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Wireless Personal Area Networks

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Re:	LB50 Comment Resolution	
Abstract	This white paper is based on the original contribution IEEE 802.15-09-0202-03 (Regulation Document Configuration). This white paper describes regulations in IEEE 802.15.7 Visible Light Communications Standard.	
Purpose	[This document is intent to resolve LB 50 comment related to regulation part 5.7, Annex B.2, and Annex I]	
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The regulations included in this white paper relate to standard IEEE 802.15.7, which addresses visible-light communications (VLC). In this whitepaper we provide insight into Green IT(Information Technology), safety requirements, frequency spectrum, and national regulations pertaining LEDs.

1. Green IT

VLC has a good potential to create new markets related to the energy scarcity, global climate change, environmental problems, and lack of radio resources.
The Kyoto Protocol is a protocol related to the international framework convention on climate change with the objective of reducing greenhouse gases that cause climate change. As of January 2008, and running through 2012, 170 countries are required to reduce their greenhouse gas emissions by a collective average of 5% below their 1990 levels.
RoHS (Restriction of Hazardous Substances Directive, 6HS) specification restricts the use of material Mercury in products, which is used in fluorescent lamps.
LED is also a better option for waste treatment than fluorescent lamp in terms of WEEE (Waste Electrical and Electronic Equipment Directive).

2. Safety requirements

2.1 Flicker

Light flicker is defined as the variation of a light stimulus that results in detectable physiological changes in humans. Light flicker can have harmful health impacts on humans.

Light flicker is regulated in

- IEC 1000-3-3/EN 61000-3-3: Electromagnetic compatibility. Part 3: Limits – Sect. 3: Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current < 16 A. 1994
- IEC 1000-3-5: Electromagnetic compatibility. Part 3: Limits – Sect. 5:

Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 16 A. 1994

2.2 Radiation safety

Regulations pertaining radiation safety of lasers are:

- IEC 60825-1: Laser safety
- ANSI Z136: Laser Safety Standards - ANSI

According to the IEC regulation there are safety classes 1, 1M, 2, 2M, 3R, 3B, and 4 for commercial products. Class 1 laser is safe under all conditions of normal use.

Regulations concerning incoherent emitters are:

- IEC 62471: new lamp safety

LEDs used as lamps would have to be assessed and classified according to the new lamp safety standard IEC 62471. In terms of this standard, even the relaxed requirements for GLS-sources (General Lighting Service) can be applied. Thus, the lighting part of the technique will definitely be covered by the lamp safety standard IEC 62471. According to existing safety standards, the durations without modulation would have to be addressed by IEC 62471, while the very same LED would have to adhere to IEC 60825-12 during data transmission.

3. Spectrum Frequency

Spectrum licenses are generally regulated in intergovernmental treaties. The spectrum under consideration covers 3 Hz to 300 GHz. There are two main communication spectrum licenses: broadcasting licensing and cellular licensing. There is also special non license spectrum such as ISM (Industrial, Scientific and Medical). The spectrum of VLC (370 THz – 870 THz) has not yet been regulated in terms of wireless data communication.

4. Region-specific regulations

4.1. European Union

The regulators in EU have a directive only to regulate frequencies below 3,000 GHz. Market access is thus governed by the remaining relevant directives, viz. safety and electro-magnetic compatibility (EMC). Safety is defined by EN60950. EMC is ascertained according to product type. If no product specifications are available, default generic emission and immunity standards do apply. RESOLUTION 955 (WRC-07) is related to consideration of procedures for free-space optical links at the World Radio communication Conference (Geneva, 2007).The items to note are

- that frequencies above 3,000 GHz are already used for various optical applications from telecommunication links to satellite remote sensing;
- that optical links are currently under consideration by several ITU-R Study Groups;
- that Recommendations ITU-R P.1621, P.1622, S.1590, RA.1630; SA.1742, SA.1805, and RS.1744 contain information pertaining to free-space optical links and remote sensing;
- that the ITU-R is in the process of preparing reports regarding the possibility and relevance of including in the Radio Regulations frequency bands above 3,000 GHz as well as fixed service applications using such frequency bands,
- that Resolution 118 (Marrakesh, 2002) of the Plenipotentiary Conference instructs the Director of the BR to report to world radio communication conferences on the progress of ITU-R studies concerning the use of frequencies above 3,000 GHz;
- that the ITU-R has identified technical aspects regarding the use of optical free-space telecommunications as an item requiring urgent study by the ITU-R Study Groups

There are resolutions to consider possible procedures for free-space optical links, taking into account the results of ITU-R studies covering at least sharing aspects with other services. A clear definition of the band limits and measures needs to be considered if allocations to various services in the Radio Regulations above 3,000 GHz are to be made feasible.

