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Entwurf

**Systeme zur Kommunikation über Hochspannungsleitungen für
Anwendungen der elektrischen Energieversorgung –
Teil 2: Anschlussgeräte für analoge Nachrichtenübertragung über
Hochspannungsleitungen (APLC)
(IEC 62488-2:2017);
Englische Fassung EN 62488-2:2017**

Power line communication systems for power utility applications –
Part 2: Analogue power line carrier terminals or APLC
(IEC 62488-2:2017);
English version EN 62488-2:2017

Systèmes de communication sur lignes d'énergie pour les applications des compagnies
d'électricité –
Partie 2: Bornes analogiques à courant porteur en ligne (CPL)
(IEC 62488-2:2017);
Version anglaise EN 62488-2:2017

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Dieser Norm-Entwurf mit Erscheinungsdatum 2018-03-09 wird der Öffentlichkeit zur Prüfung und
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Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses
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Gesamtumfang 91 Seiten

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Anwendungsbeginn

Anwendungsbeginn dieser Norm ist ...

Nationales Vorwort

Für dieses Dokument ist das nationale Arbeitsgremium K 952 „Netzleittechnik“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (www.dke.de) zuständig.

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Da sich die Benutzer des vorliegenden Normentwurfs der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der EN 62488-2 veröffentlicht. Zu deren Abschnitt 1, der den Anwendungsbereich festlegt, und Abschnitt 3, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA des vorliegenden Normentwurfs hinzugefügt. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Dieser Normentwurf steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Es ist vorgesehen, auch bei der entsprechenden zukünftigen Deutschen Norm auf die deutsche Sprachfassung zu verzichten und diese in der englischsprachigen Fassung zu veröffentlichen.

Das Original-Dokument enthält Bilder in Farbe, die in der Papierversion in einer Graustufen-Darstellung wiedergegeben werden. Elektronische Versionen dieses Dokuments enthalten die Bilder in der originalen Farbdarstellung.

Nationaler Anhang NA (informativ)

Auszugsweise Übersetzung^{N1)}

1 Anwendungsbereich

Dieser Teil von IEC 62488 gilt für Endgeräte und Systeme für die analoge Trägerfrequenzübertragung über Hochspannungsleitungen (ATFH) per Einseitenbandmodulation (AM-SSB), die zur Übertragung von Informationen über Stromversorgungsleitungen (Höchstspannung, Hochspannung und Mittelspannung) eingesetzt werden.

Das vorliegende Dokument behandelt insbesondere Basisband-Signale mit Bandbreiten von 4 kHz und 2,5 kHz oder Vielfache hiervon, die den gleichen Hochfrequenzbandbreiten für Einkanal- oder Mehrkanal-ATFH-Endgeräte entsprechen.

Bild 1 zeigt eine schematische Darstellung des Anwendungsbereichs der Norm IEC 62488-2 in einem vollständigen System zur Kommunikation über Hochspannungsleitungen.

^{N1)} Nationale Fußnote: Die Nummerierung der IEC 62488-2:2017-07 wurde beibehalten.

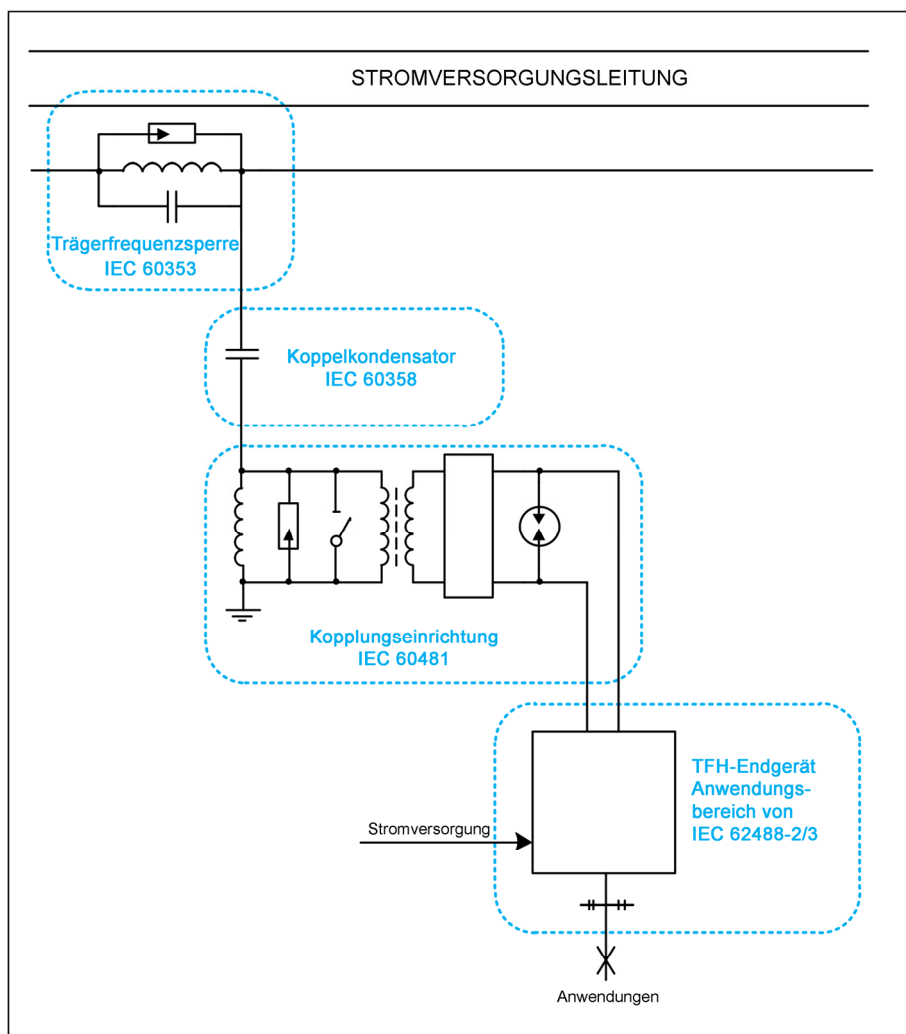


Bild 1 – Schematische Darstellung des Anwendungsbereichs von IEC 62488-2

3 Begriffe und Abkürzungen

3.1 Begriffe

Für die Anwendung dieses Dokuments gelten die Begriffe nach IEC 62488-1 und die folgenden Begriffe.

