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**APT SURVEY REPORT ON**

**WIRELESS POWER TRANSMISSION (WPT)**

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**APT SURVEY REPORT ON   
“WIRELESS POWER TRANSMISSIOIN (WPT)”**

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1. **Introduction**

Wireless Power Transmission (WPT) is a technology making it possible electrical energy from a power source to an electrical load is transmitted without an interconnection. Wireless power transmission is useful especially where connecting devices with wires are inconvenient or dangerous.

It is a new technology but is already seen with significantly increasing demand in the market. Various types of applications, that WPT technology is applied, are to be expected and studies on WPT are actively ongoing. Also, standardization activities are underway in some standardization organizations.

Given such circumstances, the APT Wireless Group (AWG) circulated the questionnaires [1] on WPT to gather information regarding applications, technologies, potential market, technical and operational characteristics, standardization, frequency bands, and regulatory status from the APT countries. The questionnaires are intended to ask about wide varieties of WPT aspects shown above and also ask for information on education, introduction, and popularization of WPT.

Based on the received responses to the questionnaires, this Survey Report is developed and prepared for information sharing in the APT countries and with related external organizations as appropriate. In addition, this Survey Report would be helpful to understand the status of WPT in Asia-Pacific region and may be used for further development of APT Recommendation(s)/Report(s). The questionnaires and the responses can be found in Chapter 2. The responses are summarized in Chapter 3 to overview the trend of WPT especially in Asia Pacific region.

1. **Questionnaires and responses**

The questionnaires are as follows:

1. Applications
2. What WPT applications do you expect in your country? There may be various types of WPT applications including cellular phones, digital camera, wearable equipment, note PC, tablet, CE appliances, Electric Vehicles, Plug-in Hybrid Electric Vehicles, industrial tools/machines, etc. Please describe your expectations. You may provide specific use cases as well.
3. Market demand and forecast
4. Please provide the list of products which are currently on the market and are to be released implementing WPT technologies in your country
5. Please provide information or estimates of current and future market size relating to market sectors for WPT devices and systems per application. You may include market size, market trends, prices, commercial timeline, and useful references (e.g. websites, documents).
6. Technologies
7. WPT technology may depend on application. Please describe technical and operational characteristics to implement WPT applications in commercial with respect to each application. These may include transmission technologies, transmission distance, transmission power, and any unique aspects.
8. If there are some technologies found by researching in academia and industry, please describe also.
9. You may provide references of technical reports, websites, or any beneficial sources to share among APT countries.
10. Standardization/guidelines/regulations
11. Does your country participate in international standardization activities of WPT such as IEEE, ITU, ISO, IEC, etc.? If so, please provide WPT activity information of international organizations for standardization/ guidelines/ regulations.
12. Are there any organizations for WPT standardization/ guidelines/ regulations in your country? It may contain standards development organization, forum activities, or governmental organization.
13. Please provide plans/ timeline and the current development status for standardization/ guidelines/ regulations in your country if available.
14. Please provide the name of the organization, contact point, plan, and status of their works if available.

|  |  |
| --- | --- |
| Name of the organization |  |
| Contact point |  |
| Plan and/or timeline of standard/guideline/regulation development |  |
| Status of standard/guideline/regulation development |  |

1. Suitable frequency bands and coexistence with the incumbents
2. Suitable frequency band for WPT may depend on technology, application, and regulatory aspects. What category of spectrum (e.g., ISM or other specific bands) and/or which frequency band(s) do you consider for WPT usage with respect to each application assumed in your country? Please provide information with reasons.
3. What steps are required to make sure your radio services protected from the usage of WPT? Is there any compliance for EMC/EMI that can be applied for WPT applications?
4. RF exposure
5. Please provide RF exposure guidelines applied in your country. Please provide RF exposure references such as international guidelines publicly available.
6. Please provide information on assessment methods/procedures used for human exposure to RF from WPT to demonstrate regulatory compliance.
7. Regulatory matter
8. If there are any regulations relating to WPT in your country, please provide detailed information.
9. If not, please explain the related rulemaking process or activities being processed for WPT currently or in future.
10. Is there any plan of type approval for WPT products in the future?
11. Others
12. Please provide any other WPT information and studies that are beneficial to share among APT countries.

