DECISION ISSUED BY THE
INFO-COMMUNICATIONS DEVELOPMENT AUTHORITY OF SINGAPORE

TECHNICAL SPECIFICATION FOR POWERLINE COMMUNICATIONS HOME NETWORKING

27 August 2012

INTRODUCTION

1. The Technical Specification for Power Line Communications ("PLC") Home Networking to be issued by IDA (hereafter referred to as "IDA TS PLC") was developed by the Telecommunications Standards Advisory Committee ("TSAC") Industry Working Group 2 ("TSAC WG2") as part of efforts to enable a "Connected Digital Home" with home networking options.

2. The IDA TS PLC was finalised by the TSAC WG2 and endorsed by the TSAC following the consideration of recommendations derived from the PLC electromagnetic compatibility ("EMC") study commissioned by IDA in May 2011 (hereinafter referred to as "IDA PLC study"). The study was carried out in consultation with the NTU School of Electrical & Electronic Engineering.

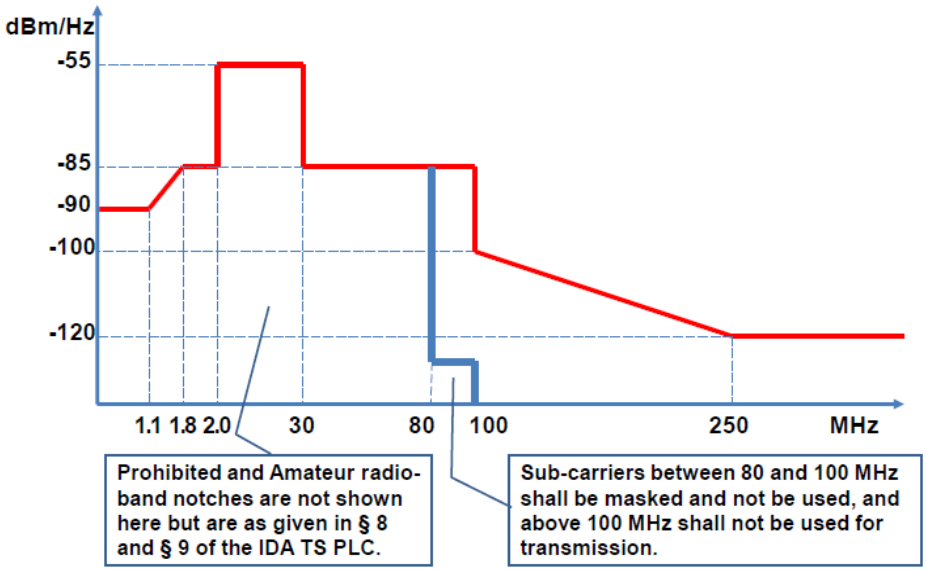
3. At the close of IDA's public consultation for the IDA TS PLC on 9 May 2012, comments were received from 5 respondents. IDA wishes to thank the respondents for their feedback. IDA has reviewed the comments received, and this document sets out IDA's decision.

SUMMARY OF RESPONSES & IDA'S DECISION

Technology neutrality of the IDA TS PLC

4. Two respondents commented that the adoption of the transmit limits defined by the ITU-T Rec. G.9964 [1] PLC mask as shown in the given Figure (Figure 6-2 of G.9964) should not contravene the principle of technology neutrality. Respondents suggested that local or regional transmit limits should be specified in the place of the G.9964 PLC mask.

5. IDA clarifies that the technical requirements defined in the IDA TS PLC for public consultation are in line with international standards. The G.9964 PLC mask may be applied independently of any PLC technology. The mask serves to outline the power limits for transmission in frequency bands defined for PLC. To minimise radiation from PLC, the actual transmit power is determined by power reduction tools or dynamic power control techniques implemented in the PLC devices for achieving minimum output power for optimum throughput.



Limit Power Spectral Density (PSD) Mask for PLC Baseband Transmission (Figure 6-2/G.9964 [1])

6. To the contrary, technology neutrality is emphasised in the IDA TS PLC as the adoption of a specific prevalent PLC system reference models to complement the G.9964 PLC mask is not prescribed. Instead, three PLC system reference models have been cited as possible options (the ITU-T Rec. G.9960 [2], the IEEE 1901 [3] and the UPA DHS [4]).

7. Respondents further suggested removing references to the UPA-DHS and the ITU-T Rec. G.9960 and G.9964. They commented that the UPA technology was no longer in existence and that the G.9964 was not technology neutral. IDA recommends that the former be supported by documentation for validation by the TSAC WG2, while the latter has been clarified in paragraphs 5 and 6, emphasising that the G.9964 PLC mask can be applied independently of any PLC technology, supported by any power reduction or dynamic power control techniques.

Views on the G.9964 PLC mask and masking of frequencies for PLC

8. Two respondents commented that a typical in-home PLC device with a transmit power below -79 dBm/Hz contradicts the peak value of -55 dBm/Hz indicated in the G.9964 PLC mask. The two respondents requested for the removal of the G.9964 requirement for masking and suggested that frequencies above 80 MHz be allowed for use for transmission.

