

ETSI TS 101 909-18 V1.1.1 (2002-08)

Technical Specification

**Digital Broadband Cable access to the public
telecommunications network;
IP Multimedia Time Critical Services;
Part 18: Embedded media terminal adapter (MTA) offering
analogue telephony services for PSTN terminals**



Reference

DTS/AT-020020-18

Keywords

IPCablecom, NGN

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Sous-Préfecture de Grasse (06) N° 7803/88

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access and Terminals (AT).

The present document is part 18 of a multi-part deliverable covering Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services. Full details of the entire series can be found in TS 101 909-1 [42].

Introduction

The cable industry in Europe and across other Global regions has already deployed broadband cable television hybrid fibre coax (HFC) data networks running the DOCSIS or EuroDOCSIS Cable Modem Protocol. The Cable Industry is in the rapid stages of deploying IP Voice and other time critical multimedia services over these broadband cable television networks.

The cable Industry has recognized the urgent need to develop ETSI Technical Specifications aimed at developing interoperable interface specifications and mechanisms for the delivery of end to end advanced real time IP multimedia time critical services over bi-directional broadband cable networks.

IPCablecom is a set of protocols and associated element functional requirements developed to deliver Quality-of-Service (QoS) enhanced secure IP multimedia time critical communications services using packetized data transmission technology to a consumer's home over the broadband cable television Hybrid Fibre/Coaxial (HFC) data network running the Cable Modem protocol. IPCablecom utilizes a network superstructure that overlays the two-way data-ready cable television network. While the initial service offerings in the IPCablecom product line are anticipated to be Packet Voice, the long-term project vision encompasses packet video and a large family of other packet-based services.

The Cable Industry is a global market and therefore the ETSI standards are developed to align with standards either already developed or under development in other regions. The ETSI Specifications are consistent with the CableLabs/ PacketCable set of specifications as published by the SCTE. An agreement has been established between ETSI and SCTE in the US to ensure, where appropriate, that the release of PacketCable and IPCablecom set of specifications are aligned and to avoid unnecessary duplication. The set of IPCablecom ETSI specifications also refers to ITU-SG9 draft and published recommendations relating to IP Cable Communication.

The whole set of multi-part ETSI deliverables to which the present document belongs specify a Cable Communication Service for the delivery of IP Multimedia Time Critical Services over a HFC Broadband Cable Network to the consumers home cable telecom terminal. 'IPCablecom' also refers to the ETSI working group program that must define and develop these ETSI deliverables.

1 Scope

IPCablecom has defined a set of protocols and associated element functional requirements in the TS 101 909 series of documents. These have been developed to deliver Quality-of-Service (QoS), enhanced secure IP multimedia time critical communication services, using packetized data transmission technology to a consumer's home over a cable television Hybrid Fibre/Coaxial (HFC) data network.

To facilitate maintenance and future enhancements to support other real-time multimedia services the TS 101 909 document series consist of multi-parts as detailed in TS 101 909 part 1: General.

The present document is: "Part 18: Embedded media terminal adapter (MTA) offering analogue telephony services for PSTN terminals' of the IPCablecom TS 101 909 series. The present document defines an analogue POTS presentation of an IPCablecom Termination Point (E-MTA) intended to deliver 3,1 kHz voiceband services equivalent to a Public Switched Telephone Network (PSTN) or equivalent network with short length 2-wire local loop.

NOTE: To be clear throughout the present document, the term "*CM/MTA*" will be used to denote an E-MTA.

The objective of the present document is to specify the physical and electrical characteristics of the CM/MTA interfaces that are part of an analogue POTS presentation of an IPCablecom CM/MTA particularly suitable for use by new network operators, or by operators operating in several European countries. The present document specifies characteristics of the CM/MTA to enable it to operate with most existing national PSTN Terminal Equipment (TE), and especially with PSTN TE designed according to the European standards for analogue presented TEs.

The electrical conditions specified at the CM/MTA are sufficient to ensure satisfactory operation of the following functions of TE:

- a) call control;
- b) transmission;
- c) dialling;
- d) ringing.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

- [1] ETSI TBR 21: "Terminal Equipment (TE); Attachment requirements for pan-European approval for connection to 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".
- [2] ETSI TBR 38: "Public Switched Telephone Network (PSTN); Attachment requirements for a terminal equipment incorporating an analogue handset function capable of supporting the justified case service when connected to the analogue interface of the PSTN in Europe".
- [3] ETSI ETS 300 659 (all parts): "Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services".
- [4] ETSI ETS 300 778: "Public Switched Telephone Network (PSTN); Protocol over the local loop for display and related services; Terminal Equipment requirements".

- [5] ITU-T Recommendation G.711 (1988): "Pulse code modulation (PCM) of voice frequencies".
- [6] ETSI TR 101 183: "Public Switched Telephone Network (PSTN); Analogue ringing signals".
- [7] ETSI ETR 206: "Public Switched Telephone Network (PSTN); Multi Frequency signalling system to be used for push-button telephones [CEPT Recommendation T/CS 46-02 E (1985)]".
- [8] ETSI ETR 201: "Public Switched Telephone Network (PSTN); Register-recall [CEPT Recommendation T/CS 20-09 E (1980)]".
- [9] ITU-T Recommendation Q.35 /E.180 (1998): "Technical characteristics of tones for the telephone service".
- [10] ETSI TR 101 041-1: "Human Factors (HF); European harmonization of network generated tones; Part 1: A review and recommendations".
- [11] ETSI ETR 344: "Terminal Equipment (TE); The technical feasibility of a harmonized plug and socket standard for European Public Switched Telephone Network (PSTN) access".
- [12] ETSI ES 201 187: "2-wire analogue voice band interfaces; Loop Disconnect (LD) dialling specific requirements".
- [13] ITU-T Recommendation Q.552 (11/2001): "Transmission Characteristics at 2-wire analogue interfaces of digital exchanges".
- [14] ITU-T Recommendation G.117 (1990): "Transmission aspects of unbalance about earth (definitions and methods)".
- [15] ITU-T Recommendation G.123 (1988): "Circuit noise in national networks".
- [16] ITU-T Recommendation G.101.1 (1993): "The Transmission Plan".
- [17] Directive 98/10/EC of the European Parliament and of the Council of 26 February 1998 on the application of open network provision (ONP) to voice telephony and on universal service for telecommunications in a competitive environment.
- [18] ITU-T Recommendation V.90 (1996): "In-band DCE control and synchronous data modes for asynchronous DTE".
- [19] ITU-T Recommendation J.112: "Transmission systems for interactive cable television services".
- [20] ETSI TS 101 909-2: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 2: Architectural framework for the delivery of time critical services over cable Television networks using cable modems".
- [21] ETSI TS 101 909-3: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 3: Audio Codec Requirements for the Provision of Bi-Directional Audio Service over Cable Television Networks using Cable Modems".
- [22] ETSI TS 101 909-4: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 4: Network Call Signalling Protocol".
- [23] ETSI TS 101 909-6: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 6: Media Terminal Adapter (MTA) device provisioning".
- [24] ETSI TS 101 909-8: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 8: Media Terminal Adapter (MTA) Management Information Base (MIB)".
- [25] ETSI TS 101 909-9: "Digital Broadband Cable Access to the Public Telecommunications Network; Part 9: Network Call Signalling (NCS) MIB Requirements".

- [26] ETSI TS 101 909-22: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 22: Management Event Messages".
- [27] Miniature 6-position plug as described in FCC 47, CFR 68.500 (10-1-98 Edition): "Code of Federal Regulations (USA); Title 47 Telecommunication; Chapter 1 Federal Communications Commission, Part 68 Connection of Terminal Equipment to the Telephone Network; Subpart F Connectors; Section 68.500 Specification".
- [28] ETSI TR 101 182: "Analogue Terminals and Access (ATA); Definitions, abbreviations and symbols".
- [29] ITU-T Recommendation J.161: "Audio codec requirements for the provision of bidirectional audio service over cable television networks using cable modems". .
- [30] ETSI TS 101 909-5: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 5: Dynamic Quality of Service for the Provision of Real Time Services over Cable Television Networks using Cable Modems".
- [31] ETSI TS 101 909-17 Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 17: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 17: Inter-domain Quality of Service".
- [32] ETSI EN 300 001: "Attachments to the Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface in the PSTN".
- [33] ETSI EG 201 050: "Speech Processing, Transmission and Quality Aspects (STQ); Overall Transmission Plan Aspects for Telephony in a Private Network".
- [34] ETSI TS 101 909-23: "Digital Broadband Cable Access to the Public Telecommunications Network; Part 23: IPAT - LCS (Internet Protocol Access Protocol - Line Control Signalling)".
- [35] ETSI ES 201 235: "Access and Terminals (AT); Specification of Dual-Tone Multi-Frequency (DTMF) Transmitters and Receivers".
- [36] ETSI ES 201 235-3: "Access and Terminals (AT); Specification of Dual-Tone Multi-Frequency (DTMF) Transmitters and Receivers; Part 3: Receivers".
- [37] ETSI ES 201 235-1: "Specification of Dual Tone Multi-Frequency (DTMF) Transmitters and Receivers; Part 1: General".
- [38] ETSI TR 101 768: "Public Switched Telephone Network (PSTN); Study on the generation of analogue ringing signals".
- [39] ETSI TR 101 959: "Access and Terminals (AT); Study on Ringing without DC (For TE and Terminal Support Interfaces)".
- [40] ETSI ES 201 729: "Public Switched Telephone Network (PSTN); 2-wire analogue voice band switched interfaces; Timed break recall (register recall); Specific requirements for terminals".
- [41] ETSI ES 201 912: "Access and Terminals (AT); Short Message Service (SMS) for PSTN/ISDN; Short Message Communication between a fixed network Short Message Terminal Equipment and a Short Message Service Centre".
- [42] ETSI ES 201 071: "Public Switched Telephone Network (PSTN); Protocol over the local loop for display services; Server Display and Script Services (SDSS)".
- [43] ETSI TS 101 909-1: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 1: General".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

access node: As used in TS 101 909-18 V1.1.1, an Access Node is a layer two termination device that terminates the network end of the ITU-T Recommendation J.112 connection. It is technology specific. In ITU-T Recommendation J.112 annex B it is the CMTS.

analogue POTS termination point: physical point at boundary of the IPCablecom System intended to accept the connection of a TE. May or not coincide with the Network Termination Point as specified in EU regulatory frame documents

answer signal: indication that a terminal is answering an incoming call

cable modem: device that terminates the IPCablecom Network and provides a data port to CPE devices

called party answer signal: signal, which may be provided at the call originating CM/MTA by the network to indicate that the called party, has answered the call

clear indication: indication that the network is attempting to release a connection

clear signal: signal indicating that a terminal is attempting to release a connection

customer premises equipment: devices that connect to the IPCablecom system that provide user interface to system services

NOTE: This includes devices that comply with specifications TBR 21 [1] and TBR 38 [2] but in general includes all User Telephony Devices (e.g. handsets, analogue modems, facsimile machines, Caller ID devices, etc.)

embedded media terminal adapter: MTA that is "embedded" (e.g. integrated) with a Cable Modem

end-of-call signal: signal provided at the CM/MTA by the network to indicate that the call has been released

IPCablecom: title of an ETSI working group project that has defined a system architecture and set of specifications that enable the delivery of real time services (such as telephony) over the cable television network

NOTE: Also refers to the specific System Architecture defined in ETSI TS 101 909 series of specifications.

loop state: state where the TE draws sufficient DC current that represents the Seize Signal

NOTE: The Loop state is also known as the on-line state or the off-hook state (see TBR 21 [1]).

media terminal adapter: device that provides an interface between the IPCablecom network and customer premises equipment. In theory a MTA may provide any one of a number of services to premises equipment. In the context of the present document the MTA provides an Analogue Telephony (POTS) termination point.

network call signalling: IPCablecom MGCP profile used for controlling calls

network termination point: physical point of connection that delineates (demarks) the end of the IPCablecom System and the start of the Customer Premises (network or equipment).