4.2. Japan

The Change in Japan's Energy Saving Law in April, 2009 is focused on the energy saving in the office/household section, which has been increasing 1.4 fold between 1990 and 2005 (the largest increase in energy consumption). There is need to further energy savings especially in the office/household sector (offices and convenient stores as well as houses/buildings).

The energy unit for companies in the past only considered factories. From April, the company unit includes not only factories, but also offices (including head office and sales offices, etc). Commercial entities consuming more than 1,500 KL annually need to report their energy usage to the Japanese government.

In order to construct a large house/building (more than 2,000 m^2), the owner needs to report its energy saving plan to Japanese government. The sales agent of houses/buildings needs to introduce the efficient energy saving methods. The energy saving methods needs to be explicitly indicated.

It is one of the features of LED that power consumption is less than the incandescent lamp. The power consumption of LED is about 1/10 of that of incandescent lamp. Given the current worldwide energy mix, this reduction in consumed electrical power leads to a reduction in carbon dioxide (CO_2) emission.

In Japan, "Electrical Appliance and Material Safety Law" known as PSE (Product Safety, Electrical Appliance & Materials) is the law that provides the technological standard related to the safety of electrical appliances. The law was enforced in April 2001. As of this law non-compliant products cannot longer be sold in Japan.

The PSE related to "Specified Electrical Appliance and Material" includes appliances such as AC adaptors, vending machines, electric toilet seats, etc. The amount of items considered in the PSE is 115 (as of December 2007). "Electrical Appliance and Material except Specified Electrical Appliance and Material" also includes appliances such as lamps, fluorescent lamps, refrigerators, vacuum cleaners, electric washing machines, etc. The number of items considered at that time was 339.

The difference between the two PSEs is related to the level of applied safety. To put it

briefly, the risk posed by appliances in “Specified Electrical Appliance and Material” is higher than “Electrical Appliance and Material except Specified Electrical Appliance and Material.” Therefore, a maker of “Specified Electrical Appliance and Material” must pass the adaptability inspection for safety by the registration inspecting agency. On the other hand, a maker of “Electrical Appliance and Material except Specified Electrical Appliance and Material” ensures the safety of the product herself or himself.

PSE also applies to desk lamps using LEDs. On the other hand, it does not apply to LED lighting itself such as a LED lamps and LED fluorescent lamp (as of September 2009). Therefore, a LED lighting maker is not required to inspect the adaptability for safety. But LED lighting maker should submit to voluntary inspection to improve consumer concerns.

4.3. Korea

There is currently no VLC regulation in Korea since the communications technology beyond 3,000 GHz has not been considered until recently. LED-related regulations are LED Lamps for safety and EMC (Electromagnetic compatibility). LED Lamp regulations pertain to LED traffic signals, LED head lamps, LED lamps with AC/DC converter. The goal of LED regulation is energy saving and electrical safety. Measureable quantities addressed in regulation are luminous intensity, luminous-intensity stability, and chromaticity.

In 2008 the government of Korea announced Green Growth with LED Promotion 1530 project. The target of the 1530 project is to replace 30% of all traditional lamps by 2015 and thus reducing the overall electrical power consumption. There will not be any use of incandescent lamps after 2013 in Korea.

Korea Regulations related to lamp are as same the following IEC documents;

- IEC 60050 - International Electro Technical Vocabulary
- IEC 60061 - Lamp caps and holders
- IEC 60360 - the standard method of measurement of lamp cap temperature
- IEC 60695-2-1-1 - Fire hazard testing
- IEC 61000-3-2 - Electromagnetic compatibility (EMC)
- IEC 61347-2-13 - Lamp control gear
- IEC 61547 - lighting equipment which is within the scope of IEC technical

committee 34, such as lamps, auxiliaries and luminaries, intended either for connecting to a low voltage electricity supply or for battery operation.

- IEC 62384 - DC or AC supplied to electronic control gear for LED modules - Performance requirements

There is no eye/skin safety regulations in Korea. Spectrum frequency regulations cover the electromagnetic spectrum from 9 kHz to 300 GHz and do thus not affect VLC.

