Telecommunications Standards Advisory Committee (TSAC)

Technical Specification

Ultra-Wideband (UWB) Devices

IMDA TS UWB
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Contents

Technical Specification for Ultra-Wideband Devices

1. Scope

1.1. This Specification defines the minimum technical requirements for ultra-wideband (UWB) devices which operate within the emission mask given in Figure 1 and the provisions given in Table 1 of this Specification. UWB devices are intended for use in confined areas of buildings or localised on-site operations.

1.2. UWB devices are meant for short range radio-communication, which involves the intentional generation and transmission of radio frequency energy that may spread over a very large frequency range and overlap with frequency bands allocated to radio-communication services. Devices using UWB technology have intentional radiation from the antenna with either a −10 dB bandwidth of at least 500 MHz or a −10 dB fractional bandwidth greater than 0.2 [Note 1] (Annex 1 of ITU-R SM.1754).

1.3. A wide variety of new short-range devices (UWB device) may employ the UWB technology. This includes the use of UWB device in communications, measurement, location, imaging, surveillance and medical systems. UWB devices will be integrated in portable and mobile equipment.

2. References

For the technical requirements captured in this Specification, reference has been made to the following standards. Where versions are not indicated, implementation of this Specification shall be based on current and valid versions of these standards published by the respective Standards Development Organisations.

ITU-R SM.1754	Measurement techniques of ultra-wideband transmissions
ITU-R SM.1755	Characteristics of ultra-wideband technology
ITU-R SM.1756	Framework for the introduction of devices using ultra-wideband technology
ITU-R SM.1757	Impact of devices using ultra-wideband technology on systems operating within radio-communication services
ETSI EN 302 065	Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (UWB DEVICE) using Ultra Wide Band technology (UWB) for communications purposes; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive
ETSI EN 302 066	Short Range Devices (UWB DEVICE); Ground- and Wall- Probing Radar applications (GPR/WPR) imaging systems; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU
ETSI EN 301 489-1	Electromagnetic Compatibility (EMC) standard for radio

[Note 1] The −10 dB bandwidth is $B_{-10} = f_H - f_L$; and the −10 dB fractional bandwidth is $\mu_{-10} = B_{-10}/f_C$; where f_H is the highest frequency at which the power spectral density of the UWB transmission is −10 dB relative to f_M, and f_L is the lowest frequency at which the power spectral density of the UWB transmission is −10 dB relative to f_M; and f_M is the frequency of maximum UWB transmission and f_C *is* the centre frequency of the −10 dB bandwidth [$f_C = (f_H + f_L)/2$].

	equipment and services; Harmonised Standard covering the essential requirements of article 3.1(b) of the Directive 2014/53/EU and the essential requirements of article 6 of the Directive 2014/30/EU; Part 1: Common technical requirements
ECC/DEC/(06)04 Amended 6 July 2007	ECC Decision of 24 March 2006 amended 6 July 2007 at Constanta on the harmonized conditions for devises using ultra-wideband (UWB) technology in bands below 10.6 GHz.
ECC/DEC/(06)08	ECC Decision of 1 December 2006 on the conditions for use of radio spectrum by Ground- and Wall-Probing Radar (GPR/WPR) imaging systems
ECC/DEC/(04)03	ECC Decision of 19 March 2004 on the frequency band 77 – 81 GHz to be designated for the use of Automotive Short Range Radars
ECC/DEC/(04)10	ECC Decision of 12 November 2004 on the frequency bands to be designated for the temporary introduction of Automotive Short Range Radars
FCC Part 15 Subpart F	Ultra-Wideband Operation
IEC CISPR 32	Electromagnetic compatibility of multimedia equipment – Emission requirements Note: Validity of the IEC CISPR 22 (2008), EMC standard for information technology equipment, will lapse by 31 March 2017, in sync with IEC's timeline for withdrawing this CISPR standard and replacing it with the CISPR 32 standard
IEC CISPR 24	Information technology equipment – Immunity characteristics – Limits and methods of measurement
ISO 7637-2	Road vehicles - Electrical disturbances from conduction and coupling - Part 2: Electrical transient conduction along supply lines only
ITU-T K.116	EMC requirements and test methods for radio telecommunication terminal equipment

3. General Requirements

3.1. Design of UWB Devices

UWB devices shall be designed to meet the following requirements:

(a) UWB devices shall not cause harmful interference to radio-communication services operating in allocated frequency bands, and cannot claim protection from these radio-communication services;

(b) UWB devices should be capable of implementing mitigation techniques [Note 2] to provide additional protection to radio-communication services;

(c) UWB devices shall be fixed with integral antenna and without the antenna connector; and

(d) The UWB device shall not be constructed with any external or readily accessible control which permits the adjustment of its operation in a manner that is inconsistent with this Specification.

