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SERIES I: INTEGRATED SERVICES DIGITAL NETWORK

Internetwork interfaces

VSAT interconnection with the PSTN

ITU-T Recommendation I.572

(Formerly CCITT Recommendation)

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ITU-T Recommendation I.572

VSAT interconnection with the PSTN

Summary

This ITU-T Recommendation describes the functional technical requirements for the incorporation of VSATs into the Access portion of national telephone networks, both public and private. Scenarios illustrate some but not all of the ways that VSATs might be deployed in this portion of the network. A pre-existing analogue network has been assumed for the discussion of transmission planning with digital technology included where significant. The annexes contain details of several national connection requirements and when considered as a whole provide a good overview of connection requirements for all national telephone networks. Additional annexes may be added in future to cover other countries.

Source

ITU-T Recommendation I.572 was prepared by ITU-T Study Group 13 (1997-2000) and approved under the WTSC Resolution 1 procedure on 10 March 2000.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSC Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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ITU-T Recommendation I.572

VSAT interconnection with the PSTN

1 Introduction

This ITU-T Recommendation considers the interworking of VSAT systems with the public telephone network, usually referred to as the PSTN. Interworking Recommendations for VSAT interworking to ISDNs ITU-T Recommendation I.571 and PSPDNs ITU-T Recommendation X.361 already exist. VSAT technology can be deployed in both public Access networks and private networks. VSAT technology offers fast deployment and the capability to communicate with any customer irrespective of location (sometimes referred to as high penetration capability).

The Public Switched Telephone Network (PSTN) is a concept that embodies all national and international telephone networks. In practice it is not possible to connect to a "concept"; therefore practical connections are always to a National telephone network that operates within a National regulatory framework. This Recommendation only deals with the technical functional requirements for interconnection to National telephone networks and not with the multitude of other issues related to interconnection with National telephone networks, such as financial issues or the universal service requirement or other national policy issues.

Telephone networks have been in existence for a long time and therefore they usually offer the end user a wide range of interfaces and features some of which are unique to a particular network within a particular country. There usually exists a set of National telephone network technical interface specifications, that are in the public domain, which specify the Requirements-for-Interconnection to a National telephone network.

The classic arrangement for connecting an end user to any national telephone network is via an Access network. The Access network has only recently acquired the status of a separate entity in telephone networks due to the influence of national privatization policies which are in the process of introducing competition into many telephone networks.

The end user is normally connected to the first level of the switching hierarchy of a National network, usually referred to as the Local Exchange (LE). This will usually be the nearest exchange to keep access costs as low as possible. However, if the nearest local exchange cannot support the required facilities, then the user may be connected to a more distant exchange that can provide the necessary services.

In parts of the world with low telephone densities there may be one or more concentration (and possibly switching) stages within the Access network before the LE, e.g. remote concentrators, Private Branch Exchanges (PBXs) or simply shared service lines. In addition, it may be economic in such an environment to employ higher speed multiplexing techniques to support several channels on one physical channel within the Access network.

2 Scope

This ITU-T Recommendation covers the technical functional requirements for the interconnection of VSAT networks to National networks.

It does not include the Regulatory requirements for interconnection to National telephone networks, which are a national matter.

Any particular VSAT network may be owned or controlled by the national network operator, or operators, or by a private network operator. Thus the VSAT network may be considered to be part of the National Access network or part of a private network.

3 References

The following ITU-T Recommendations and other references contan provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- ITU-T Recommendation E.182 (1998), *Application of tones and recorded announcements in telephone services*.
- ITU-T Recommendation G.101 (1996), *The transmission plan*.
- ITU-T Recommendation G.103 (1998), *Hypothetical reference connections*.
- ITU-T Recommendation G.107 (1998), *The E-Model, a computational model for transmission planning*.
- ITU-T Recommendation G.111 (1993), *Loudness ratings (LRs) in an international connection*.
- ITU-T Recommendation G.113 (1996), *Transmission impairments*.
- ITU-T Recommendation G.114 (1996), *One-way transmission time*.
- ITU-T Recommendation G.116 (1999), *Transmission performance objectives applicable to end-to-end international connections*.
- ITU-T Recommendation G.117 (1996), *Transmission aspects of unbalance about earth.*
- ITU-T Recommendation G.120 (1998), *Transmission characteristics of national networks.*
- ITU-T Recommendation G.121 (1993), *Loudness ratings (LRs) of national systems.*
- ITU-T Recommendation G.122 (1993), *Influence of national systems on stability and talker echo in international connections.*
- ITU-T Recommendation G.126 (1993), *Listener echo in telephone networks.*
- ITU-T Recommendation G.131 (1996), *Control of talker echo.*
- ITU-T Recommendation G.142 (1998), *Transmission characteristics of exchanges.*
- ITU-T Recommendation G.165 (1993), *Echo cancellers.*
- ITU-T Recommendation G.168 (1997), *Digital network echo cancellers.*
- ITU-T Recommendation G.173 (1993), *Transmission planning aspects of the speech service in digital public land mobile networks.*
- ITU-T Recommendation G.174 (1994), *Transmission performance objectives for terrestrial digital wireless systems using portable terminals to access the PSTN.*
- ITU-T Recommendation G.175 (1997), *Transmission planning for private/public network interconnection of voice traffic*.
- ITU-T Recommendation G.176 (1997), *Planning guidelines for the integration of ATM technology into networks supporting voiceband services*.
- CCITT Recommendation G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.
- ITU-T Recommendation G.712 (1996), *Transmission performance characteristics of pulse code modulation channels*.

– CCITT Recommendation G.722 (1988), *7 kHz audio-coding within 64 kbit/s.*

– ITU-T Recommendation G.723.1 (1996), *Dual rate speech coder for multimedia communications transmitting at 5.3 and 6.3 kbit/s*.

– CCITT Recommendation G.726 (1990), *40, 32, 24, 16 kbit/s adaptive differential pulse code modulation (ADPCM)*.

– CCITT Recommendation G.727 (1990), *5-, 4-, 3- and 2-bit sample embedded adaptive differential pulse code modulation (ADPCM)*.

– CCITT Recommendation G.728 (1992), *Coding of speech at 16 kbit/s using low-delay code excited linear prediction*.

– ITU-T Recommendation G.729 (1996), *Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear-prediction (CS-ACELP)*.

– ITU-T G-series Recommendations – Supplement 31 (1993), *Principles of determining an impedance strategy for the local network*.

– ITU-T Recommendation I.571 (1996), *Connection of VSAT based private networks to the public ISDN*.

– ITU-T Recommendation M.2101.1 (1997), *Performance limits for bringing-into-service and maintenance of international SDH paths and multiplex sections.*

– CCITT Recommendation O.131 (1988), *Quantizing distortion measuring equipment using a pseudo-random noise test signal*.

– ITU-T Recommendation P.11 (1993), *Effect of transmission impairments*.

– ITU-T Recommendation P.64 (1999), *Determination of sensitivity/frequency characteristics of local telephone systems*.

– CCITT Recommendation P.76 (1988), *Determination of loudness ratings; fundamental principles*.

– ITU-T Recommendation P.79 (1993), *Calculation of loudness ratings for telephone sets*.

– ITU-T Recommendation P.310 (1996), *Transmission characteristics for telephone-band (300-3400 Hz) digital telephones*.

– ITU-T Recommendation P.340 (1996), *Transmission characteristics of hands-free telephones*.

– ITU-T Recommendation P.360 (1998), *Efficiency of devices for preventing the occurrence of excessive acoustic pressure by telephone receiver*s.

– CCITT Recommendation Q.23 (1988), *Technical features of push-button telephone sets*.

– CCITT Recommendation Q.32 (1988), *Reduction of the risk of instability by switching means*.

– ITU-T Recommendation Q.512 (1995), *Digital exchange interfaces for subscriber access*.

– ITU-T Recommendation Q.552 (1996), *Transmission characteristics at 2-wire analogue interfaces of digital exchanges*.

– Recommendation ITU-R S.725 (1992), *Technical characteristics for very small aperture terminals (VSATs)*.

– ITU-T Recommendation T.4 (1999), *Standardization of Group 3 facsimile terminals for document transmission.*

– ITU-T Recommendation V.25 (1996), *Automatic answering equipment and general procedures for automatic calling equipment on the general switched telephone network including procedures for disabling of echo control devices for both manually and automatically established calls*.

– ITU-T Recommendation X.25 (1996), *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit*.

– ITU-T Recommendation X.361 (1996), *Connection of VSAT systems with packet-switched public data networks based on X.25 procedures*.

– ISO/IEC 11572:2000, *Information technology*, *Telecommunications and information exchange between systems – Private Integrated Services Network – Circuit mode bearer services – Inter-exchange signalling procedures and protocol*.

– ETSI ETS 300 001 (1997), *Attachments to the Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface in the PSTN*.

– ETSI I-ETS 300 003 (1991), *Business Telecommunications (BT); Transmission characteristics of digital Private Automatic Branch Exchanges (PABXs)*.

– ETSI I-ETS 300 004 (1991), *Business Telecommunications (BT); Transmission characteristics at 2-wire analogue interfaces of a digital Private Automatic Branch Exchanges PABX.*

– ETSI I-ETS 300 005 (1991), *Business Telecommunications (BT); Transmission characteristics at 4-wire analogue interfaces of a digital Private Automatic Branch Exchanges PABX.*

– ETSI EN 300 172 (1997), *Private Integrated Services Network (PISN); Inter-exchange signalling protocol; Circuit-mode basic services*.

– ETSI I-ETS 300 480 (1996), *Public Switched Telephone Network (PSTN); Testing specification for analogue handset telephony.*

– ETSI ETS 300 659-1 (1997), *Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services; Part 2; On-hook data transmission.*

– ETSI TBR 21 (1998), *Terminal Equipment* (*TE); Attachment requirements for pan-European approval for connection to the analogue Public Switched Telephone Networks (PSTNs) of TE (excluding TE supporting the voice telephony service) in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signalling.*

– ANSI T1.401 (1993), *Interface Between Carriers and Customer Installations – Analog Voicegrade Switched Access Lines Using Loop-Start and Ground-Start Signalling*.

– ANSI T1.401.01 (1993), *Interface Between Carriers and Customer Installations – Analog Voicegrade Switched Access Lines Using Loop-Start and Ground-Start Signalling With Line-Side Answer Supervision Feature*.

– ANSI T1.401.02 (1995), *Interface between Carriers and Customer Installations – Analog Voicegrade Switched Access Lines with Distinctive Alerting Features*.

– ANSI T1.405 (1996), *Network to Customer Installation Interfaces – Direct-Inward-Dialing-Analog Voicegrade Switched Access Using Loop Reverse-Battery Signalling*.

– ANSI T1.407 (1997), *Network to Customer Installation Interfaces – Analog Voicegrade Special Access Lines Using Customer-Installation-Provided Loop-Start Supervision*.

– ANSI T1.409 (1996), *Telecommunications – Network to Customer Installation Interfaces – Analog Voicegrade Special Access Lines Using E&M Signalling*.

– ANSI T1.411 (1995), *Interface between Carriers and Customer Installations – Analog Voicegrade Enhanced 911 Switched Access Using Network-Provided Reverse-Battery Signalling*.

4 Terms and definitions

This ITU-T Recommendation defines the following terms:

4.1 parented: Where a lower tier exchange is parented on a higher tier exchange in a hierarchical switched network, it means that the control and management of the lower exchange is the responsibility of the higher exchange and that probably the international traffic will be routed on a direct connection between them.

4.2 penetration: Used to refer to the portion of a whole possible market that has been reached with communication facilities.

5 Abbreviations

This ITU-T Recommendation uses the following abbreviations:

FDM Frequency Division Multiplexing

IFU Interface Unit

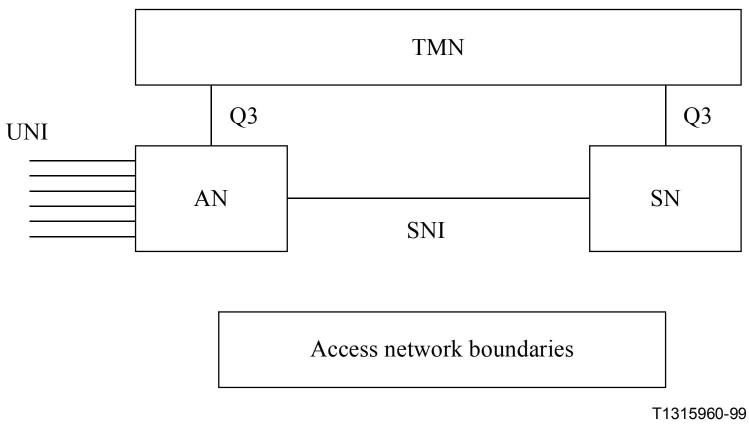
TDM Time Division Multiplexing

TDMA Time Division Multiple Access (for Radio systems)

VSAT Very Small Aperture Terminal

6 Access Network

The definition of the Access Network may be found in ITU-T Recommendation G.902 "Framework Recommendation on Functional Access Networks" which is sufficiently general to include analogue systems even though it is in the digital network series of Recommendations. Figure 1, reproduced here from Recommendation G.902, illustrates the Access Network concept.



AN Access Network
SN Service Node
SNI Service Node Interface
TMN Telecommunication Management Network
UNI User Network Interface

Figure 1/I.572 – Access Network definition

7 Scenarios

A few main classes of scenario have been defined from which may be derived various sub-scenarios. A completely exhaustive analysis was not attempted because it would result in a very large set of scenarios and some interpolation between the scenarios will almost certainly be necessary to cover any practical case.

7.1 Scenario 1 – A few single terminals connected to a National network via a VSAT network

The remote customers are served via a dedicated chain of more than one link that includes a VSAT hop and may include other wireless components. (See Figure 2.)

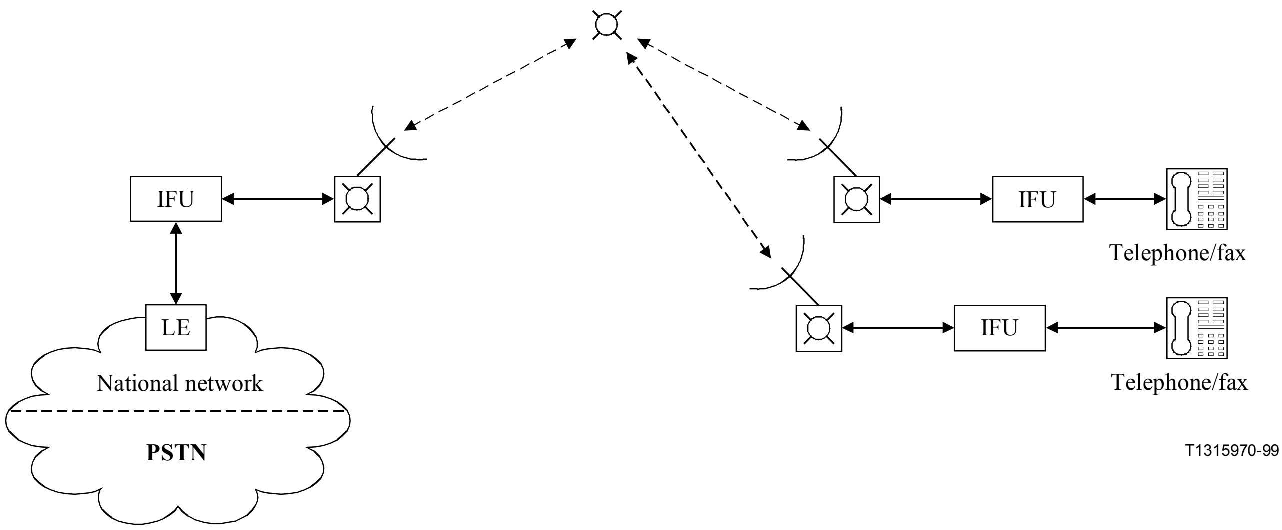


Figure 2/I.572 – Scenario 1: Single terminals

Description of Scenario 1

This, the simplest scenario, is used to introduce the various components involved in a VSAT connection to a National telephone network.

There are also operational requirements that need to be considered. Generally these come under the four headings: Transmission Planning, Signalling, Management and Operations, Administration and Maintenance OA&M.

The VSAT is connected to the National network via an analogue 2-wire line of low loss and a Local Exchange IFU. Alternative technologies may be employed but they will not be covered here.

The Local Exchange IFU will present an approved interface towards the Local exchange. The parameters that need to be controlled to achieve approval for connection for this interface are described in detail in Annex B.

The Local Exchange IFU has to support the following functions:

– Separate the two directions of transmission via a Hybrid with an adjustable balance to give good side-tone performance.

– Convert the analogue voiceband signals into digitally encoded signals and the reverse for transmission over the VSAT.

– Provide echo cancellation to cancel echoes coming back from the National network.

– Protect the VSAT equipment from overload including lightening strikes on the analogue cable to the Local Exchange.
– Provide a performance monitoring function to monitor the state of the VSAT system and its remote terminals. Communication with the monitoring function should be provided via a standardized management interface to allow attachment to national network management systems.
– Signalling would be in-band for single channel applications; therefore a DTMF tone generator would be required to forward routeing signals to the exchange and a ringing detector would be required to detect ring current from the exchange. The signalling conditions would have to be transferred to and received from the Remote Interface Unit via the VSAT.
– Protect the VSAT channels from spurious conditions such as crosstalk.
– Provide forced release of connections that are not operating correctly.

The Remote Interface Unit would have to recreate a Local Exchange interface facing the remote user's terminal, power feed with long unattended operation, loop detect, ringing current and dialling detection.

The conditions on this remote interface have to be signalled back to the Local Exchange IFU.

The Speech path has to be converted from the internal digital code of the VSAT back into analogue signals and then combined from 4-wire to 2-wire via a Hybrid which can be balanced to give good side-tone performance to the remote user.

An echo canceller would be required facing the remote user to compensate for any echoes in the remote network.

The Remote IFU must protect the VSAT equipment from overload such as lightening strikes.

It should provide monitoring of the condition and performance of the VSAT system and the remote user' lines. The information gathered should be communicated back to the Local Exchange IFU periodically.

7.2 Scenario 2 – Several end users attached to the Remote Interface Unit

In this scenario (see Figure 3), a higher speed chain would be required to support multiple users. If there was a one-to-one correspondence between the number of remote terminals and the number of analogue channels between the Local Exchange IFU and the Local Exchange, then it would be a simple matter to provide each remote terminal with its own telephone number. If the transmission capacity through the VSAT matched that provided by the analogue channels to the Local Exchange, then all the remote terminals could be in use simultaneously. This might be achieved by employing multiplexing techniques within the VSAT that allowed more simultaneous conversations to be carried than a dedicated circuit approach would permit.

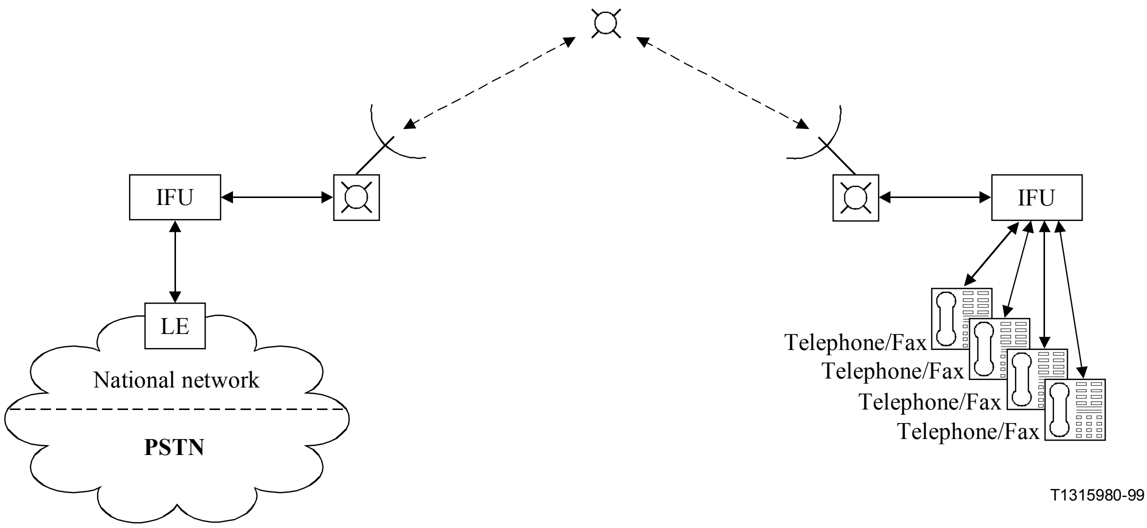


Figure 3/I.572 – Scenario 2: Several end users

If there were more remote terminals than analogue channels to the Local Exchange, then some form of sharing of resources would have to be employed. There are many methods of sharing resources to allow each remote terminal to have its own telephone number. For example, the ringing current could be applied between one leg and earth. This would double the number range that could be supported. Alternatively, different ringer cadences could be generated by the Local Exchange to indicate different end users who share one line.

The capacity of the VSAT radio channel could be increased with various multiplexing techniques to allow more simultaneous conversations. The description of these techniques is outside the scope of this Recommendation.

The performance monitoring function should be able to report on the level of congestion within the system.

The functionality of the Local Exchange IFU and Remote IFU has to be increased to support sharing of the limited resources and perhaps to allow an interrupt facility for emergency traffic.

7.3 Scenario 3 – Geographically distributed multiple user outstations

This is an extension of Scenario 2 to include geographically distributed multiple user outstations. The outstation terminations may include concentration or not, or a mixture.

This scenario (see Figure 4) illustrates that it is possible to serve a wide geographical area with just one VSAT system.

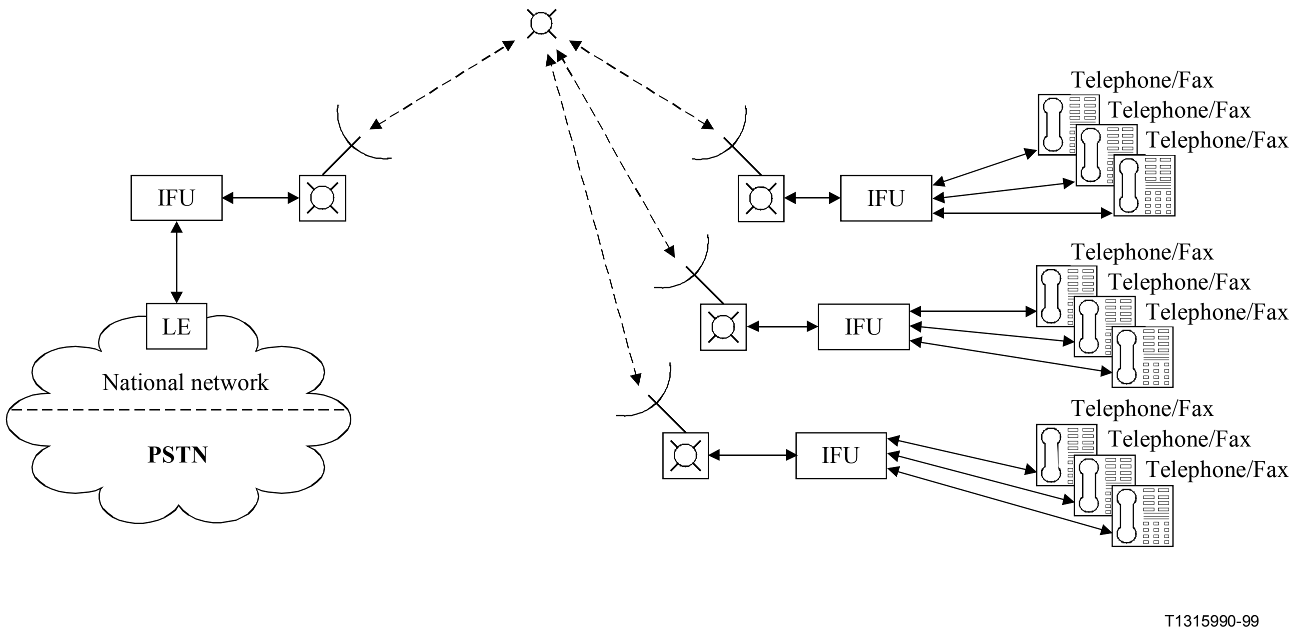


Figure 4/I.572 – Scenario 3: Geographically distributed multi-user outstations

The performance monitoring system should provide information to allow reallocation of VSAT capacity between the various outstations at suitable intervals.

Calls between outstations would have to be routed through the Local Exchange which would involve a double hop but otherwise there should be no problems.

