Telecommunications Standards Advisory Committee (TSAC)

Next Gen National Broadband Network

Powerline Communications (PLC) Home Networking

IDA TS PLC
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Infocomm Development Authority of Singapore
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Content

Technical Specification for Powerline Communications (PLC) Home Networking

1 General Requirements

1.1 Powerline Communications (PLC) is a technology which allows the transmission of voice, video and data through the low voltage electrical distribution network and premises electrical cables/wires. Since the electrical distribution network is not meant for telecommunications purposes, any users or service providers and providers of PLC equipment, as the case may be, have a responsibility to ensure that they obtain the necessary approval from the relevant authorities that have jurisdiction over the use of electrical distribution cables.

1.2 This Specification does not in any way, constitute an approval to transmit telecommunications signal over the power cables. Reference to this Specification should only be made after prior approval from the relevant authorities (as mentioned in the preceding paragraph) has been obtained.

1.3 This Specification is intended for facilitating the use of PLC for home networking, and service providers/users are required to:

(a) Ensure that the in-home PLC devices operate within the frequency range of 2 to 80 MHz, the Power Spectral Density (PSD) mask defined in § 4 and have suppressed the use of frequency bands listed in § 8 and § 9 of this Specification.

(b) Ensure that the level of the PLC device output power is set to a minimum value for communication with PSD reduction tools or dynamic power control implemented (§ 4), and that the unwanted emissions are within the limits defined in § 7 of this Specification.

1.4 Service providers who offer the PLC home networking option and suppliers of PLC devices are required to:

(a) Provide information to customers and users on how to resolve interference problems.

(b) Advise their customers that:

i. The operation of PLC devices is allowed under the condition that no interference is caused to other authorised telecommunications services, and that any interference caused by an authorised radio station, electrical or electronic equipment must be tolerated.

ii. Operation of the PLC devices may have to cease if it is found causing interference to other telecommunications services.

iii. Compliance with requirements defined in this Specification does not imply a guarantee of a certain level of performance quality or multi-vendor equipment interoperability.

1.5 The PLC devices shall be marked with the supplier or manufacturer's name or identification mark, and the supplier or manufacturer's model or type reference. The markings required shall be legible, indelible and readily visible.

2 Scope

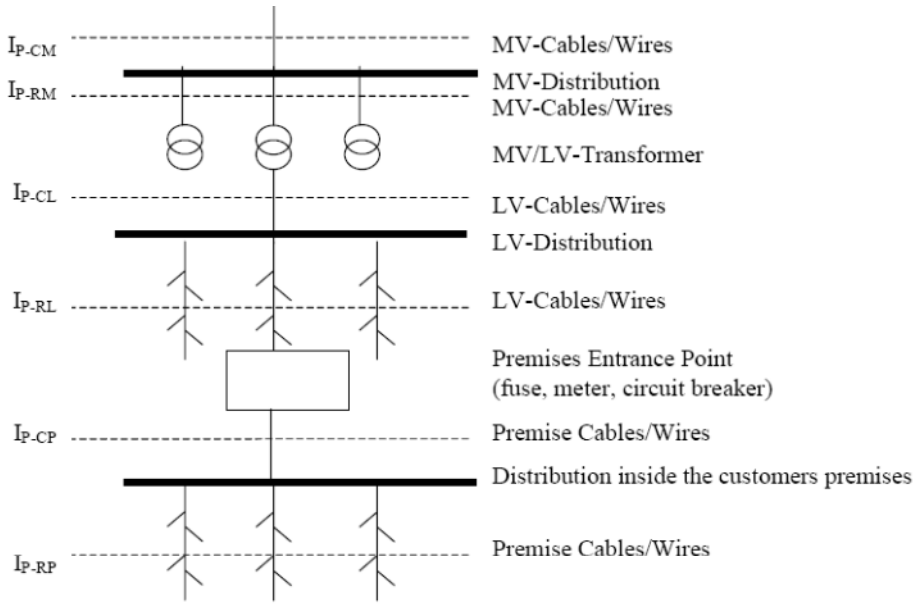
2.1 This Specification defines the minimum technical requirements for the connection of PLC devices to the mains network for the purpose of data transfer and telecommunications and also possibly, for the supply of electrical energy to the devices. The Specification is applicable to PLC home networking equipment or in-home PLC devices connected at the same premises that can comply with the Power Spectral Density (PSD) mask of the ITU-T Recommendation G.9964 [1] for in-home PLC.