3.2. Electromagnetic Compatibility (EMC) Requirements

For EMC assessment, the UWB device and/or ancillary equipment shall be classified as equipment for vehicular use or portable/mobile use (i.e. powered by its integral battery). This equipment classification is used to determine the applicability of the EMC (emission and immunity) testing requirements based on §5.5 and §7 of ETSI EN 301 489-1; or §7.5 and §9 of ITU-T K.116.

3.2.1. EMI or emission measurements

(a) Radiated emissions from associated ancillary equipment not incorporated in the UWB device shall be measured to Class B requirements defined in §4 and Tables A.4 and A.5 of IEC CISPR 32.

(b) Conducted emission at the DC power port of the UWB device intended for vehicular use, shall be measured to Class B requirements defined in §4 and Table A10 of IEC CISPR 32.

(c) Conducted emission at the AC mains port shall be measured for UWB device with dedicated charger or adapter to Class B requirements defined in §4 and Table A.10 of IEC CISPR 32. Equipment with DC power port which is powered by a dedicated AC/DC power adapter/charger is defined as AC mains powered equipment (§3.1.1 of CISPR 32).

Note 1: If UWB device is a module intended to be marketed and sold separately from a host, it shall be assessed with at least one representative host system. Modules may be internal, mounted, plug-in or external (§6.2 of IEC CISPR 32).

Note 2: Emission measurements performed to FCC Part 15 Subpart B for unintentional radiators (§15.109) may be acceptable as an alternative to IEC CISPR 32.

[Note 2] Conditions in the 4.2 to 4.8 GHz band for equipment using UWB technology without appropriate mitigation techniques should be time-limited and be replaced by more restrictive conditions beyond 31 December 2010 (ECC/DEC/(06)04 Amended 6 July 2007).

3.2.2. EMS or immunity testing

The following immunity tests may be performed on the UWB device to requirements defined in IEC CISPR 24, §11 of ITU-T K.116 or §9 of ETSI EN 301 489-1, where applicable:

(a) RF electromagnetic field (80 MHz to 1 GHz and 1.4 GHz to 6 GHz) at the enclosure of the device

(b) Electrostatic discharge at the enclosure of the device

(c) Fast transients (common mode) at DC power and AC main power ports that have cables longer than 3 m

(d) RF common mode 0.15 MHz to 80 MHz at DC power and AC mains power ports that have cables longer than 3 m

(e) Transients and surges (vehicular environment) on nominal 12V and 24V DC supply voltage input ports of mobile terminal and ancillary equipment intended also for mobile use in vehicles [ISO 7637-2]

(f) Voltage dips and interruptions at AC mains power port of mobile or portable terminal with dedicated power adapter/charger

(g) Surges, common and differential mode at AC mains power port of mobile or portable terminal with dedicated power adapter/charger

4. Technical Requirements

4.1. Provisions given in Figure 1 and Table 1 of this Specification are not applicable to outdoor installations and infrastructure, including those with externally mounted antennas. UWB devices used outdoors shall not be operating from a fixed outdoor location or antenna.

4.2. The UWB bandwidth (which refers to the −10 dB bandwidth, B_{-10} defined in Note 1) of the UWB device shall be contained in the frequency ranges permitted in the emission mask shown in Figure 1 of this Specification.

4.3. Where applicable, radiated emissions from the UWB device shall not exceed the corresponding mean and peak power (equivalent isotropic radiated power, EIRP) limits given in Table 1, operating in the permitted UWB bandwidth of the device.

4.4. The use of UWB imaging system with peak emission below the 960 MHz or in the 3400 to 10600 MHz band shall be approved on an exceptional basis (Annex A of this Specification).