ISO und IEC unterhalten Terminologie-Datenbanken zur Verwendung in der Normung unter den folgenden Adressen:

- IEC Electropedia: verfügbar unter <http://www.electropedia.org/>
- ISO Online Browsing-Plattform: verfügbar unter <http://www.iso.org/obp>

3.1.1

absoluter Leistungspegel

Leistung eines Signals, ausgedrückt in Dezibel für die Referenzleistung von 1 mW wie in Gleichung (1) festgelegt

$$X[\text{dBm}] = 10 \times \log_{10}(P/1 \text{ mW}), \quad (1)$$

Dabei ist

P = Signalleistung

3.1.2

ATFH-Einrichtung

TFH-Einrichtung mit einer LF-Schnittstelle für jeden LF-Kanal, die AM-SSB-Modulation auf die Signale am Eingang jeder LF-Schnittstelle anwendet und die modulierten Signale, die benachbarte Frequenzbänder belegen, die das HF-Übertragungsband des TFH vollständig abdecken, über die Stromversorgungsleitung überträgt

Anmerkung 1 zum Begriff: LF-Kanäle haben typischerweise eine Bandbreite von 4,0 oder 2,5 kHz, können jedoch auch eine andere Bandbreite haben.

Anmerkung 2 zum Begriff: Zusätzlich zu den angegebenen Schnittstellen dürfen auch andere Schnittstellen vorhanden sein, z. B. Datenschnittstellen, LF-Schutzsignalübertragungs- und Steuerschnittstellen oder Befehlsschnittstellen für die Schutzsignalübertragung.

3.1.3

Basishochfrequenzband

elementare Unterteilung des Hochfrequenzbereichs oder eines Teils dieses Bereichs, der einem einzigen HF-ATFH-Sende- oder Empfangskanal zugeordnet ist

3.1.4

effektiv übertragenes Sprachband

Teil des Sprachfrequenz-Basisbands, der für die Telefonkommunikation genutzt wird, ohne Telefonsignalisierungskanal

3.1.5

Pegel-Referenzpunkt

Punkt in einem System mit dem relativen Pegel 0 dBr

Anmerkung 1 zum Begriff: Genauer gesagt wird davon ausgegangen, dass ein Sinusreferenzsignal mit 1020 Hz im Sprachfrequenzband den betreffenden Signalweg mit einer Amplitude durchläuft, bei der sein absoluter Pegel im 0 dBr-Punkt 0 dBm beträgt. [ITU-T G.100.1]

Anmerkung 2 zum Begriff: Der Pegel-Referenzpunkt darf entweder physisch oder auch lediglich hypothetisch existieren.

3.1.6

LF-Kanal

Frequenzband, das für die Signalübertragung einer Niederfrequenz-Schnittstelle genutzt wird

3.1.7

Lastkapazität <für Mehrkanal-Endgerät>

maximale Einfrequenz-Sinuswellenleistung ausgedrückt in dBm₀, die von einem Mehrkanalverstärker ohne nennenswerte Überlastung übertragen werden muss

3.1.8

mittlere Hochfrequenzband-Ausgangsleistung

Ausgangsleistung eines ATFH-Endgeräts im Nennbereich des Hochfrequenzbands, gemittelt über eine im Verhältnis zur Zykluszeit der niedrigsten Modulationsfrequenz genügend lange Dauer, während der diese mittlere Leistung den Höchstwert annimmt, für den das Endgerät ausgelegt ist

3.1.9

Nennbereich des Hochfrequenzbands

Frequenzband innerhalb des Trägerfrequenzbereichs, in dem ein bestimmter ATFH-Sender oder ATFH-Empfänger betrieben wird

Anmerkung 1 zum Begriff: Der Nennbereich des Hochfrequenzbands wird auch als Nennbereich des Trägerfrequenzbands bezeichnet.

3.1.10**Ausgangsleistung im Nennbereich des Hochfrequenzbands**

Ausgangsleistung eines ATFH-Endgeräts im Nennbereich des Hochfrequenzbands, angegeben als die Hüllkurvenspitzenleistung (PEP), für die das Endgerät entsprechend den Anforderungen an die Nebenaussendungen und Kanalüberlagerungsstörungen (bei Mehrkanal-TFH-Endgeräten) ausgelegt ist und die am Hochfrequenz-Schnittstellenausgang über einer Widerstandslast gleich der Nennimpedanz verfügbar ist

