A Survey on BPL Communications Standards

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Summary

BPL technology, also known as broadband over power lines communications, uses the electrical power grid as the transmission medium, as well as the most advanced communications technology to provide high speed broadband services such as Internet access, telephony, data, etc., over the low and medium voltage distribution grid. A key issue of this technology is that no new wires need to be installed in the last mile. In addition, using the existing power grid as a transmission medium makes it possible to send and receive data through standard power sockets, and it could also be a cost-effective solution compared to other communications systems because it uses the existing power grid infrastructure. This paper gives a survey of the major standardization organizations, associations and forums related to BPL technology as well as, an analysis of the most relevant standards related to electromagnetic compatibility currently available such as: testing and measuring techniques of electromagnetic immunity and emissions, security and basic environmental testing procedures is given. In addition, the main local area networks and Internet access standards that can be applied to BPL electronic and communications equipment are reviewed.

Key words:

Broadband over Power Lines Communications, BPL, Electromagnetic Compatibility, Electromagnetic Emissions, Electromagnetic Immunity.

1. Introduction

Broadband over Power Lines (BPL) is a relatively new technology that is gaining in popularity since it can provide more efficient management of the power supply system, and provides customers another option for high-speed broadband services. BPL is the most recent technology for using power lines for delivery of high-speed data services, mainly for Internet access. It offers benefits to utilities for applications like: remote monitoring of substations, automated meter reading (AMR), monitoring of the power system, etc. However, the main key factor for the deployment of BPL systems is interference. According to the Federal Communications Commission, generally two types of emissions cause interference: radiated emissions and conducted emissions. Radiated emissions radiate outward from a source and interfere with the performance of other devices. On the other hand, conducted emissions are wavelengths that travel along wiring or another conducting medium and interrupt the performance of other devices. While, BPL technology manufacturers have focused on the elimination of noise it has faced strong opposition from amateur radio operators, as well as some emergency response agencies because the broadband data transmitted over the electric grid system is carried on or near radiofrequencies that are used by these users, resulting in interference on those frequency bands.

While concerns about radio frequency interference has not been completely resolved, the major unresolved technical issue currently been faced by BPL providers and equipment manufacturers is the lack of engineering standards for the technology. Without standardization, each manufacturer is free to design and market its own proprietary equipment that is not compatible with devices designed to perform similar functions produced by other manufacturers. However, most of the frequency band (2 to 80 MHz) intended for new BPL systems is already in use for different wireless services such as broadcasting, amateur radio or air traffic control. On the other hand, the operation of electronic equipment based on BPL technology could have a noticeable impact on the wireless services currently in operation because of the electromagnetic interference radiated by the power distribution mains when data rates higher than 2 Mbps are used. To avoid having radio noise emissions or electromagnetic interference from BPL equipment to other systems, international, regional and local standards are required in order to regulate different aspects related to electromagnetic compatibility such as electromagnetic emissions and immunity measurement, radio disturbance characteristics, limits and methods of measurement, etc.

This technical paper gives a survey of the major standardization organizations, associations and forums related to BPL technology as well as, an analysis of the most relevant standards related to electromagnetic compatibility currently available such as: testing and measuring techniques of electromagnetic immunity and emissions, security and basic environmental testing procedures is given. In addition, the main local area networks and Internet access standards that can be applied to BPL communications equipment are reviewed.

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2. Standardization Bodies

Due to, the importance that standardization has, there are international, regional and local standardization bodies around the world. Their main objective is to regulate and to approve the production of standards in different existing areas [1]. The main standardization bodies are as follows:

