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Sistemi komunikacij po elektroenergetskih vodih za elektroenergetska podjetja - 1. del: Načrtovanje analognih in digitalnih nosilnih frekvenc na elektroenergetskih vodih, ki obratujejo na visokonapetostnih (HV) električnih omrežjih

Power line communication systems for power utility applications - Part 1: Planning of analogue and digital power line carrier systems operating over HV electricity grids

Systeme zur Kommunikation über Hochspannungsleitungen für Anwendungen der elektrischen Energieversorgung - Teil 1: Planung von Systemen zur analogen und digitalen Nachrichtenübertragung über Hochspannungsleitungen

Systèmes de communication sur lignes d'énergie pour les applications des compagnies d'électricité - Partie 1: Conception des systèmes à courants porteurs de lignes d'énergie analogiques et numériques fonctionnant sur des réseaux d'électricité HT

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TITLE: Power line communication systems for power utility applications – Part 1: Planning of analogue and digital power line carrier systems operating over HV electricity grids
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

**Part 1: Planning of analogue and digital power line carrier
systems operating over HV electricity grids**

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This first edition of IEC 62488-1 cancels and replaces the relevant parts of IEC 60663 and IEC 60495, which will be withdrawn at a later date.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/XXXX/FDIS	57/XXXX/RVD

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

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

A list of all parts of IEC 62488 series, 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 publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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1 INTRODUCTION

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

5 The simultaneous use of the power distribution network for both energy transmission and data
6 communication is unique and reduces the costs of installing two services over one transmission
7 path. This communication technology is called generically power line carrier (PLC)
8 communications.

9 Therefore, by using either analogue power line carrier communication (APLC) or digital power
10 line carrier communication (DPLC) or a combination of both types of system (ADPLC), seamless
11 efficient communication may be maintained throughout the power network.

12 The development of digital techniques for communications in the HV electrical power networks
13 is now very widespread along with other applications in electronics. This is especially relevant
14 for the electrical distribution network where many of the PLC devices use analogue to digital
15 converters together with digital signal processing techniques enabling higher flexibility and HW
16 efficiency.

17 The development of the technical report “Planning of power line carrier systems” was first
18 produced by the International Electrotechnical Commission through publication IEC 60663 in
19 1980 entitled Planning of (single sideband) power line carrier systems. In 1993, the International
20 Electrotechnical Commission produced IEC 60495 “Single sideband power-line carrier
21 terminals”. In the intervening years, electronic systems and the associated communications
22 systems for electronic devices evolved and developed considerably. The introduction of digital
23 communication techniques improved the quality of transmission and reception PLC signals
24 within electronic devices, enabling them to provide more detailed quality analysis and control
25 of the data being communicated throughout the electricity distribution network, from control
26 centre to service provider.

27 Both of these standards, IEC 60663 and IEC 60495, are being updated and replaced by the
28 following: IEC 60663 is replaced by IEC 62488-1 and IEC 60495 is replaced by IEC 62488-2
29 and IEC 62488-3 covering respectively analogue, digital and hybrid analog-digital power line
30 carrier terminals.

31 These international standards apply to power line carrier (PLC) terminals used to transmit
32 information over HV power networks. Both analogue and digital modulation systems will be
33 considered.

34 IEC 62488 series consists of the following parts under the general title: Power line
35 communication systems for power utility applications:

36 Part 1: Planning of analogue and digital power line carrier systems operating over HV power
37 networks;

38 Part 2: Analogue power line carrier terminals or APLC;

39 Part 3: Digital power line carrier (DPLC) terminals and hybrid ADPLC terminals.

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POWER LINE COMMUNICATION SYSTEMS FOR POWER UTILITY APPLICATIONS –

Part 1: Planning of analogue and digital power line carrier systems operating over HV power networks

50 **1 Scope**

51 This part of IEC 62488 series applies to the planning of analogue (APLC), digital (DPLC) and
52 hybrid analogue-digital (ADPLC) power line carrier communication systems operating over HV
53 electric power networks. The object of this standard is to establish the planning of the services
54 and performance parameters for the operational requirements to transmit and receive data
55 efficiently and reliably.