Off-hook: see loop state

On-hook: see quiescent state

ring burst: single, short period signal capable of ringing the TE ring circuit

ring splash: equivalent to ring burst

ringing state: condition of the network where a ringing/alerting signal has been applied at the CM/MTA

ring trip: removal of the ringing signal at the CM/MTA in response to a valid answer signal applied to the CM/MTA

seize signal: signal indicating that a terminal is attempting to establish a connection by means of applying a loop condition

stand-alone MTA: device that provides an interface between the IPCablecom Network and customer premises equipment. In the context of the present document the S-MTA is not "embedded" (e.g. integrated) with a Cable Modem, usually relying on the data port of a Cable Modem for Network connection. Specifications for the S-MTA are outside of the scope of the present document.

terminal equipment: devices that connect to the IPCablecom system that provide user interface to system services

NOTE: This includes devices that comply with TBR 21 [1] and TBR 38 [2] but in general includes all User Telephony Devices (e.g. handsets, analogue modems, facsimile machines, Caller ID devices, etc.)

telecommunications terminal equipment: customer premises equipment equivalent to CPE to TE

uninterruptible power source: primary power source (AC Power Supply) with a backup power source (battery) for when the primary input power fails

NOTE: The UPS provides a switchover to the backup source without disruption of power to the device being supplied.

quiescent state: state where the TE draws insufficient DC current to represent the Seize Signal

NOTE 1: The Quiescent state is also known as the idle state, off-line state or the on-hook state (see TBR 21 [1]).

NOTE 2: To be clear throughout the present document, the term "*CM/MTA*" will be used to denote an E-MTA.

NOTE 3: Also refer to TR 101 182 [28] for a collection of definitions used by analogue PSTN interfaces and terminals.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

dBV	absolute voltage level expressed as dB relative to 1 V
dBm	relative level of a signal in a transmission path referenced to 1 mW across the reference (characteristic) impedance of the path
dBm0	absolute power level in dBm referred to a point of zero relative level
dBm0p	absolute power level in dBm referred to a point of zero relative level, psophometric weighting
dBmp	absolute power level in dBm, psophometric weighting
dBr	relative level of a signal in a transmission path referred to the level at a reference point on the path
pWp	pico Watt, psophometric weighting

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

A/D	Analogue to Digital converter
AGC	Automatic Gain Control
ALASS	Analogue Local Access Signalling Services
CM	Cable Modem
CM/MTA	Cable Modem with Embedded Media Terminal Adapter (E-MTA)
CMS	Call Management Server
CPE	Customer Premise Equipment
D/A	Digital to Analogue converter
DTMF	Dual Tone Multi Frequency
E-MTA	Embedded Media Terminal Adapter
HFC	Hybrid Fiber Coax.
IDC	Insulation Displacement Connector
IDP	Inter-digital pause
LD	Loop Disconnect
LF	Loading Factor

LU	Loading Unit
MTA	Media Terminal Adapter
NCS	Network Call Signaling
NID	Network Interface Device
NIU	Network Interface Unit
NTP	Network Termination Point
OSS	Operations System Support
PICS	Protocol Implementation Conformance Statement
PL-EV	Primary Line Event
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
RLR	Receiving Loudness Rating
SLR	Sending Loudness Rating
S-MTA	Stand-alone MTA
SNMP	Simple Network Management Protocol
TE	Terminal Equipment
TTE	Telecommunications Terminal Equipment
UPS	Uninterruptible Power Source

4 Overview

The present document covers requirements for the E-MTA Analogue Telephony Interface. It is the intention of the present document to address requirements only for the E-MTA. The service referred to in the present document is voice-grade communications, including communications with stations on the public switched telephone network ("PSTN").

Two CM/MTA interfaces have been identified and will be defined in the present document: (1) CM/MTA Powering and (2) the Analogue POTS interface. A third CM/MTA interface, the HFC interface connection, is defined in ITU-T Recommendation J.112 [19].

The CM provides a high speed "data port" that may be of a type Ethernet and/or USB. The choice of which type is offered in a given CM is market driven. The present document does not cover the high speed "data ports".

The analogue POTS interface requirements ensure that CPE that meets telephone industry interoperability requirements (normal telephones, answering machines, etc.) will also operate in the IP-Cablecom environment. Note that the voice-grade analogue transmission requirements are dependent on the compression algorithm utilized to transport the packetized voice signal in the IP-Cablecom architecture. These requirements are derived from existing PSTN requirements that are based on a full 64 kbps voice channel. Therefore, the requirements specified are relevant only for ITU-T Recommendation G.711 [5] audio codec. Other audio codec compression algorithms specified by ITU-T Recommendation J.161 [29] are not currently addressed in the present document.

The performance at the CM/MTA is intended to ensure that:

- the interface presented by the CM/MTA will interwork successfully with TE compliant with PSTN TE TBRs (TBR 21 [1] and TBR 38 [2]) and will support voice band services accessible across the interface;
- the network being presented at the CM/MTA will not suffer harm as a result of signals normally appearing at such an interface, when used under real-life conditions, including when TE compliant with PSTN TBRs (TBR 21 [1] and TBR 38 [2]) are connected via the CM/MTA.

Should there be any conflicts between the present document and any reference document, the specifications in the present document take precedence and shall be followed.

The vendor must describe any functions that are provided at the CM/MTA such as protection or line test, insofar as these influence the behaviour at the CM/MTA.

Refer to TS 101 909-2 [20] for an overview of the System Architecture and clause 5.1 specifically for a description of a reference MTA architecture.

Vendors must provide a CM/MTA PICS declaration of the specific features and services that are supported in any CM/MTA model.

5 CM/MTA Power

The CM/MTA has two sources of input power; the HFC Network and the local premises AC Utility.

5.1 HFC Network Powering

The HFC Network is typically powered by distributed power nodes.

Powering of the CM/MTA by the HFC Network is for further study.

5.2 Premises Powering

This is the method of providing local AC utility power directly to the CM/MTA from a receptacle at the premises.

5.2.1 Mechanical Interface

The vendor must supply an appropriate AC mains line cord compliant with the appropriate harmonized safety standards or appropriate national safety standards.

5.2.2 Input Voltage

The device should operate at the normal AC Supply voltage tolerance ranges.

5.2.3 Telephony Service Availability Considerations

The delivery of a highly available Telephony service to the users is directly impacted by the reliability of the local AC utility provider. In some administrations it is necessary to provide alternate power to bridge across AC utility power loss.

The most common method of providing alternate power for the AC utility over relatively short periods of time is to provide a battery backup system.

The following requirements assume a battery backup system is employed. These requirements are not intended to dictate any specific implementation architecture or method as long as the functional goal of the backup system is achieved.

The implementation of a battery backup system is not required by the present document but may be subject to national regulation

5.2.3.1 Back Up Power Interruptions

5.2.3.1.1 AC Utility to Back Up Supply

The CM/MTA transition from AC utility power (power loss) to a Back Up power source (battery) must maintain all established voice and data connections.

5.2.3.1.2 Back Up Supply to AC Utility

The CM/MTA transition from a Back Up power source (battery) to the AC utility power (power restoration) must maintain all established voice and data connections.

5.2.3.2 Automatic Operation

The switching from AC utility power to battery back up must operate without service personnel or user intervention.

The switching from battery back up to AC utility power must operate without service personnel or user intervention.

If the battery is capable of being re-charged (e.g. secondary cell type), the battery charger operation (e.g. starting battery charge, ending battery charge, etc.) must operate without service personnel or user intervention.

5.2.3.3 Operation without battery

The CM/MTA must maintain all connection services if the battery is removed for service or replacement.

The CM/MTA must maintain all connection services if the battery is determined as requiring replacement, see clause 5.2.3.7.2.2.

5.2.3.4 Service Limitations

During operation on backup power, data connections may optionally be disabled.

Upon return of AC utility power, data connections must be enabled.

5.2.3.5 Battery Run Time

Battery run time is dependent on the CM/MTA design, the back up system efficiency and the size and type of back up battery. These parameters represent various trade off considerations to meet specific run time goals per local administration requirements and product costs.

It is not possible to define any specific run times across all administrations therefore; the present document leaves specific run time goals to national regulation.

The vendor must specify the expected run time of the CM/MTA assuming a battery in good condition with a full charge for a representative sample of modes of CM/MTA operation in accordance with national regulations or based on Operators specification where there is no national regulation. Since vendor equipment may be configured with different types and quantities of interfaces, it is the vendor obligation to provide the appropriate combinations of port states and modes as appropriate for the equipment being offered.

The minimum modes that must be specified:

- 1) Idle Run Time - the CM/MTA is supporting the required protocol overhead, one telephony port is provisioned, all other telephone and data ports are disabled (not provisioned) and there is no active telephony connection on the provisioned telephony port. At the end of the Idle Run Time the CM/MTA must still originate a single, three minute Telephony Connection without any other connection activity.
- 2) Provisioned Run Time - The CM/MTA is supporting the required protocol overhead, all telephony and data ports are provisioned, and there are no active telephony or data connections. At the end of the Provisioned Run Time the CM/MTA must still originate a single, three minute Telephony Connection without any other connection activity.
- 3) Data Run Time - The CM/MTA is supporting protocol overhead, all telephony ports are disabled (not provisioned), all data ports are provisioned, and with a full data rate connection active, unless disabled per clause 5.2.3.4.5.
- 4) Talk Run Time - the time the CM/MTA can support the required protocol overhead, all telephony and data ports are provisioned, and there is one continuous telephony connection and no data connections.
- 5) Full Load Run Time - the time the CM/MTA can support the required protocol overhead with all of the Telephony connections active and a full rate data connection, unless disabled per clause 5.2.3.4.

5.2.3.6 Battery Recharge Time

If the battery is capable of being re-charged (e.g. secondary cell type), the vendor must specify the time to recharge the back up battery to at least 80 % of its capacity after the return of the AC utility power assuming the battery was fully discharged.

5.2.3.7 Back Up Telemetry

In order to maintain the high availability provided by the back up battery the CM/MTA must monitor various AC utility and battery states and report them to the OSS system so that the operator can replace aged or defective back up systems.

5.2.3.7.1 Operations Support System (OSS) Event Reporting

The MTA MUST support the event and alarm reporting mechanism as defined in TS 101 909-22 [26]. This mechanism is used to configure the Line Events on the MTA. This mechanism is also used to report the Line Events in a local log or to send these events to an OSS back office system via SNMP or SYSLOG.

All Line Events MUST be defined as a matched pair of "set" and "cleared" events. Eight Line Events are programmable events and therefore MAY be redefined to support a meaning other than the battery-related meanings defined in the present document. If these Line Events are redefined, then the definition of the new meaning and any coordination between systems to support this new meaning is out of the scope of IPCablecom.