The responses from APT Members are as follows with hyperlinks for detailed information:

**Table 2.1 Survey responses submitted**

|  |  |  |  |
| --- | --- | --- | --- |
| No. | Input no. | Title | Source |
| 1 | [AWG-14/INP-19](http://www.apt.int/sites/default/files/2013/03/AWG-14-INP-19_AUS_Response_to_WPT_Questionnaire.docx) | Response to the Questionnaire on Wireless Power Transmission | Australia |
| 2 | [AWG-14/INP-40](http://www.apt.int/sites/default/files/2013/03/AWG-14-INP-40_JPN-12.doc) | Response to the Questionnaire on Wireless Power Transmission | Japan |
| 3 | [AWG-14/INP-68](http://www.apt.int/sites/default/files/2013/03/AWG-14-INP-68_KOR-Ques-WPT-final.docx) | Response to the Questionnaire on Wireless Power Transmission | Rep. of Korea |
| 4 | [AWG-14/INP-91](http://www.apt.int/sites/default/files/2013/03/AWG-14-INP-91_VTN-Response_Questionnare_TG-WPT.docx) | Response to the Questionnaire on Wireless Power Transmission | Vietnam (S. R. of) |
| 5 | [AWG-15/INP-16](http://www.aptsec.org/2013-AWG15-DOCS-INP) | Response to the Questionnaire on Wireless Power Transmission | Bangladesh |
| 6 | [AWG-15/INP-17](http://www.aptsec.org/2013-AWG15-DOCS-INP) | Response to the Questionnaire on Wireless Power Transmission | Vanuatu |
| 7 | [AWG-15/INP-45](http://www.aptsec.org/2013-AWG15-DOCS-INP) | Response to the Questionnaire on Wireless Power Transmission (Second edition) | Japan |
| 8 | [AWG-15/INP-69](http://www.aptsec.org/2013-AWG15-DOCS-INP) | Response to the Questionnaire on Wireless Power Transmission | China |

1. **Summary of responses**

This section summarizes the responses mainly from Australia, China, Japan, and Korea since the other responses included many N/As.

**3.1 Applications**

It is expected that various ICT applications based on WPT technologies will be actively introduced and widely applied in the future. According to the responses, portable/mobile devices and electric vehicles using WPT are mainly expected.

A variety of applications using WPT technology is expected and can be summarized in the table below.

**Table 3.1 Summary of WPT application**

|  |  |  |
| --- | --- | --- |
| Assumed usage scene | Application examples | Specifications, functions of the usage scene, and technologies  (1) Operating power  (2) Power transmission distance  (3) Technologies |
| Non-contact WPT of household digital appliances for home use | Mobile and portable devices  (P2P charge, public charge, etc.) | (1) Transmission power  : Up to 50 W  (2) Power transmission distance: Up to 10 cm  (3) Electromagnetic inductive (Tightly Coupled) WPT, magnetic resonance (loosely coupled) WPT, or electric field coupling WPT |
| Low-power WPT of household digital appliances for home and outdoor use | Mobile and portable devices (including Tablets, Note-PCs)  Digital still cameras  Audio equipment  (headphone, etc)  Industrial equipment  Medical equipment  Game instruments | (1) Transmission power: Up to 50 W  (2) Power transmission distance: Up to several meters  (3) Magnetic resonance (loosely coupled) WPT |
| Medium-power WPT of household electrical appliances for home use | Home electrical mixer/ electrical rice cookers/ electrical heating/ Audio Visual appliances  (TV with big video screen) | (1) Transmission power  : 50 W to 1 kW  (2) Power transmission distance: Up to several 10s of centimeters from the wall, floor, or desk surface  (3) (i)Magnetic resonance (loosely coupled) WPT (ii) Capacitive coupling WPT |
| High-power WPT | EV, PHEV  Industrial applications | (1) Transmission power  : 1 kW to several 10s of kW  (2) Power transmission distance: Up to about 30 cm  (3) Electromagnetic inductive WPT, magnetic resonance WPT, or their hybrid types |

Japan provides references on WPT applications:

* BWF “GUIDELINES FOR THE USE OF WIRELESS POWER TRANSMISSION TECHNOLOGIES”, April 2011, http://bwf-yrp.net/update/2011/04/guidelines-for-the-use-of-wireless-power-transmission-technologies.html
* BWF “GUIDELINES FOR THE USE OF WIRELESS POWER TRANSMISSION TECHNOLOGIES VERSION 2.0”, April 2013, http://bwf-yrp.net/update/2013/05/20.html (Japanese only; English version development is in progress.)

**3.2 Market demand and forecast**

**3.2.1 The current situation of WPT market**

Today, WPT technologies are applied to mobile phones and are expected to be applied to various products in our life.

Australia, Japan and the Republic of Korea answered the following products are currently available in the market.