7.4 Scenario 4 – Extension of previous scenarios to include accesses to multiple main networks

The operators of these main networks may be in competition with each other or may offer different services. This scenario (see Figure 5) illustrates that in countries with more than one public network operator, it would often be considered to be good design, to ensure a high reliability of service, to include interconnections to multiple public networks. Such an arrangement might be more appropriate to private networks rather than a public network.

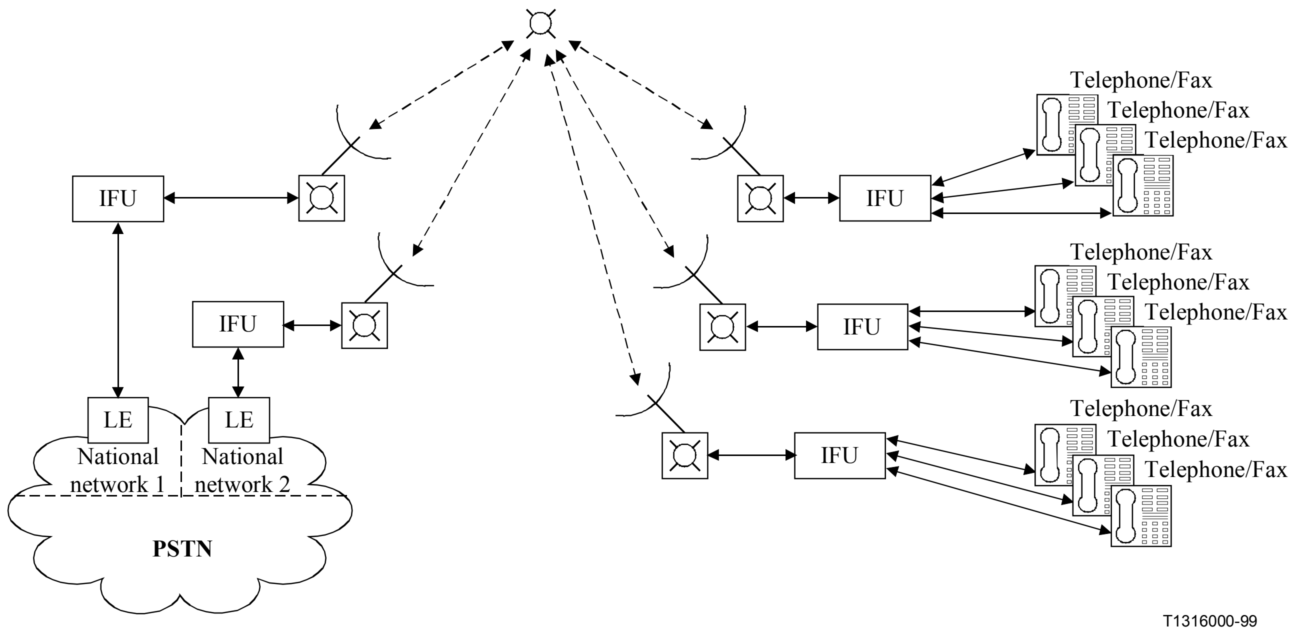


Figure 5/I.572 – Scenario 4: Multiple connections to main network

Several new issues are raised by this arrangement, e.g. the selection of the public network by the remote calling customer (extra digits may have to be dialled) and the separation and privacy of management data.

7.5 Scenario 5 – Connection via a Remote PBX

The inclusion of Remote PBXs would support calls between remote terminals connected to the same PBX without using VSAT capacity. Calls between PBXs would have to be routed via the Local Exchange unless the signalling system was intelligent enough to support routeing through the satellite without traversing the Exchange.

This scenario (see Figure 6) introduces the need to signal back to the Local Exchange when a remote terminal is engaged with an intra PBX call to minimize signalling traffic over the VSAT and to release resources in the public network as quickly as possible. A possible alternative control algorithm might be to always give priority to incoming calls from the public network.

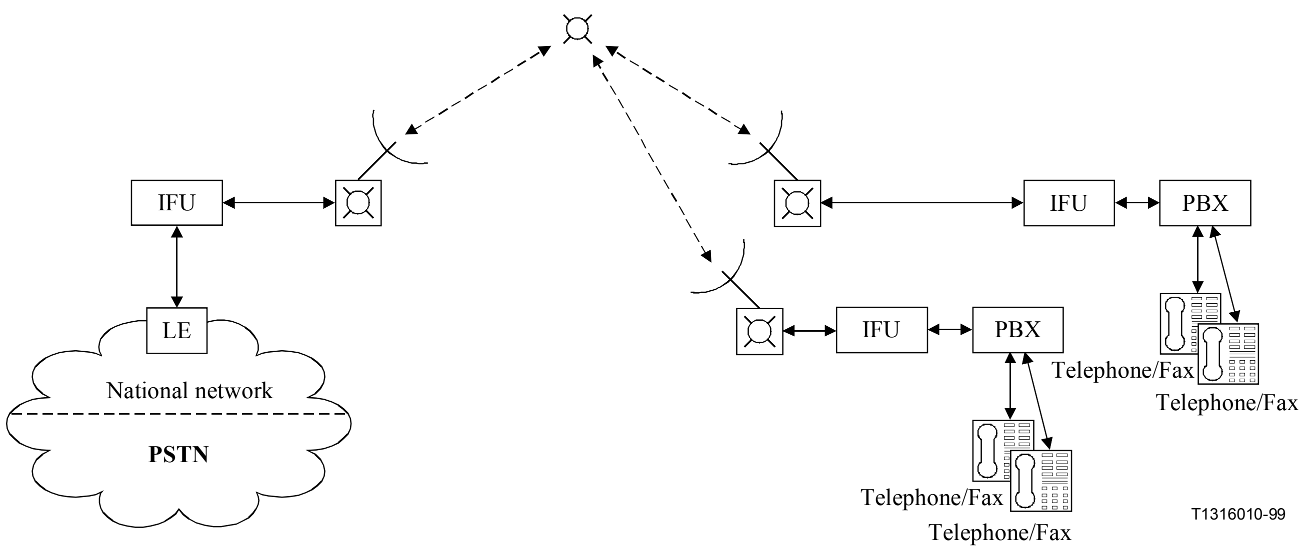


Figure 6/I.572 – Scenario 5: Inclusion of Remote PBXs

As the VSAT is digital and the PBX may be assumed to be digital for new installations and therefore that these two components are digitally connected, then the hybrid terminating impedance as seen by the remote customers' equipment should not be corrupted by the PBX. The echo cancelling in the VSAT Remote IFU should also compensate for any other longer duration effects.

7.6 Scenario 6 – Inclusion of a Local PBX

See Figure 7.

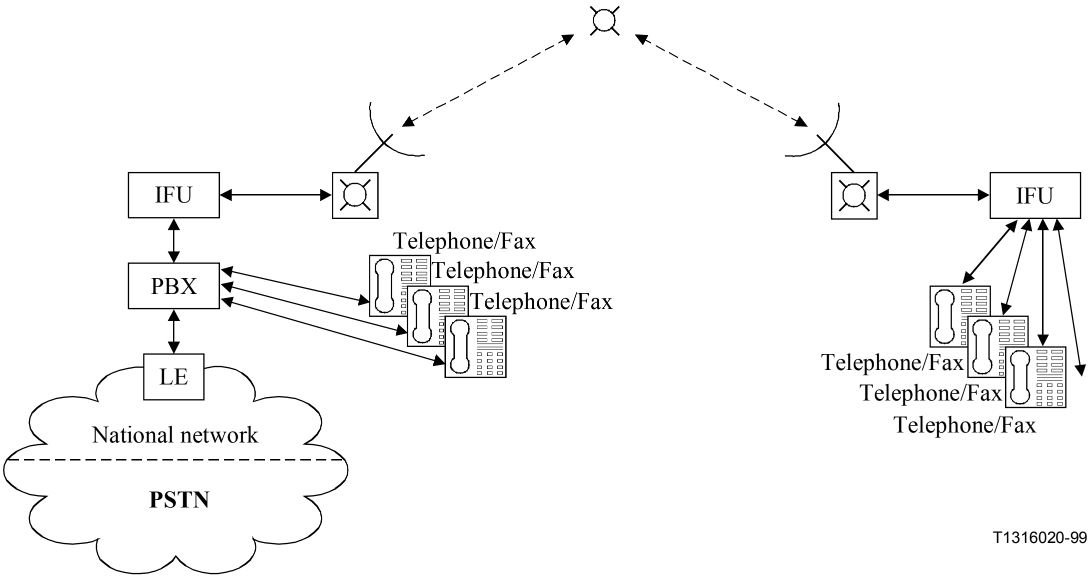


Figure 7/I.572 – Scenario 6: Local PBX

If the Local Exchange is of an older analogue design with limited monitoring and management capabilities, or if a private network is being connected, it may be preferred to parent the VSAT on a more modern digital PBX attached to the Local Exchange, e.g. to obtain more sophisticated OA&M.

7.6.1 Considerations relating to isolated digital transmission components

With this arrangement the transmission planning will have to recognize the extra losses and phase shift introduced by isolated digital items (digital islands).

Additionally, if the Local VSAT terminal presents an analogue interface to the PBX (this may be an unusual arrangement as both the VSAT and the PBX are digital) then the balancing of the various hybrids in the connection will be impacted as they will be affected by the analogue attenuation in the various connections and also by the phase shift through the 4-wire digital PBX switch. This phase shift of the reflected signal tends to corrupt the input impedance seen by the 4w/2w hybrid in the VSAT and the VSAT echo canceller in the Local Exchange IFU should be able to correct this short delay effect. A similar effect impacts on any hybrid balance as seen from the network side of the exchange although the magnitude is lessened by the loss in the 2-wire local cable from the Local Exchange to the PBX. This phase shift effect is often overlooked but it needs to be taken into account in the transmission planning for side-tone performance.

If the interconnection between the PBX and the VSAT is digital then all the signals on the VSAT side of the PBX would be in digital format but at some point it would be advisable to bring all these signals to a common encoding format to facilitate interconnection and maintenance. The details of such practical arrangements are outside the scope of this Recommendation.

The existence of local extensions on the PBX has been highlighted to point out that it would not be possible to simply mark all traffic from such an interconnection port as having already experienced a satellite hop.

The signalling between the Local Exchange and the PBX depends upon the technology of the two correspondents and is a national matter. If either one of them is based on analogue technology, then there is usually an in-band analogue signalling system employed. If both ends use digital technology, then an out-band signalling system based on an international signalling system or the ISDN method of signalling could be used. Standards for ISDN style signalling may be found in the ISO and ETSI.

7.7 Scenario 7 – PBXs at both ends

This scenario (see Figure 8) includes PBXs at both ends of the VSAT with the Local PBX connected to a public network.

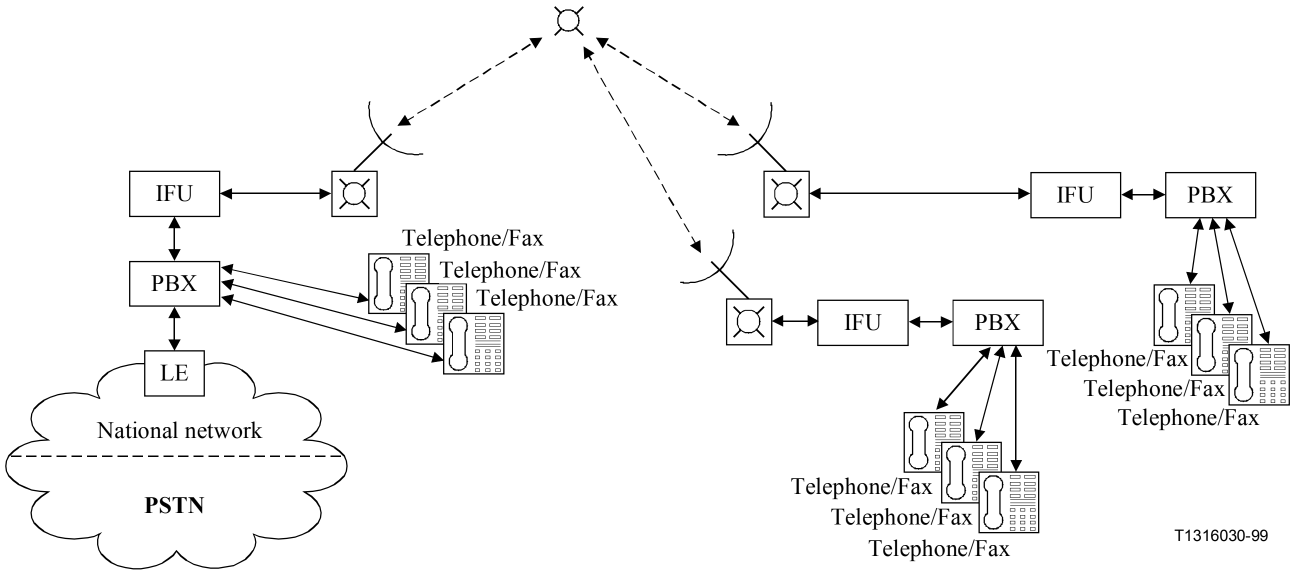


Figure 8/I.572 – Scenario 7: PBXs at both ends of the VSAT

The Transmission planning could probably assume a fully digital interconnection between the PBXs and the VSAT in such a large network.

The signalling system between the PBXs could be based on ISO standards with some small modification to exploit the broadcast capabilities of the satellite channel. One of the facilities of the signalling system should be to prevent calls being forwarded over the satellite when their target remote destination is busy.

Connections between different remote PBXs would be possible with only a single satellite hop if the signalling traffic was visible to all PBXs and they could orchestrate the choice of a voice channel from the VSAT multiplex between themselves and protect this voice channel from interruption. Then, some service could be maintained when one of the PBXs failed and even when the connection to the public network failed.

8 General issues

8.1 Transmission planning

The connection including its terminal equipment needs to be subjected to an overall transmission planning process as discussed in clause 13.

When two single terminal VSAT connections are interconnected via the Local Exchange, the propagation delay doubles but otherwise there should be no other problems. The situation is just the same as when an international call, that has been routed via a satellite, is connected to a VSAT Access connection.

8.2 Echoes

Echo cancellers would be required at both ends of the VSAT. The one near the Local Exchange needs the same performance as one employed on incoming international calls because it has to correct the same full range of national circuit echo delays. The canceller at the remote end could perform adequately with a smaller time span.

8.3 Digital encoding of voiceband signals

Digital voice encoding is employed within the VSAT and it is the responsibility of the VSAT to undertake the translation of its coding to either analogue or digital voice signals to match the needs of the interface.

Low rate voice encoding may be employed within the VSAT to increase capacity but the transmission quality and extra delay has to be considered in the overall transmission plan for this part of the Access network. Some low rate encoding is not transparent to facsimile and general data modem signals.

8.4 Remote station technology

The interface at the remote end of the VSAT would normally need analogue voiceband signals but it is not necessary in this Recommendation to limit the technological possibilities that might be exploited in such an isolated environment, i.e. the terminal equipment does not need to match that in the rest of the country.

8.5 Multiple public networks

Multiple connections to various public networks are possible with any of the scenarios. With this arrangement the Local PBX may undertake the selection of carrier networks or the remote user may still be able to choose by dialling extra initial digits. The PBX will isolate the management information of the VSAT from the public networks.

9 Interconnection policy

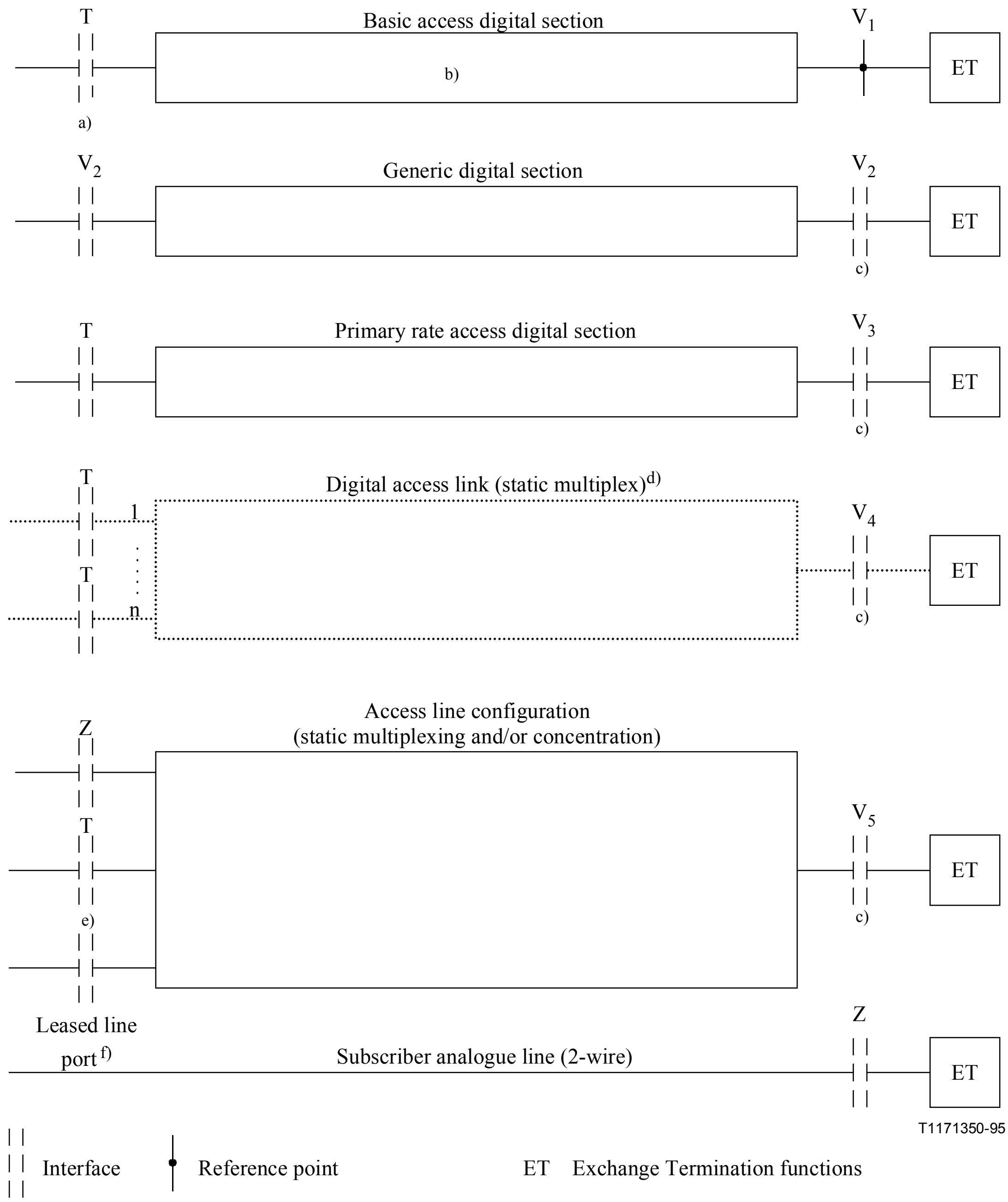
Many countries make a distinction between the "connection" to their public network and the "interoperation" of terminals across the network. This distinction clarifies the division of responsibilities between the network operator and the terminal retailer, namely, that the network operator is not responsible for the correct interoperation of two terminals across the network. Thus, the granting of permission to connect to a network does not offer any guarantee of correct performance to the end user. This is an example of the techno-regulatory environment which is different from country to country and with which terminal equipment suppliers must be fully conversant but which is well outside the scope of this Recommendation.

In all situations it is vital that the particular network operator be approached to obtain their requirements rather than relying exclusively on international or national standards.

10 Interconnection to National Telephone networks at the lowest level of the national transit network, the Local exchange

There is considerable variation in the values of the parameters of customer connections to Local Exchanges in different countries. The parameters involved in connecting to a telephone network are dependent upon the technology of the particular exchange to which connection is required but more standardization has been introduced with the change-over to digital operation of exchanges over recent years.

A classification of Exchange Interfaces for subscriber access is defined in ITU-T Recommendation Q.512 "Digital exchange interfaces for subscriber access" and analogue ports are also covered. Figure 1/Q.512 and Table 1/Q.512 are included here as Figure 9 and Table 1 to clarify the various types of exchange interface that may be encountered. For example, analogue ports are referred to as type Z interfaces and digital ports as type V interfaces.



a) Interface T is defined in ITU-T Recommendation I.411.

b) The characteristics of a digital transmission system on metallic local lines for ISDN basic rate access which may form part of the basic access digital section are defined in ITU-T Recommendation G.961.

c) The differences among V_2, V_3, V_4 and V_5 are essential multiplexing and signalling requirements. The transmission requirements are substantially identical (e.g. ITU-T Recommendations G.703 and G.704).

d) See information provided in "Background".

e) May be basic rate or primary rate access. Primary rate access only supported by $V_{5.2}$ interface.

f) For reserved connections established under control of the local exchange without control plane signalling between user and local exchange.

NOTE – Not all interfaces will necessarily exist in every implementation.

Figure 9/I.572 – Defined access configurations

Table 1/I.572 – Interface references

Access type	Interface/ reference points	Subclause	Related physical and functional Recs.	Related OAM Recs.	Application to connect
Basic access digital section	V_1	5.2	G.960[a]	M.3603	ISDN basic access (2B + D)
Generic digital section	V_2	5.3	G.703 G.704	None	Digital network equipment, supporting any combination of access types
Primary rate access digital section[b]	V_3	5.4	G.703 G.704 G.706 G.962 G.963	M.3604	ISDN primary rate access
Digital access link (Static multiplex)	V_4	5.5	Not subject to ITU-T Recommendations[c]		
Access network configurations	V_5	5.6	G.703 G.704 G.706 G.964 G.965	M.3603 M.3604[d]	A multiple of analogue subscriber lines, ISDN basic accesses and ISDN primary rate accesses with multiplexing and/or concentration capability for bearer channels
Generic analogue subscriber access	Z	6.1	None[e]	None	Analogue subscriber lines

a) ITU-T Recommendation G.961 specifies the characteristics of a digital transmission system on metallic local lines, which may form part of the basic access digital section.

b) In the case of ISDN access this is the primary rate access digital section.

c) See information in "Background".

d) For ISDN application through the V_5 interfaces.

e) Characteristics other than those defined in ITU-T Recommendations Q.551 and Q.552 are not subject to ITU-T Recommendations.

11 Local Exchange analogue ports

The analogue ports of Local Exchanges exhibit the widest range of variation. The operator of the network to which attachment is desired must be consulted to obtain the clearest understanding of their attachment requirements. For example, parameter values may be subject to variation due to traffic loading or environmental conditions on some older exchanges.

Considerable effort has been expended to bring some standardization to the definition of analogue ports (as distinct from physical modifications to the hardware of the network). The results for Europe may be found in ETSI Standard ETS 300 001 and several related ETSI Reports (ETR 075 and ETR 063) and for the United States in national standard ANSI T1.401.01.

11.1 Local Exchange basic parameters

Any LE analogue port has a set of basic interconnection parameters but the values of the parameters are technology/country/manufacturer/test-configuration/linecard specific.

The basic parameters are usually classified into d.c. & a.c. characteristics and Ringing, as follows.

d.c. characteristics

– Insulation resistance, Polarity sensitivity;

– d.c. Loop characteristics;

  Loop detection, Loop resistance tolerance, Loop current requirement, Battery support, Loop clearing conditions, Transient conditions;

– Overload susceptibility.

Ringing

– Ringing generator characteristics: voltage, waveform, cadence, variability, earthing/balance, overload, Ringing detection sensitivity, Ringer loading.

a.c. characteristics

– Input impedance, Balance, Transmission level, Receiver sensitivity, Noise and Distortion.

The precise definition and method of testing these characteristics vary from country to country but the details for the group of European countries that took part in the drafting of ETSI standard ETS 300 001 are given in Annex B, as an example.

11.2 Digital ports

The standardization of customer's digital ports by ITU is focused on the ISDN technology by clause 10/Q.512.

National specifications exist in a few countries such as the United States and the United Kingdom but these are considered to be outside the scope of this Recommendation.

12 Transmission planning

International transmission planning is introduced in ITU-T Recommendation G.101 "*The transmission plan*". Some Hypothetical Reference Connections (HRC or sometimes HRX) that may be derived from G.101 are detailed in ITU-T Recommendation G.103 "*Hypothetical Reference Connections*". This Recommendation includes the issues raised by the introduction of digital transmission and digital switching systems.

The transmission performance targets for National extensions of international connections are detailed in ITU-T Recommendation G.120 "*Transmission characteristics of national networks*". Transmission plans for internal national connections are outside the scope of ITU-T Recommendations.

A Recommendation on transmission planning that gives much more detail than the previous top level architectural Recommendations is ITU-T Recommendation G.116 "*Transmission performance objectives applicable to end-to-end international connections*" which provides guidance relating to analogue, digital, and analogue/digital terminal and network elements in hybrid networks. It recognizes private networks and digital cellular networks and that customers may provide their own terminals. It is further recognized that there is still a need to increment existing analogue systems.