9. Conversely, one respondent commented that either the transmit power be capped at -80 dBm/Hz, or guidance and clarity be given to ensure effective functioning of the dynamic power control in the PLC devices to achieve minimum output power for the intended optimum throughput. However, the

respondent requested that frequencies above 30 MHz should be masked and not be used for transmission.

10. IDA clarifies that the adoption of the G.9964 PLC mask together with the requirement for power reduction or dynamic power control is based on conclusions derived from the IDA PLC study report, as well as recent developments in PLC technology that allow for better mitigation of electromagnetic interference.

    a. The IDA PLC study report recommends restricting the PLC devices to transmit at levels less than -80 dBm/Hz, regardless of the span of the power cable between the communicating PLC devices. This limit is imposed for the worst case scenario in which PLC devices operating in homes with extremely imbalance electrical circuits will predispose the power cable to radiate at higher level if the PLC transmit power is not capped as such.

    b. However, today's PLC technology has evolved with interference mitigation techniques being made available in the PLC chipsets such as the power reduction tools defined in the ITU-T Rec. G.9964 [1] and the transmit power control techniques defined in the ETSI TS 102 447 [5]. PLC devices with any set of these techniques implemented, will have the ability to reduce their transmit power correspondingly with the channel attenuation detected between the communicating PLC devices. Referring to a European statistical model for PLC in-home operations as a guide, power cable length may be used as a factor to estimate the transmit power for the intended optimum throughput [6]. For example, 25m of power cable may correspond with 10 dB channel attenuation and a transmit power of less than -79 dBm/Hz. However, the PLC signal to noise margin which is another factor accounted for in the European statistical model, is an environmental variable.

11. Nonetheless, to pave the way forward for PLC technology, IDA has decided to adopt the G.9964 PLC mask together with the requirement for power reduction or dynamic power control as referred to in paragraph 10, as follows:

    a. PLC devices shall transmit at minimum output power, operating within the G.9964 PLC mask and implement power reduction or dynamic power control techniques.

    b. Transmit power shall be a function of the channel attenuation between 2 communicating PLC devices (typical transmit power of -80 dBm/Hz for cable length within 30 m, when operating below 30 MHz).

c. Transmit power measurement shall be based on the IEC CISPR 16-1 [7] cross-referenced in the ITU-T Rec. G.9964 [1] or its equivalent (e.g. as defined in the ETSI TS 102 447 [5]).

12. IDA notes the International Telecommunication Union's ("ITU") recommendations that the adoption of the G.9964 PLC mask and power reduction requirements will allow PLC products to *"comply with the most rigorous EMC requirements that ensure they cause no interference to radio services".* The recommendations from the IDA PLC study have correspondingly confirmed this statement as highlighted in the Table given below, particularly with the cap to radiation to maintain a wide margin between the level of radiation and the level of immunity (comparing column D and E in the Table below), expected of telecommunications and cabling systems (column E), normally ensured by proper grounding and shielding (ITU-T Rec. K.43 [11]).

ITU-T Rec. G.9964 PLC Mask [1]		IDA PLC Study Report		IEC EMI Standard [10]
A	B	C	D	E
Operating Frequencies	Transmit Power	Transmit Power	Radiation Level	Electromagnetic Immunity (EMI) Level
2 – 30 MHz	–55 dBm/Hz (max) –85 dBm/Hz (min) with power reduction	–80 dBm/Hz (refer to para.11b)	65.5 dBµV @ 3m [8]	120 dBµV
30 – 80 MHz	–85 dBm/Hz (max)	–	30 dBµV @ 10m [9]	120 dBµV
> 80 MHz	No Transmission	–	–	–

Refer to References:

[8] ETSI TR 102 324, frequency range 1.6 to 30 MHz

[9] IEC CISPR 22, frequency range 30 to 1000 MHz

[10] IEC 61000-4-6, frequency range of 150 kHz to 80 MHz

13. Two respondents requested for a lifting of the restriction in respect of the use of frequencies of up to 80 MHz while one respondent requested that the restriction to 30 MHz be maintained as the IDA PLC study seemed to have been conducted for PLC devices operating in the 2 to 30 MHz frequency range only. As clarified in paragraphs 10, 11 and 12, the G.9964 PLC mask to be adopted shall entail masking of not only power levels but also frequencies, so as to prevent interference to radio services. Although PLC interference to users of very high radio frequencies (30 to 300 MHz) is unlikely since a significantly reduced transmit power has been selected for PLC operations above the 2 to 30 MHz frequency range, IDA has decided to align with the ITU-R report [12] on the impact of PLC on radio-communication systems operating below 80 MHz and the ITU-T Rec. G.9964 [1] PLC mask, and incorporate the following requirements in the IDA TS:

a. The transmit power limit for PLC frequencies from 30 – 80 MHz shall be capped at -85 dBm/Hz (30 dB lower and more stringent than the cap of -55 dBm/Hz for PLC frequencies between 2 – 30 MHz, see column B of the above Table).

b. In addition, radiation from PLC devices operating between 30 – 80 MHz shall comply with the IEC CISPR 22 [9] limit which will ensure electromagnetic compatibility when operating above 30 MHz (see column D of the above Table).

c. Furthermore, PLC frequencies above 80 MHz shall be masked and not be used for transmission (refer to the Table above).