**Table 3.2 WPT commercialized products and developed prototypes**

|  |  |  |
| --- | --- | --- |
| Type | Application | Product |
| Commercial Products | Smartphone (Tightly-coupled WPT) | Android charge battery cover |
| Power Transmitter & Receiver  Wireless Pad and Cover |
| TV Accessory (Loosely-coupled WPT) | Wireless Charger for 3D Glasses |
| Electric Vehicle(~50 kW) | On-Line Electric Vehicle (BUS) |
| Developed Prototypes | Mobile device (~5 W) | Wireless Power Transfer System for Multiple Mobile Devices |
| Desktop, LED sign board, TV and OLED lighting device (~ 40 W) | Wireless Power Transfer System in Middle Range |

Korea provides more detail on domestic WPT trend as follows.

In the case of Korea, tightly-coupled WPT products by Wireless Power Consortium (WPC) specification and Qi certification were already released to the market and the loosely-coupled WPT product was also developed by Samsung Electronics. Prototypes of WPT system for standing lamp, digital camera, media tablet, MP3 player, PC Monitor, LED sign board, TV, laptops and electric vehicle, electrical train are being developed respectively by KAIST, ETRI, SAMSUNG, LG, LS Cable, SAMSUNG Electro-Mechanics and LG Innotek, etc.

**3.2.2 WPT market prospect**

From some statistics analyzed by the responders and global research firms commonly indicate that WPT has the great potential for growth.

China provides the following observations on WPT in mobile/potable/consumer electronics market.

From some statistics about the consumer electronics, it can be seen that WPT has the great market potential.

Firstly, the number of mobile phones around the world has reached above 6 billion at the first half year of 2012 (source: The word bank 2012 report "information and communication development ").

Secondly, the numbers of global PC (including desktops, notebooks and netbooks) shipments have reached 352.8 million in 2011. Also the pads or tablets shipments have reached 63.6million in 2011 and showed a rapid growth trend (source: Gartner). Then the LCD TV shipments have reached 206 million in 2011 (source: DisplaySearch).

Lastly, as for the huge number of other consumer electronic equipment, such as MP3, radio, camera, electronic tooth brush etc., they are countless. If WPT technology can be widely used in these consumer electronics, it can generate great business value. As Wireless Power Consortium forecast, the market value of WPT will reach 27 billion USD until 2016.

Some forecasts of WPT market potential are available as follows.

**Table 3.3 WPT market prospect**

|  |  |  |
| --- | --- | --- |
| source | Prediction | |
| category | contents |
| WPC | Market value  (global) | 27 billion USD in 2016 |
| IMS research (2011) | Shipments volume  (global) | Annual shipments of integrated wireless power receivers in mobile phones expected to reach 300 million by 2015 |
| Markets and Markets | Shipments volume  (global) | - Wireless charging pads  : shipment 9.5 million units, and revenue 475 million USD in 2017  - Wireless charging Receivers  : shipment 9.5 million units, and revenue 390 million USD in 2017 |
| IHS iSuppli and Nikkei | Market size (global) | 24 billion USD in 2015 |
| Research AND Market and Nikkei Tech-ON | Market size (global) | 7.161 billion USD in 2017  (compared to 456.86 million USD in 2011) |
| METI\* | Market demand (Japan) | - EV/PHEV  : in 2020, 150,000~200,000 vehicles/year  : in 2030, 500,000~750,000 vehicles/ year  ※ global market 20 times of domestic demand |
| Markets and Markets | Market Revenue | - Wireless Charging (Charging pads and receivers) market  : 6,453 million USD in 2017 at 57.2% CAGR, from 2012 to 2017 |
| ACMA | Domestic market status | - Creating niche market in Australia (short-term) |
| The world bank 2012 report "information and communication development ". | Market size (global) | Mobile phones |

\*METI: Ministry of Economy, Trade and Industry (Japan)

**3.3. Technologies**

Based on the responses from Japan and Korea and the report submitted for information sharing [3] [4] [13], the following table summarizing typical WPT technologies is provided.

**Table 3.4 WPT technologies**

* 1. Mobile, potable, and CE applications

|  |  |  |  |
| --- | --- | --- | --- |
|  | Tightly Coupled  (Magnetic Induction) | Loosely Coupled  (Magnetic Resonant and/or equivalent) | Capacitive coupling |
| Technology Principle | Magnetic Inductive Coupling | High Resonance | WPT via electric field |
| Technology  Character | - Size and shape of transmitting coil should be consistent with receiving coil  - Maximum interval of transmitting and receiving coil is several mm  - Magnet can be used to ensure accurate alignment of the transmitting and receiving antennas | - Transmitting antenna is used to generate a charging region  - Size and shape of receiving antenna does not have to be fully consistent with transmitting antenna  - Distance between the transmitting and receiving antenna may be a few cm | - Utilizes electric filed for WPT  - Freedom of placement in X-Y |
| Frequency Range | 10s kHz to 10s MHz | 10s kHz to 10s MHz,  ISM bands | 480 kHz - 524 kHz |
| Power Range | - Design-dependent.  - Up to 50 W in some countries’’ regulation - Higher power can be achieved. | - Design-dependent.  - Up to 50 W in some countries’’ regulation  - Higher power (e.g., a few kW and higher) can be achieved. | Up to 100 W |
| Antenna type | Coil | Coil or loop-antenna | - Active and passive electrode |
| Advantage | - Relatively high charging efficiency  - Relatively Low Cost | - Flexibility for placement and distance of receiving end  - Transmitter can supply power for several receivers within a wide range contemporary. | - High efficiency (70%) |
| Application Area | Portable devices, CE,  Industrial Fields, Specific Areas | Portable devices, CE, | Laptop PC |
| Related Alliance | Wireless Power Consortium (WPC) | Alliance for Wireless Power (A4WP) |  |