Another Recommendation of importance to transmission planning is ITU-T Recommendation G.107 "*The E-model, a computational model for transmission planning*". This defines a mathematical model to determine the collective impact of multiple impairments on the end-to-end connection performance. It includes the important concept of "Expectation Factor" which recognizes the great desire for people in remote locations to have access to the international telephone network, the PSTN.

12.1 Introduction of VSATs into the Access network

Figures 10, 11, 12 and 13 show the inclusion of VSAT systems into the Access network as part of an HRX international connection as defined in ITU-T Recommendation G.103.

These figures demonstrate that VSATs (which are defined as digital systems in Recommendation ITU-R S.725) offer considerable reduction in the possible noise power and transmission loss accumulated by National connections when compared to existing FDM analogue circuits. This improvement will be at a maximum if the VSAT is interconnected to (parented on) a digital exchange that is digitally connected to a digital International Switching Centre (ISC). Thus, a VSAT can bring high quality connections to the remotest part of large countries.

If a VSAT has to be parented on a remote analogue exchange, then some of the potential saving in noise and transmission loss will not be obtainable. Wherever possible, the number of translations from digital to analogue format should be kept to a minimum to reduce the impairments caused by concatenated encoding/decoding processes.

It should be recognized that the removal of loss from a connection by digitization will in some circumstances raise the level of noise perceived by the end user during "silent" intervals, but the overall signal-to-noise ratio will improve.

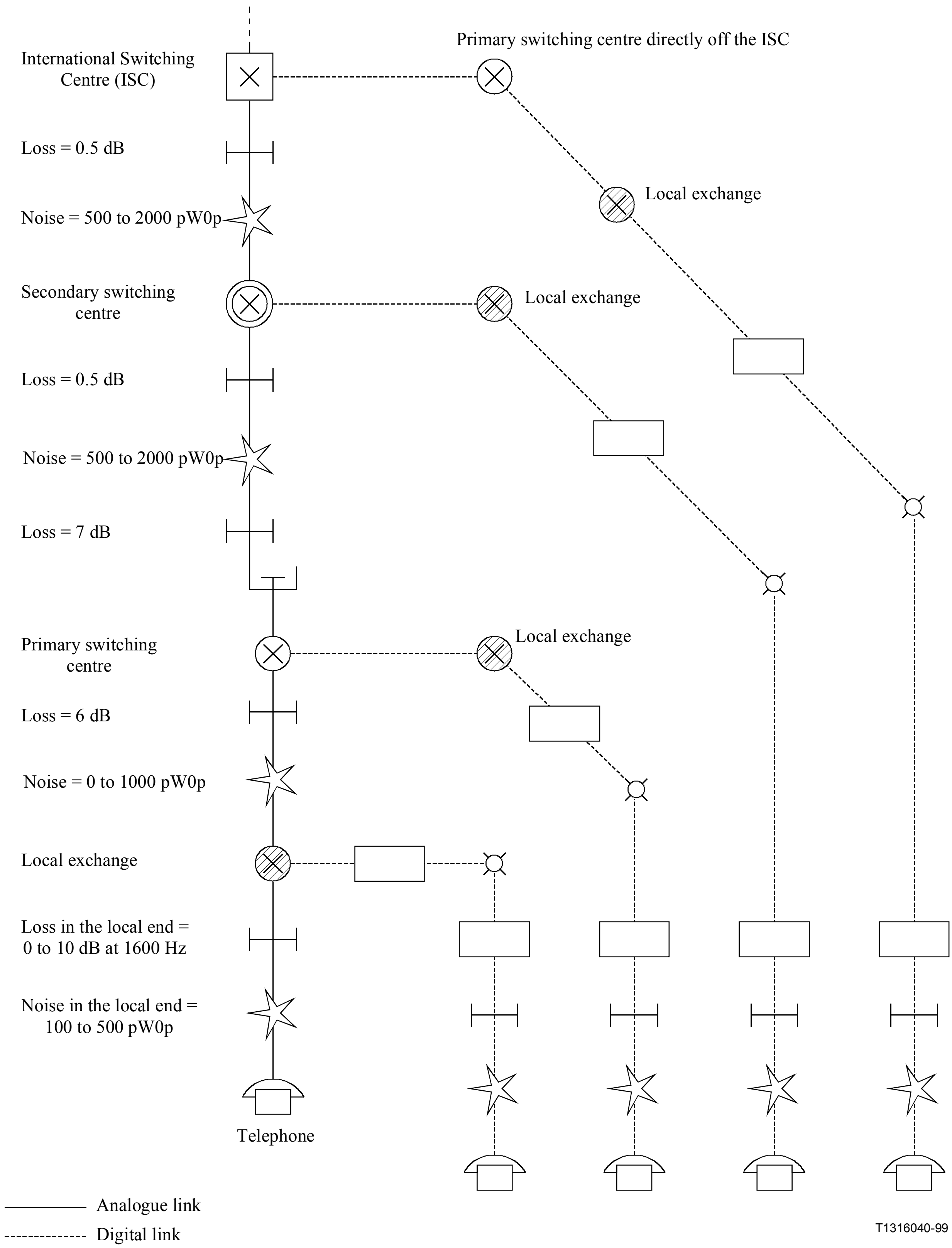
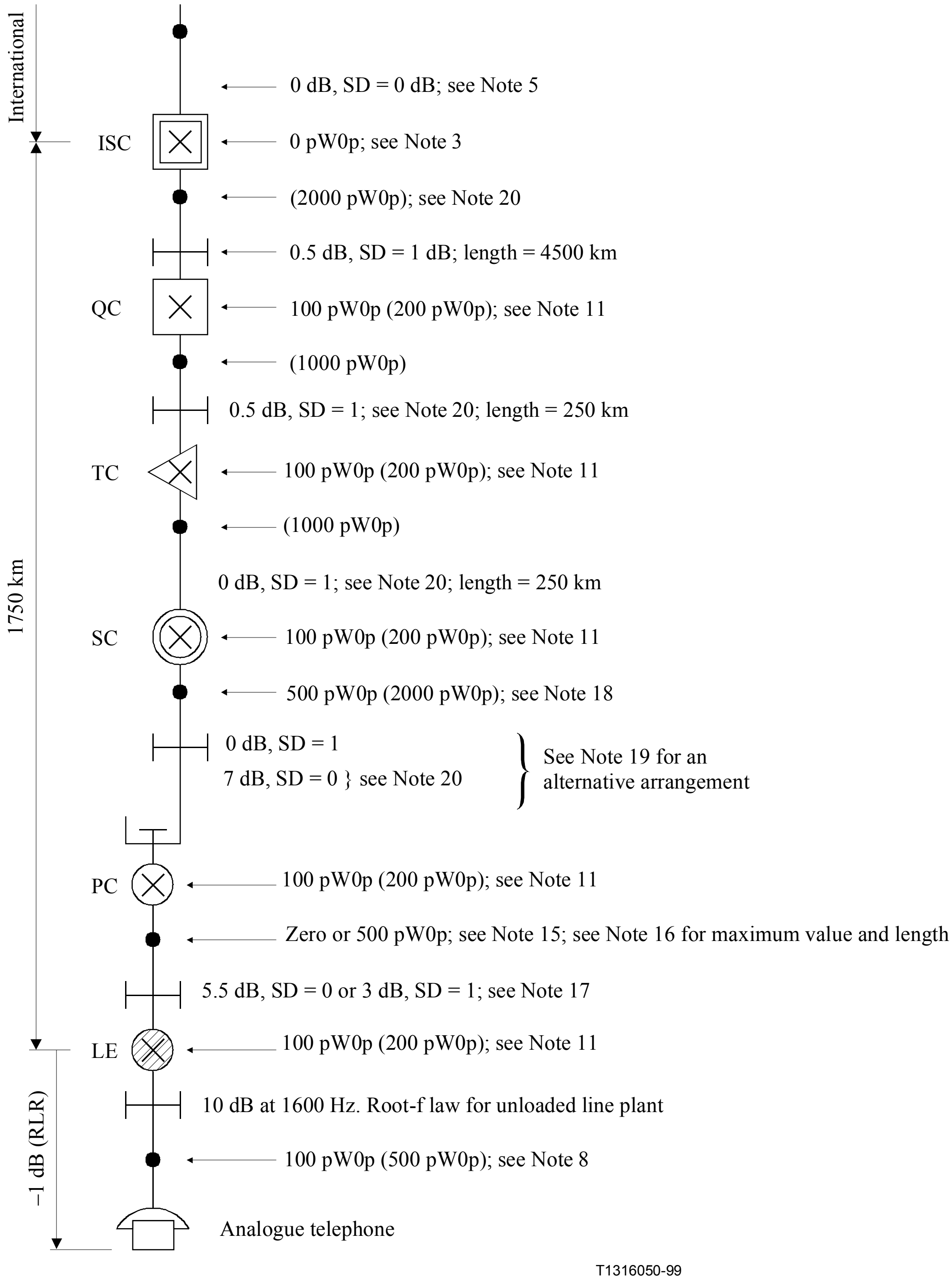
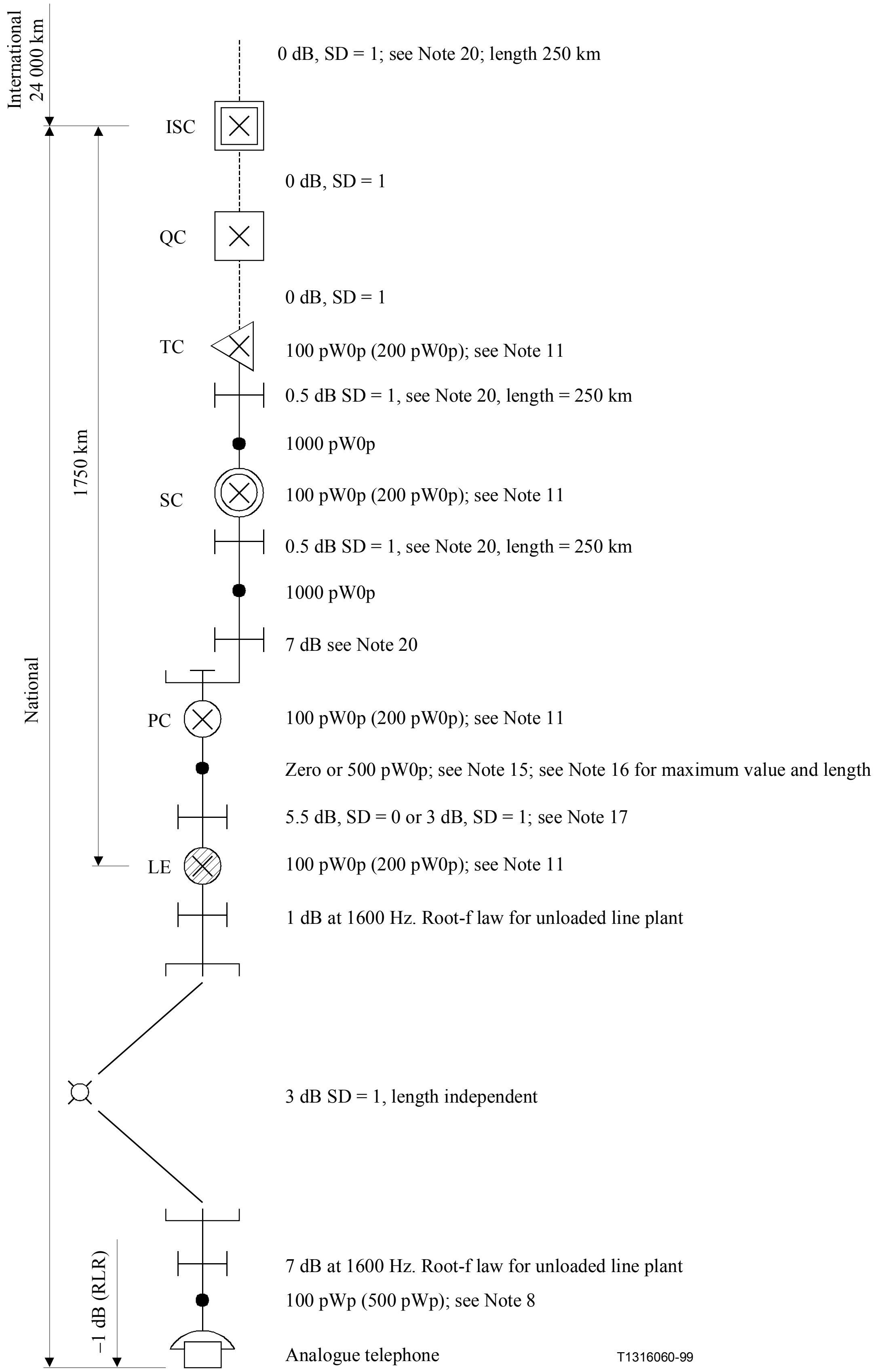


Figure 10/I.572 – Transmission plans showing alternative connection paths for VSATs



See ITU-T Recommendation G.103 for an explanation of the symbols, abbreviations and Notes.

Figure 11/I.572 – A hypothetical reference connection from ITU-T Recommendation G.103



See ITU-T Recommendation G.103 for an explanation of the symbols, abbreviations and Notes.

Figure 12/I.572 – A HRX with a VSAT in the Access portion

The HRX presentations in ITU-T Recommendation G.103 are rather compact and abstract so Figure 13 offers a translation into a more practical illustration of the noise saving available from the use of VSATs.

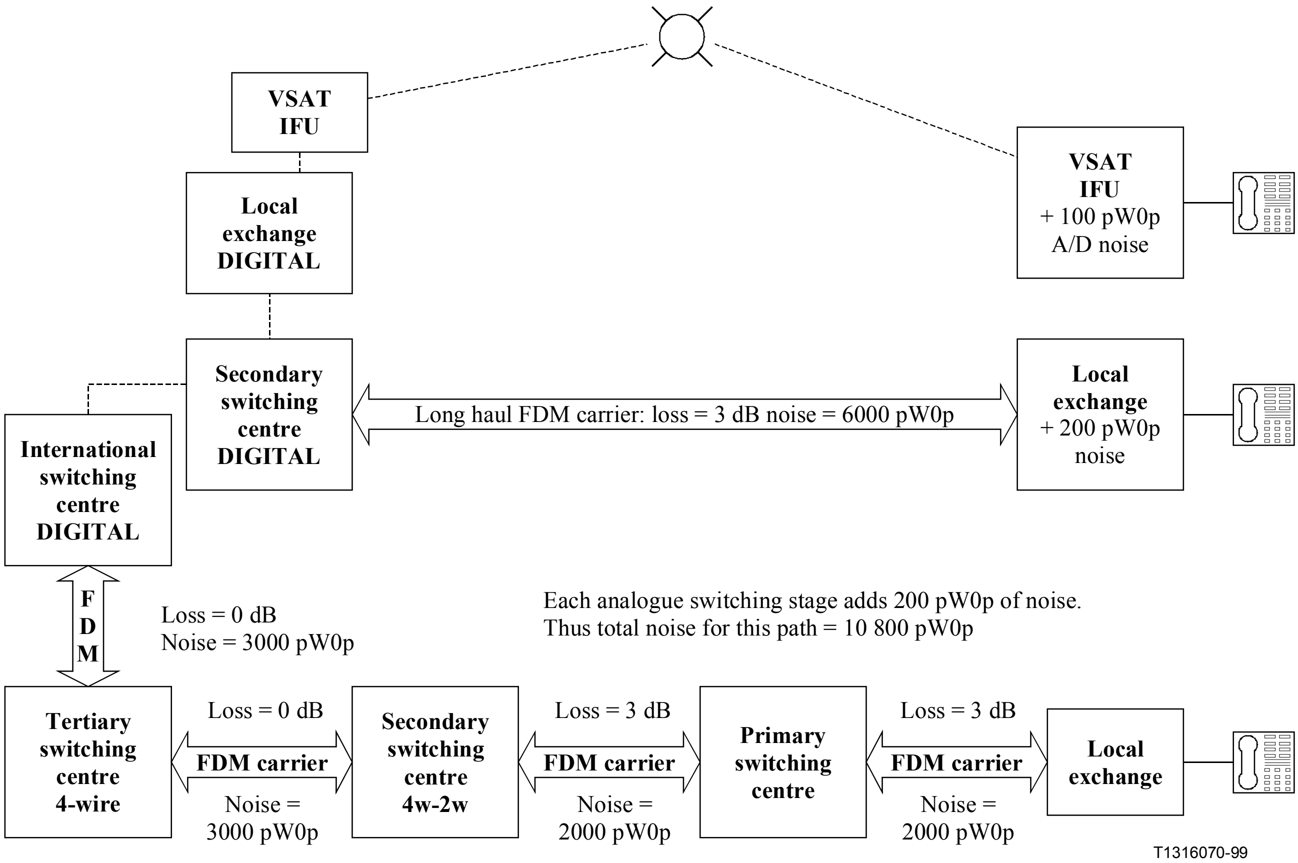


Figure 13/I.572

12.2 Transmission impairments

12.2.1 General noise and interference

The noise performance of National networks when connected to international facilities is defined in ITU-T Recommendation G.120.

Some countries require a maximum noise power of 100 pWp in the Access network but the maximum noise power given in ITU-T Recommendation G.120 is 500 pWp. The subject is complicated by the amount of digitization in the Access network. For example, the noise from an analogue exchange is allowed to be up to 200 pWp whereas a digital exchange will introduce quantization noise.

Out-of-band noise may also cause problems. For example the noise induced by power lines and the introduction of high-speed transmission technology into the copper Access network will increase crosstalk interference.

Any single tone or narrow-band noise component should be at least 10 dB below the overall noise power and preferably less than 15 dB lower. ITU-T Recommendation P.11 discusses the variation of noise level with time.

12.2.2 Quantizing noise

The quantizing noise performance is mainly determined by the first stage of A/D coding. This may be within the VSAT or an associated PBX. Further quantizing noise may be added by subsequent D/A-A/D conversions and any transcoding operations including digital attenuators and A-law to mu-law conversion and LRE operations. The accumulation of impairment may be calculated using the E-model technique defined in ITU-T Recommendation G.107 1998 version.

12.3 Transmission levels

12.3.1 The National Transmission Plan

The National Transmission Plan determines the range of signal levels at the terminal port of a Local Exchange. The VSAT system should comply with this transmission plan but higher losses may be acceptable if it is the only practical solution.

National Transmission Plans are based upon the requirement for an Overall Loudness Rating (OLR) for an international connection. The long-term and short-term targets for OLR, as determined by customer satisfaction trials, are given in ITU-T Recommendation G.111 "Loudness ratings in an international connection" and the corresponding Loudness ratings for National networks are given in ITU-T Recommendation G.121 "Loudness ratings for National Networks". Table 2 gives the target figures for Loudness Ratings.

Table 2/I.572 – Loudness Ratings for Transmission Plan Design

Country size	**Number of National Circuits in the 4-wire chain above the Primary Centre**	**Loudness Rating to the Virtual International Connecting Point Level = 0 dBr**						**Loudness ratings to the Virtual Analogue Switching Point Send Level = –3.5 dBr Receive Level = –4 dBr**	
		SLR	**Target SLR short term**	**Target SLR long term**	**RLR**	**Target SLR short term**	**Target SLR long term**	**SLR**	**RLR**
Average	up to 3	16.5	7-15	7-9	13	1-6	1-3	20	9
Large	4	17	7-15	7-9	13.5	1-6	1-3	20.5	9.5
Larger	5	17.5	7-15	7-9	14	1-6	1-3	21	10

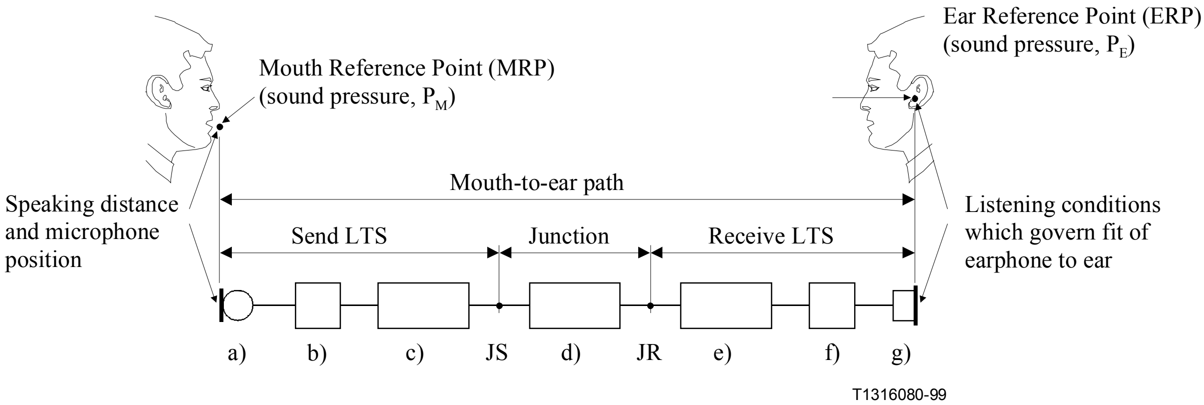
Table 2 illustrates that the national and international networks are in a state of change due to the upgrading of transmission systems to digital operation. Where possible, VSAT systems in the Access network should be designed to the long-term targets. If this is not possible then the short-term targets should be the second choice and only in extreme situations should the existing analogue targets be adopted.

The removal of loss by digitization can result in excessive signal levels in the international network and avoidance of this problem should also be part of the design process.

The speech signal level at the Local exchange port is dependent upon several variables; the sensitivity of the telephone transmitter circuit, the local line loss and the volume of the speech issued by the human speaker which is dependent to some extent upon the sidetone loss in the telephone set.

The "Loudness" at points in the transmission chain is calculated by using the concept of Loudness Ratings. This method replaces an older concept called Reference Equivalents (or Corrected Reference Equivalents when modified slightly).

Figure 14 is taken from ITU-T Recommendation P.76 "*Determination of loudness ratings; fundamental principles*" and shows the arrangement of elements employed in a telephony conversation.



a) represents the microphone of the sending local telephone system.
b) represents the electrical circuit of the telephone set of the sending local telephone system.
c) represents the subscriber's line and feeding/transmission bridge of the sending local telephone system.
d) represents the chain of circuits interconnecting the two local systems.
e) represents the subscriber's line and feeding/transmission bridge of the receiving local telephone system.
f) represents the electrical circuit of the telephone set of the receiving local telephone system.
g) represents the earphone of the receiving local telephone system.

Figure 14/I.572 – Elements of a telephone connection from a Loudness Rating perspective

Observations that assist with an appreciation of this diagram are:

– The "Junction" represents the chain of transmission systems between the local exchanges.

– The transmission loss of the Junction may be frequency dependent.

– There may be impedance miss-match at the junctions JS and JR because the image impedances on either side may not match, i.e. they may be complex impedances of non-complimentary phase and different magnitude.

The Overall Loudness Rating (OLR) measured from mouth to ear and expressed in dBs is given by the simple sum of the various elements, also expressed in dBs.

$$OLR = SLR + RLR + JLR$$

where:

SLR	Send Loudness Rating
RLR	Receive Loudness Rating
JLR	Junction Loudness Rating

The method of determining Loudness Ratings is given in ITU-T Recommendation P.64 "*Determination of sensitivity/frequency characteristics of local telephone systems*" and the calculations are explained in ITU-T Recommendation P.79 "*Calculation of loudness ratings for telephone sets*". The calculations are increased in complexity a little by the adoption of complex image impedances rather than simple resistive image impedances.

12.3.2 Selection of Loss in a VSAT system

With the assistance of ITU-T Recommendation P.79 plus the Loudness Ratings for the telephone sets in the country of interest and the national transmission plan it will be possible to calculate the signal level expected at the inputs to the VSAT system and the output levels required from the VSAT system. The final choice of levels is constrained by the stability requirement, for the worst-case international connection, but there should not be a problem if the end-to-end loss in the VSAT system is kept greater than 3 dB.

VSAT systems use digital transmission but they have analogue amplifiers at their inputs and outputs to allow adjustment of signal levels. When the VSAT employs 64 kbit/s PCM transmission as specified in ITU-T Recommendations G.711/G.712 they are inherently tolerant to a wide range of input signal levels without introducing excessive signal quantization noise (see Figure 15). Thus the signal levels do not require precise tuning. This is a considerable advantage when several local ends of differing length/loss have to be supported.