The "set" and "clear" events for the four alarm signals are defined below.

5.2.3.7.2 Telemetry Signals

5.2.3.7.2.1 Telemetry Signal 1 – AC Fail

The active alarm state of this signal indicates an "AC Fail" condition, which means the Back Up Supply, has detected a failure of the utility AC power and is operating off its battery.

The inactive alarm state of this signal indicates an "AC Restored" condition that means the Back Up Supply has detected the presence of utility AC power and is no longer operating off its battery.

PL-EV-1: active alarm state of telemetry signal 1; default meaning "AC Fail" and default severity MINOR

PL-EV-2: inactive alarm state of telemetry signal 1, default meaning "AC Restored"; PL-EV-2 always clears PL-EV-1

5.2.3.7.2.2 Telemetry Signal 2 – Replace Battery

The active alarm state of this signal indicates a "Replace Battery" condition which means the Back Up Supply, via internal test mechanisms outside the scope of the present document, has determined that the battery can no longer maintain a charge sufficient enough to provide the designed amount of battery run time and thus is failing and must be replaced with a new battery.

The inactive alarm state of this signal indicates a "Battery Good" condition.

PL-EV-3: active alarm state of telemetry signal 2; default meaning "Replace Battery" and default severity MINOR

PL-EV-4: inactive alarm state of telemetry signal 2; default meaning "Battery Good"; PL-EV-4 always clears PL-EV-3

5.2.3.7.2.3 Telemetry Signal 3 - Battery Missing

The active alarm state of this signal indicates a "Battery Missing" condition, which means the Back Up Supply has detected that a battery is not present and a battery must be installed to support the Back Up Supply.

The inactive alarm state of this signal indicates a "Battery Present" condition.

PL-EV-5: active alarm state of telemetry signal 3; default meaning "Battery Missing" and default severity MINOR

PL-EV-6: inactive alarm state of telemetry signal 3; default meaning "Battery Present"; PL-EV-6 always clears PL-EV-5

5.2.3.7.2.4 Telemetry Signal 4 - Battery Low

The active alarm state of this signal indicates a "Battery Low" condition. This condition is defined to mean that battery has sufficiently discharged (e.g., approximately 75 % to 80 % discharged) to the point where a power source can only be maintained for a short while longer.

The inactive alarm state of this signal indicates a "Battery Not Low" condition. This condition means that the battery has a charge capacity above the "battery low" threshold (e.g. at least 20 % to 25 % of full capacity).

PL-EV-7: active alarm state of telemetry signal 4; default meaning "Battery Low" and default severity MINOR

PL-EV-8: inactive alarm state of telemetry signal 4; default meaning "Battery Not Low"; PL-EV-8 always clears PL-EV-7

6 Analogue POTS Interface

The MTA analogue port represents an interface between the IPCablecom Network and Customer Premises Equipment (Telephony) designed to function when connected to the PSTN using standard PSTN interfaces. The subscriber side of this interface is an analogue interface consistent with the PSTN and the network side of this interface is a digital interface to the IP-based IPCablecom network, which rides on top of the J.112 transport. In this architecture, the MTA will reside at the subscriber premises, either inside or outside. The MTA will, in the context of the IPCablecom network, be analogueous with a PSTN NIU, NID or NTP reference point. Finally, because the network side of the port interface is digital, and the device resides close to the subscriber, the analogue subscriber side of the port interface will only be required to support relatively short metallic (copper twisted pair) drops (i.e. 150 metres or less).

In the IPCablecom System there are a number of system characteristics that are managed to achieve 'telephony quality' voice services. Reference is offered to TS 101 909-5 [30] and TS 101 909-17 [31] for technical details of these characteristics.

6.1 Mechanica aspects

The physical Analogue POTS line presentation shall be specified in such a way that a terminal manufacturer can supply a suitable terminal connector. The connection arrangements shall be according to the arrangement described below or by established practice (optional).

6.1.1 Harmonized arrangement

Where the CM/MTA is presented as a socket it shall be a socket capable of connecting with a miniature 6-position plug as specified in FCC 47 [27], CFR 68.502 clause (a 1) with contact assignments as specified in table 1. This connector is often referred to as RJ11.

Table 1: Contact Assignment

Pin-nr.	EG 201 188
1	Unspec.
2	Unspec.
3/4	Pair (a and b wire)
5	Unspec.
6	Unspec.

6.1.2 Other arrangements

6.1.2.1 Arrangement 1

Per local Administration approval, it is acceptable to provide two pair terminations presentation by the CM/MTA as a socket that must be capable of connecting with a miniature 6-position plug as specified in FCC 47 [27], CFR 68.502 clause (c1) with contact assignments as specified in Table 2. This connector is often referred to as RJ14.

Table 2: Arrangement 1

Pin-nr.	RJ 14
1	Unspec.
2	a2
3	b1
4	a1
5	b2
6	Unspec.

NOTE: Use of this option must be carefully considered with respect to EN 300 001 [32] which does not consistently define the two pair configurations across administrations and as a result, some conflicts between the RJ14 connections appear to exist when considering wiring plans with primary and secondary sockets, series terminals, earthing leads and 50 Hz metering leads.

6.1.2.2 Arrangement 2

Where the CM/MTA is presented as a wire termination point the physical presentation may (optional) be realized as a set of connection contacts (e.g. a screw terminal block, IDC) compatible with common telephony premises wiring (e.g. 0,4 mm to 0,5 mm) is required.

6.1.2.3 Further established practice

Existing installations may determine other connection arrangements.

6.2 Support of More Than One Terminal

A CM/MTA line presentation represented by the a-b termination point may support one or more terminals. The number of physical terminals is dependent on the Loading Factor the CM/MTA can support and the Loading Factors of each terminal(s) offer to the CM/MTA a-b terminals.

Then vendor must specify the CM/MTA Loading Factor capability in the PICs declaration as described in the following clauses.

Should the CM/MTA support more than one line presentation, the vendor must also specify how many line presentations are offered and if the Loading Factor is different for any of the line presentations.

6.2.1 Wiring arrangement

The vendor must describe the wiring arrangements for the connection of additional terminals on a single a-b termination. The instructions must be expressed in a way that makes it straight forward for an operator to add additional points for connection of terminals on the POTS interface premises wiring.

The vendor must describe any functions that are provided at the CM/MTA such as protection or line test, insofar as these influence the behaviour at the CM/MTA.

The performance at the CM/MTA is intended to ensure that:

- the interface presented by the CM/MTA will interwork successfully with TE compliant with PSTN TE TBRs (TBR 21 [1]) and will support voice band services accessible across the interface (TBR 38 [2]);
- the network being presented at the CM/MTA will not suffer harm as a result of signals normally appearing at such an interface, when used under normal operating conditions, including when TE compliant with PSTN TBRs (TBR 21 [1] and TBR 38 [2]) are connected via the CM/MTA.

Also refer to EG 201 120 (see Bibliography) for further detailed information.

6.2.2 Loading factors

The vendor must declare in the PICS declaration the maximum numbers of terminals per line that can be supported at the CM/MTA. This information must be supplied in terms of a Loading Factor (LF), as defined in EG 201 120 (see Bibliography).

The LF specified by the operator must be the lowest of the LFs for the individual parameters of table 3, rounded down to the nearest whole number. The minimum LF that the CM/MTA must support is to be defined by the local administration.

NOTE: In addition to the LF-value discussed above, the vendor is invited to also give the applicable values of each individual parameter. This more detailed information would enable an operator to take full advantage of the available resources at the CM/MTA.

Table 3: (Table 2 of EG 201 188 (see Bibliography)): Calculation of Loading Factors

Operating state of TE	Parameter	Test Method	Value for 100LU	Formula for calculation of LF and unit for input data
Quiescent	Resistance to earth	TBR21 [1], A.4.4.4	$R = 10 \text{ M}\Omega$	$1\ 000/R[\text{M}\Omega]$
Quiescent	DC resistance	TBR21 [1], A.4.4.1	$R = 1 \text{ M}\Omega$	$100/R[\text{M}\Omega]$
Ringing	Lowest impedance at 25 Hz	TBR21 [1], A.4.4.2.1	$Z = 4 \text{ k}\Omega$	$400/Z [\text{k}\Omega]$
Ringing	DC current during ringing	TBR21 [1], A.4.4.2.3	$I = 0,6 \text{ mA}$	$100 \times I / 0,6 [\text{mA}]$

6.2.2.1 Loading factor interpretation (informative)

Clauses 6.2.2.1.1 to 6.2.2.1.5 are of informative nature.

It is clear that the Loading Factors being defined are based on Terminal Equipment (TE) performance characterizations. The intent of using these Loading Factors in the present document is to define how much of a load the MTA can support on the a-b terminals. Therefore the MTA statement of Loading Factors relates to the magnitude of the load that can be supported, where as the TBR 21 Loading Factor relates to the load of an individual terminal (e.g. source capacity verses sink characteristics).

These views are intended to allow the connection of multiple terminals in combinations of parallel and series connections as long as the LF of the MTA is not exceeded. The MTA Vendor is required to state the minimum LF for the lowest of the four parameters in table 3, this being the maximum number of Terminal loads that can be attached to the MTA and still maintain proper operation.

As such it is necessary to extrapolate the TBR 21 [1] loading factor definitions to the MTA and to clearly interpret the meaning of the Vendor declaration of MTA loading factors (capacity).

NOTE: Caution must be exercised so as not to confuse Loading Units and Loading Factors with the number of Terminals being connected. Any Terminal will offer some number of Loading Units to contribute to the total Loading Factor.

There are four loading factors identified in table 3.

6.2.2.1.1 Resistance to Earth

TBR 21 [1] A.4.4.4 defines this as the resistance that exists from either the "a" or "b" terminal to the Terminal Equipment earthing point. From a MTA perspective this would represent an unbalance of the loop to the TE and could cause the MTA to incorrectly detect an off-hook condition. From an MTA perspective, if a sufficient number of terminals allow enough current to flow from the loop to Earth then the MTA would not be able to detect when the line was being released (on-hook).

Therefore the MTA LF must be linked to the on-line release current (resistance) so that when loaded with the maximum LF, the MTA will still detect the loop as being in the off-line state.

Assuming a MTA supports the "line release" condition on the loop as a loop resistance of 10 k Ω min.

Using the table 3 formula of $1\ 000/R$ [$M\Omega$] provides:

$$LF = (1\ 000/10k) M\Omega = 100k\ LU\ (\text{loading units})$$

This means that the MTA would be able to support Terminals with a combined LF of 100k and still detect an off-line (on-hook) state.

6.2.2.1.2 DC Resistance

The MTA LF must be linked to the on-line release current (resistance) so that when loaded with the maximum LF, the MTA will still detect the loop as being in the off-line state.

Assuming the same "line release" condition on the loop as a loop resistance of 10 k Ω min.

Using the table 3 formula of $100/R$ [$M\Omega$] provides:

$$LF = (100/10\ k) M\Omega = 10\ k\ LU\ (\text{loading units})$$

This means that the MTA would be able to support Terminals with a combined LF of 10k and still detect an off-line (on-hook) state.