* 1. EV applications

|  |  |  |
| --- | --- | --- |
|  | Resonant magnetic induction (for EV) | Shaped Magnetic Field in Resonance  (SMFIR) WPT |
| Technology Principle | Resonant magnetic induction |  |
| Technology  Character | - Optimized for several kW and higher class power transfer  - Low-cost circuit structure  - High transmission power efficiency  - Allowable X-Y alignment offset  - Acceptable transmission distance (air gap) | - New technology developed by KAIST in March 2010  - Developed for meeting demands on eco-friendly, Low-cost, high efficient transport system |
| Frequency Range | 42 kHz ~ 48 kHz,  52 kHz ~ 58 kHz,  79 kHz ~ 90 kHz, and  140.91 kHz ~ 148.5 kHz are in study. | 19 kHz ~ 21 kHz, 59 kHz ~ 61 kHz |
| Power Range | - 3.3 kW, 7 kW, and class are assumed for passenger vehicle | - Small power: 75kW  - Air gap : 20cm |
| Antenna type | Coil |  |
| Advantage | Global harmonized spectrum  Higher power transfer efficiency | - Increased power transfer efficiency  - Maximized air gap  - Reduced audible noise  - Effective shield design  - Time and cost saving |
| Application Area | Electric Vehicle while parking | On-line Electric Vehicle (OLEV) |
| Related Alliance |  |  |

**3.4 Standardization/guidelines/regulations**

International organizations dealing with WPT standardization and their relevant activities are summarized in the table below.

**Table 3.5 WPT related international organizations**

|  |  |
| --- | --- |
| Name of Organization | Activities |
| CISPR (Comite International Special des Perturbations Radioelectriques) | WPT is taken by CISPR SC-B (Interference relating to ISM radio frequency apparatus, and to overhead power lines, etc.) for discussion. The other SCs are considering WPT if they take. |
| IEC TC 100 | Survey for Technical Reports regarding WPT  - IEC TC 100 Stage 0 Project  - Survey Completed: July. 2012  - Under Drafting Technical Reports |
| IEC TC 69 | IEC TC 69 (Electric road vehicles and electric industrial trucks) WG4, together with ISO TC22 (Road Vehicles), discusses WPT for automotive. |
| ISO/IEC JTC 1 SC 6 | In-band PHY and MAC Layer Protocol of WPT  - ISO/IEC JTC 1 SC 6- Working Item was approved in Jan. 2012.  - On Circulation with WD (Working Document) |
| ITU-R SG1 WP1A | Recommendation/Report of regulatory and spectrum aspect on WPT  - Question ITU-R 210-3/1- Question Updated in Nov. 2012.  - CG-WPT was established in June 2013 for Report/Recommendation developments. |
| CEA (Consumer Electronics Association) | CEA R6-TG1 (Wireless Charging Task Group) discusses WPT and related issues. |
| SAE (Society of Automotive Engineers) | WPT standardization has been getting active since 2010. Proposed specifications by OEMs are reviewed. Standardization is to complete in 2013-2014 as IEC plans. Currently specific frequency bands selection is under consideration for future decision. |
| A4WP | Non-radiative near- and mid-range magnetic resonant coupling (highly resonant coupling) (loosely-coupled WPT).  - Baseline Technical Specification completed 2012  - Released its technical specification (ver.1) in January 2013 |
| WPC | Tightly coupled inductive coupling solutions across a range of power levels.  Website lists more than 120 members and 80 certified products including accessories,  chargers and devices  - Released technical specification (ver.1) in July 2010 |
| CJK WPT WG | To study and survey on low power and high power WPT  - Released CJK WPT Technical Report 1 in April 2013 |

In the following, organizations that are in charge of WPT standardization/guidelines/regulations in each country are introduced respectively.