3.1.11**Leistungsverhältnis**

Verhältnis zwischen den Leistungen P_1 und P_2 zweier Signale

Anmerkung 1 zum Begriff: Das Leistungsverhältnis X_{12} wird normalerweise in Dezibel (dB) angegeben und mittels Gleichung (2) berechnet

$$X_{12}[\text{dB}] = 10 \times \log_{10}(P_1/P_2) \quad (2)$$

3.1.12**relativer Leistungspegel**

Leistungspegel an einem Punkt in einem Stromkreis, der durch den Ausdruck $10 \times \log_{10}(P/P_0)$ dBr gegeben ist. Dabei ist P die Leistung eines Sinussignals mit Referenzfrequenz 1020 Hz am betreffenden Punkt und P_0 die Leistung dieses Signals am 0-dBr-Referenzpunkt [ITU-T P.10/G.100 R-8, ITU-T G.100.1]

Anmerkung 1 zum Begriff: Der Zusammenhang zwischen dem relativen Leistungspegel P_{rel} , dem absoluten Leistungspegel P und dem Leistungspegel des Systems P_0 ergibt sich aus Gleichung (3):

$$P_{\text{rel}}[\text{dBr}] = P[\text{dBm}] - P_0[\text{dBm0}] \quad (3)$$

Anmerkung 2 zum Begriff: Der relative Leistungspegel ist abhängig vom Messpunkt und nicht vom Signaltyp.

3.1.13**Nebenaussendung**

Aussendung auf einer oder mehreren Frequenzen außerhalb der erforderlichen Bandbreite, wobei der Pegel dieser Aussendung herabgesetzt werden kann, ohne dass die Übertragung der entsprechenden Information beeinträchtigt wird

Anmerkung 1 zum Begriff: Nebenaussendungen umfassen harmonische Aussendungen, parasitäre Aussendungen, Intermodulationsprodukte und Frequenzumsetzungsprodukte, jedoch nicht Außerband-Aussendungen [ITU-R SM.329-12].

3.1.14**Leistungspegel des Systems**

in dBm0 angegebener Leistungspegel, sodass x dBm0 bedeutet, dass x dB am Pegel-Referenzpunkt des Systems größer oder kleiner als 1 mW ist, je nachdem, ob x positiv oder negativ ist, d. h. dass x dB an einem beliebigen Punkt des Systems größer oder kleiner als das Pegel-Referenzsignal von 1020 Hz ist

Anmerkung 1 zum Begriff: Netze sind häufig für die Übertragung verschiedener Signaltypen (Sprache, Modem, Fax usw.) mit verschiedenen Pegeln ausgelegt, die in dBm0 angegeben werden [ITU-T G.100.1].

3.1.15**psophometrischer Leistungspegel des Systems**

psophometrisch gewichteter und in dBm0p angegebener Pegel entsprechend den Festlegungen in ITU-T O.41

Anmerkung 1 zum Begriff: Der Ausdruck dBm0p wird analog zum Ausdruck dBm0 verwendet, wenn der Pegel mit einem Psophometer statt mit einer linearen Pegelmesseinrichtung gemessen wird. Die psophometrische Gewichtung wird nur in Verbindung mit der Bestimmung von Rauschpegeln in Sprachkanälen eingesetzt. Die äquivalente Rauschbandbreite des psophometrisch gewichteten Filters beträgt etwa 1,8 kHz.

3.2 Abkürzungen

AC	Wechselstrom (en: alternating current)
AM-SSB	Einseitenband-Amplitudenmodulation (en: amplitude modulation SSB)
ATFH	analoge Trägerfrequenzübertragung über Hochspannungsleitungen (en: APLC, analogue power line carrier)
DC	Gleichstrom (en: direct current)
DTFH	digitale Trägerfrequenzübertragung über Hochspannungsleitungen (en: DPLC, digital power line carrier)
DSP	digitale Signalverarbeitung (en: digital signal processing, digital signal processor)
E&M	E&M-Signalisierung (en: ear & mouth)
FAR	voll reflexionsfreier Raum (en: fully anechoic room)
FDM	Frequenzmultiplexverfahren, Frequenzmultiplexer (en: frequency division multiplexing, frequency division multiplexer)
FSK	Frequenzumtastung (en: frequency shift keying)
FXO	Anschaltstelle Telefon (en: foreign exchange office)
FXS	Anschaltstelle Telefonnetz (en: foreign exchange subscriber)
HF	Hochfrequenz (en: high frequency)
LAN	lokales Netz (en: local area network)
LCL	Unsymmetriedämpfung (en: longitudinal conversion loss)
LF	Niederfrequenz (en: low frequency)
MIB	Managementinformationsbasis (en: management information base)
OATS	Freifeld (en: open area test site)
OSB	Symmetrie des Ausgangssignals (en: output signal balance)
PBX	Nebenstellenvermittlungseinrichtung (en: private branch exchange)
PEP	Hüllkurvenspitzenleistung (en: peak envelope power)
TFH	Trägerfrequenzübertragung über Hochspannungsleitungen (en: PLC, power line carrier)
RMS	Effektivwert (en: root mean square)
Rx	Empfänger, empfangen (en: receiver, receive)

SAC	Halbabsorberkammer (en: semi anechoic chamber)
SNMP	einfaches Netzwerkverwaltungsprotokoll (en: simple network management protocol)
SSB	Einseitenband (en: single side band)
Tx	Sender, senden (en: transmitter, transmit)
VF	Sprachfrequenz (en: voice frequency)
WAN	Weitverkehrsnetz (en: wide area network)
2W	Zweidraht- (en: two wire)
4W	Vierdraht- (en: four wire)

English Version

Power line communication systems for power utility applications
- Part 2: Analogue power line carrier terminals or APLC
(IEC 62488-2:2017)

Systèmes de communication sur lignes d'énergie pour les applications des compagnies d'électricité - Partie 2 : Bornes analogiques à courant porteur en ligne (CPL)
(IEC 62488-2:2017)