2.2 The support for PSD reduction and power management can be implemented independently of the PLC technology.

2.3 The Specification also outlines 3 possible system reference models (refer to §5 of this Specification) which may be adopted to complement the PSD mask with logical interface between the PLC home networking transceivers and the power line medium.

2.4 The PSD levels are further limited by the Electromagnetic Compatibility (EMC) requirements defined for limiting the radiated emissions according to the ETSI TR 102 324 [2] and the IEC CISPR 22 [3] standards.

2.5 PLC devices are connected at the powerline interfaces $I_{P\text{-}RP}$ of the network architecture model as shown in Figure 1, after the Low Voltage (LV) distribution in the customer premises. Figure 1 shows a schematic of an Electrical Distribution Network (EDN) substation up to the level of the Medium Voltage/Low Voltage (MV/LV) transformer, LV distribution and premises cables/wires. It shows a star configuration although ring configuration is also possible on each power level.



Note: $I_{P\text{-}YX}$ Interface Powerline – Y may be C denoting Central or R denoting Remote
X may be L denoting Low Voltage Outdoor or P denoting Premises

Figure 1 (Figure 3/ETSI TS 101 896 [4]): Physical Interfaces ($I_{P\text{-}YX}$) in the EDN

2.6 The PLC device shall be tested for compliance with the IEC 60950-1 [5] safety standard. The requirements in IEC 60950-1 that are applicable to the equipment (e.g. class of equipment, type of TNV circuit and types of components) shall be identified and complied with.

2.7 Figure A-1/Annex A (Informative) of this Specification gives the generic building block for powerline telecommunications, PLT_X. It shows how PLT device or functionality may be inserted into the different levels of the power network architecture (refer to Figure 1). It also shows how the PLT networks may be connected to the telecommunications networks at the $I_{T\text{-}CX}$ interface for

interworking, and the customer premises equipment (CPE) may be connected to the I_{T-RX} interface.

3 Abbreviations

CISPR	International Special Committee on Radio Interference
CPE	Customer Premises Equipment
DM	Differential Mode
EDN	Electrical Distribution Network
EMC	Electromagnetic Compatibility
ETSI	European Telecommunications Standards Institute
ETSI PLT	ETSI Powerline Telecommunications project
HF	High Frequency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ITE	Information Technology Equipment
ITU	International Telecommunication Union
LCM	Launched Common Mode
LPM	Limit PSD Mask
LV	Low Voltage
MV	Medium Voltage
PB	Power-line Baseband
PLC	Power-Line Communications
PLT	Power-Line Telecommunications
PSD	Power Spectral Density
PSDC	PSD Ceiling
PSM	PSD Shaping Mask
SM	Sub-carrier Mask
UPA DHS	Universal Powerline Association – Digital Home Standard

4 Power Spectral Density (PSD) Specification

4.1 Transmit PSD Mask

4.1.1 The PLC device shall have the capability to limit the transmit Power Spectral Density (PSD) mask with the tools that support power reduction or mechanisms that perform dynamic power control.

4.1.2 The limit PSD mask for operation over power lines shall be as presented in Figure 2 (ITU-T Rec. G.9964 Figure 6-2) with the values of frequencies f_L - f_H as presented in Table 1 (ITU-T Rec. G.9964 Table 6-5).

4.1.3 Sub-carriers with frequencies (80 MHz - F_{SC}) ≤ f ≤ (100 MHz + F_{SC}) shall be masked (zero power transmitted).

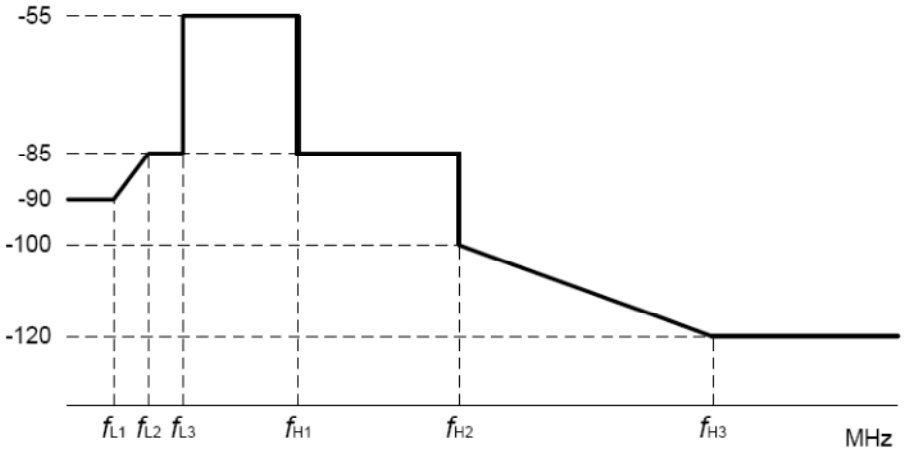


Figure 2 (Figure 6.2/ ITU-T Rec. G.9964): Limit PSD mask for baseband transmission (Amateur radio-band notches are not shown)