**Australia**

ACMA (Australian Communications and Media Authority) is a statutory authority regulating broadcasting, the internet, radiocommunications and telecommunications in Australia.

**China**

In China, CCSA (China Communication Standard Association) has been creating WPT standards for portable devices, such as Mobile Stations. In 2009, CCSA TC9 set up one new research report project “Research on Near-field Wireless Power Supply Technology”. This project has been finished in March, 2012. This report is for the wireless power supply technology research. In 2011, CCSA TC9 created two standard projects: (1).EMF Evaluation Methods for WPS; (2).EMC Limits and Measurement Methods for WPS. These two standards have been discussed over three times on the working group meeting and has been finished in the last discussion in November, 2012.(Reference: Hongbo Wang, etc., “Research on Near-field Wireless Power Supply Technology”, CCSA Research Report 2011B39)

Now, there are two new standards related to the technical requirements and test methods (part1: General; part2: Tightly Coupled) and safety requirements have been in the final draft status. More and more standard projects related to wireless power transmission will be created. The target products are audio, video, multimedia, and information technology, and telecommunication devices.

China National Standardization Administration Commission (SAC) is planning to set up a National Standardization Technical Committee (TC) on WPS. China Academy of Telecommunication Research (CATR) of MIIT has been promoting it. The TC is responsible for creating national standards on WPS for mobile phones, information technology equipment, audio, video, and multimedia devices.

**Table 3.6 Standardization activities status in China**

|  |  |
| --- | --- |
| Name of the organization | China Communication Standard Association |
| Contact point | wanghongbo@catr.cn |
| Plan and/or timeline of standard/guideline/regulation development | 1) EMC and EMF standards may be approved before December, 2013.  2) Technical requirements and safety requirements standards will be finished in 2013 |
| Status of standard/guideline/regulation development | See the first and second paragraph in this part. |

**Japan**

The WPT-Working Group of BWF (Broadband Wireless Forum, Japan) is taking responsibility for drafting WPT technical standards utilizing the ARIB (Association of Radio Industries and Businesses) drafting protocols. A draft standard developed by BWF will be sent to ARIB for approval. BWF is now performing in-depth technical study for WPT spectrum for all the applications and technologies shown in Table 3.1 with regards to both power-transmission radio wave and control-signaling-transmission mechanism. Global harmonization on spectrum should carefully be considered.

In June 2013, with the aim of directing new regulation for WPT, the Wireless Power Transmission Working Group (WPT-WG) was formed under MIC’s Subcommittee on Electromagnetic Environment for Radio-wave Utilization. Suitable frequency bands consideration and coexistence study with the incumbents are included in the main subjects of the WPT-WG. Referring to the recent study results at BWF, the following applications were addressed as primary scope of the WPT-WG.

1. WPT for EV
2. WPT for CE (mobile devices, home/office equipment)

**Table 3.7 Standardization activities status of BWF in Japan**

|  |  |
| --- | --- |
| Name of the organization | Broadband Wireless Forum (BWF) |
| Contact point | Dr. Hiroki Shoki, leader of WPT-Working Group |
| Plan and/or timeline of standard/guideline/regulation development | - Guideline Ver.1.0 completed in April 2011.  - Guideline Ver.2.0 completed in April 2013  - 1st ARIB standard(s) approval for < 50 W: 2014  (Possibly applicable with the current regulation)  - 2nd ARIB standard(s) approval for > 50 W: 2015  (Possibly need changes to the current regulations) |
| Status of  standard/guideline/regulation development | - Guideline Ver.2.0: completed in April 2013.  - Spectrum and regulation studies are ongoing.  - Toward the 1st standards, technology proposal, evaluation, selection, and drafting process will take place in 2013. |

**Republic of Korea**

MSIP (Ministry of Science, ICT and future Planning) and its RRA (National Radio Research Agency) are government agencies in charge of WPT Regulations in Korea. And main standardization organizations developing the standard for WPT are shown in the table below.

**Table 3.8 Standardization activities status in Korea**

|  |  |  |
| --- | --- | --- |
| Name | URL | Status |
| KATS | http://www.kats.go.kr/en\_kats/ | On-going  - Multi-device charging management |
| KWPT Forum |  | On-going  - spectrum related to WPT  - regulatory related to WPT |
| MFAN Forum | http://www.mfan.or.kr/ | Completed  - Use Case  - Service Scenario  - Functional Requirement  - In-band communication for WPT  - Control for management of WPT  On-going  - WPT based on magnetic resonance  - WPT based on magnetic induction |
| TTA | http://www.tta.or.kr/English/index.jsp | Completed  - Use Case  - Service Scenario  - Efficiency  - Evaluation  - In-band communication for WPT  - Control for management of WPT  On-going  - WPT based on magnetic resonance  - WPT based on magnetic induction |

As use of Wireless Power Transmission (WPT) gets more pervasive and popular, demands on spectrum designation for WPT equipment have been increasing in Korea. National Radio Research Agency (RRA) partly revised Technical Requirements for ISM equipment (RRA Notification no.2013-19) in accordance with Radio Waves Act in Dec. 24, 2013.