Systeme zur Kommunikation über Hochspannungsleitungen für Anwendungen der elektrischen Energieversorgung - Teil 2: Anschlussgeräte für analoge Nachrichtenübertragung über Hochspannungsleitungen (APLC)
(IEC 62488-2:2017)

This European Standard was approved by CENELEC on 2017-08-30. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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European foreword

The text of document 57/1867/FDIS, future edition 1 of IEC 62488-2, prepared by IEC/TC 57 "Power systems management and associated information exchange" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62488-2:2017.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2018-05-30
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2020-08-30

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Endorsement notice

The text of the International Standard IEC 62488-2:2017 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60255-26:2013	NOTE	Harmonized as EN 60255-26:2013.
IEC 60255-151:2009	NOTE	Harmonized as EN 60255-151:2009.
IEC 60495:1993	NOTE	Harmonized as EN 60495:1994.
IEC 60721-3-4:1995	NOTE	Harmonized as EN 60721-3-4:1995.
IEC 60870-5-101	NOTE	Harmonized as EN 60870-5-101.
IEC 60870-5-104	NOTE	Harmonized as EN 60870-5-104.
IEC 61869-2:2012	NOTE	Harmonized as EN 61869-2:2012.
IEC 62351 (series)	NOTE	Harmonized as EN 62351 (series).

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INTRODUCTION

IEC 62488 series is a family of standards dealing with all aspects of power line communication systems operating over electricity power lines.

These international standards apply to power line carrier terminals and systems (PLC) used to transmit information over power networks including extra high, high and medium voltage (EHV/HV/MV) power lines. Both analogue and digital modulation as well as narrow and broadband systems will be included.

The complexity and extensive size of present-day electricity generation, transmission and distribution systems are such that it is possible to control them only by means of an associated and often equally large and complex telecommunication system having a high order of reliability.

The control of electrical networks and transmission and reception of data are through a combination of analogue and digital communication systems controlling devices and systems distributed throughout the electrical network.

The emergence of digital communication systems for controlling the devices of the electrical distribution network enables faster data transmission. The traditional analogue communication systems mainly due to legacy applications are still extensively used.

The ability to represent the various electrical parameters as an analogue signal and/or a digital signal ensures the quality and quantitative aspects of seamless communication to be maintained throughout the electrical power network.

Therefore, by using either analogue power line communication, digital power line communication or a combination of both types of systems, seamless efficient communication may be maintained throughout the power network.

In many countries, Power Line Carrier (PLC) channels represent a main part of the utility-owned telecommunication system. A circuit which would normally be routed via a PLC channel can also be routed via a channel using a different transmission medium, such as a point to point radio or open-wire circuit. Since, in many cases, automatic switching is used, the actual rerouting, although predetermined, is unpredictable.

It is important, therefore, that the input and output signals and criteria exchanged among all terminal used in the communications system are compatible. This compatibility is also beneficial in creating the ability to interchange and interconnect terminals from different sources.

This document has been prepared to enable compatibility between APLC links from different sources or between APLC links and other transmission medium to be achieved and to define the terminal performance required in APLC networks.

POWER LINE COMMUNICATION SYSTEMS FOR POWER UTILITY APPLICATIONS –

Part 2: Analogue power line carrier terminals or APLC

1 Scope

This part of IEC 62488 applies to Amplitude Modulation Single Sideband (AM-SSB) Analogue Power Line Carrier (APLC) Terminals and Systems used to transmit information over power lines (EHV/HV/MV).

In particular this document covers basically baseband signals with bandwidths of 4 kHz and 2,5 kHz, or multiples thereof, corresponding to the same high frequency bandwidth/s for single or multi-channel APLC terminals.

Figure 1 shows a schematic representation of the scope of the IEC 62488-2 standard within a complete power line communication system installation.