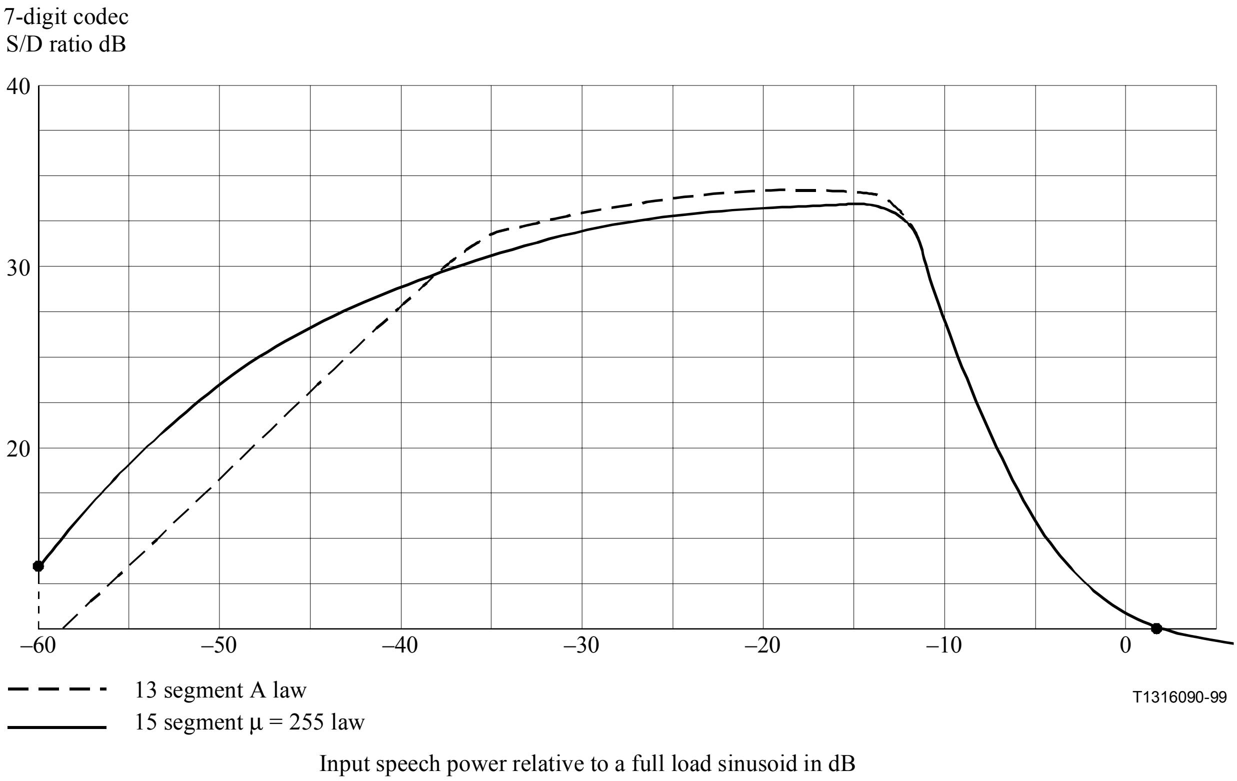


Figure 15/I.572 – PCM tolerance to a range of input signal levels

From Figure 15 it is apparent that the FDM input level (of –17 dB) would be satisfactory but it is not possible to take advantage of the speech activity factor to increase the level to –13 dB as PCM systems do not share the dynamic range of the transmission system in the same way as FDM systems.

12.3.3 Signal-to-Quantization Distortion ratio

The impact on the perceived quality of a telephone connection employing G.711 analogue to digital conversion is expressed in "Quantization Distortion Units" (qdu). A 64 kbit/s PCM system designed to ITU-T Recommendation G.711 introduces 1 qdu. A maximum of 14 qdus is allowed in an end-to-end international connection. Given that the majority of international connections are now fully digital there should be little danger of exceeding this limit by introducing VSATs in the Access network.

Digital attenuators introduce less than 1 qdu (0.7 qdu) but they also make it impossible to preserve bit stream integrity so they should be avoided if possible.

Other Low Rate Encoding coding schemes use Mean Opinion Scores (MOS) rather than qdus.

12.4 Attenuation frequency distortion

The attenuation frequency response is determined by the digital coding within the VSAT link. If this is 64 kbit/s then the frequency response is defined in ITU-T Recommendation G.711.

Some extra attenuation slope may be introduced by long lengths of local cable which have an approximately linear slope characteristic when root frequency is plotted against dB attenuation. These slopes may be equalized with advantage by a simple equalizer in the VSAT terminal equipment if care is taken not to amplify noise outside the voiceband.

12.5 Group delay frequency distortion

The Group delay frequency distortion is determined by the digital coding within the VSAT link. Simple pair cable does not introduce significant group delay distortion at voiceband frequencies.

12.6 Crosstalk

Crosstalk is a particularly important issue in the Access network where privacy between people who live close together must be protected.

Analogue to digital encoding can amplify low level signals from an insignificant level to the magnitude of the smallest digital step which might be sufficient to make the crosstalk intelligible unless special precautions are taken. A typical precaution to mitigate this effect is the introduction of a low level noise signal to break up the polarity quantization of the crosstalk. The noise is of such a low level that it is not necessary to try to remove it at the receive end. Such a precaution may not be needed in an urban environment with an adequate level of electrical noise but it may be advisable in a rural situation that is electrically quiet.

The crosstalk may arise between any two (or more) circuits including those outside the scope of the VSAT system.

For the purposes of this application the crosstalk performance targets within the VSAT system are taken from ETSI I-ETS 300 005. There are no special crosstalk pathways within the VSAT system because it is a fully digital transmission system.

12.6.1 Crosstalk parameters

Crosstalk measurements use auxiliary signals as indicated in the following figures. These signals are: the quiet PCM code which represents the value 1 with a fixed sign; and a low level activating signal. Suitable activating signals are, for example, a band limited noise signal (see ITU-T Recommendation O.131), at a level in the range –50 to –60 dBm0 or a sine-wave signal at a level in the range from –33 to –40 dBm0.

12.6.1.1 Far-end and near-end crosstalk measured with an analogue test signal

A sine-wave test signal at the reference frequency of 1020 Hz and at a level of 0 dBm0, applied to an analogue 4-wire input interface, shall not produce a level, measured selectively, at either output of any other half connection exceeding –73 dBm0 for a Near-End CrossTalk (NEXT) path and –70 dBm0 for a Far-End Crosstalk (FEXT) path. These paths are shown in Figure 16.

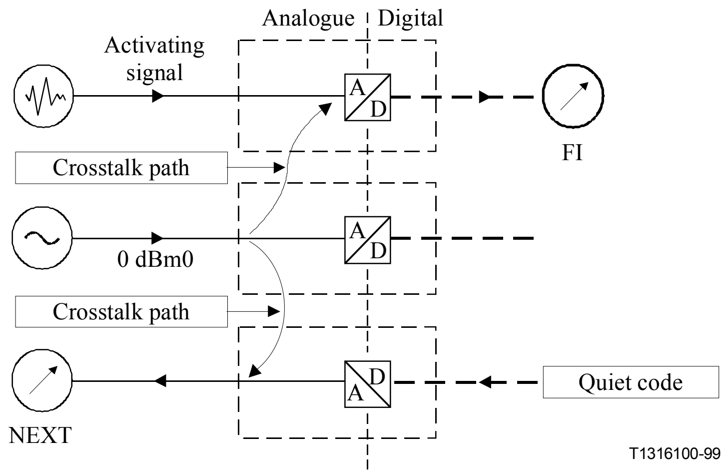


Figure 16/I.572 – Measurement with an analogue test signal between different input connections of half connections

12.6.1.2 Go-to-return crosstalk

A sine-wave test signal at any frequency in the range 300-3400 Hz and at a level of 0 dBm0, applied to the 4-wire interface of an input connection, shall not produce a level exceeding –66 dBm0, measured selectively, at the analogue output of the same half connection. See Figure 17.

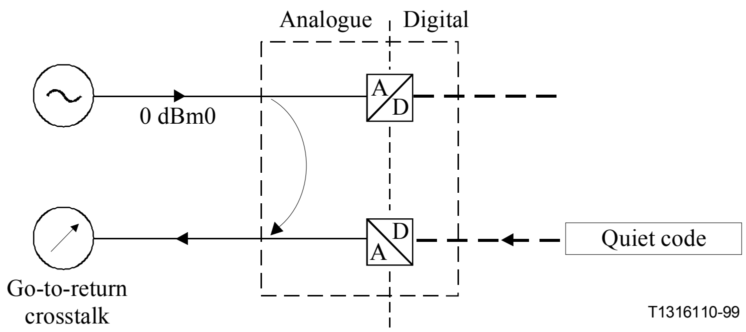


Figure 17/I.572 – Measurement with an analogue test signal between go and return directions of the same half connection

12.6.1.3 Far-end and near-end crosstalk measured with digital test signal

A digitally simulated sine-wave test signal at the reference frequency of 1020 Hz and at a level of 0 dBm0, applied to any VSAT port shall not produce a level exceeding –70 dBm0, measured selectively, for Near-End Crosstalk (NEXT) or –73 dBm0 for Far-End Crosstalk (FEXT), at either output of any other half connection. See Figure 18.

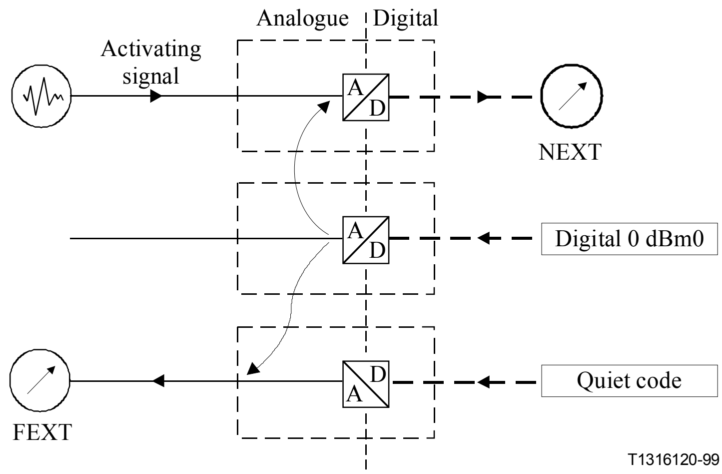


Figure 18/I.572 – Measurement with a digital test signal between different output connections of half connections

12.6.1.4 4-wire ports Go Return Crosstalk

A digitally simulated sine-wave test signal, at any frequency in the range 300-3400 Hz and at a level of 0 dBm0, applied to a VSAT 4-wire digital input port, shall not produce a crosstalk level exceeding –66 dBm0, measured selectively, at the corresponding digital output port. See Figure 19.

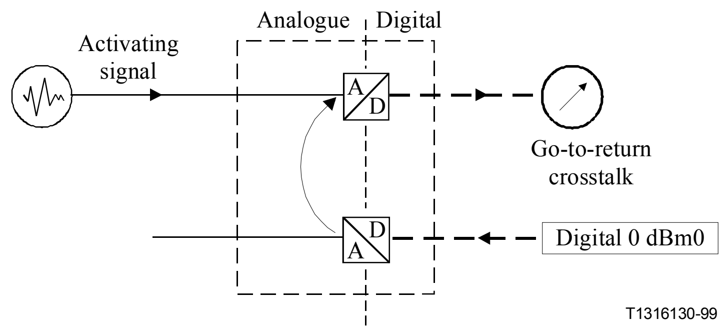


Figure 19/I.572 – Measurement with a digital test signal between go and return directions of the same half connection

12.7 Stability

Stability planning is derived from ITU-T Recommendation G.122 "*Influence of national systems on stability and talker echo in international connections*". Associated ITU-T Recommendations are G.126 "*Listener echo in telephone networks*", G.131 "*Control of talker echo*" and Recommendations on echo cancellers G.165 and G.168.

The introduction of VSAT systems into the Access network should not make it necessary to reconsider the stability criterion for the National network. For example, if the interface is 2-wire, then the stability situation is probably improved as an echo canceller is automatically included in the VSAT where there might not have been an echo canceller provided previously.

The inclusion of a VSAT link in the chain of circuits which makes up an end-to-end international connection should not present any particular problems as it will include echo cancellation and should perform in just the same way as another long distance amplified link in the international portion of a connection.

The performance of echo cancellers employed in the PSTN side of the VSAT system shall meet the limits specified in ITU-T Recommendation G.168 "*Digital network echo cancellers*". The echo canceller at the remote end of the VSAT need not have such a large time span but economics will probably dictate that the same type of echo cancelling will be deployed.

General stability planning calls for avoidance of instability during set-up, clear-down and changes in a complete connection (e.g. call-transfer).

Signalling and switching systems have an influence on the loss under set-up and clear-down conditions. For example, in some systems, 4-wire registers control the set-up and do not establish the 4-wire path until the answer signal is successfully received. In others, circuits are released immediately if busy conditions are encountered. In these circumstances the risk of oscillation does not arise.

ITU-T Recommendation Q.32 describes methods of securing an adequate loss of a national system before the called-subscriber answers (i.e. while ringing tone is transmitted) or if busy or number unobtainable conditions are encountered.

In general, it is safer to assume that there is no balance return loss provided by the called local telephone circuit (if 2-wire). In this case the necessary loss must be provided by the transmission losses in the national system.

The stability of international telephone connections at frequencies outside the band of effectively transmitted frequencies (i.e. below 300 Hz and above 3400 Hz) is governed by the following transmission losses at the frequencies of interest:

– the balance return loss at the terminating units;

– the transmission losses of the terminating units;

– the transmission losses of the 4-wire circuits.

Conditions which only last for a few tens of milliseconds can be left out of consideration because in such a short time oscillations cannot build up to a significant level.

The stability limit may be met, for instance, by imposing the following simultaneous conditions on the national network:

1) The sum of the nominal transmission losses in both directions of transmission measured between the 2-wire input of the terminating set and one or other of the virtual switching points on the international circuit, should not be less than $(4 + n)$ dB, where n is the number of analogue or mixed analogue-digital 4-wire circuits in the national chain.

2) The stability balance return loss at the terminating set should have a value not less than 2 dB for the terminal conditions encountered during normal operation.

3) The standard deviation of variations of transmission loss of a circuit should not exceed 1 dB.

With $n = 4$ the mean value becomes 10 dB and the standard deviation 4 dB.

Wholly digital circuits may be assumed to have a transmission loss with a standard deviation equal to zero. Analogue to digital coders are expected to offer much smaller variations in transmission loss than FDM carrier circuits.

The subscriber's apparatus (telephone, modem, etc.) in the local telephone circuit are assumed to be "off hook" or equivalent, and thus providing balance return loss. In practice, the distribution of stability balance return loss is distinctly skew, most of the standard deviations being provided by values above the mean. It could be unduly restrictive to assume a normal distribution.

Echo cancellers according to ITU-T Recommendations typically require 6 dB of signal loss for the *actual* signal converging the canceller. This signal loss is the ratio of incident to reflected signal power on the return path. The value of signal loss will depend both upon the loss of frequency response and the signal spectrum. Therefore, it is desirable from a performance point of view that the stability loss during an established connection should be at least 6 dB, since this will ensure proper operation for any signal (frequency spectrum) in the band 0-4 kHz.

ITU-T Recommendation G.175 provides guidance on the stability planning for Private networks.

Improved balance return losses can be obtained when the local exchange uses 4-wire switching and the local line is permanently associated with a dedicated 2-wire/4-wire conversion unit and its balance network (see ITU-T Recommendation Q.552 for examples). When there is 2-wire switching, a compromise balance network must be used.

4-wire handset telephones can contribute significant acoustic echo. Hence in some circumstances (low transmission loss, long delay times) echo control devices may be needed.

The allocation of the total response between send and receive is not critical and any reasonable division may be used provided that:

– excessive interchannel interference is avoided in national transmission systems due to an unrestricted spectrum of the transmitted signal;
– unwanted signals that may give rise to errors, e.g. hum, circuit noise, carrier leak signals, are prevented from entering the receiver.

12.8 Echo considerations

The VSAT shall be equipped with echo cancellers so that many of the echo/stability considerations raised by other types of amplified circuits which approach marginal delay durations are avoided.

Noise considerations of echo cancellers

Some echo cancellers introduce low-signal suppression instead of trying to cancel the unwanted echo very accurately. This may mean that the noise level drops so low that the customer thinks that the circuit has been disconnected and hangs up. One method of avoiding this misunderstanding is to insert a "comfort noise". This facility might be considered advisable for customers who are not highly experienced in the operation of telephone systems.

12.9 Clipping

There are several forms of clipping:

– front-end clipping which may occur when multiplexing systems are overloaded;
– temporal-clipping where small durations of the voice signal are lost due to a loss of packets/cells in a packet/cell based transmission systems; and
– power-level clipping where the signal exceeds the dynamic range of the equipment.

12.9.1 Front-end clipping

When a multiplexing system has too many demands for channel capacity there are several ways of temporally increasing the carrying capacity, e.g. reducing the number of bits allocated per channel. However, if this is insufficient then there is usually a loss of the first part of the voice burst.

12.9.2 Temporal clipping

Transport systems that packetize the information they carry into X.25 Packets or ATM Cells or FMBS Frames or other units (IP) may loose complete packets when an error is injected into the transmission system. Such systems should be designed to avoid breaks greater than 64 ms and breaks below 64 ms should be less than 0.2 per cent of active speech (ITU-T Recommendation G.116).

12.9.3 Power level clipping

Peak clipping of a speech signal is not very significant if it is not too excessive.

13 "Permission to Connect" requirements for private networks

The technical requirements for obtaining "Permission to Connect" to a public network are a national matter but they will most probably include compliance with a Safety regulation and an EMC regulation as well as requirements similar to those detailed in the annexes of this Recommendation. Attachment approval does not usually imply any guarantee of satisfactory operation other than possibly minimal telephone communication to the Emergency services.

In addition to the technical requirements there will be other Regulatory requirements to satisfy. These are well outside the scope of this Recommendation.

14 Remote terminal penetration enhancement techniques

The distant end user's terminal may not be co-located with the VSAT earth station and some significant length of landline may be involved in completing the connection.

It has been assumed in this Recommendation that the Local VSAT earth station is connected to the public network via a good quality connection that has only a small loss and distortion thus leaving the maximum margins for deployment at the distant end.

Local exchange line extension techniques can be employed to increase penetration from the distant end of the VSAT system, e.g. higher battery voltages, loading coils, more sensitive telephones, or telephones with adjustable sidetone losses to encourage louder speech.

The use of 1+1 carrier (non-companded, for data transparency) or other amplified systems would not appear to be economic as it would be simpler to move the VSAT earth station closer to the end user, assuming that power supplies were available nearer to the end user.

15 Management

15.1 Operations and maintenance

Due to the remoteness of the locations that are suitable for VSAT deployment it is anticipated that O&M facilities will include the ability to undertake remote measurements of the performance of the VSAT link and remote control of the Transmitter function at the distant end to minimize radio interference if a fault should occur. Local technical support will not usually be available and visits by specialist personnel will be slow and expensive.

This remote facility would require a separate management channel in addition to the voice signal channel.

16 Availability

Availability should be designed to be high, as such a connection would be very important and difficult to repair. The availability of VSAT links is generally quite good but the robustness of the physical components at the earth stations needs to match their environment.

17 Commissioning

Systems employing 2 Mbit/s or higher radio channels may use the commissioning tests given in ITU-T Recommendation M.2101. These are intended for commissioning transmission systems carrying core network traffic and therefore may be considered too stringent for the Access network but as this particular application will probably be providing the only connection to a remote community, then a high quality Access connection may be justified.

18 Numbering issues

A network operator may wish to indicate to a caller that the destination is only contactable via a satellite. This could be done by allocating a special number range to VSAT connected terminals but as the number of such connections is probably going to be very small this approach would sterilize a large number of numbers.

Calls from remote VSAT terminals could be marked by the LE as having already experienced one satellite delay. This would assist subsequent exchanges to avoid further satellite hops but this depends upon the Local Exchange having sufficient intelligence.

The VSAT shall be transparent to all tonal DTMF combinations as defined in ITU-T Recommendation Q.23 at all appropriate stages of the call, i.e. during call establishment and conversational voice communication.

19 The Network Operator's perspective

19.1 Billing

FFS.

19.2 Routine testing

The VSAT could provide the normal reaction to a routine test but would this indicate that the whole system right through to the remote terminal was working or just that the local VSAT terminal was still attached.

19.3 Payphone support

Support facilities for payphone operation may be required in some installations. For example, an ability to signal a reversal of line polarity to the remote terminal to initiate charging.

19.4 Call set-up times

The call set-up time shall not be increased by more than 2 seconds when compared to a local land line connection.

19.5 Special services support

Emergency service access may be supported but the possibly large geographical separation from the source of any assistance will need to be taken into account by the emergency service answering such a call. Therefore perhaps such calls should be given a special marking to advise the emergency operator that special procedures need to be followed.

ANNEX A

Organization of annexes

The annexes contain the details of the interface specifications and therefore tend to be rather large.

ANNEX B

The analogue 2-wire port facing the exchange within Europe

B.1 Introduction and methodology

To define an analogue port to an analogue telephone network is a complex matter because such a network does not have a natural interface at this point. It is designed to operate as a single entity including its terminals. An Exchange operates by sharing limited resources between thousands of customers and providing a fair balance of quality of service to each one. For example, batteries have limited capacity, ringers have limited capacity, cables have crosstalk and noise and overload will pollute the general infrastructure and will disturb all users.

The definition of telephony analogue ports has been studied extensively within Europe by ETSI so their standard ETS 300 001 has been taken as the model for the descriptions given in this annex. However, it should be recognized that this Recommendation deals with the connection of a type of local-line extender equipment and not with domestic terminals, i.e. the ETS deals with the definition of the terminals whereas this Recommendation deals with the interconnection of two networks.

It should be noted that in some countries this type of interface still has some lack of clarity as to where the public network operator's responsibilities stop and the customer's network responsibilities takes-over, depending upon the national Regulatory regime.

B.2 Identification of the states of the Terminal Equipment (TE)

B.2.1 TE allowed basic states

– quiescent state;
– off-hook condition;
– dialling state;
– interdigit state;
– communication state;
– ringing state;
– transitions between these states.

In addition to these basic states the following variants are recognized:

– Idle Line Signalling;
– Automatic line seizure;
– Automatic dialling;
– Register recall;
– Automatic answering;
– Subscriber metre pulse reception;
– Power failure.

B.2.1.1 The quiescent or idle state

The quiescent or idle state is defined as a state where the TE is connected to the network but it draws minimum current and does not activate the exchange. It is a High impedance state.

B.2.1.1.1 The Idle Line Signalling state

The Idle Line Signalling state is when a TE is capable of receiving or sending speech-band signalling without entering the loop state. A TE will normally enter the Idle line signalling state from the idle state in response to a wake-up signal received from the network, and will return to the idle state on completion of idle line signalling. The wake-up signal is either a pulse of ringing current or a reversal of the line polarity followed by a tone or combination of tones.

B.2.1.2 Loop state

The Loop state is entered when a TE draws enough d.c. current to activate the exchange. This is also called the Off-hook condition. This state commences when the TE has reached the appropriate stationary d.c. resistance level to result in a line current, which activates the exchange. The state ends with the transition to the dialling state or the quiescent state.

NOTE – Usually, the TE in loop condition is potentially capable of sending or receiving speech-band information to or from the network.

B.2.1.2.1 Automatic line seizure state

Automatic line seizure refers to seizure of the line without manual support or supervision.

B.2.1.3 Dialling state

The Dialling state is entered when a TE passes to the network break pulses or MFPB signals from the beginning to the end of the transmission of dialling information (digits and interdigit pauses).

B.2.1.3.1 Interdigit state

The interdigit state commences on conclusion of the emission of one digit and ends when emission of the next digit commences or with the beginning of the communication state, as appropriate.

B.2.1.3.2 Register recall state

The Register recall state is entered when a TE passes to the network a register recall signal.

B.2.1.3.3 Automatic dialling state

Automatic dialling is the process whereby the dialling information is transmitted after seizure of the line without manual support or supervision.

B.2.1.4 The Communication state

This commences after the end of the dialling state in the case of an outgoing call. The dividing lines between the interdigit state and the dialling state and the interdigit state and the communication state are indefinite.

This state also commences after answering of a call, in the case of an incoming call. This state ends with the transition of the TE to the quiescent state.

During this state speech-band signals may be exchanged. The speech-band is defined as the 300-3400 Hz frequency band. This band is also referred to as the voiceband.

B.2.1.5 The Ringing state

The ringing state commences from the quiescent state with the reception of the first ringing signal and ends with the answering of the call or when no further ringing signals are received.

