



IEC 62488-2

Edition 1.0 2017-07

INTERNATIONAL STANDARD



**Power line communication systems for power utility applications –
Part 2: Analogue power line carrier terminals or APLC**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.200

ISBN 978-2-8322-4507-1

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope.....	10
2 Normative references	11
3 Terms, definitions and abbreviations	13
3.1 Terms and definitions.....	13
3.2 Abbreviations	15
4 Low frequency side interfaces	16
4.1 General.....	16
4.2 Analogue interfaces	17
4.2.1 General	17
4.2.2 Voice frequency band	17
4.2.3 Nominal impedance	17
4.2.4 Return loss	17
4.2.5 Degree of unbalance to Earth	17
4.2.6 ITU-T voice channel interface	17
4.2.7 Subscriber interface.....	17
4.2.8 PBX interconnection interface.....	18
4.2.9 Narrowband telegraphic channel interface	18
4.3 Analogue teleprotection system interface	19
4.3.1 Description	19
4.3.2 Integrated teleprotection	20
4.3.3 Teleprotection interface frequency band	20
4.3.4 Teleprotection interface impedance	20
4.3.5 Teleprotection interface reflection	20
4.3.6 Teleprotection interface signal levels	20
4.3.7 Teleprotection interface control circuits.....	20
4.4 Digital interfaces	21
4.4.1 Telephony signaling interface	21
4.4.2 Internal data modem	21
5 Transmission line side high frequency interface.....	24
5.1 APLC high frequency band and channelling	24
5.2 Frequency accuracy.....	25
5.3 Signal levels	25
5.4 Nominal impedance	25
5.5 Return loss	25
5.6 Degree of unbalance to earth.....	25
5.7 Tapping loss	25
5.8 Spurious emissions.....	26
6 Quality and Performance	27
6.1 General.....	27
6.2 APLC internally generated noise	28
6.3 Automatic gain control	28
6.4 Limiter action	28
6.5 Transmit/Receive frequency difference	28
6.6 Attenuation distortion	28

- 6.7 Group-delay distortion..... 30
- 6.8 Harmonic distortion..... 31
- 6.9 Selectivity 31
- 6.10 Crosstalk attenuation 31
 - 6.10.1 Co-channel crosstalk attenuation 31
 - 6.10.2 Inter-channel crosstalk attenuation 31
- 7 Testing 32
 - 7.1 General..... 32
 - 7.2 Test setup for APLC link tests 32
 - 7.3 Return loss 32
 - 7.4 Degree of unbalance to earth 33
 - 7.4.1 General 33
 - 7.4.2 LCL 34
 - 7.4.3 OSB 34
 - 7.5 Tapping loss 35
 - 7.6 Spurious emissions 36
 - 7.6.1 Single channel terminals..... 36
 - 7.6.2 Multi-channel terminals..... 36
 - 7.7 Selectivity 36
 - 7.8 Co-channel and inter-channel crosstalk attenuation 37
- 8 Configuration and management 37
 - 8.1 General..... 37
 - 8.2 Configuration 37
 - 8.3 Network management system 38
 - 8.4 Local terminal alarms..... 38
- 9 Cyber security 38
 - 9.1 General..... 38
 - 9.2 Authentication..... 39
- 10 APLC safety 39
 - 10.1 General..... 39
 - 10.2 Safety reference standard 39
 - 10.3 Classification of APLC Terminals 39
 - 10.4 Ingress protection 41
 - 10.5 Type and routine tests 41
- 11 Storage and transportation, operating conditions, power supply..... 43
 - 11.1 Storage and transportation..... 43
 - 11.1.1 Climatic conditions 43
 - 11.1.2 Mechanical 44
 - 11.2 Operating conditions 45
 - 11.2.1 Climatic conditions 45
 - 11.2.2 Mechanical 46
 - 11.2.3 Operating conditions set of tests..... 47
 - 11.3 Power supply 48
 - 11.3.1 AC supply..... 48
 - 11.3.2 DC supply..... 48
- 12 EMC 49
 - 12.1 Emission and Immunity reference standards 49
 - 12.2 Emission..... 50