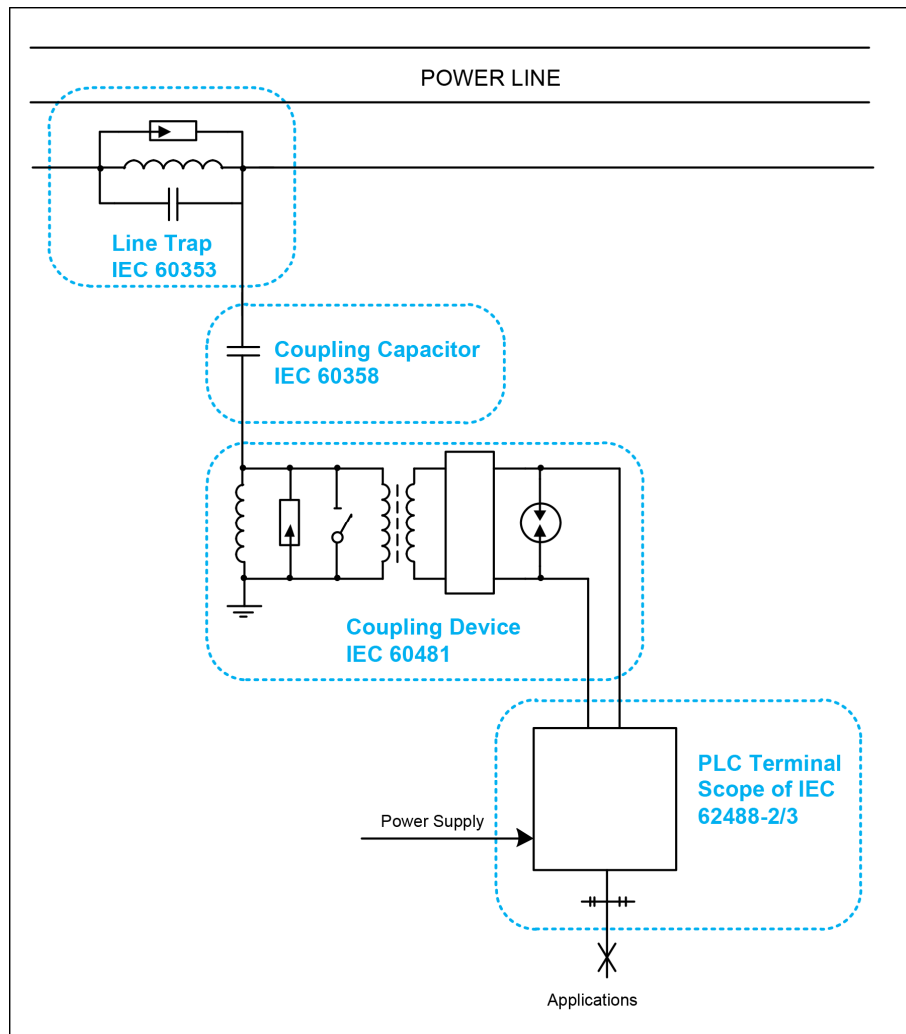


Figure 1 – Schematic representation of the scope of IEC 62488-2

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60038, *IEC standard voltages*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-31, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60255-27:2013, *Measuring relays and protection equipment – Part 27: Product safety requirements*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60721-3-1:1997, *Classification of environmental conditions – Part 3 Classification of groups of environmental parameters and their severities – Section 1: Storage*

IEC 60721-3-2:1997, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 2: Transportation*

IEC 60721-3-3:1994, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 3: Stationary use at weatherprotected locations*

IEC 60721-3-3:1994/AMD1:1995

IEC 60721-3-3:1994/AMD2:1996

IEC 60834-1, *Teleprotection equipment of power systems – Performance and testing – Part 1: Command systems*

IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3 : Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-16, *Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz*

IEC 61000-4-17, *Electromagnetic compatibility (EMC) – Part 4-17: Testing and measurement techniques – Ripple on d.c. input power port immunity test*

IEC 61000-4-18, *Electromagnetic compatibility (EMC) – Part 4-18: Testing and measurement techniques – Damped oscillatory wave immunity test*

IEC 61000-4-20:2010, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides*

IEC 61000-4-29, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

IEC 61000-6-4:2006, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*
IEC 61000-6-4:2006/AMD1:2010

IEC 61000-6-5:2015, *Electromagnetic compatibility (EMC) – Part 6-5: Generic standards – Immunity for equipment used in power station and substation environment*

IEC 62488-1:2012, *Power line communication systems for power utility applications – Part 1: Planning of analogue and digital power line carrier systems operating over EHV/HV/MV electricity grids*

CISPR 16-1-1:2015, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-2:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

CISPR 16-1-4:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*

CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 16-2-3:2016, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*

CISPR 14-1:2016, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

CISPR 22:2008, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62488-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1.1

absolute power level

power of a signal expressed in decibels referred to 1 mW as defined by Equation (1)

$$X[\text{dBm}] = 10 \times \log_{10}(P/1 \text{ mW}), \quad (1)$$

where

P = signal power

3.1.2

APLC equipment

PLC equipment with an LF interface for each LF channel, applying AM-SSB modulation to the signals at the input of each LF interface and transmitting over the power line the modulated signals, which occupy adjacent frequency bands fully covering the HF transmission band of the PLC

Note 1 to entry: The LF channel bandwidths are typically either 4,0 or 2,5 kHz, but can be different.

Note 2 to entry: In addition to the mentioned interfaces other interfaces may be present such as data interfaces, LF teleprotection and control interfaces or teleprotection command interfaces.

3.1.3

basic high frequency band

elementary subdivision of the high frequency range or part thereof allocated to a single APLC transmit or receive high frequency channel

3.1.4

effective transmitted voice band

that part of the voice-frequency baseband used for telephone communication, not including the telephone signalling channel

3.1.5

level reference point

point in a system with the relative level 0 dBr

Note 1 to entry: More specifically, a sinusoidal reference signal of 1020 Hz in the voice frequency band is thought to pass the signal path under consideration with such amplitude that its absolute level is 0 dBm at the 0 dBr point. [ITU-T G.100.1]

Note 2 to entry: The level reference point may exist physically or only hypothetically.

3.1.6

LF channel

frequency band used for the signal transmission of a low frequency interface

3.1.7

load capacity, <for the multi-channel terminal>

maximum single frequency sine wave power expressed in dBm0 which a multi-channel amplifier must transmit without appreciable overloading

3.1.8

mean high frequency band output power

output power of an APLC terminal at nominal high frequency band terminal averaged over a time sufficiently long compared with the cycle time of the lowest modulation frequency and during which this average power assumes the highest value for which the terminal has been designed

3.1.9

nominal high frequency band

frequency band in which a particular APLC transmitter or receiver is operating within the carrier-frequency range

Note 1 to entry: The nominal high frequency band is also referred to as nominal carrier frequency band.

