of the forward signal being sent.

Sending and Receiving Signals

Subsequent to seizing an outgoing inter-PBX circuit the first SSMF5 signal sent will be in the forward direction.

With the exception of certain signals which are sent in pulsed form all signal interchanges are in the compelled mode. The duration of a pulsed signal is approximately 200ms. The duration of any forward signal in a compelled sequence will not exceed 6 seconds.

Signal Conditions — Sending

Signals are sent as two simultaneous frequencies applied to the signal path as shown in Table 3.

SSMF5 Combination CODE NO.	SSMF5 Signalling Frequencies (Hz)		SSMF5 Frequency Combination CODE NO.	SSMF5 Signalling Frequencies (Hz)	
	Forward Direction	Backward Direction		Forward Direction	Backward Direction
1	1380 + 1500	1140 + 1020	9	1620 + 1860	900 + 600
2	1380 + 1620	1140 + 900	10	1740 + 1860	780 + 660
3	1500 + 1620	1020 + 900	11	1380 + 1980	1140 + 540
4	1380 + 1740	1140 + 780	12	1500 + 1980	1020 + 540
5	1500 + 1740	1020 + 780	13	1620 + 1980	900 + 540
6	1620 + 1740	900 + 780	14	1740 + 1980	780 + 540
7	1380 + 1860	1140 + 660	15	1860 + 1980	660 + 540
8	1500 + 1860	1020 + 660			

Table 3

Each signal frequency is within ±4 Hz of the frequencies shown in the above table.

Each signal frequency will be transmitted at a level of −16 dBmO ±1 dB (that is −20 dBm at a −4 dBr point). The level of the two frequencies in combination will therefore be −13 dBmO nominal. The two component frequencies forming a signal do not differ by more than 1 dB when sent.

Signal conditions — Receiving

The arrival of a frequency combination consisting of two frequencies as shown in Table 3 will be subject at the receiving PBX to the following checks:-

- The signal persists for 20 ms or longer.
- A signal will be recognised as having terminated if it has ceased for longer than 15 ms.
- There are two and only two frequencies present as shown in Table 3.
- Both frequencies are within ±10 Hz of the frequencies shown in Table 3.
- Each frequency is at a power level of between −5 dBm to −35 dBm at the PBX Receive path termination.
- The power levels of both frequencies are within 12 dB of each other for non-adjacent frequencies and within 5 dB for adjacent frequencies.

Transmission Requirements

Inland Inter-PBX Circuits

The private network over which SSMF5 is used may be 4-wire switched throughout, 2-wire switched throughout or a combination of 2-wire and 4-wire switched.

4-Wire Switched Network

All 4-wire switched networks should be engineered according to the Incremental Loss Plan as described in Ref 1. Fig 11 illustrates this plan. Each SSMF5 signal frequency is injected at the −4 dBr point on the transmit path of a BT EPS3J circuit, at a level of −20 dBm (−16 dBmO). SSMF5 signals are transmitted from end to end of a network and the use of EPS3J circuits will ensure that the received signals will fall within the limits of the SSMF5 Receiver over up to six links in tandem.

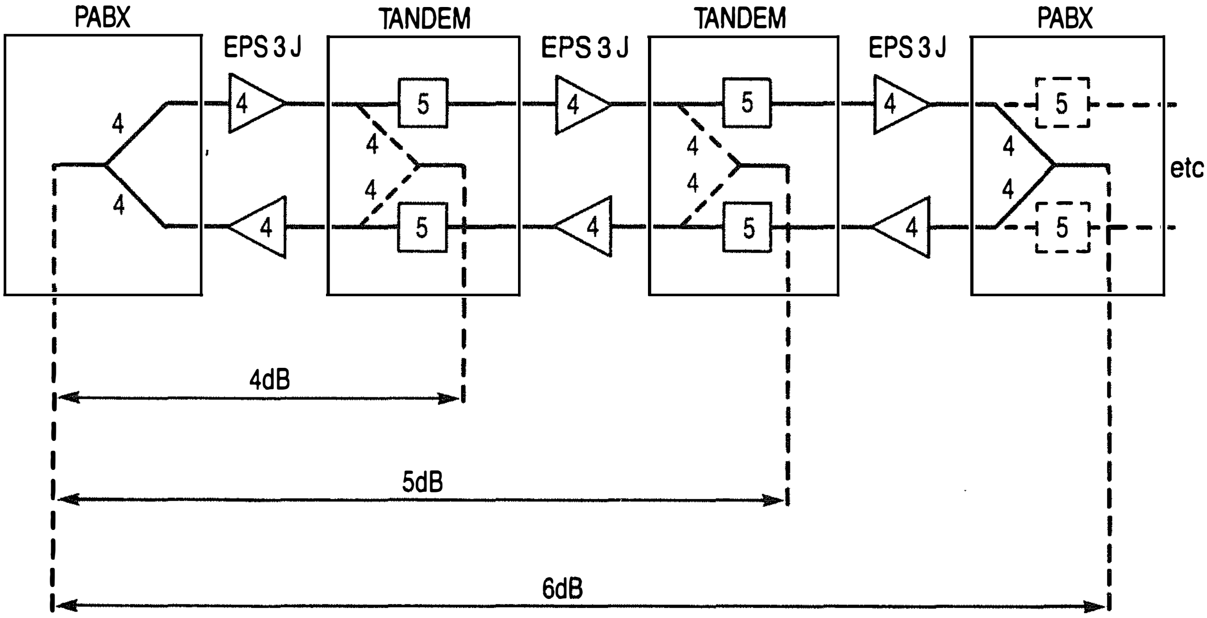


Fig 11 Incremental Loss Plan

2-Wire Switched Networks

On 2-wire switched network each SSMF5 signal frequency is injected at the 0 dBr point on the 2-wire of a 2-wire terminated EPS3J circuit at a level of −16 dBm (−16 dBmO). SSMF5 signals are transmitted end to end of a network and the use of EPS3J circuits will ensure that received signals will faill within the limits of an SMMF5 Receiver over up to 3 links in tandem.

Mixed 2-Wire and 4-Wire Switched Network

If SSMF5 is required to work over a network with a combination of 2-wire and 4-wire switched PBXs, the limiting condition for end to end working will vary with the particular arrangement. BT EPS2J circuits should be used for the inter-PBX circuits but advice from UKCHQ/PCS3.1 should be sought to determine the maximum number of links in tandem.

International Leased Lines

SSMF5 may be used on private networks that extend to European countries that contribute to CEPT agreements. When working on an international circuit it will be known as CEPT L1 Signalling System Multi-frequency Code (MFC) Signalling. The type of circuits provided and the number of tandem connexions over which a call may be set up, is subject to mutual agreement between the parties concerned. All circuits used in the tandem connexions should be to the standard of CCITT Recommentation G171 and M1010 to M1060. SSMF5. signal frequencies should be injected at a level of −16 dBmO, bearing in mind that international circuits are presented 4-wire at 0 dBr at each end. Requests for this service should be referred to BT International/IBI4.3.2.

Line Signalling Systems

SSMF5 requires the support of a line signalling system. The CEPT recommended line signalling system is in accordance with the BT standard signalling systems carrying the B or D suffix eg SSAC15-B and SSAC15-D. For enhanced working the use of one of these systems is mandatory. The line signals used on the B and D systems are:

- Seizing
- Seizing Acknowledgement or Proceed to Send
- Answer
- Clear Forward
- Clear Back
- Cleared
- Forward Service Request Recall
- Forward Link Recall
- Backward Service Request Recall
- Backward Link Recall

When basic working only is required then a standard line signalling system with an A suffix may be used eg SSAC15-A. The A suffix signalling repertoire is not so comprehensive as the B and D systems. For reference see the signal codes for these signalling systems in Section 12 of this document.

SSMF5 Signalling Group Structure

The signals are allocated to the fifteen SSMF5 codes in five forward and five backward signal groups. The signal group represented by the SSMF5 codes is changed at defined points in the call; the same SSMF5 code will therefore represent a different signal depending on its position in the sequence of the call.

Each signal group is used for a particular part of the call:

- Groups I and A are used for selection, network control and subset compatibility check.
- Groups II and B are used to exchange calling and called party information.
- Groups I and A, plus part of Groups II and B provide the necessary signals for establishing a simple call using the basic subset for the transfer of additional information.
- The remaining Group II and B signals and the Groups beyond are only provided when enhanced procedures for the transfer of additional information are used.
- Groups III and C are provided to exchange additional calling and called party information and to gain access to the supplementary services request procedures.
- Groups IV and D are provided to convey supplementary service request information and provide calling line identification.
- Groups V and E are for the enhanced routing subset. The enhanced routing subset is still under study but may include such instructions as *choose a circuit to give a specified transmission performance* eg: for a data call.

Tables 4 to 11 show the group structure for Groups I and A to Groups IV and D. Groups V and E are still under study.

Tables 4-11 follow

Table 4 Group I Forward Signals

Frequency Combination	Name of Signal	Abbrev	Note
1	Address, digit 1	I-1	Note 1
2	Address, digit 2	I-2	
3	Address, digit 3	I-3	
4	Address, digit 4	I-4	
5	Address, digit 5	I-5	
6	Address, digit 6	I-6	
7	Address, digit 7	I-7	
8	Address, digit 8	I-8	
9	Address, digit 9	I-9	
10	Address, digit 0	I-10	
11	Address, character*	I-11	
14	Address, character #	I-14	
15	End-of-digits	I-15	
13	Change-over to *enhanced routing subset*	I-13	Note 2
	Enhanced routing subset request-rejected		
12	Calling-party-category-request-rejected	I-12	
12	*Manufacturer*-request-rejected	I-12	Note 3

Note 1 — Signals used for selection.

Note 2 — Signals used to enable special actions during the selection phase.

Note 3 — Signals used for the subset compatibility check.

Table 5 Group A Backward Signals

Frequency Combination	Name of Signal	Abbrev	Note
1	Send-next-digit	A-1	Note 1
2	Tandem-encountered, send-first-digit	A-2	
8	Tandem-encountered, alternatively-routed, send-first-digit	A-8	
13	PSTN-encountered, send-next-digit	A-13	
14	Tandem-encountered, send-next-digit	A-14	
4	Call-failure	A-4	
9	Routing Congestion	A-9	
5	Send-calling-party-category	A-5	
10	*Enhanced-routing,* information-ready	A-10	Note 2
12	*Enhanced-routing,* no-information	A-12	
3	Address-complete, *basic,* change-over to groups II and B	A-3	Note 3
6	Address-complete, no-MFC	A-6	
7	Address-complete, request-manufacturer-identity	A-7	
11	Address-complete, *enhanced,* change-over to groups-II-and-B	A-11	
7	Change-over-to-*manufacturer*-procedures-subset	A-7	
15	Spare	A-15	

Note 1 — signals used during the selection phase.

Note 2 — signals used to enable special actions to be taken during the selection phase.

Note 3 — signals used for the subset compatibility check.

Table 6 Group II Forward Signals

Frequency Combination	Name of Signal	Abbrev	Note
1	Ordinary-extension	II-1	Note 1
2	Private-circuit, restricted-signalling capability	II-2	
3	Maintenance-equipment	II-3	
4	Public-switched-telephone-network (PSTN)	II-4	
5	Operator	II-5	
6	Data-transmission-equipment	II-6	
7	Operator-assisting, ordinary-extension	II-7	
8	Operator-assisting, PSTN	II-8	
9	Operator-assisting, restricted-signalling	II-9	
10	Network	II-10	Note 2
11	Ordinary-extension, holding PSTN	II-11	
13	Extraordinary extension	II-13	
14	ISDN	II-14	
12	*Enhanced*-subset-request-rejected	II-12	Note 3
15	Spare	II-15	

Note 1 — Signals used in both the *basic* and the *enhanced* subset.

Note 2 — These signals shall not be used in the *basic* subset.

Note 3 — Signal used for the subset compatibility check.

Table 7 Group B Backward Signals

Frequency Combination	Name of Signal	Abbrev	Note
1	Parked	B-1	Note 1
2	Call-failed, PSTN-barred	B-2	
3	Busy, intrudable	B-3	
4	Terminal-PABX-call-failure	B-4	
5	Unallocated-number, temporarily-out-of-service	b-5	
6	Free, intrudable	B-6	
7	Free, non-intrudable	B-7	
8	Call-failed, incoming-call-barred	B-8	
9	Terminal-PABX-congestion	B-9	
10	Busy, non-intrudable	B-10	
11	Free, operator	B-11	Note 2
12	Busy, partially-intrudable	B-12	
13	Free, partially-intrudable	B-13	
14	State of Destination Indeterminable	B-14	
15	Spare	B-15	

Note 1 — Signals used in both the *basic* and *enhanced* subset.

Note 2 — These signals shall not be used in the *basic* subset.

Table 8 Group III Forward Signals

Frequency Combination	Name of Signal	Abbrev	Note
1	Simple call	III-1	Note 1
2	Simple call, diverted	III-2	
3	Simple call, non-intrudable	III-3	
4	Simple call, diverted, non-intrudable	III-4	
9	Simple call, partially-intrudable	III-9	
10	Simple call, diverted, partially-intrudable	III-10	
15	No-further-supplementary-services-requested	III-15	
5	Supplementary-service	III-5	Note 2
6	Supplementary-service, diverted	III-6	
7	Supplementary-service, non-intrudable	III-7	
8	Supplementary-service, diverted, non-intrudable	III-8	
11	Supplementary-service, partially-intrudable	III-11	
12	Supplementary-service, diverted, partially-intrudable	III-12	
13	Spare	III-13	
14	Spare	III-14	

Note 1 — These signal indicate that the originating PABX has no further need for SSMF5 signalling.

Note 2 — These signals indicate that the originating PABX wishes to request a forward supplementary service and that further SSMF5 signalling is required beyond this group.

Table 9 Group C Backward Signals

Frequency Combination	Name of Signal	Abbrev	Note
1	Conclude MFC, no-additional-information	C-1	
2	Conclude MFC, PSTN Barred	C-2	Note 1
3	Conclude MFC, no-additional-information, non-intrusion-request-rejected	C-3	
5	Conclude MFC, PSTN Barred, Non Intrusion Request Rejected	C-5	
7	Supplementary-service, non-intrusion-request-rejected	C-7	
8	Supplementary-service	C-8	
10	Supplementary-service, PSTN-barred	C-10	
13	Supplementary-service, PSTN-barred, non-intrusion-request-rejected	C-13	
9	Send Calling Line Identification (CLI)	C-9	Note 2
11	Send CLI, PSTN-barred	C-11	
12	Send CLI, non-instrusion-request-rejected	C-12	
14	Send CLI, PSTN-barred, non-intrusion-request-rejected	C-14	
15	Request-forward-supplementary-service category	C-15	
4	Call-failure	C-4	
6	Spare	C-6	

Note 1 — These signals conclude SSMF5 signalling and return control of the call to line supervisory signals.

Note 2 — These signals cause change-over to groups IV and D signalling.

	Previous Backward Signal					
Frequency Combination	Request Forward Service Category (C-15) or Register Recall	Supplementary Service Signal (C-7, C-8, C-10 or C-13)	Backward Service Category	Backward Supplementary Svce Identification Digit (D1-D15)	Send CLI (C-9, C-11, C-12 or C-14) or Send Next CLI Digit (D-15)	Request Forward Supplementary Service Identification (D-15)
1	FORWARD SERVICE CATEGORY DIGIT 1	INVALID	The use of	These signals	CLI Digit 1	FORWARD SUPPLEMENTARY SERVICE IDENTITY DIGIT 1
2	" 2	"	these signals	may be used for	" 2	" 2
3	" 3	"	is under study	supplementary	" 3	" 3
4	" 4	"	but must not	service procedures	" 4	" 4
5	" 5	"	be used in	and their use will	" 5	" 5
6	" 6	"	response to the	be specified	" 6	" 6
7	" 7	"	escape digit	either in Annexes	" 7	" 7
8	" 8	"	'10'	to BTNR 184 or	" 8	" 8
9	" 9	"		Manufacturers	" 9	" 9
10	" 10	"		documentation.	" 10	" 10
11	" 11	"		OK NO FURTHER MFC REQUIRED	" *	" 11
12	" 12	REQUEST NOT ACCEPTED NO FURTHER MFC REQUIRED	REQUEST NOT ACC. NO FURTHER MFC REQD	REQ. NOT ACC. NO FURTHER MFC REQD	INVALID	" 12
13	" 13	INVALID	Under Study	OK FURTHER MFC POSSIBLE	INVALID	" 13
14	" 14	REQUEST NOT ACCEPTED FURTHER MFC POSSIBLE	REQ. NOT ACC. FURTHER MFC POSSIBLE	REQ. NOT ACC. FURTHER MFC POSSIBLE	CLI Digit	" 14
15	" 15	REQUEST BACKWARD SERVICE CATEGORY	REQUEST BACKWARD SUPPLEMENTARY SERVICE IDENTITY	—	END OF CLI DIGITS	" 15

Table 10 Group IV Forward Signals
Signal Meanings depend upon the previous signal

Frequency Combination	Previous Forward Signal					
	Forward Service Category (IV-1 to IV-15)	**Forward Supp. Service Indent. Digit (IV-1 to IV-15)**	**Request Backward Service Category (IV-15)**	**Request Backward Supp. Svce. Ident. Digit (IV-15)**	**CLI Digit (IV-1 to IV-10) or end of CLI Digits (IV-15)**	**OK or request not accepted (IV-11, IV-12, IV-13, IV-14)**
1	Use of these	These signals	BACKWARD SERVICE CATEGORY DIGIT 1	BACKWARD SUPP. SVCE IDENT. DIGIT 1	INVALID	INVALID
2	signals is	may be used for	″ 2	″ 2	″	″
3	under study	supp.svce.	″ 3	″ 3	″	″
4		procedures and	″ 4	″ 4	″	″
5		their use will	″ 5	″ 5	″	″
6		be specified	″ 6	″ 6	″	″
7		either in	″ 7	″ 7	″	″
8		Annexes to	″ 8	″ 8	″	″
9		BTNR 184 or in	″ 9	″ 9	″	″
10		Manufacturers Documentation	″ 10	″ 10	″	″
11		OK — CONCLUDE MFC	″ 11	″ 11	OK — CONCLUDE MFC	ACCEPT ACKNOWLEDGED CONCLUDE MFC
12	REQUEST NOT ACC. CONCLUDE MFC	REQUEST NOT ACC. CONCLUDE MFC	″ 12	″ 12	INVALID	REJECT ACKNOWLEDGED CONCLUDE MFC
13	Under Study	OK C/O TO GROUPS III/C	″ 13	″ 13	OK — C/O TO GROUPS III/C	ACCEPT RECOMMENDED C/O TO GROUPS III/C
14	REQ. NOT ACC. C/O TO GROUPS III/C	REQ. NOT ACC. C/O TO GROUPS III/C	″ 14	″ 14	INVALID	REJECT ACKNOWLEDGED C/O TO GROUPS III/C
15	REQ. FWD SUPP. SVCE IDENTITY	—	″ 15	″ 15	SEND NEXT CLI DIGIT	INVALID

Table 11 Group D Backward Signals
Signal Meanings depend upon the previous signal

Pulsed Signalling

A pulsed signal is a signal sent in the backward direction for approx 200 ms.

Signals assigned for use in the pulsed mode are backward signals A-4, A-6, B-4, B-9, C-4, and D-12, see tables 5, 7, 9 and 11.

A pulsed signal may be sent when either of the following conditions arises:-

- when the time-out on non-receipt of a signal matures before the first forward signal is received;
- following completion of a compelled signalling cycle, if no subsequent forward signal has been recognised and at least 100 ms have elapsed since the end of transmission of a backward signal.

The initiating PABX shall terminate any forward signal in the course of transmission on receipt of a pulsed signal.

It is desirable that reception of a forward signal by the responding PABX during transmission of a pulsed signal will cause that PABX to complete the signalling cycle in the compelled mode. However, the responding PABX will not act upon the information contained in such a forward signal.

A pulsed signal will have the same meaning as the corresponding signal within the compelled mode and will be interpreted accordingly by the initiating PABX.

Signal Group Changing

This sub-section gives details of the signal group changing procedures that occur at various points in the progress of signalling procedures.

On seizure, the SSMF5 codes represent groups I and A.

The forward signal change-over-to-enhanced-routing-subset (I-13) will cause a change to groups V and E. Signals in group V will change back to groups I and A on completion of the enhanced signal interchange.

The backward signal send-calling-party-category (A-5) causes change over to group II for one signal only, then signalling reverts to groups I and A. The group II signal will belong to the basic subset (II-1 to II-9). During this signal interchange the originating PABX will receive Group A signals only.

On completion of selection, the terminating PABX initiates change-over to groups II and B by sending either:

- Address-complete, basic, change-over-to-groups-II-and-B (A3)

or

- Address-complete, enhanced, change-over-to-groups-II-and-B (A-11).

When working enhanced, the groups II and B will be followed by groups III and group C signals except for conditions such as call-failure.

Supplementary service or calling line identify (CLI) indication in groups III and C will cause change over to groups IV and D.

Certain group IV and D signals cause change-over to III and C.

Register-Recall Signalling

Register-recall provides the means for control-information transfer after dismissal of common control equipment. Register-recall can, as forward or backward recall, be initiated in either direction, regardless of the direction of the original call set-up.

When the common control equipment at the destination or originating PABX is required to be recalled, the forward or backward service-request-recall signal shall be sent. The service-request-recall signal shall not recall the common control equipment of transit switches. However, certain call states may require response by a transit switch on recognition of a service-request-recall signal, eg in a three party call where branching occurs at a transit switch.

When the common control equipment in a transit switch is required to be recalled, the forward or backward link-recall signal shall be sent to the adjacent transit switch.

Following a register-recall signal, the SSMF5 codes will represent group IV and D signals. SSMF5 signalling shall start with a forward group IV signal sent by the PABX that initiated the register recall. No proceed-to-send-on-recall signal is used.

Transit Working

When a transit switch in a private network recognises a seizing signal, it responds by returning the proceed-to-send signal. The originating PABX will send the first address signal (routing digit) appropriate to that transit switch, and on receipt of this address signal the transit switch will request further address signals until sufficient have been received to route the call. When sufficient information has been received, a suitable circuit is seized, the tandem-encountered or alternatively-routed-call signal shall be returned, the SSMF5 registers released, and switchthrough initiated. The transit switch will then be ready for SSMF5 end-to-end signalling through its switch path.

In the case no idle circuit can be found, the routing-congestion signal is returned and SSMF5 signalling with the transit switch concerned is ended.

13.2.3 Outline of Call Control Procedures

Establishment of a call by means of SSMF5 can be considered in three main phases: the selection phase, the subset compatibility check phase and the dialogue phase.

The selection phase, which includes access to an enhanced routing subset * is standard in all SSMF5 applications. It enables establishment of an ordinary call.

The dialogue phase is carried out by one of the following signalling procedures subsets:

- Basic: Provides a minimum interworking capability to enable simple call set-up.
- Enhanced: Provides capability for call set-up plus access to supplementary service procedures.
- Manufacturer: Subsets enabling specific manufacturer's procedures to be used.

Where part of a multi-link call is routed via a non-SSMF5 private circuit, no dialogue phase will take place.

* under study

The particular subset used will depend upon the capabilities of the interconnected PABXs and is determined by the subset compatibility check, which is carried out after the selection phase and before possibly entering the dialogue phase.

When the dialogue phase has been entered, both PABXs exchange information, regarding the originating and destination parties in either basic or enhanced working.

The signalling procedures structure in Figure 12 shows the relationship between the subsets.

In basic working, the dialogue phase interchange is limited to one signal in each direction.

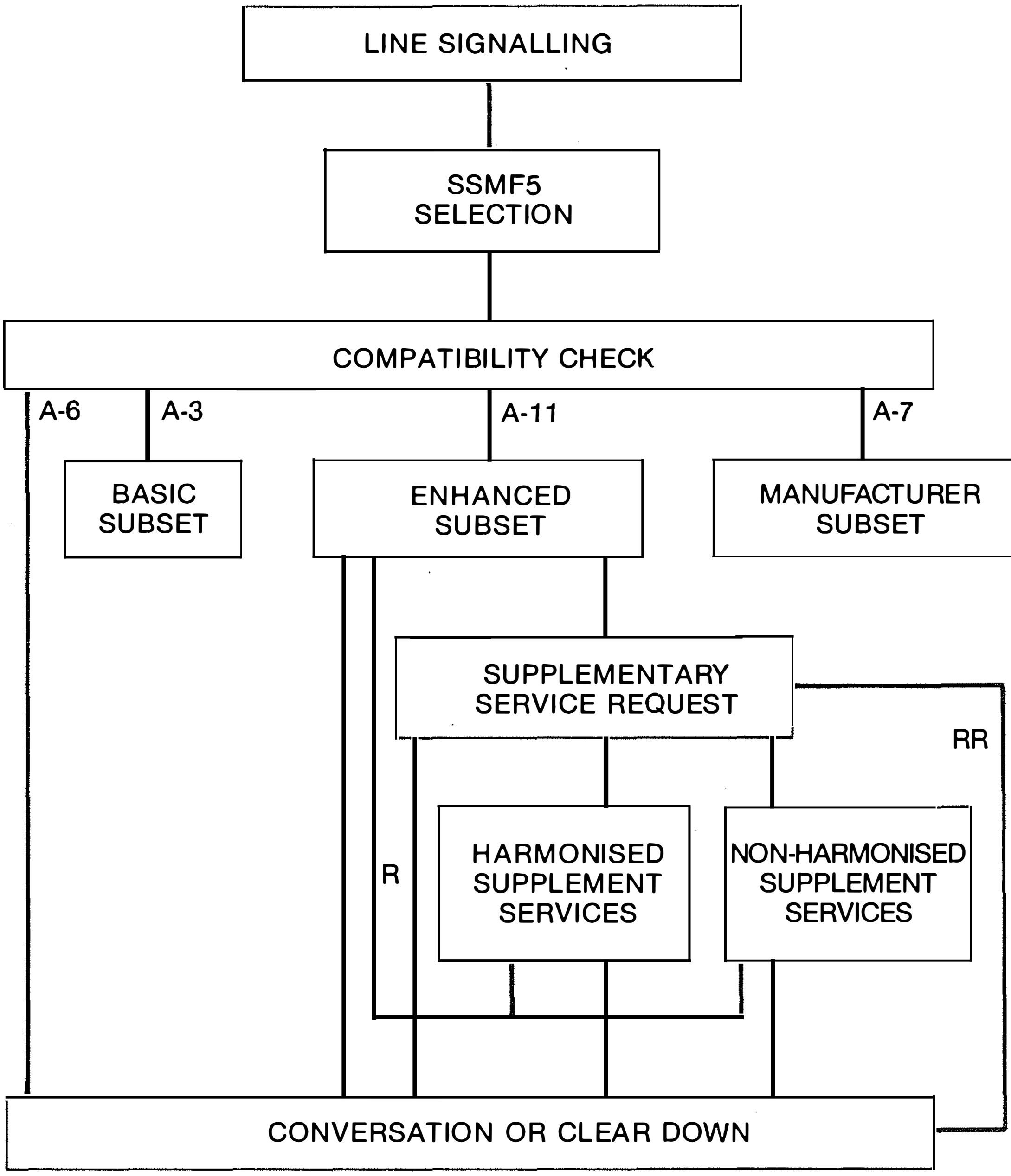
In enhanced working, the interchange involves at least two signals in each direction and may, if a supplementary service is involved, extend to many more, except for states such as parked, where only one signal interchange need take place.

The signal exchange for a supplementary service is a function of the service concerned. The procedures based on supplementary services harmonised by CEPT are specified in Annexes to BTNR 184. Procedures required for other categories of supplementary services, eg defined for national use or marketed by PABX providers, are not covered in BTNR 184. However, provisions are made in SSMF5 to gain access to such procedures.

In basic working, the service-request-recall and link-recall signals are not used.

PABXs with transit functions must be capable of repeating a service-request-recall signal to the next link.

Where a transit switch is not capable of using a link-recall signal, it will take no action on its recognition.



Legend: R = revert
RR = register-recall
A = group A backward signal

Fig 12 SSMF5 Signalling Procedures Structure

Signalling procedures for the selection phase

The selection phase covers all signalling necessary to establish a connection between the originating and terminating PABXs, including the forwarding of the required extension number to the terminating PABX.

The selection phase is entered, following the application of the seizing signal by the originating PABX. The responding PABX on recognition of the seizing signal, prepares to receive MFC signals and applies the proceed-to-send signal.

As a multi-link call is progressively set-up across a network, each transit switch applies a seizing signal to the subsequent link and each responding PABX applies the proceed-to-send signal.

To facilitate network management, backward SSMF5 signals are used during the selection phase to:

- request address signals (routing digits and extension number) one after the other, as required by the transit switch or terminating PABX, from the originating PABX; when all address digits have been sent, the originating PABX responds, if it received a further digit signal (I-15),
- inform the originating PABX of the progress of the call; eg how many transit switches have been encountered,
- inform the originating PABX of alternative routing that has occurred at a transit switch,
- inform the originating PABX that access to the PSTN is about to occur and,
- request entry into the optional enhanced routing subset * in order to influence the routing of the call; eg special quality circuits for data.

Fig 13 shows the selection phase, in arrow chart form.

Signalling procedures for subset compatibility check

On completion of selection, it is necessary for the originating and terminating PABXs to determine whether SSMF5 signalling is going to continue, and if so, which procedure subset is to be used for the remainder of the call handling.

If no further SSMF5 signalling is possible (eg a non-SSMF5 route or PSTN has been encountered by a transit switch), an address-complete, non-SSMF5, set-up-speech-path signal will be sent (A-6).

Where further SSMF5 signalling is possible, the subset compatibility check is initiated by the terminating PABX which applies one of the following signals (see Fig 14).

- Address-complete, enhanced, change-over-to-reception-of-group-B signals (A-11),
- Address-complete, request-subset-identify (A-7),
- Address-complete, basic, change-over-to-reception-of-group-B signals (A-3).

The originating PABX responds by either:

- implicitly accepting the proposed subset (enhanced basic) by sending forward information as shown in procedures for the dialogue phase below.

  or

- implicitly agreeing to attempt entry into a manufacturer subset by sending forward its subset identify digit(s) for subset compatibility checking (the range required and the allocation of subset identify digits is under study),

  or

- rejecting the proposed subset by sending either the enhanced-request-not-accepted or the manufacturer-request-not-accepted signal.

The originating PABX cannot reject a request to enter basic.

On receipt of either a request-not-accepted signal or an incompatible manufacturer subset identity, the terminating PABX will offer another subset. This interaction will continue until a common subset is found (usually enhanced or basic). Fig 14 shows the subset compatibility check in arrow chart form.

Signalling procedures for the dialogue phase

On completion of the subset compatibility check both PABXs enter one of the following procedures subsets.

* under study

Basic subset

The basic subset provides a single signal interchange in which one of the following pieces of information can be sent.

Forward information

Call originates from

- an ordinary extension,
- a restricted signalling capability private circuit,
- maintenance equipment,
- the public switched telephone network (PSTN),
- an operator position,
- data transmission equipment,
- an operator assisting an ordinary extension,
- an operator assisting a PSTN caller, or
- an operator assisting a restricted signalling capability private circuit.

Backward information

The destination is:

- in a parked state
- barred PSTN calls,
- busy with intrudable status;
- temporarily out-of-service; unallocated number,
- free with intrudable status,
- free with non-intrudable status,
- barred to incoming calls, or,
- busy with non-intrudable status.

In addition there are signals to indicate:

- terminating-PABX congestion and
- terminating-PABX call failure.

The exchange of additional information using basic is shown as the last two signals in Fig 14.

Enhanced subset

Exchange of calling and called party information

In enhanced working, the exchange of calling and called party information is by means of two signal interchanges. The first signal interchange (groups II and B) conveys the following pieces of information, in addition to the items listed under basic subset.

Forward direction:

Call originates from:

- the network,
- an ordinary extension holding a PSTN call,
- an executive extension, or,
- the ISDN.

Backward direction:

The destination is:

- an operator position,
- busy with partially-intrudable status,
- free with partially-intrudable status,

or,

- in a state with no applicable state of destination.

The second signal interchange (Groups III and C) enables further qualifying information to be exchanged, such as whether the call has been diverted, whether or not it may partially be intruded upon, whether the called party is barred access to the PSTN and whether further SSMF5 signalling is required by either PABX, eg supplementary service control information, or calling line identity.

The exchange of additional information using enhanced is shown in Fig 15 in arrow chart form.

Simple call

Following the exchange of additional information, and assuming that no supplementary services are required, the SSMF5 registers release and leave the connection under the control of line signals.

Supplementary services

In addition to establishing a call, SSMF5 enhanced signalling procedures are specified to provide access to supplementary services during the exchange of additional information before the SSMF5 registers release. The supplementary service category concerned will be determined by a supplementary service request procedure.

Forward supplementary service request

When the originating PABX requires a supplementary service it indicates this with a group III signal (III-5 to III-12). Upon recognition of this signal the destination PABX responds with the request-forward-supplementary-service category signal (C-15). This provokes change-over to group IV and D signals which are used for two SSMF5 compelled cycles dedicated to the category and supplementary service identification.

Backward supplementary services request

The destination PABX changes over to group IV and D signals by transmission of one of the signals C-7 to C-14. The response on C-7, C-8, C-10 and C-13 shall be the signal IV-15 requesting the backward supplementary service category and identity. Two cycles are used as with forward supplementary service request. The signals C-9, C-11, C-12 and C-14 initiate the sending of the calling line identify.

The above arrangements allow transmission of a range of at least 15 × 15 codes in both directions. By using Code 10 as an escape, extension is possible. The allocation of the codes to identify category groups and specific supplementary services is for further study.

Forward supplementary service requests are given priority over backward requests and, depending upon the capability of the PABXs concerned, any number of requests can be processed sequentially until neither PABX has an outstanding requirement for further SSMF5 signalling (see **revert** on Fig 12 and **sequential processing of supplementary service requests**).

Supplementary service requests can also occur after the release of SSMF5 registers, either before of after answer (**see Supplementary Services after Register Release** see below).

Signalling procedures specifications for non-harmonised supplementary services defined by a manufacturer are not shown in BTNR 184.

The relevant documentation will be provided by the manufacturer concerned. Harmonized supplementary services used in the UK and other European countries subscribing to CEPT recommendation are detailed in Annex to BTNR 184.

Calling line identity

Calling-line identity (CLI) requests normally occur as a part of the call establishment procedure by means of one of the following backward signals:

Send-CLI (Signal C-9)
Send-CLI, PSTN-barred (Signal C-11)
Send-CLI, non-intrusion-request-rejected (Signal C-12)
Send-CLI, PSTN-barred, non-intrusion-request-rejected (Signal C-14)

Since the calling line identity request is liable to occur on a large number of calls, the necessary signals are included in the main signalling procedures, and are not included in an Annex to BTNR 184 like other supplementary services. This reduces the number of signals required and consequently shortens the post dialling delay.

On completion of the calling line identity request, the responding PABX, dependent upon its capability, either concludes SSMF5 signalling, or retains its SSMF5 registers to offer a subsequent supplementary service.

Signal flows for calling line identity request are shown in Fig 18.

Supplementary services after register release

Where a supplementary service is required after the MFC registers have released, a register-recall signal will be used. Following a register-recall signal, both PABXs will automatically commence signalling in Groups IV and D. The PABX that sends the register-recall signal will be considered the initiating PABX in terms of SSMF5 and will commence the signalling procedure by sending a group IV signal.

Signal flows for forward supplementary service requests are shown in Fig 17.

Signalling within supplementary services

The subsequent signalling flows within a supplementary service depend upon which supplementary service is requested. Details will be given in the relevant Annex to BTNR 184 as they are agreed upon.

Rejection of supplementary service requests

Where a PABX cannot provide the service that has been requested, it shall return a request-not-accepted signal, and depending upon its capability, either concludes SSMF5 signalling or retains the SSMF5 register to give an opportunity for an alternative service to be requested.

Sequential processing of supplementary service requests

During a call it is possible, although improbable, that more than one service demand will need to be processed at a given time. Examples of this are listed below.

- Clash of supplementary services: an incoming call has diversion-override capability and the called party has diversion activated.
- Second attempt: A Harmonised supplementary service or calling line identification is required, following an unsuccessful attempt to request a manufacturer-specific enhancement.
- Enhancement of a supplementary service: following a supplementary service request the PABX wants to change-over to user for a manufacturer-specific enhancement.

To enable a number of supplementary service requests to be processed sequentially, the following signals are included in groups IV and D.

OK, change-over-to-groups-III and C	D-13
Request-not-accepted, change-over-to-groups III and C	D-14
OK, further-MFC-signalling-possible	IV-13
Request-not-accepted, further-MFC-signalling-possible	IV-14
Acceptance-acknowledged, change-over-to-groups-III and C	D-13
Rejection-acknowledged, change-over-to-groups-III and C	D-14

These signals, which may be used either on completion of a supplementary service or on rejection of a service request, return the signalling to groups III and C allocations, thus enabling the PABXs to either request a further service or conclude SSMF5 signalling.

On each return to Group III and C signalling, the originating PABX has priority. When the originating PABX has no further requests to make, it sends a no-further-supplementary-service-request signal (III-15). The responding PABX, on receipt of this signal, either sends a supplementary service request or concludes SSMF5 signalling by sending a conclude-SSMF5 signalling system C-1.

Manufacturer subset

When the subset compatibility check has identified a common **manufacturer** subset, call handling continues in accordance with the appropriate specifications. However, once **manufacturer** subset procedures have been entered it may still be possible to revert back to standard SSMF5 working.

The signalling procedures within **manufacturer** subsets are not given in BTNR 184 and the relevant documentation should be provided by the manufacturer concerned.

CEPT Harmonized Supplementary Services Subset

At the time of publication the following CEPT Harmonized Supplementary Services are described in BTNR 184:

- Automatic Number Identification
- Diversion
- Call Offer
- Call Back

PBX facilities are constantly evolving and SSMF5 has been designed for future growth. The following supplementary services are under study for inclusion in latter issues of BTNR 184:

- Executive Intrusion
- Operator Intrusion

The ability to support basic working ie set up a simple telephony call is mandatory for any PBX claiming SSMF5 capability. All supplementary services however are optional. The range supplied, and whether a manufacturers sub-set or a CEPT Harmonized enhanced sub-set is provided, must be agreed between the customer and his PBX supplier.

SSMF5 Signalling Sequences

The signalling sequences for a Simple Telephony Call and up to and including a supplementary services request is shown in Figs 13 to 18. For signalling sequences for specific supplementary services, refer to manufacturers documents for manufacturers sub-set and to Annex to BTNR 184 for CEPT Harmonized supplementary services.

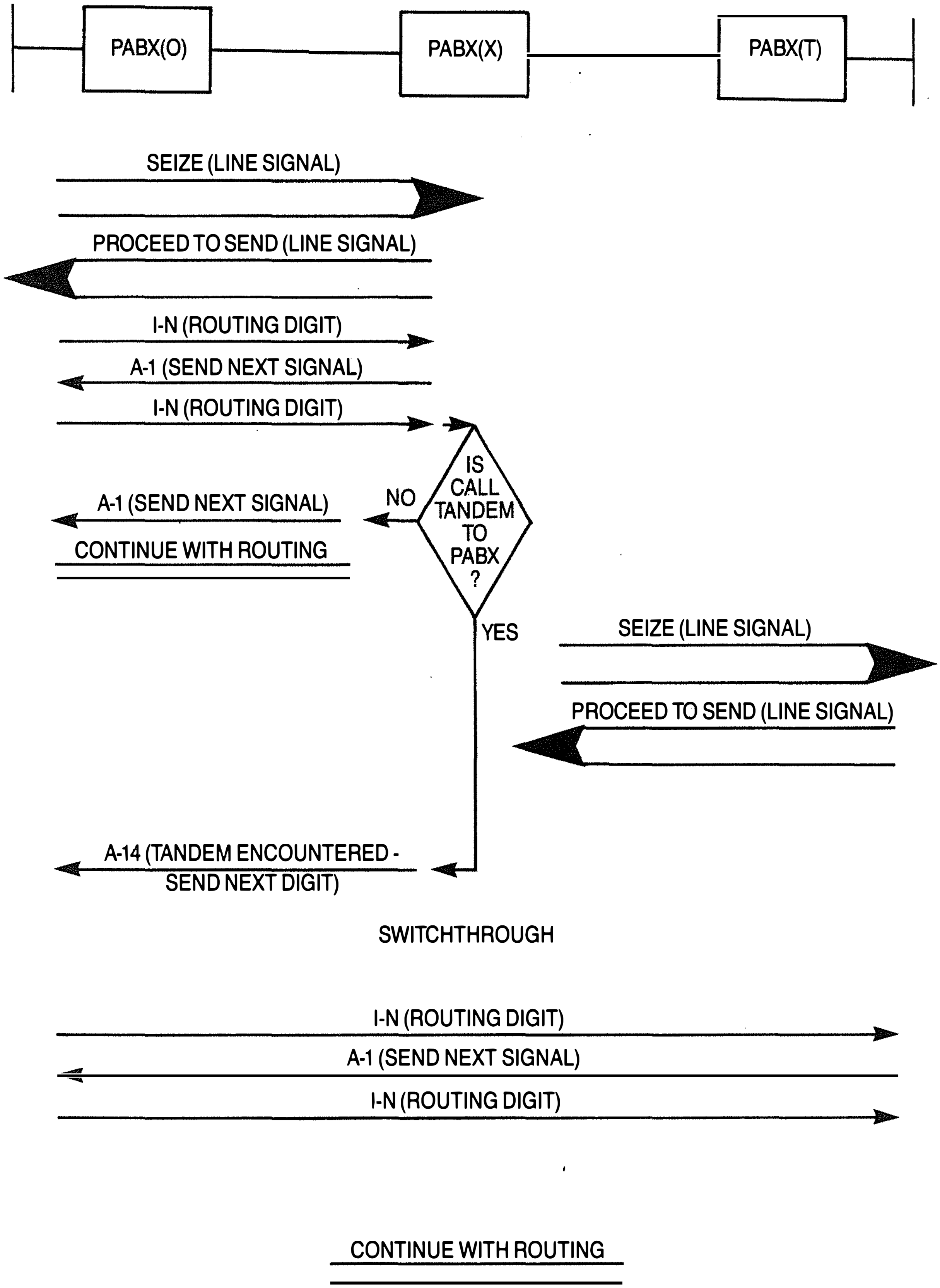


Fig 13 Routing via a transit PABX

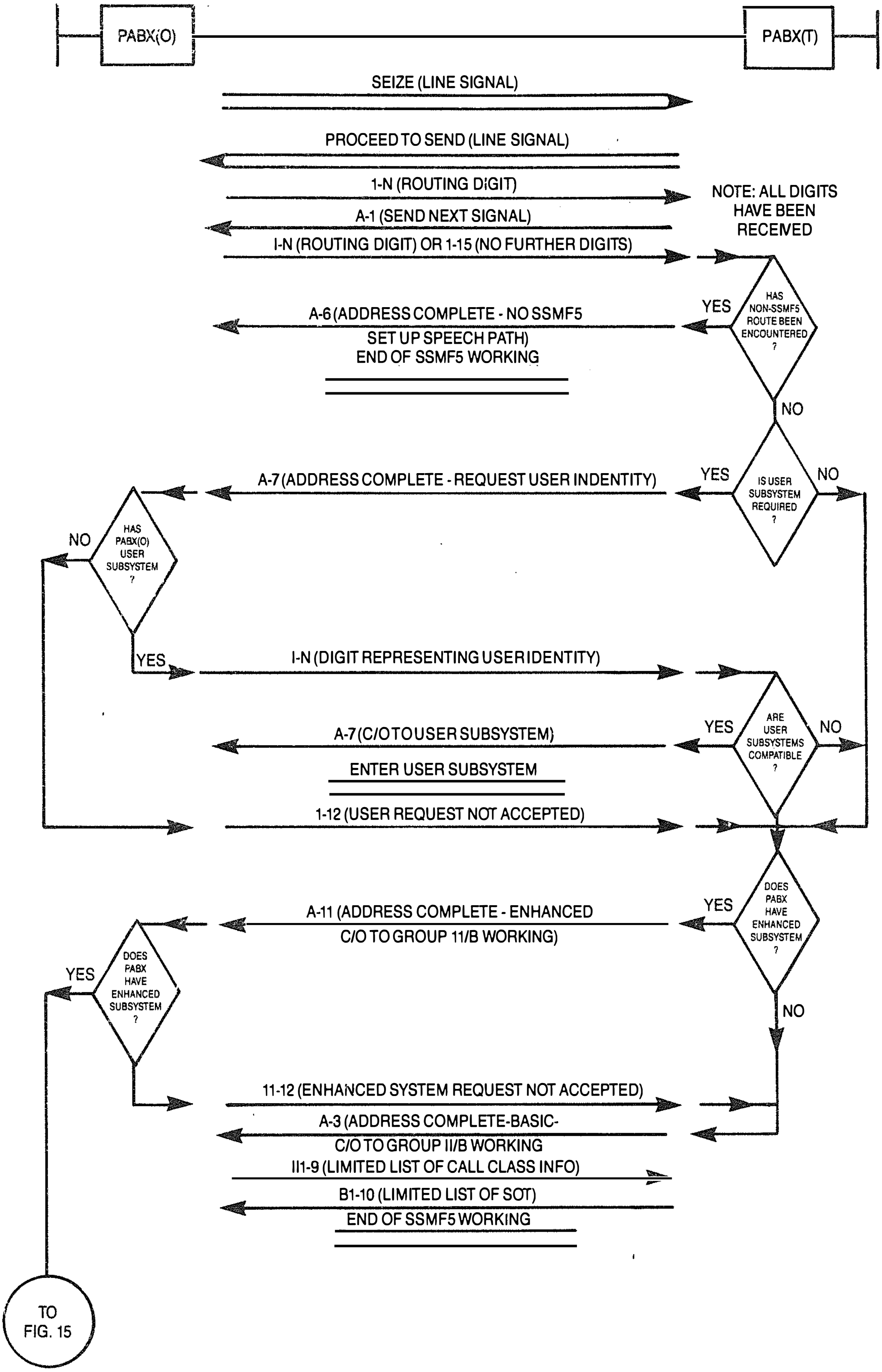


Fig 14 Compatibility check procedure

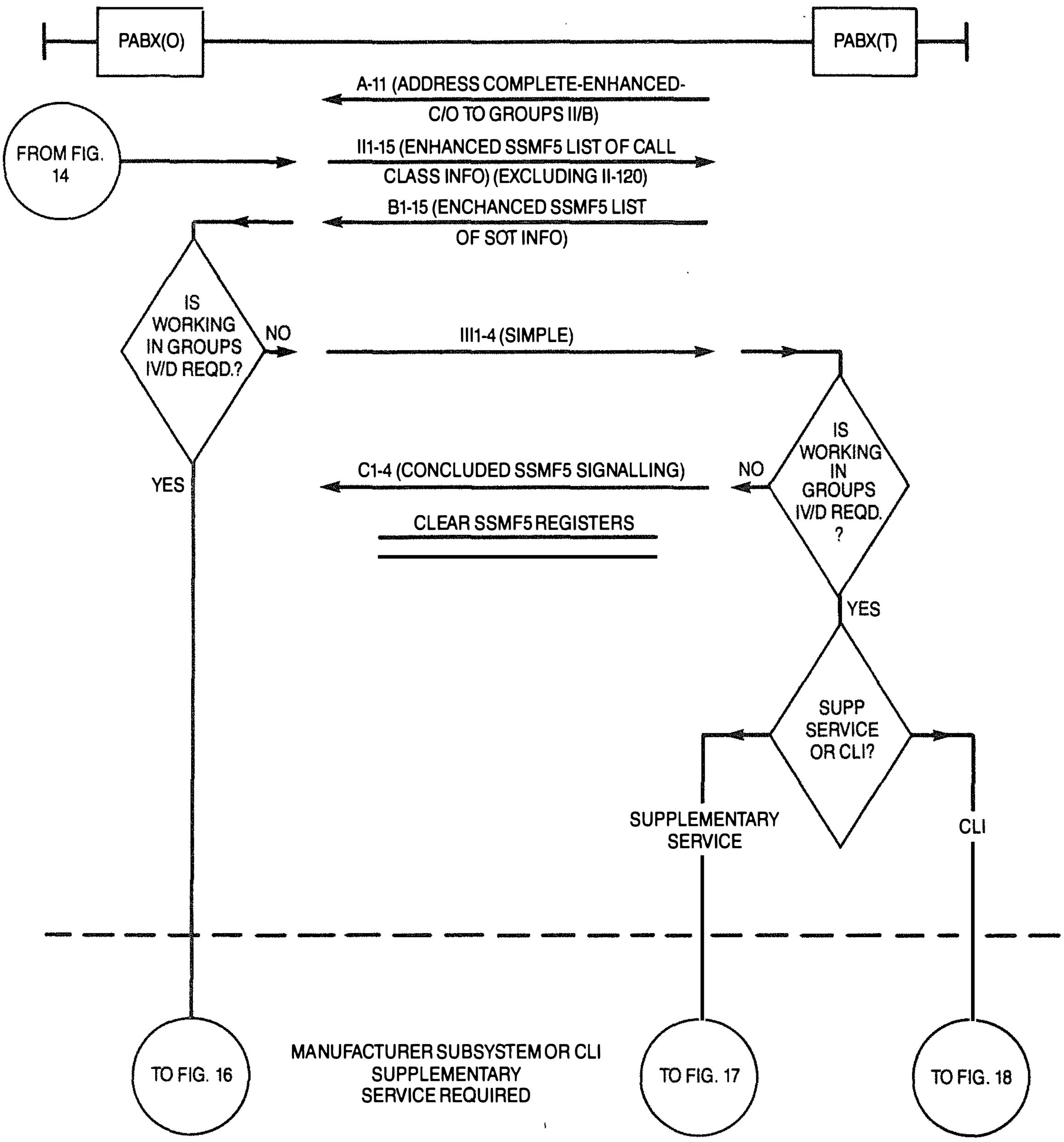


Fig 15 Exchange of SOT/COS information (enhanced SSMF5 subsystem)