2.1 International Bodies

The major bodies that produce international standards for electronic and telecommunications equipment are: The International Electrotechnical Commission, known as IEC [2], is a global organization created in 1906 that prepares and publishes international standards for all electrical, electronic and related technologies. These serve as a basis for national standardization and as references when drafting international tenders and contracts. The International Special Committee on Radio Interference, known as CISPR [3], has the aim to promote international agreement on the aspects of radio interference thereby facilitating international trade. It is related to equipment and methods for the measurement of interference produced by electric and electronic equipment above 9 kHz band. CISPR produce standards to offer protection of radio reception from interference sources such as electrical appliances of all types; electricity supply systems; industrial, scientific and medical radiofrequency (ISM); broadcasting receivers (sound and TV), etc. The International Organization for Standardization (ISO) [4], is a worldwide federation of national standards bodies from more than 140 countries, one from each country. It is a non-governmental organization established in 1947 to promote the development of standardization and related activities in the world. ISO's work results in international agreements which are published as International Standards. The International Telecommunication Union (ITU) [5], formerly known as CCITT, is an international organization within the United Nations System where governments and the private sector coordinate global telecommunications networks and services. It was founded in 1865 and became a United Nations specialized agency in 1947. It is responsible to adopt international agreements, regulations and to produce telecommunications standards.

2.2 American Bodies

The major bodies that produce standards for electronic and telecommunications equipment in the United States are: The Federal Communications Commission (FCC) [6], the Institute of Electrical and Electronics Engineers (IEEE) [7], the American National Standards Institute (ANSI) [8], Electronic Industries Alliance (EIA) [9], the Telecommunications Industry Association (TIA) [10] and the United Telecom Council (UTC) [11]. From all these bodies, the Part 15 of the code of federal regulations No. 47 applies to radiofrequency devices, including the systems based on BPL technology. UTC has created the powerline telecommunications forum (PLT forum) to investigate new broadband powerline communications technologies over power distribution mains. Also, UTC has created the United Power Line Council (UPLC), which is an alliance of electric utilities and technology companies working together to drive the development of power line communications and broadband services.

2.3 European Bodies

Within the main bodies that produce standards for electronic and telecommunications equipment in Europe are: The European Telecommunications Standards Institute (ETSI) [12], the Comité Européen de Normalisation Electrotechnique (CENELEC) [13], the Comité Europeén de Normalisation (CEN) [14], the Information and Communications Technologies Standards Board (ICTSB) [15], the Office of Telecommunications (OFTEL) [16], and the Radiocommunications Agency (RA) [17]. From all these bodies, ETSI has created the PLT Committee which is in charge of producing a set of standards for systems based on BPL technology. The ICT Standards Board (ICTSB) is an initiative from the three recognized European standards organizations: ETSI, CENELEC and CEN. All these bodies work together in the standardization of some aspects of BPL technology such as: functionality, interoperability, legal context, safety, environmental aspects, testing, etc.

2.4 International Electric Bodies

There are several international electric bodies that carry out studies in specialized areas of power systems. The main electric bodies are: The Conseil Internacional des Grands Réseaux Électriques (CIGRE) [18], the International Conference on Electricity Distribution Mains (CIRED) [19], the International Electric Research Exchange (IRE) [20], the Electrical Power Research Institute (EPRI) [21], the Edison Electric Institute (EEI) [22], the United Telecom Council (UTC) [11], and the United Powerline Council (UPLC) [23].

2.5 Mexican Local Bodies

Nationwide, in México, the body in charge to regulate and to approve the production of standards in different areas is "Secretaría de Comercio y Fomento Industrial" (SECOFI),

through "Dirección General de Normas". The electric bodies related to the production of standards for the power industry are: "Asociación de Normalización y Certificación Eléctrica" (ANCE) [24], which is responsible for producing Mexican standards for electric and electronic apparatus known as ANCE standards (NMX-J-ANCE), which are produced by "Comité de la ANCE" (CONANCE). CONANCE, also produce "Normas Oficiales Mexicanas" (NOM standards) or "Normas Mexicanas" (NMX). This body works at a regional level with the Council for Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), and at an international level with the International Electrotechnical Commission (IEC) through the Mexican Committee. ANCE has the permission from "Secretaría de Comercio y Fomento Industrial" to operate as a standardization body, as a certification body, and as a testing laboratory, under the Federal Law of Metrology and Standardization, emitted on the 1st. of July 1992. Another major electrical body is "Comision Federal de Electricidad" (CFE) [25]. It has an internal standardization system, which define, and specify the technical characteristics that the acquired equipment and materials of all types have to meet, for power supply to its users. At an international level, CFE has participation in ISO and IEC, from which Mexico is a member.