NOTE: Clause A.4.4.1 of TBR 21 [1] defines this as the resistance that exists between the "a" and "b" terminals with the Terminal Equipment in the off-line (on-hook) state. From a MTA perspective this would represent a load resistance for the balance loop and could cause the MTA to potential detect an on-line (off-hook) condition. From an MTA perspective, if a sufficient number of terminals combined to represent a low enough resistance then the MTA would not be able to detect when the line was being released (on-hook).

6.2.2.1.3 Lowest Impedance at 25 Hz

Since the MTA is providing the ring voltage/current source the capability of the MTA generator must be converted into equivalent load impedance and then applied to the LF formula. Assuming a MTA that can provide the specified minimum ring voltage across a 1 400 Ω total ringer load on the a-b terminals (including loop resistance) then the LF for that MTA would be:

Using the table 3 formula of $400/Z$ [$k\Omega$]

$$LF = (400/1\ 400) k\Omega = 285\ LU\ (\text{loading units})$$

6.2.2.1.4 DC Current During Ringing

The MTA LF must be linked to the ring trip detection current so that when loaded with the maximum LF, the MTA will still maintain ringing voltage on the a-b terminals.

This also equates Ring Trip to the "Must not Seize line state" of clause 6.4.1 (e.g. 3 mA max)

Using the table 3 formula:

$$LF = 100 \times 3\ \text{mA}/0,6\ \text{mA} = 500\ LU$$

NOTE: Clause A.4.4.2.3 of TBR 21 [1] defines this as the DC current that flows from a 60 VDC source superimposed on a 25 Hz ring signal applied to the Terminal Equipment in the off-line (on-hook) state. Under these conditions the maximum current that is to flow to a single terminal is 0,6 mA.

From a MTA perspective this would represent a current that must not be detected as a ring trip condition. Again, from an MTA perspective, if a sufficient number of terminals combined to represent a high enough DC current during ringing then the MTA would immediately detect ring trip and essentially no ringing would occur on the a-b terminals.

6.2.2.1.5 PICS Declaration

Comparing the four parameter calculations it is clear that for the example MTA the maximum Loading Factor that can be supported is the ringer load of 285 Loading Units (LU) and this would be the value stated in the PICS declaration by the vendor.

6.3 D.C. feed conditions

6.3.1 Polarity

The polarity of the d.c. voltage presented by the CM/MTA is arbitrary with respect to the CM/MTA a-b terminals.

NOTE: For polarity reversal refer to clause 6.14.5.

6.3.2 Quiescent state

6.3.2.1 Maximum voltage

The maximum open circuit d.c. voltage presented between the a-b terminals of the CM/MTA must not exceed 78 V.

6.3.2.2 Minimum voltage

When a resistor with a value of $100/LF$ Mohm, where LF is the Vendor declared LF arising from clause 6.2.2 is connected between the A and B wires of the CM/MTA, the continuous d.c. voltage appearing at the CM/MTA must not be less than 38 V.

6.3.2.3 TE Supply Interruption

Many types of terminal equipment rely on the continuous application of exchange battery voltage for the correct functioning of features.

During the quiescent state the network feed voltage applied by the CM/MTA must not be removed for periods longer than 10 seconds for maintenance or other purposes (refer to clause 6.14.6).

6.3.3 Loop current

6.3.3.1 Loop current range

When a resistor with a value in the range 0Ω to 500Ω is connected between the a-b wires at the CM/MTA, a minimum d.c. current of 18 mA must flow but must never exceed 70 mA.

NOTE 1: 18 mA is the minimum current required to match the TE access requirements for interworking with the network.

NOTE 2: The resistance range represents the resistance of the internal wiring between CM/MTA and the sockets for TE connections and all TEs including one TE in the on line (off hook) state.

6.3.3.2 Loop Current Interruptions Caused by the Terminal

Brief loop current interruptions (where the current is no more than 1,0 mA) of 20 ms between the a-b wires must not cause any change of condition at the CM/MTA.

6.4 Seize signal

6.4.1 Must not seize condition

When a resistor with a value such as to cause a loop current not greater than 3,0 mA d.c. to flow is connected at the a-b wires of the CM/MTA, it must not be recognized by the network as a seize signal.

The CM/MTA must not recognize a seize condition when the loop current changes from quiescent to the Seized Loop Levels of clause 6.4.2 for a period of less than a value stated by the vendor. This value must not be less than 10 ms.

6.4.2 Must seize condition

When applied to a line that is in the Cleared State (see clause 6.5.1), a resistor with a value such as to cause a loop current not less than 10,0 mA d.c. to flow is connected for a period as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25] at the a-b wires of the CM/MTA, it must be correctly accepted by the CM/MTA as a seize signal.

Upon the detection of a Seized Condition, the CM/MTA must send the appropriate NCS message per TS 101 909-4 [22].

6.5 Clear signal

6.5.1 Must clear signal generated by TE

In order to ensure satisfactory operation of the seize/clear function, hysteresis must be provided between the seize and clear current. The Clear Signal Threshold current must be at least 0,5 mA lower than the seize signal threshold current of clause 6.4.2.

When the load applied at the a-b wires of the CM/MTA is such as to reduce the loop current below the Clear Signal Threshold current for a period greater than the Maximum Hook Flash (t_0) provisioned value as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25], then the CM/MTA must accept this as a clear signal and signal the CMS per the appropriate TS 101 909-4 [22] NCS message.

6.5.2 Clear indication from the network

Depending upon the network characteristics, a connection may be cleared:

- a) as a result of calling party TE providing a clear signal to the network; or
- b) as a result of either the calling party or the called party TE providing a clear signal to the network; or
- c) at the instigation of the network itself, independently of the state of the calling party or the called party.

Depending on the Network implementation architecture, a PSTN end-of-call signal may be generated by a Network element (e.g. the LE Switch or an Announcement Server) or by the CM/MTA when directed by the CMS. This end-of-call signal must be given as a release tone as specified in clause 6.13.1.

NOTE: If the CM/MTA is capable of providing other end-of-call signals in addition to the release tone, e.g. polarity reversal (see clause 6.14.5) or K-break (see clause 6.14.6), the vendor must declare this capability in the CM/MTA PICS document.

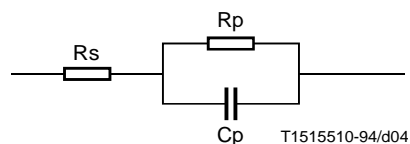
6.6 Seizing the line for a new call

After the network has recognized the call clear signal from the TE (see clause 6.5.1), the CM/MTA must allow the TE to seize the line for a new call according to clause 6.4. In particular, an event indicating that the TE has applied a new seizure condition must not be ignored whenever it occurs following recognition by the CM/MTA of a call clear signal.

6.7 POTS interface impedance

The impedance presented by the network between the a and b wires of the CM/MTA when in the loop state (Seized line) must have a return loss as shown in figure 1 with respect to the reference impedance:

$$Z_{ref} = (R_s = 270 \text{ Ohm in series with } (R_p = 750 \text{ } \Omega \text{ in parallel with } C_p = 150 \text{ nF})).$$



This requirement must be met for any d.c. current that can be delivered at the CM/MTA (i.e. between the short circuit current and 18 mA).

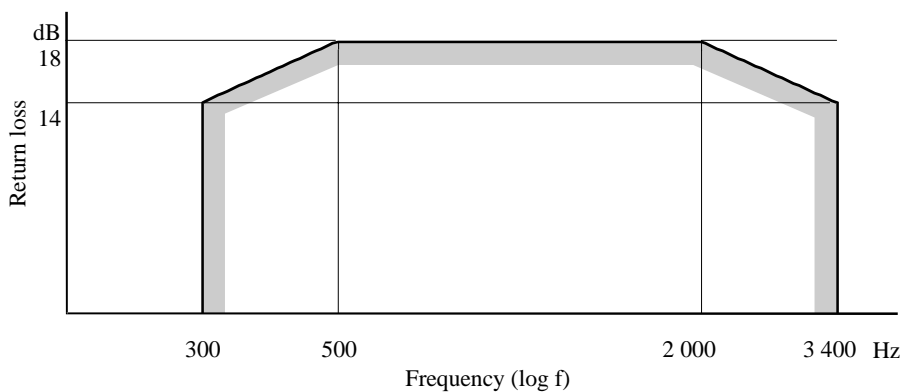


Figure 1: Minimum value of return loss against the test network for the exchange impedance at a 2-wire interface (figure 1/Q.552)

NOTE: It is advised that the design of the CM/MTA follows relevant ITU-T Recommendations, in particular Recommendation Q.552 [13].

Optional: The Z_{ref} may be modified per established national practice.

6.8 Balance about earth

A CM/MTA line Termination in the Seized State (e.g. "on line", "off hook", "talk mode"), must meet the balance about earth measured as Longitudinal Conversion Loss in figure 2.

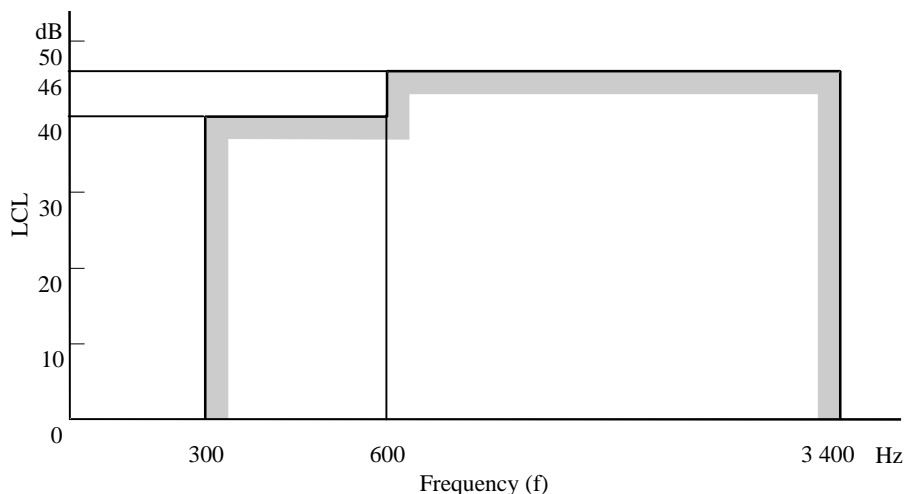


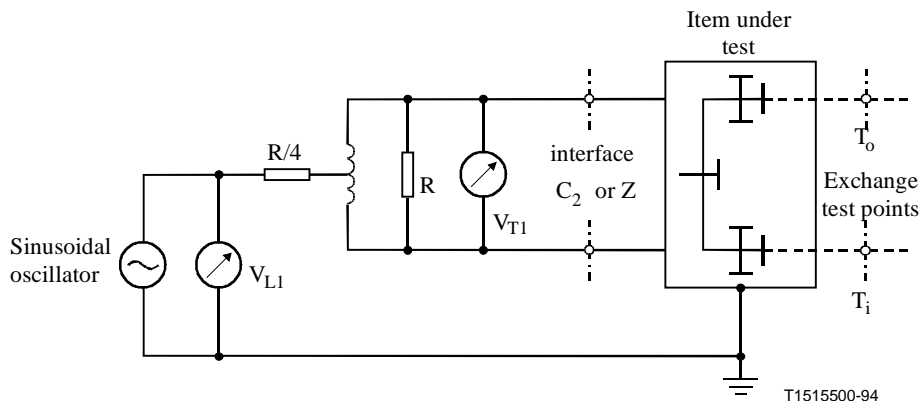
Figure 2: Minimum values of LCL measured in the arrangement shown in figure 3: /Q.552

NOTE: See ITU-T Recommendation Q.552 [13], clause 2.1.2.