Use of PLC devices for home networking

14. One respondent commented that there should be clarity between the measurement of radiation from PLC networks and PLC devices. IDA clarifies that the IDA TS PLC specifies for home networking which comprises at least a pair of PLC devices. The term PLC network will represent the pair of PLC devices to be activated for performing measurements of the actual transmit power between the two communicating PLC devices and the radiation occurring as a result. IDA further clarifies that the ETSI TR 102 324 [8] and the IEC CISPR 22 [9] are applicable for measuring radiation from PLC networks operating between 2 – 30 MHz and between 30 – 80 MHz, respectively (refer also to column D of the above Table).

Multiple Input / Multiple Output (MIMO) for PLC

15. IDA notes the proposal from one respondent to include the ITU-T Rec. G.9963 [13] specification for MIMO in the IDA TS PLC. As the impact of using MIMO for PLC to transmit over 3 power-line conductors (live, neutral and ground) has yet to be deliberated at the TSAC WG2, IDA has forwarded this proposal to the TSAC WG2 for further study. IDA welcomes and looks forward to contributions from the respondent to the work of TSAC WG2 in this aspect.

Conducted emissions from PLC devices

16. IDA notes the request from two respondents for the continual monitoring of harmonisation of EMC standards for the PLC conducted emission. A placeholder has been provided in the IDA TS PLC for capturing the conducted emission characteristics of PLC networks/devices as an additional measure for avoiding risk of electromagnetic interference; and as part of the EMC requirements for telecommunication equipment (pending ratification of the Amendment 1 to the IEC CISPR 22 [14] and the CENELEC pr EN 50561 [15] by the respective Standards Development Organisations).

SUMMARY OF IDA'S DECISION

17. In summary, as laid out in this Decision, IDA is of the view that conformity with the requirements set out in the IDA TS PLC will reduce the risk of potential electromagnetic interference to telecommunications services (see paragraphs 10, 11, 12 and 13).

    a. PLC devices shall transmit at minimum power for the intended optimum throughput, complying with the G.9964 PLC mask and the requirement of power reduction or dynamic power control (see column B of the given Table).

    b. The requirement of power reduction or dynamic power control shall include the masking of frequencies above 80 MHz as well as the notching of prohibited frequencies and frequency bands designated for amateur radio (also refer to the given Figure and Table).

    c. Radiation from PLC devices operating between 2 – 30 MHz shall comply with the ETSI TR 102 324 [8] limit whereas radiation from PLC devices operating between 30 – 80 MHz shall comply with the IEC CISPR 22 [9] limit (see column D of the given Table).

18. IDA hereby issues the finalised IDA TS PLC on 27 August 2012. A copy of the finalised IDA TS PLC will be published on IDA's website. For the avoidance of doubt, the finalised IDA TS PLC shall replace and supersede the previously issued Reference Specification for PLC Equipment (IDA RS PLC, August 2003).

19. Notwithstanding the issuance of the finalised IDA TS PLC, IDA is cognisant of the need for a lead time for PLC devices in the market to comply with the IDA TS PLC for purposes of equipment registration. As such, licensees shall only be required to ensure that PLC devices comply with the requirements set out in the finalised IDA TS PLC with effect from **1 June 2013**.

20. Between 27 August 2012 and 1 June 2013, licensees are encouraged to adopt the requirements set out in the IDA TS PLC. However, licensees are reminded to ensure that any PLC device in his possession does not cause interference to any telecommunication system or service.

REFERENCES

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

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

[3] IEEE 1901 (07/2009) Standards Working Group

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

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

[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 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

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

[10] IEC 61000-4-6 (2008), Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields

[11] ITU-T Recommendation K.43 (7/2009), Protection against Interference: Immunity requirements for telecommunication network equipment

[12] International Telecommunications Union on Radio-communications (ITU-R) Report, ITU-R SM.2158 (2009) - Impact of power line telecommunication systems on radio-communication systems operating in the LF, MF, HF and VHF bands below 80 MHz

[13] ITU-T Recommendation G.9963 (12/2011), Unified high-speed wire-line based home networking transceivers – Multiple input/multiple output (MIMO) specification

[14] Amendment 1 to CISPR 22 Ed. 6.0: Addition of limits and methods of measurement for conformance testing of power line telecommunication ports intended for the connection to the mains (CIS/I/301/CD)

[15] CENELEC pr EN 50561: 2011, Powerline Communications apparatus used in low voltage installations - Radio disturbance characteristics - Limits and methods of measurement - Part X: Apparatus for in-home use operating between 1.6065 and 470 MHz