3. Associations and Forums

3.1 North American

The main associations and forums related to BPL technology in the United States of North America are: The Powerline Communications Association (PLCA) [26], the Powerline Telecommunications Forum (PLT Forum) [27], the Powerline World [28], the Home Plug Alliance [29], the Continental Automated Building Association (CABA) [30], the Universal Plug and Play Forum (UpnP) [31], the Automatic Meter Reading Association (AMRA) [32], the National Rural Electric Cooperative Association (NRECA) [33], and the American Public Power Association (APPA) [34].

3.2 European

The main associations and forums related to BPL technology in Europe are: The Powerline Communications Forum [35], the Powerline as an Alternative Local Access Project (PALAS) [36], the Communications Management Association (CMA) [37], the German Association for Information Technology, Telecommunications and New Media (BITKOM) [38], the European Information, Communications and Consumer Electronics Technology Industry Association (EICTA) [39], the Powerline Telekommunkations Forum [40], and the European Automatic Meter Reading Association (Euro-AMRA) [41].

4. Applicable Standards

In this section, the most relevant standards related to electromagnetic compatibility (EMC) currently available, such as: testing and measuring techniques of electromagnetic immunity and emissions, security and basic environmental testing procedures is analyzed. Also, the main local area networks and Internet access standards that can be applied to BPL technology is reviewed. The major standards applicable to electric and electronic equipment, including BPL equipment are as follows [1]:

4.1 EM Immunity Generic Standards

One generic standard of electromagnetic compatibility applicable to BPL equipment is:

IEC 61000-1. Specifies the immunity requirements for electrical and electronic equipment intended for use in residential, commercial and light-industrial environments in the frequency range 0 Hz to 400 GHz [42].

4.2 EM Immunity Basic Standards

The basic standards for electromagnetic immunity tests applicable to BPL equipment are:

IEC 61000-4-2. Specifies the immunity requirements and test methods for electrical and electronic equipment subjected to static discharges [43].

IEC 61000-4-4. Specifies the immunity requirements and test methods for electrical and electronic equipment when subjected to repetitive fast transients (bursts) [44].

IEC 61000-4-5. Specifies the immunity requirements, test methods, and range of recommended test levels for equipment to unidirectional surges caused by over voltages from switching and lighting transients [45].

IEC 61000-4-6. Specifies the conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio-frequency (RF) transmitters in the frequency range 9 kHz up to 80 MHz [46].

IEC 61000-4-8. Specifies the immunity requirements of

equipment, only under operational conditions, to magnetic disturbances at power frequency related to: residential and commercial locations; industrial installations and power plants; and medium voltage and high voltage substations [47].

IEC 61000-4-11. Specifies the immunity test methods and range of preferred test levels for electrical and electronic equipment connected to low-voltage power supply networks for voltage dips, short interruptions, and voltage variations [48].

CISPR 24. Specifies the immunity test requirements and for equipment defined in the scope in relation to continuous and transient, conducted and radiated disturbances, including electrostatic discharges in the frequency range from 0 Hz to 400 GHz [49].

CISPR 16-1. Specifies the characteristics and performance of equipment for the measurement of radio disturbance voltages, currents and fields in the frequency range 9 kHz to 18 GHz [50].

4.3 EM Emissions Basic Standards

The basic standards for the measurement of electro-magnetic emissions applicable to BPL equipment are:

CISPR 22. Specifies the procedures for the measurement of the level of spurious signals and limits generated by the information technology equipment for the frequency range 9 kHz to 400 GHz for both class A and class B equipment [51].