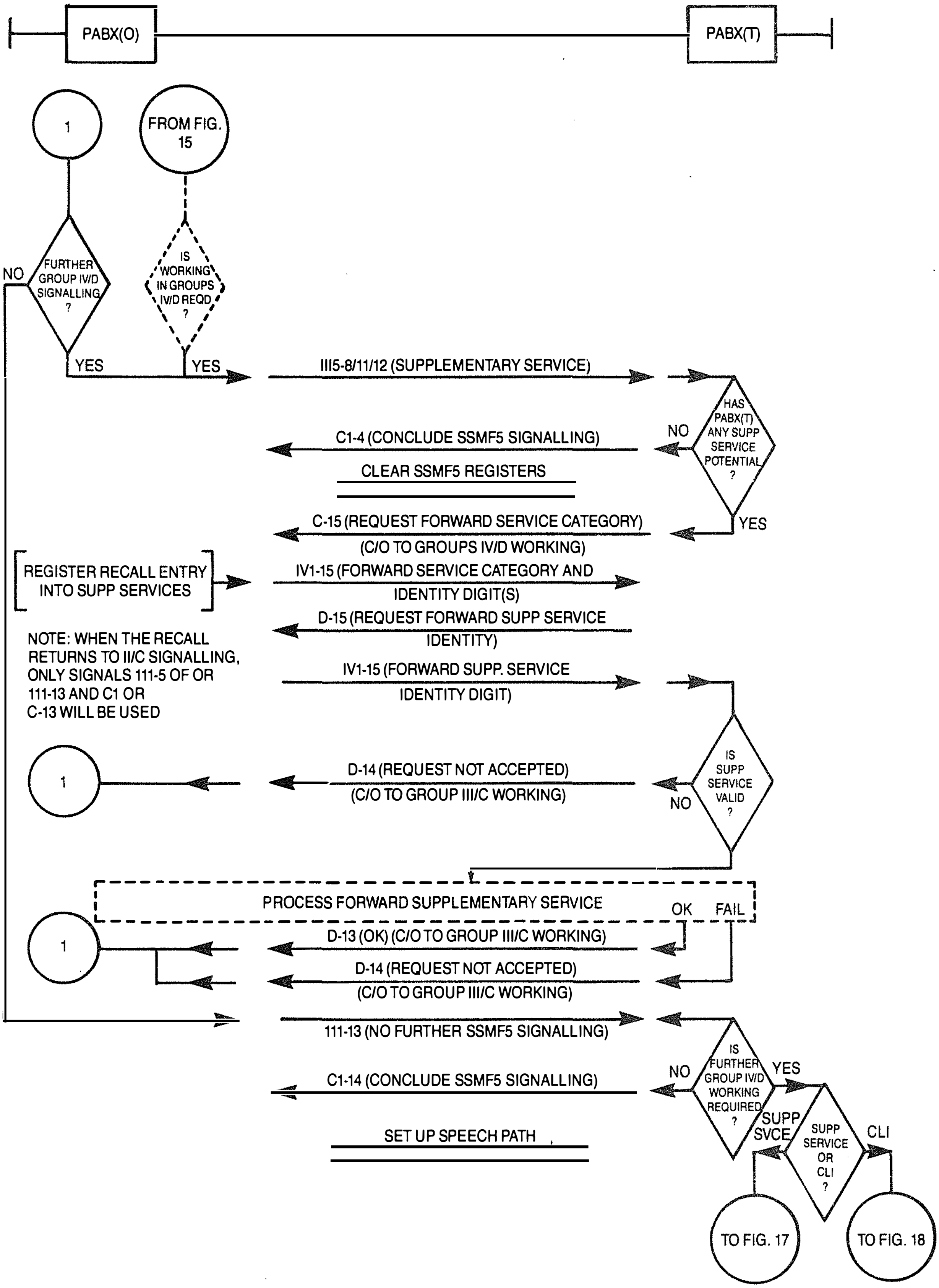


Fig 16 Forward supplementary service request

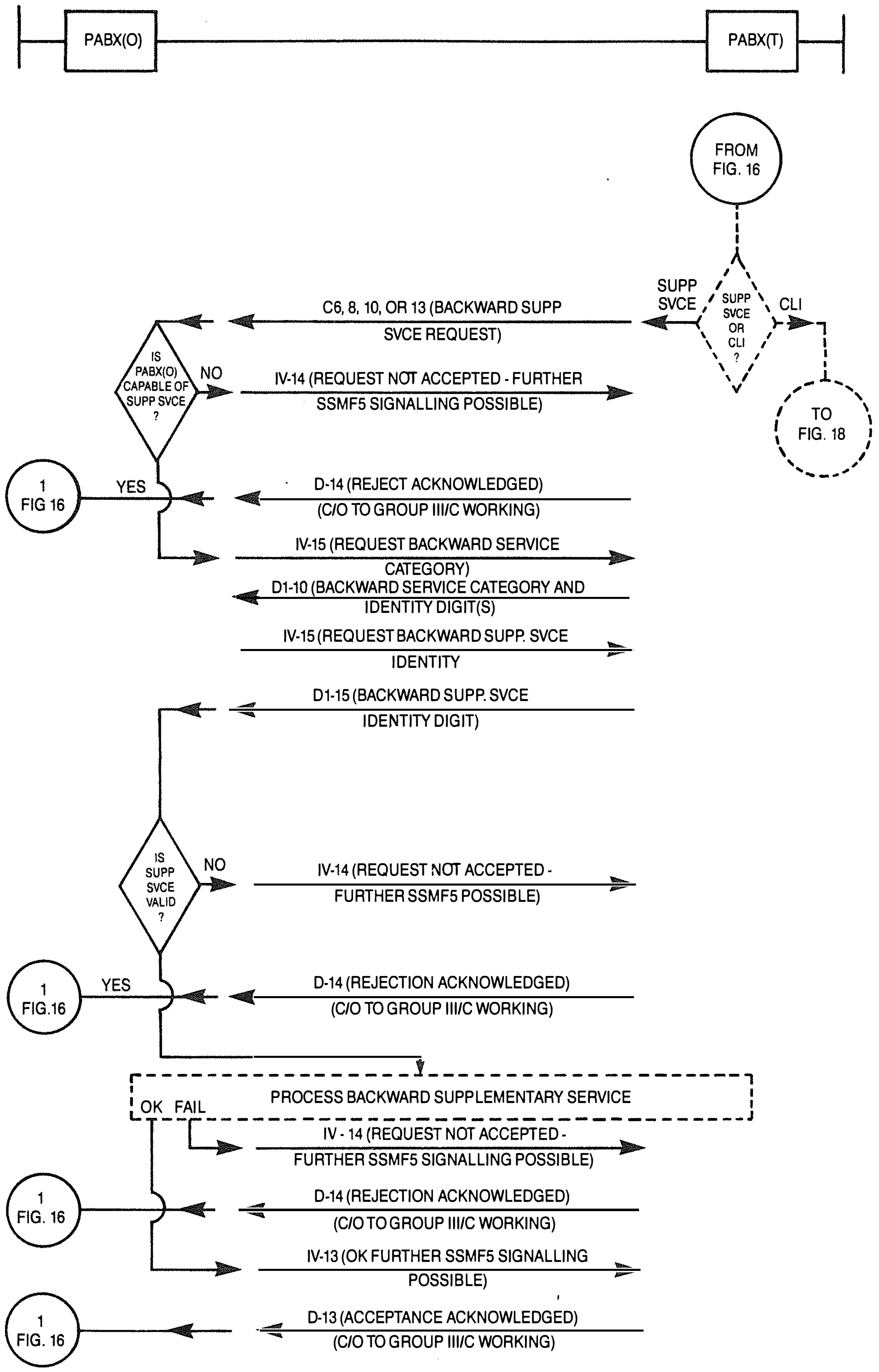


Fig 17 Backward supplementary service request

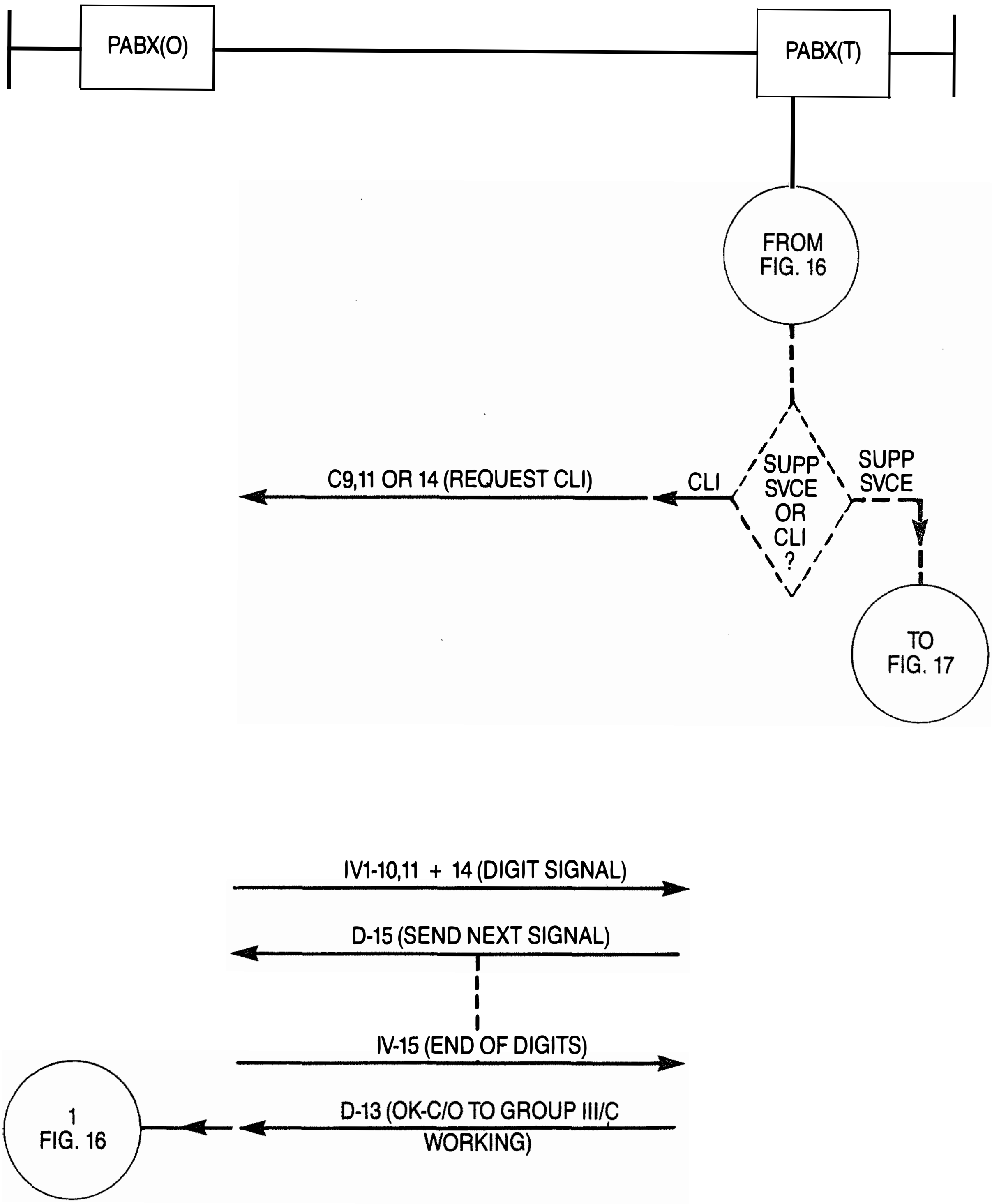


Fig 18 Calling line identity request (CLI)

13.3 Signalling System Multi-Frequency No. 4(SSMF4) — Use as an Inter-PBX Signalling System

General Description

SSMF4 is a signalling system whose primary purpose is to transmit address information from a push-button telephone to the PSTN local exchange or to a PABX extension line circuit. However, the system may be adapted to provide fast call set up over an inter-PBX circuit, signals being sent from the common processor equipment (CPU) in one PABX to the CPU in another PABX. See Fig 19.

The signal frequencies are arranged in two groups of four frequencies, and each signal consists of two frequencies, one from the low frequency group and one from the high frequency group. There are therefore up to sixteen discrete signals, all in the forward direction.

Unlike SSMF5, SSMF4 does not support any supplementary services neither does it contain any call management signals; it may be used only to set up a Simple Telephony Call.

SSMF4 operates in the forward direction only, there being no backward signals. It does not therefore have the security of a compelled signalling system, such as SSMF5.

Calls are established on a link by link basis. If tandem working, using SSMF4, is required the signals are regenerated at each intermediate PABX.

Its use as an inter-PBX signalling system is primarily to provide an inexpensive form of fast call set up. The SSMF4 Senders and Receivers may very well already be provided on a PBX to enable SSMF4 signalling from extension telephones to the PBX and to enable SSMF4 signals to be transmitted to the PSTN local exchange. The extra cost to provide inter-PBX working is likely to be small.

SSMF4 provides routing information only. It must be supported by a suitable line signalling system to provide supervisory signals ie seizure, answer, clear.

The Senders and Receivers in the PBX should conform to the requirements described in CEPT Recommendation T/CS 46-02 Multi-Frequency Signalling System to be used for Push-Button Telephones.

Outline of Operation

The common equipment in a PBX receives the routing information from an extension telephone either in 10 PPS form or as SSMF4 signals. If the digits received indicate that an inter-PBX route is required the appropriate outgoing line is seized and a SSMF4 sender in the CPU register is connected to this line. The required routing digits are re-transmitted over the line in the form of SSMF4 signals according to the code shown in Table 12.

Depending on the capability of the distant PBX, a pre-sending pause is introduced of the appropriate length to allow the distant SSMF4 incoming Receiver to become associated.

When all digits have been sent the common equipment releases.

SSMF4 signals can be transmitted over one inter-PBX link only. Calls are therefore set up on a link by link basis and if tandem working is required the SSMF4 signals are regenerated.

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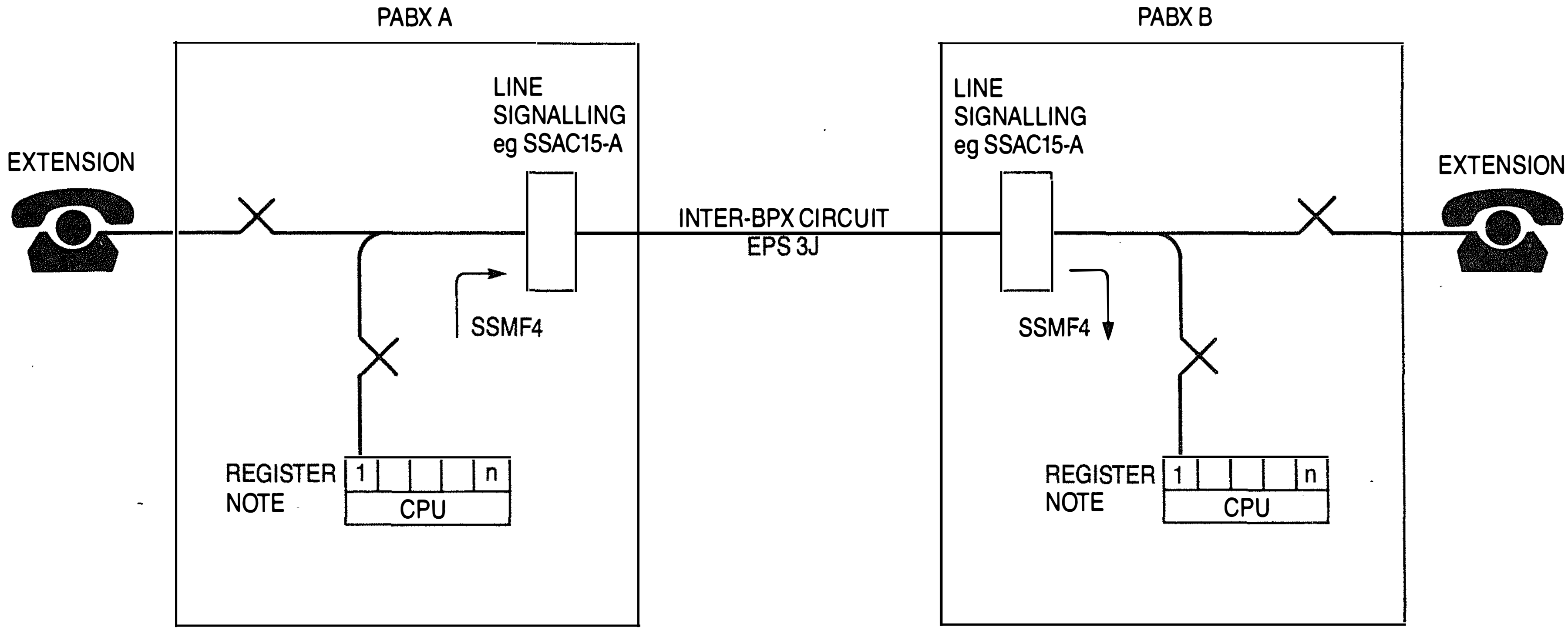


NOTE: The SSMF4 Senders & Receivers are contained in the Registers associated with the CPU.

Fig. 19 SSMF4 Between PBX's Call Set Up in the Direction A to B

A clear distinction must be drawn between the simple SSMF4 inter-PBX signalling system used in the United Kingdom and System L1 Multi-Frequency Push-Button Inter-Register Signalling for inter-European use. This latter system, described in CEPT Recommendation T/CS 49-04, whilst using the same MF signalling frequencies and signal codes, has a larger repertoire of line signals than SSMF4. It may also be used in a bi-directional form, in which case it includes a dialogue phase, MFPB signals being exchanged in both directions.

At the time of publication, system L1 MFPB Inter-Register Signalling is not in use in the UK and a description is not therefore included in this issue of the handbook.

SSMF4 Signal Frequencies and Codes

Signal Frequencies:

The signal frequencies are selected from two separate groups within the speech band (300-3400 Hz), a low group and a high group, each group providing four signalling frequencies. These frequencies are:-

— low group frequencies: 697, 770, 852, and 941 Hz
— high group frequencies: 1209, 1336, 1477, and 1633 Hz

Signal Format:

Each signal consists of two and only two of the signalling frequencies; one frequency from each of the low and high groups. Both frequencies are applied simultaneously in parallel across the line.

Signal Code:

The 16 discrete signals are allocated as shown in Table 12.

Table 12 High group frequencies

	Hz	1209	1336	1477	1633
Low group frequencies	697	1	2	3	A
	770	4	5	6	B
	852	7	8	9	C
	941	*	0	#	D

Table 12 gives the full allocation of signal codes. The system may be utilized with only 10 discrete signals, in which case the signals designated *, #, A, B, C and D will not be used; or with 12 discrete signals, in which case the signals A, B, C and D will not be used.

Sending SSMF4 Signals

The SSMF4 Sender is located in a Register associated with the Common Processor Unit (CPU), it is connected to the outgoing inter-PBX circuit whilst SSMF4 signals are being sent and then released.

Signal Out-Put Requirements

Frequency Tolerance:

The output frequencies are maintained within ±1.5% of the values shown in Table 12.

Sending Level:

The sending levels are:

— the high frequency group — 9 dBMO ±2 dB
— the low frequency group — 11 dBMO ± 2 dB

With a restriction that the level of the higher frequency component of the compound signal is 2 dB ± 1 dB above the level of the lower frequency component.

The send levels are chosen such that the average power levels of two signals (– 9 dBMO and – 11 dBMO) combined equal – 7 dBMO. To this may be added an Activity Factor of – 6 dBMO, this gives an average power level for the two signals combined of – 13 dBMO. This level conforms with the transmission loading requirements of BT HF line plant and CCITT recommendation Q15.

The high frequency group of signals are transmitted with a pre-emphasis of 2 dB to take account of the probability of a higher attenuation on BT lines at the higher frequencies. A tolerance of 1 dB is specified since it may be assumed that a drift in the power levels of the two single frequency components will be correlated.

Signal Timing:

The duration of the signal transmitted is 70 ms ± 5 ms with a minimum inter-digit pause of 65 ms.

Receiving SSMF4 Signals

The arrival of a frequency combination consisting of 2 frequencies as shown in table 12 will be subject at the receiving PBX to the following checks:

- A signal persists for 40 ms or longer
- A signal will be recognised as having terminated if it ceases for 20 ms or longer.
- Two and only two frequencies are present one of each of the low and high frequency groups as shown in Table 12.
- Each of the two frequencies is within ± (1.5% + 2 Hz) of the nominal value. The + 2 Hz component takes account of frequency shift due to any FDM system in the inter-PBX link.

Receiver Guarding:

The SSMF4 Receiver is designed to give a degree of immunity to false operation due to speech, crosstalk etc large enough to operate the Receiver. This is clearly particularly necessary when SSMF4 is used in its normal mode for signalling from a telephone to the exchange. When SSMF4 is used as an inter-PBX signalling system however, since the near and far end transmission paths are disconnected during signalling, the conditions are not so onerous. As the Receiver design is normally common for both applications, for completeness, the guarding requirements are described below:

The two signal frequencies will be recognised so long as the total power level in accompanying frequencies do not exceed the values shown in Table 13 at the Receiver path termination.

Table 13

Accompanying frequencies	15 Hz-33 Hz	33 Hz-300 Hz	300 Hz-480 Hz	480 Hz-3400 Hz	> 3400 Hz
Total power of accompanying frequencies	+24 dBM	Falling at 20 dB per octave	−41 dBM	20 dB below the received level of the low freq group signal or −41 dBM whichever is higher	−34 dBM rising at 6 dB per octane to a level of +10 dBM

Transmission Requirements

The Standard SSMF4 Receiver is designed to operate over a local line with a maximum insertion loss at 1600 Hz of approximately 10 dB. The minimum send level of the SSMF4 sender is −12 dBM (low frequency group); so the maximum sensitivity of the Receiver at −25 dBM is suitable for this purpose. The same Receiver will normaly be used for inter-PBX working. To ensure that the SSMF4 signals, when received over an inter-PBX circuit, meet the requirements of the SSMF4 receiver, both for minimum level and level difference between the two frequency components, signalling must be confined to one inter-PBX link only. If tandem working is required the SSMF4 signals must be regenerated at each intermediate stage. Circuits to BT EPS3J Standard must be used to provide the appropriate loss and frequency/attenuation characteristics.

Application

Many modern Stored Program Control PABXs can be adapted to provide SSMF4 signalling over inter-PABX circuits and some customers will find this an attractive option. A number of BT PABXs can provide this facility, see Section 15 Table 11 and subject to Department of Trade and Industry approval, the option may be offered to customers as an alternative to 10 PPS signalling, where fast call set up is required.

End of Section 13

Private Circuit Services Signalling Handbook

Section 14 — Standard Inter-PBX Signalling Systems

British Telecom have developed three families of Standard Analogue Line Signalling Systems — SSDC10, SSDC5 and SSAC15, see Section 12, and one standard digital common channel signalling system — DPNSS1, for inter-PBX working, described in Section 13.1.

In addition there is a Standard Multi-frequency Code inter-register signalling system which is supported by one of the standard line signalling systems. This system, known as SSMF5, is described in Section 13.2. All these systems have a standard signalling protocol, defined in BTNR documents so that inter-working is guaranteed. One or other of these systems should always be considered as a preferred choice unless there are overriding reasons for choosing an alternative.

BT Standard Inter-PBX Signalling Systems

Those systems defined in BTNR documents and in general use are:-

SSDC10-A. This is the only system in this generic family to be defined and to be generally available. The B and D versions are generally not necessary since the facility can be covered by the provision of SSAC15-B and SSAC15-D.

SSDC5-A. This is the only system in this generic family to be defined and to be generally available, but SSDC5-B and SSDC5-D have been developed for certain PBXs. The protocol can be deduced from that for SSAC15-B and SSAC15-D. In addition SSDC5-D can be provided on any PBX with an SSDC5-A interface using an SSDC5-A/SSDC5-D signalling converter (Signalling Unit No. 46A) this is described in Section 17.

SSAC15-A, SSAC15-B, SSAC15-D. These systems are all defined in BTNR documents. SSAC15-A is generally available and SSAC15-B and SSAC15-D are available on specific PBXs. See Sections 15.4 and 15.6 for availability on BT PBXs. In addition SSAC15-D can be provided on any PBX with an SSDC5-A interface using an SSDC5-A/SSDC5-D signalling converter (Signalling Unit No. 46A) in association with a Signalling Unit No. 44B.

DPNSS1. This digital common channel signalling system is fully defined in BTNR documents. See Section 15.6 for availability on BT PBXs.

SSMF5. This system is defined in BTNR documents. It has been developed for a number of PBX types. For availability on BT PBXs see Section 15.6. It is an inter-register signalling system used to convey address and supplementary services information only and therefore has to be supported by a standard line signalling system, for example SSAC15-B.

Standard Signalling Protocol

Each of the standard inter-PBX line signalling systems has a suffix A, B or D which defines the signalling protocol eg SSAC15-A has the same signalling protocol (or language) as SSDC5-A. The choice of a particular protocol will depend on the facilities required by the signalling system and the facilities available on the PBXs concerned. For example SSAC15-B is required to support SSMF5 as it provides for the appropriate register recall signals. And SSAC15-D is required on certain international circuits in order to match the signalling facilities of overseas PBXs.

Manual Signalling as Preferred System

There are certain circumstances when Manual Signalling may be the preferred system. One example would be an international circuit where it may be the only system mutually recognised by the two countries concerned. Another might be where alternative speech/data is required and the complications presented by switching automatic signalling circuits presents an obstacle (see Section 20 on Alternative Speech/data). In addition manual signalling is common on the older PBXs, particularly PMBXs. The first choice for manual signalling should be Manual Balanced Battery (M/BB) and the second choice should be Manual Alternating Current (M/AC).

Manual Signalling should never be provided on PSTN access circuits since through clearing to the PSTN is required on such circuits. It should also be avoided when the circuit forms part of a tandem network due to difficulties arising from lack of through clearing.

End of Section 14

Private Circuit Services Signalling Handbook

Section 15 — Selection of Inter-PBX Signalling Systems

15.1 Selection of Signalling Systems

The selection of the signalling method will depend on:-

a. the type of signalling required by the customer (Manual or Automatic) and as permitted by the EPS and the customer's terminal equipment arrangements

b. the routing (type of plant availability, physical or HF (FDM or PCM)

c. the preferred method, if a choice is available

d. whether the circuit is to be tandem connected with any other circuits, see Section 18

e. the Department of Trade and Industry Approval status of the selected signalling system on the PBX concerned.

The circuit designer should have regard for the type of plant over which the circuit may be routed, particularly if the circuit is over 11 km chargeable length. The increasing penetration of HF PCM systems into the junction network on routes of 11 km and over requires the circuit designer to ensure that a signalling method that requires a dc path is not chosen if planned plant re-arrangements might necessitate the circuit being re-routed over PCM plant within a few years.

The circuit designer should consult with the cable planning group for information about a particular cable route. BT has an obligation to continue to provide a signalling facility, where it is BT provided and any subsequent re-arrangements of plant necessitating a change or re-design of signalling method could prove less economic than selecting a signalling system, suitable for use over HF (FDM or PCM), at the outset.

If a customer requires BT to maintain his privately provided signalling equipment the customer's attention should be drawn to BT policy on dc signalling paths as set out in Section 9. The customer should be advised against selecting a signalling method requiring a dc path if known future planned plant re-arrangements are likely to cause him to have to change his signalling equipment and thereby incur an overall cost penalty.

NOTE: PCM channels do not offer a continuous dc path, but some PCM Signalling Units have been developed for private circuits and for use with 30 channel PCM systems which will permit dc signalling to be used (see Section 17). DC signalling cards for 24 channel systems will not be produced.

Where a customer uses a dedicated 30 channel PCM System then DPNSS1 (Digital Private Network Signalling System No. 1) is indicated so long as the PBXs concerned are capable of providing it.

A number of types of signalling may provide the required facilities and signal satisfactorily over the distance and type of circuit to be provided. However on older PBXs some signalling systems are technically unsatisfactory and are only retained in the signalling tables because other more satisfactory systems are not available on the PBX concerned.

Choice of Signalling System for New Routes

Signalling system choice will depend upon the combination of terminating equipment at the customers premises.

15.1.1 PABX to PABX, PMBX, HES or K&LU

Automatic signalling should always be chosen. On PSTN access circuits automatic signalling is compulsory to facilitate through clearing to the PSTN and it is also desirable on inter-PBX private circuits forming part of a customer's private network. The primary selection is made from the Selection Charts in Figs 1 to 6. If the preferred method of signalling is not available on the PBX concerned an alternative should be chosen in the following order of preference:-

a. SSDC10 (SCDC on older PBXs)

b. LOOP but only if SSDC10 is not available

c. SSDC5 (on customers private groups only)

d. SSAC15 (or SSAC13 under the conditions described in Section 12.7).

NOTE: Digital Private Network Signalling System No. 1 (DPNSS1) will be a first choice given the circumstances described in Section 15.3, Note 22.

15.1.2 Any Combinations of PMBXs, HESs and K&LUs

The primary selection is made from the Selection Charts in Figs 1 to 6. If the preferred method of signalling is not available on the PBX concerned an alternative should be chosen in the following order of preference:-

a. SSDC10 (SCDC on older PBXs)

b. LOOP but only if SSDC10 is not available

c. SSDC5 (on customers private groups only)

d. M/BB or M/AC

e. SSAC15 (or SSAC13 under the conditions described in Section 12.7).

A/WE is not a preferred signalling system and it has only been retained for use between BECB10 and HES3 and 4 because of the limited signalling interface equipment available for the BECB10.

15.1.3 Key Systems without Inter-PBX Facilities connected to PABX and PMBX

Key systems without inter-PBX facilities must be treated as a Special Case. It is possible to provide inter-PBX working on these systems so long as the system concerned provides a Standard Loop calling exchange line port with outgoing dialling or MFPB.

The facility may be provided by means of a circuit between an exchange line port on the key system and an extension port at the distant PBX. Outgoing calls from the key system are made by an extension selecting the designated exchange line port by depressing the appropriate key and sending address information into the extension port at the distant PBX to route the call. Incoming calls to the key system are received by a calling condition on the designated exchange line port, the call then being transferred as required to the wanted extension. The BT Ensign system is an example of the use of this method of providing inter-PBX working. For availability on BT systems in general see Table 10.

Limitations on Use

In general PSTN access is not permitted over this type of circuit. Reference should be made to the approval status of the key system concerned.

Transmission Requirements

Standard EPS should be used as for any other Private Circuit. The quality of circuit will be determined by the customers requirements, the signalling system used and whether tandem working is involved.

Method of Signalling between Key System and Distant PBX

The method of signalling chosen will be subject to the same constraints as those for external extensions. (Refer to Section 16) but the general rules to follow are:-

a. Circuits within the signalling limits of the exchange line port and the extension port at the distant PBX, and within the transmission limits required by the customer or imposed by tandem working, may be connected directly on a 2-wire basis.

b. Circuits outside the signalling and/or transmission limits described in (a) but within 2000 ohm loop resistance and no more than 5 dB outside the required insertion loss, may be connected on a 2-wire basis making use of Line Extenders LEA2/- and LES1/4A.

c. Circuits requiring a 4-wire transmission path should make use of SSAC15-C signalling. Use of Signalling Units No. 53A (at extension port) and No. 54A (at exchange line port) is recommended.

Choice of Signalling Systems for Existing Routes

Signalling systems having different facilities or requiring different operating procedures must not be used on the same route. When new circuits are added to an existing route the signalling system used on the new circuit should be the same as that used on the existing circuits provided it is a standard method and meets any tandem network requirements where applicable. Otherwise the new circuit signalling should be chosen in accordance with the instructions for new routes, and Section 18 for tandem considerations, to give the same facilities as the existing circuits. On routes with mixed signalling all record cards should make it clear that the route is mixed signalling with details of the system being used on each individual circuit.

15.2 Procedure for Selecting Signalling System

Primary Selection

Figs 1 to 6 are a series of Selection Charts which will enable a primary selection of the most suitable signalling system to be made for a given set of circumstances.

Final Selection

Having chosen the most suitable signalling system from the Selection Charts, reference should now be made to Tables 3 to 11 to establish whether this signalling system is available on the PBXs concerned.

Older and Obsolescent BT PBXs

Information on the availability of signalling on older BT PBXs is contained in Tables 3 to 5. If the signalling system chosen under primary selection is not available on one or other of the PBXs concerned the next most suitable signalling system should be chosen. Table 2 should be referred to to assist in this process.

Modern BT PBXs

Information to identify the signalling equipment on modern BT PBXs is contained in Tables 9 to 11. In most cases the standard inter-PBX signalling systems are available on BT PBXs; the exception to this are certain key systems which having no inter-PBX interface, inter-PBX working can only be provided, as described in Section 15.1.3.

Non-BT PBXs

The same procedure should be followed as for BT PBXs but the manufacturers handbook, for the PBX concerned, should be consulted to establish the availability of the chosen signalling system and any suitable alternative.

Signalling and Transmission Limits for the Selected Signalling System

These are described under the description of the signalling system in Sections 11 and 12, in the information tables and their associated notes.

Full use should be made of the information notes associated with the Selection Charts and information tables when making a final selection.

Signalling Systems for Fast Call Set up and Integrated Network Services

Customers requiring advice on methods of providing fast call set and the provision of supplementary services between PABXs should be informed of the availability on specific PBXs of the following systems. Refer to Section 13 for descriptions of these systems and details of their application.

a. **Digital Private Network Signalling System No. 1 (DPNSS1)**
This is a comprehensive common channel signalling system. It incorporates the line supervisory signals as well as address and supplementary services information. For availability on BT PBXs see Table 11.

b. **Signalling System Multi-Frequency No. 5 (SSMF5)**
This is an inter-register signalling system using the speech transmission path. It requires the support of a standard line signalling system eg SSAC15-B. For availability on BT PBXs see Table 11.

c. **Signalling System Multi-Frequency No. 4 (SSMF4)**
This is an MFPB system designed for use over local lines from a telephone to the local exchange. It has been adapted for inter-PBX working and is available on certain specified PBXs to provide fast call set up over inter-PBX circuits, basic call only. It requires the support of a standard line signalling system eg SSAC15-A. For availability on BT PBXs see Table 11.

For non-BT PBXs the customer should make enquiries regarding the availability of these systems with his PBX supplier or Telecom Consultant.

Primary Selection Charts Figs 1-6 follow

15.3 Primary Selection Charts

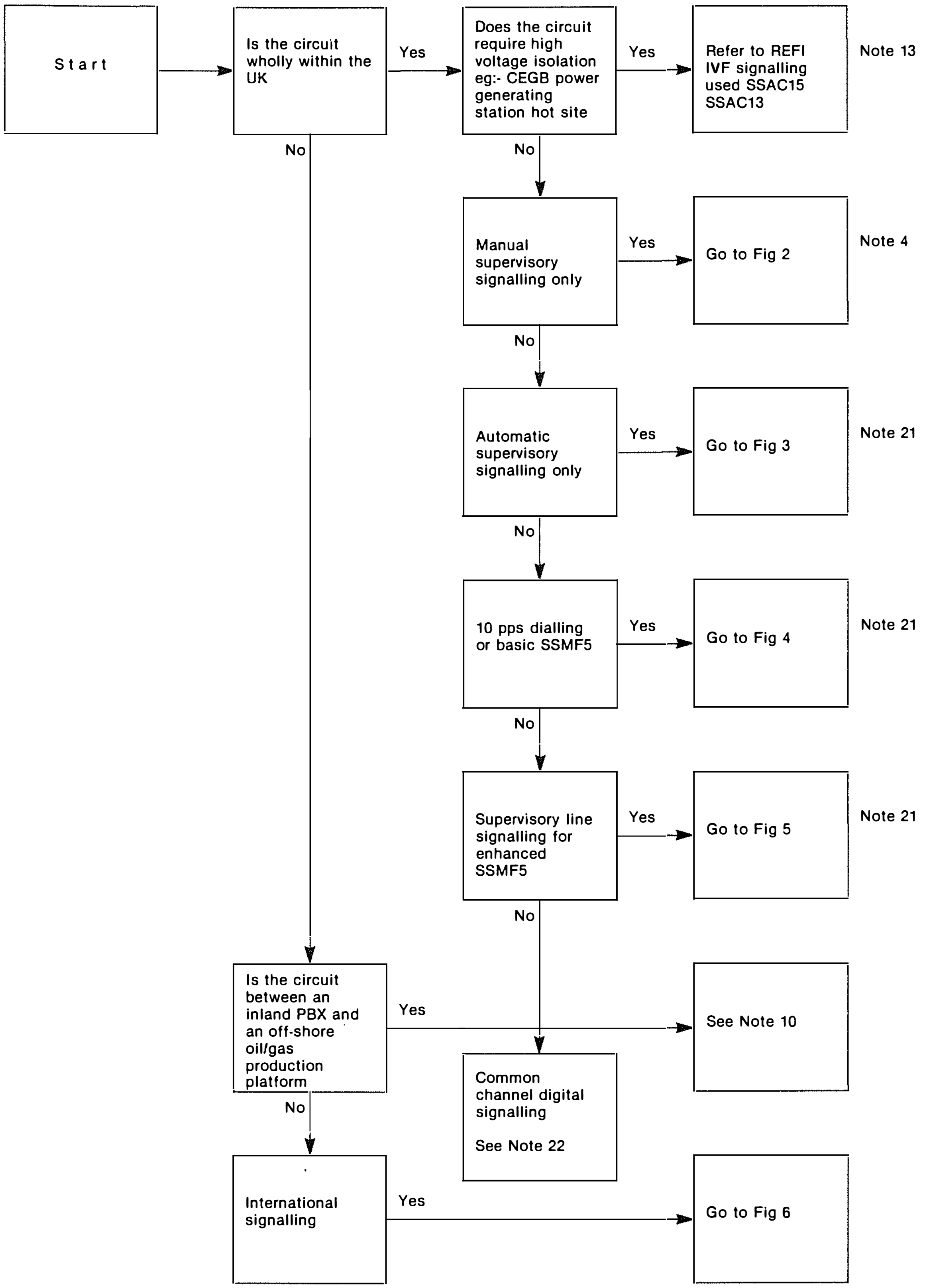


Fig 1 Determination of Inter-PBX Signalling System by Service Type and Facility

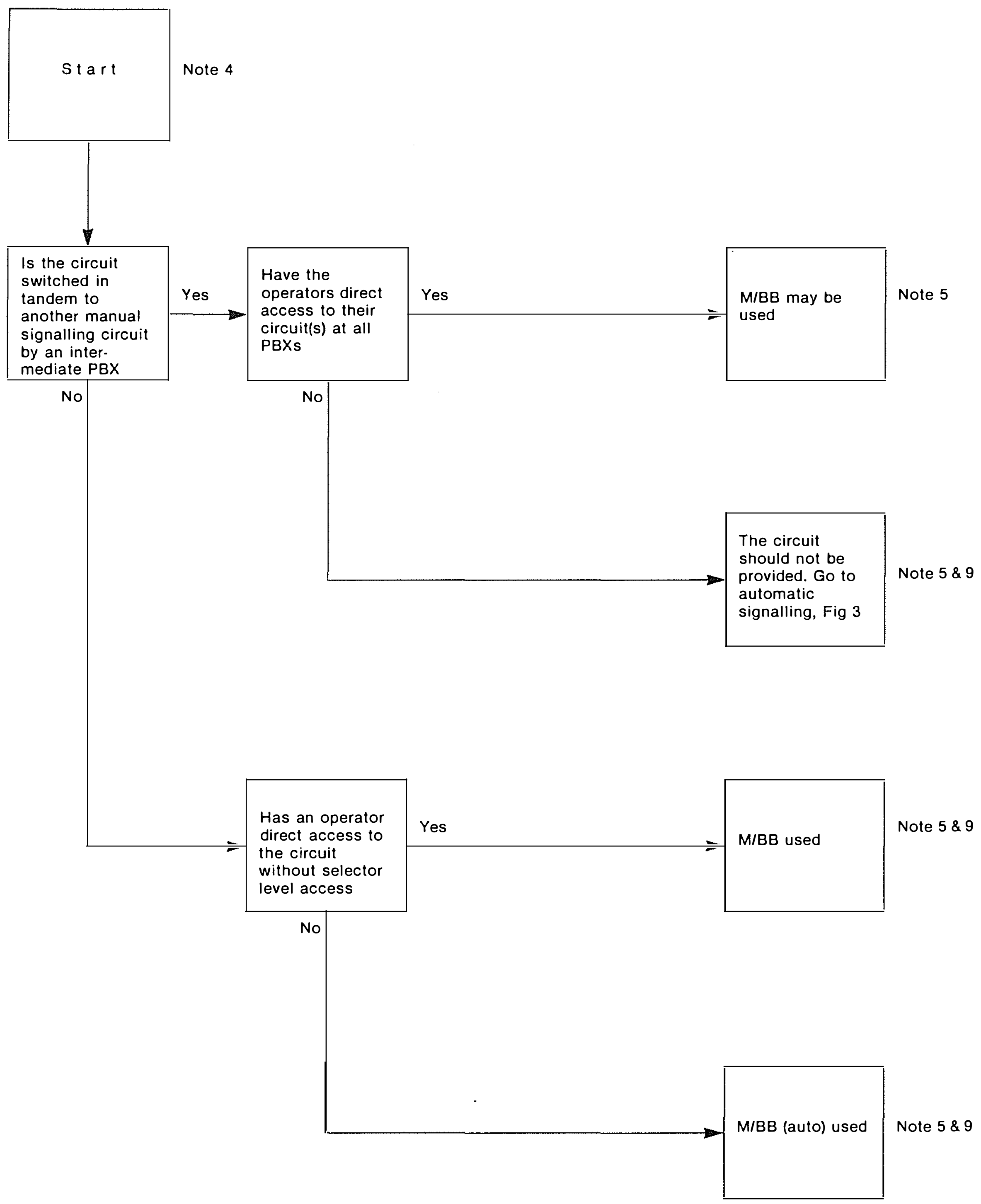


Fig 2 Manual Supervisory Signalling Only

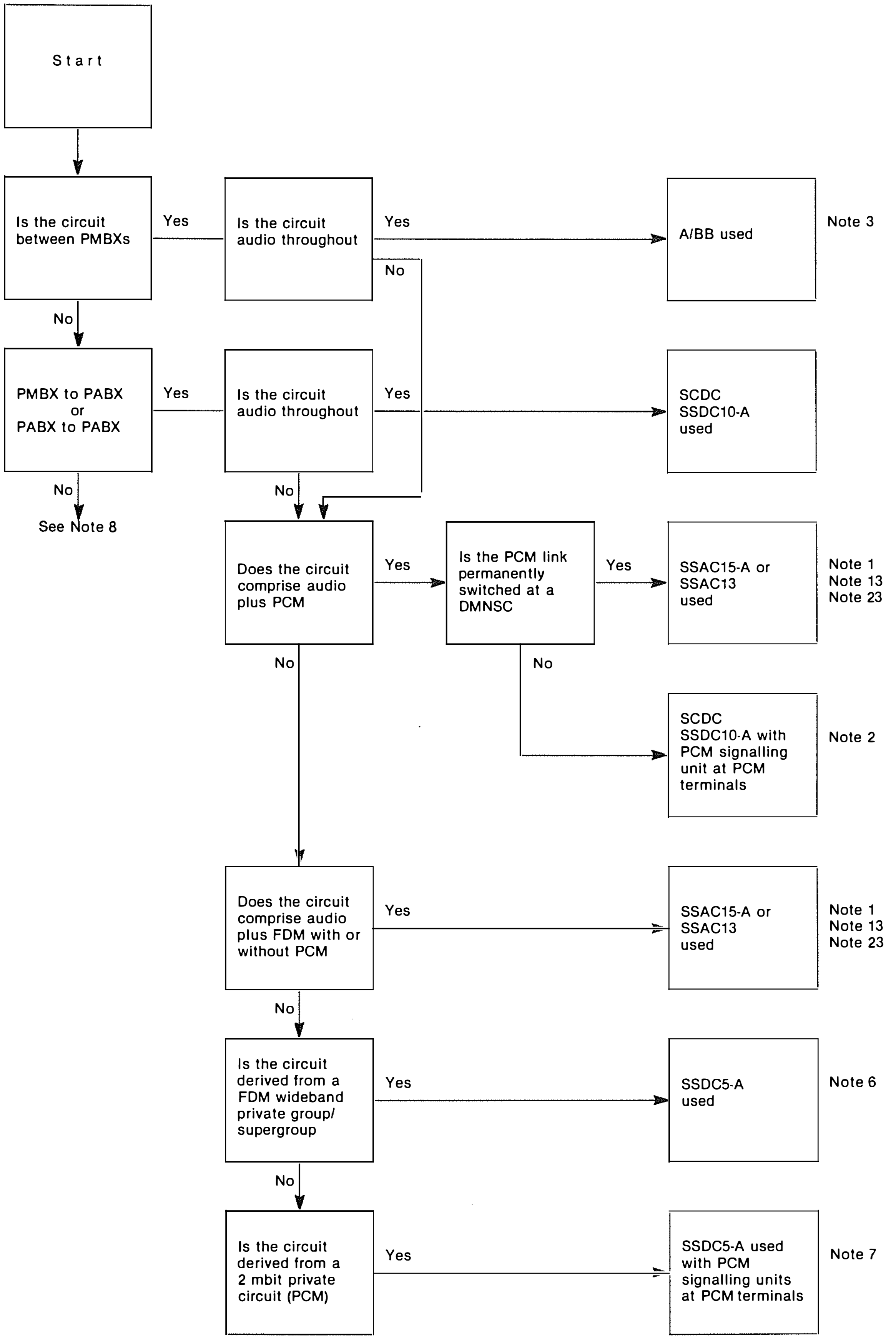


Fig 3 Automatic Supervisory Signalling Only

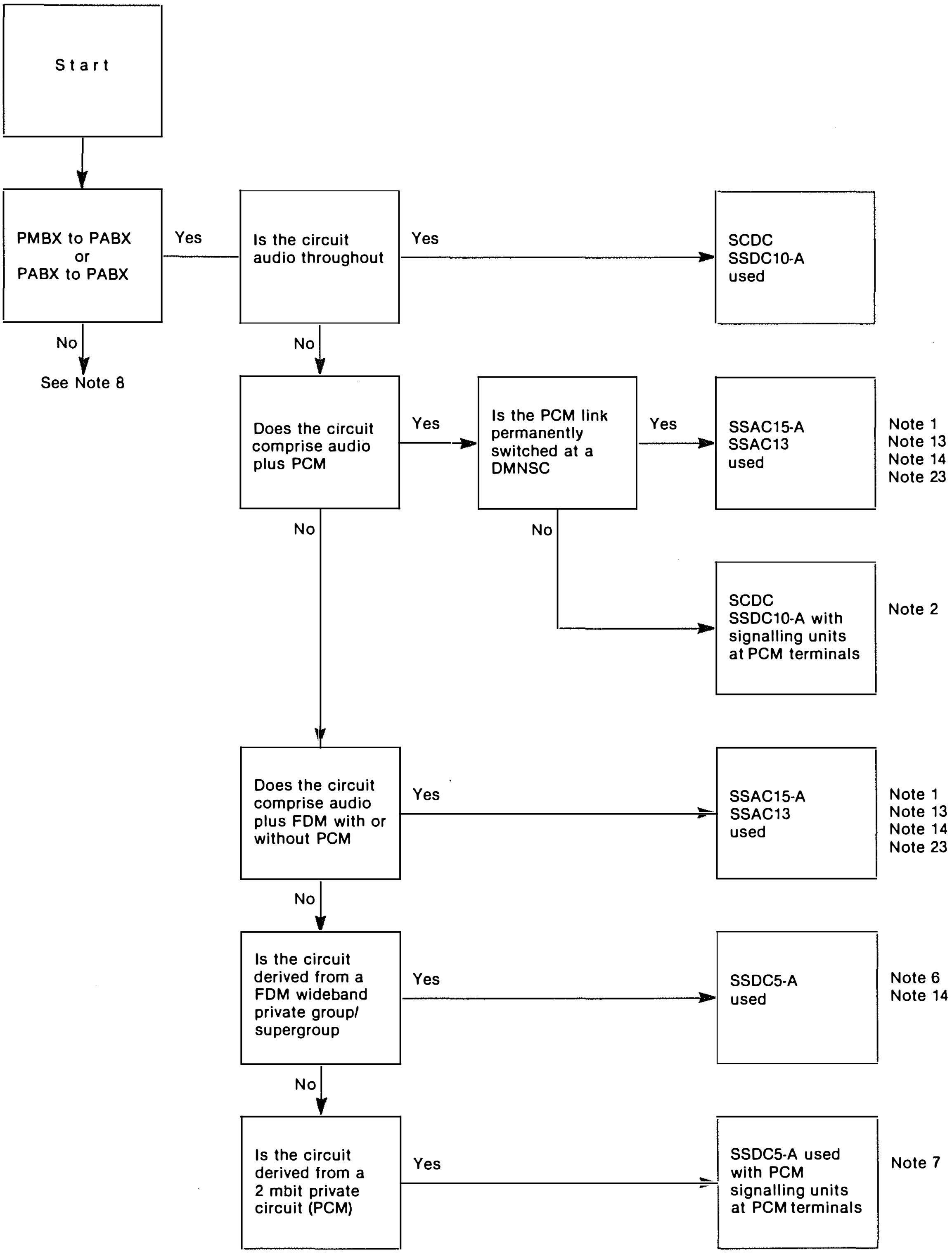


Fig 4 Automatic Supervisory Signalling with 10 pps Dialling SSMF4 inter-PBX working or Basic SSMF5 inter-register Signalling (Note 11)