Test Method

Longitudinal conversion loss at the a-b terminal should be measured in accordance with the principles given in clause 4.1 /ITU-T Rec. O.9. Figure 3 shows an example of the basic measuring arrangement for digital exchanges. Arrangements containing two resistors each of value $R/2$ may also be used (see clause 5.1/ITU-T Rec. O.9).

Measurements of the longitudinal and transverse voltages should preferably be done with a frequency-selective level meter.



R should be in the range of 600-900 Ω

$$\text{Longitudinal conversion loss (LCL)} = 20 \log_{10} \left| \frac{V_{L1}}{V_{T1}} \right| \text{ dB}$$

NOTE 1 – Provisions should be made for representative DC currents to be present.

NOTE 2 – Special care must be taken in those applications using active hybrids.

Figure 3: Arrangement for measuring LCL (Figure 3/Q.552)

6.9 Analogue transmission

The transmission performance aspects are given at the CM/MTA since the CM/MTA provides the digital network to analogue line interface conversion. It is advised that the design of such interface is based on ITU-T Recommendation Q.552 [13]. Interfaces complying with Q.552 will meet the requirements of this clause (note that Q.552 does not specify the exact value of relative levels).

Due to the fact that this is a specification of the CM/MTA that provides the digital network to analogue line interface, one observation point is available. Thus in principle it is not possible to state performance between two points. However, a fictitious point in the transmit and receive digital path (G.711 A-law PCM, 0 dBr) is established for reference purposes. The following subclauses are based on the existence of this fictitious point.

While the CM/MTA must comply with TS 101 909-3 [21] that may include low rate (compressed) codec support, the sub-clauses that follow assume a G.711 A-law PCM codec is being used.

The IPCablecom protocol allows the use of different size voice packets. The timings included in the sub-clauses that follow assume a 10 ms packet size.

The use of low rate codecs or different packet sizes may influence the following sub-clauses and these influences are subject to further study.

6.9.1 Transmission path establishment

The CM/MTA must establish a transmission path in less than 200 ms from the fictitious digital reference point to the analogue line.

bUpon receiving a MDCX or CRCX NCS message per TS 101 909-4 [22] (in either on-hook and off-hook state).

6.9.2 Transmission delay and other quality parameters

NOTE: This is for further study for future release of the present document.

6.9.3 Echo performance

The CM/MTA must implement Echo canceller devices per TS 101 909-3 [21] and the guidance on QoS in EG 201 050 [33].

6.9.4 Relative level

To enable full signal handling capacity, the nominal relative levels (at 1 020 Hz) at the CM/MTA must be:

Input relative level = +4 dBr;

Output relative level = -11 dBr.

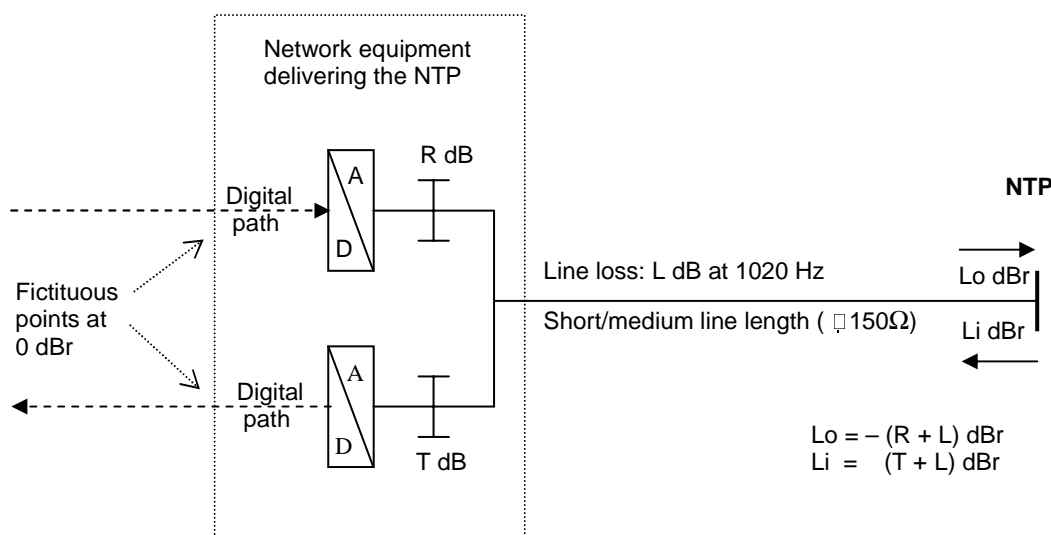
NOTE 1: The concept of relative levels is described in ITU-T Recommendation G.101.1 [16].

NOTE 2: These relative levels are chosen to obtain optimum performance for a speech telephony terminal in accordance with TBR 38 [2] having nominal SLR = +3 dB and RLR = -8 dB.

NOTE 3: Some types of CM/MTA that provides a constant d.c. current feeding with a low loop current setting may false the Automatic Gain Control (AGC) function of existing TEs. Therefore it is recommended that such CM/MTAs provide a method or function in order to provide acceptable TE performance under these conditions, especially on short line lengths.

OPTIONAL: The relative levels may be modified per established national practice. Alternate values must be declared in the CM/MTA PICS.

The relative level is assumed to be 0 dBr on the digital side of the analogue/digital conversion point in the local network. See figure 4.



6.9.5 Variation of gain with input level

With a sine wave test signal at the reference frequency 1 020 Hz and at a level between -55 dBm0 and + 3 dBm0 applied to the 2-wire analogue interface of any input connection, the gain variation of that connection, relative to the gain at an input level of -10 dBm0, shall lie within the limits given in figure 5. The measurement shall be made with a frequency selective level meter to reduce the effect of the environmental noise. This requires a sinusoidal test signal.

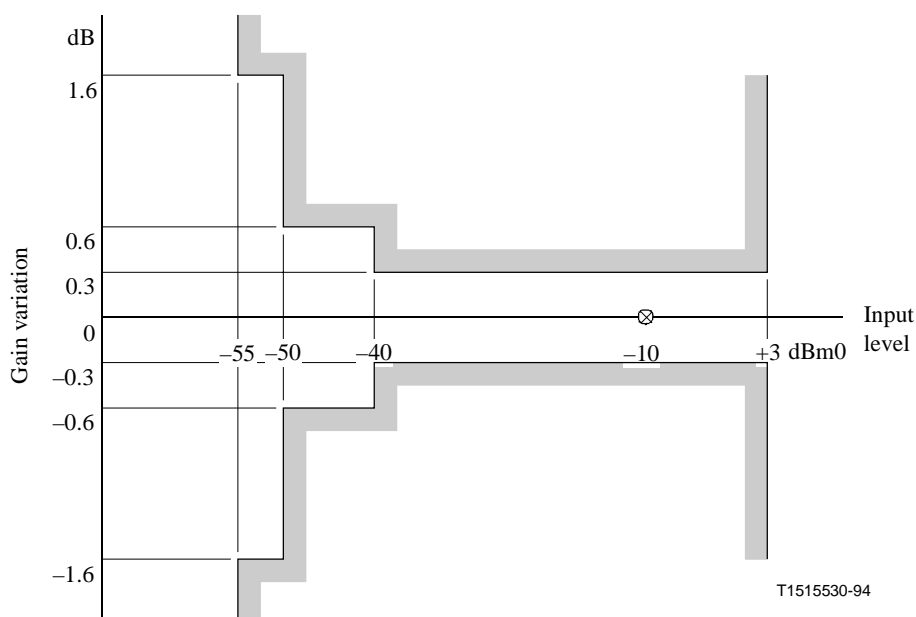


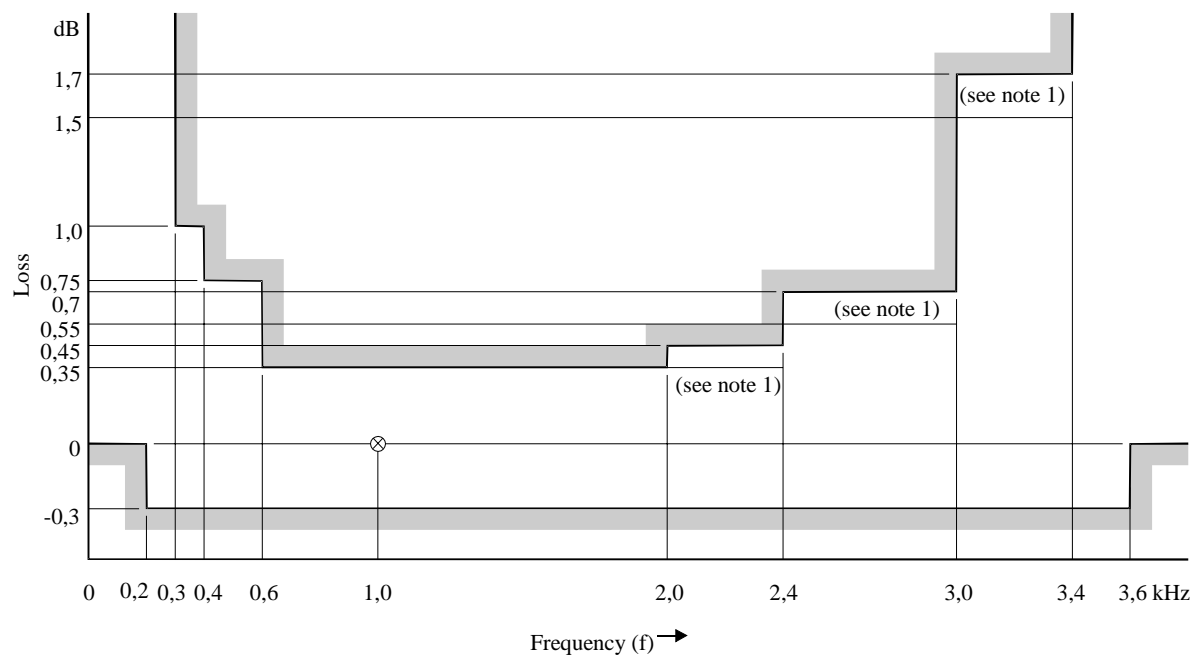
Figure 5: Variation of gain with input level (Figure 4/Q.552)

Per local Administrations the L_i value may be different and care should be exercised to coordinate any changes in L_i with regards to system performance and test conditions across the Input levels, noise and stability specifications.