B.3 d.c. characteristics

B.3.1 Contents

- Polarity
- Insulation resistance
  - TE in quiescent condition
    - Line terminal to line terminal
    - Line terminals to signal earth
    - Line terminals to user accessible parts
  - TE in loop condition
    - Line terminals to signal earth
    - Line terminals to user accessible parts
    - d.c. current and loop resistance
    - Transient response of loop current
    - Quiescent to loop state
    - Loop current transfer
    - Series resistance
- d.c. overload susceptibility

B.3.2 Central Battery Exchange Systems

Telephone networks in Europe employ central battery exchange systems to ensure the availability of the telephone service, or a minimum set of it, when the public electricity power supply fails.

The energy to power the telephones in houses and offices is supplied from the exchange battery which can support the normal service load for periods depending upon the speed of response of mobile generator sets held on standby by the network operator. A period of 24 hours is typical but most exchanges have means of shedding customer's lines, down to emergency lines only, in which state the battery will last much longer.

In the communication state the d.c. power has to be fed out to the telephone at the same time as voiceband signals are passing through the exchange. This is achieved by the transmission bridge as shown schematically in Figure B.1.

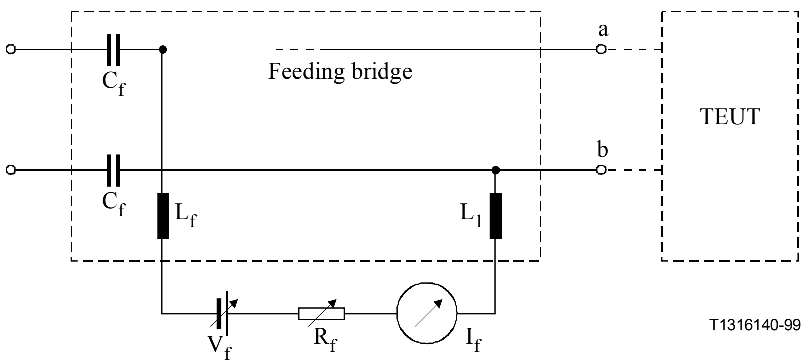


Figure B.1/I.572 – Typical d.c. feeding and transmission bridge circuit

To deduce the d.c. conditions at a customer's premises served by such an exchange given the variability introduced by the differences in the local lines it is more realistic to simply explain the chain of components involved in the access connection and then to define each component. Thus this section defines such things as battery voltage, maximum allowable line resistance (to ensure a minimum loop holding current) and the values of the transmission bridge components.

B.3.2.1 d.c. feeding arrangements

The d.c. feeding arrangements differ for each Administration but generally are of a similar nature to that given in the Idealised Feeding Bridge illustrated in Figure B.1.

The feeding resistance R_f includes the resistance of the inductor L_f. The standard values of inductors L_f and capacitors C_f for each national Administration are in Table B.1.

B.3.2.2 Battery voltages employed within Europe

There are several different battery voltages used within Europe and different voltages may be found within countries as well as between countries.

In addition to the voltage differences, the resistance of the transmission bridges also varies, as does the minimum holding current requirement.

Table B.1/I.572 – Exchange d.c. parameters

Country	Exchange voltage	Normal voltage variation	Extreme voltage excursion
Austria	60		72
Belgium	48	44.5-53	
Bulgaria	48 60	44-48-52 54-60-66	
Cyprus	48	43-53	
Czech Republic	48 60	43-48-58 54-60-66	
Denmark	50	44-56	
Finland	50	44-58	
France	50 94	45-54 86-104	56
Germany	60		
Greece		44-66	
Hungary		48-60	
Iceland		43-56	
Ireland	48		
Italy	48	44-52	
Luxembourg	60		
Netherlands		42-66	
Norway		24-60	
Poland	48 60	+6v –5v ± 6v	
Portugal		45-55	

Table B.1/I.572 – Exchange d.c. parameters *(concluded)*

Country	Exchange voltage	Normal voltage variation	Extreme voltage excursion
Slovenia	48	45-53	
Spain		43-56	
Sweden			
Switzerland	Remote equipment Const Current feed in speech state	None-constant supply during idle	60 75
United Kingdom	50		

B.3.2.3 Battery polarity at the line terminals

All countries in Europe agree that all the requirements placed upon the TE shall be met independently of the polarity of the d.c. voltage at the line terminals of the Terminal Equipment Under Test (TEUT).

B.3.3 Insulation resistance

The TEUT shall not be modified in any way before this test.

B.3.3.1 TE condition

The requirements shall be met, when the TEUT is in the quiescent condition and after the TEUT has had each test voltage, up to the declared value of V max, applied for a time sufficient to allow transient effects arising from the application of that test voltage to be absent.

B.3.3.2 Requirements

Resistance between the two line terminals to be connected to the network, R1 (Mohms),

Resistance between the line terminals shorted together and any signal earth terminals, R2 (Mohms),

Resistance between the line terminals shorted together and all user accessible parts of the TE, other than earth or signal earth terminals, R3 (Mohms).

B.3.3.2.1 Required values

R1 = **1, 3 or 5** (Mohms);

R2 = **1, 5, 10 or 100** (Mohms);

R3 = **5, 10 or 100** (Mohms): This parameter should be part of the safety requirements say some countries.

Test voltages 100, 200 or 250 V d.c.

In countries where it is permitted to take some small value of power from the exchange on a permanent basis then the loop insulation resistance is a function of the allowed bleed current. This is usually defined in terms of the Ringer Equivalent Number (REN) of the TEUT. The current drawn by the TEUT shall be not greater than (30 × REN) μA or, where the REN = 0, it shall not be greater than 5 μA.

B.3.3.2.2 Ringer equivalent number

The REN of a TE is a parameter, which allows the numbers of items of TE that can be connected in parallel on a single port to be calculated. REN = 1 is a simulated standard bell consisting of an inductor of 55 H in series with a resistor of 7 kohms.

The maximum REN loading of a single line is usually 4.

Thus, the higher the REN of a TE, the lower its impedance at ringing frequencies, the lower its insulation resistance between the line terminals, and the greater the permissible leakage current drawn in the quiescent state.

A supplier may declare the REN of an item of TE to be greater than its measured value in order to prevent other items of equipment from being connected in parallel with it, or to be allowed to draw a greater quiescent state line current than would be otherwise permitted.

In some countries whilst in the idle line signalling state the TE may draw current from the network up to a maximum total current of 2.5 mA irrespective of the number of TEs. Optionally, when entering the idle line signalling state, the TE may draw a current in excess of that specified above to ensure the continuity of the circuit. Commencing 20 ms ± 5 ms from the end of the wake-up signal the current should rise to any valid loop state current but it should not exceed 25 mA for not less than 5 ms and not more than 16 ms. The timing constraints are intended to ensure that parallel connected TE do not apply current pulses sequentially and thereby generate a false loop state indication to the network.

B.3.3.2.3 TE in loop condition

The requirements shall be met after the TEUT has been placed in the loop condition and after a test voltage up to V max. has been applied for a time sufficient to allow transients to settle.

B.3.3.2.3.1 Resistance between each of the line terminals and the signal earth terminals and resistance between each of the line terminals and all user accessible parts of the TE, other than any earth terminals

This requirement is considered to be part of the safety requirements by many countries.

In some countries these are not mandatory requirements. A figure of 10 Mohms at a test voltage of 100 V d.c is acceptable.

B.3.4 d.c. conditions in the loop state

B.3.4.1 d.c. line current range, Transmission Bridge Components and allowed Loop d.c. resistance

In the loop or off-hook state, a terminal in any given country will have to tolerate the d.c. conditions indicated in Table B.2. For attachment approval, a TE will have to comply with the requirements for any given country, including items such as d.c. masks, which include a requirement for positive incremental resistance for all values of line current.

Table B.2/I.572 – d.c. conditions

Country	Allowed loop resistance (ohms)	Loop current range (mA)	Transmission bridge parameters		
			Resistance Ω	Inductance H	Capacitance µF
Austria		19 .. 60		≥5	47
Belgium	1365	25..120	360	5	20
Bulgaria	1200	20 .. 60	1000	50	5
Cyprus	1340	20 .. 100	400	4	2
Czech Republic	1600	0 .. 50	600	>4	>2
Denmark	1900		500	>2	>2
Finland		20 .. 50	800	2	>2
France	1100 1560		300 1400	100	5
Germany		20 .. 60	500 + 500	47	5
Greece		20 .. 80		20	5
Hungary	1960		440	>10	>5
Iceland		14 .. 70	800	>2	>2
Ireland	5000	18 .. 80	0	470	10
Italy	1160		720	2	>1
Luxembourg		14 .. 60		>47	>5
Netherlands	1340	15.5 .. 82.5	800	20	2
Norway	3040		460	>10	>5
Poland	1000 1000		800 1000	>4	>5
Portugal		17 .. 70	300	>4	>2.5
Slovenia	1800	20 .. 60	400 + 400	≥5	≥20
Spain		18.5 .. 100	500	>20	>5
Sweden				>100	>10
Switzerland		18 .. 100	800	>47	>5
United Kingdom	2000	0 .. 125	400	>400	>10

B.3.4.2 Additional requirement for d.c. characteristics

Some networks require additional restrictions on the range of d.c. characteristics of a voice terminal so that the local exchange can make an automatic assessment of the loop resistance and, depending on the value, insert additional signal loss in the analogue part of the 4-wire path to provide improved control of loudness and echo performance on short lines. This automatic adjustment of loss is analogous to the manual setting of exchange pads, dependent on the line loss, that is necessary in some networks.

As an example, in the United Kingdom the following lower limit is added to the d.c. mask:

In addition to the requirements of subclause 2.3 of ETS 300 001, when the line terminals are connected to a voltage source of 50 V d.c. in series with a 400-ohm resistor and a variable resistor, the steady-state voltage measured at the terminals of the TEUT should be greater than the limits given in Table B.3.

Table B.3/I.572 – Lower limit curves for d.c. characteristics

Current (mA)	Voltage (V)
12.5	0
12.5	2.3
20	6
100	10

B.3.4.3 Loop current transients

B.3.4.3.1 Quiescent to loop state transition

When the TE changes from a quiescent to a "loop" state, the change in current transient should be such that it is within the allowed deviation d from the steady state value within t_c ms after the commencement of the change. See Table B.4.

Table B.4/I.572 – Transient response – Quiescent to loop state

Country	Settling time (ms)	Loop current deviation from steady state (mA)	Speed of loop establishment ms	Min or max current (mA)
Austria	600	0	300	1.25 min
Belgium		Not mandatory		
Bulgaria	150	1		
Cyprus	100	1		
Czech Republic	100	Within mask	12	20
Denmark	100	± 10%		
Finland		Not mandatory		
France	400	Within mask	300	150 max
Germany	120	Within mask		
Greece		Not mandatory		
Hungary		Not mandatory		
Iceland		Not mandatory		
Ireland		Not mandatory		
Italy			15	15 min
Luxembourg	100	1		
Netherlands		Not mandatory		
Norway			30	13.5
Poland		Not mandatory		
Portugal		Within mask		
Slovenia	150	± 10%		
Spain	time to 5 mA	Within 1 mA of steady state	25 + time to 5 mA	4.25 min
Sweden		Not mandatory		
Switzerland		± 10%		
United Kingdom		Not mandatory		

B.3.5 Overload susceptibility

B.3.5.1 d.c. Overload susceptibility

TE in the loop state shall withstand the application of a d.c. feeding voltage of increased value V_f via a series resistor of reduced value R_f or a current I_o for a given time T_o as given in Table B.5.

Table B.5/I.572 – d.c. overload susceptibility

Country	V_f	R_f	I_o (mA)	T_o (minutes)
Austria		Not mandatory		
Belgium	53	400		5
Bulgaria	66	500		5
Cyprus	66	300	125	5
Czech Republic				
Denmark	56	220		Continuous
Finland		Not mandatory		
France	54	300		5
Germany				
Greece	66		100	5
Hungary		Not mandatory		
Iceland	56	400	125	30
Ireland		Not mandatory		
Italy		Not mandatory		
Luxembourg	66	300		5
Netherlands	66	300		1
Norway		Not mandatory	30	13.5
Poland		Not mandatory		
Portugal		Not mandatory		
Slovenia	53	800-2000	60	
Spain		300	125	5
Sweden		Not mandatory		
Switzerland		500		
United Kingdom		Not mandatory		

Some countries regard this requirement as part of the equipment Safety standard.

B.3.5.2 a.c. + d.c. overload susceptibility

Terminal equipment shall withstand continuous application of the worst case exchange d.c. voltage plus the Ringing signal; when in the quiescent state, when in transition from the quiescent to the Loop state and when in the Loop state for a defined period. After this overload the TE shall operate normally. The required tolerance limits are given in Table B.6.

Table B.6/I.572 – a.c. + d.c. overload susceptibility

Country	d.c. (volts)	Ringer amplitude (Volts r.m.s.)	R_f	F1	F2	Ton (s)
Austria						
Belgium	130	60	400	25		Continuous
Bulgaria	110	60	500	50		Continuous
Cyprus						
Czech Republic	120	0	500	50		Continuous
Denmark	130	56	150	25		
Finland						
France						
Germany						
Greece	135	66	25	50		Continuous
Hungary	100	48	200	50		Continuous
Iceland						
Ireland		48	1200	17	25	2
Italy						
Luxembourg						
Netherlands	90	66	800	25		Continuous
Norway						
Poland	90	60	1000	25	50	Continuous
Portugal	120	55	500	15	30	Continuous
Slovenia	53	90		25		
Spain		56	300	25		Continuous
Sweden						
Switzerland		50	500	25		
United Kingdom						

B.4 Voiceband signal transmission characteristics

The transmission characteristics covered in this clause are: Unbalance about earth, Input and Output Impedance, Maximum Transmission levels and Noise levels. Transmission planning is covered in the main body of the Recommendation.

B.4.1 Input impedance of the TE

B.4.1.1 Input impedance in the quiescent state

If the input impedance is non-resistive, then the modulus of the input impedance depends upon the frequency of measurement. The requirements are specified in four frequency bands in Table B.7,

where:

Z1 = 200 to 2000 Hz,

Z2 = 2000 to 4000 Hz,

Z3 = 4000 to 10 000 Hz,

Z4 = 10 000 to 18 000 Hz.

Z4 is not applicable to TE equipped with 12 or 16 kHz meter-pulse detectors.

Table B.7/I.572 – Input impedance of the TE in the quiescent state

Country	Z1 kohms	Z2 kohms	Z3 kohms	Z4 kohms	V test a.c. r.m.s.	V test d.c.
Austria						
Belgium	20	20			1	48
Bulgaria	15	15				60
Cyprus	30	20	10	5	1.5	48
Czech Republic	15				0.775	0
Denmark	30	30	15	7.5	1.5	56
Finland	10	10			0.5	48
France					0.775	3-70
Germany						
Greece	10	10	8	5	0.775	44-66
Hungary						
Iceland	30	30		5	1	48
Ireland	50	25	10		1	48
Italy	10	10			0.775	44-52
Luxembourg						
Netherlands					1.5	66
Norway	50	25	5		0.775	60
Poland						
Portugal	15	15	6	6	1.5	55
Slovenia	>6	>6			0.775	48
Spain	30	30	5	5		
Sweden		8		1	1	60
Switzerland		50	500	25		
United Kingdom	10	10			1	50

B.4.1.1.1 Input impedance in the Idle Line Signalling state

Only the United Kingdom defines this condition, as follows: not less than 200 ohms for the frequency range 200 to 4000 Hz. Where the modulus of the impedance is less than 10 000 ohms the phase angle should not exceed +5 degrees.

B.4.1.2 Input impedance in the Loop state

When testing TE capable of generating and receiving speech signals, the acoustic transducers must be properly loaded/terminated. For TE incorporating a handheld acoustic transducer assembly, the handset should be mounted against an artificial head as defined in ITU-T Recommendation P.76. For TE incorporating hands-free acoustic transducer arrangements, the transducer assemblies must be placed in an anechoic chamber as defined in ITU-T Recommendation P.340.

The input impedance of TE is expressed as a return loss against a reference impedance.

The reference impedance adopted for telephony is discussed in ITU-T G-series Recommendations – Supplement 31 "*Principles of determining an impedance strategy for the local network*". The adoption of a complex impedance is claimed to reduce the level of echoes from 2-4 wire hybrids by a factor of 10 dB. This is considered to be very valuable in this application where echoes are important so it is mandatory that complex impedances be employed in VSAT systems complying with this Recommendation.

The impedance employed for exclusively non-analogue applications, such as modems, is commonly a simple 600-ohm resistance.

There is a lack of agreement on the parameters of the complex reference impedance although they are all based upon the same circuit, a resistor in series with a capacitor with another resistor in parallel. Table B.8 gives the values for the reference impedance components.

This requirement is independent of polarity.

Table B.8/I.572 – Complex impedance component values

Country	Frequency band (Hz)	Loop current range (mA)	Reference impedance	Return loss (dB)
Austria	300-3400	19-60	600	14
Belgium	300-3400	20-Imax	600 150+830/72nF	14-18 Voice PBX
Bulgaria	300-3400	20-60	600 or 220+820/115nF	14
Cyprus	300-3400	100	600	14
Czech Republic	300-3400	40		>14
Denmark	300-3400	8-Imax	600 400+500/330nF	10 18-14 Voice
Finland	300-3400	20-50	600	10
France	300-3400		600	14 >9 Voice
Germany	300-3400	20-60	220+820/115nF	>6
Greece	300-3400	20-80	600 400+500/50nF	14
Hungary	300-3400	20-Imax	600	14
Iceland	300-3400	14-Imax	600	10
Ireland	300-3400	20-100	600	14
Italy	300-3400		600	14
Luxembourg	300-3400	60	600	14
Netherlands	300-3400		600	14
Norway	300-3400	17-Imax	600 120+820/110nF	>14 9 Voice
Poland	300-3400		600 220+820/115nF	14 14-18 Voice
Portugal	300-3400		600 Zref	14 10
Slovenia	300-3400	20	600 220+820/115nF	14

Table B.8/I.572 – Complex impedance component values *(concluded)*

Country	Frequency band (Hz)	Loop current range (mA)	Reference impedance	Return loss (dB)
Spain	300-3400		600	10-12-14-10
Sweden	300-3400		270+750/150nF	14-18-14
Switzerland	300-3400		220+820/115nF	14
United Kingdom	200-3400	25-100	600 370+620/310nF	14 12

The TE must not be transmitting energy into the port under test above a level which would alter the result by more than 0.1%.

B.4.1.3 Unbalance about earth

The 2-wire interface to the TE should be balanced with respect to earth in both Quiescent and Loop states. In some countries special exceptions may be allowed for conditions where the TE is operating in shared-service mode (where ringing is from one leg to earth) and TE employing Register Recall (where an earth is applied within the loop state).

When there is no earth connection on the TE (i.e. a passive or double insulated device) then the TE must be mounted on an earth plate in a realistic orientation for the test that verifies this requirement.

Only two countries require this test:

Germany	50-300 Hz	>30 dB	300-600 Hz	>40 dB	600-3400 Hz	>46 dB
United Kingdom	46 dB					

The requirement applies for all values of loop current and the verification tests are performed at several values of loop current.

The energizing signal used in the test would depend on the type of terminal. For a voice terminal, an acoustic sinewave of 1 kHz at 5 dBPa from an artificial mouth would normally be employed.

B.4.2 Multi-parameter Balance requirements

Balance specifications involve more than one parameter. The definition of these parameters is to be found in ITU-T Recommendation G.117. Many countries use this ITU standardized approach to the definition of balance conditions.

B.4.2.1 Summary of the terminology used in balance requirements

One-port networks

a) Transverse reflexion factor (transverse return loss) (TRL);

b) Transverse conversion ratio (loss) (TCL);

c) Longitudinal conversion ratio (loss) (LCL);

d) Longitudinal impedance ratio (loss) (LIL);

e) Transverse output voltage (level) (TOL);

f) Longitudinal output voltage (level) (LOL).

Voltages e) and f) are unwanted signals which are usually uncorrelated to the wanted signals.

In addition, the following transfer parameters are for each of the two directions of transmission:

a) Transverse transfer ratios (losses) (TTL);

b) Transverse conversion transfer ratios (losses) (TCTL);

c) Longitudinal transfer ratios (losses) (LTL);

d) Longitudinal conversion transfer ratios (losses) (LCTL).

Signal generating devices

– Output signal balance ratio (losses) (OSB).

This parameter is in addition to the six one-port parameters.

Signal receiving devices

a) Input longitudinal interference ratio (loss) (ILIL).

b) Longitudinal interference threshold voltage (level).

These parameters are in addition to the six one-port measures. If the wanted signal is longitudinal (e.g. as in a signalling system) and the interfering voltage transverse, replace the word *longitudinal* with *transverse*.

B.4.2.2 Longitudinal conversion loss

This Balance parameter is used by most countries. (See Tables B.9 and B.10.)

Table B.9/I.572 – LCL in Quiescent state

Country	Longitudinal conversion loss (dB)	Frequency band (Hz)	Longitudinal conversion loss (dB)	Frequency band (Hz)	Longitudinal conversion loss (dB)	Frequency band (kHz)
Austria	52	300-3400				
Belgium PBX	48 40	300-3400 300-600	46	600-3400		
Bulgaria	30	50-300	52	300-3400		
Cyprus	50	40-3400	50	15 000- 17 000		
Czech Republic	40	40-300	50	300-3400	50	15-17
Denmark	50	40-600	55	600-3400	6/octave	>3.4
Finland	40	40-300	50	300-600	55	0.6-3.4
France	40	50-300	50	300-3400		
Germany						
Greece	40	40-300	40	300-3400	52-6/octave	3.4-18
Hungary						
Iceland	40	40-600	46	600-3400		
Ireland	40	40-300	50	300-600	52	0.6-3.4
Italy	40	300-3400				
Luxembourg						
Netherlands	46	48-52	46	300-3400		
Norway	40	16-300	46	300-600	52	0.6-3.4

Table B.9/I.572 – LCL in Quiescent state *(concluded)*

Country	Longitudinal conversion loss (dB)	Frequency band (Hz)	Longitudinal conversion loss (dB)	Frequency band (Hz)	Longitudinal conversion loss (dB)	Frequency band (kHz)
Poland	40	300-600	46	600-3400		
Portugal	40	40-300	50	300-600	55	0.6-3.4
Slovenia	46	300-3400				
Spain	52	50	40 50	50-300 300-600	55 44	0.6-3.4 12
Sweden	40	15-50	46	50-600	52 50	0.6-3400 10-17
Switzerland	40	40-300	46	300-3400		
United Kingdom						

Table B.10/I.572 – LCL in Loop state

Country	Longitudinal conversion loss (dB)	Frequency band (Hz)	Longitudinal conversion loss (dB)	Frequency band (Hz)	Longitudinal conversion loss (dB)	Frequency band (kHz)
Austria	52	300-3400				
Belgium PBX	48 40	300-3400 300-600	 46	 600-3400		
Bulgaria	30	50-300	52	300-3400		
Cyprus	50	40-3400	50	15000-17000		
Czech Republic	40	40-300	50	300-3400	50	15-17
Denmark	50	40-600	55	600-3400	6/octave	>3.4
Finland	40	40-300	50	300-600	55	0.6-3.4
France	40	50-300	50	300-3400		
Germany		300-3400				
Greece	40	40-300	40	300-3400	52-6/octave	3.4-18
Hungary	40	40-600	46	600-3400		
Iceland	40	40-600	46	600-3400		
Ireland	40	40-300	50	300-600	52	0.6-3.4
Italy	40	300-3400				
Luxembourg	52	300-3400				
Netherlands	46	48-52	46	300-3400		
Norway	40	16-300	46	300-600	52	0.6-3.4
Poland	40	300-600	46	600-3400		
Portugal	40	40-300	50	300-600	55	0.6-3.4

Table B.10/I.572 – LCL in Loop state *(concluded)*

Country	Longitudinal conversion loss (dB)	Frequency band (Hz)	Longitudinal conversion loss (dB)	Frequency band (Hz)	Longitudinal conversion loss (dB)	Frequency band (kHz)
Slovenia	46	300-3400				
Spain						
Sweden	40	15-50	46	50-600	52 50	0.6-3400 10-17
Switzerland	40	40-300	46	300-3400		
United Kingdom	46	300-3400				

B.4.3 Voiceband signal/frequency characteristics of the TE

The TE shall conform to the requirements of this subclause for both polarities of line voltage.

Where the terminal requires an additional power supply for the telephony function to operate, then the requirements of this subclause shall be met with this power supply operative.

B.4.3.1 Introduction

For historical reasons, European transmission parameters have different values in different countries. The existing requirements have been specified using a common format and ETSI has derived tentative values for send and receive loudness ratings and for sidetone performance as targets for handset telephony in the future, when inter-exchange connections are digital and the only source of loss is in the analogue access network.