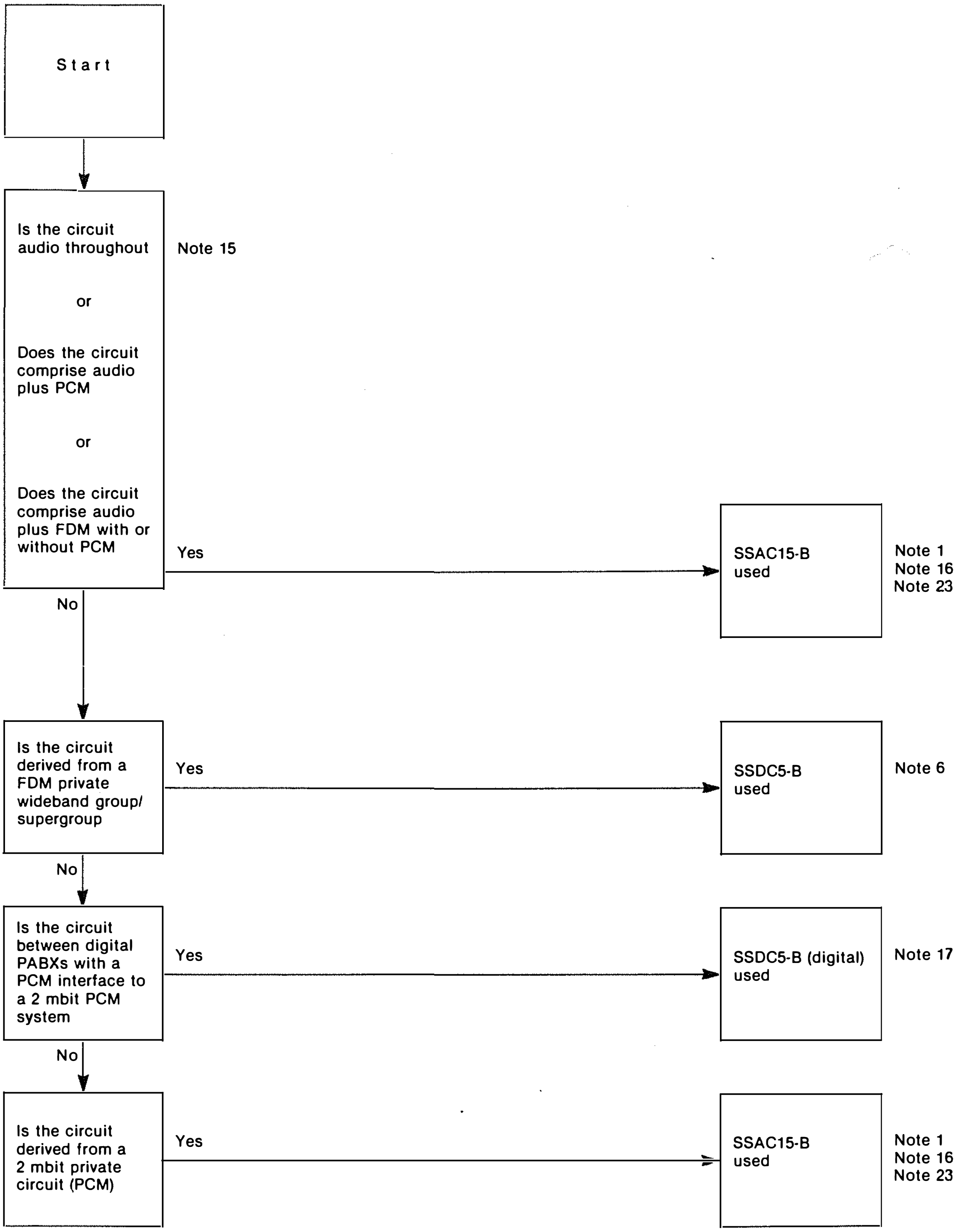


Fig 5 Automatic Supervisory Signalling used with Enhanced SSMF5 Inter-Register Signalling

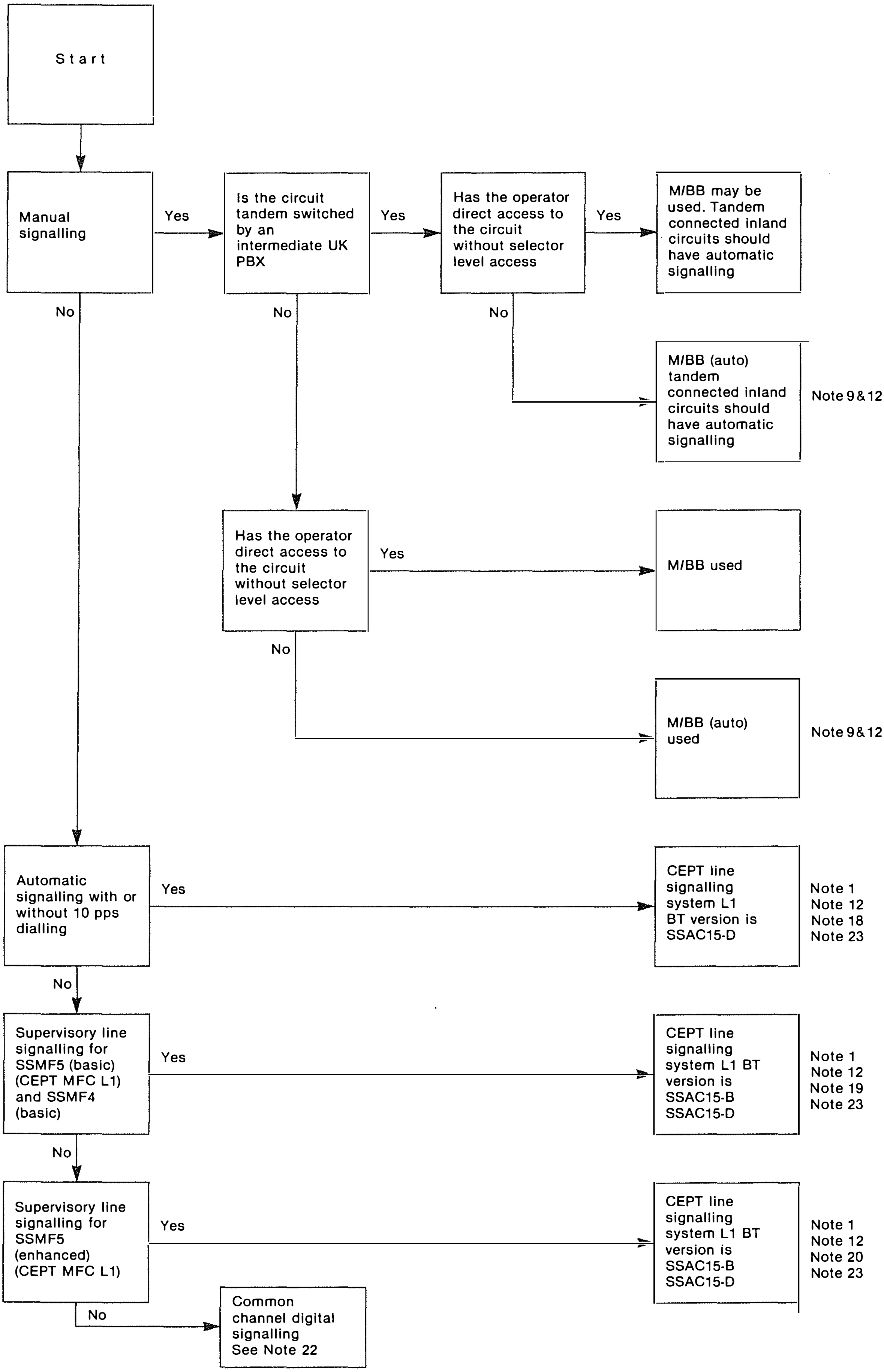


Fig 6 International Signalling

15.3.1 Notes on Primary Selection Charts

Note 1

The SSAC15 Signalling System may not be used on any transmission system employing Time Assignment Speech Interpolation (TASI) techniques, as it will tend to occupy a speech channel continuously when in the idle state. Many Geo-Stationary Satellite systems use this method.

Note 2

SSDC10-A signalling units are available on 1st and 2nd generation 30 channel PCM equipment. Signalling units F5A and F5/1 respectively. See also Ref 2.

Note 3

A/BB is not available on PMBX/1A and PMBX12. Use SSDC10-A (SCDC).

Note 4

Manual signalling is not normally a preferred signalling system but there are certain circumstances where it may be chosen. One example would be on international circuits where it may be the only system mutually recognised by the two countries concerned. Another might be where alternative speech/data is required and the complication presented by switching automatic signalling circuits creates an obstacle. In addition manual signalling is common on older PBXs, particularly PMBXs, and where the operator has direct access to the circuit, may be treated as a preferred system.

Note 5

M/BB must not be used on PSTN access circuits and should be avoided on tandem connections; go to Fig 3.

Note 6

On the 12th channel of some wideband FDM groups SSAC15 or SSAC13 should be used in place of SSDC5. See Section 12.5.2.

Note 7

SSDC5/PCM signalling units are available on 1st and 2nd generation 30 channel PCM equipment. 1st generation PCM Signalling Unit No. 31A. 2nd generation PCM Signalling Unit No. G2/1 and G2/2. As an alternative SSAC15-A may be used.

Note 8

Where one or both of the installations is a Key System without standard inter-PBX signalling, then inter-PBX working may be provided as described in Section 15.1.3. See also Table 10 for interface arrangements on BT Key Systems. Where the Key System does provide standard inter-PBX signalling, treat as a PABX.

Note 9

At PMBX4, PMBX11 and PABX7, which provide M/BB (auto), the automatically applied ring-off signal should be disconnected, see Ref 9.

For PABXs with no direct operator access to manual circuits, M/BB (auto) may be provided by means of an SSDC5-A/M/BB (auto) converter, a LT/CY38935/1 available from BT London Regional Stores Liaison Officer.

Note 10

Inter-PBX signalling to an off-shore oil/gas production platform.

a. The off-shore sections of the speech circuit will be routed via radio links, line-of-sight and tropospheric scatter, as appropriate, in tandem. Tropospheric scatter radio paths may be subject to fading, and for this reason SSAC15 is recommended as the preferred inter-PBX signalling system on these circuits. SSAC15 is not susceptible to the effects of fading when a call is in progress. Either SSAC15-A, SSAC15-B or SSAC15-D may be chosen depending on the service required. SSAC15-A to support 10 pps dialling on SSMF4 inter-PBX working and SSAC15-B to support SSMF5.

b. When the on-shore CTE is co-located with the on-shore PBX, out-band E and M signalling, SSDC5, may be chosen if the customer particularly requests it. In which case he should also provide a "Bearer fail and Guard" arrangement, as described in Diagram SA 10053 and SA/SAW 10051, for protection against circuit fading. The use of SSDC5 is not recommended if SSAC15 is available on the PBXs concerned.

Note 11

SSMF5 inter-register signalling is not used on PMBXs.

Note 12

The signalling system is determined bi-laterally, with the country concerned by BT International/IBI4.3.2.

Note 13

For limitations on the use of SSAC13 see Section 12.7.

Note 14

The preferred line signalling systems to support SSMF5 (basic) and SSMF4 inter-PBX working, are systems with the A suffix ie SSDC10-A, SSDC5-A and SSAC15-A; but SSDC5-B SSDC5-D or SSAC15-B, SSAC15-D or SSAC13 are all able to support these MF systems, and where there are overriding reasons for doing so, these systems may be used for that purpose.

Note 15

Although a physical circuit may be available SSDC10-B is not used since this system has not been specified and is not available. SSAC15-B is the preferred system.

Note 16

SSAC15-B is the preferred system but SSAC15-D may be used where there is an overriding reason for doing so. It should be noted that SSAC15-D provided by means of an SSDC5-A/SSDC5-D converter eg a Signalling Unit No. 46A, is not capable of supporting enhanced SSMF5.

Note 17

Both Merlin DX and Merlin BTeX have a digital PCM SSDC5-B interface. For availability on non-BT digital PABXs the Manufacturers Handbook should be consulted.

Note 18

SSAC15-D is the preferred international signalling system to support 10 pps dialling but SSAC15-A can be used by mutual agreement between the two countries concerned.

Note 19

SSAC15-B is the preferred international signalling system to support SSMF5 (basic) or SSMF4 (basic) but SSAC15-D may be used as an alternative. SSAC15-A may be used by mutual agreement between the two countries concerned.

Note 20

SSAC15-B is the preferred international signalling system to support SSMF5 (enhanced) but SSAC15-D may be used as an alternative.

Note 21

Part time or alternative speech/data working on inter-PBX circuits with automatic signalling presents a number of problems and should normally be avoided. SSAC13 should never be used for this purpose. See Section 19 on alternative speech/data switching.

Note 22

Common Channel Digital Signalling is transmitted on channel 16 of a 30 channel PCM system, or by means of a Modem, via an additional private circuit which is dedicated to signalling. The preferred system is Digital Private Network Signalling System No. 1 (DPNSS1). This system is described in Section 13.1. The availability on BT PABXs is shown in Table 11.

Some PABXs can provide a form of CCITT No. 7 but inter-working between different manufacturers' PBXs beyond basic call set up, is problematical and penetration into the Private Network for this system is likely to be small.

A common channel system is indicated as a first choice where the customer:-

i. specifies a PBX capable of providing the facility

ii. requires fast call set-up and/or integrated services

iii. has sufficient number of circuits on the inter-PBX routes concerned to justify the expense of providing a common channel signalling system.

Note 23

Use of Echo Suppressors on SSAC15 circuits. Should the circuit employing SSAC15 require the use of Echo Suppressors eg on Satellite circuits, the Echo Suppressors must be fitted outside the signal path or be cancelled when signal tone is present.

15.4 Final Selection of Signalling System on Older PBXs

PABXs

Table 3 details the relay sets and signalling limits for the signalling system chosen by reference to Section 15.1 and 15.2, Primary Selection Charts Figs 1 to 6 and Table 2.

Additions to routes on PABX4 using relay-sets SA 8364 or equivalent, Automatic Generator Signalling (AGS), should not be made. If additional circuits are required between PABXs employing AGS then the followng alternatives should be considered:-

a. Provide a new route from a new selector level on each PABX using a signalling system that will signal over the required distance and give the required facilities.

b. Replace all the existing AGS equipment with a current signalling system.

On privately purchased PABXs the customer must provide a suitable relay set to give the required signalling conditions. This relay set may conform to the circuitry of the standard SA diagram or it may be a manufacturers design which has been approved by BT to give the same facilities. The final choice of signalling system remains the responsibility of BT.

Tables 3, 4 and 5 show signalling systems that are not recommended for new work. These are included for reference when consideration is being given to existing routes. See also paragraph below.

Ring Tone on Circuits to PMBXs

On inter-PBX circuits between a PABX and a PMBX it is preferred that ring tone be returned to the calling extension/ operator when the PMBX is being called. The interface relay sets on which this facility is provided are given in Table 1.

Table 1

PABX	A/WE	SCDC	SSAC13
1	—	—	SA 8132
2	—	—	SA 8148
3	SA 8163	SA 10101	SA 8240
4	SA 8362	—	SA 8366
5	SA 8456	SA 10105	SA 8460
6	SA 8481/1	SA 10106	SA 8486
7	—	SA 10107	SA 10010

The facility is not available on any other standard PABX relay sets. If it is essential that ring tone is provided, for economic reasons, it may be necessary to use a A/WE signalling although it is a non-preferred signalling system. On privately purchased PABXs the customers contractor should be asked to provide ring tone on the PABX relay set irrespective of the type of signalling being used.

PMBXs

Table 4 details the relay sets or units auxiliary apparatus (UAAs) and signalling limits for signalling systems chosen by reference to Sections 15.1 and 15.2, Primary Selection Charts and Table 2. Table 4 shows signalling systems not recommended for new work. These are included for reference when consideration is being given to existing routes.

House Exchange Systems (HES) and Key and Lamp Units (K&LU)

Table 5 details the relay sets and units auxiliary apparatus (UAAs) to be used on HES or K&LU chosen by reference to Section 15.1 and 15.2, Primary Selection Charts and Table 2. Table 5 shows signalling systems not recommended for new work. These are included for reference when consideration is being given to existing routes.

SA Diagram Index

An index to all SA diagrams is contained in Ref 3.

Limitations on the use of SSAC13 Equipment

SSAC13 was the first UK inter-PBX signalling system to enable automatic signalling to be provided over HF line plant. Since 1979 SSAC13 has been largely superseded for new work by SSAC15-A and may be considered, to some extent, an obsolescent system. However under some circumstances it is still provided on certain types of installation:-

1 At existing BT Strowger PBXs where spare rack capacity exists for SSAC13 equipment, when the appropriate SSAC13 equipment is available from Stores and when SSAC13 equipment is available at the distant PBX.

2 Between non-BT PBXs by mutual agreement between the parties concerned.

15.4.1 Signalling System Selection for New Routes on Older PBXs

Table 2

Type of PBX or Apparatus	PABX1	PABX2	PABX3	PABX4	PABX5	PABX6	PABX7	PMBX1A	PMBX2/2A	PMBX2/3A	PMBX2/4A1	PMBX3/3	PMBX3/5	PMBX4&11	CB873	AT3796 N1070	BECB10	HES3	HES4	K&LU 50 V	K&LU 24 V
PABX1	abc	abc	abc	abc	abc	abc	abc	abc	ac	abc	ac	ac	abc	abc	a	abc	dc	abc	abc	abc	abc
PABX2	abc	abc	abc	abc	abc	abc	abc	abc	ac	abc	ac	ac	abc	abc	a	abc	dc	abc	abc	abc	abc
PABX3	abc	abc	abc	abc	abc	abc	abc	abc	ac	abc	ac	ac	abc	abc	a	abc	dc	abc	abc	abc	abc
PABX4	abc	abc	abc	abc	abc	abc	abc	abc	ac	abc	ac	ac	abc	abc	a	abc	dc	abc	abc	abc	abc
PABX5	abc	abc	abc	abc	abc	abc	abc	abc	ac	abc	ac	ac	abc	abc	a	abc	dc	abc	abc	abc	abc
PABX6	abc	abc	abc	abc	abc	abc	abc	abc	ac	abc	ac	ac	abc	abc	a	abc	dc	abc	abc	abc	abc
PABX7	abc	abc	abc	abc	abc	abc	abc	abc	ac	abc	ac	ac	abc	abc	a	abc	dc	abc	abc	abc	abc
PMBX1A	abc	abc	abc	abc	abc	abc	abc	abec	aec	abec	aec	aec	abec	abec	ae	abec	dec	abc	abc	abec	abec
PMBX2/2A	ac	ac	ac	ac	ac	ac	ac	aec	aec	aec	aec	aec	aec	aec	ae	aec	dec	ac	ac	aec	aec
PMBX2/3A	abc	abc	abc	abc	abc	abc	abc	abec	aec	abec	aec	aec	abec	abec	ae	abec	dec	abc	abc	abec	abec
PMBX2/4A	ac	ac	ac	ac	ac	ac	ac	aec	aec	aec	aec	aec	aec	aec	ae	aec	dec	ac	ac	aec	aec
PMBX3/3	ac	ac	ac	ac	ac	ac	ac	aec	aec	aec	aec	aec	aec	aec	ae	aec	dec	ac	ac	aec	aec
PMBX3/5	abc	abc	abc	abc	abc	abc	abc	abec	aec	abec	aec	aec	abec	abec	ae	abec	dec	abc	abc	abec	abec
PMBX4&11	abc	abc	abc	abc	abc	abc	abc	abec	aec	abec	aec	aec	abec	abec	ae	abec	dec	abc	abec	abec	abec
CB873	a	a	a	a	a	a	a	ae	ae	ae	ae	ae	ae	ae	ae	ae	de	a	a	ae	ae
AT3796 N1070	abc	abc	abc	abc	abc	abc	abc	abec	aec	abec	aec	aec	abec	abec	ae	abec	dec	abc	abc	abec	abec
BECB10	dc	dc	dc	dc	dc	dc	dc	dec	dec	dec	dec	dec	dec	dec	de	dec	dec	fc	fc	ec	ec
HES3	abc	abc	abc	abc	abc	abc	abc	abc	ac	abc	ac	ac	abc	abc	a	abc	fc	abc	abc	abc	abc
HES4	abc	abc	abc	abc	abc	abc	abc	abc	ac	abc	ac	ac	abc	abc	a	abc	fc	abc	abc	abc	abc
K&LU 50 V	abc	abc	abc	abc	abc	abc	abc	abec	aec	abec	aec	aec	abec	abec	ae	abec	ec	abc	abc	abec	abec
K&LU 24 V	abc	abc	abc	abc	abc	abc	abc	abec	aec	abec	aec	aec	abec	abec	ae	abec	ec	abc	abc	abec	abec

The types of apparatus the inter-PBX circuit will terminate on should be located on the horizontal and vertical scale. The choice of signalling system, in order of preference from left to right, is given at the junction of the horizontal and vertical column eg for an inter-PBX circuit between a PABX6 and a PMBX2/3A the choice of signalling is abc:- 1st SCDC, 2nd SSDC5-A, 3rd Automatic In Band (SSAC15 or SSAC13).

Key to Signalling Systems

a. SCDC
b. SSDC5-A (Customers private groups only)
c. Automatic In Band (SSAC15 or SSAC13)
d. Loop
e. M/AC or M/BB
f. A/WE

15.4.2 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating at an Older PABX

Table 3

	Signalling System			
	Automatic bothway with or without dialling			
PBX	**SCDC Notes 1, 4 & 14 & 24**	**LOOP Notes 1, 2 & 4**	**SSDC5-A Note 18**	**SSAC13 Notes 1, 5 13 & 17**
PABX 1	SA 8131 3.8 kohms	SA 8127 1.2 kohms	SA 101450 (modified SA 8131)	SA 8132 + SA 8289 + SA 8290
PABX 2	SA 8147 3.8 kohms	SA 8141 1.2 kohms	SA 101600 (modified SA 8147)	SA 8148 + SA 8290 + SA 8290
PABX 3	SA 10101 3.8 kohms Note 34	SA 8161 1.2 kohms	Available from PABX manu- facturer or SA 10101	SA 8240
PABX 4 Note 3	SA 8363 3.8 kohms	SA 8357 1.2 kohms	Available from PABX manu- facturer	SA 8366
PABX 5	SA 10105 3.8 kohms Note 21 & 25	SA 8457 2.1 kohms	SA 10105 modified to SA 101500 Note 21 & 25	SA 8289 + SA 8290 + SA 8460
PABX 6	SA 10106 3.8 kohms Note 25	SA 8479 2.0 kohms	SA 10106 modified to SA 101510 Note 25	SA 8486
PABX 7	SA 10107 & SA 10009 3.8 kohms Note 25	SA 8550 1.2 kohms Note 15	SA 10107 modified to SA 10152 plus SA 10009 Note 25	SA 10009 + SA 10010

Satellite Working on PABX 3 and 4

PABX 3

Bothway, incoming or outgoing at a satellite	SA 8177	1.4 kohm Note 8
Bothway at main PABX	SA 8178	900 kohm Note 8
Outgoing at main PABX	SA 8174	1.1 kohm Note 8
Incoming at main PABX	SA 8173	1.4 kohm Note 8

PABX 4

Bothway, incoming or outgoing at a satellite	SA 8361	1.2 kohm Note 8
Bothway at main PABX	SA 8360	1.2 kohm Note 8 & 9
Outgoing at main PABX	SA 8359	1.2 kohm Note 8
Incoming at main PABX	SA 8358	1.2 kohm Note 8

NB For notes see paragraph 15.4.5.

For SSAC15-A, SSAC15-D and SSAC5-D signalling on PABXs see next page.

15.4.2 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating at an Older PABX

Table 3 (Contd)

	Signalling System		
	Automatic bothway with or without dialling		
PBX	**SSAC15-A Note 27 & 30**	**SSAC15-D Note 27 & 33**	**SSDC5-D Note 33 & 18**
PABX 1	SA 101450 (modified SA8B1) plus Signalling Unit No. 44B Note 28	SA 101450 (modified SA 8131) plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PABX 2	SA 101600 (modified SA 8147) plus Signalling Unit No. 44B Note 28	SA 101600 (modified SA 847) plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PABX 3	SA 10101 or manu- facturers equivalent plus Signalling Unit No. 44B or manufacturers equivalent Note 28 & 31	SA 10101 or manu- facturers equivalent plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PABX 4	SSDC5-A available from manufacturer plus Signalling Unit No. 44B or manufacturers equivalent Note 28 & 31	SSDC5-A available from manufacturer plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29

NB For notes see paragraph 15.4.5.

For PABXs 5, 6 and 7 see next page.

15.4.2 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating at an Older PABX

Table 3 (Contd)

	Signalling System		
	Automatic bothway with or without dialling		
PBX	**SSAC15-A** **Note 27 & 30**	**SSAC15-D** **Note 27 & 33**	**SSDC5-D** **Note 33 & 18**
PABX 5	SA 10105 modified to SA 101500 plus Signalling Unit No. 44B Note 28	SA 10105 modified to SA 101500 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PABX 6	SA 10106 modified to SA 101510 Signalling Unit No. 44B Note 28	SA 10106 modified to SA 101510 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PABX 7	SA 10107 modified to SA 101520 + SA 10009 plus Signalling Unit No. 44B Note 28	SA 10107 modified to SA 101520 + SA 10009 plus Signalling Unit No. 46A Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29

NB For notes see paragraph 15.4.5.

15.4.2 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating at an Older PABX

Table 3 (Contd)

Signalling System				
Automatic		Manual		
A/WE Out Earth Dialling In	A/WE Bothway without dialling	M/AC Bothway	M/BB Bothway	
SA 8130- 2.0 kohm SA 8109- 2.6 kohm Note 2, 4, 19 & 22	SA 8128 4.2 kohm Note 4 & 20	SA 8129 Note 6	SA 8129 16.0 kohm Note 6	PABX 1
SA 8146- 2.0 kohm SA 8109- 2.6 kohm Note 2, 4, 19	SA 8142 4.2 kohm Note 4 & 20	SA 8143 Note 6	SA 8143 18.0 kohm Note 6	PABX 2
SA 8163- 2.0 kohm SA 8190- 2.6 kohm Note 2, 4 & 19	SA 8162 4.2 kohm Note 4 & 20	SA 8191 Note 6	SA 8191 18.0 kohm Note 6	PABX 3
SA 8362- 2.0 kohm Note 2, 4 & 19	SA 8362 4.2 kohm Note 4 & 20	—	—	PABX 4 Note 3
SA 8456- 2.2 kohm Note 2, 4 & 19	—	—	—	PABX 5
SA 8481- 2.0 kohm Note 2, 4 & 19	—	—	—	PABX 6
SA 8109- 2.6 kohm Note 2, 4 & 19	—	SA 8568 Note 6 & 15	SA 8568 10.0 kohm Note 6, 15 & 26	PABX 7

NB For notes see paragraph 15.4.5.

15.4.3 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating at a PMBX

Table 4

PBX	Signalling System			
	Automatic bothway with or without dialling			
	SCDC Bothway with or without dialling Notes 1, 4, 14 & 24	**SSDC5-A Bothway with or without dialling Note 18**	**SSAC13 Bothway with or without dialling Notes 1, 5, 13 & 17**	**E Loop AC-in E or Loop dial-out Notes 1, 2, 4, 10 & 12**
PMBX 1A	SA 7526 3.8 kohm	SA 7256 modified to SA 101470	SA 7570 to N 760	SA 7515
PMBX 2/2A	UAA 100 to diag N 1139 3.8 kohm	Note 32	SA 7572 to diag N 762	UAA 99A to diag N 1138
PMBX 2/3A	UAA 100 to diag N 1149 3.8 kohm	UAA 99A (modified) to diag N 766 (Spl)	SA 7572 to diag N 762	UAA 99A to diag N 1148
PMBX 2/4A	UAA 100 to diag N 1159 3.8 kohm	Note 32	SA 7572 to diag N 762	UAA 99A to diag N 1158
PMBX 2/4A	UAA 100 to diag N 1159 3.8 kohm	Note 32	SA 7572 to diag N 762	UAA 99A to diag N 1158
PMBX 3/3	UAA 100 to diag N 1727 3.8 kohm	Note 32	SA 7572 to diag N 762	UAA 99A to diag N 1160
PMBX 3/5	UAA 100 to diag N 1728 3.8 kohm	UAA 97 (modified) to diag N 768 (Spl)	SA 7572 to diag N 762	UAA 99A to diag N 1161
PMBX 4 & 11	SA 7615 to diag N 2245 3.8 kohm	SA 7614 to diag N 767 (Spl)	SA 7574 to diag N 764	SA 7614 to diag N 2244
PMBX 12	SA 101830 3.8 kohm	461 LSU 400 LM Note 35		
PMBX CB 873	UAA 103 to diag N 772 3.8 kohm	—	—	UAA 45 to diag N 880
PMBX AT3796 N 1070	UAA 103 to diag N 777 3.8 kohm	UAA 45 (modified) to diag N 765	SA 7571 to diag N 761	UAA 45 to diag N 880
PMBX BECB10	—	—	SA 7573	SA 7315

NB For notes see paragraph 15.4.5.

For SSAC15-A, SSAC15-D and SSDC5-D signalling systems see next page.

15.4.3 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating at aPMBX

Table 4 (Contd)

	Signalling System		
	Automatic bothway with or without dialling		
PBX	**SSAC15-A Note 27 & 30**	**SSAC15-D Note 27 & 33**	**SSDC5-D Note 33 & 18**
PMBX 1A	SA 7526 modified to SA 101470 plus Signalling Unit No. 44B Note 28	SA 7526 modified to SA 101470 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PMBX 2/2A	Note 32 plus Signalling Unit No. 44B Note 28	Note 32 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PMBX 2/3A	UAA 99A modified to diag N 766 plus Signalling Unit No. 44B Note 28	UAA 99A modified to diag N 766 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PMBX 2/4A	Note 32 plus Signalling Unit No. 44B Note 28	Note 32 plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PMBX 3/3	Note 32 plus Signalling Unit No. 44B Note 28	Note 32 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PMBX 3/5	UAA 97 modified to diag N 768 plus Signalling Unit No. 44B Note 28	SA 7614 to diag N 767 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29

NB For notes see paragraph 15.4.5.

For signalling on PMBX 4, PMBX 11, PMBX 12 and PMBX AT 3796 see next page.

15.4.3 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating at a PMBX

Table 4 (Contd)

	Signalling System		
	Automatic bothway with or without dialling		
PBX	**SSAC15-A Note 27 & 30**	**SSAC15-D Note 27 & 33**	**SSDC5-D Note 33 & 18**
PMBX 4 & 11	SA 7614 to diag N 767 plus Signalling Unit No. 44B Note 28	SA 7614 to diag N 767 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
PMBX 12	461 LSU 400 LM plus Signalling Unit No. 44B Note 35 & 36	461 LSU 400 LM plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28, 29 & 37	Provide SSDC5-A plus Signalling Unit No. 46A Note 29 & 37
PMBX AT3796 N 1070	UAA 45 modified to diag N 765 plus Signalling Unit No. 44B Note 28	UAA 45 modified to diag N 765 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29

NB For notes see paragraph 15.4.5.

For A/BB, A/WE, M/AC and M/BB on PMBXs see next page.

15.4.3 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating at a PMBX

Table 4 (Contd)

Signalling System				
Automatic		Manual		
A/BB Bothway without dialling Note 4	**A/WE Bothway without dialling Notes 4 & 20**	**M/AC Bothway Note 6**	**M/BB Bothway Notes 4, 6 & 10**	PBX
	SA 7151 1.95 kohm	SA 7518 and modify PBX to SA 7521	SA 7520 and modify PBX to SA 7521 3.7 kohm	PMBX 1A
UAA 97 to diag N 1137 (Spl) 13.0 kohm	UAA 97 to diag N 1130 4.8 kohm	UAA 98 to diag N 1134	UAA 98 to diag N 1135 25.2 kohm	PMBX 2/2A
UAA 97 to diag N 1147 (Spl) 13.0 kohm	UAA 97 to diag N 1140 4.8 kohm	UAA 98 to diag N 1144	UAA 98 to diag N 1135 25.2 kohm	PMBX 2/3A
UAA 97 to diag N 1157 (Spl) 13.0 kohm	UAA 97 to diag N 1150 4.8 kohm	UAA 98 to diag N 1154	UAA 98 to diag N 1155 25.2 kohm	PMBX 2/4A
UAA 97 to diag N 1726 13.0 kohm	UAA 97 to diag N 1202 4.8 kohm	UAA 98 to diag N 1723	UAA 98 to diag N 1724 25.2 kohm	PMBX 3/3
UAA 97 to diag N 1206 13.0 kohm	UAA 97 to diag N 1215 4.8 kohm	UAA 98 to diag N 1219	UAA 98 to diag N 1220 25.2 kohm	PMBX 3/5
SA 7612 to diag N 2240 13.0 kohm	SA 7612 to diag N 2236 4.8 kohm	SA 7613 to diag N 2242	SA 7613 to diag N 2242 25.2 kohm Note 26	PMBX 4 & 11
			SA 101840	PMBX 12
UAA 45 to diag N 719 (Spl) or N 774 (Spl) 4.8 kohm	UAA 45 to diag N 710 or N 770 2.2 kohm	UAA 985 to diag N 716	UAA 985 to diag N 717 5.3 kohm	PMBX CB 873
UAA 45 to diag N 729 (Spl) or N 779 (Spl) 4.8 kohm	UAA 45 to diag N 721 or N 775 2.2 kohm	UAA 985 to N 726	UAA 985 to diag N 727 5.3 kohm	PMBX AT 3796 or 1070
	SA 7315 4.35 kohm	SA 7309	SA 7309 14.0 kohm	PMBX BECB 10

NB For notes see paragraph 15.4.5.

15.4.4 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating on HESs and K&LUs

Table 5

	Signalling System		
	Automatic bothway with or without dialling		
Equipment	SCDC Notes 1, 4, 14 & 24	SSDC5-A Note 18	SSAC13 Notes 1, 5, 13 & 17
HES 3 & 4 (50 V)	SA 10036 3.8 kohm Note 23	SA 10016 or SA 10050 Note 23	SA 9230
K&LU Order table working (50 V)	SA 10036 3.8 kohm	SA 10016 or SA 10050	SA 9230
K&LU Speech broadcast working (24 V)	SA 10036 3.8 kohm	SA 10016 or SA 10050	SA 9230

NB For notes see paragraph 15.4.5.

For other signalling systems on HES and K&LU see next two pages.

15.4.4 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating on HESs and K&LUs

Table 5 (Contd)

	Signalling System		
	Automatic bothway with or without dialling		
Equipment	SSAC15-A Note 27 & 30	SSAC15-D Note 27 & 33	SSDC5-D Note 33 & 18
HES 3 (50 V)	SA 10016 plus Signalling Unit No. 44B Note 28	SA 10016 plus Signalling Unit No. 46A Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
HES 4 (50 V)	SA 10016 plus Signalling Unit No. 44B Note 28	SA 10016 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
K&LU order table working (50 V)	SA 10016 plus Signalling Unit No. 44B Note 28	SA 10016 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29
K&LU speech broadcast working (24 V)	SA 10016 plus Signalling Unit No. 44B Note 28	SA 10016 plus Signalling Unit No. 46A plus Signalling Unit No. 44B Note 28 & 29	Provide SSDC5-A plus Signalling Unit No. 46A Note 29

NB For notes see paragraph 15.4.5.

For other signalling systems on HES and K&LU see next page.

15.4.4 Table of Signalling Limits and Interface Relay Sets for Inter-PBX Circuits terminating on HESs and K&LUs

Table 5 (Contd)

Signalling System				
Automatic			Manual	
A/BB Bothway without dialling Note 4	A/WE Bothway without dialling Note 4	AC in Loop out	M/BB Bothway Notes 4 & 6	Equipment
Unit Q 415 to diag Q 447 13.0 kohm	Unit Q 415 to diag Q 442 4.8 kohm	Unit Q 415 to diag Q 446 Note 11	—	HES 3 (50 V)
Unit Q 524 to diag Q 568 13.0 kohm	Unit Q 524 to diag Q 562 4.8 kohm	Unit Q 524 to diag Q 564 Note 11	—	HES 4 (50 V)
—	Unit SA 9153 to diag SA 9157 Figs 3 & 4 2.8 kohm	Units SA 9151 and SA 9152 to diag SA 9157 Fig 7 1.0 kohm	Unit SA 9153 to diag SA 9157 Fig 7 15.0 kohm	K&LU Order table working (50 V)
—	—	—	Unit SA 9153 to diag SA 9161 7.2 kohm	K&LU Speech broadcast working (24 V)

NB For notes see paragraph 15.4.5.

15.4.5 Notes for Tables

Note 1

For tandem dialling limits see Section 18.

Note 2

A single link point to point circuit must not include more than 56 km of 4-wire amplified circuit because of pulse degradation if loop or A/WE with dialling is used.

Note 3

For pre-standard PABX 4 inter-PBX interface relay sets are given in the manufacturers diagram series. The signalling systems and signalling limits applicable are those quoted for PABX 3 in Table 3.

Note 4

In the case of 2-wire circuits the resistance value shown is the maximum permissible loop resistance of the pair. In the case of 4-wire circuits the figure refers to the maximum permissible resistance of the signalling phantom (ie half the loop resistance of one pair).

Note 5 **Transmission Requirements for SSAC13 Circuits**

SSAC13 was originally designed to operate over an EPS2A circuit, that is a circuit with a maximum nominal insertion loss of 10 dB at 800 Hz. The SSAC13 2280 Hz send level was adjusted to ensure that the received level was +23 dBm or higher (the maximum sensitivity of the SSAC13 Receiver is −26 dBm but an allowance must be made for the ±3 dB variation of insertion loss with time). This has resulted in some circuits carrying higher signal levels than those recommended to conform to the loading requirements of BT HF line plant and CCITT Recommendation Q15. The position now is that all new circuits shall be provided to the following standard:

2-wire connected SSAC13 — Provide the circuit to EPS3G and provide appropriate LTF to convert 4-wire to 2-wire. The system is situated at the 0 dBr send point in the 2-wire path and the 2280 Hz send level is standardised at −10 dBmO (−10 dBm at a 0 dBr point).

There is no limit on line length. A description of the SSAC13 equipment on all BT PABX of the older type is contained in Ref 4.

A description for lining up the 2280 Hz signal level on circuits provided to EPS2A is contained in Ref 7.

Note 6

The limits of signalling for 25 Hz was previously quoted in terms of distance for various cable conductor sizes. This has been rationalised to a signalling loop resistance limit of 2.2 kohm. The limit for M/BB on physical circuits is given in Tables 4, 5 and 6. However by using signalling repeaters and converters there is no practical limit to the distance that can be signalled using M/AC or M/BB.

Note 7

The supply voltage for all PABXs listed is 50 V nominal.

Note 8

These limits may be varied when the circuits form part of a tandem dialling network, see Section 18. The limit of SA 8177 is reduced to 1000 ohm when used in association with an alarm extension circuit.

Note 9

The 1200 ohm limit is reduced to 800 ohm when used in association with an alarm extension circuit.

Note 10

The signalling resistance shown is that for the PBX minimum supply voltage obtained from mains operated power units ie 22 V or 45 V as appropriate.

Note 11

Limit is set by the voltage available at the distant end.

Note 12

The limit is determined by the distant PABX relay set except for the PMBX 1A (SA 7515) when the limit is 1950 ohm.

Note 13

The signalling system relay sets 1/SA 8299 and 2/SA 8299 are always required when SSAC13 is provided.

Note 14 Limits for SCDC and SSDC10-A

Circuits employing SCDC or SSDC10-A must satisfy a pulsing limit, a signalling resistance limit and an insulation resistance limit. Where only operator to operator working is required, the pulsing limit need not be applied.

a. **Pulsing Limit**
The pulsing limit is expressed as the maximum permissible CR value of the signalling path and is obtained by multiplying the sum of the capacitances (microfarad) of all sections of the signalling path by the sum of all the resistances (ohm) of all sections. This limit is 42000 microfarad ohm.

b. **Signalling Resistance Limit**
This is expressed in terms of the maximum loop resistance of the signalling path and must not exceed 3.8 kohm.

c. **Insulation Resistance Limit**
The insulation resistance of the signalling path must be greater than 100,000 ohm.

The total resistance of the signalling path should include the resistance of all transformers, loading coils, two wire-four wire terminating units and the resistance of cable pairs.

The total capacitance should include any capacitance across line transformers, two-wire-four-wire terminating units and, for two-wire amplified circuits, the capacitance in the amplifier itself. It is not necessary to include capacitance in the SCDC relay sets.

Values of MU and CJ cable capacitances may be obtained from Ref 5 and 6 and local cable inter wire capacity can be taken as:-

Conductor		Dialetric Material	Mean interwire capacity 10 GF per km
Size mm	Materials		
0.32	Cu	Polyethelene	50.08
0.40	Cu	Polyethelene	50.55
0.50	Cu	Polyethelene	49.89
0.63	Cu	Polyethelene	51.04
0.90	Cu	Polyethelene	53.99
0.5	Al	Polyethelene	61.27
0.8	Al	Polyethelene	64.29
0.32	Cu	Paper	42.58
0.40	Cu	Paper	45.24
0.50	Cu	Paper	44.26
0.63	Cu	Paper	49.97

Values of resistance for cable conductor, loading coils and line transformers are given on card A140. It should be remembered that on four-wire circuits the two line conductors in parallel form one leg of the signalling path. Negative impedance or two-wire hybrid amplifiers may each be regarded as equivalent to an additional 2 microfarad and 100 ohm.

Note 15

Relay sets SA 8550 and SA 8568 may only be used to provide inter-PBX private circuits.

Note 16

Relay sets SA 8131 and SA 8147 may be modified to Works Specification S(W) 2210 to remove dial tone for network applications.

Note 17

For the retention and suppression of dial tone and SSAC13 connexion details see Ref 4 and 7.

Note 18

There is no signalling limit for SSDC5-A and SSDC5-D used for out of band signalling. However the maximum single wire resistance of the E or M wire between the CTE and the SSDC5 interface relay set is 25 ohm which represents a maximum distance of 275 metres on 0.5 mm Cu cable. When distances in excess of 275 metres are involved, increasing the gauge of the wire to reduce the resistance is not in itself an acceptable alternative and therefore 275 metres should be considered to be the maximum cable distance between CTE and the interface relay set. See also Section 12.5.1 SSDC5 — Signal path limits.

Note 19

Not to be used for new circuits. See also note 22.

Note 20

To be used for inter-switchboard circuits to K&LUs only.

Note 21

If the circuits are to be part of a private network and pause free dialling is required into the PABX 1, PABX 2, PABX 5, then relay set SA 10022 (modified SA 8131/SA 8147) plus a pulse regenerator SA 10026 must be used instead of the SA 8131 and SA 8147 on the PABX 1 and PABX 2 respectively, and an additional pulse regenerator SA 10026 used in conjunction with the SA 10105 or SA 101500 on the PABX 5.

Note 22

Relay set SA 8109 must be used if **spare jack** positions are used on the automatic equipment to provide circuits in addition to the normal three inter-PBX circuits. This is not a preferred signalling system and should not normally be used. These spare jack positions are restricted for use only on circuits that are not connected to automatic switching equipment at the distant end.

Note 23

Exchange line positions must be used on the HES 3 & 4.

Note 24

SCDC will inter-work with SSDC10-A as long as the optional signals are not required.

SCDC is the forerunner of SSCD10-A and has been superseded by it. The signalling conditions are identical to SSDC10-A and the signal code is shown in Section 12.4, Table 1. SCDC differs from SSDC10-A in two respects:

a. SCDC does not provide for the optional signals shown in Table 1, Section 12.4.

b. The line characteristic limits quoted in Ref 8 for SCDC of 4.4 kohm loop resistance and CR of 76,000 microfarad ohm have been standardised with SSDC10-A at 3.8 kohm and 42,000 microfarad ohm.

When a new circuit is provided it should be provided to the new standard. If the distant PBX is changed to a new type, the circuit should be surveyed to ensure it meets the standard for SSDC10-A, if it does not meet this standard SSAC15-A should be considered.

Note 25

Older installation on PABX 5, 6 and 7 may have an interim arrangement of converters to provide the signalling facility. See Ref 8.

Note 26

At PMBX 4, PMBX 11 and PABX 7 which provide M/BB (auto) in that the Manual Signals are applied automatically, the automatically applied Ring Off Signal should be disconnected, see Ref 9.

Note 27 Transmission Requirement for SSAC15-A and SSAC15-D

Inland inter-PBX circuits. The signalling system is connected in a 4-wire mode and is situated at the 0 dBr point in the Receive path and the −4 dBr point in the Transmit path of a BT EPS3G circuit. The performance at 2280 Hz of such a circuit will ensure that signal tone received levels are within the sensitivity range (−3 dBm to −29 dBm) of the SSAC15-A Signal Receiver.

Either a physical audio circuit or a circuit including an HF section (FDM or PCM) is suitable. There is no limit on line length.

International Leased Lines. SSAC15-A may occasionally be provided on International lines but SSAC15-D is the preferred method under CEPT agreements.