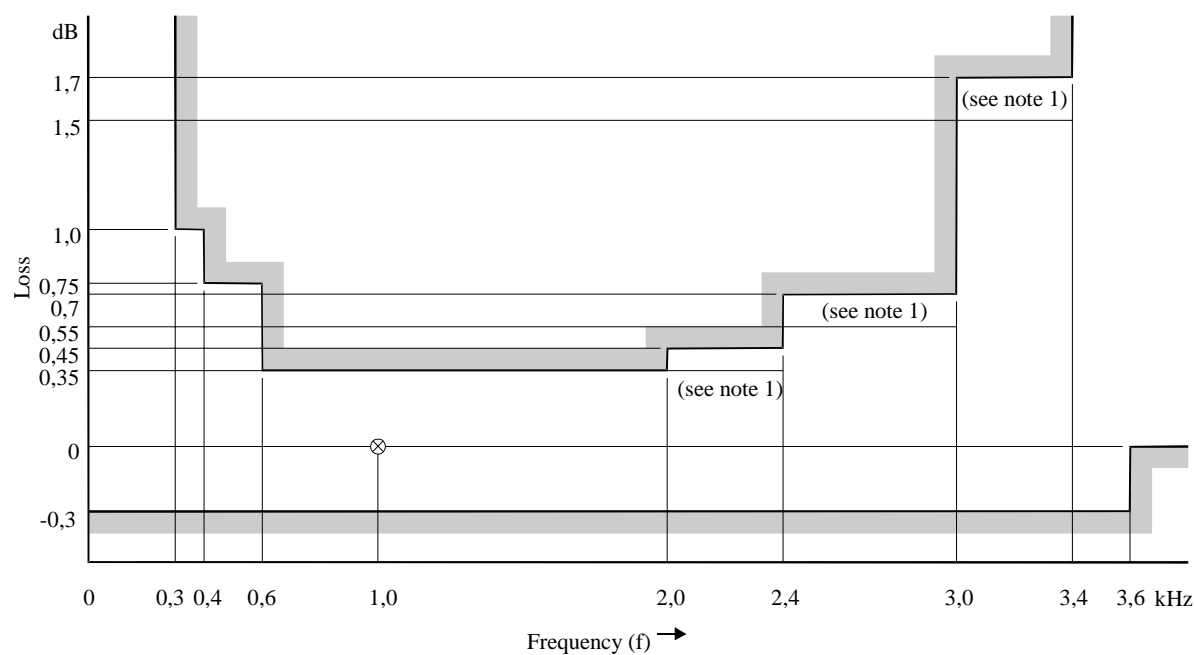
6.9.6 Loss distortion with frequency

The loss distortion with frequency of any input or output connection according to clause 1.2.5/Q.551 shall lie within the limits shown in the mask of figure 6a or figure 6b respectively using an input level of -10 dBm0.

NOTE: Attention is drawn to the need to accommodate voice band data applications that require a greater bandwidth for optimum operation (e.g. ITU-T Recommendation V.90 [18] modems). It is recommended that the bandwidth available be as wide as is practicable in order to accommodate such applications.



a) Input connection



b) Output connection

NOTE 1: In the marked frequency ranges relaxed limits are shown which apply if the maximum length of exchange cabling (see clause 2/Q.551) is used. The more stringent limits shown apply if no such cabling is present.

NOTE 2: In applying these specifications to the CM/MTA a-b terminals the more stringent limits apply.

Figure 6: Loss distortion with frequency (Figure 5/Q.552)

6.9.7 Audio coding law

The CM/MTA must support the Codec plan as defined in TS 101 909-3 [21] and as directed in NCS messages per TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

6.9.8 Noise

6.9.8.1 Weighted noise

6.9.8.1.1 Output connection per Q.552 clause 3.2.2.1.1

For an output relative level of $L_o = -11.0$ dBr the resulting maximum total noise level L_{TNO} for the output connection is:

L_o (dBr)	L_{INO} (dBm0p)	P_{AN} (pWp)	P_{TNO} (pWp)	L_{TNO} (dBmp)
-11	-75	200	202.51	-66.94

Per local administration, if the L_o plan is different from -11 dBr (see clause 6.9.4), then the noise specification will need to be re-stated per guidance of ITU-T Recommendation Q.552 [13].

6.9.8.1.2 Input connection per Q.552 clause 3.2.2.1.2

The total maximum psophometric power L_{TNI} allowed at the fictitious test point (see clause 6.9) with an input relative level of $L_i = 4$ dBr is:

L_i (dBr)	L_{INI} (dBm0p)	P_{AN} (pWp)	P_{TNI} (pWp)	L_{TNI} (dBmp)
4	-67	200	279.15	-65,54

Per local administration, if the L_i plan is different from 4 dBr (clause 6.9.4), then the noise specification will need to be re-stated per guidance of ITU-T Recommendation Q.552 [13].

6.9.8.2 Single frequency noise

The level of any single frequency (in particular the sampling frequency and its multiples), measured selectively at the interface of an output connection, shall not exceed -50 dBm0.

Between 300 Hz and 3 400 Hz, the level of any single frequency measured selectively and corrected by the psophometric weighting factor (see Table 1/O.41) shall not exceed -73 dBm0p (provisional value).

NOTE: See 1.2.3.1/Q.551 with regard to common measurement conditions.

6.9.9 Crosstalk

Only applicable for CM/MTA that provides more than one analogue Telephony interface.

For crosstalk measurements, auxiliary signals are injected as indicated in figure 7 and figure 8.

NOTE: A CM/MTA that only supports two analogue Telephony interfaces must test for NEXT and FEXT separately since only two analogue interfaces are available for signal application and measurement.

These signals are:

- the quiet code (see clause 1.2.3.1 of ITU-T Recommendation Q.551);
- a low level activating signal, e.g. a sine wave at a level in the range from -33 dBm0 to -40 dBm0. Care must be taken in the choice of frequency and the filtering characteristics of the measuring apparatus in order that the activating signal does not significantly affect the accuracy of the crosstalk measurement.

6.9.9.1 Far-end and near-end crosstalk measured with 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 2-wire interface, shall not produce a level in any other half-connection exceeding -73 dBm0 for near-end crosstalk (NEXT) and -70 dBm0 for far-end crosstalk (FEXT) (see figure 7).

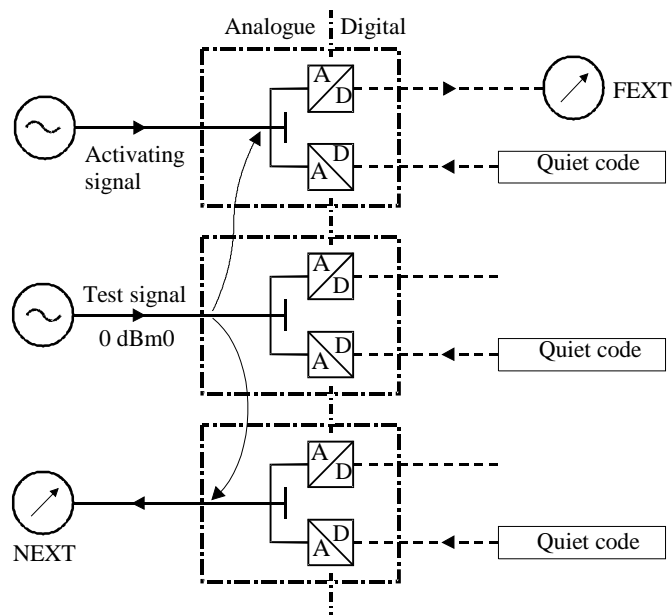


Figure 7: FEXT and NEXT measurements with analogue test signal (Figure 7/Q.552)

6.9.9.2 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 applied at a level of 0 dBm0 to the fictitious test point (see clause 6.9), shall not produce a level in any other half-connection exceeding -70 dBm0 for near-end crosstalk (NEXT) and -73 dBm0 for far-end crosstalk (FEXT) (see figure 8).

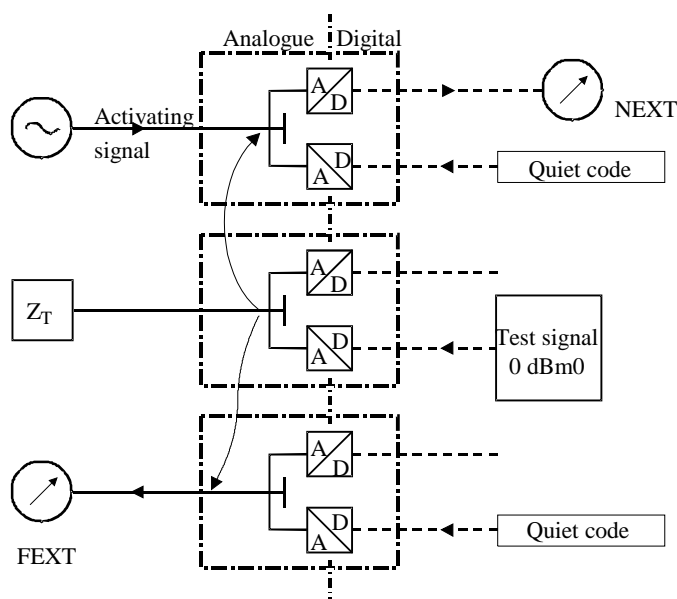


Figure 8: FEXT and NEXT measurements with digital test signal (Figure 8/Q.552)

6.9.10 Total distortion including quantizing distortion

With a sine wave test signal at the reference frequency of 1020 Hz (see ITU-T Recommendation O.132) applied to the 2-wire interface of an input connection, or with a digitally simulated sine wave signal of the same characteristic applied to the fictitious digital reference point defined in clause 6.9 of an output connection, the signal-to-total-distortion ratio, measured at the corresponding outputs of the half-connection with a proper noise weighting (see Table 1/O.41) shall lie above the limits given in figure 9.

NOTE: The sinusoidal test signal is chosen to obtain results independent of the spectral content of the exchange noise.

Resulting templates for the signal-to-total distortion ratio of input and output connections in a local exchange are shown in figure 9 per clause 6.9.4 where $L_i = 4$ dBr and $L_o = -11$ dBr are defined.

The signal-to-total distortion ratio for other relative levels as defined by the local administration can be calculated by using the formula given in clause 3.4.2 of ITU-T Recommendation Q.551. If the Local Administration specifies alternate levels the Vendor should state in the PICS declaration the calculated values based on the alternate levels.

The values of figure 9 include the limits for the coding process given in figure 12 of ITU-T Recommendation G.712 and the allowance for the noise contributed via signalling circuits from the exchange power supply and other analogue sources, which is limited to -67 dBmp for an a-b (Z) interface (with feeding) by annex A of ITU-T Recommendation G.123 [15].

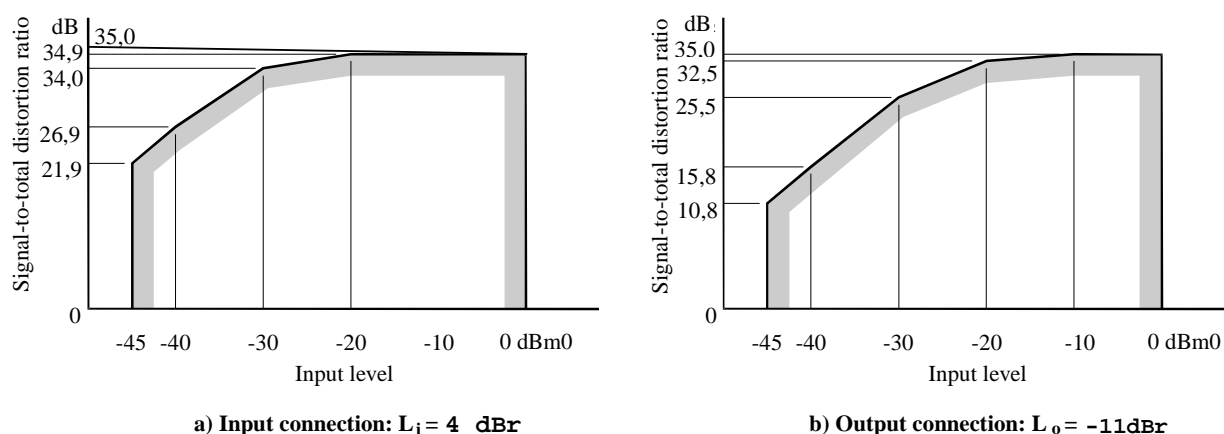


Figure 9: Limits for signal-to total distortion ration as a function of input level (a) and output level (b) including analogue noise, input connection $L_i=4$ dBr and $L_o = -11$ dBr with signalling on separate wires

NOTE: The levels shown in figures 9a and 9b are not the same as figure 8 of ITU-T Recommendation Q.552 [13] because Q.552 assumes values of $L_i = 0$ dBr and $L_o = -7$ dBr.