Provisions defining WPT technology and WPT equipment are added in the Article 3 of the Notification. And field strength level and frequency bands permitted for WPT equipment in Korea are prescribed in the Article 4 of it.

According to the Article 4, field strength levels of fundamental emission and unwanted emission from WPT equipment shall comply with the followings.

* First, in the case of WPT equipment operating within 19 kHz ~ 21 kHz and 59 kHz ~ 61 kHz, field strength level shall be less than or equal to 100 µV/m at the distance of 100 m.
* Second, in the case of WPT equipment operating within 100 kHz ~ 205 kHz, field strength level which was measured at the distance of 3 m, of fundamental emission shall be less than or equal to 500 µV/m (measured value is multiplied by 6π/λ, λ is wavelength), the level of unwanted emission shall not exceed the level of fundamental emission.
* Third, in the case of WPT equipment operating within 6765 kHz ~ 6795 kHz, field strength level shall be less than or equal to the level specified in the table below.

|  |  |  |
| --- | --- | --- |
| Frequency | Field strength | Notes |
| 9 kHz ~ 10 MHz | 78.5-10log(f/9) dBµV/m | - Measured at the distance of 10 m  - f shall be kHz frequency  - Resolution Bandwidth (RBW) is 200 Hz within 9 kHz ~150 kHz band, 9 kHz within 150 kHz ~30 MHz band and 120 kHz within 30 MHz ~1,000 MHz band  - Quasi-peak mode is applied |
| 10 MHz ∼30 MHz | 48 dBµV/m |
| 30 MHz ∼230 MHz | 30 dBµV/m |
| 230 MHz ∼1000 MHz | 37 dBµV/m |

**3.5 Suitable frequency bands and coexistence with the incumbents**

Based on the responses from Japan and Korea, the following table summarizes frequency bands for WPT in use or under consideration.

Many of the APT member countries have not allocated spectrum for WPT. It is pointed out that a clearer guidance is needed to choose which frequency band can be used for WPT. WPT technology using tightly coupled is using the certain spectrum in commercial. However, frequency bands for other types of WPT are under consideration in most countries. Some typical examples are shown in the table below

**Table 3.9 Frequency bands for WPT in use or under consideration**

1. Mobile, potable, and CE applications technologies

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency bands or ranges | | Characteristics | Status of Concerned countries |
| 20.05 kHz ~ 38 kHz,  42 kHz ~ 58 kHz,  62 kHz ~ 100 kHz | | Suitable for high power application  : power efficiency  : regulatory aspect (EMI, EMF) | - Japan : considering for CE |
| 110 kHz ~ 205 kHz | | Suitable for low power application  Tightly-coupled WPT | - Japan: WPC Wireless charger in commercial  - Republic of Korea : WPC Wireless charger in commercial |
| ~ 300 kHz | |  | - Republic of Korea : WPC Wireless charger in commercial |
| 480 kHz ~ 524 kHz | | Suitable for capacitive coupling technology design | - Japan: considering for capacitive coupling WPT |
| ISM band | 6.78 MHz | Designated by ITU-R  : global harmonization  : unrestricted emission  : relatively a vacant spectrum  Loosely-coupled WPT  (Magnetic resonance WPT) | - Japan : considering for mobile, portable, and CE devices  - Republic of Korea : Designated for ISM equipment in Dec. 2013 |
| 13.56 MHz |  | - Republic of Korea : Wireless charger for 3D glasses |
| 2.45 GHz |  | - Japan : considering for low power applications |

In Korea, Ministry of Science, ICT and future Planning (MSIP) of Korea partly revised the “Republic of Korea Table of Frequency Allocations” to make 6765 kHz ~ 6795 kHz band available for ISM equipment in Dec. 20, 2013 (MSIP Notification no.2013-185). ISM equipment shall not cause harmful interference to other stations and cannot be protected from other radio services, in accordance with the notification. In short, WPT equipment can operate within 6765 kHz ~ 6795 kHz band in Korea, because it is classified into ISM equipment.