Table 1 (Table 6-5/ ITU-T Rec. G.9964): Parameters of Limit PSD mask for the 25MHz-PB, 50MHz-PB, and 100MHz-PB band plans

Parameters	Frequency (MHz)	PSD (dBm/Hz)	Note/Description
f_{L1}	1.1	−90	Additional reduction below 1.1 MHz is to reduce crosstalk into ADSL
f_{L2}	1.8	−85	Coincides with the Amateur radio band
f_{L3}	2.0		
$f_{L3} + \Delta F$	$2.0 + \Delta F$	−55	ΔF is an arbitrary small positive value
$f_{H1} - \Delta F$	$30 - \Delta F$	−55	ΔF is an arbitrary small positive value
f_{H1}	30	−85	ΔF is an arbitrary small positive value
$f_{H2} - \Delta F$	$100 - \Delta F$		
f_{H2}	100	−100	
f_{H3}	250	−120	
NOTE – All sub-carriers above $f_{H2} - \Delta F$ shall not be used for transmission (neither data nor any auxiliary information).			

4.2 Reduction of the Transmit PSD

4.2.1 PSD reduction capability of the PLC device shall either be determined by tools defined in § 5 of

the ITU-T Rec. G.9964 or be determined by other mechanisms for dynamic power control that produce the same effect.

4.2.2 PLC devices shall be required to transmit at minimum power with PSD reduction tools or dynamic power control implemented.

4.2.3 The transmit PSD shall be a function of the channel attenuation between 2 communicating PLC devices (typical PSD of -80 dBm/Hz for power cable length[1] < 30 m, CISPR/I/PT PLT Document [6]).

4.3 Measurements of the Limit PSD Mask (LPM) and Total Transmit Power

4.3.1 Measurements of LPM for transmission over the power line can be made using equipment conforming to the IEC CISPR 16-1 [7] specifications using an RMS detector with a "maximum hold" function and using a resolution bandwidth of 9 kHz for frequencies below 30 MHz and 120 kHz for frequencies above 30 MHz. In order to conform to the IEC CISPR 22 and make reliable measurements, the PLC equipment shall be active at least 10% of the time and sustain the transmit power level for a minimum of 250 ms.

4.3.2 The standard termination (load) impedance of power line for measuring PSD mask and total transmit power shall be 100 Ohm.

4.3.3 The total transmit power of the PLC equipment terminated with the standard termination impedance shall not exceed +20 dBm when measured in the frequency range of 0.005 – 100 MHz (Table 6-12/ITU-T Rec. G.9964).

4.3.4 Alternatively, measurements of the PSD can also be performed, following §6 of the ETSI TS 102 447 [8].

5 System Reference Models for PLC Networking Transceivers

5.1 Specification of the transmit PSD and tools for supporting the reduction of the transmit PSD should be complemented by a system architecture and reference model as defined in the ITU-T Recommendation G.9960 [9], the IEEE 1901 [10] or the UPA DHS [11].

[1] As a guide for taking power cable length as a factor to estimate PSD for the intended optimum throughput:
100m cable length corresponds with 40 dB attenuation and -55 dBm/Hz PSD (at maximum);
25m cable length corresponds with10 dB attenuation and -79 dBm/Hz PSD; and
10 m cable length corresponds with 4 dB attenuation and -87 dBm/Hz PSD.
[IEC CISPR/I/PT PLT Document]

6 Conducted Emission Characteristics of PLC Networks

6.1 Understudy[2]

7 Radiated Emission Characteristics of PLC Networks[3]

7.1 Radiated Emission Measurements below 30 MHz (PLC devices or home networks)

7.1.1 Radiated emissions from the PLC device below 30 MHz shall be measured according to the ETSI TR 102 324 [2] and shall be less than the value given in Table 2 (Table 1/ ETSI TR 102 324).