The type of circuit provided shall be mutually agreed between the parties concerned but should be to the standard of CCITT Recommendation G171 and M1010 to M1060. International circuits are normally presented 4-wire at 0 dBr at each end, so care should be taken to ensure that the 2280 Hz received signal tone level is within the sensitivity range of the signal receiver (−3 dBm to −29 dBm). Requests for this service should be referred to BT International/IBI4.3.2.

Note 28

The installation arrangements for Signalling Unit No. 44B are shown in Diagram SA/SAW 102290.

Note 29

The installation arrangements for Signalling Unit No. 46A are shown in Diagram SA/SAW 103270.

Note 30

A few very early installations were fitted with a Signalling Unit No. 44A (Northern Telecom). The installation arrangements are described in Diagrams SA/SAW 102100 (2-wire presented to PBX) and SA/SAW 102130 (4-wire presented to PBX).

Note 31

The manufacturers equivalent to the Signalling Unit No. 44B is likely to be either a Signalling Unit No. 44A (Northern Telecom) or a Signalling Unit No. 44C (Wescom).

Note 32

PMBX 2/2A and PMBX 2/4A may provide SSDC5-A by locally adapting UAA 99A modified to Diagram N 766. PMBX 3/3 may provide SSDC5-A by locally adapting UAA 97 modified to Diagram N 768.

Note 33

Provision of SSDC5-D and SSAC15-D by means of Signalling Unit No. 46A does not provide the optional signals (see Table 5, Section 12.6.3) other than *answer*.

Note 34

SA 10101 supersedes SA 8215 which is provided on some older installations.

Note 35

SSDC5-A on the PMBX 12 is on an STC manufacturers diagram.

Note 36

The Signalling Unit No. 44B is mounted in the PMBX 12 cabinet according to the STC Manufacturers drawings.

Note 37

For SSAC15-D and SSDC5-D on a PMBX 12 the Signalling Units are mounted external to the equipment cabinet.

15.5 Equipment Association Times on Older PABXs

Definition

Equipment association time is the time between the equipment recognising that it is required to perform a function and being in a state where the function can be performed. On private networks this can occur on both the outgoing and incoming side of an exchange.

On the outgoing side the switching equipment must be associated with the required outgoing line before any information is sent forward, and incoming, the line must be associated with the switching equipment before any additional routing or extension digits can be utilised, otherwise mis-routing or wrong numbers will occur.

When equipment is directly associated with a private circuit such as directly connected selectors on most PABX 3s there are no associated time problems but where connect circuits are encountered (PABX 7s and some PABX 4s) or where registers are used (crossbar exchanges) then the association times can be in excess of the inter digital pause (IDP) and precautions must be taken to ensure satisfactory calling.

Solution

Two methods are currently used to enable inter-PBX circuits to work satisfactorily into older BT standard PABXs with equipment association time problems.

The methods available are:-

- Those involving pauses during dialling and the use of a subsequent dial tone.
- Pause free dialling involving the use of special or additional equipment.

Pauses During Dialling

The application of dial tone to the caller when the originating exchange equipment has associated with the line and the distant exchange common control equipment (where either are applicable) has been seized and is ready to receive dial pulses. This dial tone can be applied at the called PABX and although theoretically dial tone on some older PBXs has a frequency too low for transmission over amplified circuits, in practice many dial tone sources generate sufficient harmonics to enable the tone to be recognised as a low level dial tone at the calling end. On modern PBXs dial tone may be transmitted satisfactorily over inter-PBX circuits.

Alternatively dial tone can be sent to the caller by the send end interface relay set on receipt of a signal from the called PABX. The latter arrangement is preferred. See Table 6 and 7. On proprietary PABXs the customer is responsible for determining the need for an application of dial tone. Where dial tone is required the PABX manufacturer should be asked to provide it using the preferred method of application.

This method of overcoming association time problems is satisfactory for point to point working but gives rise to complications when employed on private networks. See Ref 10.

Methods of Achieving Pause Free Dialling

Two methods are currently used.

Pulse Storage or Delay

The introduction of delay and/or storage of dial pulses in the called PABX interface relay set so that the equipment will have time to associate before the incoming relay set begins to repeat the dial pulses into the PABX switching equipment. It is not necessary to send second dial tone to the caller since continuous dialling can go on with normal IDPs, the called end relay set introducing sufficient delay to ensure seizure before pulsing into the called PABX. See Table 6 and 8.

Dedicated Control and Link Circuit

Providing a relay set or relay sets that duplicate the function of the PABX common control and link circuit equipment thus making it unnecessary to wait for the common PABX equipment to become available. There is therefore a permanent inter-connecting circuit associated with the inter PBX circuit and no second dial tone or pulse delay is required. See Table 6 and 8.

Proprietary PABX

The equipment manufacturer will determine how to achieve pause free dialling on proprietary PABXs that have equipment association time problems when the customer makes this a requirement.

Register Controlled Satellites

Where a register controlled satellite is parented on a main BT standard PABX 3 or 4 that has dial tone circuits to Diagram SA 8288 at the main PABX. Care should be taken to ensure that the dial tone circuit can only be picked up from the satellite.

Tandem Working

Tandem working of inter-PBX circuits and private networks should be dealt with in accordance with Section 18.

Tables 6, 7 and 8 follow

Table 6

Dial Tone Requirements on BT PABXs Connected to Inter-PBX Circuits

Standard BT PABX Type	Possible PABX Equipment Association Time relative to an 800 mSec Inter Digital Pause (IDP)		Operating Conditions for Various Signalling Systems							
			Signalling System							
			SSAC13		SCDC		Loop Disconnect		SSDC5	
	O/G	I/C	O/G	I/C	O/G	I/C	O/G	I/C	O/G	I/C
1	greater than	greater than	A	B	C	D	C	E	(2)	(2)
2	greater than	greater than	A	B	C	D	C	E	(2)	(2)
3	less than	less than	F	B	F	B	F	B	F	B
4	less than	less than	F	B	F	B	F	B	F	B
5	greater than	greater than	A	B	A	B	C	E	(2)	(2)
6	greater than	greater than	A	B	A	B	C	E	(2)	(2)
7	greater than	greater than	A	B	A	B	C	E	(2)	(2)

Notes

1 When assessing the requirements it is necessary to consider the O/G conditions for the PABX at the calling end of the circuit and the I/C conditions for the PABX at the distant end.

2 A modified SCDC Relay Set is used, dial tone requirements as for SCDC signalling.

3 The PABX 4 referred to in the above table is a standard BT directly connected selector type. The table is not valid for other types of PABX 4.

Keys

A 2nd Dial Tone provided locally. Not required to be returned from distant end.

B Dial Tone not required to be returned to caller before extension number is dialled.

C 2nd Dial Tone required to be returned to caller from distant end, or tandem unit, before routing or extension digits are dialled.

D When regenerator SA 10026 and relay set SA 10022 are used dial tone not required to be returned to caller before extension number dialled. With SA 8131 and SA 8147 Dial Tone is required to be returned to caller before extension number is dialled.

E Dial Tone required to be returned to caller before extension number is dialled.

F No 2nd Dial Tone requirements. Caller can dial network access digit and then routing digits without having to pause.

Table 7

Relay Sets able to Return Dial Tone to the Caller from the Send End Relay Set

Standard PABX BT	SCDC	SSAC13
1	—	SA 8132
2	—	SA 8148
3	—	SA 8240
4	—	SA 8366
5	SA 10105	SA 8460
6	SA 10106	SA 8486
7	SA 10107	SA 10010

Table 8

Relay Sets that give Pause Free Dialling into a Standard BT PABX

Into a PABX	SCDC	SSAC13
1	SA 10022 + SA 10026	SA 8132 + SA 8289 + SA 8290
2	SA 10022 + SA 10026	SA 8148 + SA 8289 + SA 8290
3	Pause Free Dialling	Pause Free Dialling
4	Inherent in PABXs	Inherent in PABXs
5	SA 10105 + SA 10026	SA 8289 + SA 8290 + SA 8460
6	SA 10106	SA 8486
7	SA 10107 + SA 10009	SA 10009 + SA 10010

15.6 Final Selection of Signalling System on Modern PBXs

Signalling Systems on PBXs

Table 9 details the inter-PBX signalling interface arrangements available on modern BT PBXs. Having selected the most suitable signalling system from the Primary Selection Charts Figs 1 to 6, the specific arrangement for any BT PBX can be determined from this Table.

Fast Call Set up and Integrated Network Services

The availability of Multi-Frequency Code Signalling and Digital Private Network Signalling on BT PBXs is shown in Table 11.

Key Systems

BT Key Systems without inter-PBX Signalling facilities but which can be provided with inter-PBX working are listed in Table 10.

Non BT PBXs

It is the customers responsibility to provide the appropriate signalling system based on the advice given him by BT, by reference to the Primary Selection Charts Figs 1 to 6.

Limitations on the use of SSAC13

SSAC13 was the first UK inter-PBX signalling system to enable automatic signalling to be provided over HF line plant. Since 1979 SSAC13 has been largely superseded for new work by SSAC15-A and may be considered, to some extent, an obsolescent system. However under some circumstances it is still provided on certain types of installation:

- At new or existing BT non-Strowger PBXs where external factors preclude the use of SSAC15-A and an SSAC13 interface is available at the PBX. A typical external factor is a new PBX interworking with an existing PBX at which SSAC13 equipment is already installed.
- Between non-BT PBXs by mutual agreement between the parties concerned.

Ring Tone on Circuits to PMBX

On inter-PBX circuits between a PABX and a PMBX it is preferred that ring tone is returned to the calling extension/ operator when the PMBX is being called. Wherever possible the outgoing PABX should be programmed to provide this facility on the circuit concerned.

System Association Time on Modern PBXs

System association time is the time between the system recognising that it is required to perform a function and being in a state where the function can be performed. When signalling over private networks the particular association time with which the planner must contend is the time between seizure of the outgoing circuit to a distant PABX and the point at which this PABX is ready to receive address information.

With inter-register signalling eg SSMF5, and with digital common channel signalling systems eg DPNSS1, the Signalling System itself ensures that the distant equipment is ready to receive before the information is sent. This does not apply to SSMF4 as this is not a compelled system. With 10 pps signalling however, system association time may present a problem. The distant PABX, would ideally be required to receive pulsed information within a normal IDP. The preferred association time for modern PABXs, as described in British Telecom Requirement documents, is 100 ms. With a PABX designed on this basis no difficulty in achieving pause free dialling may be expected. However many PABXs have an association time which may exceed a normal IDP and under these circumstances it will be necessary to:-

- Introduce a pre-sending pause at the outgoing PBX to allow sufficient association time at the incoming PBX. (Many PBXs have a choice of pre-sending pause timings), or,
- If the PBX concerned cannot provide a pre-sending pause then the distant PBX must return dial tone to indicate that it is ready to receive address information.

It should be noted that SSAC15-A has a *delay dialling* signal and SSAC15-D has a *proceed to send* signal. If both outgoing and incoming PBXs are capable of using these signals then a pre-sending pause on those systems is not necessary.

Key systems without standard inter-PBX signalling but provided with inter-PBX working as described in Section 15.1.3 are not subject to association time problems as dial tone is always returned from the distant PABX extension line port.

Table 9 follows

15.6.1 Signalling Interface Circuits for Inter-PBX Circuits Terminating on Modern PABXs

Table 9

	Signalling System			
PBX	**SSDC10-A Note 1 & 4**	**Loop Note 1, 2 & 3**	**SSDC5-A Note 11**	**SSDC5-D Note 11**
Monarch	SA 20090 SA 20094 Note 5 & 6	SA 20093 SA 20094 Note 6, 7 & 8	SA 20036 SA 20092 SA 20094 Note 6, 9 & 10	Note 24 & 25
Regent 245 247	ASU 9110-313 Note 17		ASU 9110-313	Note 24 & 25
Regent 245 247 248	SSDC5-A ASU Not yet coded Note 17 & 18		SSDC5-A ASU Not yet coded Note 18	Note 24 & 25
Viceroy & Kinsman	9102-011-011- NA Note 17		9102-011-011- NA	Note 24 & 25
Herald & Pentara	SA 20010 Note 21		SA 20010 Note 21	Note 24 & 25
Senator	DPA 1209A on even numbered extension port plus inter-PABX adaptor SA 10254 plus Signalling Unit No. 45A Note 22 & 24		DPA 1209A on even numbered extension port plus Inter-PABX adaptor SA 10254 Note 22	Note 24 & 25
Ambassador	Inter-PBX adaptor SA 10254 connected to extension 4 only. Plus Signalling Unit No. 45A Note 23 & 24		Inter-PABX adaptor SA 10254 connected to extension 4 only. Note 23	Note 24 & 25

Table 9 (Contd)

Signalling Interface Circuits for Inter-PBX Circuits Terminating on Modern PABXs

	Signalling System				
PBX	**SSDC10-A Note 1 & 4**	**Loop Note 1, 2 & 3**	**SSDC5-A Note 11**	**SSDC5-B Note 11**	**SSDC5-D Note 11**
Merlin DX	Trunk Interface No. 2 Note 26, 27	Trunk Interface No. 2 Note 26	Trunk Interface No. 3 Note 28	Trunk Interface No. 3 Note 28, 29	Note 24 & 25
Merlin BTeX	BPC-909	BPC-910	BPC-910 BPC 902 Note 30, 31	Note 29	Note 24 & 25

Table 9 (Contd)

Signalling Interface Circuits for Inter-PBX Circuits Terminating on Modern PABXs

	Signalling System		
PBX	**SSDC15-A Note 1 & 12**	**SSAC15-D Note 1 & 12**	**SSAC13 Note 1 & 15**
Monarch	SA 20067 SA 20095 Note 13 & 14	SA 20095 Note 14	SA 20064 + SA 20065 SA 20094 Note 14 & 16
245 Regent 247	ASU 9110-13	Note 19 & 24	ASU 9110-213
245 Regent 247 248	SSAC15-A ASU not yet coded Note 18	Note 19 & 24	SSAC13 ASU not yet coded
Viceroy & Kinsman	9102-011-021-NA	Note 19 & 24	Note 20
Herald & Pentara	SA 20555	Note 19 & 24	Note 20
Senator	DPA 1209A on even numbered extension port plus inter-PBX adaptor SA 10254 plus Signalling Unit No. 44B Note 22 & 24	Note 19 & 24	
Ambassador	Inter-PBX adaptor SA 10254 connected to extension 4 only plus Signalling Unit No. 44B Note 23 & 24	Note 19 & 24	

Table 9 (Contd)

Signalling Interface Circuits for Inter-PBX Circuits Terminating on Modern PABXs

	Signalling System				
PBX	**SSAC15-A Note 1 & 12**	**SSAC15-B Note 1 & 12**	**SSAC15-D Note 1 & 12**	**SSAC13 Note 1 & 15**	**M/AC Note 33**
Merlin DX	Trunk Interface No. 3 Note 28	Trunk Interface No. 3 Note 28	Note 19 & 24	Trunk Interface No. 3 Note 28	Trunk Interface No. 4
Merlin BTeX	BPC 902 Note 31	BPC 902 Note 31	BPC 902 Note 31	BPC 903	

15.6.2 Key Systems Without Inter-PBX Facilities

Provision of inter-PBX working on Key systems of this type is described in Section 15.1.3. **See also Note 40.** This Table lists the Exchange line interface arrangements on each BT System to which the circuit is connected.

Table 10

Key System	Method of connexion to Exchange Line Port
Ensign	The inter-PBX circuit is connected to the designated exchange line terminals on Distribution Unit SA 20309 Note 34
Emblem	The inter-PBX circuit is connected to the designated exchange line terminals in the Box Connexion 340A. The Emblem system should be re-programmed for PABX working when connected in this way.
Marquis	The inter-PBX circuit is connected to the designated exchange line terminals in the Box Connexion 270B. Note 35
Octara	The inter-PBX circuit is connected to the designated exchange line terminals.
Septara	The inter-PBX circuit is connected to the designated exchange line terminals.

15.6.3 Signalling Systems for Fast Call Set-up and Integrated Network Services

Table 11

	Signalling System				
PABX	**SSMF1**	**SSMF4 Note 36**	**SSMF5 Note 37**	**DPNSS1 Note 39**	**CCITT No. 7**
Merlin DX	available	available Note 38	available	available	
Merlin BTeX		available Note 38	available	available	available
Monarch		available Note 38			
Regent 248		available Note 38			

15.6.4 Notes on Final Selection Tables

Note 1

For Tandem working see Section 18.

Note 2

A single link point-to-point circuit must not include more than 56 km of 4-wire amplified circuit because of pulse degradation if loop with dialling is used.

Note 3

In the case of 2-wire circuits the resistance value shown is the maximum permissible loop resistance of the pair. In the case of 4-wire circuits the figure refers to the maximum permissible resistance of the signalling phantoms (ie half the loop resistance of one pair).

Note 4 Limits for SSDC10-A and SCDC

Circuits employing SSDC10-A or SCDC must satisfy a pulsing limit, a signalling resistance limit and in insulation resistance limit. Where only operator to operator working is required, the pulsing limit need not be applied.

a. **Pulsing Limit**
The pulsing limit is expressed as the maximum permissible CR value of the signalling path and is obtained by multiplying the sum of the capacitances (microfarads) of all sections of the signalling path by the sum of all the resistances (ohms) of all sections. This limit is 42000 microfarad ohm.

b. **Signalling Resistance Limit**
This is expressed in terms of the maximum loop resistance of the signalling path and must not exceed 3.8 kohm.

c. **Insulation Resistance Limit**
The insulation resistance of the signalling path must be greater than 100,000 ohm.

The total resistance of the signalling path should include the resistance of all transformers, loading coils, two wire-four wire terminating units and the resistance of cable pairs.

The toal capacitance should include any capacitance across line transformers, two wire-four wire terminating units and, for two wire amplified circuits, the capacitance in the amplifier itself. It is not necessary to include capacitance in the SCDC relay sets.

Values of MU and CJ cable capacities may be obtained from Ref 11 and 12 and local cable inter-wire capacity can be taken as:-

Conductor		Dialectric Material	Mean interwire capacity 10 GF/km
Size mm	Materials		
0.32	Cu	Polyethelene	50.08
0.40	Cu	Polyethelene	50.55
0.50	Cu	Polyethelene	49.89
0.63	Cu	Polyethelene	51.04
0.90	Cu	Polyethelene	53.99
0.5	Al	Polyethelene	61.27
0.8	Al	Polyethelene	64.29
0.32	Cu	Paper	42.58
0.40	Cu	Paper	45.24
0.50	Cu	Paper	44.26
0.63	Cu	Paper	49.97

Values of resistance for cable conductor, loading coils and line transformers are given on card A140. It should be remembered that on four-wire circuits the two line conductors in parallel form one leg of the signalling path. Negative impedance or 2-wire hybrid amplifiers may each be regarded as equivalent to an additional 2 microfarad and 100 ohm.

Note 5

SA 20090 is a discrete card carrying 2-wire SSDC10-A only.

Note 6

SA 20094 is a dc multiple signalling facility card which can be programmed for SSDC10-A and SSDC5-A, 2-wire and 4-wire options are available. It should be the first choice for new work.

Note 7

SA 20093 is a discrete card carrying loop signalling only. It will operate over a maximum line loop resistance of 2 kohm.

Note 8

Loop signalling is not yet provided on the dc multiple signalling card SA 20094. Districts will be advised if and when it becomes available.

Note 9

2-wire option only available on SA 20036.

Note 10

2-wire or 4-wire options are available on SA 20092.

Note 11

There is no signalling limit for SSDC5-A, SSDC5-B and SSDC5-D used for out of band signalling. However the maximum signal wire resistance of the E or M wire between the CTE and the SSDC5 interface relay set is 25 ohm which represents a maximum distance of 275 metre on 0.5 mm Cu cable. When distances in excess of 275 metre are involved, increasing the gauge of the wire to reduce the resistance is not in itself an acceptable alternative and therefore 275 metre should be considered to be the maximum cable distance between CTE and the interface relay set. See also Section 12.5.1 SSDC5 — Signal path limits.

Note 12 Transmission Requirements for SSAC15-A, SSAC15-B and SSAC15-D

Inland inter-PBX circuits The signalling system is connected in a 4-wire mode and is situated at the 0 dBr point in the Receive path and the −4 dBr point in the Transmit path of a BT EPS3G circuit. The performance at 2280 Hz of such a circuit will ensure that signal tone received levels are within the sensitivity range (−3 dBm to −29 dBm) of the SSAC15-A Signal Receiver. When multi-frequency signalling is used, either SSMF4 or SSMF5, an EPS3J circuit should be chosen to give the required response to MF signals. Either a physical audio circuit or a circuit including an HF section (FDM or PCM) is suitable. There is no limit on line length.

International Leased Lines SSAC15-A may occasionally be provided on international lines either with 10 pps, CEPT System L1 MFPB (SSMF4) or CEPT L1 MFC Inter-register signalling (SSMF5). Basic code only.

SSAC15-B may be used on international lines which employ CEPT System L1 Multi-frequency Signalling (SSMF5).

SSAC15-D is normally provided on international lines, usually with 10 pps but it may also support CEPT System L1 MFPB (SSMF4) or CEPT System L1 MFC (SSMF5).

The type of circuit provided shall be mutually agreed between the parties concerned but should be to the standard of CCITT Recommendation G171 and M1010 to M1060. International circuits are normally presented 4-wire at 0 dBr at each end, so care should be taken to ensure that the 2280 Hz received signal tone level is within the sensitivity range of the signal receiver (−3 dBm to −29 dBm). Requests for this service should be referred to BT International/IBI 4.3.2.

Note 13

SA 20067 is a discrete card carrying SSAC15-A only.

Note 14

SA 20095 is an ac multiple card which can be programmed for SSAC15-A, SSAC15-D and SSAC13. (2-wire and 4-wire options are available on SSAC13.) This card should be the first choice for new work.

Note 15 Transmission Requirements for SSAC13

SSAC13 was originally designed to operate over an EPS2A circuit, that is a circuit with a maximum nominal insertion loss of 10 dB at 800 Hz. The SSAC13 2280 Hz send level was adjusted to ensure that the received level was −23 dBm or higher (the maximum sensitivity of the SSAC13 Receiver is −26 dBm but an allowance must be made for the ±3 dB variation of insertion loss with time). This has resulted in some circuits carrying higher signal levels than those recommended to conform to the loading requirements of BT HF line plant and CCITT Recommendation Q15. The position now is that all new circuits shall be provided to the following standards:

- 2-wire connected SSAC13 — Provide the circuit to EPS3G and provide appropriate LTF to convert 4-wire to 2-wire. The system is situated at the 0 dBr send point in the 2-wire path and the 2280 Hz send level is standardised at −10 dBmO (−10 dBm at a 0 dBr point). If the circuit is carrying multi-frequency signals, either SSMF4 or SSMF5 on EP3J should be provided to give the required response to MF signals.
- 4-wire connected SSAC13 — The signalling system is situated at the 0 dBr point in the Receive path and the −4 dBr point in the Transmit path of an EPS3G circuit. The 2280 Hz send level is standardised at −10 dBmO (−14 dBm at a −4 dBr point). When multi-frequency signalling is employed, either SSMF4 or SSMF5 an EPS3J circuit should be chosen to give the required response to MF signals.

Either a physical audio circuit or a circuit including an HF section (FDM or PCM) is suitable. There is no limit on line length.

Note 16

SA 20064 (control) and SA 20065 (line) provide one SSAC13 termination only.

Note 17

On Regent, Viceroy and Kinsman SSDC10-A is provided by using an SSDC5-A interface and an external SSDC5-A/SSDC10-A Converter — ASU 9110-65, mounted in a UAA 104A.

Note 18

Regent 248 ASUs are compatible with the 245 and 247.

Note 19

SSAC15-D may be provided (but without optional signals other than *Answer*) by using the SSDC5-A interface and a Signalling Unit No. 46A and a Signalling Unit No. 44B. See Diagram SA/SAW 103270 for terminating arrangements. It should be noted that when SSAC15-D is provided in this way it can support SSMF5 only in the basic mode.

Note 20

SSAC13 may be provided, but only as a last resort and under exceptional circumstances by using a non-standard arrangement to Diagram SA/SAW 103260.

Note 21

Herald and Pentara SA 20010 has a dual function, providing either SSDC5-A or SSDC10-A.

Note 22

DPA 1209A is a modified extension card to give compatibility with the Inter-PBX adaptor SA 10254. It may be used on even numbered extension ports only. It is identified by its orange handle. The adaptor SA 10254 takes the place of an extension port therefore each adaptor reduces the extension capacity by one.

Note 23

On Ambassador an inter-PBX adaptor SA 10254 can only be provided on extension 4. Switches SW4 and SW5 should be closed on the AESS CCU.

Note 24

For a description of the Signalling Units (converter) and their application see Section 17.

Note 25

SSDC5-D may be provided (but without the optional signals, other than *answer*) by using the SSDC5-A interface and a Signalling Unit No. 46A. See Diagram SA/SAW 103270 for terminating arrangements. It should be noted that when SSDC5-D is provided in this way it can support SSMF5 only in the basic mode.

Note 26

Trunk Interface No. 2 is a dc Multiple Signalling Pack which can be programmed for SSDC10-A and Loop.

Note 27

An SSDC10-A digital trunk is available enabling a dedicated PCM Channel to be terminated at the distant end in a SSDC10-A digital interface or a PCM/SSDC10-A Signalling Unit No. 4A or Signalling Unit F5/1.

Note 28

Trunk Interface No. 3 is an ac multiple signalling pack which can be programmed for SSDC5-A, SSDC5-B, SSAC15-A, SSAC15-B and SSAC13. 2-wire and 4-wire options are available on SSAC13.

Note 29

An SSDC5-B digital trunk is available which will support SSMF5. A typical use might be where enhanced high speed signalling is required where the distant PBX has a digital interface and SSMF5 capability, but no DPNSS No. 1 capability.

Note 30

BPC 910 is a dual dc pack providing both SSDC5-A and Loop Signalling.

Note 31

BPC 902 is a multiple signalling pack providing SSDC5-A and SSAC15-A, SSAC15-B and SSAC15-D. A 4-wire transmission path is provided.

Note 32

The BPC 910 Loop Signalling will operate over a maximum line loop resistance of 1500 ohm for inter-PBX working and 1000 ohm for DDI.

Note 33

The limit for signalling 25 Hz is a signalling loop resistance of 2.2 kohm. However by using signalling repeaters and converters there is no practical limit to the distance that can be signalled using M/AC or M/BB.

Note 34

On Ensign the inter-PBX circuit may be connected to any exchange line port but if the system is equipped with 2-wire telephones either the exchange lines or the inter-PBX circuits should be barred *dial 9* access. Access from 2-wire telephones to the barred group would not be possible.

Note 35

On Marquis where exchange lines and inter-PBX circuits are provided on the System, these circuits should be programmed into separate groups.

Note 36

SSMF4 on inter-PBX circuits provides fast call set-up for a Simple Telephone Call only. See Section 13.3.

Note 37

SSMF5 between different manufacturers PBXs, beyond basic working ie Simple Telephone Call, is problematical in that, generally, each manufacturer uses his own Manufacturers Sub-Set for enhanced working to provide supplementary services. If supplementary services are required, agreement between the customer and his PBX supplier on compatibility is absolutely essential. Harmonised supplementary services are described in BTNR 184. See Section 13.2 for a description of SSMF5.

Note 38

At the time of publication SSMF4 has not been given approval on this PBX. If a request for this service is received, check the current approval status.

Note 39

A Simple Telephony call is a mandatory requirement of a PBX that supports DPNSS1, the supplementary services are optional however and the range provided is subject to agreement between customer and his PBX supplier. For a description of DPNSS1 see Section 13.1.

Note 40

When the distant PBX is also a Key System and is unable to provide a 2-wire extension port, ie it uses data signalling extension terminals only, then a link between exchange line ports at either end may be provided by using a Special Signalling Converter to provide the appropriate interface conditions. This Unit may be used on its own on 2-wire circuits or in conjunction with SSAC15-C equipment, eg Signalling Units No. 53A and 54A, on 4-wire circuits.

This Special Signalling Unit has not yet been designated but information on availability and application may be obtained from BTE Business Systems SS2.4.3, Telephone 0394 693694.

End of Section 15

Private Circuit Services
Signalling Handbook

Section 16 — Signalling on External Extensions

Definition of an External Extension

An external extension is an extension on a PBX or from a main telephone which is routed outside the Branch Telecoms System.

Signalling Requirements

The signalling requirements on external extensions fall within two broad categories; circuits that require no auxiliary signalling equipment and circuits that require auxiliary signalling equipment to extend the normal PBX signalling limits.

The descriptions that follow apply to 2-wire presented extension circuits using standard 10 pps or SSMF4 signalling only. The limits for extensions using digital signalling either on the speech pair or on a separate data pair, are described in the appropriate system instructions.

Transmission Requirements

The transmission requirements are discussed in this section only when they relate to the signalling requirements. For details of the transmission requirements for External Extensions see Section 7 and Ref 1.

16.1 Extension Circuits with no Auxiliary Signalling Equipment

This type of circuit will normally be within the same exchange area as the main PBX.

10 pps Signalling

The signalling limits that apply will depend on whether the extension line feed current is exchange fed or is supplied from the PBX transmission bridge, or Subs Line Interface Circuit — SLIC (this is usually known as local feed current).

On exchange fed circuits the signalling limit for the extension line plus the DEL must equal the circuit for a DEL on that particular exchange. See Fig. 1.

On local fed extensions the signalling limit for the extension is treated separately from the exchange line signalling limit and is the signalling limit for the PBX concerned. See Fig. 2

SSMF4 Signalling

When a PBX provides SSMF4 (MFPB) from extension telephones, in almost all cases the SSMF4 signals are regenerated at the PBX for calls to the PSTN. In this case the extension signalling limits may be treated separately from the DEL.

The maximum permitted insertion loss for an external extension which is routed over 2-wire line plant is 6 dB at 1600 Hz. SSMF4 will operate satisfactorily over such a circuit.

In those rare situations where the PBX is transparent to SSMF4 signals, and they are passed direct from the extension telephone to the local exchange, then the extension line insertion loss plus the DEL insertion loss must not exceed 8.5 dB at 1600 Hz.

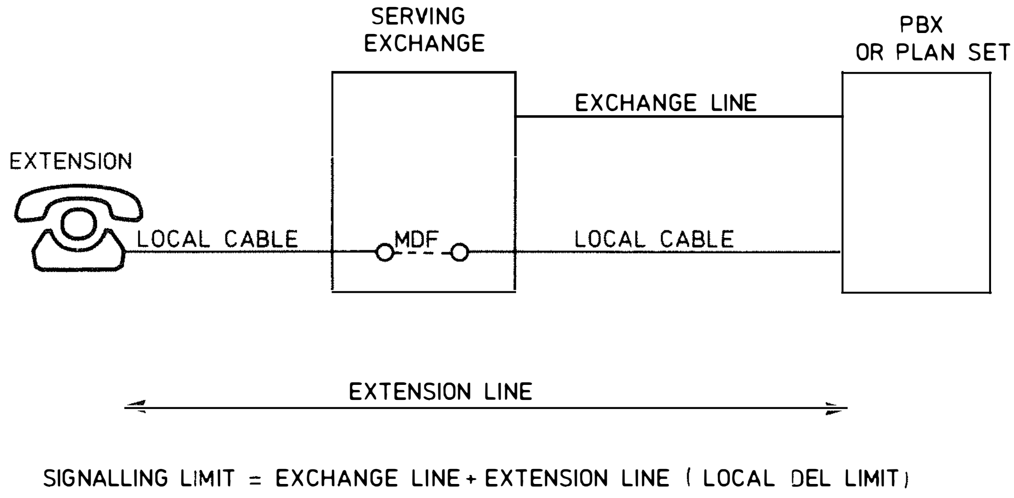


Fig. 1 Exchange Fed PBX Extension without Auxiliary Equipment

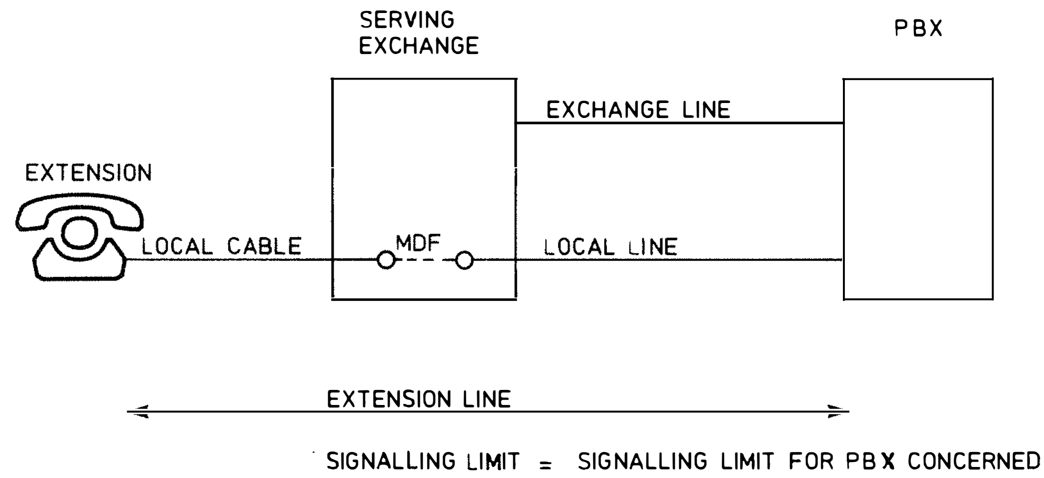


Fig. 2 Local Fed PBX Extension without Auxiliary Equipment

16.2 External Extensions Requiring Auxiliary Signalling Equipment

16.2.1 2-Wire Routed Extensions

Loop Resistance Limits and Transmission Limits Using Line Extenders Audio and Line Extenders Signalling

Extension circuits outside the normal signalling limits of the PBX concerned may be routed over 2-wire circuits using Line Extenders Audio (LEA2/-) and Line Extenders Signalling (LES1/4A). The circuit must meet two conditions:

- The total loop resistance does not exceed 2000 ohm. (The maximum operational limit of an LES1/4A.)
- The insertion loss of the extension circuit lies between 6-11 dB at 1600 Hz.

The transmission requirement of a 2-wire routed extension circuit is that the insertion loss shall not exceed 6 dB at 1600 Hz. In practice, by using Line Extenders Audio LEA2/- the insertion loss of the circuit may be extended to 11 dB; the 5 dB gain of the LEA reducing the effective loss to 6 dB.

Limiting Condition Imposed by the Transmission Requirements

As an example of the limiting condition imposed on the maximum loop resistance by the transmission requirements, consider a local cable with copper conductors of 0.5 mm diameter. A 2-wire circuit of this type will have an insertion loss of 11 dB at 1600 Hz when the loop resistance equals 1100 ohm. Therefore using such a conductor, if the extension circuit is outside the normal PBX limits but within 1100 ohm loop resistance, the transmission and signalling limits can be met using LES2/- and LES1/4A.

The limit on loop resistance will vary with conductor type and may be deduced from BT Form A140, applying the transmission limit of 11 dB insertion loss at 1600 Hz. For example, an 0.5 mm aluminium conductor cable has an insertion loss of 2.5 dB/km at 1600 Hz therefore:-

$$\frac{11\ \text{dB}}{2.5\ \text{dB}} = 4.4\ \text{km (maximum route distance)}$$

and as this conductor gives a loop resistance of 280 ohm/km:-

The limiting loop resistance = 4.4 x 280 = 1232 ohm.

The loop resistance limit deduced in this way will apply only to PBXs with a local feed current. See Fig. 4.

For PBX extensions with exchange fed current the situation becomes more complex. The transmission requirements for the DEL and the extension circuit are treated separately, see Ref 1 but for signalling purposes the loop resistance of the DEL and the extension circuit are added together. So long as the total loop resistance does not exceed 2000 ohm, that is the limit imposed by the LES1/4A, the facility may be provided. See Fig. 3

SSMF4 Signalling

The same conditions apply for external extensions with auxiliary equipment as for external extension without auxiliary equipment. It should be noted however that only the LEA2/2A is suitable for transmitting SSMF4 signals.

Recall

Both earthed loop recall and timed disconnexion recall may be used with both LEA2/- and LES1/4A.

Limitations on Use of LEA2/- and LES1/4A

i. On exchange fed PBX extensions an LES cannot be fitted if an LES is already fitted on one or more DEL.

ii. The LEA2/- is a voiced switched device and should not be fitted in the extension circuit if an LEA2/- is already fitted in one or more DEL. Voice switched LEA must not be connected in tandem. Only one voice switched LEA is permitted per local end ie a maximum of two devices in any complete connection through the PSTN otherwise a loss of intelligibility may result.

NOTE Where an LEA3/- (not voice switched) is fitted in an exchange line, an LEA2/- may be used in the extension circuit.

iii. The LEA2/- will not allow the transmission of Duplex and Half Duplex data services.

iv. The LEA2/1A cannot be used in association with SSMF4 telephones. Choose LEA2/2A.

v. The LEA2/- and LES1/4A are suitable for use on 2-wire extensions on all BT PBXs. Provisions of this facility on privately provided PBXs will depend on electrical compatibility; for example, some PBXs use dc Code C signalling from extension telephones. The LES1/4A cannot accommodate this form of signalling.

vi. The use of LES1/4A and LEA2/- is not possible on any PBX extensions using digital signalling either on the speech pair or on a separate data pair. The Herald and Pentara system are examples of PBXs that use the latter system.

vii. Only LEA2/- and LES1/4A are suitable for use on PBX external extensions.

viii. An LEA2/- includes an economy circuit which switches the LEA off when it is not in use. Due to differences between the reference voltage source and the power supply voltage, this circuit may operate erratically when the LEA is used in an external extension. Consequently, the economy circuit must be disabled by the method described in Ref 2. This turns the LEA permanently on and the LED will glow continuously. This action is always required when the extension circuit current is fed from the exchange battery.

The strap need not be fitted when the extensions current is fed from a PBX transmission bridge.

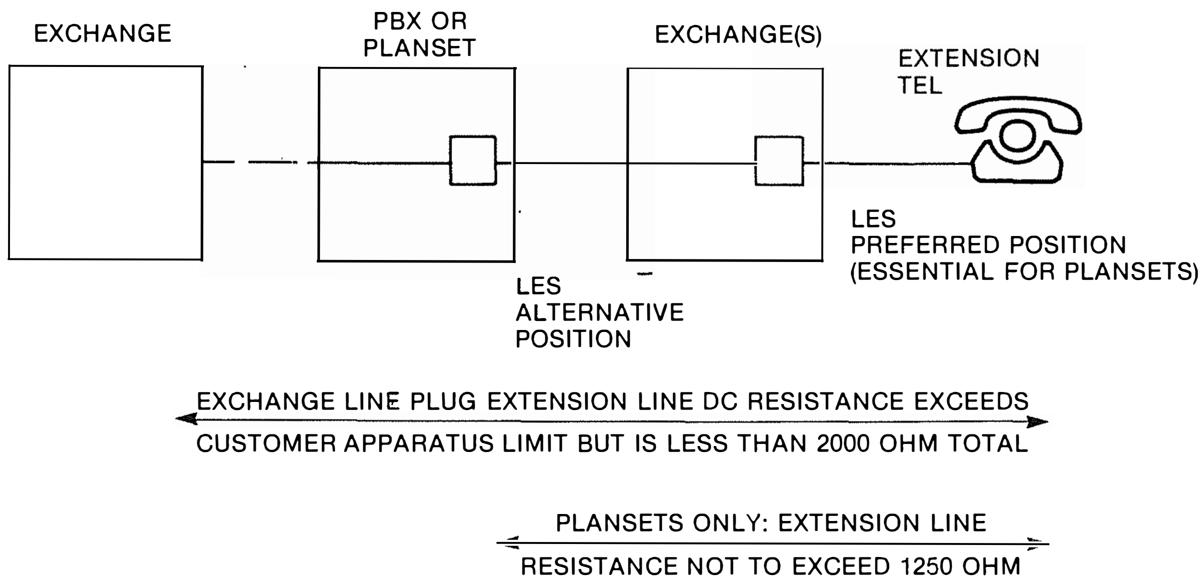


Fig. 3 External Extension from Exchange Fed Customer Apparatus

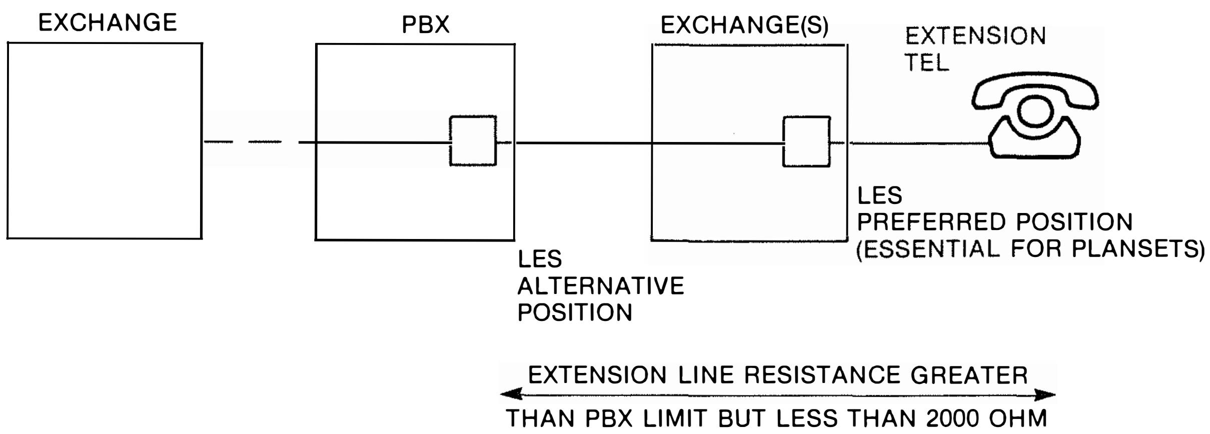


Fig. 4 External Extension from a PBX which includes a Local Feed Transmission Bridge

Descriptions of LEA and LES

Line Extenders are described in Ref 2. There is also a BTHQ Training Division document TGN 0022 which gives a very full description of the units and their application.

Long Line Signalling Unit (AT 60595)

The LLSU is superseded for new work by the LES1/4A. Its use is described in Ref 3. It may be used under exceptional circumstances where an LES1/4A cannot be provided.

Relay Set AT 60595 was originally intended for 2-wire unamplified circuits only, but may be used in association with an LEA2/-. The signalling circuits are given in the table below, but as with the LES1/4A the limiting conditions for loop resistance are largely determined by the transmission requirements.

Under exceptional circumstances the LLSU is used on 4-wire amplified circuits, where the loop resistance of the 4-wire phantoms does not exceed 2000 ohm, but as a general rule this should be avoided and SSAC15-C should be provided in such cases.

The unit is normally fitted in the local serving exchange, or if transmission requirements cannot be met in this way, at the PBX installation.

The relay set should be made up locally to Specification T 60595. On those PBX systems, such as Herald and Pentara where the PBX ringing voltage is lower than usual, it is necessary to change Relay RG in the relay set to Relay No. 9539, to increase its sensitivity.

The notes on Diagram AT 60595 do not cover the provision of earthed loop recall from the extension telephone, but the circuit and strapping arrangements can accommodate this facility, as follows:- Provide all straps shown -2-2-, and also strap Terminal 9 to Terminal 19.

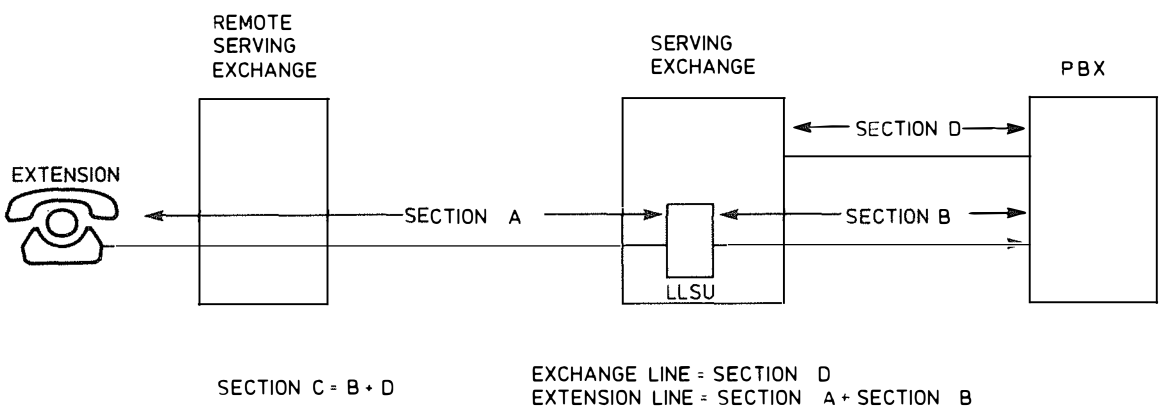


Fig. 5 External Extension on a PBX using LLSU

Table 1

Signalling Limits on External Extensions using R/S AT 60595

Section	Limit to be Applied
A Extension to LLSU	2000 ohms
B LLSU to PBX	Add 100 ohm to the PBX extension signalling limit
C LLSU to Exchange	Exchange Line signalling limit (DEL)
D PBX to Exchange	Exchange Line signalling limit (DEL)

SSMF4 Signalling

An extension circuit including a LLSU AT 60595 is subject to the same conditions as those described for circuits without auxiliary signalling equipment.

16.2.2 4-Wire Routed External Extensions

Where the external extension circuit cannot be provided by the means described under 2-wire routed extensions, then a 4-wire amplified circuit is indicated. The preferred method of providing signalling on a 4-wire circuit, whether it be a physical circuit or a circuit including an HF section, FDM or PCM, is to use Signalling System AC15-C (SSAC15-C).

16.2.2.1 Signalling System AC15-C (SSAC15-C)

System Description

SSAC15-C is a 1 VF inband signalling system for the transmission of supervisory signals and 10 pps digits between a telephone instrument, or equivalent, and a PBX extension or public exchange line termination. It uses a single signal frequency of 2280 Hz, in each direction of a 4-wire transmission path, the presence or absence of this frequency indicates a specific signal dependant on when it occurs in the signalling sequence, and in some cases upon its duration. When the circuit is idle, low level signalling tone is continuously present in the direction telephone instrument to PBX, whilst in the direction PBX to telephone instrument, a continuous Tone-off condition is present.

SSAC15-C meets the requirements for CEPT line signalling system L2 and is described in detail in CEPT Recommendation T/CS 49-12, 1982.

For the purpose of this description, reference is made to an Instrument Signalling Unit (ISU) and an Exchange Signalling Unit (ESU). This does not imply that the signalling equipment cannot form an integral part of either the telephone or PBX.

The Instrument Signalling Unit (ISU) is located at the telephone instrument and the Exchange Signalling Unit (ESU) is located at the PBX extension termination.

The SSAC15-C system may not be used on any transmission system employing Time Assignment Speech Interpolation (TASI) techniques, as it will tend to occupy a speech channel continuously when in the idle state.

Echo Suppressors

Should the circuit employing SSAC15-C require the use of echo suppressors eg on satellite circuits, the echo suppressors must be fitted outside the signal path or be cancelled when signal tone is present.

Application

SSAC15-C is the preferred method of signalling on external extensions using a 4-wire transmission facility, for both inland and international circuits, where either 10 pps pulsing or Multifrequency Push Button (MFPB) (SSMF4) signalling is employed.

Transmission Requirements

Inland External Extensions

The transmission requirements for SSAC15-C meet the requirements for 4-wire external extensions as described in Ref 1.

Both the ISU and the ESU are connected in a 4-wire mode and each is situated at distant ends of the circuit, at the + 1 dBr point in the receive path and the – 4 dBr point in the transmit path of a BT EPS3B circuit. The performance at 2280 Hz of such a circuit will ensure that signal tone received levels are within the sensitivity range (– 3 dBm to – 29 dBm) of the SSAC15-C signal receiver. When SSMF4 signalling is employed, using MFPB keyphones, an EPS3E circuit should be chosen to give the required response to MF signals. Either a physical audio circuit or a circuit including an HF section (FDM or PCM) is suitable. There is no limit on line length.

International Leased Lines

SSAC215-C may be provided on International lines either with 10 pps or Multifrequency Push Button (MFPB) signalling to CEPT Recommendation T/CS 46-02. The type of circuit provided shall be mutually agreed between the parties concerned but should be to the standard of CCITT Recommendation G171 and M1010 to M1060. International circuits are normally presented 4-wire at 0 dBr at each end, so care should be taken to ensure that the 2280 Hz received signal tone level is within the sensitivity range of the signal receiver (– 3 dBm to – 29 dBm). Requests for this service should be referred to BT International/IBI4.3.2.