MPT 1570. Specifies the electromagnetic radiation limits, as well as the measurement of the magnetic field strength from telecommunications systems operating over material substances in the frequency range 9 kHz to 300 MHz [52].

FCC CFR 47-Part 5. Specifies the regulations for carrier current systems under which a radio-frequency device such as: an intentional, unintentional, or incidental radiator may be operated without an individual license. This standard includes the Amendment of Part 15 regarding new requirements and measurement guidelines for access broadband over power line systems [53].

ANSI C63.4. Specifies United States consensus standard methods, instrumentation, and facilities the for measurement of radio-frequency (RF) signals and noise emitted from electrical and electronic devices in the frequency range 9 kHz to 40 GHz [54].

ETSI TR 102 324. The technical report describes the radiated emissions characteristics and associated method of measurements of state of the art powerline communications networks. The document also reports the radiated emission characteristics of powerline communication networks [55] in the frequency range 1.605 MHz to 30 MHz (see Table1).

Table 1: Radiated emissions for BPL networks

Frequency (MHz)	Field strength dB(μA/m) quasi-peak	Reference measurement distance (m)	Measurement bandwidth (kHz)
1.605- 30	14	3	9

CENELEC CLC/prTS 50217. This guide describes analysis methods of disturbance emission to be applied in-site for identification of the disturbance source and resolution of complaint. It is not intended to kind of conformity assessment [56].

4.4. Safety Standards

The safety standards applicable to BPL equipment are:

IEC 60950-1. Specifies the requirements intended to reduce risks of fire, electric shock or injury for the operator and layman who may come into contact with the equipment and, where specifically stated, for a service person [57].

EN 41003. This standard applies to equipment designed and intended to be connected to a telecommunications network termination. The standard covers the requirements and compliance criteria for protection of equipment users from hazards in the equipment [58].

IEC 60481. Applies to coupling devices for power line carrier (PLC) systems which are connected between the coupling capacitors and the carrier-frequency connection to the PLC terminal and gives requirements for safety, protection, isolation and carrier-frequency [59].

4.5 Surge Testing Basic Standards

IEEE C62.45. The scope of this recommended practice is the performance of surge testing on electrical and electronic equipment connected to low-voltage ac power circuits, specifically using the recommended test waveforms defined in IEEE Std. C62.41.2. Nevertheless, these recommendations are applicable to any surge testing, regardless of the specific surges that may be applied [60].

IEEE C62.43. Applies to surge protectors used in balanced or unbalanced data, communications and signaling circuits with voltages equal to or less than 1000 Vrms or 1200 Vdc. The surge protectors covered are multiple-component series or parallel combinations of linear and non-linear elements, packaged for the purpose of limiting voltage, current, or both [61]. An example of a three-terminal

voltage-limiting protector, which is shown connected between a transmission line and the protected circuit in Figure 1.

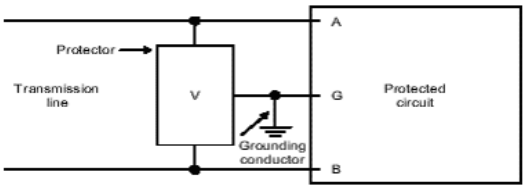

Fig. 1 Protection of circuit composed of two signaling leads and a ground terminal [61].

4.6 Environmental Testing Basic Standards

The environmental testing basic standards applicable to BPL equipment are:

IEC 60068-2-3. Specifies the environmental testing procedures and the suitability of components, equipment or other articles for use and storage under conditions of high relative humidity [62].

ANSI C63.16. This standard provides a guide for the electrostatic discharge (ESD) test methodologies and criteria for electronic equipment. Based upon ESD events on electronic equipment in actual-use environments, a process to establish ESD test criteria is provided [63].

IEEE 1613. Establishes a common reproducible basis for designing and evaluating communications networking devices for use in this harsh environment. Service conditions, electrical ratings, thermal ratings, and environmental testing requirements are defined for communications networking devices to be installed in electric power substations [64].