Table 2 (Table 1/ETSI TR 102 324): Radiated Emissions from PLC Networks below 30 MHz

Frequency Range (MHz)	Field Strength (dBµA/m quasi-peak)	Reference Measurement Distance (m)	Measurement Bandwidth (kHz)
1.605 to 30	14	3	9

7.1.2 In the frequency range 1.605 to 30 MHz, the magnetic component of the radiated emission shall be measured. A calibrated measuring system according to IEC CISPR 16-1 [7] consisting of a radio disturbance measuring receiver, an associated loop antenna for measurement of magnetic field components and a tripod is required. Other specialised equipment such as resonant loop antennas can also be used. A measuring bandwidth of 9 kHz and a Quasi-peak detector shall be used.

7.2 Radiated Emission Measurements above 30 MHz (PLC devices or home networks)

Radiated emissions from the PLC device above 30 MHz shall be measured according to the IEC CISPR 22 [3] and shall meet the limits of Table 3 (Table 6/CISPR 22).

Table 3 (Table 6/CISPR 22): Limits for Radiated Disturbance of class B ITE at a measuring distance of 10 m

Frequency range MHz	**Quasi-peak limits dBµV/m**
30 to 230	30
230 to 1000	37
Note 1 The lower limit shall apply at the transition frequency. Note 2 Additional provisions may be required for cases where interference occurs.	

[2] Developments to the Amendment 1 to the IEC CISPR 22 and the CENELEC prEN 50561-1 will be monitored for harmonisation, and upon the IEC or ITU achieving consensus in the EMC standard for measuring PLC conducted emissions, requirements will be incorporated in this Specification.

[3] The term PLC network will represent at least a pair of PLC devices to be activated for performing measurements of the actual transmit power between two communicating PLC devices and the resulting radiation.

8 Prohibited Frequencies

8.1 PLC transmission in the following frequency bands is prohibited and shall be suppressed by PSD reduction of at least 30 dB with respect to the transmit level outside of the PSD reduction with widths encompassing the suppressed frequency bands.

(a) 2.850 – 3.025 MHz

(b) 5.480 – 5.730 MHz

(c) 6.525 – 6.685 MHz

(d) 8.815 – 8.965 MHz

(e) 10.005 – 10.100 MHz

(f) 10.7 MHz

(g) 11.275 – 11.400 MHz

(h) 74.800 – 75.200 Mhz

9 Amateur Radio Frequency Bands

9.1 PLC transmission in the following amateur radio frequency bands shall be suppressed by PSD reduction of at least 30 dB with respect to the transmit level outside of the PSD reduction with widths encompassing the suppressed frequency bands.

(a) 3.500 – 3.900 MHz

(b) 7.000 – 7.100 MHz

(c) 10.100 – 10.1500 MHz

(d) 14.000 – 14.350 MHz

(e) 18.068 – 18.168 MHz

(f) 21.000 – 21.450 MHz

(g) 28.000 – 29.700 Mhz

10 References

[1] ITU-T Recommendation G.9964 (12/2011), Unified high-speed wire-line based home networking transceivers – Power Spectral Density (PSD) Specification

[2] ETSI TR 102 324 v1.1.1 (2004-05) Powerline Telecommunications (PLT); Radiated emissions' characteristics and measurement method of state of the art powerline communication networks

[3] IEC CISPR 22 (2008), Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement

[4] ETSI TS 101 896 v1.1.1 (2001-02) Powerline Telecommunications (PLT); Reference Network Architecture Model; PLT Phase 1

[5] IEC 60950-1 International Electrotechnical Commission – Safety of Information Technology Equipment

[6] CISPR/I/PT PLT, “Average Reduction of the PSD Mask by PLC Power Management”, Dr.-Ing. Michael Koch, (2009-06)

[7] IEC CISPR 16-1 (2010), Specification for radio disturbance and immunity measuring apparatus and methods

[8] ETSI TS 102 447 V1.1.1 (2008-06), Powerline Telecommunications (PLT); Programmable PSD Mask; Specifications for Access and Indoor Systems

[9] ITU-T Recommendation G.9960 (12/2011), Unified high-speed wire-line based home networking transceivers – system architecture and physical layer specification

[10] IEEE P1901 (07/2009) Standards Working Group

[11] UPA DHS v1.0 (02/2006) Universal Powerline Association Digital Home System (UPA DHS) Specification v1.0

Annex A
(Informative)

Interfaces of PLC Equipment for connection to Telecommunications Network

Interworking between PLT and telecommunications networks is demarcated by the I_{T-CX} as shown in the PLT building block of Figure A-1 (Figure 1/ETSI TS 101 896).