Outline of Operation Viewed from ESU

Outgoing Call from ESU

Idle

In the idles state the ESU sends a continuous tone-off condition to the ISU and the ISU sends a continuous tone-on condition to the ESU to indicate the circuit is free. This tone-on signal takes the form of a continuous low level (– 20 dBmO) 2280 Hz tone. The power level of this continuous signal is chosen to conform to the transmission loading requirements of British Telecom HF line plant and CCITT Recommendation Q15.

Calling Signal

On receipt of ringing current from the PBX line circuit a calling signal is sent from the ESU to line in the form of 2280 Hz tone-on pulses in step with the periods of ringing current. The initial portion of these tone-on signals is sent at high level (– 10 dBmO), to ensure proper operation in the presence of noise, and then reverts to low level (– 20 dBmO). Tone-on signals of less than 400 ms (approximately) duration will be sent at high level throughout. Whilst calling, the caller is prevented from hearing the 2280 Hz signal returned from the distant end until an answer condition is received.

Answer Signal

When the distant telephone handset is lifted, the continuous tone-on idle signal from the ISU is terminated. The tone-off signal is recognised by the ESU as an answer signal and it applies a loop condition to the 2-wire line into the PBX extension circuit to trip ringing current.

Recall Signal

The Recall button is pressed at the telephone instrument and when it is released a recall signal is sent to line from the ISU in the form of a 2280 Hz tone-on pulse, sent at high level and of approximately 225 ms duration. This signal is recognised at the ESU and an earthed loop recall signal is transmitted to the PBX extension line circuit.

Clear Signal

When the distant telephone handset is replaced a clear signal is sent from the ISU. This takes the form of a continuous tone-on signal, the initial portion of which is sent at high level (– 10 dBmO), to ensure proper operation in the presence of noise, and then reverts to low level (– 20 dBmO), for the idle state. The clear signal is recognised by the ESU and the answer loop into the PBX extension circuit is disconnected.

Incoming Call to ESU

Idle

As for outgoing call.

Seizing Signal

When the distant telephone handset is lifted the continuous tone-on idle signal from the ISU is terminated. The tone-off signal is recognised by the ESU as a seizure condition and it applies a loop condition to the 2-wire line into the PBX extension circuit to seize the PBX equipment.

Address Information

Digital information is sent either in 10 pps form as pulses of signalling tone (decadic pulses) or as multifrequency MFPB signals. The ESU is transparent to MFPB signals, the unit simply providing a transmission path. 10 pps pulses are received as pulses of tone-on during the break period. These pulses of tone are transmitted by the ISU at high level (– 10 dBmO) to ensure proper operation, in the presence of noise. The tone pulses are corrected by the ESU and converted to loop/disconnect pulses into the PBX extension circuit.

Recall Signal

The recall button is pressed at the telephone instrument and when it is released a recall signal is sent to line from the ISU in the form of a pulse of tone-on for approximately 225 ms duration. This signal is recognised at the ESU and an earthed loop recall signal is transmitted into the PABX extension line circuit.

Clear Signal

When the telephone handset is replaced a clear signal is sent from the ISU. This takes the form of a continuous tone-on signal, the initial portion of which is sent at high level (– 10 dBmO), to ensure proper operation in the presence of noise and then reverts to low level (– 20 dBmO) for the idle state. The clear signal is recognised by the ESU and the holding loop is disconnected from the 2-wire into the PBX extension circuit to release the PBX equipment.

Outline of Operation Viewed from ISU

Outgoing Call from ISU

Idle

In the idle state the ESU sends a continuous tone-off condition to the ISU and the ISU sends a continuous tone-on condition to the ESU to indicate that the circuit is free. This tone-on signal takes the form of a continuous low level (– 20 dBmO) 2280 Hz tone. The power level of this continuous signal is chosen to conform to the transmission loading requirements of British Telecoms HF line plant and CCITT Recommendation Q15.

Seizing Signal

When the telephone is lifted a loop condition is detected by the ISU and the continuous tone-on condition is terminated. This is recognised at the ESU as a seizure condition and the PBX equipment is seized.

Address Information

Digital information is sent from the telephone instrument either in 10 pps form as loop/disconnect pulses or as multifrequency MFPB signals. The ISU is transparent to MFPB signals, the unit simply providing a transmission path. 10 pps loop/disconnect pulses are received by the ISU and pulses of 2280 Hz signal tone are sent to line coincident with the break pulses. These pulses of tone are transmitted at high level (– 10 dBmO) to ensure proper operation in the presence of noise.

Recall Signal

The recall button is pressed at the telephone instrument connecting an earthed loop signal into the ISU. This signal is recognised and when the recall button is released, a timed pulse of tone-on of approximately 225 ms duration, is sent to line, this is recognised by the ESU as a recall signal and an earthed loop signal is applied to the PBX equipment.

Clear Signal

When the telephone handset is replaced, the disconnection of the loop is detected by the ISU and a Clear signal is sent to line. This takes the form of a continuous tone-on signal, the initial portion of which is sent at high level (– 10 dBmO) to ensure proper operation in the presence of noise and then reverts to low level (– 20 dBmO) for the idle state. The clear signal is recognised by the ESU and PBX equipment is released.

Incoming Call to ISU

Idle

As for outgoing call.

Calling Signal

A calling signal is received at the ISU in the form of tone-on pulses from line in step with the periods of ringing current received from the PBX by the ESU. The initial portion of these tone-on pulses is sent at high level (– 10 dBmO) to ensure proper operating in the presence of noise and then reverts to low level (– 20 dBmO). Tone-on signals of less than 400 ms (approximately) duration will be sent at high level throughout. The pulses of tone-on are converted by the ISU into periods of ringing current connected to the 2-wire to the telephone instrument in step with the tone-on pulses.

Answer Signal

When in response to the calling signal the telephone handset is lifted, a loop condition is detected by the ISU and the continuous tone-on signal being sent to line is terminated. This is recognised by the ESU as an answer signal and it applies a loop condition into the PBX to trip ringing current.

Recall Signal

The recall button is pressed at the telephone instrument, connecting an earthed loop signal into the ISU. This signal is recognised and when the recall button is released, a timed pulse of tone-on, of approximately 225 ms duration, is sent to line. This is recognised by the ESU as a recall signal and an earthed loop signal is applied to the PBX equipment.

Clear Signal

When the telephone handset is replaced the ISU detects the disconnection of the loop condition and a clear signal is sent to line by the ISU. This takes the form of a continuous tone-on signal, the initial portion of which is sent at high level (– 10 dBmO), to ensure proper operation in the presence of noise, and then reverts to low level (– 20 dBmO) for the idle state. The clear signal is recognised by the ESU and the answer loop into the PBX is removed.

SSAC15-C Signal Code

Table 2

Call originated by the telephone instrument.

Signal	Condition from ISU	Condition from ESU
Idle	Continuous tone-on	Continuous tone-off
Seizing	Continuous tone-off	—
Address Informationn	Decadic pulsing or MFPB Signals	—
Recall	Recall tone-on pulse	—
Clear	Continuous tone-on	—

Call from the PBX.

Signal	Condition from ESU	Condition from ISU
Idle	Continuous tone-off	Continuous tone-on
Seizing	Calling tone-on pulses in step with ringing current	—
Answer	Continuous tone-off	Continuous tone-off
Recall	—	Recall tone-on pulse
Clear	—	Continuous tone-on

Realising SSAC15-C

Some PBXs may have an SSAC15-C extension interface (ESU) integral with the PBX. BTDX can provide this facility, but in the majority of cases SSAC15-C is provided by means of converters, as shown in Fig. 6. Even where the ESU is integral with the PBX, the ISU is, at present, invariably provided as a separate unit from the telephone instrument.

Equipment Used to Provide SSAC15-C

For both BT provided PBXs and non-BT provided PBXs, BT can offer Signalling Units No. 53A (ESU) and Signalling Units No. 54A (ISU). These are described in detail in Section 17.

Figure 6 follows

7-MCS780

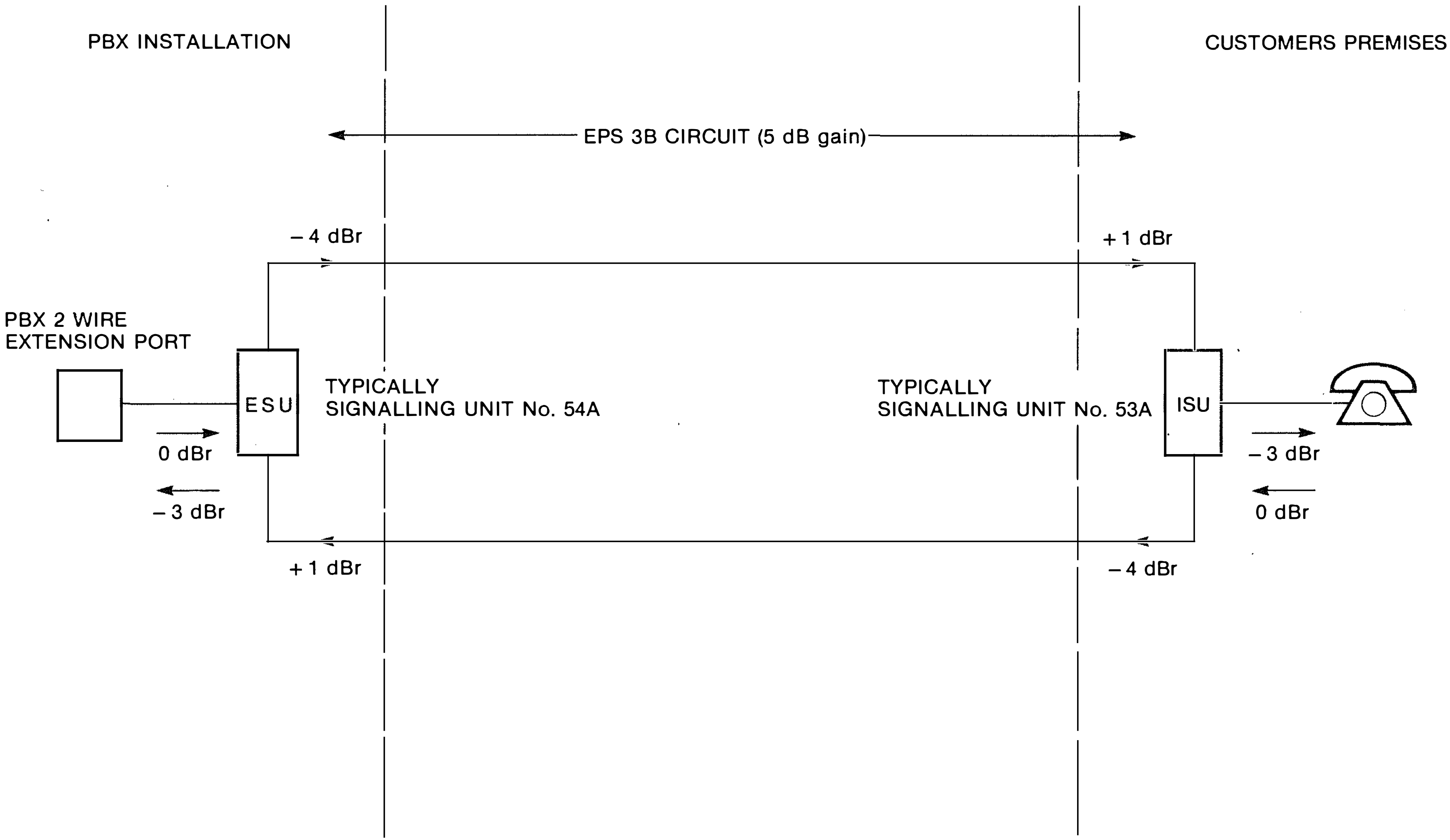


Fig. 6 Schematic Diagram of External Extension using SSAC15-C

SSAC15-C System Features

The sender and receiver requirement for SSAC15-C, both ESU and ISU, are common with those for SSAC15 in general. For completeness these are described below. Other system features, for the ESU and the ISU, being different from each other, are described separately.

2280 Hz Receiver

2280 Hz signal tone detected on the Receive path is accepted by the Receiver if it is within the frequency range 2280 Hz ± 15 Hz and is rejected if it is outside the frequency range 2280 Hz ± 75 Hz. The sensitivity of the Receiver is such that incoming signal levels between −3 dBm and −29 dBm are accepted and a signal level of −39 dBm or below is rejected.

Assuming an EPS3B circuit ie with a 5 dB gain at 800 Hz, the nominal received levels are −9 dBm, with high level tone sent at −14 dBm (−10 dBmO) and −19 dBm, with low level tones sent at −24 dBm (−20 dBmO). The extended acceptance range of the Receiver takes account of the frequency/attenuation response of the line at 2280 Hz.

The Receiver has two modes of operation:

Guarded

On the receipt of the first 225 ms (approximately) of signal frequency the Receiver will accept only a narrow band of frequencies and the guard circuit is operative. The signal frequency is compared with all other frequencies that are present. A signal frequency is accepted only if the power level at 2280 Hz exceeds the power level at accompanying guard frequencies by an amount shown in Table 3.

Table 3

Accompanying Frequency (Hz)	500	750	1000	1250	1500	1750	2000	3000
Total power level of signalling tone (2280 Hz ± 75) above accompanying frequencies (dB)	7	10	12	12	12	11	7	9

The guard ratio is chosen to meet two requirements. These are that:-

- Speech and impulsive noise frequencies containing a 2280 Hz component will not give a false signal indication.

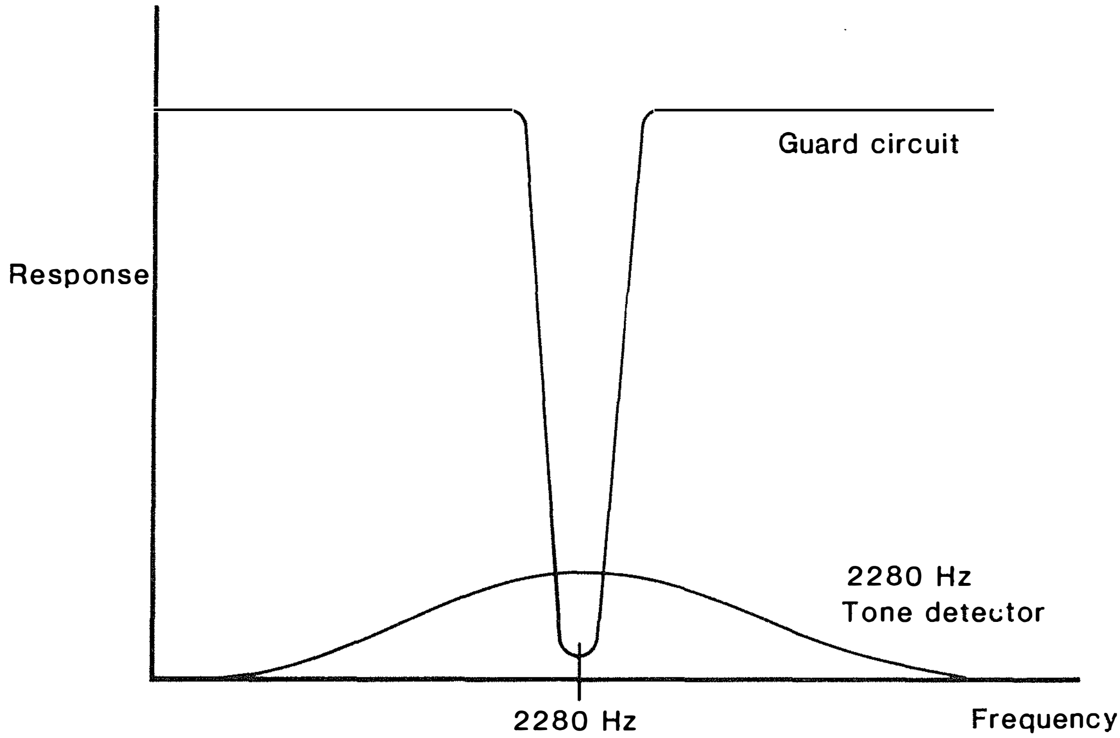
and

- A genuine 2280 Hz signal is not prevented from being recognised by normally acceptable levels of background noise. Typically the acceptance band of the receiver in the narrow band state is 2280 Hz ± 45 Hz.

Unguarded

Should the tone-on signal persist for longer than 225 ms (approximately) the receiver will switch to the unguarded mode. In this condition the guard circuit is inhibited and the effective bandwidth of the receiver is increased to 2280 Hz ± 1000 Hz approximately. The guard circuit is removed so that the receiver can hold to low level tone accompanied by normal background noise. The increased bandwidth give a measure of protection against short term line disconnections.

Fig. 7 Frequency Response of SSAC15-C Receiver



Sender 2280 Hz Oscillator and Tone Gate

The 2280 Hz oscillator transmits signal tone to line within the frequency limits 2280 Hz ± 5 Hz. In the idle state signal tone is transmitted at low level −24 dBm (−20 dBmO at a −4 dBr point in the transmission path). When the circuit is seized or when sending 10 pps make pulses, the tone gate is turned off and signal tone is prevented from being sent to line (tone-off condition). When an outgoing clear signal or a pulsed signal eg 10 pps break tone is sent to line, this tone is sent at high level −14 dBm (−10 dBmO at a −4 dBr point in the transmission path) for a period of 300-550 ms or for the duration of the pulse, whichever is shorter, and then reverts to low level tone, −24 dBm. These tone levels are chosen to conform to the short term and long term transmission loading requirements of British Telecoms HF line plant and CCITT Recommendation Q15. The initial portion of each tone-on signal, and the whole of a pulsed signal is sent at high level to ensure that the signals are received and recognised by the distant Signal Receiver in the face of normally acceptable levels of line noise, both random and impulsive.

ESU System Features (Fig. 8)

Receive Path Split

On receipt of a tone-on signal the Receive path is split within 20 ms and remains split for up to 300 ms after cessation of tone-on.

This will ensure that *idle* tone is not heard by a caller when a call is set up in the direction ESU to ISU. It also prevents spill over of tone eg during 10 pps pulsing, into a succeeding circuit.

Transmit Path Split

When a tone-on signal is sent from the ESU the transmit path must be isolated from the effects of near end noise and speech, otherwise mutilation of tone-on signals may result. This can be achieved by splitting the transmit path whilst incoming *idle* tone is present and maintaining the split for approximately 150 ms after cessation of *idle* tone.

Incoming Signal Persistance Checks

All incoming tone-off and tone-on signals from line are subject to persistance checks. This is to guard against false signal simulation due to short line disconnections and signal tone spill over. All tone-on signals are subject to a recognition time of approximately 30 ms. Tone-off signals are subject to a recognition time of approximately 40 ms or longer. If the previous tone-on condition is shorter than 300 ms the tone-off persistance check is 10 ms. This is to allow for the recognition of the full range of valid 10 pps make pulses.

Pulse Discrimination

The ESU is required to discriminate between incoming tone-on signals of different lengths.

Clear Signal

A tone on signal persisting for at least 250 ms is passed to the PBX as a clear signal.

10 pps Make Pulses

Tone-on pulses persisting for between 35-150 ms are passed to the PBX as digit pulses.

Recall Signal

A tone-on pulse of between 210-240 ms is passed on to the PBX as an earthed loop recall signal.

Figure 8 follows

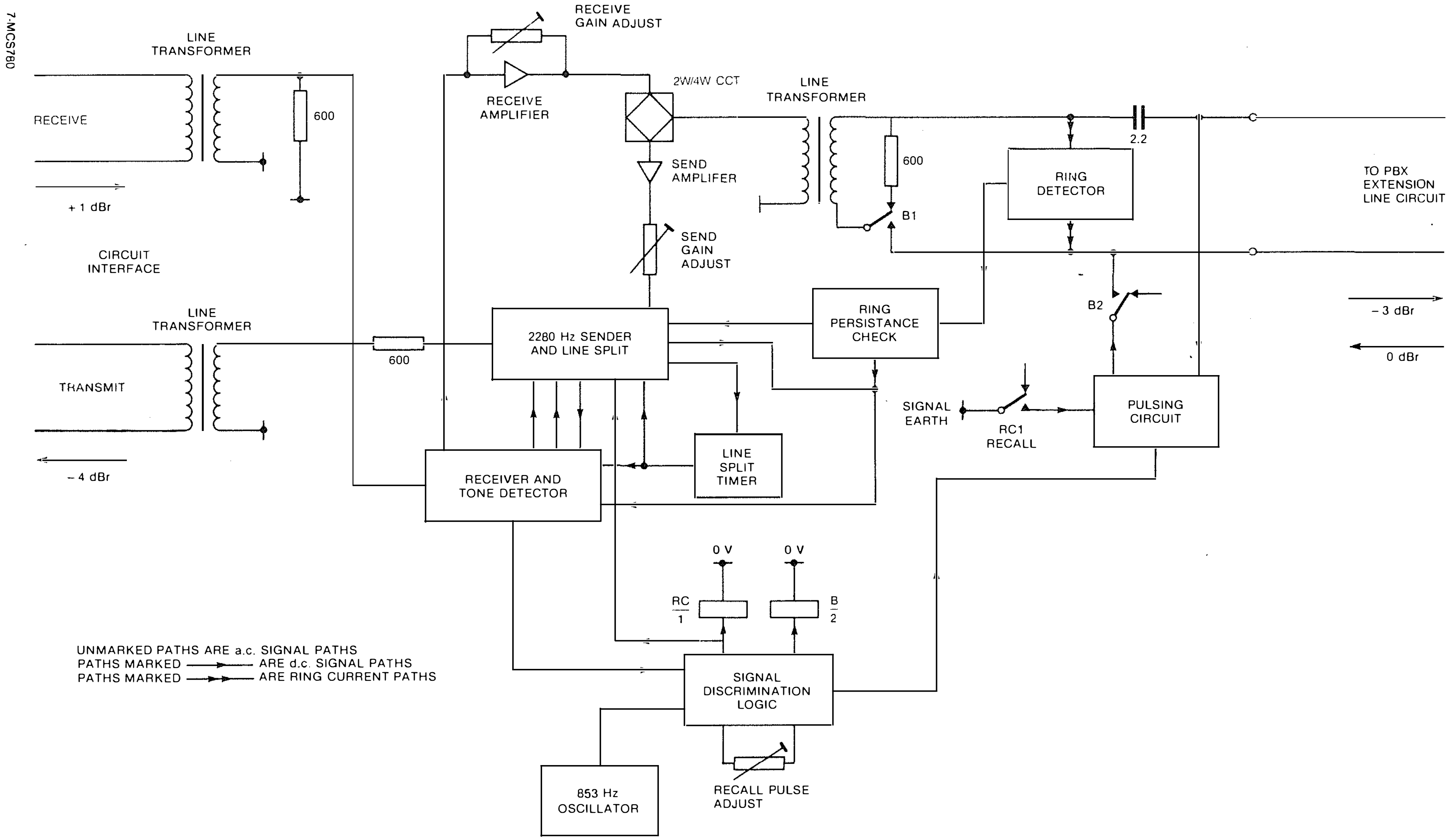


Fig. 8 Typical SSAC15-C ESU Interface

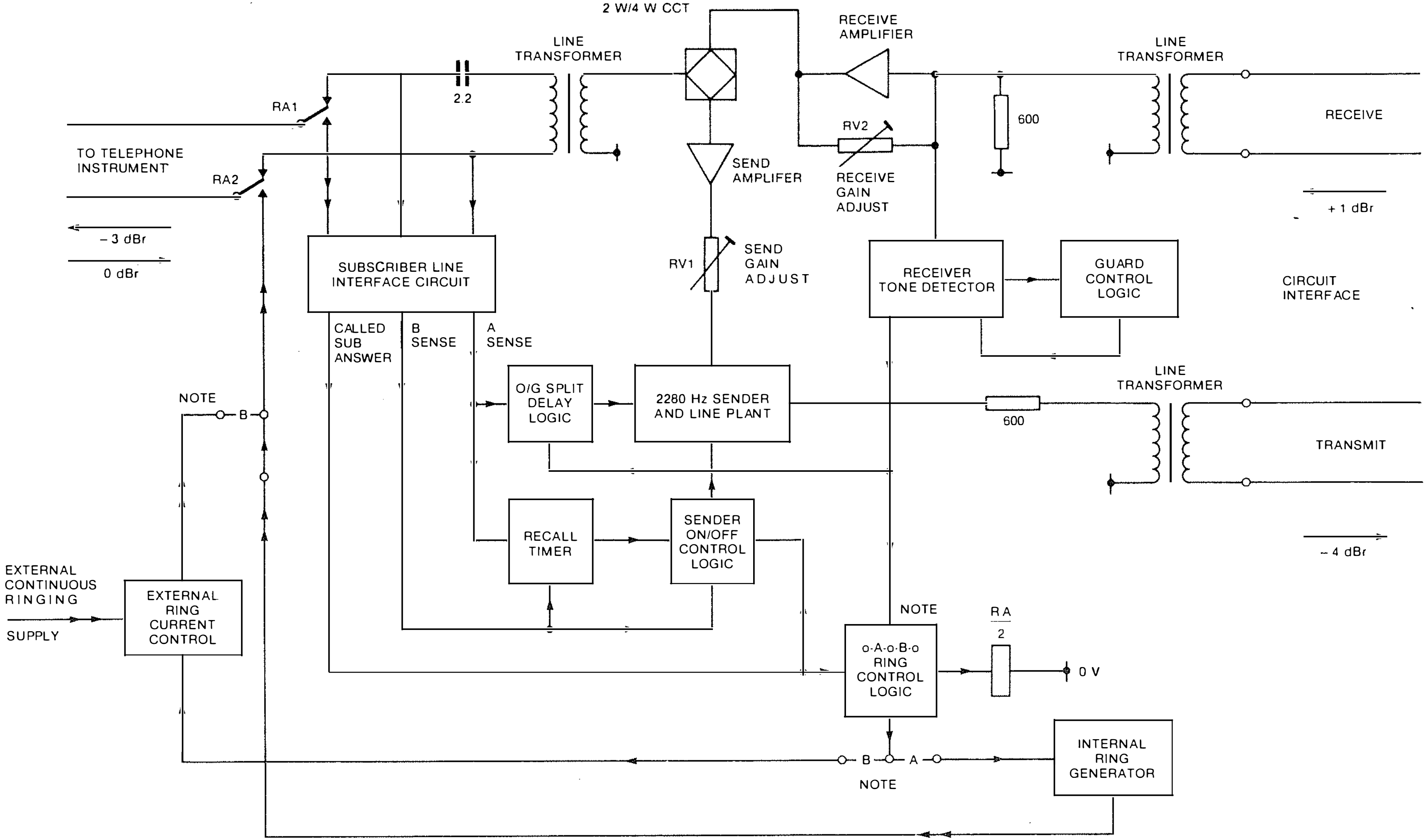
ISU System Features (Fig. 9)

Transmit Path Split

When a signal is to be sent or received the transmit path must be isolated from any source of speech, noise or incoming calling signal; otherwise signal mutilation may occur. The line remains split after tone-on signal has ceased for between 75-160 ms.

Incoming Signal Persistance Check

Incoming calling signals are subject to persistance checks. This is to guard against signal simulation due to short line disconnexions and signal spill over. All signals, both tone-on and tone-off are subject to a 35 ms recognition time.



NOTE. FOR EXTERNAL RINGING SUPPLY REMOVE STRAP A AND PROVIDE STRAP B

UNMARKED PATHS ARE a.c. SIGNAL PATHS
PATHS MARKED ——►—— ARE d.c. SIGNAL PATHS
PATHS MARKED ——►►—— ARE RING CURRENT PATHS

Fig. 9 Typical SSDC15-C ISU Interface

16.2.2.2 Signalling Systems DC8 (SSDC8)

This system is based on SSDC2 out-of-area equipment but incorporates a recall signal. It can be used on most types of PBXs, where a 2-wire extension port is available.

SSDC8 is an obsolescent system and is superceded for all new work by SSAC15-C as it is subject to certain transmission problems, see below.

SSDC8 will enable the range of external extensions to be extended over a 4-wire amplified physical circuit of up to 4000 ohm loop resistance on the 4-wire phantoms. It requires three discrete signalling wires to pass the information between the PABX and the extension and these are derived from the speech quad by arranging one pair as a normal phantom to give one signalling wire and splitting the other pair with blocking capacitors to obtain two more signalling wires. The units are described in diagrams SA/SAW 102220 and SA/SAW 102230 respectively and are constructed locally.

In some cases, the provision of three signalling wires around an amplifier can cause low frequency instability. To reduce the risk of instability, the circuit should be equalised such that the loss/frequency response at all frequencies below 800 Hz is as near as possible to the worst case response permitted by the EPS. In addition, to introduce a degree of negative feedback across the amplifier, a reversal should be inserted in the two signalling wires derived via the capacitors on the transformer units.

END of Section 16

Private Circuit Services Signalling Handbook

Section 17 — Automatic Signalling Converters

17.1 Signalling Conversion

It is often necessary on an Inter-PBX connection or on an External Extension or OOA Exchange line, to convert from one method of signalling to another. This may arise for a number of reasons. For example, on Inter-PBX circuits where:-

- The transmission path available is incompatible with the signalling systems on the PBX concerned.
- The PBX has no spare capacity for the preferred signalling system, but does have an alternative signalling system available that may be converted to the preferred type.
- It is necessary to extend the signalling path of a derived channel on Channel Translating Equipment (CTE) over an audio section to a distant PBX.
- One signalling Protocol is converted to another, eg converting SSDC5-A to SSDC5-D where a UK PBX is working to a PBX situated in another European country, and where the UK PBX cannot provide the D type protocol.
- An analogue signalling system is transmitted over an audio section and is converted to a digital form for transmission over a PCM section.
- On External Extensions or out of Area Exchange Lines, where the signalling conditions from the PBX extension line circuit or the Public Exchange Line Circuits respectively, are converted into a suitable form for transmission over an amplified circuit and vice-versa at the telephone instrument.

Signalling Units capable of performing these functions, and currently available, are described in the following sub-sections, together with information on their application.

Signalling Units No. 44B, 45A, 46A, 53A and 54B are the signalling units most commonly used at present. These units form a family of signalling units using standard signalling methods and sharing a common mounting practice.

17.2 Signalling Unit No. 44B

The Signalling Unit No. 44B is an SSDC5 to SSAC15 (E&M/1VF) converter. It is used primarily to convert a PBX SSDC5-A interface to SSAC15-A.

SSAC15-A is a continuous tone type in band line signalling system for the link by link transmission of supervisory signals and 10 pps digits. It uses a single frequency of 2280 Hz in each direction of a 4 wire transmission path, the presence or absence of this frequency indicates a specific signal dependent upon when it occurs in the signalling sequence and in certain cases upon its duration. When the circuit is idle low level signalling tone is continuously present in both direction.

The signalling unit is connected in a 4-wire mode and is situated at the +0 dBr point in the Receive path and the −4 dBr point in the Transmit path of a British Telecommunications plc EPS 3G circuit.

SSDC5-A is a 10 pps dc Signalling System which uses a combination of *earth-on* and *earth-off* conditions to represent specific signals. The signalling path is separate from the speech path; the signalling pair being termed E and M leads.

The Signalling Unit is suitable for both 2-wire switched and 4-wire switched PBXs.

A block schematic diagram of the Signalling Unit No. 44B is shown in Fig 1. The signalling unit signal code for SSAC15-A is shown in Table 1. A full description of SSAC15-A is given in Section 12.6 and a full description of SSDC5-A is given in Section 12.5.

The Unit may also be used in conjunction with a Signalling Unit No. 46A to convert a PBX SSDC5-A interface to SSAC15-D. See description of the Signalling Unit No. 46A.

Unit Description

The Signalling Unit consists of two printed wiring boards mounted on a 62 type card frame.

It occupies eight modules of mounting space in a 62 type shelf.

The Unit contains both line terminating transformers and a 2-wire/4-wire terminating unit. Each port presents a 600 ohm terminating impedance.

The 2280 Hz signal tone is generated within the unit.

Test links are provided on the front panel as shown in Fig 2.

A press button is provided on the front panel to connect 2280 Hz signal tone to line, at High level, for test purposes.

The Unit is normally presented 2-wire to the PBX but may, by changing internal straps, be converted to a 4-wire presentation. A Kit No. 357A is required in this case to provide an alternative front panel. See Fig. 3.

A full description of the Unit is contained in Specification S 1382.

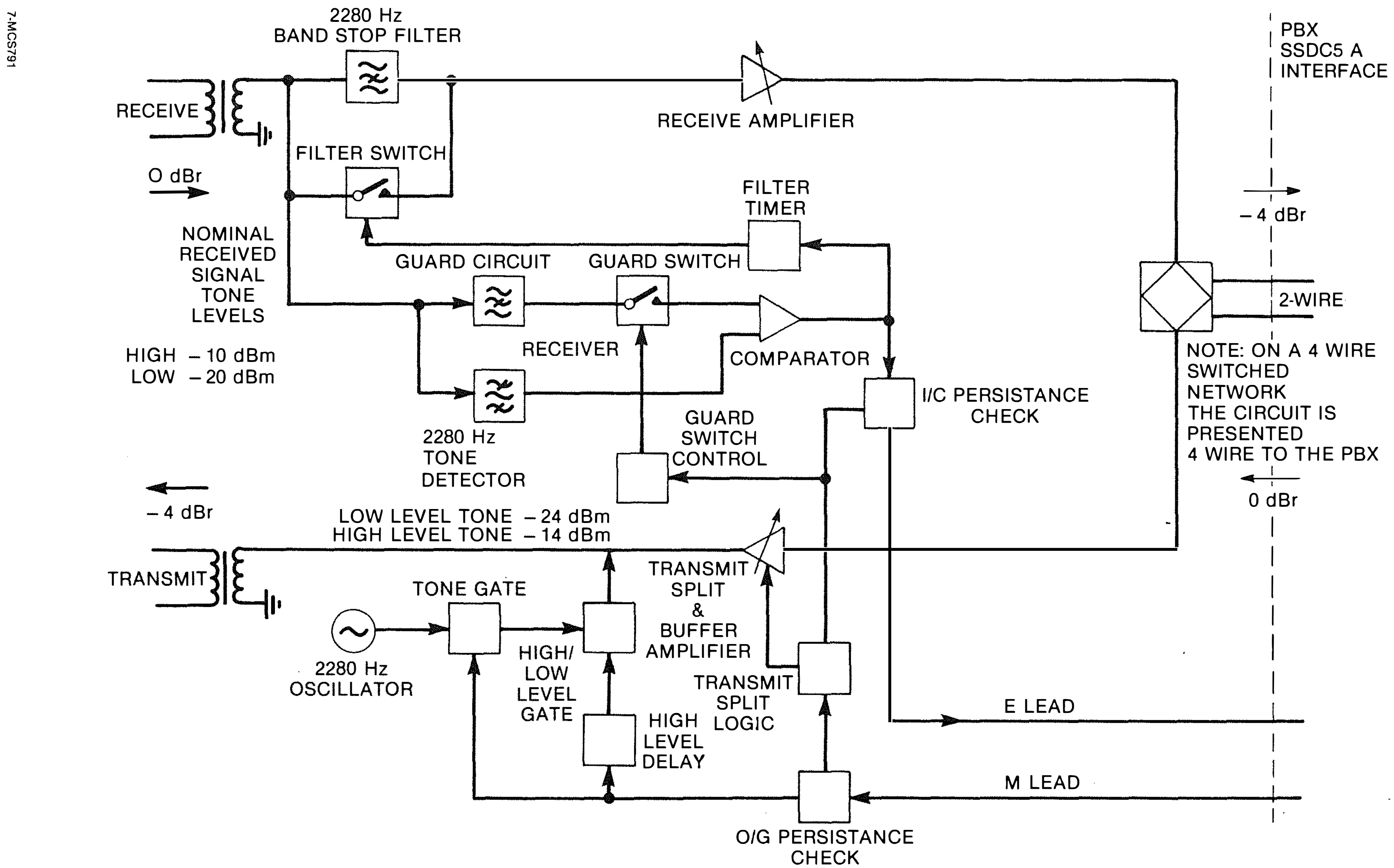


Fig 1 Signalling Unit No. 44B Block Schematic

Table 1

SSAC15-A Signal Code for Signalling Unit No. 44B

	Outgoing PBX		Incoming PBX	
	Signal wires	**Send pair**	**Send pair**	**Signal wires**
Idle	Earth off M wire Earth off E wire	Tone on	Tone on	Earth off M wire Earth off E wire
Seizing	Earth on M wire Earth off E wire	Tone off	Tone on	Earth off M wire Earth on E wire
Digit pulse	Earth off M wire During break pulses Earth off E wire	Tone on during digit break pulses	Tone on	Earth off M wire Earth off E wire During BK pulses
Answer	Earth on M wire Earth on E wire	Tone off	Tone off	Earth on M wire Earth on E wire
Clear forward with CSH	Earth off M wire for longer than 300 ms Earth on E wire	Tone on for longer than 300 ms Note 1	Tone off	Earth on M wire Earth off E wire
Clear back forward held	Earth on M wire Earth off E wire	Tone off	Note 1 Tone on for longer than 300 ms	Earth off M wire for longer than 300 ms Earth on E wire
Clear forward with called party clear	Earth off M wire Earth off E wire	Tone on for longer than 300 ms Note 1	Tone on	Earth off M wire Earth off E wire
Delay dialling	Earth on M wire Earth on E wire	Tone off	Tone off	Earth on M wire Earth on E wire
Proceed to send	Earth on M wire Earth off E wire	Tone off	Tone on	Earth off M wire Earth on E wire
Forward auxiliary signal	Earth off M wire for a period of 45-135 ms Earth either on or off the E wire	Tone on for a period of 45-135 ms	Tone either on or off	Earth off the E wire for 45-135 ms Earth either on or off the M wire
Backward auxiliary signal	Earth on M wire Earth off E wire for 45-135 ms	Tone off	Tone on for 45-135 ms	Earth off M wire for 45-135 ms Earth on E wire

NOTE 1 High level *Tone on* shall be sent for the duration of the signal or for a minimum of 300 ms (whichever is shorter) and for a maximum of 550 ms after which it must be reduced to low level.

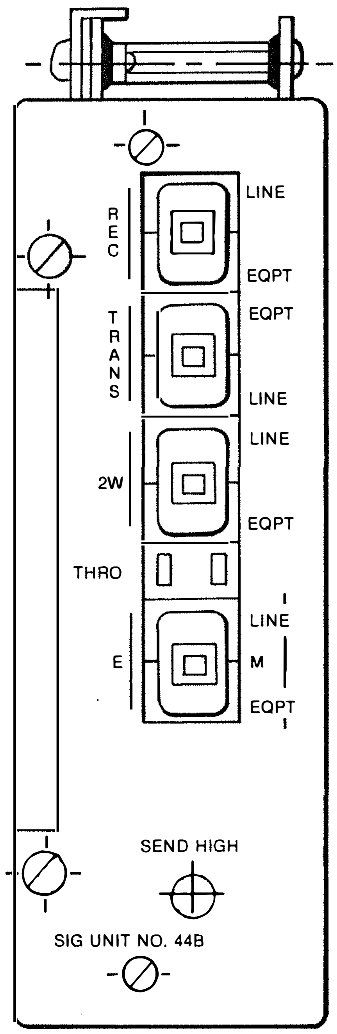


Fig 2 Front Panel of Signalling Unit No. 44B

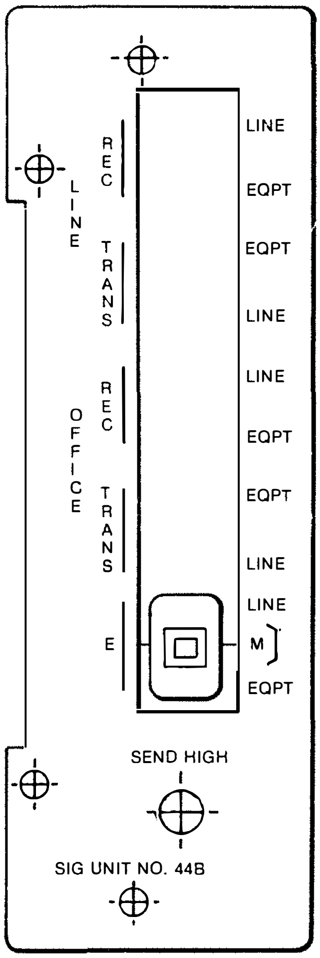


Fig 3 Alternative Front Panel for Signalling Unit No. 44B for 4 wire Presentation to PBX (Kit No. 357A)

Circuit details are available on Diagrams SA/SAW102061, SA10207 and SA10208.

The circuit operation is described in the diagram notes for Diagrams SA10207/SA10208.

Pulse Correction

The Signalling Unit No. 44B provides 10 pps pulse correction in both directions of call set-up. The correcter meets the digit pulse distortion and correction requirements for PBXs as described in BT POR 1180.

It may be assumed therefore that, even where the PBX concerned does not include pulse correction or regeneration, the use of the signalling unit in the inter-connection will ensure compliance with overall network pulsing requirements.

Transmission

The Unit is adjusted during manufacture to give an insertion loss 2-wire to Transmit, and Receive to 2-wire, of 4 dB nominal at 800 Hz.

Installation Wiring and Mounting

Full details of PBX terminating arrangements for the Signalling Unit No. 44B are shown on Diagram SA/SAW102290. Further information on suitable Racks, Cabinets and Cases for mounting the Unit, is given in sub-section 17.11 of this section.

17.3 Signalling Unit No. 45A

The Signalling Unit No. 45A is an SSDC5 to SSDC10 (E&M/SSDC10) converter. It is used primarily to convert a PBX SSDC5-A interface to SSDC10-A and to extend the E&M signalling path of a derived channel on Channel Translating Equipment (CTE) over an Audio Section to a distant PBX (see Fig 4).

SSDC10-A is a 10 pps dc Line Signalling System which uses a combination of CB, reversed CB, loop and earth conditions to provide the appropriate line signals. A 2-wire dc signal path is required and can comprise either a 2-wire line or the phantoms of a 4-wire line.

SSDC5-A is a 10 pps dc Signalling System which uses a combination of *earth-on* and *earth-off* conditions to represent specific signals. The signalling path is separate from the speech path; the signalling pair being termed E&M leads.

A full description of SSDC10-A is given in Section 12.4 and a full description of SSDC5-A is given in Section 12.5.

The Unit is inserted in the signalling path as shown in Fig 4 and Fig 5.

Space is provided on the Signalling Unit frame for mounting the transmission line terminating transformers or 2-wire/4-wire terminating unit, as required by the LTF. The unit thus provides a self contained signalling and line terminating facility. A typical arrangement is shown in Fig 5.

The Unit may be used with both 2-wire and 4-wire switched PBXs.

A block schematic of the Signalling Unit is shown in Fig 6 and the Signalling Unit Signal Code for SSDC10-A is shown on Table 2.

Unit Description

The Signalling Unit consists of two printed wiring boards mounted on a 62 type card frame.

It occupies 12 modules of mounting space in a 62 type shelf.

Space is provided for mounting one or two transformers as required by the Line Terminating Facility (LTF).

Front panel labels for each of the Line Terminating Facility (LTF) options available are supplied (Fig 1A to 1E Diagram SA/SAW102840 refers).

The Unit is supplied with the front panel wired to Diagram SA/SAW102840 Fig 1E (2-wire/4-wire Terminating Unit).

Test links are provided on the front panel. The arrangement for SA/SAW102840 Fig 1E is shown in Fig 7.

A full description of the Unit is contained in Specification S 1400.

Circuit details are available on Diagram SA/SAW100650.

The circuit operation is described in diagram notes for Diagram SA/SAW100650.

Pulse Correction

The Signalling Unit No. 45A provides 10 pps pulse correction in both directions of call set-up. The corrector meets the digit pulse distortion and correction requirements for PBXs as described in BT BTR 1180. It may be assumed therefore that, even where the PBX concerned does not include pulse correction or regeneration, the use of the signalling Unit in the inter-connection will ensure compliance with overall network pulsing requirements.

Installation Wiring and Mounting

Full details of PBX terminating arrangements for the Signalling Unit No. 45A are shown on Diagram SA/SAW102840. Further information on suitable Racks, Cabinets and Cases for mounting the Unit, is given in sub-section 17.11.