3.1.10

nominal high frequency band output power

output power of an APLC terminal at nominal high frequency band expressed as the peak envelope power (PEP) for which the terminal has been designed, compatible with the requirements for spurious emissions and inter-channel interference (for multi-channel PLC terminals), available at the high frequency interface output across a resistive load equal to the nominal impedance

3.1.11

power ratio

ratio between the powers P_1 and P_2 of two signals

Note 1 to entry: The power ratio X_{12} is usually expressed in decibels (dB) and is calculated according to equation (2)

$$X_{12}[\text{dB}] = 10 \times \log_{10}(P_1/P_2). \quad (2)$$

3.1.12

relative power level

power level at a point on a circuit given by the expression $10 \times \log_{10}(P/P_0)$ dBr, where P represents the power of a sinusoidal signal at the reference frequency 1020 Hz at the point concerned and P_0 the power of that signal at the 0 dBr reference point [ITU-T P.10/G.100 R-8, ITU-T G.100.1]

Note 1 to entry: The relation between the relative power level P_{rel} , the absolute power level P and the system power level P_0 is given by Equation (3):

$$P_{\text{rel}}[\text{dBr}] = P[\text{dBm}] - P_0[\text{dBm0}] \quad (3)$$

Note 2 to entry: The relative power level depends on the measuring point and not on the type of signal.

3.1.13

spurious emissions

emissions on a frequency, or on frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information

Note 1 to entry: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions [ITU-R SM.329-12].

3.1.14

system power level

power level expressed in dBm₀, such that x dBm₀ means x dB above or below 1 mW at the level reference point of the system, according to whether x is positive or negative, i.e. x dB above or below the level reference signal of 1020 Hz at any point of the system

Note 1 to entry: Networks are often designed to carry different types of signals (speech, modem, fax, etc.) at different levels, expressed in dBm₀ [ITU-T G.100.1].

3.1.15

system psophometric power level

psophometrically weighted level expressed in dBm_{0p} as defined according to ITU-T O.41

Note 1 to entry: The term dBm_{0p} is used in the same way as dBm₀ when the level is measured with a psophometer instead of a flat-response level measuring set. The psophometric weighting is used only in connection with the specification of noise levels on voice channels. The equivalent noise bandwidth of the psophometrically-weighted filter is about 1,8 kHz.

3.2 Abbreviations

AC	Alternating Current
AM-SSB	Amplitude Modulation SSB
APLC	Analogue PLC
DC	Direct Current
DPLC	Digital PLC
DSP	Digital Signal Processing, Digital Signal Processor
E&M	Ear & Mouth
FAR	Fully Anechoic Room
FDM	Frequency Division Multiplexing, Frequency Division Multiplexer
FSK	Frequency Shift Keying
FXO	Foreign Exchange Office
FXS	Foreign Exchange Subscriber
HF	High Frequency
LAN	Local Area Network
LCL	Longitudinal Conversion Loss
LF	Low Frequency
MIB	Management Information Base
OATS	Open Area Test Site
OSB	Output Signal Balance
PBX	Private Branch Exchange
PEP	Peak Envelope Power
PLC	Power Line Carrier
RMS	Root Mean Square
Rx	Receiver, receive
SAC	Semi Anechoic Chamber
SNMP	Simple Network Management Protocol
SSB	Single Side Band

Tx	Transmitter, transmit
VF	Voice Frequency
WAN	Wide Area Network
2W	Two Wire
4W	Four Wire

4 Low frequency side interfaces

4.1 General

All interfaces described in Clause 4 are optional. However, as stated in the definition of 0, it shall be possible to configure APLC equipment such that it has one low frequency interface for each LF channel.

Figure 2 shows the generic architecture of an APLC terminal with the LF interfaces on the left and the RF interface on the right. The type of interface – digital (1) or analogue (2) – is indicated. In addition, two internal conceptual signals appear in this figure: (1) The “Baseband signal”, representing the FDM multiplexed signal of all LF signals and (2) the “Passband signal”, representing the baseband signal converted to the RF band by SSB modulation. These two signals are generally not accessible by the user. In case only one LF interface is present, the function of the block “Frequency Division Multiplexer / Demultiplexer” degenerates to a simple through connection.