4.7 Telecommunications Standards

The telecommunications standards applicable to BPL equipment are:

ETSI EN 300 386. The standard covers the EMC requirements for equipment intended to be used within a telecommunication network, such as switching equipment (local telephone exchanges), general purpose equipment, non-radio transmission equipment (multiplexers, line equipment and repeaters), power supply equipment (central power plant), and supervisory equipment (network management equipment) [65].

ETSI TS 101 867. The present document specifies the procedures to ensure a co-existence of access and in-house BPL systems in the spectrum from 1,6 to 30 MHz. It deals with the co-existence between a power line communication system intended for consumer usage (home, apartment, etc.) and a power line system owned and operated by a service provider. The aim of this technical specification is to avoid interference between these two groups of legal owners by technical measures, when appropriate mutual agreements between both parties have not been reached [66]. Figure 2, shows the frequency ranges for access and in-house which are in the solid lines. The dotted line shows the flexible area which can be used by the in-house service in absence of access service or by the access service in absence of in-house service.

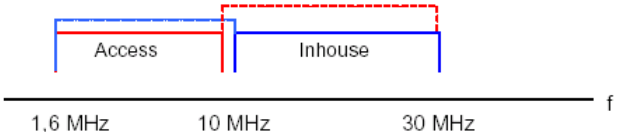

Fig. 2 Frequency ranges for BPL equipment [66]

Priority frequency range for access BPL systems:
1,6 MHz ≤ faccess < 10 MHz
Priority frequency range for in-house BPL systems:
10 MHz < finhouse < 30 MHz

ETSI TR 102 049. The aim of this technical report is to achieve a consistent view on the quality of a service (QoS) on PLC home network for voice, audio, video and data services [67]. The QoS requirements shall be described in a layered view according to the ISO-OSI model.

ETSI TR 102 494. Specifies the technical requirements of in-house PLC modems. The PHY, MAC, DLC and Convergence layers are included. For instance data rates, BER, repeating, functionality, latency, jitter, encryption, synchronization, etc., will be defined [68]. Figure 3 shows applications that will be possible with a BPL in-home backbone.

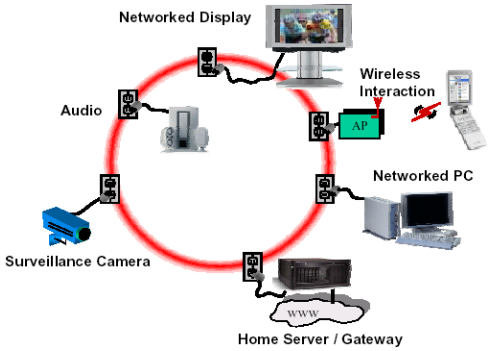

Fig. 3 BPL application scenarios [68]

ANSI C.93.5. This Standard applies to single function powerline carrier (PLC) equipment used to transfer information over power line transmission circuits [69].

4.8 Local Area Networks Standards

The local area network standards applicable to BPL equipment are:

IEC 8803-2. Specifies the functionality requirements that must be meet in the implementation of local area networks (LANs) employing Carrier Sense Multiple Access / Collision Detection (CSMA/CD) as the access control method [70].

IEEE 802.1D/1P. Specifies the functionality requirements for the interconnection of IEEE 802 local area networks (LANs) through internetwork devices known as MAC bridges, which has the task of implementing the medium access control (MAC) function in the OSI Reference Model's logical link control sublayer [71].

ITU-T H.323. Specifies terminals, equipment, and services for multimedia communication over local area networks (LANs), which do not provide a guaranteed quality of service (QoS). H.323 terminals and equipment may carry real-time voice, data, and video, or any combination, including video telephony [72].