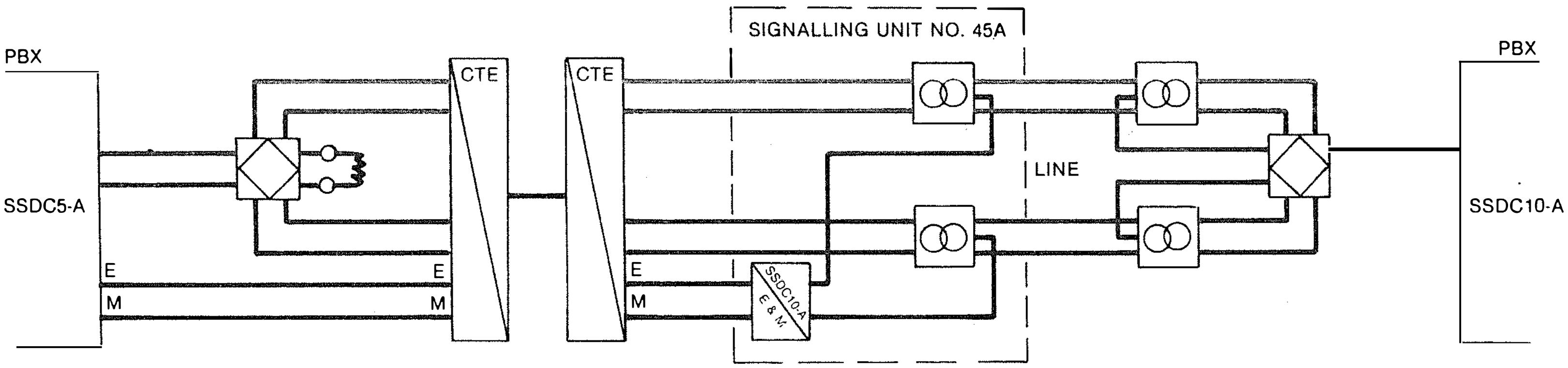


Fig 4 Extending a Channel on a Private Group over an Audio Section using a Signalling Unit No. 45A

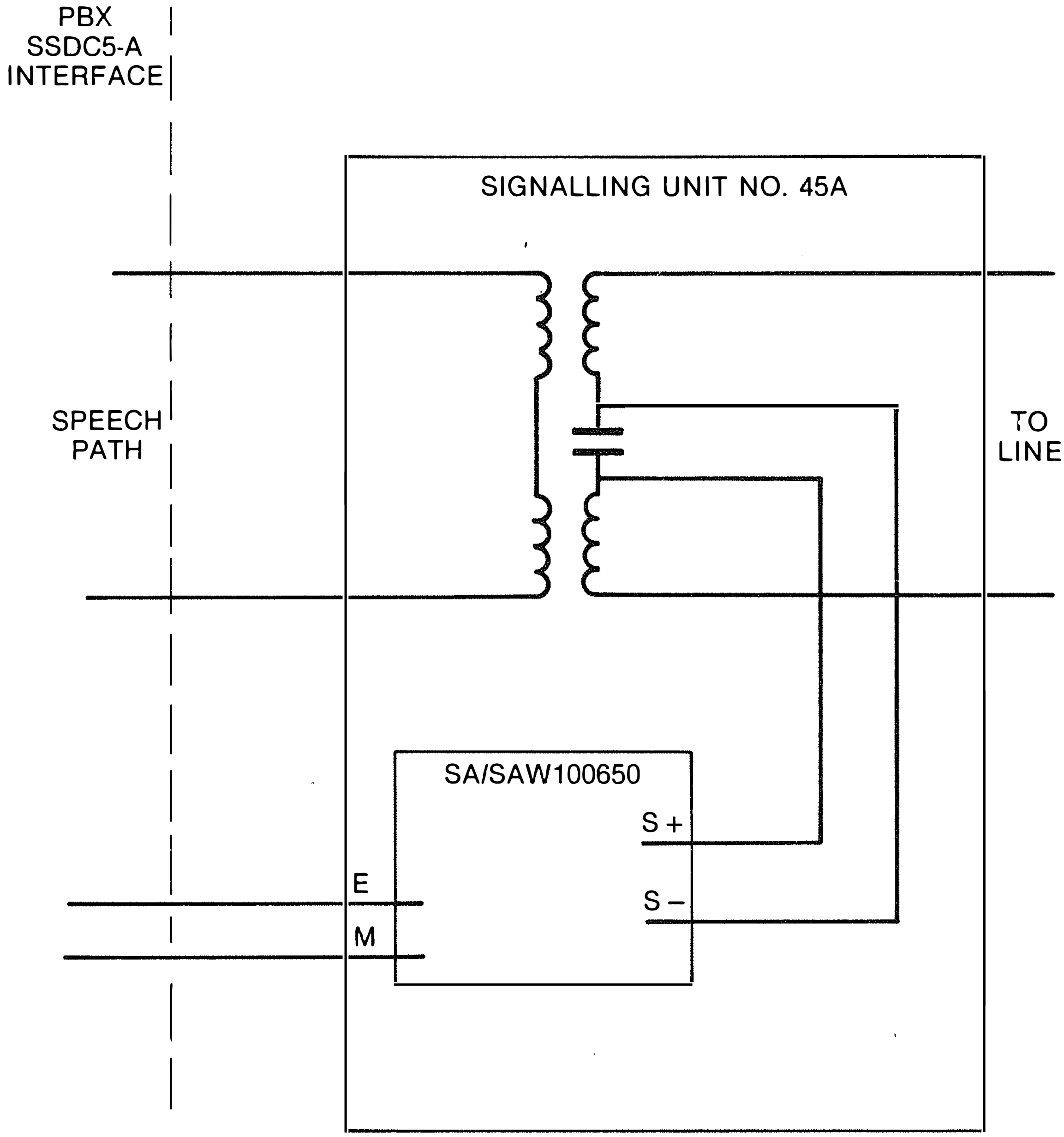


Fig 5 Typical Arrangement for Combining the Line Terminating Facility with a Signalling Unit No. 45A for other LTF see Diagram SA/SAW102840

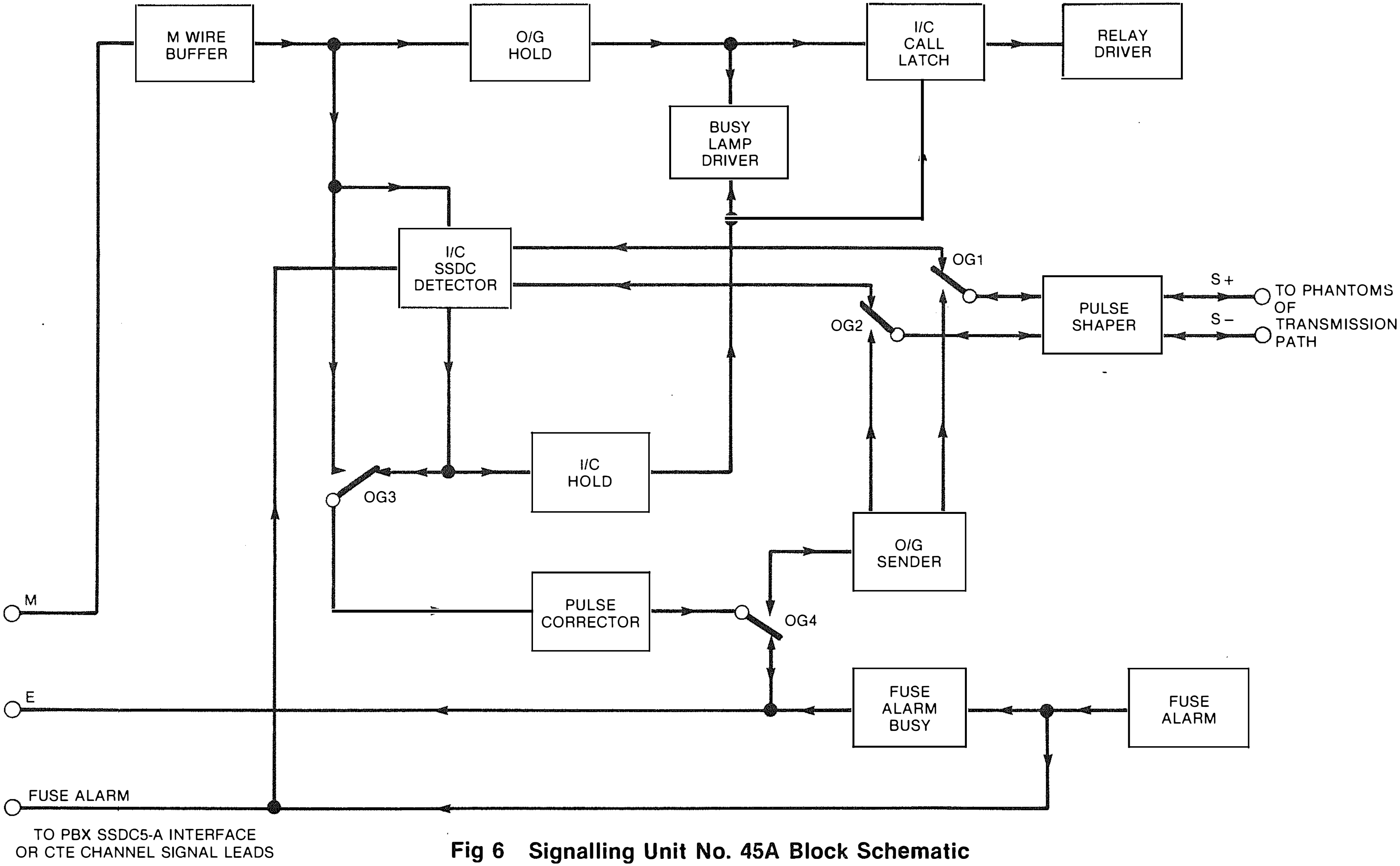


Fig 6 Signalling Unit No. 45A Block Schematic

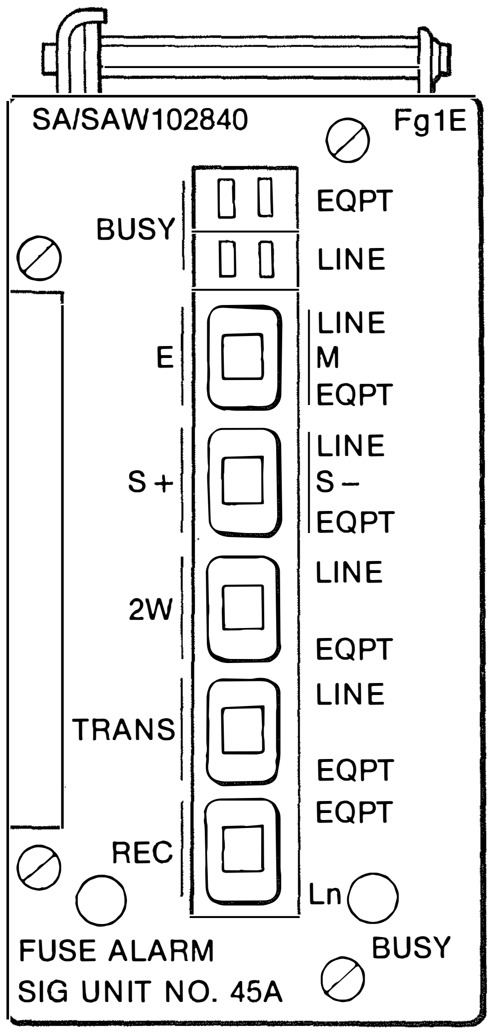


Fig 7 Front Panel of Signalling Unit No. 45A

NOTE: Front Panels for Figs 1A to 1D are supplied with the Unit.

Table 2

SSDC10-A Signal Code for Signalling Unit No. 45A

Signal	Outgoing PBX		Incoming PBX	
	Signal wires	Line Conditions	Line Conditions	Signal wires
Idle	Earth off M wire Earth off E wire	Loop	Loop	Earth off M wire Earth off E wire
Seizing	Earth on M wire Earth off E wire	Earth A wire — neg batt B wire	—	Earth off M wire Earth on E wire
Forward hold	Earth on M wire Earth off E wire	Earth A wire - Neg batt B wire	—	Earth off M wire Earth on E wire
Delayed dialling (optional)	Earth on M wire Earth on E wire	—	Earth A & B	Earth on M wire Earth on E wire
Proceed to send (optional)	Earth on M wire Earth off E wire	—	Loop	Earth off M wire Earth on E wire
Digit signals 1-0	Earth off M wire in step with digit pulses Earth off E wire	Neg batt A wire — earth B wire pulses corres- ponding to digit signals sent	—	Earth off M wire Earth off E wire in step with digit pulses
Answer	Earth on M wire Earth on E wire	Earth A wire — neg batt B wire	Earth A & B	Earth on M wire Earth on E wire
Backward hold	Earth on M wire Earth on E wire	—	Earth A & B	Earth on M wire Earth on E wire
Clear forward	Earth off M wire Earth on E wire	Neg batt a wire Earth B wire for longer than 300 ms	—	Earth on M wire Earth off E wire
Clear back	Earth off M wire Earth off E wire	—	Loop for longer than 300 ms	Earth off M wire Earth off E wire
Forward auxiliary signal (optional)	Earth off M wire Earth on E wire	Neg batt A wire Earth B wire for 45-135 ms	Earth A & B	Earth on M wire Earth off E wire for 45-135 ms
Backward auxiliary signal (optional)	Earth on M wire Earth off E wire for 45-135 ms	Earth A wire — neg batt B wire	Loop for 45-135 ms	Earth off M wire for 45-135 ms Earth on E wire

17.4 Signalling Unit No. 46A

The Signalling Unit No. 46A is an SSDC5-A to SSDC5-D converter. It is used primarily to provide SSAC15-D when associated with a Signalling Unit No. 44B. The converter is inserted in the E&M signalling leads between the Signalling Unit No. 44B and a PBX SSDC5-A terminating circuit, thereby converting SSDC5-A signalling protocol to SSAC15-D. See Fig 8.

The Signalling Unit may also be used to provide SSDC5-D to the signal path of a derived wideband channel, as shown in Fig 9.

SSAC15-D is used on international inter-PBX circuits and meets the requirements of CEPT Signalling System L1. Fig 10 shows how a typical terminal package might be assembled. The system is also used on inland inter-PBX circuits where appropriate.

Providing SSAC15-D by means of the Signalling Unit No. 46A does not imply that all optional signals, as described in Table 3, are available. It must be assumed that where a PBX is providing an SSDC5-A interface the only optional signal available is *Answer*. This imposes no restriction on 10 pps or SSMF4 signalling, but means that only *basic* SSMF5 can be supported ie no *enhanced* working.

A full description of SSAC15-D is given in Section 12.6.

A full description of SSDC5-A is given in Section 12.5.

The Signalling Code for conversion of SSDC5-A to SSDC5-D is shown in Table 3.

A block schematic diagram of the Signalling Unit No. 46A is shown in Fig 11.

Selective Switched Options

The CEPT L1 Signalling System accommodates a number of variations in signalling procedure. To ensure compatibility in all cases the Signalling Unit No. 46A is supplied with a number of selective options, these are:-

Incoming Options

Option A Applied on all routes with incoming MFC or MFPB signalling. If an Answer Signal is not received within 20 secs of seizure a Clear Back Signal is applied to the line side M lead. The incoming seizure is maintained on the office side E lead until a Clear Forward Signal is received. A subsequent Answer Signal is disregarded.

Option B Applied on routes where a Proceed to Send signal is specifically required by the outgoing PABX or where the incoming PABX has a register association time in excess of 100 ms. A Proceed to Send signal is sent within 750-800 ms of incoming seizure.

Option C Applied on incoming routes where the outgoing PBX does not require an Answer Signal. An Answer Signal received on the office side M lead is disregarded.

Option D Applied on incoming routes to PBMXs. Inhibits Clear Back on non-receipt of address information.

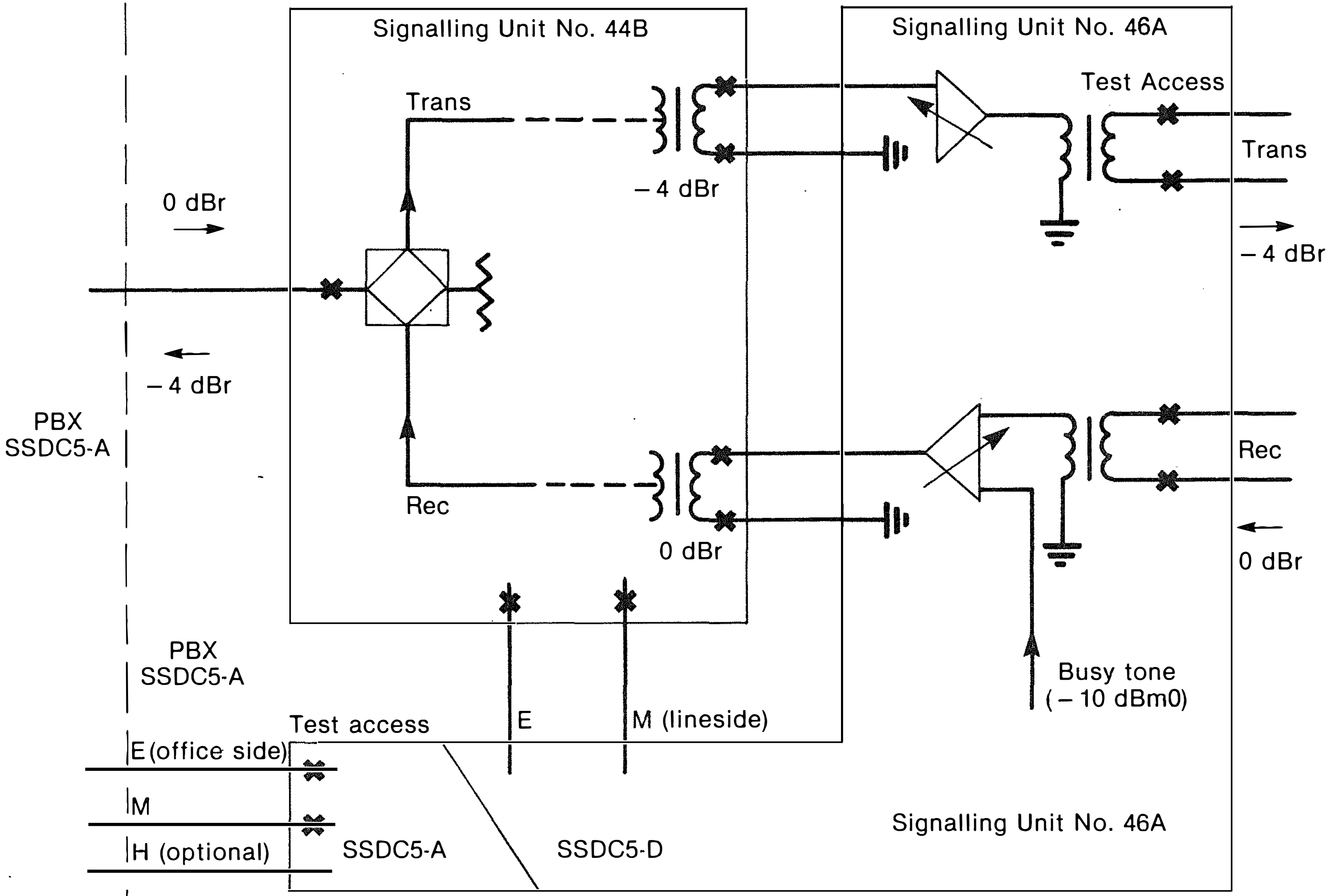


Fig 8 Signalling Unit No. 46A used with a Signalling Unit No. 44B to provide SSAC15-D
Note: The Transmission Reference Levels are for an Inland Inter-PBX Circuit.

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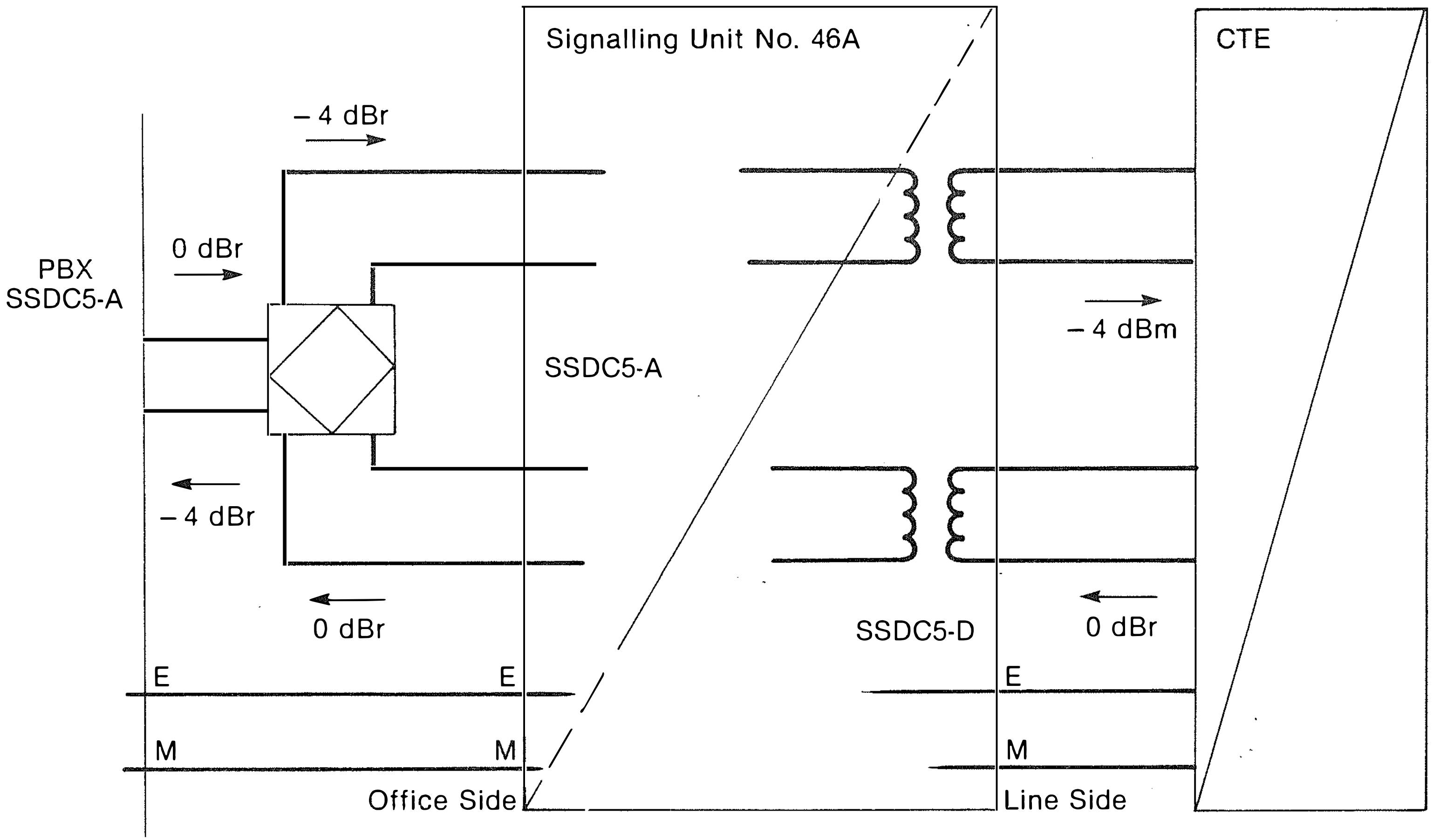

Fig 9 Signalling Unit No. 46A Converting SSDC5-A to SSDC5-D on the Signal Path of a Derived Channel on Channel Translating Equipment (CTE)
Note: Transmission Reference Levels shown are for an Inland Inter-PBX Circuit

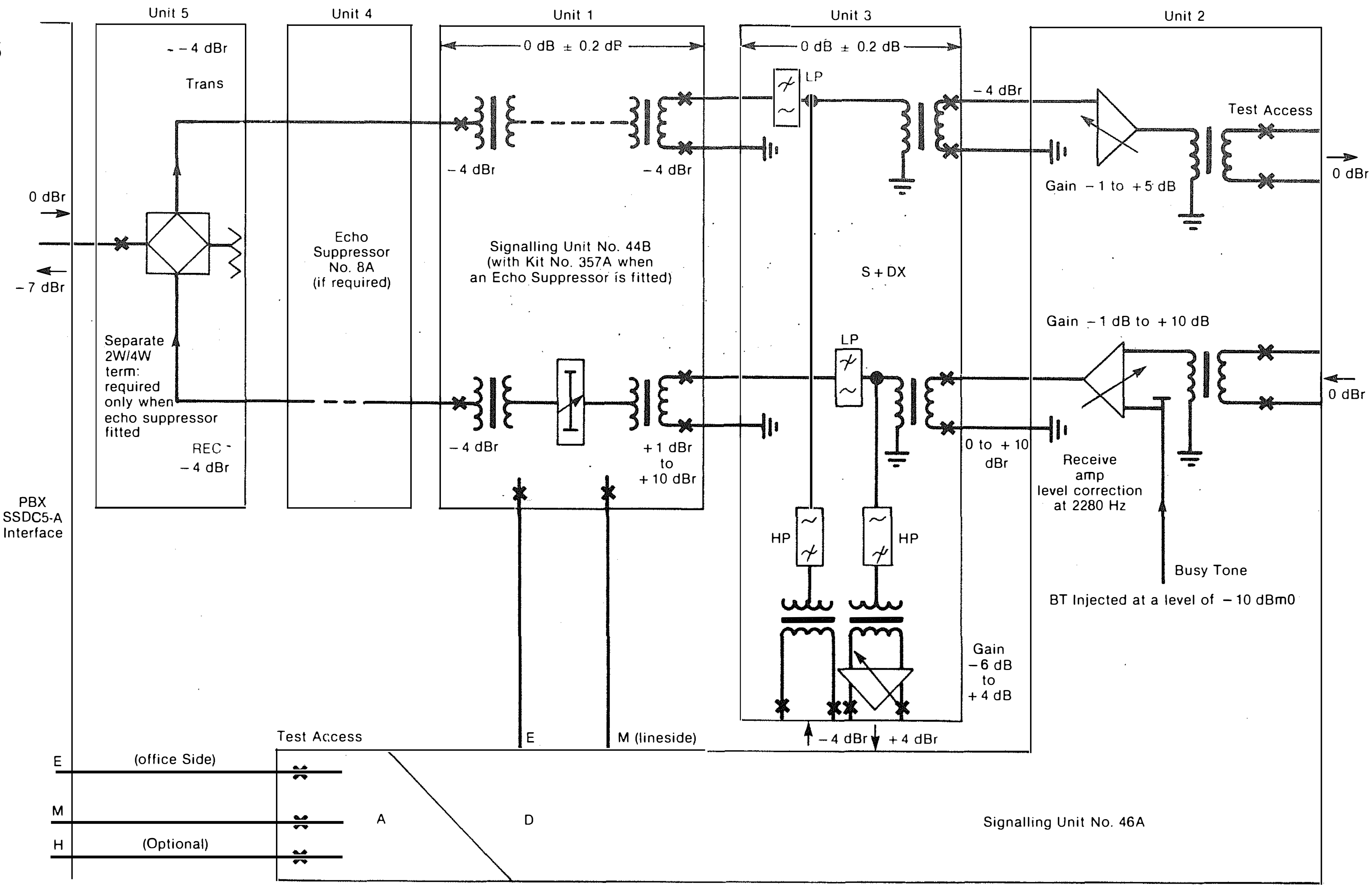

Fig 10 International Leased Line Package — CEPTL1 and S + DX

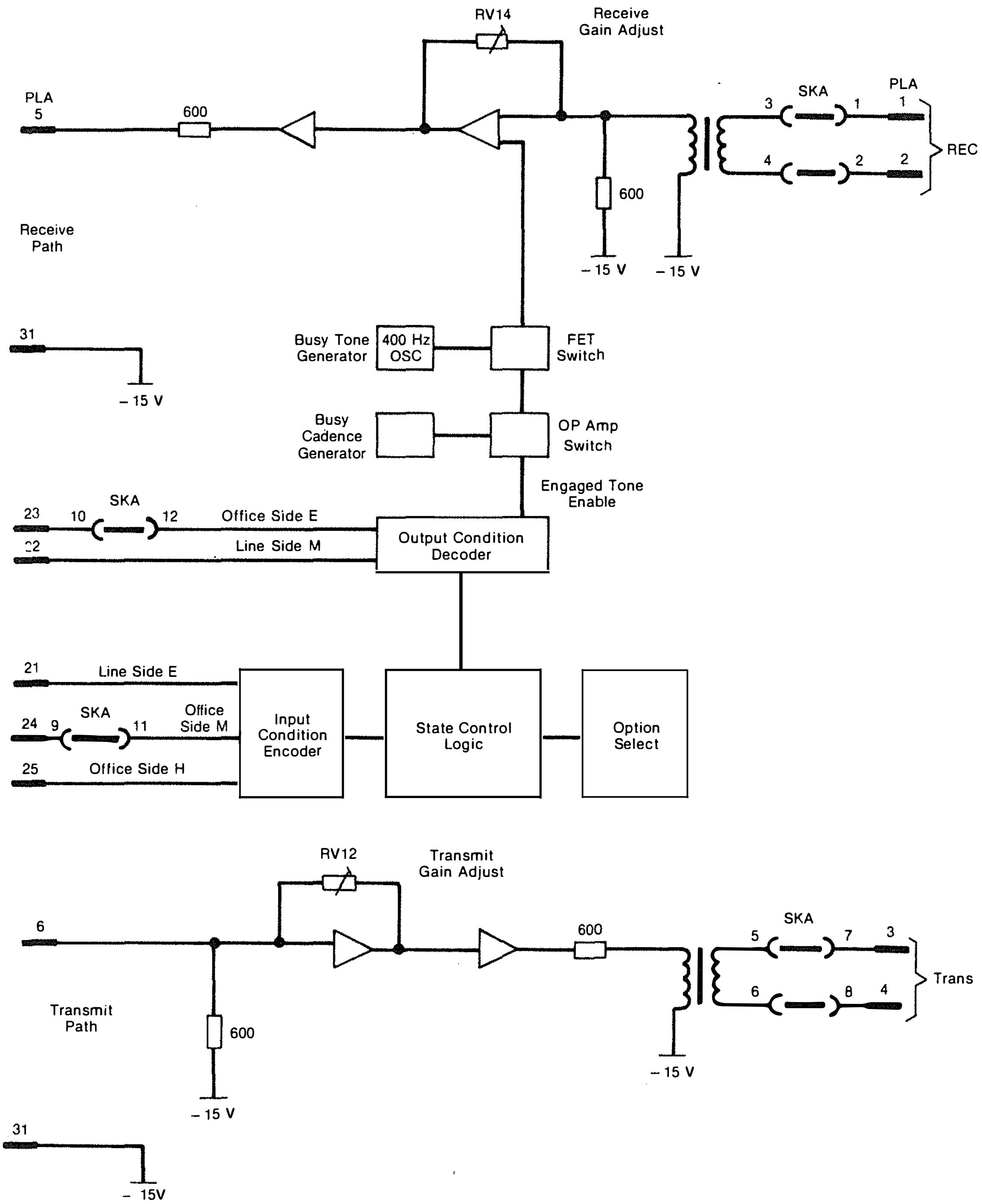

Fig 11 Signalling Unit No. 46A Block Schematic

Outgoing Options

Option E Applied on outgoing routes to PMBXs or on routes where O/G MFPB signalling is employed and where no answer signal is returned. One second after the receipt of a Seizing Acknowledge/Proceed to Send signal an Answer Signal is applied to the line side E lead.

Option F Applied on MFC routes and all routes where an Answer signal is always returned. A pulsed Answer Signal detected on the line side E lead is re-transmitted as a steady state Answer Signal on the office side E lead within 155 ms. Subsequent pulsed signals are passed from line side to office side unaltered.

$\overline{\text{Option E}}$ and $\overline{\text{Option F}}$ On 10 pps routes only. Where neither Option E or Option F apply a locally generated Answer Signal is generated N seconds after the end of digit pulsing. N to be a selected variable of 8, 12 or 16 seconds. The time 'N' selected should approximate to an estimate of the average time for the call to be routed to its destination.

It can be seen that it will be necessary to establish what the precise signalling conditions are, on the route concerned, before selecting the options.

Initial Setting of Option Switches All Option Switches, A, B, C, D, E, F and H, SW101, SW103 and SW201 are set to the NOT position. Option Switch SW102 is set to the N = 8 seconds position.

Treatment of Signals

To give a greater understanding of the process of conversion from SSDC5-A to SSDC5-D and vice-versa, and the purpose of the various Option Switches, the treatment of signals is described in some detail.

Sending and Deleting Signals at the Incoming End

Seizure

A Seizure condition on the line side E lead is transmitted to the office side E lead within 3 ms.

Seizing Acknowledge

A Seizing Acknowledge signal is applied to the line side M lead within 60-65 ms of incoming seizure where Option B is not applied.

Proceed to Send

A Proceed to Send signal is applied to the line side M lead within 750-800 ms of incoming seizure where Option B is applied.

Digit Pulses

Digit Pulses detected on the line side E lead are re-transmitted on the office side E lead within 5 ms; any pulse distortion does not exceed ± 1 ms.

Clear Back signal on non-receipt of digits. If digit pulses are not received within 10 secs of seizure, Clear Back signal is applied to the line side M lead. The seizure condition is maintained on the office side E lead.

Answer

An Answer signal detected on the office side M lead will result in either:-

- where no answer signal is required by the distant PBX Option C applies. The Answer signal on the office side M lead is disregarded; or
- where an Answer signal is required by the distant PBX an Earth-off pulse of 45-135 ms duration is transmitted on the line side M lead within 5 ms of detection of the Answer signal on the office side M lead. Option C does not apply.

Clear Forward

A Clear Forward signal detected on the line side E lead is transmitted to the office side E lead within 3 ms.

Within 5 ms of receiving a Clear Forward signal on an unanswered call, the Seizing Acknowledge/Proceed to Send signal is removed from the line side M wire, that is, except when a busy condition is detected on the H wire from the PBX. The Seizing Acknowledge/Proceed to Send signal is maintained until the busy condition is removed.

Clear Back

A Clear Back signal detected on the office side M lead is transmitted to the line side M lead within 5 ms unless a busy condition is detected on the H wire from the PBX. Subsequent removal of the busy condition results in the Clear Back signal being transmitted.

Forward Recall

A Forward Recall signal detected on the line side E lead will be re-transmitted on the office side E lead within 3 ms. Pulse distortion does not exceed ± 1 ms.

Backward Recall

A Backward Recall Signal detected on the office side M lead will be re-transmitted on the line side M lead within 3 ms. Pulse distortion does not exceed ± 1 ms.

Forward Auxiliary Signals A and B

These signals, detected on the line side E lead, will be re-transmitted on the office side E lead within 3 ms. Pulse distortion does not exceed ± 1 ms.

Backward Auxiliary Signals A and B

These signals, detected on the office side M lead, are re-transmitted on the line side M lead within 3 ms. Pulse distortion does not exceed ± 1 ms.

Clear Back on Non-Receipt of MFC or MFPB Address Information

If no Answer signal is detected on the office side M lead within 20 secs of incoming seizure a Clear Back signal is applied to the line side M lead. The seizure condition is maintained on the office side E lead until a Clear Forward is detected. Option A applies. A subsequent Answer Signal is disregarded.

Sending and Detecting Signals at the Outgoing End

Seizure

A seizure condition on the office side M lead shall be transmitted to the line side M lead within 3 ms.

Seizing Acknowledge/Proceed to Send

These signals are electrically identical and their detection on the line side E lead will either:-

- be disregarded where Option E does not apply, or
- one second after the receipt of the signal an Answer signal is applied to the office side E lead. Option E applies.

Digit Pulses

Digit pulses detected on the office side M lead are re-transmitted on the line side M lead within 5 ms. Pulse distortion shall not exceed ± 1 ms.

N seconds after the receipt of the last 10 pps digit an Answer signal is applied to the office side E lead. N is a selected variable of 8, 12 or 16 seconds.

Answer

An Answer signal detected on the line side E lead is either:-

- disregarded if Option F does not apply, or
- subject to the discrimination requirements, will result in an Answer signal being applied to the office side E lead within 155 ms of the commencement of the incoming answer pulse when Option F applies.

  NOTE It is necessary to distinguish between an answer pulse of 35-150 ms duration and a Clear Back signal which exceeds 300 ms. It is also necessary where Option F applies to discriminate between an answer signal and subsequent backward recall and Backward Auxiliary signals.

Clear Forward

A Clear Forward signal detected on the office side M lead to be re-transmitted on the line side M lead within 3 ms.

Clear Back

When an Answer pulse has been received, a Clear Back signal detected on the line side E lead is transmitted to the office side E lead within 3 ms.

When an Answer pulse has not been received, a Clear Back signal detected on the line side E lead that persists for 155 ms (to discriminate between an Answer and a Clear Back signal) is transmitted to the office side E lead.

A Clear Back signal detected on the line side E lead when an Answer signal has not been generated or under Option F has not been received, results in Engaged Tone being connected to the caller, unless a Clear Forward signal has already been received.

If a Clear Back signal is not received on an unanswered call within 400 ms following a Clear Forward signal, the signal on the line side E is treated as an incoming seizure.

Forward Recall

A Forward Recall Signal detected on the office side M lead is re-transmitted on the line side M lead within 3 ms. Pulse distortion does not exceed ± 1 ms.

Backward Recall

Subject to the discrimination requirements of a Backward Recall signal detected on the line side E lead is re-transmitted on the office side E lead within 3 ms. Pulse distortion does not exceed ± 1 ms.

Forward Auxiliary Signals A and B

These signals, detected on the office side M lead, are re-transmitted on the line side M lead within 3 ms. Pulse distortion does not exceed ± 1 ms.

Backward Auxiliary Signal A

Subject to the discrimination requirements a Backward Auxiliary Signal A detected on the line side E lead is re-transmitted on the office side E lead within 3 ms. Pulse distortion does not exceed ± 1 ms.

Backward Auxiliary Signal B

Subject to the discrimination requirements, a Backward Auxiliary Signal B detected on the line side E lead is re-transmitted on the office side E lead within 3 ms. Pulse distortion does not exceed ± 1 ms.

Discrimination between Answer signal, Backward Recall signal and Backward Auxiliary Signals A and B.

All these signals have similar electrial characteristics and they will all be disregarded if Option F does not apply.

When Option F applies discrimination depends on the position of the signal in the sequence of the call. The Answer Signal always arrives first; subsequent signals in this category are passed through unaltered.

Unit Description

The Signalling Unit consists of two printed wiring boards mounted on a 62 type card frame.

It occupies 8 modules of mounting space on a 62 type shelf.

The Unit contains two line terminating transformers as shown in Fig 11.

The Unit presents a 600 ohm terminating impedance on both line and office side of the Transmit and Receive pairs.

Test links are provided on the front panel as shown in Fig 12.

A full description of the Unit is contained in Specification S 1599.

Circuit details are available on Diagram SA/SAW 103280, Sheets 1-46.

The circuit operation is described on the State Flow Diagram. SA/SAW 103280, Sheet 45.

Transmission

The unit is adjusted during manufacture to give an insertion loss, in both directions of the 4-wire transmission path, of 0 dB measured at 800 Hz.

Installation Wiring and Mounting

Full details of PBX terminating arrangements when used with a Signalling Unit No. 44B to provide SSAC15-D are shown on Diagram SA/SAW 103270. Further information on suitable racks, cabinets and cases for mounting the Unit, is given in sub-section 17.11.

Table 3

Signalling Code for Conversion by the Signalling Unit No. 46A of SSDC5-A to SSDC5-D

Signal	Outgoing PBX		Incoming PBX	
	Office Side Signal wires	Line Side Send pair	Line Side Send pair	Office Side Signal wires
Idle	Earth off E wire Earth off M wire	Earth off E wire Earth off M wire	Earth off E wire Earth off M wire	Earth off E wire Earth off M wire
Seizure	Earth on M wire Earth off E wire	Earth on M wire Earth off E wire	Earth on E wire Earth off M wire	Earth on E wire Earth off M wire
Seizing acknowl- edge or proceed to send note — see Option B	Earth on M wire Earth off E wire	Earth on M wire Earth on E wire	Earth on E wire Earth on M wire	Earth on E wire Earth off M wire
Digit pulses	Earth off M wire during break pulses Earth off E wire	Earth off M wire during break pulses Earth on E wire	Earth off E wire during break pulses Earth on M wire	Earth off E wire during break pulses Earth off M wire
Answer (optional from I/C end except on MF routes)	Earth on M wire Earth on E wire	Earth on M wire Earth off pulse on E wire — 35 to 150 ms	Earth on E wire Earth off pulse on M wire — 45 to 135 ms	Earth on E wire Earth on M wire
Clear forward with CHS	Earth off M wire for longer than 300 ms Earth on E wire	Earth off M wire for longer than 300 ms Earth on E wire	Earth off E wire for longer than 300 ms Earth on M wire	Earth off E wire for longer than 300 ms Earth on M wire
Clear back forward held	Earth on M wire Earth off E wire for longer than 300 ms	Earth on M wire Earth off E wire for longer than 300 ms	Earth on E wire Earth off M wire for longer than 300 ms	Earth on E wire Earth off M wire for longer than 300 ms
Clear forward with called party clear	Earth off M wire for longer than 300 ms Earth off E wire	Earth off M wire for longer than 300 ms Earth off E wire	Earth off E wire for longer than 300 ms Earth off M wire	Earth off E wire for longer than 300 ms Earth off M wire
Forward recall (optional) with CSH	Earth off pulse 45-135 ms Earth on E wire	Earth off pulse 45-135 ms Earth on E wire	Earth off pulse 35-150 ms Earth on M wire	Earth of pulse 35-150 ms Earth on M wire
Backward recall (optional)	Earth on M wire Earth off pulse on E wire for 35-150 ms	Earth on M wire Earth off pulse on E wire for 35-150 ms	Earth on E wire Earth off pulse on M wire for 45-135 ms	Earth on E wire Earth off pulse on M wire for 45-135 ms

Table 3 continued on next page

Table 3 (Contd)

Signal	Outgoing PBX		Incoming PBX	
	Office Side Signal wires	**Line Side Send pair**	**Line Side Send pair**	**Office Side Signal wires**
Forward auxiliary signal A (optional)	Earth off pulse on M wire for 45-135 ms Earth on E wire	Earth off pulse on M wire for 45-135 ms Earth on E wire	Earth off pulse on E wire for 35-150 ms Earth on E wire	Earth off pulse on E wire for 35-150 ms Earth on E wire
Backward auxiliary signal A (optional)	Earth on M wire Earth off pulse on E wire for 35-150 ms	Earth on M wire Earth off pulse on E wire for 35-150 ms	Earth on E wire Earth off pulse on M wire for 45-135 ms	Earth on E wire Earth off pulse on M wire for 45-135 ms
Forward auxiliary signal B (optional)	Earth off pulse on M wire for 45-135 ms; Earth on for 30-70 ms; Earth off for 45-135 ms Earth on E wire	Earth off pulse on M wire for 45-135 ms; Earth on for 30-70 ms; Earth off for 45-135 ms Earth on E wire	Earth off pulse on E wire for 35-150 ms; Earth on for 20-80 ms; Earth off for 35-150 ms Earth on M wire	Earth off pulse on E wire for 35-150 ms; Earth on for 20-80 ms; Earth off for 35-150 ms Earth on M wire
Backward auxiliary signal B (optional)	Earth on M wire Earth off pulse on E wire for 35-150 ms; Earth on for 20-80 ms; Earth off for 35-130 ms	Earth on M wire Earth off pulse on E wire for 35-150 ms; Earth on for 20-80 ms; Earth off for 35-150 ms	Earth on E wire Earth off pulse on M wire for 45-135 ms; Earth on for 30-70 ms; Earth off for 45-135 ms	Earth on E wire Earth off pulse on M wire for 45-135 ms; Earth on for 30-70 ms; Earth off for 45-135 ms

NOTE: Optional signals are available for use by the PABX. The converter is capable of responding to all optional signals.

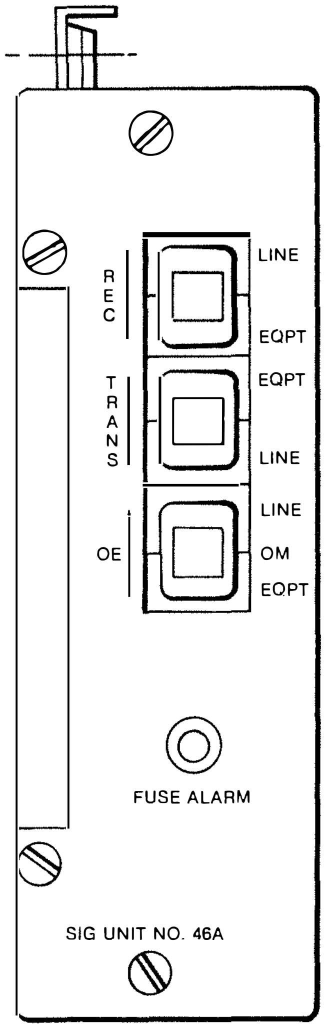

Fig 12 Front Panel of the Signalling Unit No. 46A

17.5 Signalling Unit No. 53A

PBX Termination for Long External Extension

The Signalling Unit No. 53A converts PBX extension line interface signalling conditions to 1VF line conditions in accordance with SSAC15-C. The Unit, referred to as the Equipment Signalling Unit (ESU), is located at the PBX extension termination and is designed to work to a Signalling Unit No. 54A, referred to as the Instrument Signalling Unit (ISU), located at the telephone instrument. See Fig 13.

The Signalling Unit No. 53A may only be connected to 2-wire extension ports. Its use on data type extension terminals is not permitted eg as provided on Ensign and Octara.

The Signalling Unit No. 53A may also be used, in association with the Signalling Unit No. 54A to provide inter-PBX working on Key Systems, eg Ensign, Octara etc, as described in Section 15.1.3, see also Fig 14. The Unit can only be used on loop calling exchange lines.

The Signalling Unit No. 53A may also be used in association with a Signalling Unit No. 54A to provide Out of Area Exchange line working, over a 4-wire transmission path, where the line terminates on:-

- A telephone instrument.
- A PMBX Exchange line.
- An incoming only Exchange line to a PABX.
- An Automatic Call Distribution Equipment that does not require a Clear condition from the Public exchange.

In effect, any situation where the Public exchange is not required to provide a Clear condition such as, earth calling, disconnect clear or line reversal.

System Description

SSAC15-C is a 1VF inband signalling system for the transmission of supervisory signals and 10 pps digits between a telephone instrument, or equivalent, and a PBX extension or public exchange line termination. It uses a single signal frequency of 2280 Hz, in each direction of a 4-wire transmission path, the presence or absence of this frequency indicates a specific signal dependent on when it occurs in the signalling sequence, and in some cases upon its duration. When the circuit is idle, low level signalling tone is continuously present in the direction telephone instrument to PBX, whilst in the direction PBX to telephone instrument, a continuous tone-off condition is present.

A full description of SSAC15-C is given in Section 16.

A block schematic of the Signalling Unit No. 53A is shown in Fig 15.

The Signalling Code for SSAC15-C is given in Table 4.

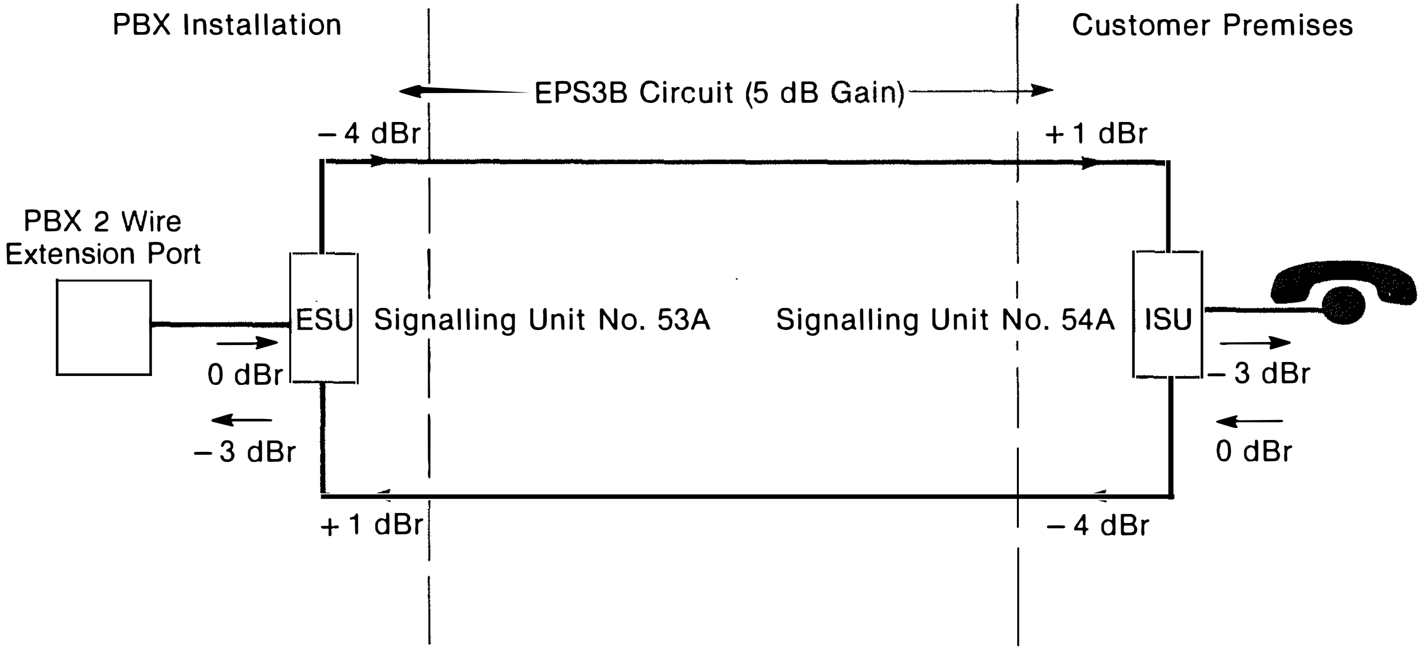

Fig 13 Schematic Diagram of External Extension using SSAC15-C

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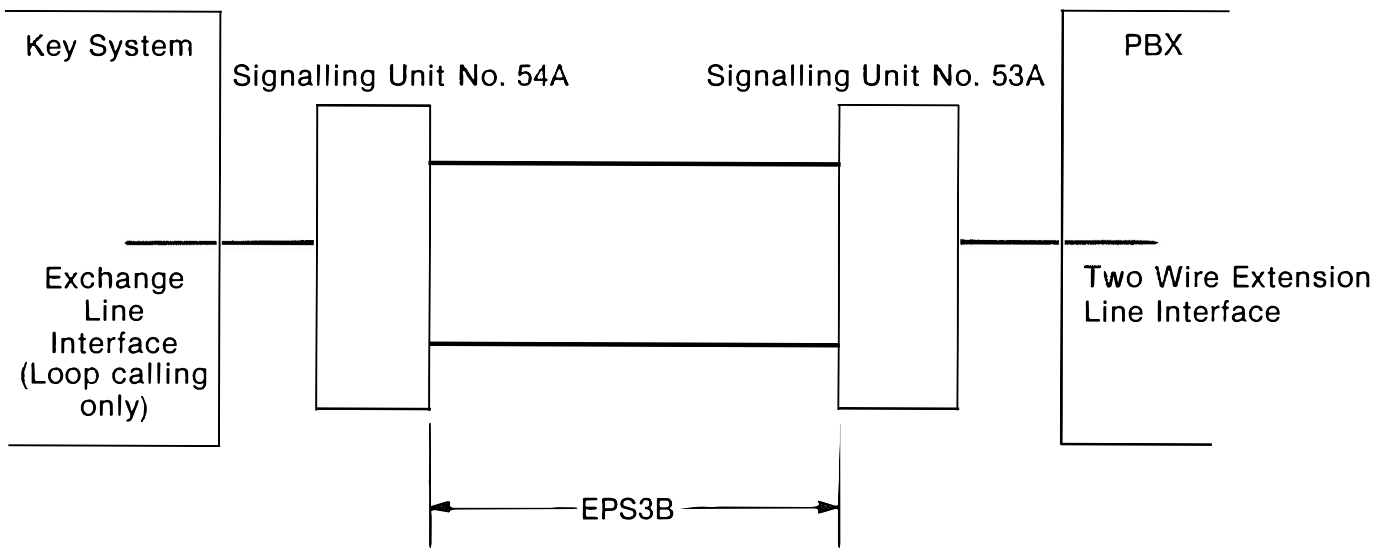


Fig 14 Signalling Units No. 53A & 54A used to provide SSAC15-C Inter-PBX working on a Key system to a PBX

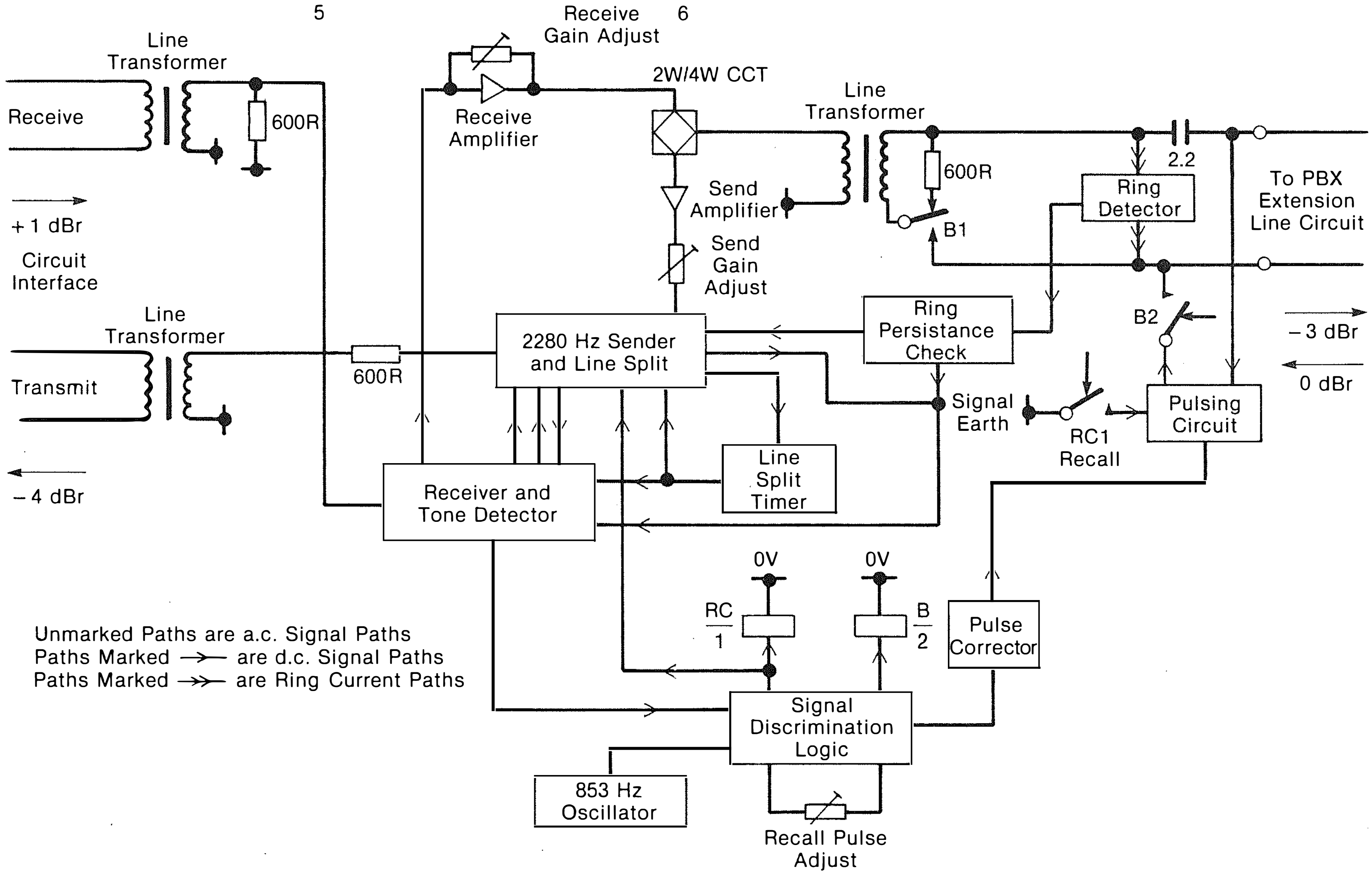


Fig 15 Signalling Unit No. 53A Block Schematic

Table 4

SSAC15-C Signal Code

Call originated by the telephone instrument.