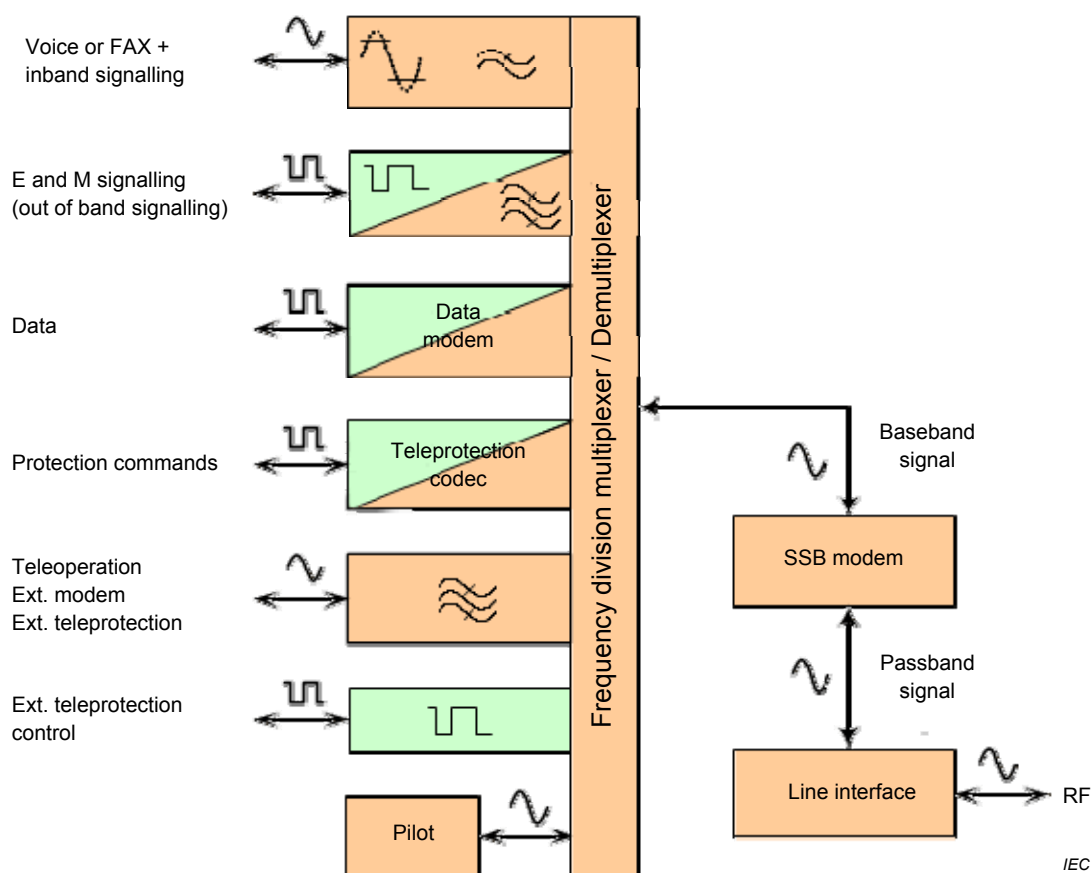


Figure 2 – Generic architecture of an APLC terminal

4.2 Analogue interfaces

4.2.1 General

In 4.2, a description of the analogue interfaces is given. For each of them the key parameters and the recommended characteristic values are indicated. All levels are specified as absolute power levels (dBm) unless otherwise noted.

4.2.2 Voice frequency band

The effective transmitted voice-frequency band is 300 to 3 400 Hz according to ITU-T G.232. Other recommended values for the effective transmitted voice band are:

- 300 to 2 400 Hz,
- 300 to 2 000 Hz.

4.2.3 Nominal impedance

The nominal impedance of all analogue low-frequency inputs and outputs shall be 600 Ω balanced.

4.2.4 Return loss

The return loss for all voice-frequency interfaces shall not be less than 14 dB within the effective transmitted frequency band.

4.2.5 Degree of unbalance to Earth

For all voice-frequency inputs longitudinal conversion loss and outputs signal balance shall not be less than 40 dB within the effective transmitted frequency band.

4.2.6 ITU-T voice channel interface

4.2.6.1 Description

One of the most used interfaces is related to the voice applications. Typically, it is used for interconnection to/from the multiplexor transit of subscriber service. One or more voice channel interfaces could be present in each terminal if needed.

4.2.6.2 Voice signal levels

- The minimum range of the transmit input level shall be -17 to 0 dBm
- The minimum range of the received output level shall be -7 to $+4$ dBm

4.2.7 Subscriber interface

4.2.7.1 Description

In some cases it is requested to make a subscriber connection to a PBX from a remote location. To make this possible APLC links provide for the telephone connection between PBX and two-wire telephone set by configuring a PBX interface at the local APLC terminal and a subscriber interface at the remote APLC terminal.

In Figure 3 a possible application scheme is given.

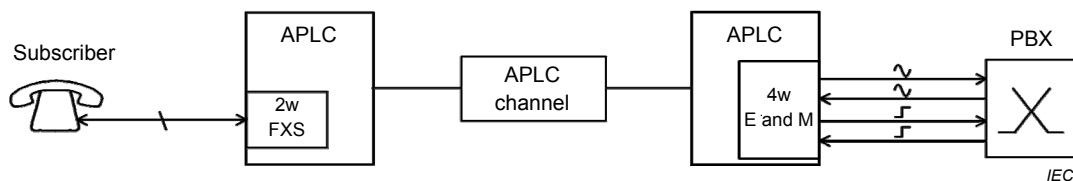


Figure 3 – Subscriber PBX interfaces local and remote

There is also the possibility to have a 2W interface to the PBX (2W-FXO interface), as an alternative to the 4W interface shown in the right side of Figure 3.

4.2.7.2 Voice signal levels

The relative two-wire/four-wire levels used for voice differ from country to country. They shall preferably be within the following recommended ranges:

- The minimum range of the transmit input level shall be -17 to 0 dBm
- The minimum range of the received output level shall be -7 to $+4$ dBm

4.2.8 PBX interconnection interface

4.2.8.1 Description

When the interconnection between two PBXs is needed, APLC is configured to provide the four-wire interface including the correct signaling.

In Figure 4 a possible application scheme is given.

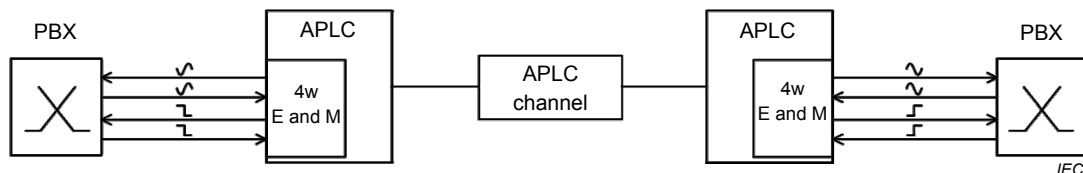


Figure 4 – Interfaces for PBX trunk interconnection through APLC link

4.2.8.2 Voice signal levels

The relative four-wire levels used for voice differ from country to country. They shall preferably be within the following recommended ranges:

- The minimum range of the transmit input level shall be -17 to 0 dBm
- The minimum range of the received output level shall be -7 to $+4$ dBm

4.2.9 Narrowband telegraphic channel interface

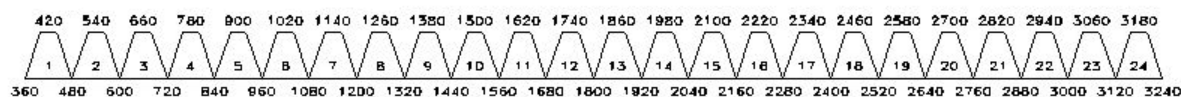
4.2.9.1 Description

Subclause 4.2.9 refers to the transit of low symbol rate modulated telegraphic channels (i.e. 50, 100, 200, 600, 1 200 Bauds) typically used for carrying remote control and metering signals from the RTUs to the SCADA central systems.