4.4 USA

LEDs have received a lot of attention in recent years primarily due to its promise of being a replacement to the more traditional illumination methods (incandescent and fluorescent) due to its lower energy consumption. Energy use and its management has become a national priority in the U.S., and according to the National Institute of Standards and Technology (NIST), lighting accounts for 8% of the total national energy usage. Therefore, LED-based lighting is expected to play an important role in reducing the energy usage. Apart from state level, county level, and city level regulations that govern the display of large LED signage, there are few national level regulations that govern the use of LEDs and LED systems. There are, however, specific international regulations that cover lamps and lamp systems (including LEDs) which must be met. The two main standards that are relevant to VLC systems are the following optical radiation safety standards: (1) lamp-safety standard IEC 62471 and (2) laser-safety standard IEC 60825-12. Below we will briefly outline the two standards along with additional information on LEDs that may be useful.

Free-space optical communications is covered by the laser-safety standards IEC 60825 series, primarily IEC 60825-12. Non-laser applications are generally covered by the lamp-safety standard IEC 62471. The IEC 62471 covers lamps and lamp systems operating in the 200 nm to 3000 nm wavelength range. This standard covers pulsed lighting sources such as fluorescent lighting as well as LED dimming by use of pulse-width modulation. IEC 60825-12 regulates free space optical communication, and it specifically includes LED based systems. Thus, in a VLC system two different safety standards are applicable depending on whether the system is used for lighting only or lighting plus communications. Until this paradoxical situation is resolved, VLC systems must comply with both the standards.

Another relevant standard to be considered is IEC 61000-3-2 and IEC 61000-3-3 for harmonic emissions and flicker where all lighting products fall under Class C. ANSI lighting standard also covers harmonic emissions.

All lighting products sold in the United States are subject to industry standards governing safety and performance. Standards are important to ensure that products will have high quality and their performance will be specified uniformly for commerce and trade. Several standards have been developed fairly recently that detail the color specifications of LED lamps and LED light fixtures, and the test methods that manufacturers should use when testing these solid state lighting products for total light output, energy consumption and chromaticity, or color quality.

The Energy Information and Security Act of 2007 began the process of restricting the sale of inefficient lamps in the US.

NIST is working with the U.S. Department of Energy (DOE) to support its goal of developing and introducing solid-state lighting to reduce energy consumption for lighting by 50 percent by the year 2025. The department predicts that phasing in solid-state lighting over the next 20 years could save more than $ 280 billion in 2007 dollars.

The Illuminating Engineering Society of North America (IESNA) published a documentary standard LM-79, which describes the methods for testing solid-state lighting products for their light output (lumens), energy efficiency (lumens per watt) and chromaticity, and LM-80 for lifetime, or lumen depreciation. The American National Standards Institute (ANSI) standard C78.377-2008 specifies the recommended color ranges for solid state lighting products using cool to warm white LEDs with various correlated color temperatures.

The American National Standards Institute (ANSI), Washington, D.C., oversees the creation, promulgation, and use of industry norms and guidelines, including the following key standards of relevance to solid-state lighting (SSL) products.

- C78.377, “Specifications for the Chromacity of Solid State Lighting Products,” will specify the recommended chromacity ranges for white light LEDs with various correlated color temperatures (CCTs) and ensure communication of chromacities to consumers.
- C82.SSl1, “Power Supply,” will specify operational characteristics and electrical safety of SSL power supplies and drivers.
- C82.77-2002, “Harmonic Emission Limits - Related Power Quality

Requirements for Lighting," will specify the maximum allowable harmonic emission of SSL power supplies.

The Illuminating Engineering Society of North America (IESNA), New York, is the recognized North American technical authority on illumination.

- TM-16-05, "IESNA Technical Memorandum on Light-Emitting Diode (LED) Sources and Symptoms," will provide a general description of LED devices and systems and answer common questions about the use of LEDs.
- RP-16, "Nomenclature and Definitions for Illuminating Engineering Addendum," will provide industry-standard definitions of lighting terms, including all lighting technologies. The document is currently being updated to include definitions of SSL lighting terms.
- LM-79*, "IESNA Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products," will specify procedures for measuring total luminous flux, electrical power, luminous efficacy, and chromaticity of SSL luminaires and replacement lamp products.
- LM-80*, "IESNA Approved Method for Measuring Lumen Depreciation of LED Light Sources," will specify procedures for determining lumen depreciation of LEDs and LED modules (but not luminaires) related to effective useful life of the product.

FCC specifies requirements for maximum allowable unintended radio-frequency emissions from electronic components, including SSL power supplies and electronic drivers under "47 CFR Part 15, "Radio Frequency Devices,"

Underwriters Laboratories (UL), Northbrook, Ill., has developed a safety standard, "Light-Emitting Diode (LED) Light Sources for Use in Lighting Products," which specifies the minimum safety requirements for SSL components, including LEDs and LED arrays, power supplies, and control circuitry.