56 Such analogue and digital power line carrier systems are used by the different electricity supply
57 industries and integrated into their communication infrastructure using common communication
58 technologies such as radio links, fibre optic and satellite networks.

59 **2 Terms, definitions and abbreviations**

60 **2.1 Terms and definitions**

61 For the purposes of this document, the following terms and definitions apply.

62 NOTE Other terms used in this standard and not defined in this clause have the meaning attributed to them
63 according to the International Electrotechnical Vocabulary (IEV).

64 **2.1.1**

65 **amplitude modulation**

66 **AM**

67 modulation technique in which information is transmitted through amplitude variation of a carrier
68 wave

69 **2.1.2**

70 **analogue interface**

71 interface dedicated to the processing of voiceband analogue signals

72 **2.1.3**

73 **anomaly**

74 small discrepancy between the actually received and the desired data

75 Note 1 to entry: The occurrence of a single anomaly does not cause interruptions of the applications using the
76 transmitted data.

77 **2.1.4**

78 **attenuation**

79 power reduction along a transmission line for the mode or modes under consideration,
80 quantitatively expressed either by the ratio or the logarithm of the ratio of an input power at the
81 initial point to the corresponding output power at the final point

82 **2.1.5**

83 **availability**

84 time or fraction of time a system is operational over a given time interval

85 2.1.6**86 background noise**

87 noise present over all real high voltage power-line channels due mainly to corona and, partial
88 discharges and electromagnetic interference with other PLC equipments operated over the
89 same electricity grid and other interferences due to radio stations working in the same radio
90 frequency spectrum

91 2.1.7**92 bit error ratio****93 BER**

94 ratio of the number of bits errors received divided by the total number of bits sent

95 2.1.8**96 bit error ratio test****97 BERT**

98 set of instruments and measurement methodology to be adopted to evaluate the BER of a
99 transmission system

100 2.1.9**101 broadband over power line****102 BPL**

103 technology that allows data to be transmitted over utility power lines using bandwidths of several
104 MHz

105 Note 1 to entry: These systems typically run over a frequency spectrum in a range from 1 MHz to 30 MHz allowing
106 the transmission of broadband communications. These systems can be found on all the range of power lines from
107 LV to MV. The BPL systems are means to deliver broadband communications to homes and business facilities.
108 Among the BPL systems, we can distinguish the systems used outside the homes or offices (to-the-home-internet
109 access also called access BPL or smart-grid applications operated by the electricity companies) and the "in-home"
110 or "in-house" applications used for home networking (Generally using an Ethernet network technology) and
111 automation. These applications are generally called Home Plug applications.

112 2.1.10**113 carrier-frequency range**

114 bandwidth available for a specific power line carrier communication technology

115 Note 1 to entry: In Europe, the typical carrier-frequency range for narrowband HV PLC is 3 kHz to 148,5 kHz or for
116 broadband PLC is 1,6 MHz to 30 MHz. For the USA IEEE PLC standard the frequency range is 45 kHz to 450 kHz.
117 Parts of the range may be barred by national regulations.

118 2.1.11**119 channelling**

120 elementary subdivision of the carrier frequency range or part thereof allocated to a single PLC
121 transmits and receive channel (bidirectional)

122 2.1.12**123 coloured noise**

124 non-white noise or any wideband noise whose spectrum has a non-flat shape

125 Note 1 to entry: Also called non-white noise; examples are pink noise, brown noise and autoregressive noise.

126 2.1.13**127 corona noise**

128 noise caused by partial discharges on insulators and in air surrounding electrical conductors of
129 overhead power lines

130 Note 1 to entry: Discharges occur on the three different phase conductors at different times. The corona noise level
131 is considerably dependent on weather conditions. The effect of the corona noise is particularly strong under foul
132 weather conditions.