4.9 Internet Access and Data Encryption Standards

In relation with equipment based on broadband over power lines communication technology or BPL, the most relevant standards for Internet access and data encryption supported in routers and BPL equipment are: The RFC 894 intended for the transmission of IP Datagrams over Ethernet networks [73]; the RFC 791 which is the Internet Protocol (IP) [74]; the RFC 793 which is the Transmission Control Protocol (TCP) [75]; the RFC 765 which is the RFC 765 which is the File Transfer Protocol (FTP) [76] ; the RFC 1034 [77] and RFC 1035 [78], are the standards for the Domain Names System (DNS); the RFC 1157 is the Simple Network Management Protocol (SNMP) [79]; the RFC 1158 is the Management Information Base (MIB-II) for network management of TCP/IP-based Internets [80]; the RFC 2131 is the Dynamic Host Configuration Protocol (DHCP) [81]; and FIPS 46-2, is the Data Encryption Standard (DES) [82].

4.10 Recent Standardization Efforts

Currently, there are new standardization efforts for BPL systems from bodies like ETSI, FCC and IEEE. With the purpose of adapting the electric infrastructure to support Internet access and other broadband services, in 2005 IEEE started to work on the definition of the communication channel for BPL systems with the aim of accelerate the deployment of commercial products in the U.S. The IEEE is working in the projects: P1901, P1675, and P1775, which are part of a planned IEEE series of BPL standards that will cover major aspects of broadband power line communication technology such as safety, EMC, media, coexistence, interoperability and education. In its turn, FCC has included the subpart G in Part 15 which is related to BPL systems access. Next a brief description of the above mentioned standards is given.

IEEE P1901. The objective of this project is to develop a standard for high speed (>100 Mbps at the physical layer) communication devices via alternating current electric power lines, so called Broadband over Power Line (BPL) devices [83]. The standard will use transmission frequencies below 100 MHz. This standard will be usable by all classes of BPL devices, including BPL devices used for the first-mile/last-mile connection (<1500m to the premise) to broadband services as well as BPL devices used in buildings for LANs and other data distribution (<100m between devices). This standard will focus on the balanced and efficient use of the power line communications channel by all classes of BPL devices, defining detailed mechanisms for coexistence and interoperability between different BPL devices, and ensuring that desired bandwidth and quality of service may be delivered. The standard will address the necessary security questions to ensure the privacy of communications between users and allow the use of BPL for security sensitive services. This standard is limited to the physical layer and the medium access sub-layer of the data link layer, as defined by the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) Basic Reference Model. The effort will begin with an architecture investigation, and this will form the basis for detailed scope of task groups that will work within P1901 to develop the components of the final standard.

IEEE P1675. The objective of this standard will be to provide testing and verification standards for the commonly used hardware, primarily couplers and enclosures, for Broadband over Power Line (BPL) installations, and provide standard installation methods to ensure compliance with applicable codes and standards [84]. This project will not cover repeater/node hardware, data transmission, protocols, or other aspects of BPL related to the internal workings of this technology.

IEEE P1775. The objective of this standard will be electromagnetic compatibility (EMC) criteria, and consensus test and measurements procedure for broadband over power lines communication (BPL) equipment and installations. The standard will reference existing national

and international standards for BPL equipment and installations [85]. It will not include the specific emission limits, which are subject to national regulations. By providing test and measurement guidance as well as EMC criteria, this proposed EMC standard will serve as a bridge between national spectrum regulations, power utility practice and other interested party concerns. It is also will clearly identify the basic definitions of the applicable EMC parameters for BPL equipment and installations as well as measurements conditions and settings.

FCC Part 15-Subpart G. This subpart sets out the regulations for access broadband over power line (access BPL) devices operating in the 1.705-80 MHz band over medium or low voltage lines [86]. FCC has added significant new rules and restrictions to BPL that are intended to address the EMC issues raised during the proceedings. One new rules state that BPL is an unintentional emitter of RF energy. However, BPL is also a carrier-current device. As such, it needs to meet the FCC emissions limits for intentional emitters. As a carrier-current device, it is exempt from the conducted emission limits that govern most unintentional emitters. In addition, access BPL equipment must be certificated by the FCC before it can be marketed. In this case, certification can be done only by the Commission, not the technical certification bodies that authorize most products. BPL must not operate in certain locations near critical installations. Other important rule is the ZIP code locations, frequencies used and contact information for BPL operators must be included in an industry BPL interference database. Also, BPL systems must be designed with the ability to remotely configure frequency use, power levels and have a remote shut-off mechanism.