(2) EV application technologies

|  |  |  |
| --- | --- | --- |
| Frequency bands or ranges | Characteristics | Status of Concerned countries |
| 20 kHz ~150 kHz | Suitable for high power application  : power efficiency  : regulatory aspect (EMI, EMF) | - Japan : considering globally harmonized EV/PHEV WPT spectrum  (42 kHz ~ 48 kHz, 52 kHz ~ 58 kHz, 79 kHz ~ 90 kHz, 140.91 kHz~148.5 kHz)  - Republic of Korea : already allocated to Electric Vehicle in 2011  (19 kHz ~ 21 kHz, 59 kHz ~ 61 kHz) |

In China, laws and regulations exist for safety, electromagnetic fields, environment protection and energy efficient identification, but not specifically for wireless power transmission. Also there is no frequency designated for WPT currently. All the issues related to WPT are under studies

**3.6 RF exposure**

Each country has own guideline or regulation on RF exposure in compliance with ICNIRP98, which does not include WPT devices and suitable measurement method yet.

**Table 3.10 Regulatory status on RF exposure**

|  |  |  |
| --- | --- | --- |
| Country | RF exposure | RF assessment |
| Australia | - The ACMA is responsible for the management of the mandatory *Radiocommunications (Electromagnetic Radiation – Human Exposure) Standard 2003* (incorporating amendments to Radiocommunications (Electromagnetic Radiation - Human Exposure) Amendment Standard 2011 (No. 2)),  : specifying the RF exposure limits for most mobile and portable radiocommunication transmitters with integral antenna operating 100 kHz ~ 300 GHz  - Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz (RPS3)  : set by ARPANSA (Australian Radiation Protection and Nuclear Safety Agency) | * Such devices are required to show compliance using test methods such asEN 62209-2 * (Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz) <http://infostore.saiglobal.com/store/details.aspx?ProductID=1465960.>The ACMA mandates the limits for RF and EMR exposure set by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). The primary source of RF exposure limit information is ARPANSA’s *Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz* (RPS3) - <http://www.arpansa.gov.au/Publications/codes/rps3.cfm> |
| China | (see section 3.4 ) | (see section 3.4 ) |
| Japan | - BWF’s guideline on RF exposure  <http://bwf-yrp.net/english/> : compliance requirements  - Referring to Radio Radiation Protection Guidelines and ICNIRP guidelines  : RF exposure limit | BWF of Japan considers the following approaches in RF exposure assessment.   * Assume specific worst cases, such a case that a part of the human body is contiguous to Tx or located between Tx and Rx. * Additional safety measures to take into account if safety cannot be declared. * Magnetic fields by the WPT products are non-uniform and RF exposure is expected to be local. Therefore ICNIRP guidelines can be safer references. Simulation assessment methodologies such as radiation dosimetry are suggested to consider if dosimetry experts can participate. * Assessment method should not take longer time unnecessarily and not intend to search for exact RF exposure. It should be a reasonable one which could be useful for certification procedures and acceptance tests. |
| Republic of Korea | - Plans to revise current EMF regulation to include WPT device for application during 2013 | - Plans to introduce assessment methods specified for WPT during 2013 |

**3.7 Regulatory matter**

This section excerpts regulatory matters descriptions in the responses and describes country by country.

**Australia**

Under Australian regulatory arrangements, radiocommunications devices must comply with any applicable standards and radiocommunications transmitters must not be operated without a license. ACMA (Australian Communications and Media Authority) regulates EMC through Radiocommunications Labelling Notice 2008.

**China**

About radio regulation files in China, there are many WPT related radio regulations. The following are main regulations which manage the issue of WPT radio emission.

1. People's Republic of China Ministry of Industry and Information Technology, the 16th Order (2010): People's Republic of China Regulations on the Radio Frequency Allocation. This ensures the normal operation of the radio business, and to prevent mutual interference between the various radio services, radio stations and WPT system.
2. People's Republic of China State Council, the People's Republic of China the Central Military Commission, the 128th Order (1993): People's Republic of China Regulations on Radio. This regulation strengthens radio management and maintenances airwaves order. According to varieties of WPT technology and control communications part, WPT devices may be same as normal radio system and under control of such regulations.
3. People's Republic of China State Council, People's Republic of China the Central Military Commission, No. 579 Order (2010): People's Republic of China Radio Control Requirements. This is the latest regulation about restrictions on radio stations, radio transmitting equipment, and radiation of radio waves of non-use of radio equipment, technical blocking measures, as well as the implementation of a specific radio frequency emission of radio waves, radiation and dissemination mandatory management.

National Radio Regulatory Commission in China is considering the rules and requirements of type approval for WPT products.

Control signaling and charging may use same frequency and there is no existing RF emission limit specification applicable to WPT devices, which may lead to potential interference to other systems in similar or concerned frequency band(s). Considering the future development of WPT and coexistence with other systems, China currently inclines to attribute WPT devices as Short Range Devices (SRD) from the radio point of view. The management approach of SRD’s relevant specification can be used for reference.