12.2.1	Radiated and conducted emission	50
12.2.2	Low frequency disturbance emission	54
12.3	Immunity	54
12.3.1	EMC Environment.....	54
12.3.2	Functional requirements	56
12.3.3	Immunity test list	56
Annex A (normative) Characteristics of compandors for telephony (based on the withdrawn ITU-T Recommendation G.162).....		59
A.1	General.....	59
A.2	Characteristics of compandors	59
A.3	Definition and value of the unaffected level	59
A.4	Ratio of compression and expansion.....	59
A.5	Range of level.....	60
A.6	Signal to noise ratio	60
Annex B (informative) APLC communication model.....		61
B.1	General.....	61
B.2	AM-SSB modulation technique.....	64
B.3	Functional blocks of an APLC terminal.....	65
Annex C (informative) HF modulated power signal		67
C.1	General.....	67
C.2	Discrete tone signals	67
C.3	Voice channels	69
C.4	Composite channels.....	70
C.5	Calculation examples	72
C.5.1	General	72
C.5.2	Calculation example 1: Load capacity and PEP	72
C.5.3	Calculation example 2: Power distribution adjustment.....	72
Bibliography.....		74
Figure 1 – Schematic representation of the scope of IEC 62488-2		10
Figure 2 – Generic architecture of an APLC terminal.....		16
Figure 3 – Subscriber PBX interfaces local and remote.....		18
Figure 4 – Interfaces for PBX trunk interconnection through APLC link		18
Figure 5 – Low symbol rate ITU-T telegraphic channelling		19
Figure 6 – Commonly used EIA RS-232 connector.....		22
Figure 7 – Commonly used V.11 connector		22
Figure 8 – ETH IEEE 802.3 RJ45 type connector		24
Figure 9 – ETH IEEE 802.3 SC type connector		24
Figure 10 – Tapping loss limits for APLC terminals		26
Figure 11 – Maximum level of spurious emissions outside the high frequency band		27
Figure 12 – Reference points for measuring APLC parameters		28
Figure 13 – Attenuation distortion limits for the voice frequency band of 300 Hz to 3400 Hz (ITU-T G.232)		29
Figure 14 – Attenuation distortion limits for the voice frequency band of 300 Hz to 2400 Hz		29
Figure 15 – Attenuation distortion limits for the voice frequency band of 300 Hz to 2000 Hz		29

Figure 16 – Group delay distortion limits for the voice frequency band of 300 Hz to 3400 Hz	30
Figure 17 – Group delay distortion limits for the voice frequency band of 300 Hz to 2400 Hz	30
Figure 18 – Group delay distortion limits for the voice frequency band of 300 Hz to 2000 Hz	31
Figure 19 – Test circuit for return loss measurement.....	33
Figure 20 – Test circuit for LCL measurement (Tx port)	34
Figure 21 – Test circuit for OSB measurement (Rx port)	35
Figure 22 – Test circuit for Tapping Loss measurement	35
Figure 23 – Test circuit for selectivity measurement.....	37
Figure 24 – LF disturbances measurement setup	54
Figure B.1 – Basic components of the APLC Terminal	61
Figure B.2 – Baseband and pass band signals correspondence in SSB modulation	61
Figure B.3 – APLC Terminal LF, baseband and HF interfaces identification	62
Figure B.4 – Examples for low frequency signals with bandwidth 4 kHz (IEC 62488-1).....	62
Figure B.5 – Composition of the modulating baseband for eight telephony channels with signalling APLC terminal (source Japan NC).....	62
Figure B.6 – Line-up limits of circuits for a 4 kHz channel terminal (ITU-T G.120)	63
Figure B.7 – Example of HF channelling plan (4 kHz based – IEC 62488-1).....	64
Figure B.8 – Principle of phasing SSB modulator	64
Figure B.9 – Principle of phasing SSB demodulator	65
Figure B.10 – Generic APLC terminal main functional blocks	66
Figure C.1 – Sine wave and its probability distribution	68
Figure C.2 – Probability of combined sine waves	69
Figure C.3 – Nominal high frequency band output power of multichannel PLC terminals.....	70
Table 1 – FSK symbol rate and related narrowband standards.....	23
Table 2 – Basic insulation [Table C.6 of IEC 60255-27:2013]	40
Table 3 – Double or reinforced insulation [Table C.10 of IEC 60255-27:2013]	40
Table 4 – List of Type and Routine Tests [Table 12 of IEC 60255-27:2013]	42
Table 5 – Classification of climatic conditions [Table 1 of IEC 60721-3-1:1997]	43
Table 6 – Climatic tests for storage and transportation.....	44
Table 7 – Classification of climatic conditions from Table 1 of IEC 60721-3-3:2002	46
Table 8 – Classification of mechanical conditions from Table 6 of IEC 60721-3-3:2002.....	47
Table 9 – Climatic tests	47
Table 10 – Sinusoidal vibration test	48
Table 11 – Non-repetitive shock test.....	48
Table 12 – Emission – Enclosure port [Table 1 of IEC 61000-6-4:2011 (ed.2.1)]	50
Table 13 – Emission – Low voltage AC mains port [Table 2 of IEC 61000-6-4:2011 (ed.2.1)].....	52
Table 14 – Emission – Telecommunications/network port [Table 3 of IEC 61000-6-4:2011 (ed.2.1)]	53
Table 15 – Characterization of the electromagnetic phenomena [Table 1 of IEC 61000-6-5:2015]	55