Table 2: Radiated emissions for BPL networks [86]

Usage	Freq. (MHz)	Field Strength (μV/m)	Measurement Distance (m)	Measurement Bandwidth (kHz)	Detector
Carrier Current Systems	1.705-30.0	30	30	9	quasi-peak
Class A, in commercial, business and industrial areas	30-88	90	10	120	quasi
Class B, marketed for use in residential areas	30-88	100	3	120	quasi

5. Conclusions

In this section, the conclusions from a survey of the most relevant standards that can be applied to broadband power lines (BPL) communications carried out, are given. It can be concluded that there are several bodies actively working on the production of standards for the development and implementation of commercial BPL systems. The major bodies that are currently working either on the production of standards, integrated circuits, or systems based on BPL technology are mainly standardization bodies, electric bodies, local bodies, associations, forums, etc. The most important standardization bodies are: ETSI, CENELEC, IEC, ANSI, CISPR, IEEE, EIA, TIA, ITU and the FCC. The topics covered by their standards are: electromagnetic compatibility, testing and measuring techniques of electromagnetic immunity and emissions, security, basic environmental testing procedures, local area networks and Internet access. Within the main electric bodies are: CIGRE, EPRI, UTC and UPLC, which carry out studies in specialized areas of, power systems at a global level. In Mexico, the major local bodies are ANCE and CFE. At an international level CFE has participation in ISO and IEC from which CFE is a member. The most relevant associations and forums related to BPL technology are: PLCA, AMRA, CABA/HAA, CMA and APPA; the forums PLC, PLT, UPnP, PTF and the HomePlug Alliance. These associations and forums are composed of a number of industries, manufacturers of communications and electronic equipment, service providers, independent consultants, and potential users of BPL products. Related to standardization, it can be concluded that most of current standards can be applied to BPL technology. For instance, in relation with electromagnetic compatibility, the immunity generic and basic standards, the immunity and emissions basic standards, produced by the international bodies such as IEC, CENELEC, CISPR, FCC, ANSI, etc., are applicable to all type of electrical and electronic equipment including BPL equipment. The same case is for standards related to safety, environmental testing, local area networks and Internet access currently available. However, there is a need for standards concerning the operation of BPL systems, particularly in the medium and high frequency range 2 MHz to 80 MHz proposed, due to BPL technology could have a noticeable impact on the wireless services currently in operation such as broadcasting, amateur radio, etc. Also, there is a need for international, regional and local standards in order to ratify the feasibility that high frequency electromagnetic emissions can be conducted over low voltage electrical distribution mains. On the other hand, the broadband BPL technology proposed requires a high bandwidth, in relation with the high data rates been proposed (greater than 2 Mbps). Therefore, new standards exclusively for systems based on BPL technology supporting not only very high data rates but very high bandwidths are needed in the near future.

Currently, there are new standardization efforts for BPL systems from bodies like ETSI, FCC and IEEE with the purpose of adapting the electric infrastructure to support Internet access and other broadband services. New modulation techniques offer the possibility to use the power lines for high speed communications. This new high speed media is open, and locally shared by several BPL devices.

IEEE is working in projects such as P1901, P1675, and P1775 which are part of a planned IEEE series of BPL standards which will cover major aspects of broadband power line communication technology: safety, EMC, media, coexistence, interoperability and education. In its turn, FCC has included the subpart G in Part 15 which is related to BPL systems access. Finally, the most relevant work done by ETSI is the production of quality of service requirements for BPL home networks in order to support typical applications such as voice, video and data.

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