**Japan**

WPT is not clearly defined in the current Japanese regulation. Japan MIC is considering discipline for WPT in line with a report of its Subcommittee on “Promotion of Efficient Use of Frequencies”. The committee completed the final report in the middle of December, 2012. The report is available at

<http://www.soumu.go.jp/menu_news/s-news/02kiban09_03000165.html> (Japanese only).

The report addresses facilitating smooth introduction of the “Facilities Utilizing High Frequencies” equipment, directing establishment of appropriate disciplinary rule making for WPT equipment implementation. MIC is considering regulations policy for WPT in line with the report.

As products using WPT technologies are being developed at a gradual basis, the issues on preparing the regulatory guidelines for compliance of WPT products at a national and international level are being raised.

Comprehensive emission rules and system-specific emission rules are prescribed in the Japan Radio Law. Various rules are applied to WPT products depending on the purpose and output power. MIC is working on regulatory matters in close cooperation with concerned industries to facilitate WPT implementation.

MIC is taking into account certification procedures. WPT systems will be in widespread use indoors and outdoors. Therefore proper policy such as type-approval certification today applied to such commonly-in-use CE equipment as microwave ovens and/or IH cookers would be considered.

WPT applications of non-communication equipment less than 50 W may be allowed to be operated without permission. Conformity assessment policy including type approval for WPT would be taken into account.

**Republic of Korea**

1. Korea provides more detailed and broad-range of information in the response than the summary below. For details, please refer to AWG-14/INP-68. License: WPT equipment over 50 W is classified as ISM equipment and needs a license for operation. But those under 50 W, “Registration of conformity” including weak electric field strength and EMC testing is enough for operation.
2. EMC/EMI: CISPR-11 has been applied to WPT, but RRA revised the existing relevant regulation to classify WPT as domestic devices in June 2013.
3. General Regulations: All radiocommunications equipment including WPT devices should comply with three regulations under Radio Waves Act, 1)Technical regulation, 2)EMC Regulation, 3)EMF Regulation. The followings are the further explanation regarding technical regulations in Korea. Regarding explanation about EMC and EMF Regulation in Korea, please see [AWG-14/INP-68](http://www.apt.int/sites/default/files/2013/03/AWG-14-INP-68_KOR-Ques-WPT-final.docx).

**Table 3.11 Applied regulations to WPT**

|  |  |  |  |
| --- | --- | --- | --- |
| Power level | Name of application | Applied technical regulations | Licensing matter and  Concerned WPT technology |
| Low power  (≤ 50 W) | Extremely low power radio device | SRD | - Unlicensed  - Commercial products using tightly-coupled technology |
| ISM Equipment | ISM | - Unlicensed  - Considering products using loosely-coupled technology |
| High power  (≥ 50 W) | ISM Equipment | ISM | - Licensed  - Installed in a specific area  - SMFIR |

1. **Conclusion**

This Report presents the survey results on WPT with regards to applications, technologies, potential market, technical and operational characteristics, standardization, frequency bands, and regulatory status from APT countries based on the responses to “APT QUESTIONNAIRE ON WIRELESS POWER TRANSMISSION (AWG-13/OUT-10)” [1]. The gathered information includes some facts and data from market, industries, standard development organizations, administrators, and related organizations on WPT. Various WPT technologies are expected to be used for many applications such as handset, MP3 player, camera, TV, robot, laptop and electric vehicles.

Through the questionnaire survey, it was found that Japan and Korea have been seeking for frequency ranges for WPT and take them into considerations on technical regulation as observed rapidly increasing demand of WPT-applicable devices. China has been studying the WPT related technologies. In addition, the studies on EMI/EMC and RF exposure to human bodies from WPT devices are needed and in progress. Further studies are needed in AWG to seek for global and/or regional harmonization of regulations and technology standards of the WPT devices.

Finally, the Task Group points out the fact only four countries could provide specific information responding to the questionnaires. That means that the WPT technology is in the very early stage of development in the APT countries. Many countries in the APT region have not provided information to the questionnaire and they may refer to this Report and may begin study of WPT. The AWG shall continue information sharing with the APT countries on the subjects shown in the questionnaire for facilitating studies of WPT.

**REFERENCES**

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[11] Japan, AWG-15/INP-45 “Response to the Questionnaire on Wireless Power Transmission” 19 August, 2013

[12] China, AWG-15/INP-69 “Response to the Questionnaire on Wireless Power Transmission” 19 August, 2013

[13] ARIB, AWG-15/INP-19 “CJK WIRELESS POWER TRANSMISSION/TRANSFER (WPT) TECHNICAL REPORT 1 (FULL VERSION)” 9 August, 2013

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