6.9.11 Discrimination against out-of-band signals applied to the input interface

This clause is only applicable to input connections.

6.9.11.1 Input signals above 4,6 kHz

With a sine-wave signal in the range from 4,6 kHz to 72 kHz applied to the 2-wire interface of an input connection at a level of -25 dBm0, the level of any image frequency produced at the fictitious digital reference point defined in clause 6.9 corresponding to the input connection shall be at least 25 dB below the level of the test signal.

6.9.11.2 Overall requirement

Under the most adverse conditions encountered in a national network, the half-connection should not contribute more than 100 pW0p of additional noise in the band 10 Hz to 4 kHz at the output of the input connection, as a result of the presence of out-of-band signals at the 2-wire interface of the input connection.

6.9.12 Spurious out-of-band signals received at the output interface

This clause is only applicable to an output connection.

6.9.12.1 Level of individual components

With a digitally simulated sine wave signal in the frequency range 300 Hz to 3 400 Hz and at a level of 0 dBm0 applied to the fictitious digital reference point defined in clause 6.9 of a half-connection, the level of spurious out-of-band image signals measured selectively at the 2-wire interface of the output connection shall be lower than -25 dBm0.

6.9.12.2 Overall requirement

Spurious out-of-band signals should not give rise to unacceptable interference in equipment connected to the IPCablecom network. In particular, the intelligible and unintelligible crosstalk in a connected channel should not exceed a level of -65 dBm0 as a consequence of spurious out-of-band signals at the half-connections.

6.9.13 Echo and stability

Terminal Balance Return Loss (TBRL) as defined in ITU-T Recommendation Q.552 [13] clause 3.1.8.1 is introduced in order to characterize the CM/MTA performance required to comply with the network performance objective of ITU-T Recommendation G.122 with respect to echo and stability.

The TBRL of an interface is measured in the talking state as in an established connection through the fictitious digital reference point defined in clause 6.9.

The parameter "Stability Loss", as defined in Recommendation G.122, applies to the worst terminating conditions encountered at a 2-wire interface in normal operation.

Using the arrangement of figure 10 (figure 9 of ITU-T Recommendation Q.552 [13]) and sinusoidal test signals, the measured TBRL should exceed the limits shown in figure 11. The Balance Test Network reference impedance is the network given in clause 6.7. Optionally, in special cases, the reference impedance may be modified according specific network practice.

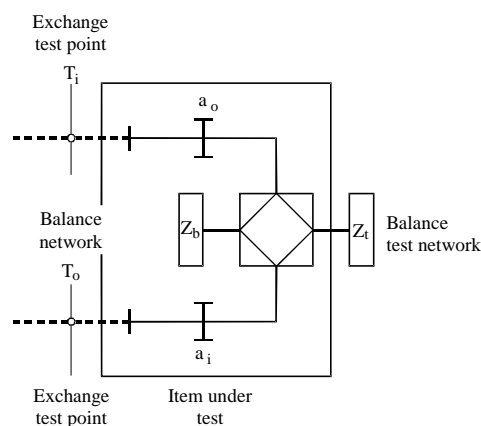


Figure 10: Arrangement for measuring the loss a_{i_0} (Figure 9/Q.552)

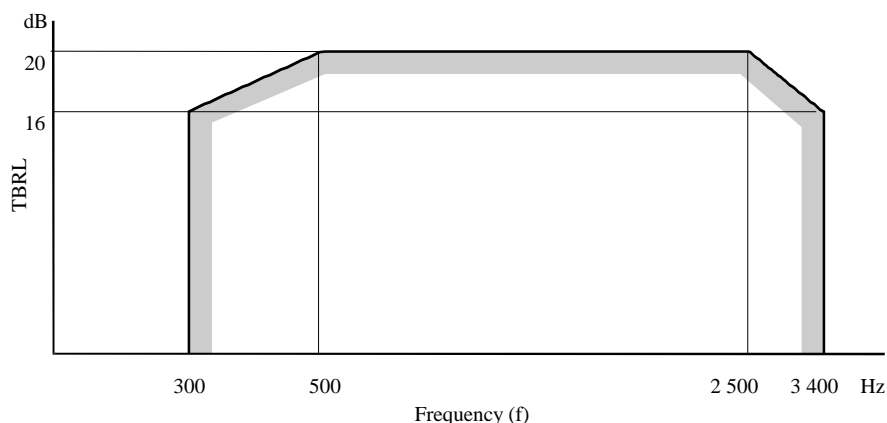


Figure 11: Limits for TBRL (Figure 10/Q.552)

6.10 Dialling

6.10.1 Dual tone multi frequency dialling

Support of Dual Tone Multi Frequency (DTMF) dialling is required.

Depending on the Network implementation architecture (e.g. LE Switch per TS 101 909-23 [34]), the CM/MTA may be required to pass the DTMF signalling from the analogue POTS interface to any network element (e.g. LE Switch) or in a non-switch architecture the CM/MTA may be required to detect and decode the DTMF Signals according to ES 201 235 [35] (see note 1), and signal the decoded digits to the CMS per the appropriate TS 101 909-4 [22] NCS message as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

NOTE 1: Decode DTMF digits across the range of -5,0 dBV to -15,0 dBV. Levels taken from the DTMF transmit level of TBR 21 [1] plus a small margin. The levels are not the same as in the DTMF receiver standard ES 201 235-3 [36], which specifies a reception range between -2 dBV to -28 dBV. The reason for this deviation is that this present document specifies requirements at the CM/MTA where the line length to the terminal is very short (150 metres). This means that the levels appearing at the CM/MTA will be approximately the same as the levels transmitted from the terminal.

NOTE 2: See ES 201 235-1 [37] and ES 201 235-3 [36] for more information on DTMF receivers.

6.10.2 Loop disconnect dialling

OPTIONAL: Loop Disconnect dialling (Pulse Dialling) see clause 6.14.1.

6.11 Dial tone

6.11.1 Delay

Depending on the Network implementation architecture, the CM/MTA may be required to pass the dial tone signals (e.g. LE Switch per TS 101 909-23 [34]) to the analogue POTS interface or the CM/MTA may be required to generate the Dial Tone Signals per the appropriate NCS message per TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

In the TS 101 909-23 [34] architecture, the CM/MTA adds transmission delay per clause 6.9.1 to the overall network element signalling and transmission delays to make up the Dial Tone delay time.

When directed to generate dial tone per TS 101 909-4 [22], the CM/MTA must generate dial tone within 250 ms of the detection of a valid seize signal per clause 6.4.

6.11.2 Removal

Depending on the Network implementation architecture, the CM/MTA may be required to pass dialling signals (e.g. LE Switch per TS 101 909-23 [34]) from the analogue POTS interface or the CM/MTA may be required to disable dial tone signals per the appropriate NCS message per TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

In the TS 101 909-23 [34] architecture, the CM/MTA must pass DTMF signals per clause 6.10 or decode loop disconnect dialling signals per clause 6.14.1. In this architecture, the delay in dial tone removal is dependent on the overall network element signalling, transmission and device (LE Switch) delays in addition to the delays encountered in either clauses 6.10 or clause 6.14.1.

When directed to remove dial tone per TS 101 909-4 [22], the CM/MTA must remove the dial tone within 250 ms of the detection of the first valid digit by either clause 6.10 or clause 6.14.1.

6.11.3 Signal characteristics

See in clause 6.13 the signal characteristics.

6.12 Ringing

6.12.1 Waveshape

The CM/MTA must provide a ringing supply with a nominal frequency per the appropriate NCS message per TS 101 909-4 [22] as defined by provisioning or configuration per TS 101 909-6 [23] and TS 101 909-9 [25] ± 1 Hz.

NOTE: The harmonized frequency value according ES 201 970 (see Bibliography) is 25 Hz; common ring frequencies are 20 Hz and 50 Hz. However, 20 Hz is not widely used in Europe and some TE do not respond to 20 Hz signals in some countries probably due to the fact that it represents harmonic values of the loop disconnect dialling. There are also European networks using 50Hz signals for meter pulse signalling.

It is recommended that the ringing signal is balanced with respect to earth and applied to the a-b terminals 180° out of phase.

OPTIONAL: The a.c ringing signal may be superimposed on a d.c. voltage as specified in clause 6.3.2.

In any case, where the ringing signal is not superimposed on a d.c. voltage, a d.c. voltage must be presented during the off (silent) parts of the ring cadence.

6.12.1.1 Option 1 Sinusoidal Waveshape

A sinusoidal waveshape must be essentially symmetrical with an even order harmonic content not exceeding 5 %.

6.12.1.2 Option 2 Non-Sinusoidal Waveshape

A non-sinusoidal waveshape must be essentially symmetrical with a peak to rms voltage ratio in the range 1,2 to 1,6.

6.12.2 Ringing drive capability per line

The open circuit a.c. voltage must not exceed 100 V_{rms} at the CM/MTA interface.

The CM/MTA must provide sufficient ringing current so as to produce a voltage not less than 35 V rms across an a.c. load of 400/LF k Ω , where LF is the stated LF arising from clause 6.2.2.

OPTION: A lower capability may be provided per local administration agreement.

NOTE 1: A single TE may present a load of 4 k Ω at the CM/MTA. However, terminals normally present considerably higher impedance at the CM/MTA.

NOTE 2: Caution must be observed so as not to exceed national practice for duration-limited source safety.

NOTE 3: Additional guidance is offered in TR 101 768 [38] and TR 101 959 [39] on overlap feeding (DC) and ringing (AC) voltages.

6.12.3 Ring generator capacity

A CM/MTA that supports more than one Telephony interface must have sufficient ringing capacity to ring at least two interfaces simultaneously with the full line load as defined in clause 6.12.2.

OPTION: A lower capacity may be provided per local administration agreement.

NOTE: In an IPAT/LE architecture using the TS 101 909-4 [22] "L" line package, the CM/MTA operates as a "slave" to the V5 ring cadence in order to meet timing requirements for the LE generated "On Hook" data (e.g. CLID) transmission. To meet the LE timing requirements, the Ring Cadence Delay per clause 6.12.4.1 and the Ring Burst Delay per clause 6.12.5.1 must be met. In this architecture, the capability to ring all available lines with the full line load as defined in clause 6.12.2 must be met.

In the Softswitch architecture the CM/MTA rings the lines autonomously and locally times and generates "On Hook" data (e.g. CLID) transmission. In this mode the local administration may allow delayed (e.g. staggered) ringing across multiple lines to load share the ringer capacity.