133 2.1.14**134 coupling capacitor**

135 capacitor used for the coupling of the carrier signal to the power line in a PLC system

- 136 **2.1.15**
137 **coupling system**
138 group of devices used to couple the PLC high frequency signals to the power line. Usually
139 coupling system consist of an line trap, a coupling capacitor and a coupling device
- 140 **2.1.16**
141 **defect**
142 large discrepancy between the actually received and the desired data
- 143 Note 1 to entry: Defects cause interruptions of the applications using the transmitted data and are used as input for
144 performance monitoring, the control of consequent actions, and the determination of fault causes.
145 Examples are: loss of signal, sync loss, alarm indication signal, slip, loss of frame alignment.
- 146 **2.1.17**
147 **distribution line carrier**
148 **DLC**
149 system for communication over the distribution power lines
- 150 Note 1 to entry: They DLC systems can be narrow band high speed communication systems on the medium voltage
151 distribution network, or broadband/narrow band communication systems on the low voltage distribution network.
- 152 **2.1.18**
153 **effectively transmitted signal-frequency band**
154 that part of the frequency band used for the transmission of the baseband signal
- 155 **2.1.19**
156 **environment**
157 external conditions in which a system operates
- 158 Note 1 to entry: Different classes of constraints and limits for EMC/EMI are defined for environment classes such
159 as industrial, commercial, domestic.
- 160 **2.1.20**
161 **error free second**
162 **EFS**
163 a one second period without bit error
- 164 **2.1.21**
165 **errored second**
166 **ES**
167 a one-second period in which one or more bits are in error
- 168 **2.1.22**
169 **errored second ratio**
170 **ESR**
171 ratio of errored seconds ES to total seconds in available time during a fixed measurement
172 interval
- 173 **2.1.23**
174 **Ethernet interface**
175 interface dedicated to the processing of data signals in accordance with IEEE 802.3
- 176 **2.1.24**
177 **forward error correction**
178 technique used for correcting errors in data transmission over unreliable or noisy
179 communication channels by encoding the message at the sender in a redundant way by using
180 an error-correcting code so as to enable the receiver to correct a limited number of bit errors

- 181 **2.1.25**
182 **frame check sequence**
183 **FCS**
184 extra bits or characters added to a data frame for error detection
- 185 **2.1.26**
186 **frame loss rate**
187 the number of frames that never reached the destination divided by the number of frames
188 transmitted successfully by the source
- 189 Note 1 to entry: It is usually expressed as a percentage.
- 190 **2.1.27**
191 **frequency division multiplexing**
192 **FDM**
193 multiplexing technique in which several transmitters are allotted separate frequency bands for
194 transmission over a common channel
- 195 **2.1.28**
196 **frequency shift keying modulation**
197 **FSK**
198 a frequency modulation technique in which coded information is transmitted through discrete
199 frequency changes of a carrier wave
- 200 **2.1.29**
201 **group delay**
202 propagation time of a narrowband signal from input to output of a linear system
- 203 Note 1 to entry: Mathematically, group delay equals the negative derivative of the phase shift in radians between
204 input and output of a linear system versus angular frequency.
- 205 **2.1.30**
206 **impulsive noise**
207 noise consisting of short-duration pulses of random amplitude and random duration
- 208 **2.1.31**
209 **jitter**
210 short-term variations of the significant instants of a timing signal from their ideal positions in
211 time (where short-term implies that these variations are of frequency greater than or equal to
212 10 Hz)
- 213 **2.1.32**
214 **latency**
215 time from the source sending a packet into a packet switched network to the destination
216 receiving it
- 217 Note 1 to entry: One-way latency is distinguished from round trip latency, which is the one-way latency from source
218 to destination plus the one-way latency from the destination back to the source. Round-trip latency is more often
219 quoted, because it can be measured from a single point. Note that round trip latency excludes the amount of time
220 that a destination system spends processing the packet.
- 221 **2.1.33**
222 **Coupling device**
223 unit which interfaces the HV side of power line with the PLC equipment (also known as line
224 matching unit (LMU))
- 225 Note 1 to entry: It usually consists of a box mounted near the coupling capacitor. Its characteristics are normalized
226 by IEC 60481.