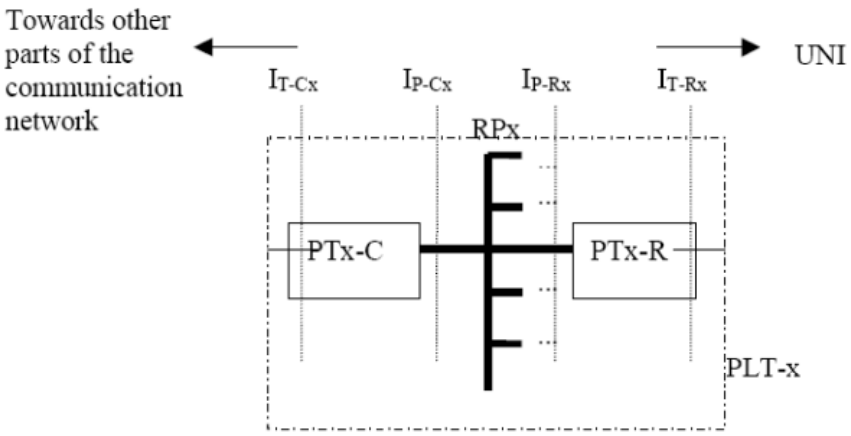


Figure A-1 (Figure 1/ETSI TS 101 896): Generic Building Block PLT_X

X	X may be L denoting Low Voltage Outdoor or P denoting Premises
I_{T-CX}	Interface Telecommunication Central connection point to a core backbone network or to I_{T-RX} of another PLT_X in a layered PLT structure
I_{P-CX}	Interface Powerline Central connection point to the Electrical Distribution Network (EDN)
I_{P-RX}	Interface Powerline Remote connection point to the Electrical Distribution Network (EDN)
I_{T-RX}	Interface Telecommunication Remote connection point to either customer equipment or to I_{T-CX} of another PLT_X in a layered PLT structure
RP_X	Reference Point to the respective section of the EDN
PT_{X-C}	Powerline Transmission Central modem unit, which modulates information from I_{T-CX} in downstream direction into RF signal on the I_{P-CX}, and demodulates an upstream RF signal from the I_{P-CX} into the I_{T-CX}.
PT_{X-R}	Powerline Transmission Remote modem unit, which modulates information from I_{T-RX} in upstream direction into RF signal on the I_{P-R_X}, and demodulates a downstream RF signal from the I_{P-RX} into the I_{T-RX}.
PLT_X	Powerline Telecommunications building block

The current IDA Specifications for equipment connection to the various telecommunications networks core backbone networks) are:

- IDA TS PSTN
- IDA TS ISDN
- IDA TS ADSL
- IDA TS CM
- IDA TS DLCN
- IDA TS BISDN
- IDA Guide NNI
- IDA RS NTE

This list is subject to review and updating.

These IDA Specifications are available from www.ida.gov.sg under Policies & Regulation.

Annex B

Conformity Assessment Checklist

IDA TS PLC	Description	CR	Complied Yes/No	Remarks
2.6	IEC 60950-1 safety standard	M		
4.1.1	Limit PSD with tools for power reduction or mechanisms for dynamic power control	M		
4.1.2	Limit PSD Mask as shown in Figure 2 with parameters as given in Table 1.	M		
4.1.3	Sub-carriers with frequencies (80 MHz - F_{SC}) ≤ f ≤ (100 MHz + F_{SC}) shall be masked.	M		
4.2.1	PSD reduction capability shall either be determined by the tools (SM, PSM, Notching and PSDC) defined in § 5 of ITU-T Rec.G.9964 or be determined by other mechanisms that produce the same effect.	M		
4.2.2	PLC devices shall transmit at minimum power with PSD reduction tools or dynamic power control implemented.	M		
4.2.3	The transmit PSD shall be a function of the channel attenuation between 2 communicating PLC devices.	M		
4.3	Measurements of the Limit PSD Mask (LPM) and total transmit power (IEC CISPR 16-1)	M		
5	System Reference Models for PLC networking transceivers	O		
7.1	Radiated emission measurements below 30 MHz (ETSI TR 102 324)	M		
7.2	Radiated emission measurements above 30 MHz (IEC CISPR 22)	M		
8	Listed prohibited frequency bands suppressed	M		
9	Listed amateur radio frequency bands suppressed	M		

CR : Compliance Requirement
M : Mandatory
O : Optional

Annex C

Corrigendum & Addendum

Changes to the IDA RS PLC (August 2003)			
Page	**TS Ref.**	**Items Changed**	**Effective Date**
		The IDA TS PLC Issue 1 (August 2012) has superseded the IDA RS PLC Issue 1(August 2003).	27 Aug 2012