In an IPAT/LE architecture using the TS 101 909-4 [22] "E" line package, the CM/MTA has the capability to signal the end of the first ring burst (e.g. operation complete) so that the IPAT/LE can then generate the "On Hook" data (e.g. CLID) transmission. This enables the CM/MTA to delay (e.g. stagger) ring cadences across multiple lines so as to load share the ringer capacity in a manner similar to the Softswitch architecture.

6.12.4 Ring cadence

Ringing cadence is defined in the appropriate NCS message per TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

6.12.4.1 Ring cadence delay

The CM/MTA must apply the appropriate ring cadence within 50 ms of the receipt of the NCS ring cadence message.

NOTE: In an IPAT/LE architecture using the TS 101 909-4 [22] "L" line package, the CM/MTA operates as a "slave" to the V5 ring cadence in order to meet timing requirements for the LE generated "On Hook" data (e.g. CLID) transmission. To meet the LE timing requirements, the Ring Cadence Delay per this clause and the Ring Burst Delay per clause 6.12.5.1 must be met. In this architecture, the capability to ring all available lines with the full line load as defined in clause 6.12.2 must be met

In the Softswitch architecture the CM/MTA rings the lines autonomously and locally times and generates "On Hook" data (e.g. CLID) transmission. In this mode the local administration may allow delayed (e.g. staggered) ringing across multiple lines to load share the ringer capacity. In this architecture the staggered ringing algorithms in the CM/MTA supersede the Ring Cadence Delay per this clause and the Ring Burst Delay as defined in clause 6.12.5.1.

In an IPAT/LE architecture using the TS 101 909-4 [22] "E" line package, the CM/MTA has the capability to signal the end of the first ring burst (e.g. operation complete) so that the IPAT/LE can then generate the "On Hook" data (e.g. CLID) transmission. This enables the CM/MTA to delay (e.g. stagger) ring cadences across multiple lines so as to load share the ringer capacity in a manner similar to the Softswitch architecture. In this architecture the staggered ringing algorithms in the CM/MTA supersede the Ring Cadence Delay per this clause and the Ring Burst Delay as defined in clause 6.12.5.1.

6.12.4.2 Ring cadence timing distortion

The ring cadence timing distortion must be within ± 50 ms of the defined ring cadence timing.

6.12.5 Ring burst (Ring Splash)

Ring burst (Ring Splash) is defined in the appropriate NCS message per TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

6.12.5.1 Ring burst delay

The CM/MTA must apply the appropriate ring burst within 50 ms of the receipt of the NCS ring cadence message.

NOTE: In an IPAT/LE architecture using the TS 101 909-4 [22] "L" line package, the CM/MTA operates as a "slave" to the V5 ring cadence in order to meet timing requirements for the LE generated on hook data (CLID) transmission. To meet the LE timing requirements, the Ring Cadence Delay per clause 6.12.4.1 and the Ring Burst Delay per this clause must be met. In this architecture, the capability to ring all available lines with the full line load as defined in clause 6.12.2 must be met.

In the Softswitch architecture the CM/MTA rings the lines autonomously and locally times and generates on hook data (e.g. CLID) transmission. In this mode the local administration may allow delayed (e.g. staggered) ringing across multiple lines to load share the ringer capacity. In this architecture the staggered ringing algorithms in the CM/MTA supersede the Ring Cadence Delay per clause 6.12.4.1 and the Ring Burst Delay per this clause.

In an IPAT/LE architecture using the TS 101 909-4 [22] "E" line package, the CM/MTA has the capability to signal the end of the first ring burst (e.g. operation complete) so that the IPAT/LE can then generate the on hook Data (e.g. CLID) transmission. This enables the CM/MTA to delay (e.g. stagger) ring cadences across multiple lines so as to load share the ringer capacity in a manner similar to the Softswitch architecture. In this architecture the staggered ringing algorithms in the CM/MTA supersede the Ring Cadence Delay per clause 6.12.4.1 and the Ring Burst Delay per this clause.

6.12.5.2 Ring burst timing distortion

The ring burst timing distortion must be within ± 50 ms of the defined ring burst timing.

6.12.6 Ring trip

Any ringing signal presented by the CM/MTA must be removed within 200 ms of a line seizure signal consisting of a d.c. condition as defined in clause 6.4 being applied to the CM/MTA.

Upon detection of the Ring Trip, the CM/MTA must transmit the appropriate NCS message per TS 101 909-4 [22].

6.13 Supervisory signals

NOTE 1: Further information on tones generated by the network may be found in TR 101 041-1 [10].

NOTE 2: The tones specified in this clause are in accordance with ITU-T Recommendation Q.35/E.180 [9].

Depending on the Network implementation architecture, the CM/MTA may be required to pass the supervisory signals (e.g. LE Switch per TS 101 909-23 [34]) to the analogue POTS interface or the CM/MTA may be required to generate the Supervisory Signals per the appropriate NCS message per TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

6.13.1 Supervisory tones

The following types of supervisory tone must be provided:

- a) dial tone;
- b) number unobtainable tone;
- c) ring tone;
- d) busy tone.

When directed to generate tones per the appropriate NCS message per TS 101 909-4 [22], the frequency and amplitude of the tones must be as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

It is recommended that the following additional supervisory tones are also provided:

- e) release tone (if such a tone is used as specified in clause 6.5.2);
- f) special dial tone (often used to indicate the presence of messages waiting, or call forward activated);
- g) special information tone;
- h) release tone (if not provided as e) above);
- i) call waiting tone;
- j) congestion tone.

6.13.2 Tone levels

The level of supervisory tones applied by the CM/MTA across the reference impedance load Z_{ref} , should be within the range of $-18 \text{ dBV} \pm 6 \text{ dBV}$.

Depending on Network implementation architecture, this level may be a function of the LE Switch generated level less the CM/MTA "Lo" loss (clause 6.9.4) or the level may be per the appropriate NCS message per TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

6.13.3 Cadences and frequencies

Depending on the Network implementation, cadences and frequencies may be supplied by another network element (e.g. LE Switch or Announcement Server) or they may be generated by the CM/MTA per the appropriate NCS message per TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

6.14 Optional functions

Each of the functions listed in this clause are to be considered independent options unless specified otherwise. The Vendor must declare in the CM/MTA PICS document which of these options is supported.

6.14.1 Loop disconnect dialling

The CM/MTA must recognize breaks in the loop current below the Clear Signal Threshold current of clause 6.5 and correctly interpret them in time as Loop Disconnect (LD) signals as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25] and must send the appropriate NCS message per TS 101 909-4 [22].

NOTE 1: Terminals with automatic LD signalling will normally generate pulse trains with a maximum IDP of 920 ms. It is possible for terminals with manual LD signalling to exceed this limit.

NOTE 2: Information on the requirements for TE with LD signalling capability may be found in ES 201 187 [12].

6.14.2 Register recall (Hook Flash)

The CM/MTA shall recognize breaks in the loop current below the Clear Signal Threshold current of clause 6.5 and as defined in time by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25] applied at the CM/MTA as a register recall signal. In response to a Register Recall signal the CM/MTA must send the appropriate NCS message per TS 101 909-4 [22].

NOTE: Information on the requirements for TE with Register Recall signalling capability may be found in ES 201 729 [40].

6.14.3 Metering

The CM/MTA must apply to the Analogue Line the appropriate meter pulse in response to NCS message directives per TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25].

6.14.4 ALASS and other enhanced services

In order to support the provision of ALASS services to the TE, the CM/MTA shall apply to the Analogue line signals selected from the list below, according to TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25] for the implemented options:

- a) a single burst of ringing current with or without polarity reversal;
- b) provision of loop current up to 2,5 mA at a voltage greater than 32 V without it being treated as a seize signal;
- c) ignore on-line value dc current pulses not exceeding 25 ms duration, i.e. do not treat as a seize signal.

NOTE 1: More details may be found in EN 300 659 [3] for the NTP and EN 300 778 [4] for the TE. For the implementation of ALASS services these standards should be followed. By fulfilling the signalling requirements established in EN 300 659, parts 1 and 2 [3], the interface may support enhanced services based on protocols specified in EN 300 659 [3] or other standards.

NOTE 2: ES 201 912 [41] standardizes the Short Message Service (SMS) for the User Based Solution (UBS), protocols for analogue TE of the PSTN/ISDN to communicate with the appropriate service center. To implement such services no specific additional requirement is necessary in the present document, it is enough to fulfil the requirements of ES 300 659, parts 1 and 2 [3].

NOTE 3: ES 201 071 [42] standardizes the Server Display and Script Services protocol (SDSS), which is also a protocol supporting enhanced services based on interfaces considered in the scope of the present document. To implement such services no specific additional requirement is necessary in the present document, it is enough to fulfil the requirements of ES 300 659, parts 1 and 2 [3].

6.14.5 Polarity reversal

The CM/MTA must apply the appropriate line polarity reversal to the Analogue Line in response to NCS message directives per TS 101 909-4 [22].

NOTE 1: In order to ensure compatibility with the installed base of terminals in certain European States it may be necessary to use polarity reversals to indicate start and end of ringing signal. In these cases, compatibility must be adequately ensured if the normal d.c. polarity is reversed when the first ringing voltage is applied. The polarity must revert to the normal polarity when the line is seized or cleared. The CM/MTA must not autonomously apply polarity reversal. The CM/MTA must provide polarity reversal in response to NCS message directives per TS 101 909-4 [22].

NOTE 2: Polarity reversal can be used to indicate called party answer and end-of-call.

NOTE 3: Polarity reversal can also be used for other signalling purposes (e.g. as given in ES 300 659 [3]).

6.14.6 End of call signal ("K-break")

An end-of-call signal consisting of a reduction in the a-b terminal interface loop current to below 1 mA for a certain period is referred to as K-break. The CM/MTA must apply the "K-break" signal to the Analogue Line in response to a NCS message directive per TS 101 909-4 [22] as defined by Provisioning or Configuration per TS 101 909-6 [23] and TS 101 909-9 [25]. The CM/MTA must apply the signals with timing distortion within ± 25 ms.

During the K-break, the CM/MTA must maintain a loop closure state (Line Seizure State) towards the network.

6.14.7 Payphones

Many Payphones operate by using a combination of polarity reversal, meter pulse or "K-break" signals. Due to the wide range of payphone variations the specifics of this operation require further study. As defined in the above clauses, CM/MTAs that support these optional features must be capable of supporting Payphone services under the appropriate CMS control using the defined NCS message set of TS 101 909-4 [22].

Annex A (Informative): Bibliography

ETSI EG 201 188 (V1.2.1): "Public Switched Telephone Network (PSTN); Network Termination Point (NTP) analogue interface; Specification of physical and electrical characteristics at a 2-wire analogue presented NTP for short to medium length loop applications".

ETSI EG 201 120: "Public Switched Telephone Network (PSTN); Method of rating terminal equipment so that it can be connected in series and/or in parallel to a Network Termination Point (NTP)".

ETSI ES 201 168 (V1.2.1): "Speech processing, Transmission and Quality aspects (STQ); Transmission characteristics of digital Private Branch eXchanges (PBXs) for interconnection to private networks, to the public switched network or to IP gateways".

ETSI ES 201 970: "Access and Terminals (AT); Public Switched Telephone Network (PSTN); Harmonized specification of physical and electrical characteristics at a 2-wire analogue presented Network Termination Point (NTP)".

History

Document history		
V1.1.1	August 2002	Publication