The tentative values were derived from the long term objectives for Sending Loudness Rating (SLR) and Receiving Loudness Rating (RLR) described in ITU-T Recommendation G.121, assuming R and T pads of 7 dB and 0 dB respectively. An average loss for the access network connection was assumed to be 4 dB. This might require additional attenuation to be inserted in the local exchange to pad out short lines.

These values have been incorporated in the tables as tentative values for future harmonization.

The values given in the tables of national values have been derived by transposing existing national regulatory requirements into values that would be obtained by the harmonized test methods contained in ETSI standard I-ETS 300 480.

Where national values were not provided, the proposed harmonized values have been inserted and marked with an *.

Compliance with these requirements will ensure satisfactory two-way speech of a quality consistent with the ITU-T P series of Recommendations.

The testing specification for analogue handset telephony is specified in ETSI I-ETS 300 480.

The following functions are outside the scope of I-ETS 300 480:

– hands-free or loudspeaking function;

– cordless telephony;

– telephony for people with audio-related impairments (e.g. telephones with additional receive amplification as an aid for the hard of hearing);

– telephony terminals designed for use in hostile environments;

– key systems or Private Automatic Branch eXchange (PABX) system dependent terminals;
– telephones using non-linear or time variant signal processing techniques.

B.4.3.2 Sending and Receiving Loudness Ratings

The values shown in Tables B.11 and B.12 are those measured at terminals A and B in Figure 1 of ETSI I-ETS 300 480, and **do not** include any attenuation due to a local telephone line.

B.4.3.2.1 Sending Loudness Rating

The Sending Loudness Rating (SLR), expressed as a function of feed resistance R_f shall conform to the values shown in Table B.11.

Table B.11/I.572 – Sending Loudness Rating

Country	SLR (dB) R_f max	Tol. (dB)	SLR (dB) R_f mid	Tol. (dB)	SLR (dB) R_f min	Tol. (dB)
Tentative values for future harmonization	**+3**	**±4**	**+3**	**±4**	**+3**	**±4**
Austria	+3.4	±2	NM	NM	+3.5	±2
Belgium	+3	±4	+3	±4	+3	±4
Bulgaria	+3*	±4*	+3*	±4*	+3*	±4*
Cyprus	+3	±4	+3	±4	+3	±4
Czech Republic	+2.5	±2.5	+2.5	±2.5	+2.5	±2.5
Denmark	+2	±3	+2	±3	+2	±3
Finland	+3.25	±4.25	+3.5	±4	+6.5	±3.25
France	+2	±4	+5	±4	+7	±4
Germany	+4	±3	+4	±3	+4	±3
Greece	+3	±3	+3	±3	+3	±3
Hungary (1 and 2)	+2 +2	±3 ±3	+4 +4	±3 ±3	+5 +7	±3 ±3
Iceland	+3	±4	+3	±4	+3	±4
Ireland	+1	+4 –6	+1	+4 –6	+5	±4
Italy	+1	±3	+2	±3	+4	±3
Luxembourg	+3	±4	+3	±4	+3	±4
Malta	+3*	±4*	+3*	±4*	+3*	±4*
The Netherlands	+6.5	±4.5	+6.5	±4.5	+6.5	±4.5
Norway	0	±4	0	±3	0	±3
Poland	+4	±4	+4	±4	+4	±4
Portugal	+3*	±4*	+3*	±4*	+3*	±4*
Romania	–1	±5	–0.5	±5	+4.5	±4.5
Russia	+3*	±4*	+3*	±4*	+3*	±4*
Slovak Republic	+3*	±4*	+3*	±4*	+3*	±4*
Slovenia	+3*	±4*	+3*	±4*	+3*	±4*
Spain	+2.5	±3.5	+4.5	±3.5	+6.5	±3.5
Sweden	0	+4 –2.5	0	+4 –2.5	+5	+4 –2.5

Table B.11/I.572 – Sending Loudness Rating *(concluded)*

Country	SLR (dB) R_f max	Tol. (dB)	SLR (dB) R_f mid	Tol. (dB)	SLR (dB) R_f min	Tol. (dB)
Switzerland	+5	±3.5	NM	NM	+5	±3.5
Turkey	+3	±4	+3	±4	+3	±4
United Kingdom	0	±4.5	0	±4.5	+3.5	±4.5
NOTE – Hungary (1) and (2) define two acceptable alternative loudness control characteristics.						

B.4.3.2.2 Receiving Loudness Rating

The Receiving Loudness Rating (RLR), expressed as a function of feed resistance R_f, shall conform to the values shown in Table B.12.

Table B.12/I.572 – Receiving Loudness Rating

Country	RLR (dB) R_f max	Tol. (dB)	RLR (dB) R_f mid	Tol. (dB)	RLR (dB) R_f min	Tol. (dB)
Tentative values for future harmonization	**–8**	**±4**	**–8**	**±4**	**–8**	**±4**
Austria	–11	±2	NM	NM	–11	±2
Belgium	–8	±4	–8	±4	–8	±4
Bulgaria	–8*	±4*	–8*	±4*	–8*	±4*
Cyprus	–8	±4	–8	±4	–8	±4
Czech Republic	–8	+5 –3	–8	+5 –3	–8	+5 –3
Denmark	–8	±3	–8	±3	–8	±3
Finland	–7.25	±3.75	–7.5	±3.5	–4.25	±2.75
France	–12	±4	–9	±4	–7	±4
Germany	–7	±3	–7	±3	–7	±3
Greece	–8	±3	–8	±3	–8	±3
Hungary (1 and 2)	–9 –9	±3 ±3	–8 –7	±3 ±3	–7 –4	±3 ±3
Iceland	–8	±4	–8	±4	–8	±4
Ireland	–11	+3 –5	–11	+3 –5	–7	±3
Italy	–12	±3	–9	±3	–7	±3
Luxembourg	–8	±4	–8	±4	–8	±4
Malta	–8*	±4*	–8*	±4*	–8*	±4*
The Netherlands	–6.5	±4.5	–6.5	±4.5	–6.5	±4.5
Norway	–8	±4	–8	±3	–8	±3
Poland	–6	±4	–6	±4	–6	±4
Portugal	–8*	±4*	–8*	±4*	–8*	±4*
Romania	–8.5	±4	–8	±4.5	–3.5	±4.5
Russia	–8*	±4*	–8*	±4*	–8*	±4*

Table B.12/I.572 – Receiving Loudness Rating *(concluded)*

Country	RLR (dB) R_f max	Tol. (dB)	RLR (dB) R_f mid	Tol. (dB)	RLR (dB) R_f min	Tol. (dB)
Slovak Republic	–8*	±4*	–8*	±4*	–8*	±4*
Slovenia	–8*	±4*	–8*	±4*	–8*	±4*
Spain	–8.5	±3.5	–6.5	±3.5	–5.5	±3.5
Sweden	–12	+4 –2.5	–12	+4 –2.5	–7	+4 –2.5
Switzerland	–8	±3.5	NM	NM	–8	±3.5
Turkey	–8	±4	–8	±4	–8	±4
United Kingdom	–8	±3.5	–8	±3.5	–4.5	±3.5
NOTE – Hungary (1) and (2) define two acceptable alternative loudness control characteristics.						

B.4.3.2.3 Volume control

Where a user-controlled receiving volume control is provided, the RLR shall meet all the relevant values shown in Table B.12 for one setting of the control.

The position of the volume control that achieves RLRs as close as possible to their nominal values is to be taken as the "nominal" setting of the volume control.

NOTE – It is not necessary to strive to achieve values closer than 1 dB.

With the volume control set to the minimum position, the RLR shall not be greater than (quieter than) 18 dB.

B.4.3.3 Sidetone

The SideTone Masking Rating (STMR) shall conform to the value shown in Table B.13 when tested with the terminations and feed resistances shown. Where a user-controlled receiving volume control is provided, at its "nominal" setting the STMR shall conform to the value shown in Table B.13.

Table B.13/I.572 – Sidetone rating

Country	Termination a and R_f min STMR (dB)	Termination b and R_f for sidetone STMR (dB)	Termination c and R_f max STMR (dB)
Tentative values for future harmonization	**+5**	**+10**	**+5**
Austria	+5	+10	+5
Belgium	+5	+10	+5
Bulgaria	+5*	+10*	+5*
Cyprus	+5	+10	+5
Czech Republic	+5	+5	+5
Denmark	+5	+10	+5
Finland	+5	+10	+7
France	+10	+10	+5
Germany	+5	+10	+5
Greece	+7	+12	+7

Table B.13/I.572 – Sidetone rating *(concluded)*

Country	Termination a and R_f min STMR (dB)	Termination b and R_f for sidetone STMR (dB)	Termination c and R_f max STMR (dB)
Hungary (1 and 2)	+5	+10	+5
Iceland	+5	+10	+5
Ireland	+5	+7	+7
Italy	+5	+10	+4
Luxembourg	+5	+10	+5
Malta	+5*	+10*	+5*
The Netherlands	+0	+0	+0
Norway	+5	+10	+0
Poland	+5*	+10*	+5*
Portugal	+5*	+5*	+5*
Romania	+5	+7	+1
Russia	+5*	+10*	+5*
Slovak Republic	+5*	+10*	+5*
Slovenia	+5*	+10*	+5*
Spain	+5	+10	+7
Sweden	+2	+2	+2
Switzerland	+5	+7	+7
Turkey	+5	+10	+5
United Kingdom	+5	+7	+7
NOTE – Hungary (1 and 2) defines two acceptable alternative loudness characteristics that in this case are the same.			

B.4.3.4 Distortion

B.4.3.4.1 Sending distortion

The "total" harmonic distortion (summed up to the 5th harmonic) shall not be greater than 7% when measured with an input of –4.7 dBPa.

B.4.3.4.2 Receiving distortion

The harmonic distortion (summed up to the 5th harmonic) shall not be greater than 7%, when measured with an input electro motive force (e.m.f) of –12 dBV.

Where a user-controlled receiving volume control is provided, the above requirement applies for the "nominal" setting of the volume control.

B.4.3.4.3 Sidetone distortion

The harmonic distortion (summed up to the 5th harmonic) shall not be greater than 10% when measured with an input of –4.7 dBPa. Where a user-controlled receiving volume control is provided, the above requirement applies for the "nominal" setting of the volume control.

B.4.3.5 Sensitivity-frequency response

The sensitivity-frequency responses shall be met at both polarities and all values of allowed loop current.

B.4.3.5.1 Sending

The sending sensitivity versus frequency shall not be greater than the upper limit and not less than the lower limit given in Table B.14 and shown in Figure B.2.

Table B.14/I.572 – Sending sensitivity limit curves

	Frequency (Hz)	Level (dB)
Upper Limit	100	–9
	2000	+4
	4000	+4
	8000	–16
Lower Limit	300	–14
	2000	–6
	3400	–11

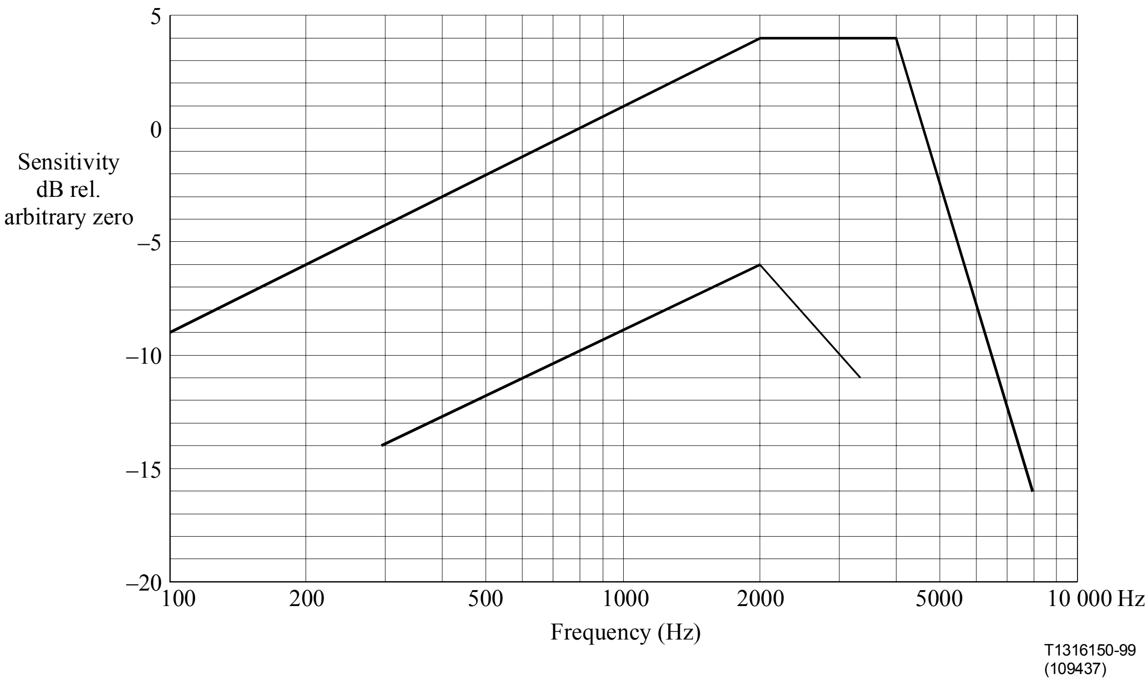


Figure B.2/I.572 – Sending sensitivity/frequency limits

B.4.3.5.2 Receiving

The receiving sensitivity versus frequency shall not be greater than the upper limit and not less than the lower limit given in Table B.15 and shown in Figure B.3.

Additionally, the sensitivity at 8 kHz shall be at least 25 dB below the sensitivity at 1 kHz.

Table B.15/I.572 – Receiving sensitivity limit curves

	Frequency (Hz)	Level (dB)
Upper limit	100	–10
	200	+2
	4000	+2
	8000	–18
Lower limit	300	–9
	1000	–7
	3400	–12

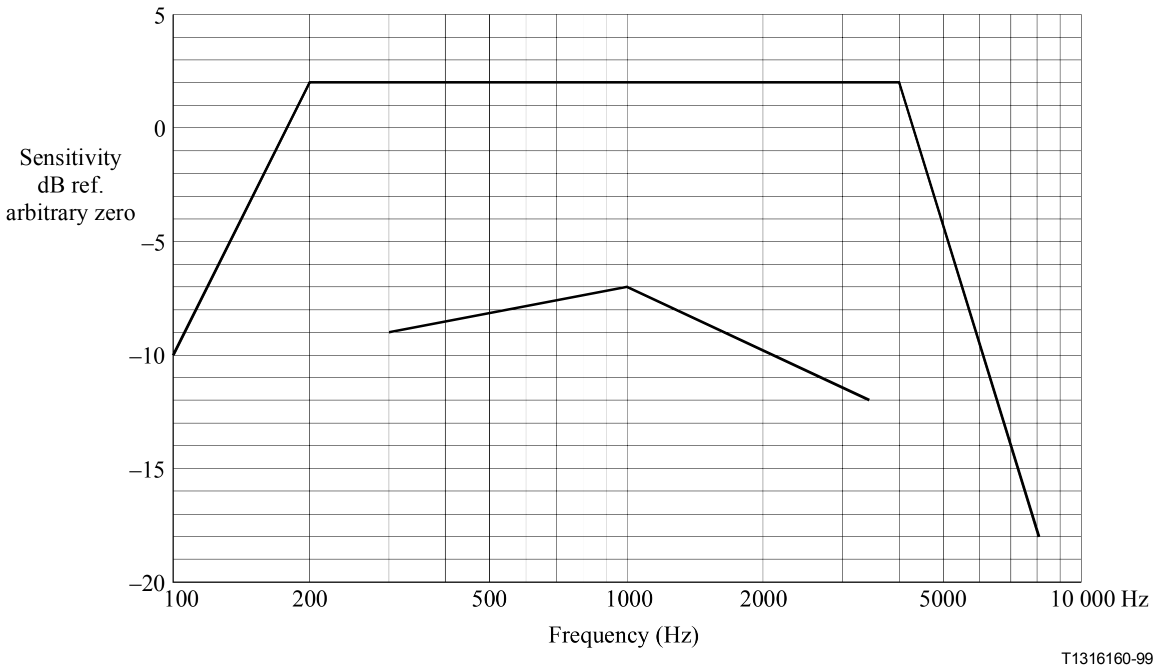


Figure B.3/I.572 – Receiving sensitivity/frequency limits

B.4.4 Maximum signal levels at the TE

B.4.4.1 Sending power capability

The harmonic distortion (summed up to the 5th harmonic) shall be not greater than 10% when a pure tone signal of 1000 Hz is applied at the Mouth Reference Point (MRP) at a Sound Pressure Level (SPL) of 5 dBPa.

B.4.4.2 Receiving power-handling capability

The harmonic distortion (summed up to the 5th harmonic) of the received signal shall be not greater than 10% when a pure sinusoidal signal of 1 V pk-pk. (open circuit voltage) is applied to the line terminals via the prescribed transmission bridge and test configuration generator at 1000 Hz. Where a user-controlled receiving volume control is provided, the above requirement applies for the "nominal" setting of the volume control.

B.4.4.3 Linearity (variation of gain with input level)

B.4.4.3.1 Sending

With the value of R_f specified, the sensitivity determined with an input SPL of –4.7 dBPa shall not differ by more than 2 dB from the sensitivity determined with an input SPL of –19.7 dBPa.

B.4.4.3.2 Receiving

With the value of R_f specified, the sensitivity determined with an input signal of –12 dBV shall not differ by more than 2 dB from the sensitivity determined with an input signal of –32 dBV.

Where a user-controlled receiving volume control is provided, the above requirement applies for the "nominal" setting of the volume control.

B.4.4.4 Maximum acoustically stimulated output

The maximum signal generated as a result of any acoustic stimulus shall not be greater than 8 V peak-to-peak.

B.4.4.5 Acoustic shock

The prevention of acoustic shock is a safety requirement.

In the absence of any relevant safety standard, the limits are defined in ITU-T Recommendation P.360 "*Efficiency of devices for preventing the occurrence of excessive acoustic pressure by telephone receivers*".

B.4.4.5.1 Continuous signal

The sound pressure level in the artificial ear should not exceed 24 dBPa (r.m.s.).

B.4.4.5.2 Peak signal

The receiving equipment shall limit the peak sound pressure level in the artificial ear to less than 36 dBPa.

B.4.5 Noise

B.4.5.1 Sending noise

The psophometrically-weighted noise produced by the apparatus in the sending direction shall not be greater than –64 dBmp.

B.4.5.2 Receiving noise

The noise level measured in an artificial ear shall not be greater than –49 dBPa(A). Where a user-controlled receiving volume control is provided, the above requirement applies for the "nominal" setting of the volume control.

B.4.6 Immunity to out-of-band signalling

Out-of-band signalling used in some networks can seriously affect the speech performance of a telephony terminal.

As an example, in Germany and Switzerland, the following requirement is used to control the effect of meter pulses which are applied by the network at each termination point.

B.4.6.1 Sending

An out-of-band signalling with a pulse ratio (1s "on" and 5s "off") and with an emf of +20 dBV should not cause the output signal to change by more than 1 dB compared with the reference measurements.

B.4.6.2 Receiving

An out-of-band signalling with a pulse ratio (1s "on" and 5s "off") should not cause the output signal to change by more than 1 dB compared with the reference measurements.

B.4.7 National limits on the level of signals sent to line

B.4.7.1 Levels for non-real time speech signals

The level of real-time speech signals sent to line by a telephone instrument is determined by its Send Loudness Rating (SRL) but the levels of other types of signal (modem tones or recorded speech) must also be controlled to prevent overload and crosstalk within the public network.

Most countries call up a 600-ohm termination applied via a transmission bridge for this requirement. This allows measurements to be taken over a range of loop currents. See Table B.16 for the required values.

Some countries call for their complex terminating impedance when performing this measurement and this requirement may become more widespread in the future.

This subclause does not include DTMF signalling tones.

Table B.16/I.572

Country	Max voice power level (dBm)	Max voiceband data signal Tx one-way (dBm)	Max voiceband data signal Tx two-way simultaneously (dBm)	Loop current range or minimum (mA)	Loop current max driving conditions Vdc Rfeed
Austria	–10	–9	–9	19-60	
Belgium PBX loaded with complex Z	–6 –6	–6 –6	–6 –6	20 20	43 360
Bulgaria	–10	–10	–10	27	60 1000
Cyprus	–10	–10	–10	27	48 440
Czech Republic	–9	–10 default max = 0	–10 default max = 0	15-50	60
Denmark	–10	–10	–10	8-100	
Finland	–10	–10	–10	20-50	
France	–10	0	0	20-60	
Germany	–9			20	60 0
Greece	–10	–10	–10	20-80	
Hungary	–6	0	0	20-80	
Iceland	–10	–10	–10	14-70	
Ireland	–10	–10			
Italy	–3	–3	–3	18-80	
Luxembourg	–6	–6	–6	14-60	
Netherlands					
Norway	–10	–10	–10	15-65	
Poland	–10	–10	–10	17-70	

Table B.16/I.572 ***(concluded)***

Country	Max voice power level (dBm)	Max voiceband data signal Tx one-way (dBm)	Max voiceband data signal Tx two-way simultaneously (dBm)	Loop current range or minimum (mA)	Loop current max driving conditions Vdc Rfeed
Portugal	–10	–10	–6	20-100	
Slovenia	–6	–6	–6	20-60	
Spain	–10	–10 default –3 max	–10 default –3 max	18.5-100	
Sweden	–10	–10	–13	14-50	
Switzerland	–10	–9	–9	18-100	
United Kingdom	–9	0 to –13	0 to –13	25-100	

B.4.7.2 Protection of in-band signalling systems

Modem signals are different to voice signals because their spectral power distributions are filtered and they can defeat the "guard" circuits used in in-band signalling receivers and cause misoperation of the signalling system. Table B.17 and Figure B.4 define the spectrum power distribution that must be employed by the TE to ensure that In-band signalling systems are not disrupted.

Table B.17/I.572 – Coordinates of limit curves for power level in a 10 Hz bandwidth

Limit curve	Frequency (Hz)	Power level in 10 Hz (dBm)
Upper limit (Note)	<30 30 100 200 3000 3200 3800 4000	<–33 –33 –16 –6 –6 –6 –15 –44
Area A	2130 2200 2340 2430 2130	–6 –33 –33 –6 –6
Area B	900 1000 1000 2000 2000 2130 900	–6 –23 –45 –45 –23 –6 –6

Table B.17/I.572 – Coordinates of limit curves for power level in a 10 Hz bandwidth *(concluded)*

Limit curve	Frequency (Hz)	Power level in 10 Hz (dBm)
Area C	3000 3200 3800 3800 3000 3000	–6 –6 –15 –60 –60 –6
Area D (Note)	3800 3800 4000 4000 3800	–15 –60 –60 –44 –15
NOTE – Signals in areas C and D may be relatively highly attenuated by the network and may therefore not be received effectively.		

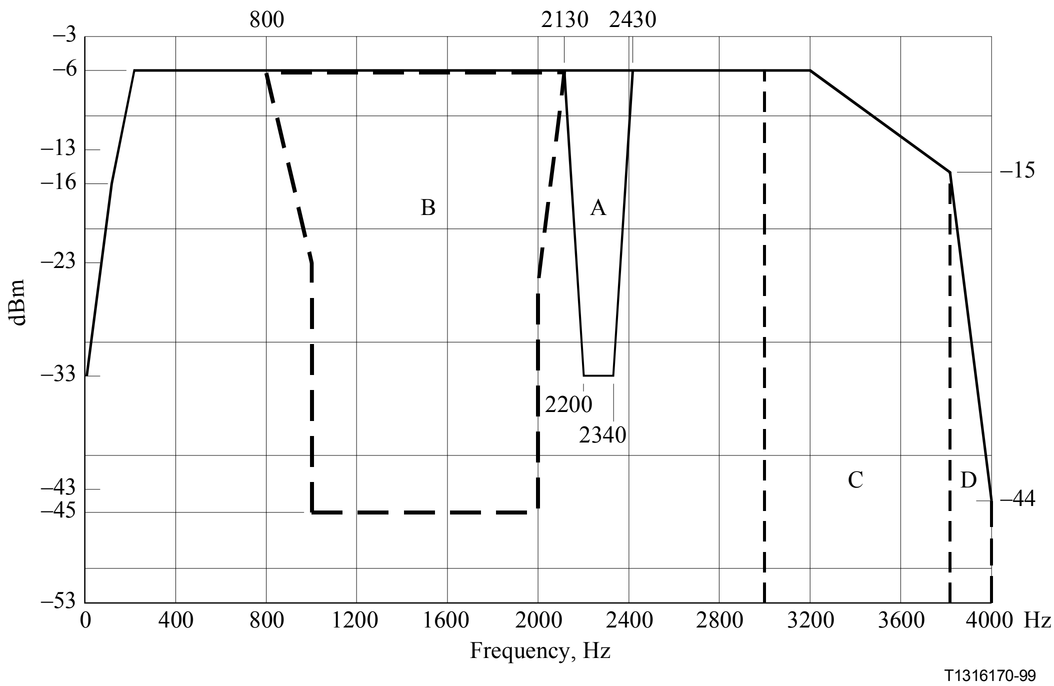


Figure B.4/I.572 – Spectrum power distribution to protect in-band signalling systems

Unwanted outband signals

FFS.