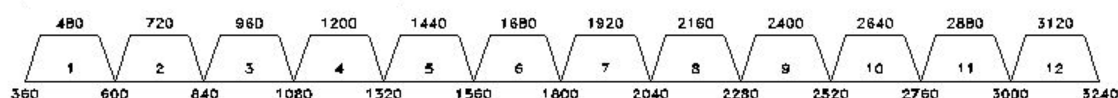
4.2.9.2 Narrowband telegraphic channelling

For asynchronous data transmission within ITU-T voice channels and according to the type of modulation used, a frequency division multiplexing and channelling plan as shown in Figure 5 is most commonly used.

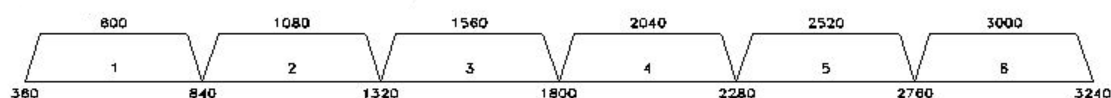
50 Bd/120 Hz CCITT R36 Channels



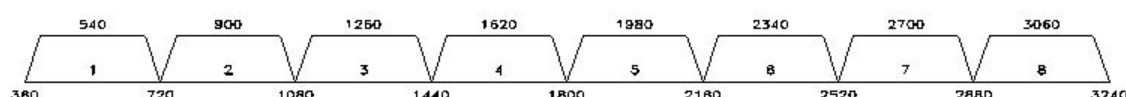
100 Bd/240 Hz CCITT R37 Channels



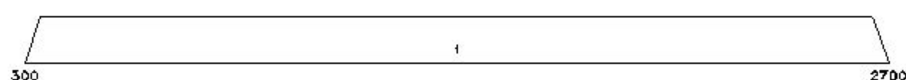
200 Bd/480 Hz CCITT R38A Channels



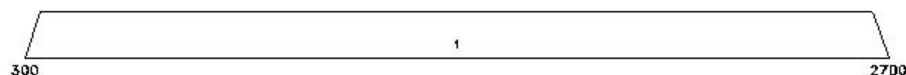
200 Bd/360 Hz CCITT R38B Channels



600 Bd CCITT V23 Channels



1 200 Bd CCITT V23 Channels



IEC

Figure 5 – Low symbol rate ITU-T telegraphic channelling

The bandwidth used within the voice channel ranges for each telegraphic channel from 120 Hz up to 2 400 Hz.

This allows the multiplexing of one or more FSK modulated signals with symbol rates from 50 Baud to 1200 Baud.

4.2.9.3 Telegraphy signal levels

The relative four-wire levels used for telegraphic modulated signals shall preferably be within the following recommended ranges:

- The minimum range of the transmit input level shall be –20 dBm to 0 dBm
- The minimum range of the received output level shall be –20 dBm to 0 dBm

4.3 Analogue teleprotection system interface

4.3.1 Description

A typical goal of a selective analogue teleprotection device consists of accelerating, delaying, locking or conditioning the protection relay (line distance protection, insulation gas low pressure protection) installed in the field at both sides of an APLC link.

This is achieved by transmitting a command from one teleprotection device to the other by a suitable transmission system, fast, safe and reliable in order to control the way the protection relay at the other end of the line section behaves.

APLC terminals optionally may have on board an integrated analogue selective teleprotection device with its interface enabling the communication with protection device.

Another possible option includes a simple analogue interface enabling the communication between an external teleprotection device with an APLC terminal.

In the first case the interface process signals/commands directly exchanged with the field protection relay. It means that no low frequency signals exchanged but simply logic criteria/commands.

In the second case the interface cooperates with an external selective teleprotection device. Therefore the interface may consist of voice-frequency input/output and control circuits.

The inputs and outputs shall preferably be decoupled from the other signal/command inputs/outputs.

4.3.2 Integrated teleprotection

In this case the functional requirements of teleprotection command systems as defined in IEC 60834-1 shall be applied.

4.3.3 Teleprotection interface frequency band

The nominal frequency band used for teleprotection service shall be specified within the frequency range of the nominal voice channel.

It can be a fully dedicated and pre-allocated frequency band or an alternative one which is allocated when the terminals switch to the teleprotection mode.

For this second operational mode – in order to reduce the risk of interference – the inhibition of all other signals present at the low frequency interface is requested.

4.3.4 Teleprotection interface impedance

- The input/output impedance shall be 600 Ω .

4.3.5 Teleprotection interface reflection

- The return loss shall be not less than 14 dB.

4.3.6 Teleprotection interface signal levels

- The minimum range of the transmit input level shall be –20 dBm to 0 dBm.
- The minimum range of the received output level shall be –20 dBm to 0 dBm.

4.3.7 Teleprotection interface control circuits

Control inputs may be provided to accomplish boosting of the teleprotection signal up to a maximum specified high frequency PEP output power and to interrupt the other signals for a short time of typically less than 500 ms during teleprotection transmission or reception.