Signal	Condition from ISV	Condition from ESU
Idle	Continuous tone-on	Continuous tone-off'
Seizing	Continuous tone-off	—
Address Information	Decadic pulsing or MFPB Signals	—
Recall	Recall tone-on pulse	—
Clear	Continuous tone-on	—

Call from the PBX.

Signal	Condition from ESV	Condition from ISU
Idle	Continuous tone-off	Continuous tone-on
Seizing	Calling tone-on pulses in step with ringing current	—
Answer	Continuous tone-off	Continuous tone off
Recall	—	Recall tone-on pulses
Clear	—	Continuous tone-on

Unit Description

The Signalling Unit No. 53A consists of one printed wiring board mounted on a 62 type card frame.

It occupies 8 modules of mounting space in a 62 type shelf.

The Unit contains line terminating transformers and a 2-wire/4-wire terminating unit, as shown in block schematic diagram Fig 15.

The Unit presents a 600 ohm terminating impedance on the Receive and Transmit paths of the 4-wire line. The 2-wire presents a complex impedance designed to match a local line.

The 2280 Hz signal tone is generated within the Unit.

Test links are provided on the front panel as shown in Fig 16.

A switch is provided on the front panel for connecting 2280 Hz signal tone to line for test purposes.

A full description of the Unit is contained in Specification S 1572.

Circuit details are available on Diagram SA/SAW102990.

The circuit operation is described in Diagram notes for Diagram SA/SAW102990.

Transmission

The 2-wire of the Signalling Unit No. 53A presents a complex impedance to line which is designed to match BT local cables. The insertion loss will vary with frequency when sending and measuring with instruments terminated in a 600 ohm non-reactive impedance. The performance requirements are therefore given in terms of a nominal loss when the 2-wire line is terminated in a complex impedance to match the signalling unit, and a corrected figure when terminated in 600 ohm non-reactive impedance.

Insertion loss 2-wire to Transmit: Nominal loss 4 dB; measured with 600 ohm termination, 2.8 dB at 800 Hz.

Insertion loss Receive to 2-wire: Nominal loss 4 dB; measured with 600 ohm termination, 4.4 dB at 800 Hz.

Pulse Correction

The Signalling Unit No. 53A provides 10 pps Pulse Correction. The correcter meets the digit pulse distortion and correction requirements for PBXs as described in BT BTR 1180. It may be assumed therefore that, even if the PBX concerned does not include Pulse Correction or regeneration, the use of the Signalling Unit will ensure compliance with overall network requirements, both private and PSTN.

Installation Wiring and Mounting

Full details of PBX terminating arrangements are shown on Diagram SA/SAW103240. Further information on suitable racks, cabinets and cases for mounting the Unit is given in sub-section 17.11.

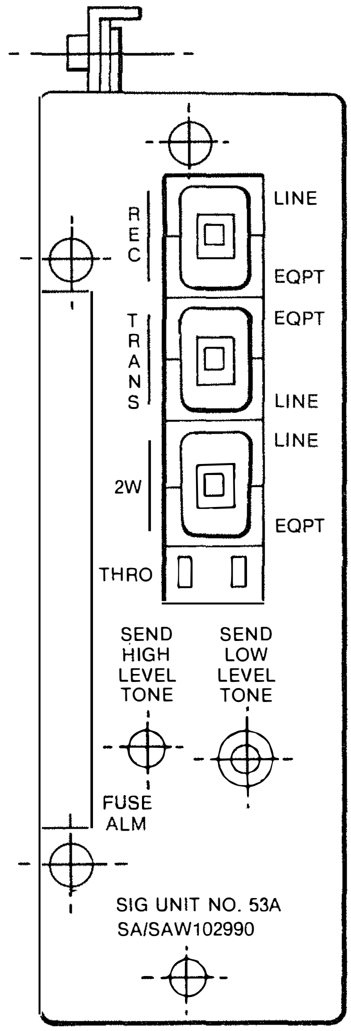


Fig 16 Front Panel of Signalling Unit No. 53A

17.6 Signalling Unit No. 54A

Telephone Termination for a Long External Extension

The Signalling Unit No. 54A converts telephone line interface signalling conditions to 1VF line conditions in accordance with SSAC15-C. The Unit, referred to as the Instrument Signalling Unit (ISU), is located at the telephone instrument, and is designed to work to a Signalling Unit No. 53A, referred to as the Equipment Signalling Unit (ESU), located at the PBX extension termination or to any other approved SSAC15-C ESU. See Fig 13.

The Signalling Unit No. 54A may only be connected to a Standard 2-wire type telephone ie not to data type extension terminals eg as provided on Ensign, Octara etc.

The Signalling Unit No. 54A may also be used, in association with the Signalling Unit No. 53A, to provide inter-PBX working on Key systems, eg Ensign, Octara etc, as described in Section 15.1.3. See also Fig 14.

The Signalling Unit No. 54A may also be used in association with a Signalling Unit No. 53A to provide Out of Area Exchange line working, over a 4-wire transmision path, where the line terminates on:-

- A telephone instrument.
- A PMBX Exchange line.
- An incoming only Exchange line to a PABX.
- An Automatic Call Distribution Equipment that does not require a Clear condition from the Public exchange.

In effect, any situation where the Public exchange is not required to provide a Clear condition such as, earth calling, disconnect Clear or line reversal.

System Description

SSAC15-C is a 1VF inband signalling system for the transmission of supervisory signals and 10 pps digits between a telephone instrument, or equivalent, and a PBX extension or public exchange line termination. It uses a single signal frequency of 2280 Hz, in each direction of a 4 wire transmission path, the presence or absence of this frequency indicates a specific signal dependent on when it occurs in the signalling sequence, and in some cases upon its duration. When the circuit is idle, low level signalling tone is continuously present in the direction telephone instrument to PBX, whilst in the direction PBX to telephone instrument, a continuous tone-off condition is present.

A full description of SSAC15-C is given in Section 16.

A block schematic of the Signalling Unit No. 54A is shown in Fig 17.

The Signalling Code for SSAC15-C is given in Table 4.

Unit Description

The Signalling Unit No. 54A consists of one printed wiring board mounted on a 62 type card frame.

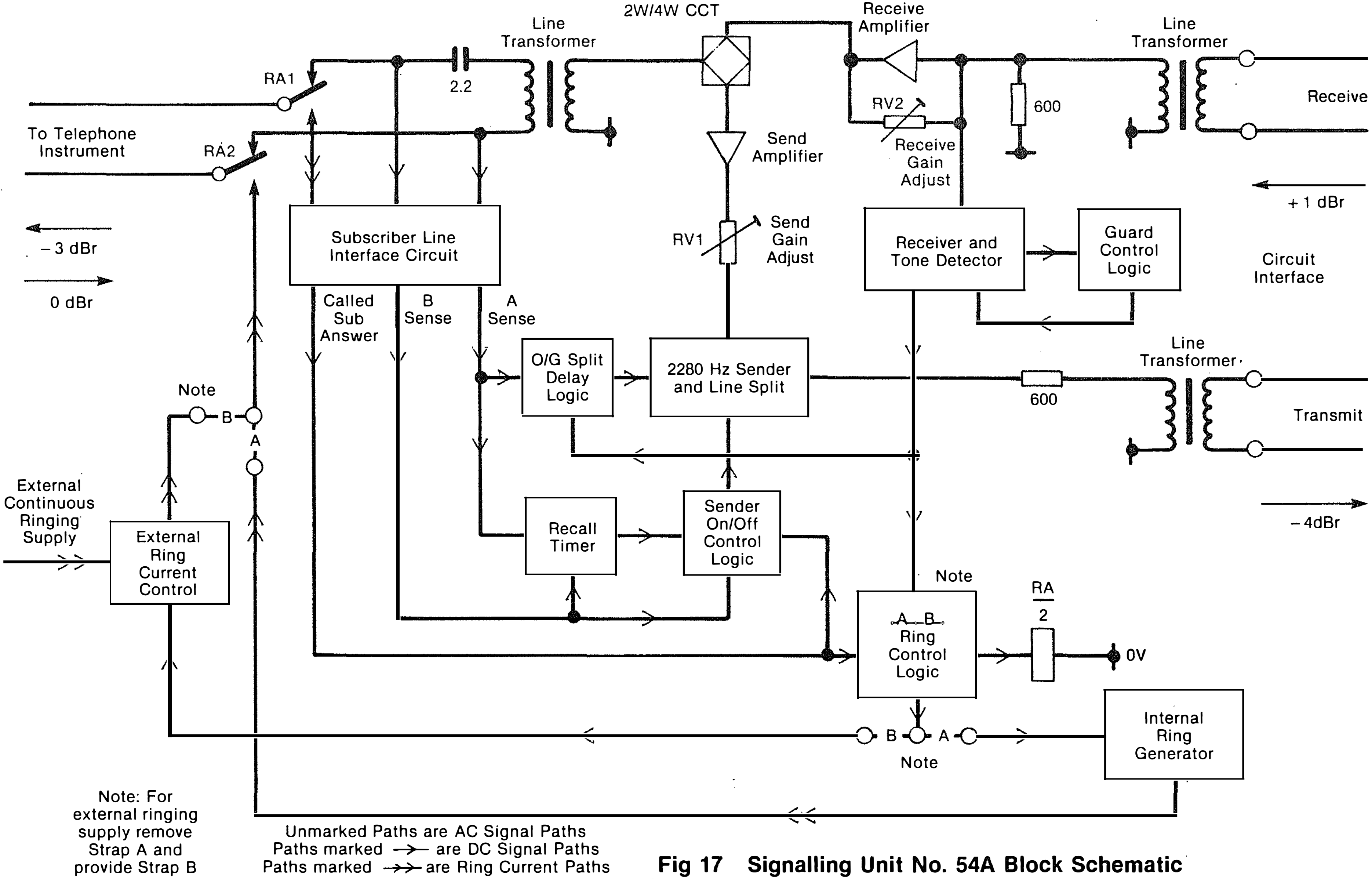


Fig 17 Signalling Unit No. 54A Block Schematic

It occupies 8 modules of mounting space in a 62 type shelf.

The Unit contains line terminating transformers and a 2-wire/4-wire terminating unit, as shown in block schematic diagram Fig 16.

The Unit presents a 600 ohm terminating impedance on the Receive and Transmit paths of the 4-wire line. The 2-wire presents a complex impedance designed to match a local line.

The 2280 Hz signal tone is generated within the Unit

Test links are provided on the front panel as shown in Fig 18.

A switch is provided on the front panel for connecting 2280 Hz signal tone to line for test purposes.

A full description of the Unit is contained in Specification S 1573.

Circuit details are available on Diagram SA/SAW103000.

The circuit operation is described in Diagram notes for Diagram SA/SAW103000.

Transmission

The 2-wire of the Signalling Unit No. 54A presents a complex impedance to line which is designed to match BT local cables. The insertion loss will vary with frequency when sending and measuring with instruments terminated in a 600 ohm non-reactive impedance. The performance requirements are therefore given in terms of a nominal loss when the 2-wire line is terminated in a complex impedance to match the signalling unit, and a corrected figure when terminated in 600 ohm non-reactive impedance.

Insertion loss 2-wire to Transmit: Nominal loss 4 dB; measured with 600 ohm termination, 2.5 dB at 800 Hz.

Insertion loss Receive to 2-wire: Nominal loss 4 dB; measured with 600 ohm termination, 4.5 dB at 800 Hz.

NOTE: If it is necessary to check or adjust the insertion loss of the Unit, then in order to isolate the test equipment from the 2-wire of the Unit, the procedure described below should be followed:-

Transmit Path Insertion Loss: At a frequency of 800 Hz and a send level of 0 dBm and with both sending and receiving test equipment terminated in 600 ohms, adjust RV1 until the loss 2-wire to 4-wire transmit is -2.7 dB $\pm$ 0.2 dB. The sender should be coupled into the 2-wire via a 1:1 transformer (Transformer No. 477A or equivalent) to isolate the sender and provide a d.c. loop for the SLIC.

Receive Path Insertion Loss: At a frequency of 800 Hz and a send level of 0 dBm and with both sending and receiving test equiment terminated in 600 ohms, adjust RV2 until the loss 4-wire receive to 2-wire is -4.7 dB $\pm$ 0.2 dB. The receiver should be coupled into the 2-wire via a 1:1 transformer (Transformer No. 477A or equivalent) to isolate the sender and provide a d.c. loop for the SLIC.

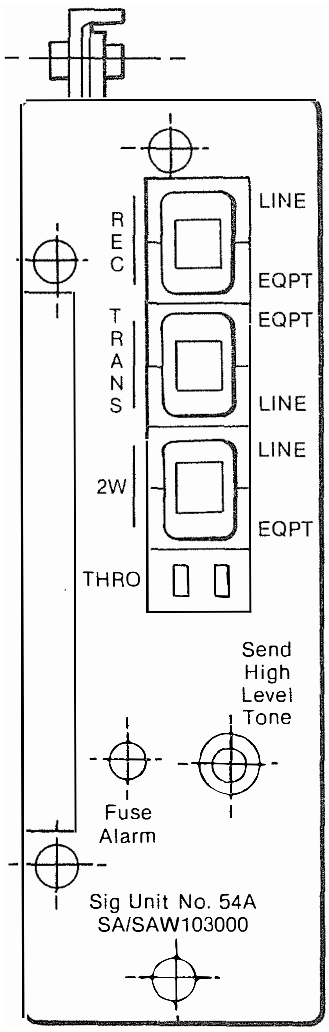


Fig 18 Front Panel of Signalling Unit No. 54A

Installation Wiring and Mounting

Full details of PBX terminating arrangements are shown on Diagram SA/SAW103250. Further information on suitable racks, cabinets and cases for mounting the Unit is given in sub-section 17.11.

17.7 Signalling Unit No. 59A

Public Exchange Termination for an Out of Area Exchange Line

The Signalling Unit No. 59A converts public exchange subscribers line interface conditions to 1VF line conditions in accordance with SSAC15-E. The unit referred to as the Equipment Signalling Unit (ESU), is located at the public exchange end of an Out of Area exchange line connection. It is designed to work to a Signalling Unit No. 60A. Referred to as the Instrument Signalling Unit (ISU), located at the subscribers end.

The equipment provides for both loop calling or earth calling conditions into the public exchange, and so may terminate either on a telephone, a loop calling PBX exchange line port or an earth calling PBX exchange line port, at the subscribers end.

System Description

SSAC15-E is a 1VF in band system for the transmission of supervisory signals and 10 PPS/MF4 between a telephone, a PBX exchange line port or equivalent termination and a public exchange subscribers line circuit. It uses a single frequency of 2280 Hz in each direction of a 4-wire transmission path, the presence or absence of this frequency indicates a specific signal dependant on when it occurs in the signalling sequence, and in some cases upon its duration. When the circuit is idle, low level signal tone is continuously present in the direction subscribers equipment to public exchange equipment, whilst in the direction public exchange to subscriber, a continuous tone-off is present.

A full description of SSAC15-E is given in Section 19.

Equipment practice

The unit is assembled on a PWB in accordance with equipment practice TEP1E.

The unit is described in detail in Specification T 4593.

Availability

The Signalling Unit No. 59A will be available, in the first instance, only for the Derived Services Network (Linkline). Its general availability will be announced in due course.

17.8 Signalling Unit No. 60A

Subscribers End Termination for an Out of area Exchange Line

The Signalling Unit No. 60A converts telephone, or equivalent, line interface signalling conditions to 1VF line conditions in accordance with SSAC15-E. The unit, referred to as the Instrument Signalling Unit (ISU) is located at the subscribers end of an Out of Area Exchange line connection. It is designed to work to a Signalling Unit No. 59A, referred to as the Equipment Signalling Unit (ESU), located at the public exchange end.

The equipment accepts both loop calling or earth calling conditions from the subscribers equipment, and so may terminate either on a telephone, a loop calling PBX exchange line port or an earth calling PBX exchange line port, at the subscribers end.

System Description

SSAC15-E is a 1VF in band system for the transmission of supervisory signals and 10 PPS/MF4 between a telephone, a PBX exchange line port or equivalent termination and a public exchange subscribers line circuit. It uses a single frequency of 2280 Hz in each direction of a 4 wire transmission path, the presence or absence of this frequency indicates a specific signal dependant on when it occurs in the signalling sequence, and in some cases upon its duration. When the circuit is idle, low level signal tone is continuously present in the direction subscribers equipment to public exchange equipment, whilst in the direction public exchange to subscriber, a continuous tone-off is present.

A full description of SSAC15-E is given in Section 19.

Equipment Practice

The unit is assembled on a PWB in accordance with equipment practice TEP1E.

The unit is described in detail in Specification T 4593.

Availability

The Signalling Unit No. 59A will be available, in the first instance, only for the Derived Services Network (Linkline). Its general availability will be announced in due course.

17.9 Signalling Units for 30 Channel PCM Systems

Where an inter PBX circuit or an external extension is routed in whole or in part over a PCM link then in-band VF signalling ie SSAC15 or SSAC13, may be used. However in some cases it may be convenient and cost effective to use a d.c. analogue/PCM converter at the Muldex.

Tables 5, 6 and 7 list all PCM signalling units currently in use or soon to be introduced. Not all units are available through ordinary requisition procedures — some units have been purchased for special projects. Table 8 gives their present status and availability.

The majority of these units have no application in private networks but are included for completeness and ease of identification.

Enquiries regarding these units should be directed to UKCHQ/AES4.2.3.

Tables 5, 6, 7 and 8 follow:

Signalling Units for 30 Channel PCM Systems

Contents

Table 5

1. Signalling Units Constructed in 62 Type EP (1st Gen)
   (for use on Equipment Muldex No. 2200)

Item No.	S/U PCM	Spec RC	Description	Comments
1	A1A	5922	O/G 2-wire L/D, P Wire Metering	Major use in PN see ISIS TMN / PCM / B019
2	A1B	5922	O/G 2-wire L/D Batt Tested, M Wire Metering, P Wire Manual Hold, Forced release	As for Item 1
3	A1C	5922	O/G 2-wire L/D, OOR, P Wire Metering P Wire Manual Hold	As for item 1
4	A1D	5922	O/G 2-wire, MOJ Metering on P or M Wire, Group Control Lead	As for item 1
5	A1E	5922	O/G 2-wire L/D, P Wire or 2-wire Manual Hold C & FC Signal Repetition	As for item 1
6	A1F	5922	O/G 2-wire L/D, P Wire Metering P Wire Manual Hold, C & FC Repetition	
7	B1A	5923	I/C 2-wire L/D	As for item 1
8	B1B	5923	I/C 2-wire L/D, Forward Holding Manual Hold Detection	As for item 1
9	B1C	5923	I/C 2-wire L/D, Battery Testing, OOR (TKO), Pulse Correction	As for item 1
10	B1D	5923	I/C 2-wire L/D, Forward Holding, Pulse Correction	As for item 1
11	B1E	5923	I/C 2-wire L/D, MOJ Metering No. P Wire	As for item 1
12	B1F	5923	I/C 2-wire L/D, Manual Hold, C & FC Detection	As for item 1
13	B1G	5923	I/C 2-wire L/D, Plug Answer Manual Hold, C & FC Detection	As for item 1
14	C4A	5930	2-wire Bothway No Signalling in TS 16	
15	D2A	6255	4-wire O/C Earth/Disconnect signalling on phantoms, (SSAC8) Converts to L/D Codes in TS 16.	For use in TXE2
16	D2B	6644	Improved Version of D2A, Supersedes D2A	For use in TXE2 and UAXs

Table 5 (Contd)

Item No.	S/U PCM	Spec RC	Description	Comments
17	F2A	5924	4-wire Bothway, Earth/Disconnect (SSAC8) on Phantoms	
18	F2B	5924	As F2A plus Adjustable Gain	
19	F4A	5929	4-wire Bothway, No Signalling in TS 16	
20	F4B	5929	4-wire Bothway, Adjustable Gain No Signalling in TS 16	
21	F4C	5929	4-wire Bothway, Adjustable Attenuation, No TS 16 Signalling	
22	F5A	6258	4-wire Bothway, SSDC Signalling Adjustable Gain	For use in the private network on inter PBX routes
23	30A		2-wire or 4-wire, Bothway Adjustable Gain, Signalling:- ● Balanced Battery ● Ringing (17/25 Hz) ● B earth in, Ringing out ● B earth in, Reversal out Signalling path is via 2-wire, 4-wire phantoms or separate wires	For use on London Overlay, NDPCN in the Private Network Note 3
24	31A		2-wire or 4-wire Bothway, Earth/ Disconnect Signalling on Separate Wires, Earth off idle mode only	As for item 23 Note 3
25	32A		2-wire External Extension Exchange end, L/D, Earth recall	As for item 23 Note 3
26	32B		2-wire External Extension Exchange end, L/D, Earth Calling	As for item 23 Note 3
27	33A		2-wire External Extension Subs end, L/D, Earth recall	As for item 23 Note 3
28	33B		2-wire External Extension Subs end, L/D, Earth Calling	As for item 23 Note 3
29	34A		4-wire External Extension Exchange end, L/D Signalling via phantoms, Earth recall, 2 ringing detectors for S/S working, Adjustable gain	As for item 23 Supersedes S/U 49B for new work. Note 3
30	34B		4-wire External Extension Exchange end, MF Signalling, Seizure via Earth recall, 2 ringing detectors for S/S working, No gain	As for item 23 Supersedes S/U 49A for new work, Not Required for NDPCN Note 1
31	35A		4-wire External Extension Subs end L/D signalling via phantoms, Shared party working, Ringing and Ring trip, Earth recall, Adjacent Gain	As for item 23, Supersedes S/U 50A for new work. Note 3

Table 5 (Contd)

Item No.	S/U PCM	Spec RC	Description	Comments
32	36A		4-wire bothway, 4E & 4M Signalling	As for item 23 Note 3
33	49A		Same as S/U 34B (Item 30). Note 1	Merseyside Police Network Notes 1 & 3
34	49B		Same as S/U 34A (Item 29) Note 1	As for item 33 Notes 1 & 3
34	50A		Same as S/U 35A (item 31) Note 1	As for item 33 Notes 1 & 3

Table 6

2 Signalling Units Constructed in Tep1(E). (Second Generation). (For use in Equipment Muldex No. 6000/-)

Item No.	S/U PCM	Spec RC	Description	Comments
36	A1/1	8130	2-wire O/G L/D, Facilities as for items 1 to 6 (RC5922)	For general use in the public network See ISIS TMN / PCM / B024
37	A1/2	8130	2-wire O/G L/D, Silent reversal MOJ With/Without eth tst P Wire	As for item 36
38	A1/3	8130	2-wire O/G L/D, No P Wire, Manual Hold, C & FC	As for item 36
39	B1/1	8131	2-wire I/C L/D, Facilities as for items 7 to 13 (RC5923)	As for item 36
40	D1/1	8130	4-wire O/G L/D, Signalling on phantoms, Adjustable Transmission, Manual-Hold, C & FC	As for item 36, but mainly for International Interconnect
41	D2/1	8133/4	4-wire O/G, Earth/disconnect signalling on phantoms (SSAC8) or separate wires (E & M), Converts to L/D sig codes in TS 16	For use in TXE2 & UAX Exchanges, & International Exchanges for R2 signalling
42	E1/1	8131	4-wire I/C L/D, Signalling on phantoms, Adjacent Transmission, C & FC	As for item 36, but mainly for International Interconnect
43	E3/1	8155	4-wire I/C DC3, Seize, Clear, Answer, No impulsing, Adjacent Transmission	Public network International Interconnect
44	F4/1	8049	4-wire bothway extender unit Adjustable attenuation, 15.5 × 0.5 dB No. TS 16 signalling	Public & Private Networks, NDPCN

Table 6 (Contd)

Item No.	S/U PCM	Spec RC	Description	Comments
45	48A		4-wire bothway extender unit Adjustable attenuation, 15.5 × 0.5 dB No TS signalling No Lighting Protection	Private Networks, NDPCN. GEC PV Des. 1SCP 009B. Note 3
46	F5/1		Second generation version of S/U F5A, see item 22	Private Networks, GEC PV Des 1SCP 013A. Note 3.
47	47A		4-wire bothway, serial repetition of TS 16 codes via phantoms or separate pair, Adjustable attention	GEC PV Design 1SCP 012A. Note 3. Also known as F10/1
48	G2/1	8132	2-wire or 4-wire Bothway Facilities as for items 14, 17-21 (RC5930, 5924, 5929), Plus earth Disconect signalling on separate Wires (E & M)	For general use in the public network. As item 36.
49	41A		2-wire or 4-wire bothway, earth disconnect signalling on separate wires (E & M), accepts range of input levels	GEC PV Design 1SCP 004B, Note 3. Also known as G2/2.
50	42A		2-wire or 4-wire external extension exchange end, L/D signalling via 2-wire or phantoms, Earth recall, and ringing detector	GEC PV Design 1SCP 011A. Note 3. (Also known as G7/1).
51	43A		2-wire or 4-wire external extension subscribers end, signalling via 2-wire or phantoms, Line feed, ringing ring trip, earth recall	GEC PV Design 1SCP 010A. Note 3. (Also known as G7/2)
52	40A		2nd Generation Version of S/U 30A see item 23	GEC PV Design 1SCP 01AA. Note 3. (also known as G8/1)
53	K7/1	8183	2-wire Out of Area Exchange Line 'A' End (Subscribers End) S/U, Loop Calling, Loop Calling/Disconnect clear, Earth Calling Loop/Disconnect Signalling, Line feed, Ringing current, Ringing trip, Register Recall, SPM, Malicious call alarm Sub controlled Busy Sub controlled Transfer Sub controlled Group Transfer	New Unit under Development

Item No.	S/U PCM	Spec RC	Description	Comments
54	L7/1	8184	2-wire Out of Area Exchange Line 'B' End (Exchange End) S/U Loop Calling, Loop Calling/Disconnect clear, Earth Calling, Loop/Disconnect Signalling, Ringing detector, Register, Recall, SPM, Malicious call alarm Sub controlled Busy Sub controlled Transfer Sub controlled Group Transfer	New Unit under Development
55	A6/1	8156 + + + 8157	2-wire O/G Leg Signalling, Flashing, OOR, Transfer, Fixed Transmission (– 3.0 dB) 2-wire O/G d.c. Loop Signalling, Flashing, OOR, Transfer, Fixed Transmission (– 3.0 dB).	For SVI/CNI/ Traffic, New development
56	J9/1	8158	2 or 4-wire O/G d.c. 2 signalling, M/hold, CFC MOJ Adjustable Transmission	For public network, New development
57	H9/1	8159	2 or 4-wire I/C d.c. 2 signalling, M/hold, OOR MOJ Adjustable Transmission	For public network, New development
58	B1/2	8131	As for item 39 but with silent detection of MOJ reversals on 2W	For public network, New development
59	B6/1	8185	2-wire I/C Leg Signalling, Flashing, OOR, Transfer, Fixed Transmission (– 3.0 dB)	For SVI/CNI Traffic. New development

Table 7

3. Signalling Units Constructed in Tep1(E). (Third Generation). (For use in Equipment Muldex No. 6100)

Item No.	S/T PCM	Spec RC	Description	Comments
60	A1/1	8251	Same as item 36 (A1/1)	New generation unit under development - **not** physically compatible with item 36.
61	B1/1	8252	Same as item 39 (B1/1)	New generation unit under development - **not** physically compatible with item 39.
62	G2/1	8253	Same as item 48 (C2/1)	New generation unit under development - **not** physically compatible with item 48.

4. Notes:

   1. Units 49A, 49B and 50 are incorrectly coded as Signalling Units No. X. For all orders subsequent to the Merseyside Police Network initial supply contract these S/Us have been re-coded Signalling Unit PCM Nos. 34B, 34A and 35A respectively. TEP 4400/1 are GEC Specification.
   2. Signalling Unit PCM No. 37A (4-wire Bothway with serial repetition of TS 16 codes via phantoms) is no longer required in 62 type EP, see Item 46.
   3. These Signalling Units are PV Items and have been developed outside the control of UKCHQ/AES4.2.3 are not in a position to offer *in depth* technical support in respect of these units. All enquiries should be made to:

      GEC Ltd
      Telephone Works
      COVENTRY.

5. Abbreviations:

   CFN — Coin & Fee Check Signal Repetition.
   CNI — Changed Number Interception.
   EP — Equipment Practice.
   I/C — Incoming.
   L/D — Loop/disconnect.
   NDPCN — National Digital Private Circuit Network.
   O/G — Outgoing.
   OOR — Operator Override.
   O/S — Operator Services.
   PN — Public network.
   PV — Private Venture.
   S/T — Signalling Tributary.
   SVI — Service Interception.
   TS 16 — Time Slot 16.

Table 8

6. Signalling Units for 30 Channel PCM Systems Status of Signalling Units

Item No.	S/U No.	Status/Availability	Suppliers
1	A1A	Rate Book Item (Code 81 6659)	MCSL, PPNL, GEC, STC
2	A1B	" " " (Code 81 6660)	" " " "
3	A1C	" " " (Code 81 6661)	" " " "
4	A1D	" " " (Code 81 6662)	" " " "
5	A1E	" " " (Code 81 6663)	" " " "
6	A1F	" " " (Code 81 6664)	" " " "
7	B1A	" " " (Code 81 6665)	" " " "
8	B1B	" " " (Code 81 6666)	" " " "
9	B1C	" " " (Code 81 6667)	" " " "
10	B1D	" " " (Code 81 6668)	" " " "
11	B1E	" " " (Code 81 6669)	" " " "
12	B1F	" " " (Code 81 6670)	" " " "
13	B1G	" " " (Code 81 6671)	" " " "

Table 8 (Contd)

Item No.	S/U No.	Status/Availability	Suppliers
14	C4A	Rate Book Item (Code 81 6672)	MCSL, PPNL, GEC, STC
15	D2A	" " " (Code 81 6673)	" " " "
16	D2B	" " " (Code 81 7053)	" " " "
17	F2A	" " " (Code 81 6674)	" " " "
18	F2B	" " " (Code 81 6675)	" " " "
19	F4A	" " " (Code 81 6676)	" " " "
20	F4B	" " " (Code 81 6677)	" " " "
21	F4C	" " " (Code 81 6678)	" " " "
22	F5A	" " " (Code 81 6679)	" " " "
23	30A	PV Design for NDPCN	GEC
24	31A	" " "	"
25	32A	" " " (Code 81 7072)	"
26	32B	" " " (Code 81 7076)	"
27	33A	" " " (Code 81 7073)	"
28	33B	" " " (Code 81 7077)	"
29	34A	" " " (Code 81 7074)	"
30	34B	" " "	"
31	35A	" " " (Code 81 7074)	"
32	36A	" " "	"
33	49A	Merseyside Police Network Contract only	"
34	49B	Merseyside Police Network Contract only	"
35	50A	Merseyside Police Network Contract only	"
36	A1/1	Rate Book Item (Code 81 6960)	MSCL, PPNL, GEC, STC
37	A1/2	Rate Book Item (Code 81 7325) (only 100 units delivered)	GEC
38	A1/3	Rate Book Item (Code 81 7326) (only 100 units delivered)	"
39	B1/1	Rate Book Item (Code 81 8962)	MCSL, PPNL, GEC, STC
40	D1/1	Rate Book Item (Code 81 7220)	MCSL
41	D2/1	Rate Book Item (Code 81 7203)	MCSL, PNL, GEC, STC
42	E1/1	Rate Book Item (Code 81 7221) (1000 Units delivered)	MCSL
43	E3/1	Rate Book Item (Code 81 7205) (All time buy of 490 units)	PPNL
44	F4/1	Rate Book Item (Code 81 7151)	MCSL, PPNL, GEC, STC

Table 8 (Contd)

Item No.	S/U No.	Status/Availability	Suppliers
45	48A	PV design for NDPCN, (as item 44 but without protection).	GEC
46	F5/1	" " " (Code 81 7152)	"
47	F10/1	" " " (Code 81 7150)	"
48	G2/1	Rate Book Item (Code 81 6964)	MCSL, PPNL, GEC, STC
49	41A	PV Design for NDPCN (Code 81 7147)	GEC
50	42A	" " " " (Code 81 7148)	" "
51	43A	" " " " (Code 81 7149)	"
52	40A	" " " " (Code 81 7146)	"
53	K7/1	New Design (RB Code 81 7527) (Delivery March 86)	MCSL
54	L7/1	New Design (RB Code 81 7528) (Delivery March 86)	MCSL
55	A6/1	New Design (RB Code 81 7483) (Delivery December 1985)	GEC
56	J9/1	New Design (RB Code 81 7526)	MCSL
57	H9/1	New Design (RB Code 81 7526)	MCSL
58	B1/2	New Design (RB Code 81 7477) (Delivery October 1985)	GEC
59	B6/1	New Design (RB Code 81 7524) (Delivery 6/86 to 9/86)	GEC
60	ST A1/1	Under development. 4800 ordered, delivery 12/85 to 4/86.	PPNL
61	ST B1/1	Under development. 4800 ordered, delivery 12/35 to 4/86.	PPNL
62	ST G2/1	Under development. 2400 ordered, delivery 12/85 to 4/86	PPNL

17.10 Non-Standard Signalling Converters

Over a period of years a number of non-standard electro-mechanical signalling converters have been developed for various purposes. These units have largely been superceded by standard methods; however, very occasionally they may prove useful for a specific application.

It should be stressed that only when the particular facility required cannot be met by the use of standard methods, or possibly by buying in an approved proprietary item, should recourse be made to these units.

All the units listed here are made up locally from standard parts requisitioned from BT Materials Department or obtained locally.

Table 9

Diagram No.	Spec	Title and Description	Application
SA/SAW10008	S 1209	Inter-PBX loop to SCDC conversion circuit	To provide loop to SCDC conversion where the PBX has only loop signalling
SA/SAW10016	—	E & M signalling conversion relay set for telephone type termination	To connect a telephone to an inter-PBX circuit via a signalling unit No. 44B or 45B
SA/SAW101680	S 1369	SSAC13 terminating relay set for telephone type termination	To connect a telephone to an SSAC13 inter-PBX circuit via R/S SA 8299
SA/SAW103260	S(W) 2296	SSAC13 to E & M conversion for inter-PBX working	To connect an SSDC5-A PBX interface to an SSAC13 line signalling system via R/S SA 8299

17.11 62-Type Mounting Apparatus for Signalling Units

The family of Signalling Units comprising Signalling Units No. 44B, 45A, 46A, 53A and 54A are all mounted on 62-type long card frames, and so can be accommodated in any 62-type mounting practice. This sub-section deals with wall mounted cases specially designed for these units and also suitable general purpose 62-type racks and cabinets.

17.11.1 Equipment Signalling No. 27A

The Equipment Signalling No. 27A is a wall mounted case designed to accommodate Signalling Units at Customer premises. It will take a single Signalling Unit mounted on a 62 type card frame. The equipment incorporates a mains driven — 50 volt d.c. power pack suitable for energising a single Signalling Unit. The case is based on the Box connection 300 format. The equipment also contains insulation displacement connectors for terminating external line pairs etc and a telephone socket.

The Equipment Signalling No. 27A wiring is shown on Diagram SA10333, it is wired for and contains all the necessary external connections for, the following Signalling Units.

Signalling Unit No. 44B	SSAC15 — A
" " " 45A	SSDC10 — A
" " " 46A	SSDC5 — D
" " " 53A)	SSAC15 — C
" " " 54A)	Note: The telephone socket is in asssociation with the SU 54A.

The Power Unit is suitable for input mains voltages in the range 220 volt d.c. 250 volt a.c. and will deliver up to 250 mA at — 50 volt d.c. to a single Signalling Unit. A mains cord and 13 amp plug is provided.

The equipment is wall mounted and may be swung out on a hinged assembly for access to the Signalling Units and power pack input and fuses.

Dimensions 420 mm × 320 mm × 90 mm.

17.11.2 Case No. 232A

The case No. 232A is a wall mounted case designed to house signalling units at customers premises. The internal accommodation comprises two frame works, one vertically above the other, each providing for two 12 module 62-type card frames.

The case is factory wired for, and contains all the necessary external connections for four of the following signalling units:

Signalling Unit No. 44B	SSAC15 — A
" " " 45A	SSDC10 — A
" " " 46A	SSDC5 — D
" " " 53A)	SSAC15 — C
" " " 54A)	

Wiring arrangements are shown on the terminating diagram for the signalling unit concerned.

External cabling is via a plug and socket. Connector No. 226-50.

The equipment is wall mounted and may be swung out on a hinged assembly to allow access to the front panels of the signalling units.

Dimensions of the case: 470 mm × 300 mm × 160 mm.

In order to allow the case to be used in a variety of applications the design allows for flexibility of card guide positioning. For example, the case can be re-wired and fitted with up to six, 8 module units. Each new position will require a guide, card I/D67384 and a Connector No. 205D 40A. Additional, external wiring can be accommodated by fitting an extra connector 226B 50A.

An external negative 50 volt supply is required, either supplied from the customers PBX or from a separate mains to neg 50 volt power unit. The capacity of the power unit will depend on the type and number of signalling units fitted. A list of BT power units may be found in Ref 1.

The maximum current drawn by each type of signalling unit is:

Signalling	Unit	No.	44B	100 mA
"	"	"	45A	200 mA
"	"	"	46A	140 mA
"	"	"	53A)	210 mA
"	"	"	54A)	210 mA

17.11.3 Rack Apparatus No. 73

The standard 62-type rack is a rack apparatus No. 73A which is 2743 mm (9′ – 0″) high. Where height permits, the 3200 mm (10′ – 6″) size — rack apparatus No. 73D may be used. Conversely it may be necessary to use the 2286 mm (7′ – 6″) size — rack apparatus No. 73E in a situation where height is restricted.

The rack apparatus No. 73 will take a standard 62 type shelf, and for the signalling units this will be an un-equipped shelf — shelf D67383. The shelf occupies 152.4 mm of rack height so the maximum number of shelves per rack is:

Rack	apparatus	No.	73A	— 17	Shelves
"	"	"	74D	— 20	"
"	"	"	73E	— 14	"

In practice the total number of shelves is restricted by power dissipation considerations. See below.

Each shelf D67383 requires a Guide, card I/D 67384 and a connector 205D 40A for each equipped position.

Wiring

Each circuit is wired according to the appropriate terminating arrangement diagram for the signalling unit concerned:

Signalling	Unit	No.	44B	Diagram	SA/SAW	102290
"	"	"	45A	"	"	102840
"	"	"	46A	"	"	103270
"	"	"	53A	"	"	103240
"	"	"	54A	"	"	103250

Power Supply

An external negative 50 volt supply is required to power the Signalling Units. This is either taken from the customers PBX, if spare capacity is available, or from a separate mains to neg 50 volt power unit. The capacity of the power unit will depend on the type and number of Signalling Units fitted. A list of BT power units may be found in Ref 1.

The power dissipation for each type of Signalling Unit is given in Table 10.

Power Dissipation

According to Specification RC 2000, the total power dissipation of all equipment mounted on any rack apparatus No. 73 (regardless of height) shall not exceed 400 watts, and the total power dissipation of all equipment mounted on a shelf shall not exceed 100 watts.

These maximum dissipation figures impose a restriction on the number of Signalling Units that may be mounted in a rack.

The maximum power dissipation for each type of signalling unit is given in Table 10.

Table 10

Signalling Unit	Max Power per Unit	Power per fully Equipped Shelf	Occupancy Factor — 0.7
44B	5 watt	12 units — 60 watt	42 watt
45A	10 "	8 " — 80 "	56 "
46A	7 "	12 " — 84 "	58.8 "
53A	10.5 "	12 " — 126 "	88.2 "
54A	10.5 "	12 " — 126 "	88.2 "

It can be seen that no fully equipped shelf exceeds the maximum dissipation of 100 watt.

The total dissipation permitted by a rack may be increased by mounting equipped shelves in alternate positions and fitting heat deflectors D78872 in the spare shelf position. These heat deflectors include a ventilated front panel.

For a single stand-alone rack in a low heat environment the total dissipation may be 750 watt.

For a rack asociated with other equipment racks in a high heat environment the total dissipation may be 530 watt.

17.11.4 Auxiliary Equipment Cabinet (C & N)

This cabinet is suitable for office accommodation and is supplied in kit form. It is described in detail in Ref 2.

The cabinet will provide suitable mounting for up to 4 horizontal 62-type shelves of 86 module width. For mounting the Signalling Units the Shelf D67588 is used, this will take up to 10, 8 module width units and up to 7, 12 module width units.

Each Shelf D67588 requires a Guide, Card I/D67384 and a connector 205D40A for each equipped position.

In practice the total number of shelves may be restricted by power dissipation considerations. See below.

The cabinet dimensions are:

Height 850.9 mm
Width 545 mm
Depth 595 mm

Wiring

Each circuit is wired according to the appropriate terminating arrangement diagram for the signalling unit concerned.

Signalling Unit No. 44B	Diagram SA/SAW102290
" " " 45A	" " 102840
" " " 46A	" " 103270
" " " 53A	" " 103240
" " " 54A	" " 103250

Power Supply

An external negative 50 volt supply is required to power the signalling units. This is either taken from the customers PBX, if spare capacity is available, or from a separate mains to neg 50 volt power unit. The capacity of the power unit will depend on the type and number of signalling units fitted. A list of BT power units may be found in Ref 1.

The power dissipation for each type of Signalling unit is given in Table 10.

Depending on the heat dissipation requirements it may be possible to mount the power unit within the cabinet.

Power Dissipation

The maximum heat dissipation permitted for the cabinet is 200 watts. The maximum number of signalling units mounted in the cabinet must be restricted to ensure this value is not exceeded. See Table 10.

Ordering

The kit is ordered direct from the manufacture as a "British Telecoms Auxilliary Equipment Cabinet" from:

C & N electrical Industries Ltd
Mumby Road
GOSPORT
Hampshire

A full description of method of assembly is contained in Ref 2.

17.11.5 CABINET I/TG 2453

This cabinet is intended for use in an office environment and is supplied in a fully assembled form. It is described in detail in Ref 3.

The cabinet will provide suitable mounting for up to three horizontal 62-type shelves of 86 module width. For mounting the signalling units, the Shelf D67588 is used, this will take up to ten, 8 module width units and up to seven, 12 module width units.

Each Shelf D67588 requires a Guide, Card I/D67384 and a Connector 205D40A for each equipped position.

In practice the total number of shelves may be restricted by power dissipation considerations. See below.

The cabinet dimensions are:

Height 714 mm
Width 575 mm
Depth 514 mm

Wiring

Each circuit is wired according to the appropriate terminating arrangement diagram for the signalling unit concerned.

Signalling	Unit	No. 44B	Diagram	SA/SAW102290		
"	"	" 45A	"	"	102840	
"	"	" 46A	"	"	103270	
"	"	" 53A	"	"	103240	
"	"	" 54A	"	"	103250	

Power Supply

An external negative 50 volt supply is required to power the signalling units. This is either taken from the customers PBX, if spare capacity is available, or from a separate mains to negative 50 volt power unit. The capacity of the power unit will depend on the type and number of signalling units fitted. A list of BT power units may be found in Ref 1.

The power dissipation for each type of Signalling unit is given in Table 10.

Depending on the heat dissipation requirements it may be possible to mount the power unit within the cabinet.

Power Dissipation

The maximum heat dissipation permitted for the cabinet is 200 watt. Therefore the maximum number of signalling units mounted in the cabinet must be restricted to ensure this value is not exceeded. See Table 10.

Ordering

The cabinet I/TG 2453 is ordered from BT Materials Department in the normal way.

17.11.6 Proprietary Wall Cases

To meet the need for flexibility in wall mounted cases to house 62 type Signalling Units, a range of cases has been produced by Keltek Electronics Ltd of Kelso. These are based on the same format as the Equipment Signalling No. 27A.

The range of cases offered includes:

Wall Case 2A	Designed to mount two 62 type Signalling Units of upto 12 module width. No power unit includes.
Wall Case 2P	Designed to mount two 62 type Signalling Units or upto to 12 module width. Includes a mains to negative 50 volt power unit providing upto 250 mA of supply current.
Wall Case 4A	Designed to mount four 62 type Signalling Units up to 12 module width. No power unit included.