Outband noise

FFS.

B.5 The calling function

The calling function is defined as a chain of events initiated by the TE to set up a connection.

The sequence of events is:

- establish the loop state from the quiescent state;
- detect that the exchange is ready to receive digits, i.e. detect dial tone;
- dial distant terminal's number in one or more stages;
- detect call failure when necessary, busy or not available condition, or time-out to no-tone;
- determine if repeat attempts are required, control number and frequency of repeat attempts:
  - detect ring tone,
  - detect answer condition;
- enable transmission;
- revert to the quiescent state at the end of the call or if some failure is detected.

The establishment of the Loop state has been covered in a previous subclause.

The initiation of the calling sequence may be manual or automatic but even when the initiation has been manual the monitoring of the correct operation of the call set-up may be automatic rather than manual.

B.5.1 Detection of the dialling reception state of the exchange

Manual operation relies on the reception of an audible dial tone to indicate that the exchange is ready to receive dialling digits. There may be a short interval just at the start of the dial tone when the exchange is not ready to receive digits but this is usually much shorter than manual operation of the dialling device can intercept.

Automatic operation can also detect dial tone or it can simply wait for a longer interval and then assume that dial tone will be present.

B.5.1.1 Dial tone detector sensitivity

The detector shall be activated under the conditions defined in Table B.18.

Table B.18/I.572 – Dial tone detector sensitivity

Country	Frequency band or components (Hz)	Min-Max level (dBm)	Minimum duration (s)	Cadence	Identity of different dial tones	Impedances
Austria	380-490	–26 to –16		Continuous	National	600
Belgium	415-460 900 ± 10 + 1020 ± 10 + 1140 ± 10	–20 to –3 –28 to –3 –28 to –3 –28 to –3	0.85 2.4 2.4 2.4		National International International International	600 or complex in PBXs
Bulgaria	380-470	–25 to–5	0.8	Continuous	National	600
Cyprus	325-375 and 425	–22 to –7	3	Continuous	National	600
Czech Republic	370-500	–25 to –3	5	Continuous	National	600
Denmark	350-500	–35 to 0	4	Continuous	National	600

Table B.18/I.572 – Dial tone detector sensitivity *(concluded)*

Country	Frequency band or components (Hz)	Min-Max level (dBm)	Minimum duration (s)	Cadence	Identity of different dial tones	Impedances
Finland	375-475	–20 to –14	4	Continuous	National	600
France	425-455 425-455 + 315-345 Special	–27 to –10 –32 to –10	2 2		First National Second National Special	600 600 600
Germany	425	–29 to 0	0.2	Continuous	National	600
Greece	400-475	0	2	Continuous	National	600
Hungary	375-475	–25 to –5	2	Continuous	National	600
Iceland	400-450	–30 to 0	4	Continuous	National	600
Ireland				Continuous	National	
Italy	410-440	–25 to –6	4	Continuous	National	600
Luxembourg	380-490	–26 to –6.5	2	Continuous	National	600
Netherlands	340-550 340-550	–25.7 to –3.8	1	Continuous	National Special	600
Norway	350-500	–30 to –6	0.8	Continuous	National	600
Poland	360-450	–26 to –5	2	Continuous	National	600
Portugal	300-450	–30 to –5	3	Continuous	National	600
Spain	320-480 or 570-630	–35 to 0	3	Continuous 1: 0.1 0.32: 0.02	National	600
Slovenia	425 ± 15	–20 to –6		0.2 s tone 0.3 s pause 0.7 ms tone 0.8 ms pause ±10%		
Sweden	375-475	–25 to 0		0.3 on 0.05 off	National	600
Switzerland	375-475 DT + 1 other	–23 to 0	2 <1	Continuous Continuous	National Special	600 600
United Kingdom				Continuous	National	600

B.5.1.2 Dial tone detector insensitivity

The dial tone detector should be insensitive enough to discriminate dial tone from other noise on the line at this stage of the call set-up process. (See Table B.19.)

Table B.19/I.572 – Limits for dial tone insensitivity

Country	Insensitive to frequency components below (Hz)	Insensitive to frequency components above (Hz)	Insensitive to signal levels below (dB)	Insensitive to signals with the wrong cadence
Austria				
Belgium	160	700	–45	
Bulgaria				
Cyprus				
Czech Republic			–35	Ton<380 ms
Denmark	110	2000	–45	Ton<1200 ms
Finland			–52	<500 ms
France	160	900	–50	
Germany				
Greece	350	525	–45	200 ms
Hungary			–45	600 ms
Iceland	50	4000	–40	
Ireland				
Italy	350	550	–48	
Luxembourg				
Netherlands			–31.8	
Norway				
Poland				
Portugal	160		–45	
Slovenia	Not mandatory			
Spain	160	1000	–45	
Sweden				800 ms
Switzerland	225	1000	–48	550
United Kingdom				

B.5.1.3 Decadic dialling

B.5.1.3.1 Loop pulsing format and timing

In all countries except Sweden, the number of break pulses in a sequence corresponds to the digit being transmitted apart from the digit 0 when 10 pulses are emitted. In Sweden the digit D+1 pulses represent being sent so that the digit 9 needs 10 pulses, for example.

Loop-disconnect dialling operates at a nominal 10 pulses per second throughout Europe but the timing details are not uniform across Europe. The timing values are listed in Table B.20.

Table B.20/I.572 – Dialling timing

Country	Make period and tolerance in ms	Break period and tolerance in ms	Pulse rate tolerance (Hz)	Minimum interdigit pause (ms)
Austria	40 ± 2	60 ± 3	0.5	800
Belgium	34 ± 4	66 ± 7	1	400
Bulgaria	40	60	1	200
Cyprus	33 ± 3	67 ± 5	1	450
Czech Republic	40 ± 5	60 ± 5		800
Denmark	34 ± 7	68 ± 12		450
Finland				720
France	33 ± 4	66 ± 7	1	800
Germany				680
Greece	38.5 ± 3	61.5 ± 3	1	400
Hungary	33.333	66.666	1	350
Iceland	40 ± 5	60 ± 5	1	450
Ireland	33 ± 3	67 ± 3	1	240
Italy	40	60	1	190
Luxembourg	40 ± 2	60 ± 3	0.5	800
Netherlands	38.5 ± 7.5	61.5 ± 10	1	700
Norway				
Poland	34 ± 7	67 ± 10	1	800
Portugal	33.333	66.666	1	600
Slovenia	40 ± 5	60 ± 5	1	250
Spain			1	450
Sweden	40 ± 5			500
Switzerland	40 ± 5	60 ± 5		620
United Kingdom	33 + 4 – 5	67 + 5 – 4	1	240

These timings are referred to defined current values, which also differ between countries.

B.5.1.3.2 Pre-pulsing period

The pre-pulse period is defined as a minimum period for which a minimum current must be flowing before the first break is inserted. This avoids any transients caused by the initial loop seizure transition. A typical period is one second and a typical current is 20 mA.

National differences spread from 250 ms to 1.5 s.

B.5.1.3.3 Break pulse period

The break pulse duration is defined as the duration of a drop in loop current below a given threshold, typically 0.5 mA. The duration for each country in Europe can be found in Table B.20.

B.5.1.3.4 Make pulse period

The make pulse duration is defined as a period when the loop current exceeds a given threshold, typically 20 mA. The durations are given in Table B.20.

B.5.1.3.5 Interdigit pause

The interdigit pause is defined as a minimum time duration where the loop current exceeds a given value. With manual dialling using a rotary dial there is typically an interdigit pause of 800 ms made up of a lost-motion period of 240 ms built into the dial mechanism plus the time that it takes to rotate the fingerplate to the desired number.

With an automatic dialling system, numbers can be generated much faster but a minimum time must be allowed for the exchange to move its selectors. In electronic exchanges, the numbers can be received more quickly but not all exchanges within a country may be electronic. Hence, the minimum duration between pulse trains varies quite widely between countries. The values are given in Table B.20.

B.5.1.3.6 Post pulsing period

The post pulsing period is required to allow the transients in the loop current caused by the dialling pulse trains to settle before acoustic sensors are switched to line. A typical duration is 1 s but shorter intervals may be allowed for automatic equipment that does not employ acoustic reception devices.

B.5.1.3.7 EMC due to dialling

EMC suppression is usually required across the dialling circuitry to meet national EMC limits.

B.5.2 Dialling with MFPB (DTMF)

The specification of an MFPB dialler involves frequencies, levels, durations, transients, impedances, allowed combinations, restoration times and background noise levels.

B.5.2.1 Frequency combinations

The MFPB signalling system uses combinations of two frequencies transmitted simultaneously to signal digits and other symbols. One frequency is chosen from four frequencies in a lower group and the other from four in an upper group as shown in Table B.21. The frequency tolerance is ±1.5% in most countries.

Table B.21/I.572 – Frequency combinations in MFBP (DTMF)

Lower group (Hz)	Upper group (Hz)			
	1209	1336	1477	1633
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	*	0	#	D

During the transmission of these tones the specified loop conditions balance with respect to earth and the return loss presented to line must still be within the defined limits for TE.

The significance of the * and # symbols varies between countries but are usually used to access or activate special facilities in the exchange.

B.5.2.2 Transmit levels

There are two basic options for transmit levels and some countries allow slightly wider tolerances on these basic options:

Option 1

Higher frequency group = –9 ± 2 dB

Lower frequency group = –11 ± 2 dB

Option 2

Higher frequency group = –6 ± 2 dB

Lower frequency group = –8 ± 2 dB

B.5.2.3 Unwanted spectrum components

Unwanted spectral components from sources within the TE such as the microphone should be suppressed during MFPB transmission to a level at least 20 dB below the lower frequency group transmit level. The level of any individual frequency component within a band of 125 Hz should be below the following limits:

– 300-4300 Hz –33 dB;

– 4300-28 000 Hz –37 dB at 4300 Hz falling at 12 dB/octave thereafter;

– 28 000-150 kHz –70 dB.

B.5.2.4 MFPB transients

There are limits on the rise and fall time of the OFF-ON and ON-OFF transitions of the tones. These are typically 7 ms and 10 ms respectively. An overshoot limit is also required.

B.5.2.5 Pulse and pause durations

With both manual and automatic operation of the sending circuitry, the minimum pulse duration and the minimum pause between pulses is usually 65 ms. Some countries require slightly longer durations.

B.5.2.6 Post dialling pause

After the end of the transmission of the total sequence of digits, most countries call for a maximum interval before the terminal is able to receive voice signals which varies from 0.1 to 1.5 s.

B.5.3 Automatic calling precautions

Repeat attempts by automatic Callers are regulated in most countries. A first repeat attempt to the same number should not take place before an interval of 5 s, typically, has elapsed and a second or subsequent attempt should wait for 60 s. A maximum of 12 to 15 attempts is allowed before a longer duration pause of up to 120 mins is required.

Automatic Callers using numbers stored in memory need to have some means to prevent the use of memory locations which are nominally empty or otherwise out of use.

Call progress monitoring by some means is necessary for hands-free telephony terminals or other applications where a person is supposed to take over the call after dialling or answer.

Automatic Callers without dial tone detectors should not start dialling for 2 to 6 s after loop seizure but should not wait for more than 5 to 10 s. Several countries make dial tone detectors mandatory.

Misdirected call attempts from automatic calling equipment are a source of annoyance to telephone network customers and are often very expensive to trace and correct. For example, the victim of the misdirected call may be in a different country from the source of the misprogramming.

B.5.3.1 Identification signals

Automatic calling equipment shall send to line an identification signal to indicate to an answering terminal (human or machine) that a piece of automatic equipment is calling. This signal may be a tone or a voice announcement but it must be initiated within 5 s of the end of dialling or detection of the answering condition. The type of tone is application-dependent; see relevant ITU-T Recommendations such as T.4 for facsimile equipment.

B.6 The answering function

The answering function is a vital part of the completion of a connection and in general, networks only start charging after a call is answered. Therefore, network operators are most concerned to ensure that any customer's equipment is capable of indicating an incoming call under all possible conditions. In some countries the acoustic bell is still part of the operators' network equipment and it cannot be disconnected until an alternative approved device is connected to the line.

The answering function is the translation of the Ringing current to an audible, visual or vibration effect to alert a human user. For an automatic terminal the answering function is the definition of the sensitivity and insensitivity of the ringing detector and then the timings associated with Loop establishment to answer the call.

B.6.1 Ringing detectors

a.c. ringing is the method used by the exchange to call the terminal equipment. Ringing may also be employed in the reverse direction on Magneto exchanges where the exchange does not provide power to the terminal equipment and therefore loop calling is not possible.

B.6.1.1 Ringing signal detector characteristics

In the quiescent state the TE shall connect its ringing detector to line. Acoustic bell ringing detectors do not require any power other than that provided by the ringing current so they can operate during a local power failure but electrically powered TE would not detect the ringing during power failure.

For the purposes of this Recommendation, only electrically powered TE will be considered. The requirements for the ringing detection circuits of such TE are detailed in Table B.22.

Table B.22/I.572 – Ringing detectors that output electrical signals

Country	Ringing voltage across terminals (r.m.s.)	Ringing frequency range (Hz)	Total series resistance (ohms)	d.c. voltage	Response time maximum (ms)
Austria	25-60	40-55	500	20, 60	200
Belgium	25-75	23-27	1000	48	250
Bulgaria	30-90	22-52	2200	60	
Cyprus	30-85	23.5-26.5	440-1740	48	200
Czech Republic	25-90	25 ± 3 50 ± 5	500	20-60	200
Denmark	40-120	25 ± 2.5	500-2400	44-56	200
Finland	35-75	25 ± 3	800-1710	44-58	
France	28-90	50 ± 5	300	0.45-54	200
Germany				0	200

Table B.22/I.572 – Ringing detectors that output electrical signals *(concluded)*

Country	Ringing voltage across terminals (r.m.s.)	Ringing frequency range (Hz)	Total series resistance (ohms)	d.c. voltage	Response time maximum (ms)
Greece	25-90	16-50	500	44-66	200
Hungary	40-100	20-30	500	48	400
Iceland	30-90	22-28	800	48	200
Ireland	25-75	17, 25	5000	43-53	
Italy	26-80	20-50	800	48	200
Luxembourg	45-75	25 ± 2.5	500	48	200
Netherlands	35-90	23-27	800	66	200
Norway	28-90	25 ± 3	460-1200 460-3500	24 60	350
Poland	40-90	25 ± 5 50 ± 10	800-1000	43-66	
Portugal	30-120	16.666 ± 1.666 25 ± 5	500-2500	45-55	10 000
Slovenia	25-60	20-54	800-1920	48	200
Spain		20-30	200	48	
Sweden	30-90	25 ± 3 50 ± 1	800-2200	33-60	200
Switzerland	20-90	21-55	600-2200	43-57	
United Kingdom					

For this style of ringing detector the circuitry would typically consist of a high-power dissipation resistor in series with an isolation capacitor, of 250 v rating with a value of 0.3 to 1 microfarad, and an opto-isolated coupler. Thus, the impedance is mainly resistive and constant.

With electro-acoustic ringing detectors, the impedance is not constant and some countries require a minimum voltage to current ratio throughout the ringing phase, e.g. 3500.

To simplify the understanding of how many devices may be attached to a single exchange line by the general public, some countries have introduced the concept of Ringer Equivalent Number (REN). The REN number is clearly marked on each piece of telecommunications equipment that is approved for connection to the national telephone network. The National administration declares the maximum REN that may be attached to a single line, e.g. in the United Kingdom this is REN = 4 which is equivalent to a total impedance of about 2.5 kohms.

B.6.1.2 Ringing detector insensitivity

The ringing indicator or detector shall not produce an output signal that indicates ringing has been detected when the ringing current is less than 10 volts r.m.s., typically, across the line terminal. In addition, it should be insensitive to loop-disconnect dialling pulses on a parallel TE.

B.6.2 Automatic answering function

B.6.2.1 Automatic establishment of the Loop state

TE with an automatic answer function should operate with an answering delay of 1 to 6 s and should not take longer than 7 to 60 s. Terminals with a mixture of manual and automatic operation such as a telephone and an auto-answering facsimile machine may have operator selectable answering delays for the automatic function.

B.6.2.2 Automatic answering indicator

An automatic answering terminal, which is not under human supervision, must send an answering tone or voice message to line to inform the caller that an automatic station has answered. This signal should commence within 2.5 s of entering the off-hook state, typically. The duration of this signal or voice message is application-dependent; see for example, ITU-T Recommendations V.25 for modem procedures and T.4 for facsimile procedures.

B.6.2.3 Manual override

It must be possible for a human operator to override an automatic terminal at any time.

An exception may be allowed for Alarm systems.

B.6.3 Loss of signal

An automatic terminal shall revert to the quiescent state when the signal that it is receiving drops below a workable level as defined for the particular application that is running. Typically, for non-voice signals this would be a level of less than –48 dBm and for voice signals a level less than –43 dBm.

B.6.4 Automatic terminals with network-tone detectors

Such terminals should return to the quiescent state within 5 to 20 s of detecting a network tone that indicates that a call has failed. This would include the unexpected receipt of dial tone, for example.

B.6.5 Power failure

When terminal equipment is powered by a source other than the exchange line to which it is connected, there is a need to avoid unplanned behaviour of the terminal in the event of power failure which might lead to very long call holding times or false call attempts or a relay chatter condition which would generate noise.

If a terminal includes a telephony function, that function should continue to work from the exchange line power at least as far as being able to make calls to Emergency numbers. If this is not possible, then a normal telephone set should be automatically switched into service at the same location on power failure.

Power failure should revert the TE to the quiescent state irrespective of what state it was in when the power failed.

On restoration of the power, the terminal should still meet all the limitations imposed by the regulations for attachment approval. A TE may automatically initiate a call to a service centre to report the power failure.

An autocalling TE may recommence its activity without human supervision when power is restored.

An autoanswer TE should stay in the quiescent state when power is restored until it receives a call.

Stored numbers should not be changed by breaks in the power other than to have the store locations marked as empty.

B.7 Connection methods

Physical connection methods to national telephone networks are very different from country to country.

ETSI ETS 300 001 chapter 8, Connection Methods, contains a good summary of the current situation but it should be recognized that the situation is in a state of flux at the present time.

B.8 Frequencies for customer's meter operation

See Table B.23.

Table B.23/I.572 – Frequencies and levels for pulse metering

Country	Frequency Min (Hz)	Frequency Max (Hz)	Minimum level	Max level	Meter pulse timing (ms)
Austria	11 928	12 072	50 mV	2.5 V	>50 on, >50 gap
Belgium	15 840	16 160	–18 dBm	+17 dBm	>80 on, >220 gap
Bulgaria	15 840	16 160	–18 dBm	+17 dBm	>50 on, >100 gap
Cyprus	15 840	16 160	100 mV	4 V	80-300 on, >400 gap
Czech Republic	15 920	16 080	–25 dBm	+15 dBm	80-180 on, >140 gap
Denmark	11 916	12 084	–27 dBm	+15 dBm	75-200 on, >50 gap
Finland	15 950	16 050	240 mV	8 V	100-20 on, >350 gap
France	11 880 48	12 120 52	–19 dBm 36 V	+13 dBm 70 V	100-150 on, >160 gap 100-150 on, >160 gap
Germany	15 920	16 080	–23 dBm	+21 dBm	78-1020 on, >132 gap
Greece	15 250	16 750	–18 dBm	+18 dBm	>50 on, >90 gap
Hungary	11 940	12 060	–25 dBm	+10 dBm	100-200 on, 400 gap
Iceland	11 940	11 960	–20 dBm	+13 dBm	140 on, >130 gap
Ireland	11 880	12 100	45 mV	2.6 V	100-140 on,
Italy	11 880	12 120	65 mV	2.4 V	100-150 on, >150 gap
Luxembourg	15 920 48	16 080 52	3.75 V	8.7 V	90-170 on,
Netherlands	48	52	65 V	100 V	70-200 on,
Norway	15 840	16 160	–25 dBm	+7 dBm	120-180 on, >120 gap
Poland	15 800	16 200	70 mV	2.4 V	100-150 on, >350 gap
Portugal	11 880	12 120	–19 dBm	+15 dBm	120-250 on,
Slovenia	15 780	16 220	80 mV	2400 mV	100-180 on, >100 gap
Spain	11 880 49	12 120 51	1.6 V 90 V	2.4 V 100 V	>50 on, >50 gap 50:90 or 70:70
Sweden	11 940	12 060	5.5 mV	447 mV	
Switzerland	11 880	12 120	110 mV	10 V	<50 on, >90 gap
United Kingdom	16 000 50	Under development	40 V	45 V	>200 on, >1500 gap

Low frequency meter pulses of 50 Hz applied longitudinally have been employed in the past but this method is being withdrawn in most countries.

ANNEX C

European network tones

ITU-T Recommendation E.182 is a good general informative reference on network tones throughout the PSTN but this annex contains a description of the National network tones for Europe.

C.1 Dial tones

See B.5, Calling function, and C.7, Tones for other purposes.

C.2 Ringing tones

See Table C.1.

Table C.1/I.572 – Frequencies and levels for ringing tone

Country	Minimum frequency (Hz)	Maximum frequency (Hz)	Minimum level (dBm)	Max level (dBm)	Immediate ring tone burst (s)	Pause after first burst (s)	Long term cadence (s) ON:OFF
Austria	400	490	–43	– 6.5			1:5 ± 20%
Belgium	420	455	–37	–4			1:3 ± 0.1
Bulgaria	380	470	–43	–5	0.2-1	0-9 s	0.67 + 2, 5/3 + 6 or 1:4 ± 10% or 1:9 ± 10%
Cyprus	400	450	–25	–10			1:5/3
Czech Republic	370	500	–30	–3	0.36-1.1		1:4 ± 10%
Denmark	400	450	–43	–6.5			0.75:7.5 ± 20% or 1:4 ± 10%
Finland	400	450	–20	–14			1:4 ± 0.25
France	425	455	–38	–10		0-3.8 s	1.5:3.5 ± 10%
Germany	382.5	495	–47	0	0.09-0.275 or 0.45-1.1	0-4.4 s	0.79-1.1:3.7-4.4
Greece	400	475					1:4
Hungary	375	475	–38	–5			1.25:3.75 ± 20%
Iceland	400	450	–43	–7			1.2:4.7
Ireland	400	450	–16	0			0.4:0.2
Italy	410	440	–43	–6			1:4 ± 10%
Luxembourg	380	490	–43	–6.5			1:4

Table C.1/I.572 – Frequencies and levels for ringing tone *(concluded)*

Country	Minimum frequency (Hz)	Maximum frequency (Hz)	Minimum level (dBm)	Max level (dBm)	Immediate ring tone burst (s)	Pause after first burst (s)	Long term cadence (s) ON:OFF
Netherlands	340	550	–25.7	–3.8	0.6-1.2	0-4.5 s	1 ± 25%:4 ± 10%
Norway	410	440	–30	–6			1:4 ± 10%
Poland	360	450	–30	0			1:4 ± 20%
Portugal	300	450	–30	–5			1 ± 20%:5 ± 20%
Slovenia	410	440	–20	–8			1:4 ± 10%
Spain	410	440	–37	–5			1:5/3
Sweden	400	450	–43	–10			1:5
Switzerland	400	450	–33	–6.5	0.25-0.5	0-4 s	1 ± 0.25:4 +2/ –0.5
United Kingdom	400	450	–37	0	0.4-1	2	0.4:0.2:0.4:2 ± 25%

C.3 Busy tones

See Table C.2.