Table 16 – Port classification	56
Table 17 – Performance criteria	56
Table 18 – Immunity test list	57
Table C.1 – Load capacity of voice channels	71

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**POWER LINE COMMUNICATION SYSTEMS
FOR POWER UTILITY APPLICATIONS –**

Part 2: Analogue power line carrier terminals or APLC

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62488-2 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

This first edition of IEC 62488-2 cancels and replaces the relevant parts of IEC 60663 and IEC 60495, which will be withdrawn at a later date.

This standard is to be used in conjunction with IEC 62488-1.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
57/1867/FDIS	57/1891/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 62488 series, published under the general title *Power line communication systems for power utility applications*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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.

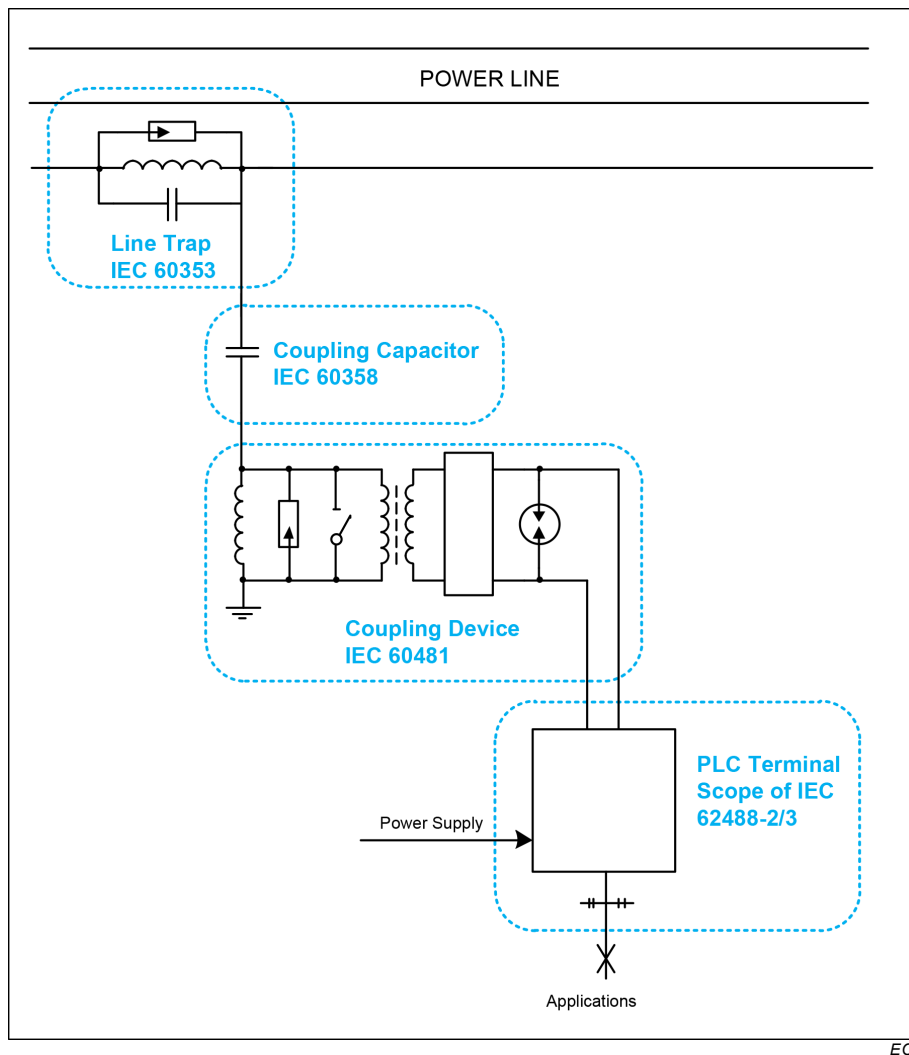


Figure 1 – Schematic representation of the scope of IEC 62488-2

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*