These cases should be obtained direct from the manufacturer. Enquiries should be directed to:

Keltek Electronics Ltd
Pinacle Hill Industrial Estate
Kelso
Roxburghshire
SCOTLAND
TD5 8DW

Telephone 05732 3601.

End of Section 17

Private Circuit Services
Signalling Handbook

Section 18 — Tandem Networks — Signalling

Introduction

Signalling Information, which is required to route a call from its point of origin to its final destination and supervise the call once the destination has been reached, must remain within defined limits of distortion for satisfactory network operation.

In devising a signalling plan for private networks the objective is to ensure that the received signals are capable of operating the final terminating equipment. This must be achieved when the originating signal, which has a tolerance with respect to number of pulses per second and make/break ratio, in the case of 10 pps digits and with respect to frequency and level in the case of Multifrequency signals, has been subjected to additional distortion in the transmission links and the intermediate switching stages.

10 pps Digital Signalling

For automatic switching equipment to respond correctly to incoming signalling information the received signals must be within certain defined target limits. These limits, which are a combination of factors, may be different for each type of PBX equipment practice. To simplify the planning procedure the worst case terminal equipment is assumed ie a Strowger PBX.

The signals leaving the signalling source vary both in length of make and break pulse, according to the make/break ratio, and the speed of the telephone dial, or equivalent.

Telephone dials, in acceptable adjustment will be within the limits: speed; 7-12 pps, Ratio; 63%-72% break.

Distortion is added to these signals during transmission from one end of the connexion to the other, both as a result of pulse repetition at originating, intermediate and terminal switching stages and due to imperfections in the transmission media. As a consequence the make pulses may be shortened to such an extent that they fall outside the target. In this case the received pulse contains insufficient energy to operate the receiving device or is too short to overcome any persistance checking arrangements.

Alternatively the make pulse may be lengthened to the point where they inhibit the release of the detecting device, in which case the next make pulse is not detected.

To ensure satisfactory performance over a multilink connection it may be necessary to ensure that pulse regeneration or pulse correction is introduced at one or more switching stages.

Line Signalling Systems

The standard inter-PBX signalling systems (see Section 14) should always be recommended for use in private networks. These systems are fully specified and have a predictable performance on a link by link basis. The recommended systems are:-

SSDC10 (SCDC)
SSDC5
SSAC15

The appropriate version for the facility required, should be chosen ie Suffix A, B or D.

Loop Disconnect Signalling

Loop Disconnect Signalling may be used in place of SSDC10, assuming that the signal path is within limits for the PBXs concerned, but only in exceptional circumstances eg loop signalling is the only system available on one or other of the PBXs or loop signalling already exists on the route concerned.

SSAC13

SSAC13 may be used in place of SSAC15-A under the conditions described below:

- At existing BT Strowger PBXs spare rack capacity exists for SSAC13 equipment, when the appropriate SSAC13 equipment is available from Stores and when SSAC13 equipment is available at the distant PBX.
- At new or existing BT non-Strowger PBXs where external factors preclude the use of SSAC15-A and an SSAC13 interface is available at the PBX. A typical external factor is a new PBX interworking with an existing PBX at which SSAC13 equipment is already installed.
- Between non-BT PBXs by mutual agreement between the parties concerned.

Manual Signalling

Manual Signalling is not recommended for tandem connections in private circuit networks. The absence of the automatic clear facility can cause operational difficulties.

Pulse Correction and Re-generation

All modern PBX, approved for connexion to BT lines are evaluated for inter-working between private network line signalling systems. The PBX concerned must meet the requirements for 10 pps digital signalling described in British Telecoms Requirements (BTR) 1180 Section 2. The requirements for incoming and outgoing 10 pps digital signalling for all combinations of standard inter-PBX line signalling systems, are covered.

The PBX concerned may either re-generate digit signals, in which case they are re-transmitted within the limits 10 $\pm$ 0.5 pps with break ratio 60% to 68%, or the digit signals are corrected and transmitted within the limits described in BTR 1180 Section 2 paragraph 3.5.

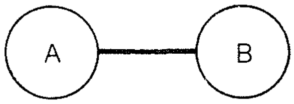


FIG. 1

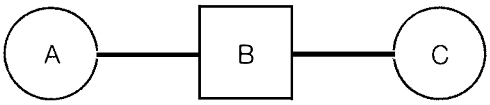


FIG. 2

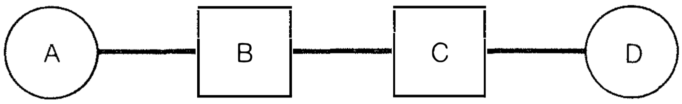


FIG. 3

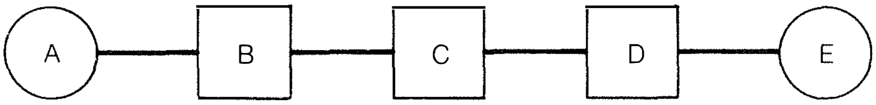


FIG. 4

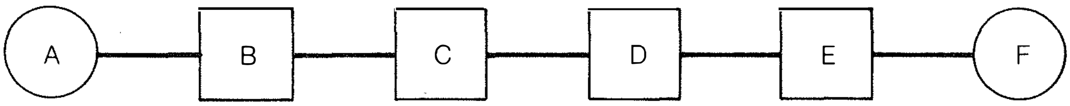
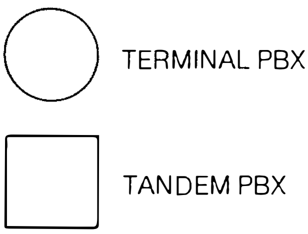


FIG. 5

KEY



Signalling Planning Guide

General guidance is given here on when and where pulse correction is required for a given number of inter-PBX circuits in tandem. Where correction is required it should be at least to the standard described in BTR 1180 for SSAC15.

A signalling link employing SSDC5 out-of-band, introduces rather more distortion on 10 pps digital signal than SSDC10 or loop/dis, as there is an extra pulse repetition stage for each link.

Where a PBX provides an SSDC5 interface to a signalling converter the signalling system is considered to be that provided by the converter ie SSDC10 or SSAC15.

A signalling link employing a signalling converter such as a Signalling Unit No. 44B (SSAC15) or Signalling Unit No. 45A (SSDC10), which includes pulse correction to the standard described in BTR 1180, may be taken to have introduced the necessary pulse correction on that link, in both directions. This will also apply when the circuit is routed via a channel on a Private Wide Band Group using SSDC5 signalling and then extended over physical plant with SSDC10 signalling using a Signalling Unit No. 45A.

A signalling link employing SSAC13, old style, using Relay Set SA 8299 at the incoming end, can be considered as meeting the pulse correction requirements described in BTR 1180.

It is important to note that SSAC15 and SSAC13 links are always provided with pulse correction at the incoming PBX.

Modern PBX will almost invariably regenerate 10 pps digital signals on all inter-PBX circuits.

The following guide lines will apply to all types of PBX.

Signalling over one or two circuits (Fig 1 and 2) pulse correction is not essential for any combination of the recommended line signalling systems. Except that pulse correction is always provided on SSAC15 and SSAC13 links.

Signalling over three circuits (Fig 3).

- Pulse correction is not essential if all links are SSDC10 (SCDC).
- If SSDC5 out-of-band, is used on one or more of the circuits then pulse corrections is required at least one of the intermediate stages B or C.

Signalling over four circuits (Fig 4).

- Pulse correction is not essential if all links are SSDC10 (SCDC).
- Pulse correction is required on at least one of the intermediate switching stages when one link only is SSDC5 out-of-band.
- If SSDC5 is used over two or more links then pulse correction is required at the mid-point, intermediate stage C.

Signalling over five circuits (Fig 5). Pulse correction is required at one intermediate stage, either C, D or E, but if SSDC5 is employed on one or more links then pulse correction is required at two intermediate stages either C and D or C and E.

Signalling over six circuits or more. For transmission reasons such a connection will almost certainly be 4-wire switched, and the tandem PBXs will be Stored Program Control (SPC) with regeneration of digits pulses at al! intermediate switching stages if 10 pps digital signalling is used. With such a network however, the signalling system used is likely to be SSMF5 or DPNSS1.

SSMF5 — Links in Tandem

The transmission requirements for SSMF5 are described in Section 13.2. To summarise, the maximum number of links in tandem for SSMF5 signalling is:-

4-wire switched network — 6 links
2-wire switched network — 3 links
Mixed 2 and 4-wire switched network — Consult UKCHQ/PCS3.1
International leased lines — Consult BT International/IBI4.3.2.

SSMF4 — Links in Tandem

The transmission requirements for SSMF4 are described in Section 13.3. When tandem working is required, SSMF4 signals must be regenerated at each intermediate stage.

DPNSS1 — Tandem Working

A general description and outline operation for DPNSS1 is given in Section 13.1.1 and 13.1.2.

By its nature DPNSS1 is a link by link system, with regeneration at each intermediate stage. There is therefore no limit, from a signalling viewpoint, on the number of links in tandem.

End of Section 18

Private Circuit Services Signalling Handbook

Section 19 — Signalling on Out-Of-Area Exchange Lines

Facilities are available for connecting customers to the Public Switched Telephone Network (PSTN) via an exchange other than the local exchange to which the customer would normally be connected. Such exchange lines are known as Out-of-Area Exchange Lines (OOAE/L) and are considered part of the PSTN. However, for provisioning purposes they should be dealt with using Private Services procedures.

The exchange from which service is provided is known as the Remote Exchange and the exchange to which the customer is directly connected is known as the Serving Exchange.

Circuit with no Auxiliary Signalling Equipment

A circuit with no auxiliary Signalling Equipment has to be within the transmission and signalling limits of the Remote Exchange.

Circuits Requiring Auxiliary Signalling Equipment

There are a number of methods for extending the range of signalling on OOAE/L. These systems convert the signalling interface conditions at the public exchange and at the customers equipment, into a form suitable for transmission over a long line. The method used depends on the nature of the transmission path between the serving exchange and the remote exchange.

These signalling systems are described in the following sub-sections.

19.1 Out-of-Area Exchange Lines Using Line Extenders

Out-of-area exchange lines outside the normal signalling limits of the Remote Exchange may be routed over 2-wire circuits, so long as the total loop resistance does not exceed 2000 ohm, by using a Line Extender Signalling (LES1/4A). The arrangement is shown in Fig 1.

Line Extenders Audio (LEA) may be used in association with the LES1/4A to meet the transmission limits required. When LEA and LES are used together the LES must always be adjacent to the line. See Fig 2.

Line Extenders may be used on both loop calling or earth calling equipment and when used on a PBX exchange line, note should be taken of any use of line extenders on PBX extension circuits, since certain limitations may arise. See Section 16.2.

Line Extenders are described in Ref 1. There is also a Training Division document, TGN 0022 which gives a full description of the units and their applications.

19.2 Long Line Signalling Unit (AT 60595)

The signalling limits for the Long Line Signalling Unit (LLSU) are:-

LLSU to customer (Section A in Fig 3) is 2000 ohm loop resistance, and remote exchange to LLSU (Section B in Fig 3) is 1000 ohm loop resistance.

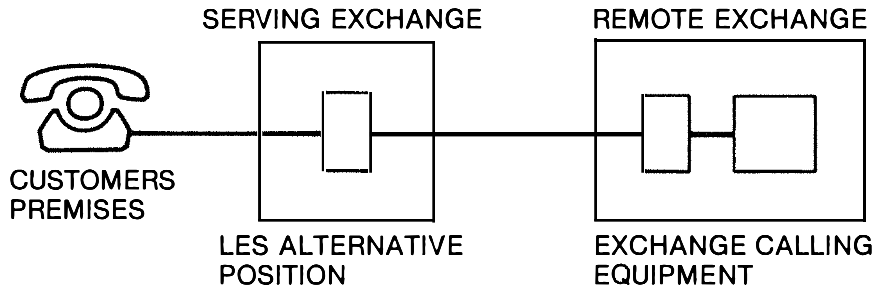


Fig 1 Out-of-Area Exchange Line using a Line Extender Signalling (LES)

The Line Extender Signalling must always be adjacent to the line

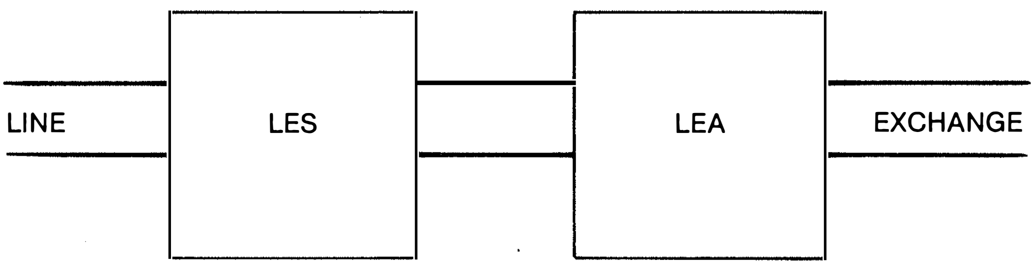


Fig 2

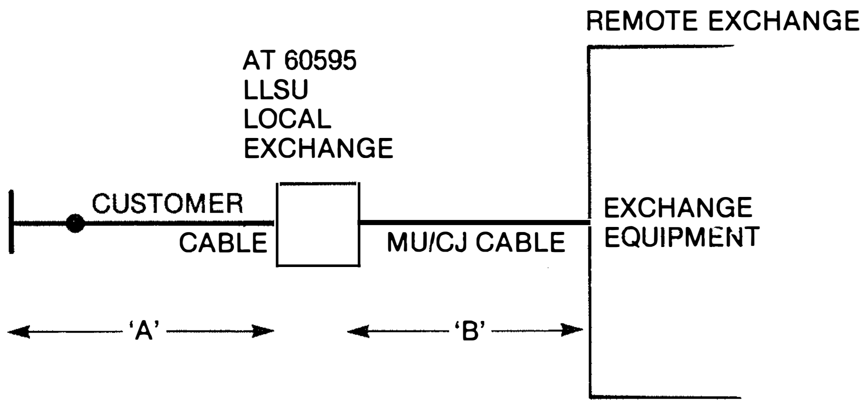


Fig 3 OOAE/L Using a Long Line Signalling Unit AT 60595

The LLSU should not be used when the signalling conditions can be met using an LES1/4A. However, where the 2000 ohm limit of the LES is exceeded, but the signalling limits of the LLSU can be met, the LLSU is recommended.

The LLSU is not suitable for use on Earth Calling PBXs.

Line Extenders Audio (LEA) may be used in association with the LLSU to meet the transmission limits required.

The LLSU should not be used on 4-wire amplified circuits.

The signalling unit incorporates a 50 V transmission bridge, with ballast feed giving pulse repetition and ring repeat facilities. The customer's side of the unit will accept loop and dial signals and repeat these to the remote exchange. In the reverse direction the unit will repeat ringing signals from the remote exchange to the customer. The customer's local exchange is usually the most convenient place for the unit to be located (see Fig 3). Where the exchange areas concerned are not adjacent the unit can be located at any auto-exchange en route provided that the signalling and transmission limits either side of the LLSU are met.

Relay set AT 60595 is made up locally to Specification T 60595.

19.3 Signalling System DC No. 2 (SSDC2)

SSDC2 is an OOAE/L signalling system based on the Single Commutation Double-Current method of signalling. The signalling techniques used are similar to SSDC10.

This signalling system provides OOAE/L working over audio line plant where a metallic path can be provided end to end. Over 2-wire circuits the signalling path is provided by the speech pair. On 4-wire circuits the signalling path is derived from the phantoms of the Receive and Transmit pairs. The system operates by regulating the direction of line current — Commutation — to achieve recognisable signals over long lines. The use of line current reversals counters the effect of high line Capacitance times Resistance (CR) values.

Characteristics of Signalling Path

To ensure the satisfactory recognition of signals, particularly 10 pps digits the line characteristics must fall within the following limits:-

a. Signalling path **loop resistance.** 0-8.2 kohm.

b. Signalling path **CR value.** 0-76,000 microfarad ohm. The CR value is obtained by multiplying the sum of the capacitances (UF) of all sections of the signalling path by the sum of the resistances (ohm) of all sections. The sum of capacitances shall include the capacitance of cables assessed with reference to cable mutual electro-static capacitance values.

c. Signalling path **insulation resistance.** Greater than 100 kohm.

The SSDC2 system comprises two relay sets one at the customers premises or the local exchange, AT 60459 (Specification T 60459) and the other at the remote exchange, AT 60458 (Specification T 60458). See Fig 4. These relay sets are fitted in the 2-wire of the transmission path.

The equipment will respond to both loop calling and earth calling customers equipment.

The Signal Code for SSDC OOAE/L working is shown in Table 1.

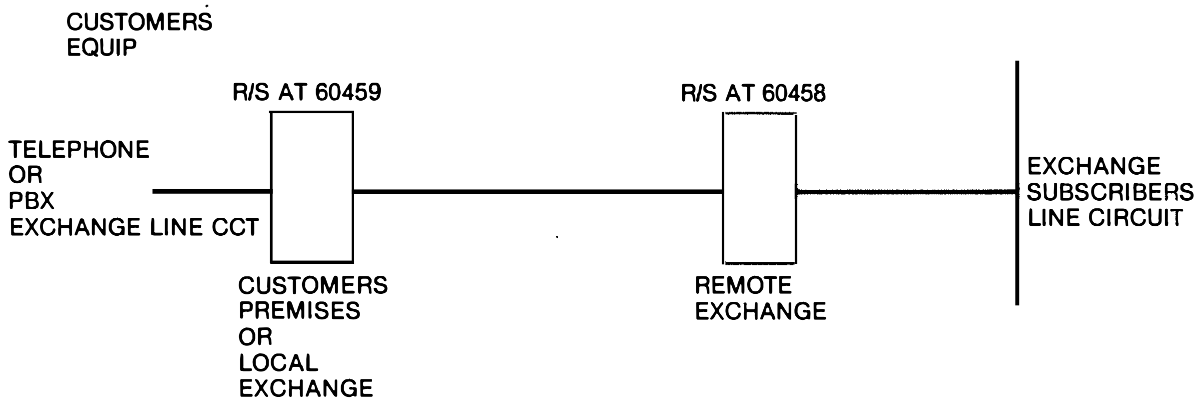


Fig 4 OOAE/L Using SSDC2 Signalling

When the customer requires private meter facilities then provide relay sets AT 61233 (Specification T 61233) at the local exchange and relay set AT 61232 (Specification T 61232) at the remote exchange. Unidirectional outgoing working only is available with these relay sets.

TABLE 1

SSDC2 OOAE/L SIGNAL CODE

Call Originated by the OOA Customer

Signal	Local R/S Condition	Remote R/S Condition
Idle	Earth B wire Negative Batt A wire	Loop
Seizure	Earth A wire Batt B wire	—
Digit Signals	Earth B wire Negative Batt A Corresponding to digit signals sent or MFPB Signals	—
Clear Forward with Junction Guard	Earth B wire Batt A wire	Earth A and B
Junction Guard Release	Earth B wire Negative Batt A wire	Loop

Call from the Remote Exchange

Idle	Earth B wire Negative Batt A wire	Loop
Seizing	—	Earth A and B
Answer	Earth A wire Negative Batt B wire	—
Clear back	Earth B wire Negative Batt A wire	—
Clear forward	—	Loop

SSDC2 OOAE/L Working on TXE2 Exchanges

To enable OOAE/L provision using DC2 signalling to work satisfactorily at a TXE2 exchange, an interface circuit is necessary. See Ref 2.

19.4 Signalling System AC14

Use

SSAC14 is a 1 VF signalling system normally used on Out-of-Area Exchange Lines (OOAE/L).

The system is basically a 4-wire signalling system using a single frequency of 2280 Hz but including terminating units to give a 2-wire presentation to the customers line and 3-wire to the exchange equipment on OOAE/L.

Signalling Limits

The 2280 Hz tone is transmitted to line at a nominal power level of −10 dBmO. The 2280 Hz receiver has an operating bandwidth of 2280 Hz ± 25 Hz and operates over the signal level range −6 dBm ±9 dBmO. The dc side of the local exchange relay set operates to a maximum 1000 ohm loop.

Location of Relay Sets

AC14 is made up of the following Relay Sets: 2/4649A plus 2/4650A which are wired to Diagram ATW 60331 and are generally known as the 'Main Exchange' Relay Sets; and 1A1/AT 60330 plus 2/4648A which are wired to Diagram ATW 60330 and are known as the 'Local Exchange' Relay Sets. As their description suggests, both groups of Relay Sets should normally be fitted at the BT Exchanges. The terminal Relay Sets each include a Terminating Unit to permit 2-wire extension to the customers premises or exchange equipment as appropriate. Where transmission considerations rule out the use of a 2-wire local network extension at either or both ends of a circuit, then a modification may be applied to bypass the Terminating Units and permit the use of 4-wire amplified lineplant

When AC14 signalling is used to provide OOAE/L service, the AT 60331 *Main Exchange* Relay Sets will be located at the BT Exchange from which Out-Of-Area Service is to be given while the AT 60330 *Local Exchange* Relay Sets will be located at the exchange serving the customers premises. See Fig 5.

Transmission Requirements

Both the Main Exchange R/S and the Local Exchange R/S are connected in a 4-wire mode and each is situated at distant ends of the circuit, at the +1 dBr point in the receive path and the −4 dBr point in the transmit path of a BT EPS3B circuit. The performance at 2280 Hz of such a circuit will ensure that signal tone received levels are within the sensitivity range of the SSAC14 signal receiver. When SSFM4 signalling is employed, using MFBP keyphones, an EPS3E circuit should be chosen to give the required response to MF signals. Either a physical audio circuit or a circuit including an HF section (FDM or PCM) is suitable. There is no limit on line length.

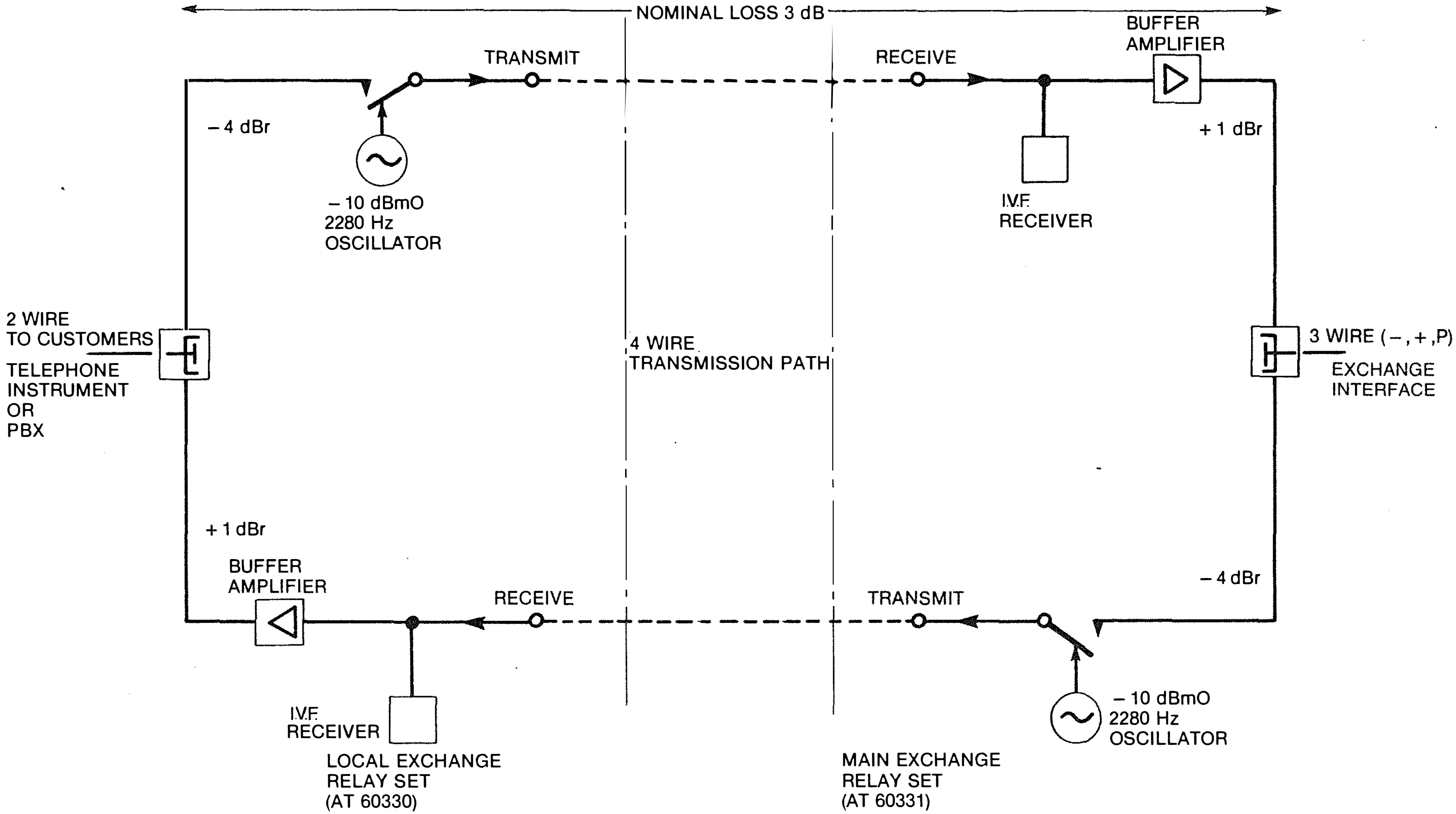


Fig 5 SSAC14 Out-Of-Area Equipment

Section 19 Table 2

SSAC14 Signal Code

Direction of Transmission	Signal	Signal Duration	Recognition Time (ms)
Forward, from Caller	Seizure Digit pulses Forward Clear	60-120 ms 44-102 ms 650 ms minimum	20-40 2-30 350-525
Backward to Caller	Ringing Answer Check tone (Note)	(400 ms on* (200 ms off* (400 ms on* (2 seconds off* 60-120 ms Continuous	70 — 70 — —

NOTE: Check tone is sent from the Main Exchange end on cleardown and persists until the exchange equipment has cleared, to provide a guard signal on earth calling PABXs.

* approximate duration.

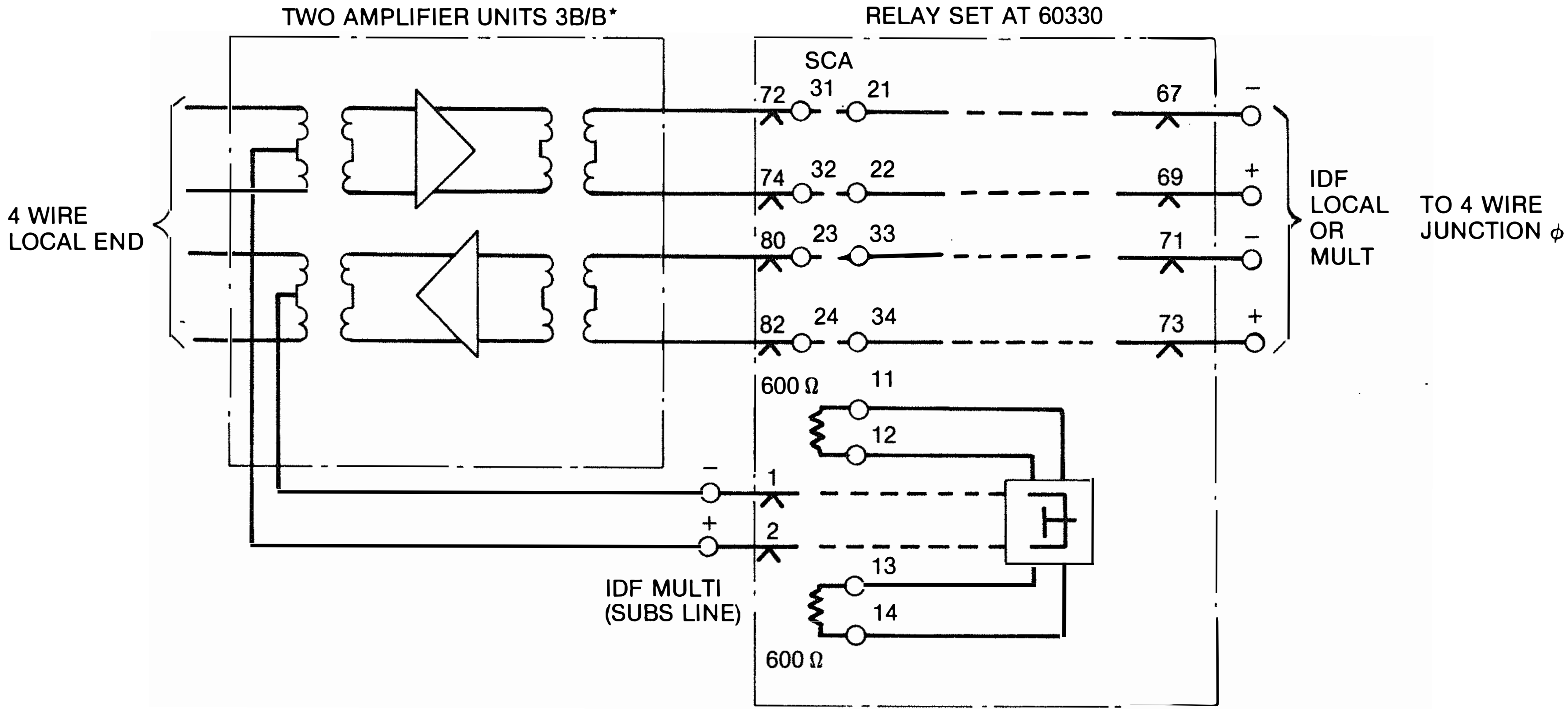
Modification to the SSAC14 (AT 60330) Relay Set to Accommodate 4-wire Local Plant

The practice of siting the AT 60330 at the customers premises should be avoided whenever possible due to the associated high installation costs. In most cases the AT 60330 relay set should be sited at the serving exchange and the circuit extended 2-wire to the customers premises. The configuration described in this paragraph permits the siting of the AT 60330 relay sets at the serving exchange when the local line must be 4-wire amplified to meet overall loss constraints (Ref 3). The following limitations have to be applied to the 4-wire extension modification:-

- The 25 Hz signalling path resistance must not exceed 1000 ohm (Phantom Loop) or premature ring trip may occur.
- This configuration requires that the AC14 has been permanently wired to allow echo suppression to be fitted and, since it uses this permanent wiring, it precludes the use of echo suppression on circuits modified in this way.

Modification Refer to Fig 6

The terminating unit in the relay set is disconnected at SCA by recovering strap connections 11-21, 12-22, 13-23, 14-24, the 4-wire transmission path may now be extended to the IDF (Echo suppressor strip connection) by inserting straps 21-31, 22-32, 23-33, 24-34, for connection to suitable amplifiers and line transformers. the −ve and +ve, which appear as *Sub Line* on the IDF (mult) are connected to the phantoms of the line transformers for signalling purposes. The amplifiers are set up to levels shown on Fig 6. A locally prepared label should be attached to the relay set indicating that it is working to this configuration.

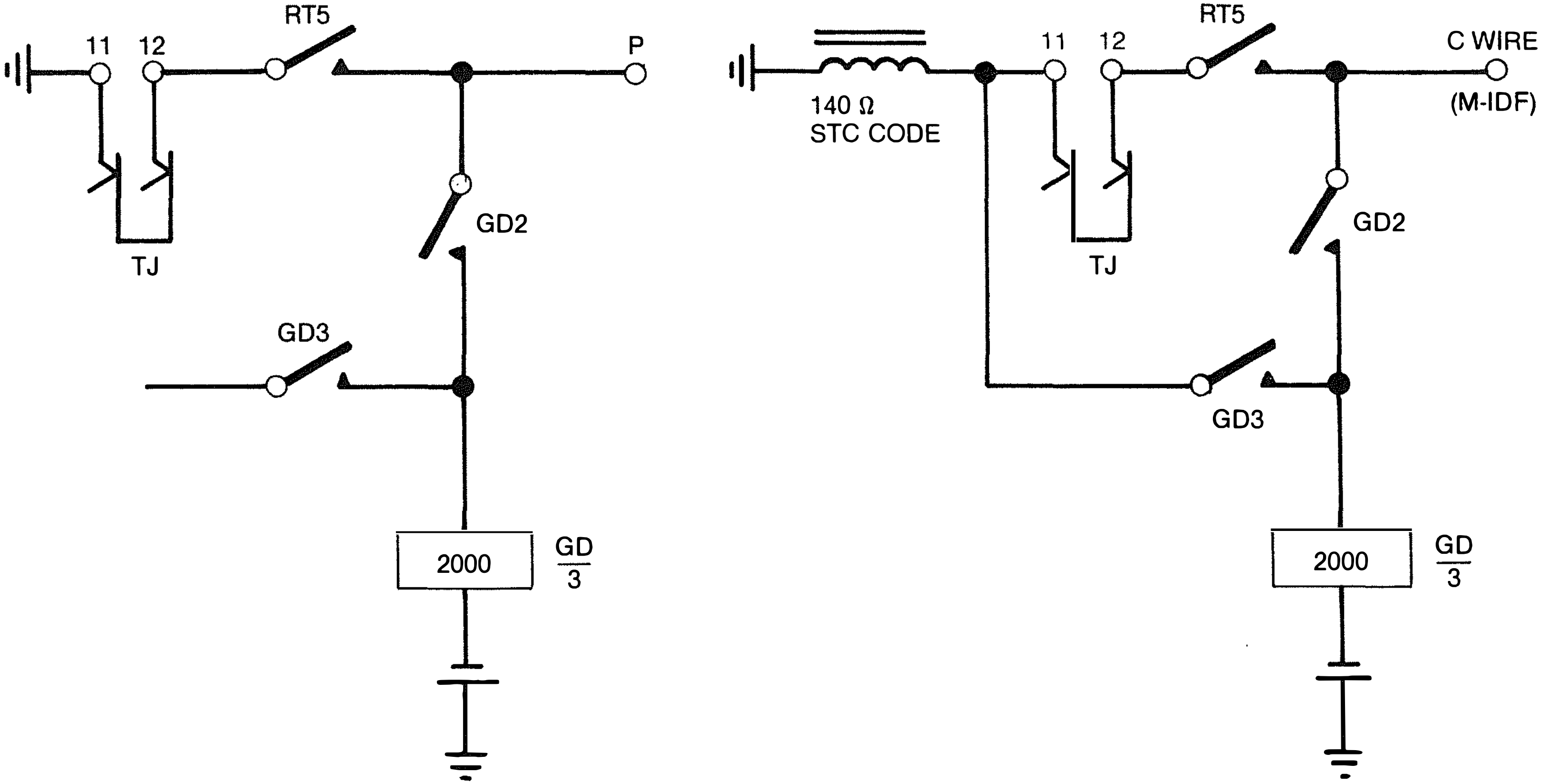


* AMPLIFIERS SET UP TO GIVE + 1 dBr AND − 4 dBr AT 800 Hz ON LINE SIDE OF LTF 3B AT CUSTOMERS PREMISES.

ϕ JUNCTION LINE PLANT SET UP TO GIVE + 1 dBr and − 4 dBr AT 800 HZ ON JUNCTION SIDE OF RELAY SET IN SERVING EXCHANGE.

Fig 6 Modification To AT 60330 For 4 Wire Through Working

7-FD372



COMPONENT REQUIRED 140 OHMS STC COIL CODE
34 CC LOO 050 FAR

Fig 7 Modification To AT 60331 For TXK3 Exchange Working

Out-of-Area Exchange Line Using SSAC14 Signalling on a TXK3 Type Exchange

In order to use Relay Set AT 60331 to give Out-of-Area service on a TXK3 exchange it is necessary to modify the relay set by inserting a 140 ohm resistive inductor in series with the 'P' wire between the earth and Pin 11 on the TJ link see Fig 7.

Out-of-Area Exchange Line Using SSAC14 Signalling on TXE2 Type Exchange

To enable an OOAE/L using SSAC14 (AT 60330, AT 60331) signalling to work satisfactorily from a TXE2 Exchange, an interface circuit is necessary. See Ref 2.

19.5 Signalling Systems AC15-C (SSAC15-C) OOAE/L

SSAC15-C, employing Signalling Units No. 53A and 54A, may be used to provide OOAE/L working where the customers equipment terminates in:

- A telephone instrument
- A PMBX exchange line
- An incoming only exchange line on a PABX or Call Distribution equipment

In effect, any situation where the customer equipment does not require a clear signal from the public exchange, and employs loop calling.

SSAC15-C is described in Section 16.2.2.1.

The Signalling Units No. 53A and 54A are described in Sections 17.5 and 17.6 respectively.

The Signalling Unit No. 53A is located at the remote exchange end. The unit is mounted in 62 type practice and so, if transmission requirements permit, it may be convenient to install it at the nearest Repeater Station.

The Signalling Unit No. 54A is located at the customers end of the OOAE/L. It should normally be installed at the customers premises using one of the mounting arrangements described in Section 17.11.

19.6 Signalling System AC15-E (SSAC15-E)

System Description

SSAC15-E is a 1 VF in band system for the transmission of supervisory signals and 10 pps/MF4 between a telephone, a PBX exchange line port or equivalent termination and a public exchange subscribers line circuit. It uses a single frequency of 2280 Hz in each direction of a 4-wire transmission path, the presence or absence of this frequency indicates a specific signal dependant on when it occurs in the signalling sequence, and in some cases upon its duration. When the circuit is idle, low level signal tone is continuously present in the direction subscribers equipment to public exchange equipment, whilst in the direction public exchange to subscriber, a continuous tone-off is present.

SSAC15-E meets the requirements for CEPT line signalling system L2 and is described in detail in CEPT Recommendation T/CS 49-12, 1982. See also description of SSAC15-C in Section 16.2.2.1. For specific BT purposes the SSAC15-E system requires additional signals compared with the CEPT L2 protocol. These additional signals are *disconnect clear* and *backward guard.*

For the purposes of this description, reference is made to an Equipment Signalling Unit (ESU), located at the Remote exchange end of an Out-of-Area Exchange Line (OOAE/L) and to an Instrument Signalling Unit (ISU), located at the local exchange or customers end. This does not imply that the signalling equipment cannot form an integral part of either the public exchange of the customers terminal equipment.

The SSAC15-E system may not be used on any transmission system employing Time Assignment Speech Interpolation (TASI) techniques, as it will tend to occupy a speech channel continuously when in the idle state.

Echo Suppressors

Should the circuit employing SSAC15-E require the use of echo suppressors eg on satellite circuits, the echo suppressors must be fitted outside the signal path or be cancelled when signal tone is present.

Transmission Requirements

The transmission requirements for SSAC15-E meet the requirements for 4-wire Out-of-Area Exchange Lines as described in Ref 3.

Both the ISU and the ESU are connected in a 4-wire mode and each is situated at distant ends of the circuit, at the + 1 dBr point in the receive path and the − 4 dBr point in the transmit path of a BT EPS3B circuit. The performance at 2280 Hz of such a circuit will ensure that signal tone received levels are within the sensitivity range (− 3 dBm to − 29 dBm) of the SSAC15-E signal receiver. When SSMF4 signalling is employed, using MFPB keyphones, an EPS3E circuit should be chosen to give the required response to MF signals. Either a physical audio circuit or a circuit including an HF section (FDM or PCM) is suitable. There is no limit on line length.

Outline of Operation

The following facilities are provided by SSAC15-E.

Outgoing Calls

Outgoing access from subscriber equipment with loop calling or earth calling principles.

Digit signalling by loop disconnect at 10 pps or remains transparent for MF4 signalling.

Extending subscriber recall signals to the exchange by either a timed disconnection (Register Recall) or earthed loop principles (PBX Extension Recall).

Repeating a called subscriber answer condition. The exchange end signalling unit will detect reversed A and B wires if the exchange is able to provide the signal, or a first meter pulse if the signalling unit is co-located.

Guarding against PABX access until the exchange is free following cleardown of a call by Disconnect Clear and Earth-calling principles.

Incoming Calls

Detection of an incoming call to the subscriber by reversal of the exchange A and B wires and/or a ringing current signal.

Repeating the exchange calling signal to the subscriber as follows:

- the reversal directly.
- the ringing current as a 1 second burst of ringing at either exchange cadence or self generated cadence.

Guarding against PABX access until the exchange is free following clear-down of an incoming call.

Disconnection of the exchange calling condition and sending a signal to trip the ringing at the exchange and when the subscriber answers an incoming call.

Extending subscriber recall signals to the exchange by either Register Recall (a timed disconnection) or PBX Extension Recall (earthed loop) principles.

Repeating the exchange supervisory condition as a disconnect clear signal to the subscriber when an incoming call clears down.

Guarding against PABX access until the exchange is free following clear-down of an incoming call.

Providing a repeat attempt and alarm if the disconnect clear signal is not acted upon.

Provision of a follow-on call trap while the disconnect clear signal is operational.

Table 3 follows

SSAC15-E Signal Code

Table 3

Call originated from the Customers Equipment

Signal	**Condition from ISU**	**Condition from ESU**
Idle	Continuous tone-on	Continuous tone-off
Seizing	Continuous tone-off	—
Address information	Decadic pulsing (tone-on during break pulse) or MFPB signals	—
Answer	Continuous tone-off	Tone on pulse for 45-135 ms
Recall	Tone-on for 50-130 ms (timed dis) or 210-240 ms (earthed loop)	Continuous tone-off
Clear	Continuous tone-on	—
Disconnect Clear	—	Tone-on pulse for 300-400 ms
Backward Guard	—	Tone-on pulse for longer than 300 ms (may be prolongation of disconnect clear signal)

Table 3 (Contd)

Call from the Remote Exchange

Signal	Condition from ISU	Condition from ESU
Idle	Continuous tone-on	Continuous tone-off
Seizing	—	Calling tone-on pulses in step with exchange ringing current
Answer	Continuous tone-off	Continuous tone-off
Recall	Tone-on for 50-130 ms (timed dis) or 210-240 ms (earthed loop)	—
Clear	Continuous tone-on	—
Disconnect clear	—	Tone-on pulse for 300-400 ms
Backward Guard	—	Tone-on for longer than 300 ms (may be prolongation of the disconnect clear signal)

NOTE: High level tone is sent for the duration of the signal or for a minimum of 300 ms (whichever is shorter) and for a maximum of 550 ms after which it is reduced to low level.

SSAC15-E System Features

These are essentially the same as those described for SSAC15-C in Section 16.2.2.1.

Availability

SSAC15-E will be available, in the first instance, only for the Derived Services Network (Link line). Its general availability will be announced in due course.

End of Section 19

Private Circuit Services Signalling Handbook

Section 20 — Diversion of Private Circuits for Alternative Speech/Data

The general requirements for diversion of speech band private circuits for alternative uses, is described in Ref 1.

The purpose of this Section of the Handbook is to bring to the attention of planners further problems associated with switching automatic signalling systems.

In Ref 1 it is recommended that when line diversion is required on inter-PBX circuits employing automatic signalling, the preferred signalling system on the line concerned, should be SSAC 15, and that the method of switching should be by *snatching* the circuit. When an SSAC 15 circuit is disconnected for line diversion the PBX equipment at either end assumes a seized condition. This has the effect of busying the circuit against outgoing access whilst the line is diverted. On the older type of PBXs this would result in a *PG* condition which might ultimately bring up a *deferred* alarm. It would be possible in most cases for the alarm to be cancelled under line diversion conditions, and therefore no maintenance difficulty would arise.

On many modern PBXs however, a *PG* condition is routinely scanned by automatic monitoring equipment and after a time-out period, there is a fault print out and an alarm indication. This can cause considerable difficulty from a maintenance viewpoint.

The provision of line diversion on SSAC 15 circuits associated with such PBXs is therefore not recommended.

Circuits employing SSDC 5 suffer from much the same problem in that the PBX access is busied by seizing the equipment. SSDC 5 also cannot be recommended for line diversion in the circumstances described above.

As neither SSAC 13 or SSDC10 may be recommended for line diversion (Ref 1). It can be seen that the use of the facility on modern PBXs is restricted to manual signalling circuits, of which, there are very few anyway. The effect of all this is that, in effect, the facility can seldom be provided.

The position is relieved somewhat by virtue of the fact that modem data speeds on 2-wire circuits have increased substantially in recent years. The need for 4-wire diversion has been reduced, since relative high data bit rates may be transmitted from an extension circuit on one PBX to an extension circuit on another.

End of Section 20

Private Circuit Services Handbook

TI/ISIS References

This Appendix will be updated and reissued at appropriate intervals. For the immediate future, copies and quoted TI may be obtained via District Managers from UKCHQ/PCS3.1 Block A Government Buildings London Road Stanmore WD7 4PT. ISIS documents can be obtained from your ISIS Distribution Centre.

Section 1

Nil

Section 2

Nil

Section 3

Ref 1	TI	B3 K0001	Private Services
2		B3 K0002	Procedural Arrangements
3		C3 P3000	Provision of Private Services
4		C4 C0050	Customer Works Co-ordination
5		C4 C0060 A8 K1510	Form A4217 — Application for Private Services
7		A8 K0011	Line Terminating Facilities to Customers Premises
8		A8 K0013	Inland Speechband Private Circuits
9		A8 K0405	Inland Speechband Private Circuits
10		A8 K1008	DC Signalling Paths or Speechband Private Circuits
11		C3 P6000 to C3 P6081	Private Services — Line Terminating Facilities
12		C3 P6200 to C3 P6274	Private Services — Line Diversion Arrangements

Section 4

Nil

Section 5

Ref 1	TI	A8 K0013	Inland Speechband Private Circuits

Section 6

Ref 1	TI	A8 K1008	DC Signalling Paths
2		A8 K1005	Introduction of incremental loss plan for 4 wire switched speech networks
3		A8 K0013	Inland Speechband Private Circuits

Section 7

Ref 1	TI	C3 A0103	External Extensions

Section 8

Ref 1	TI	B4 K0002	Speechboard Private Circuit Facilities
2		A8 K0011	Line Terminating Facilities

Section 9

Ref 1	TI A4 K1008	DC Signalling Paths on Speechband Private Circuits

Section 10

Ref 1	TI A8 K1004	Private Circuit Speech Networks

Section 11

Ref 1	TI A5 F1028	Panel Signalling No. 7
2	A5 F3072	Inland Speechband Private Services
3	A5 F3062	Units Signalling Nos. 18A and 18B
4	A5 F3071	Private Circuits IVF Signalling Unit No. 27A
5	TXA/IPP/F010 (A6 D1101)	

Section 12

Ref 1	TI C3 P1061	Provision of Inter PBX Services
2	CSS/APC/B051 (A8 F0020)	Utilization of Channels in Private Group and S/Groups Inland Private Circuits
3	C3 P5000	Description of SSAC 13
4	C3 P5001	Setting Up SSAC 13

Section 13

Ref 1	TI A8 K1005	Private Circuit Speech Networks

Section 14

Nil

Section 15

Ref 1	EPT/PPS/B011	Earth, Potential Protection
2	TMN/PCM/B016	PCM Signalling (30 CH)
3	TI C3 A5000 to C3 A5008	Indexes of SA etc Diagrams
4	C3 P5000	Description of SSAC 13
5	TMN/CFE/B011 (A2 C2011)	Line Plant Planning
6	A3 G2051	Building Out Networks for Audio Cable Pairs
7	C2 P5001	Setting Up SSAC 13
8	C3 P1061	Provision of Inter PBX Services
9	E5 A0101	Customers Telephone Apparatus
10	A8 K1004	Private Circuit Speech Networks
11	A2 C2011	Line Plant Planning
12	A3 G2051	Building Out Networks for Audio Cable Pairs

Section 16

Ref 1	TI C3 A0103	External Extension Inter PBX Extension and Out of Area Exchange Lines
2	A2 C1082 to A2 C1085	Line Extenders for Local Line Network
3	C3 A0101	Long Exchange Lines and External Extensions

Section 17

Ref 1	TI C3 Q0020	Power Units
2	C3 18469	Auxiliary Equipment Cabinet
3	C3 18465	Cabinet 1/TG2453

Section 18

Nil

Section 19

Ref	1	NWK/LNK/C075	Line Extenders
	2	TXE/XE2/B190	TXE2 Exchanges
	3	C3 A0103	Residential Extensions

Section 20

Ref	1	TI A8 K0406	

End of Appendix