Table C.2/I.572 – Busy tones in Europe

Country	Minimum frequency (Hz)	Maximum frequency (Hz)	Minimum level (dBm)	Max level (dBm)	Cadence (ms) ON:OFF
Austria	400	490	–43	–6.5	300:300 ± 20% 400:400 ± 20%
Belgium	420	455	–37	–4	500:500 ±10%
Bulgaria	380	470	–43	–5	200:500 ± 10% 150:475 ± 10% 250:250 ± 10% 500:500 ± 10%
Cyprus	400	450	–25	–10	500:500
Czech Republic	370	500	–30	–3	125-370:225-500 or 330:330
Denmark	400	450	–43	–6.5	450:450 ± 20% 250:250 ± 10%
Finland	400	450	–20	–14	300:300 ± 8%
France	425	455	–38	–10	500:500 ± 10%
Germany	382.5	495	–47	0	432-528:432-528 or 97-203:382-578
Greece	400	475			300:300

Table C.2/I.572 – Busy tones in Europe *(concluded)*

Country	Minimum frequency (Hz)	Maximum frequency (Hz)	Minimum level (dBm)	Max level (dBm)	Cadence (ms) ON:OFF
Hungary	375	475	–38	–5	300:300 ± 20%
Iceland	400	450	–43	–7	250:250
Ireland	395	405	–16	0	500:500 ± 50%
Italy	410	440	–43	–6	500:500 ± 10%
Luxembourg	380	490	–43	–6.5	480:480 ± 10%
Netherlands	340	550	–25.7	–3.8	400-600:400-600
Norway	410	440	–30	–6	500:500 ± 10%
Poland	360	450	–30	–5	500:500 ± 10%
Portugal	300	450	–30	–5	500:500 ± 20%
Slovenia	410	440	–20	–8	500:500 ± 10%
Spain	410	440	–35	–5	200:200
Sweden	400	450	–43	–10	250:250
Switzerland	400	450	–33	–6.5	500:500 +50/–300
United Kingdom	320	480	–37	0	375:375 ± 25%

C.4 Congestion tones

See Table C.3.

Table C.3/I.572 – Frequencies and levels for congestion tone

Country	Minimum frequency (Hz)	Maximum frequency (Hz)	Minimum level (dBm)	Max level (dBm)	Cadence (ms) ON:OFF
Austria	400	490	–43	–16	200:200 ± 20%
Belgium	420	455	–37	–4	167:167 ± 12
Bulgaria	380	470	–43	–5	200:500 ± 10% or 150:475 ± 10% or 250:250 ± 10% or 500:500 ± 10%
Cyprus	400	450	–25	–10	250:250
Czech Republic	400	450	–30	–3	65:165 ± 16%
Denmark	400	450	–43	–6.5	450:450 ± 20% 250:250 ± 10%
Finland	400	450	–20	–14	200-250:200-250
France	425	455	–38	–10	500:500 ± 10%
Germany	382.5	495	–47	0	216-264:216-264 or 97-203:382-578
Greece	400	475			300:300

Table C.3/I.572 – Frequencies and levels for congestion tone *(concluded)*

Country	Minimum frequency (Hz)	Maximum frequency (Hz)	Minimum level (dBm)	Max level (dBm)	Cadence (ms) ON:OFF
Hungary	375	475	–38	–5	300:300 ± 20%
Iceland	400	450	–43	–7	250:250
Ireland	Not used				
Italy	410	440	–43	–6	200:200 ± 10%
Luxembourg	380	490	–43	–6.5	240:240 ± 10%
Netherlands	340	550	–25.7	–3.8	180-330:180-330
Norway	410	440	–30	–6	200:200 ± 10%
Poland	360	450	–30	–5	500:500 ± 10%
Portugal	300	450	–30	–5	200:200 ± 20%
Slovenia	410	440	–20	–8	500:500 ± 10%
Spain	410	440	–37	–5	3×200:2×200+600
Sweden	400	450	–43	–10	250:750
Switzerland	400	450	–33	–6.5	180-300:180-300
United Kingdom	400	450	–37	0	400:350 or 225:525 ± 25%

C.5 Special information tones

See Table C.4.

Table C.4/I.572 – Frequencies and levels for information tone(s)

Country	Freq. 1 (Hz)	Freq. 2 (Hz)	Freq. 3 (Hz)	Minimum level (dBm)	Max level (dBm)	Cadence (ms)
Austria	950	1400	1800	–43	–9	330 each tone, rising pitch, then 1000 pause
Belgium digital	950	1400	1800	–42	–4	330 each tone, rising pitch, then 1000 pause
Belgium analogue	900	1380	1860	–42	–4	330 each tone, rising pitch, then 1000 pause
Bulgaria	950	1400	1800	–37	–5	330 tone, 30 pause
Cyprus	Not used					
Czech Republic	950	1400	1800	–34	–3	330 tone, 330 pause
Denmark	950	1400	1800	–43	–6.5	330 each tone, then 1000 pause

Table C.4/I.572 – Frequencies and levels for information tone(s) *(concluded)*

Country	Freq. 1 (Hz)	Freq. 2 (Hz)	Freq. 3 (Hz)	Minimum level (dBm)	Max level (dBm)	Cadence (ms)
Finland	950	1400	1800	–27	–21	330 each tone, then 1000 pause
France	950	1400	1800	–40	–10	330 each tone, then 1000 pause
Germany	Not used					
Greece	Not used					
Hungary	950	1400	1800	–25	–8	330 each tone, then 1000 pause
Iceland	950	1400	1800	–55	–20	
Ireland	950	1400	1800	–16	0	330 each tone, rising pitch, then 1000 pause
Italy	950	1400	1800	–43	–6	330 each tone, rising pitch, then 1000 pause
Luxembourg	Not used					
Netherlands	950	1400	1800	–23	–12	330 each tone, then 1000 pause
Norway	950	1400	1800	–30	–6	330 each tone, then 1000 pause
Poland	950	1400	1800	–30	–5	330 each tone, rising pitch then 1000 pause
Portugal	950	1400	1800	–30	–5	330 each tone, then 1000 pause
Slovenia	950	1400	1800			330 each tone, then 1000 pause
Spain	950	1400	1800	–39	–12	333 each tone, then 1000 pause
Sweden	950	1400	1800	–55	–20	
Switzerland	950	1400	1800	–33	–6.5	300 each tone, rising pitch then 1000 pause
United Kingdom	950	1400	1800	–37	0	330 each tone, rising pitch

C.6 Call in progress tone

A Call in progress tone is only used by three countries within Europe and each one uses a different frequency. The cadence is the same at 50 ms ON and 50 ms OFF.

C.7 Tones for other purposes

See Table C.5.

Table C.5/I.572 – Frequencies and levels for other purposes

Country	Freq. 1 (Hz)	Freq. 2 (Hz)	Freq. 3 (Hz)	Minimum level (dBm)	Max level (dBm)	Cadence (ms) ON:OFF
Austria						
Special dial tone	340-425	400-450		–26	–16	Continuous
Acknowledgement +ve	340-425	400-450				1000:5000
Acknowledgement –ve	340-425	400-450				400:400
Intrusion tone	400-450			–43	–6.5	150:150:150:1950
Call waiting tone	400-450			–36	–10	40:1950
Belgium						
Special dial tone	420	455		–20	–4	1000:250
Special confirmation	420	455				40:40
Belgium analogue						
International dial tone	900	1020	1140	–28	–4	330 for each tone
Bulgaria						ITU-T Recs. E.180/E.182
Cyprus						
Number unobtainable	400	450		–25	–10	2500:500
Call waiting	400	450		–33	–18	200:200:200:600
Czech Republic						
Dialling tone-services	400	450		–25	–9	165:165:165:165:165:660:660
Waiting tone	400	450		–30	–9	1000:170:330:3500
Denmark						
Finland						
Intrusion tone	425			–27	–21	200:300:200:1300
Call waiting tone 1	425					150:150:150:800
Call waiting tone 2	425					150:8000
Queue tone	950	950	1400			650:325:325:30:1300:2600
France						
Special dial tone	330	440		–25	–10	Continuous
Second dial tone	330	440		–30	–10	Continuous
Howler	425	455		–25	–10	500:500
Germany						
Special dial tone	400	425		–29	0	Continuous
Intrusion tone	450			–53	–6	172-294:172-294:172-294:1280
Call waiting tone	425			–53	–6	180:180:180:4500
Greece	Not used					
Hungary						
Second dialling tone	252			–31	–11	Continuous
		425		–26	–6	Continuous
Intrusion tone	425			–46	–13	300:300:300:1500
Call waiting tone	425			–25	–5	400:1960
Iceland						
Ireland						

Table C.5/I.572 – Frequencies and levels for other purposes *(continued)*

Country	Freq. 1 (Hz)	Freq. 2 (Hz)	Freq. 3 (Hz)	Minimum level (dBm)	Max level (dBm)	Cadence (ms) ON:OFF
Italy Special dial tone Intrusion tone Waiting tone	 410 410 410	 440 440 440		 –25 –30 –25	 –6 –11 –10	 Continuous 200:200:200:1400 1000 single burst
Luxembourg						
Netherlands Special dial tone Positive indication tone Negative indication tone Call waiting tone Paging acceptance tone	 400 400 400 400 1575	 450 450 450 450 1625		 –25.7 –25.7 –25.7 –31.7 –25.7	 –3.8 –3.8 –3.8 –9.8 –3.8	 450-550:35-75 Continuous 50-100:50-100 450-550:9200-9800 Continuous
Norway Special dial tone Intrusion tone Call waiting tone Warning tone Howler	 425 1400 1400 1400 950	 470		 –30 –22 –22 –22	 –6 0, 4.5, 9, 13.5, 18.5	 Continuous alternations at 400 ms. 2000 one burst. 200:2000:200: 90 000:200:90 000 400:15 000 4000 ms at each level repeated 3 times
Poland Second dial tone Special dial tone Call waiting tone	 350 425	 425		 –31 –27 –27	 –5 –5 –5	 Continuous 1500:100 150:150:150:4000
Portugal Special dial tone Positive indication Negative indication	 E.182 E.182 E.182					 1000:200 1000:200 As special information tone in E.182
Spain Second dial tone Special dial tone Call waiting tone Warning tone (intrusion tone) Number unobtainable	 570 410 410 1350 410	 630 440 440 1450 440		 –21 –20 –15 –60 –35	 –5 –5 –6 –33 –5	 Continuous 1000:100 or 320:20 2x600:200+1000 400:5000 2×235:190+490 or 2×235:150+150
Sweden Special dial tone Call waiting tone Warning tone	 400 400 379	 450 450 421		 –25 –25 –40	 –10 –10 –25	 320:40 200:500:200 one burst. 100:1500

Table C.5/I.572 – Frequencies and levels for other purposes *(concluded)*

Country	Freq. 1 (Hz)	Freq. 2 (Hz)	Freq. 3 (Hz)	Minimum level (dBm)	Max level (dBm)	Cadence (ms) ON:OFF
Switzerland						
Call waiting tone	425					200:200:200:4000
Confirmation tone	425	850				200:200:200:1200 tones interlaced
Intrusion tone	1400					200:2000
Warning tone	1400					450:15 000
United Kingdom						
Number unobtainable	400			–37	0	Continuous

ANNEX D

D.1 Analogue 4-wire interfaces to a public network

Within Europe only two countries claim to support 4-wire analogue interfaces to their public networks, the United Kingdom and Norway.

These ports are defined in ETSI publications I-ETS 300 003, 300 004 and 300 005.

In these publications the 4-wire port has the designation K4 and the 2-wire port is called K2.

ANNEX E

Remote user network interface

E.1 Scope

This annex details the requirements for a locally powered analogue RemoteUser Network Interface unit that provides an analogue interface port facing the end user that is capable of supporting the user's terminal equipment.

E.2 References

[1] ETSI standard ETS 300 001.

[2] ETSI report TBR 21.

[3] ITU-T Recommendation Q.552.

[4] ETSI standard ETS 300 659-1.

E.3 Abbreviations

For the purposes of this annex, the following abbreviations apply:

FWA Fixed Wireless Access

REN Ringing Equivalent Number

TE	Terminal Equipment

UNI	User Network Interface

E.4 Introduction

This annex specifies an exchange port simulator to support end-user's terminal equipment located in the customer's premises when technologies other than galvanic connection via copper or aluminium cable pairs are employed in the Access network (e.g. VSAT, FTTH, FWA, cable modem for CATV network).

E.5 Requirements

E.5.1 Line characteristics

The line lengths between the Remote Interface Unit and the TE in a VSAT-based application could be just as variable as they are for a traditional rural Local Exchange.

E.5.2 d.c. characteristics requirements in the quiescent state

E.5.2.1 Polarity

The polarity of the d.c. voltage presented to the terminal equipment from the Remote User Network Interface Unit during the quiescent state should be that the B-wire is negative with respect to the A-wire.

E.5.2.2 Minimum voltage

When a resistor of not less than 10 kohms is connected between the A- and B-wires of the Remote User Network Interface, the d.c. voltage should not be less than 21 volts (or up to 90 volts for specially long lines). National safety requirements must be met.

E.5.3 Requirements in the Loop state

The Remote User Network Interface Unit Loop State is established when a loop current that is adequate for the operation the TE is established. This would typically be 20 mA but some TE could operate satisfactorily down to 10mA or even lower if the TE was self powered.

E.5.3.1 d.c. characteristics

In the Remote User Network Interface's basic configuration it should be capable of providing a loop current of 20 mA into a loop resistance of 500 ohms. The current should be limited to not greater than 30 mA.

Long line feeding arrangements may be incorporated in the Remote User Network Interface that could support higher resistance loops. This might provide a lower line current with a higher feeding voltage.

E.5.3.2 a.c. characteristics

During the active state, the Remote User Network Interface Unit must support voiceband transmission.

E.5.3.2.1 Impedance

The impedance presented by the Remote User Network Interface Unit to the user's terminal port should have a return loss as shown in Figure E.2 with respect to the impedance shown in Figure E.1.

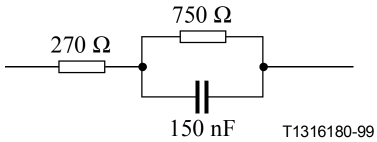


Figure E.1/I.572 – Z ETSI

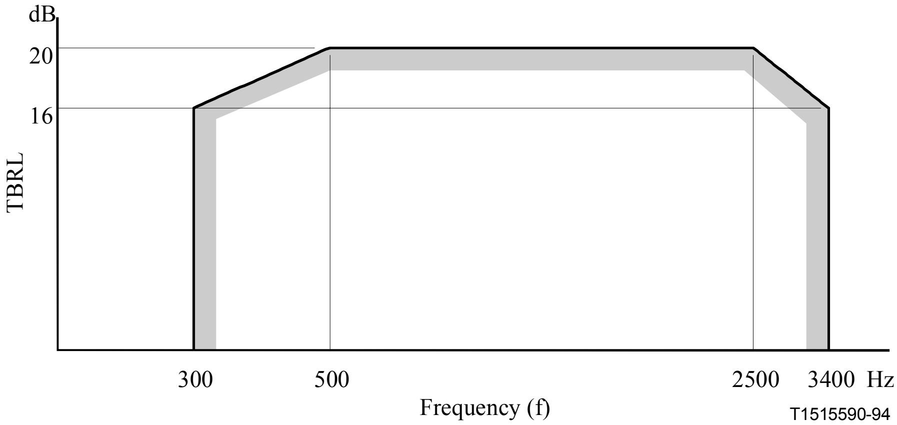


Figure E.2/I.572 – Mask for the return loss

NOTE – According to [3], the user's TE should set its balance impedance to Z_B (see Figure E.3).

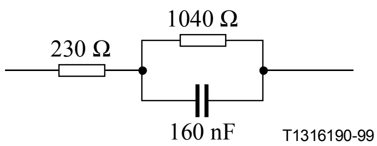


Figure E.3/I.572 – Z_B

E.5.4 Requirements in the ringing state

E.5.4.1 During the ringing signal

E.5.4.1.1 Load

The maximum ringing load or the corresponding maximum allowed Ringing Equivalent Number (REN) load are country specific. Therefore the ringing power generated by the Interface Unit should be sufficient to cover the National requirements efficiently.

E.5.4.1.2 a.c. characteristics

The a.c. voltage level of the ringing signal must be within the National Safety limits but high enough to trigger Ring Trip in most terminals for the full range of allowed loads. A programmable setting may be necessary. A voltage range from 32 to 90 volts r.m.s. would probably cover most requirements. Some current limiting that could cope with an initial surge would be beneficial.

The frequency of the ringing signal should be programmable over a range of frequencies from 15 to 25 to 50 Hz.

A sinusoidal shape is not mandatory but sharp transitions should be avoided to reduce EMC and crosstalk.

A rounded trapezoidal shape is acceptable with a crest factor between 1.2 and 1.6.

The ringing generator should be balanced, with a balance return loss >15 dB.

E.5.4.1.3 d.c. characteristics

During ringing, a d.c. voltage is required between the A- and B-wires to detect the off-hook or Loop condition of the user's TE.

E.5.4.1.4 Cadence

The Cadence should follow the ringing pattern from the Local Exchange as this pattern is sometimes used to identify one of several users even when only one telephone instrument is employed.

E.5.4.1.5 Ring trip detection

When a resistor ≤500 Ω is connected during the ringing state between the A- and B-wires of the Remote User Network Interface Unit, the off-hook condition must be detected within 100 ms.

E.5.4.2 During ringing pauses

E.5.4.2.1 d.c. characteristics

During the ringing signal pauses, the d.c. voltage remains on line to perform the off-hook detection.

E.5.4.2.2 a.c. characteristics

During ringing pause, the line interface should be able to perform the on-hook data transmission in accordance with [4] or National requirements.

E.6 Transmission characteristics

The transmission characteristics follow the requirements of the National Transmission Plan.

E.7 Metering

E.7.1 Frequency

The frequency of the metering pulses should be 12 kHz ± 0.5% (± 60 Hz) or 16 kHz ± 0.5% (± 80 Hz).

E.7.2 Level

When a resistor not less than 200 Ω is connected between the A- and B-wires, the a.c. voltage of the metering pulse signal should not be less than 400 mV r.m.s.

E.8 Payphone option

The line interface must be able to support a payphone.

ANNEX F

Telephone network interfacing in the United States of America

F.1 Introduction

In the United States there is a liberalized market for terminal equipment and a multitude of competing network operators. The ANSI standards use the generic term "Carrier" to refer to the network operators. The customer may purchase and install their own terminal equipment and arrange for maintenance from an independent contractor. Thus a good comprehensive standard for the interface is very important.

F.2 References

The American National Standards Institution, Committee T1, publish the following series of standards relating to attachment to National telephone networks.

American National Standard for Telecommunications

T1.401 – 1993	Interface Between Carriers and Customer Installations – Analogue Voicegrade Switched Access Lines Using Loop-start and Ground-start Signalling Dated: 18 August 1993, replaces the 1988 version.
T1.401.01 – 1994	Interface Between Carriers and Customer Installations – Analogue Voicegrade Switched Access Lines Using Loop-start and Ground-start signalling With Line-side Answer Supervision Feature
T1.401.02 – 1995	Interface between Carriers and Customer Installations – Analogue Voicegrade Switched Access Lines with Distinctive Alerting Features
T1.405 – 1996	Network-to-Customer Installation Interfaces – Direct-Inward-Dialling Analogue Voicegrade Switched Access Using Loop Reverse-Battery Signalling
T1.407 – 1997	Network to Customer Installation Interfaces – Analogue Voicegrade Special Access Lines Using Customer-Installation-Provided

	Loop-Start Supervision
T1.409 – 1996	Network to Customer Installation Interfaces – Analogue Voicegrade Special Access Lines Using E & M Signalling
T1.411 – 1995	Interface between Carriers and Customer Installations – Analogue Voicegrade Enhanced 911 Switched Access Using Network-Provided Reverse-Battery Signalling

The format of the title pages has been presented above as well as the simple sequence of words of the title.

F.3 Abbreviations

CI Customer Installation

NI Network Interface (as defined by the FCC Rules and Regulations Part 68, 1992, "Connection of terminal equipment to the telephone network")

F.4 d.c. conditions

F.4.1 Battery supply

A 48 volt d.c. Central Battery system is employed with the positive terminal traditionally connected to earth but the exchange battery is left floating with respect to earth on later model electronic exchanges.

Allowance must be made for a possible potential difference between the exchange earth and the customer's earth of ± 3 volts d.c.. Much larger earth potential differences may be encountered in special situations such as on circuits into Power stations.

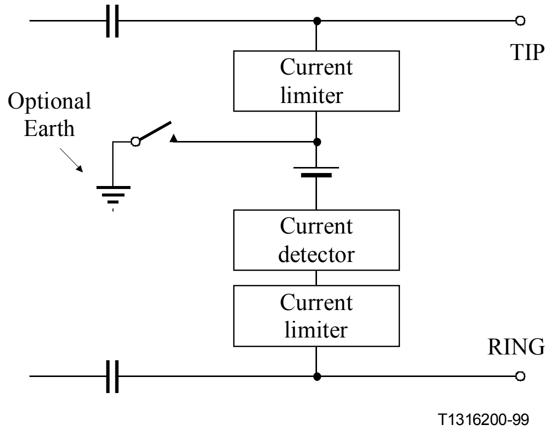


Figure F.1/I.572 – Schematic circuit of exchange interface

Terminal equipment should not rely on the polarity of the exchange battery supply for correct operation, i.e. the Tip may not always be the positive line terminal.

F.4.2 Battery connections at a 4-wire interface

When a 4-wire interface is being used the battery is available on the phantoms of the 4-wire connection (see Figure F.2).

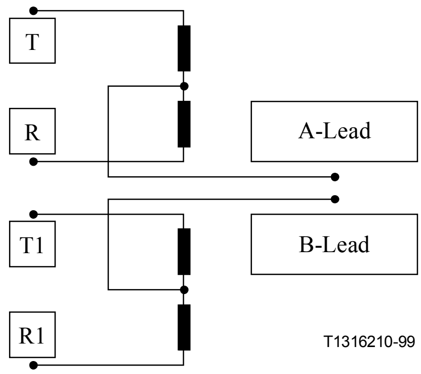


Figure F.2/I.572 – d.c. feeding arrangements for 4-wire interfaces

F.5 Interface states

The Customer's Interface operates with the following distinct states:

1) the Idle state;
2) the Service Request state;
3) the Addressing state;
4) the Call Processing;
5) the Ringing and Alerting state;
6) the Communications state.

F.5.1 Idle state

During the Idle state the voltage across the Customer's line interface, TIP and RING, may vary from 0 to 105 volts.

On new design exchanges the voltage should be 21 volts minimum into a 5 Mohms load.

Noises which may be confused with Ringing should not last longer than 125 ms.

An Insulation resistance of 30 Mohms is called for.

F.5.2 Service Request state

This state is entered when the customer initiates a calling condition towards the exchange. This may be one of 2 conditions:

a) a Loop is typical for single line installations; or
b) a calling earth, called a "ground start", for multiline installations such as PBXs.

The Loop condition is recognized in 180 ms minimum by the exchange. It must not encompass breaks of duration greater than 1 ms.

The ground start earth is applied to the RING via a 1050 ohm resistor and is used on busy lines to avoid dual seizure from both ends of the circuit during the 4 s pause in the ringing.

F.5.3 Addressing state

Dial tone is usually applied to the calling line by the exchange in less than 3 s but in the worst case it may never appear. There are different dial tones in different parts of the country.

Wait for at least 70 ms after receipt of dial tone before commencing dialling.

The exchange may reverse the battery polarity during dialling and it may insert breaks of up to 20 ms.

Dial-tone is usually removed within 500 ms of receiving the first digit.

The duration of the dialling phase is usually 20 to 40 s maximum.

If no digits are received for 5 s then dial tone is removed and an announcement issued.

A break of 1 s or greater is taken as an ON-HOOK condition.

Dialling pulses have the following specification; frequency from 8 to 11 pulses per seconds (PPS), break period from 58 to 64%, interdigit pause 700 ms minimum on electro-mechanical exchanges and 300 ms on electronic exchanges.

F.5.4 Call Processing state

The call processing state starts after the end of dialling. A break of 1 s or more will initiate clearing of the call.

F.5.5 Ringing and Alerting state

Some exchanges apply a "Ring Pre-Trip Test" before the start of ringing.

The exchange ringing current varies between exchanges. Its frequency can be anywhere between 15.3 to 68 Hz with a voltage range from 40 to 175 V r.m.s. and a crest factor from 1.2 to 1.6. The most common ringing supply is 20 Hz ± 3 Hz at a voltage of 40-106 V r.m.s.

The ringing current is applied at the same time as the exchange battery. The loop condition is recognized within 200 ms whatever the condition of the ringing supply.

The cadence of the ringing supply can be varied to signal different customers sharing the same line. Typically a pause of 4 s is included in the cadence.

F.5.6 Communication state

End-to-end communication can proceed.

A return to Idle state time of 1.5 s is required after the loop is broken.

A CSO alarm will be raised in the exchange after 12 s if the called customer does not clear down.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	**Integrated services digital network**
Series J	Transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
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Geneva, 2001