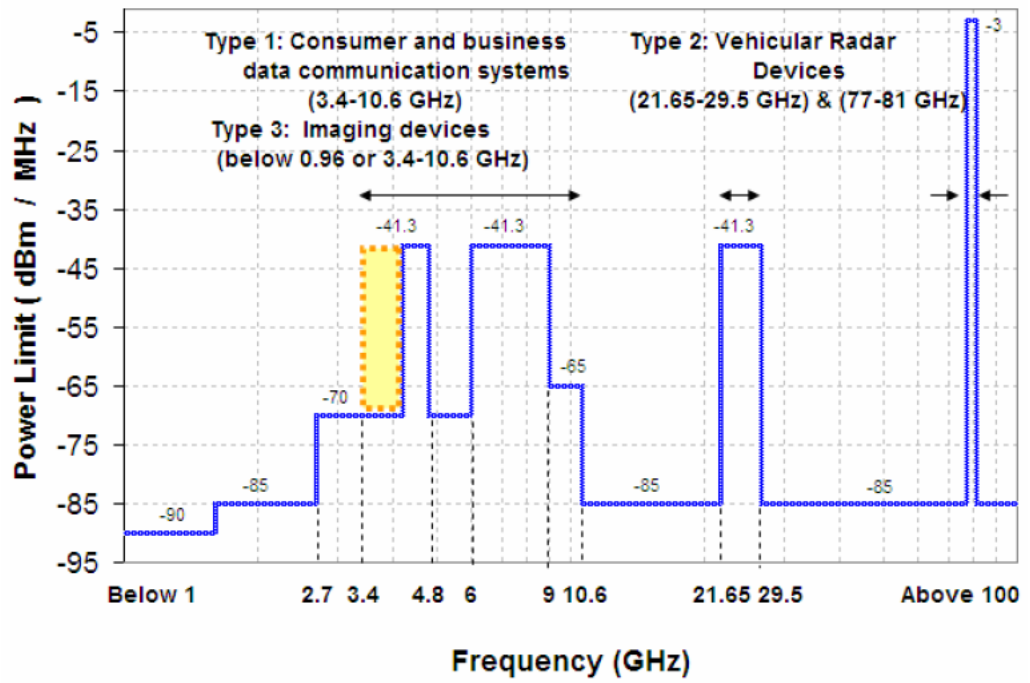

Figure 1: UWB Emission Mask

4.5. Transmission Activity

4.5.1. If the UWB device is operating as a communication system, it shall transmit only when it is sending information to an associated receiver. The UWB device shall cease transmission within 10 seconds unless it receives acknowledgment from the associated receiver. The UWB device must continue to receive an acknowledgement of transmission at least every 10 seconds else it must cease transmitting.

4.5.2. If the UWB device is operating as a non-communication system such as an imaging system, it shall contain a manually operated switch that causes the transmitter to cease operation within 10 seconds of being released by the operator. It is also permissible to operate an imaging system by remote control provided the imaging system ceases transmission within 10 seconds of the remote switch being released by the operator.

4.6. Mitigation Techniques

UWB devices may employ the following mitigation techniques to reduce the impact on radio-communication systems:

(a) Spectral control techniques of UWB emissions

i. Smoothing the power spectral-density of UWB signals by an appropriate choice of the timing jitter;

ii. Using a pseudo-noise code sequence to decrease the spikiness of the UWB signals and lower the power spectral-density (PSD) in certain frequency bands; or

iii. Using various pulse shapes to control the fractional bandwidth and the PSD of UWB signals.

(b) Cross polarization

Cross polarization can be effective in mitigating interference from some devices using UWB technology when polarizations of the interferer(s) and the victim receiver are known.

(c) Notch filtering

Notch filters can suppress certain spectral contents of the mono-cycle UWB pulse or other UWB pulses. However, notch filtering may be impractical to implement since in-band notches may impair the performance of devices using UWB technology.

(d) Frequency hopping

It is possible to reduce the emission to certain frequency bands by hopping the frequency of the UWB signal in a proper manner. Moreover, emission to the frequency band of a victim system can be effectively suppressed by disabling the hopping to the corresponding frequency band.

(e) Chirp signalling

It is possible to reduce the emission to the frequency band of a victim system by continuously changing the frequency of the UWB pulse.

(f) Frequency agile modulation

Frequency agile UWB modulation allows for an emission level definition according to actual requirements at each portion of the UWB RF spectrum. It could also support programmable emission levels based on regional code transferred to the physical layer from the upper layers.

(g) Carrier-leak-free burst oscillator

Using a burst oscillator that does not generate carrier leak at pulse-off allows locating the spectrum of the oscillator at an arbitrary position within the permitted band for the device using UWB technology. Consequently, a device using UWB technology and a carrier-leak-free burst oscillator may effectively mitigate interference by locating the interfering spectrum sufficiently far from the victim band.

(h) Spatial radiation control techniques

These techniques limit the radiation of the UWB signal in certain directions and reduce the total transmit power:

i. Antenna directivity

In certain UWB applications (e.g. GPR and vehicular radar), the directivity of UWB antennas could help minimize the interference.

ii. Multiple antenna directivity

A number of approaches using multi-element antennas at one or both sides of the radio link can be used: switched beam (angular) diversity on the receive side; switched beam diversity on the transmit side; and spatial diversity on the receive side and on the transmit side, or on both sides, using several combining schemes.

iii. Array antenna

An array antenna technique makes it possible to spatially and adaptively restrict the radiation to a victim system according to the locations of the interferer and the victim system. This also enables to reduce the total emission power. Various adaptation algorithms can be used.

(i) Combined mitigation techniques

Combining multiple mitigation techniques makes it possible to reduce interference in a flexible and effective manner.

(j) Detect And Avoid (DAA) technology

This technique has been proposed to mitigate UWB interference. The general principle is that UWB devices should detect the presence of signals from other radio systems and reduce its transmitted power down to a level where it does not cause interference to these systems.

(k) Listen before talk (LBT)

The transmitter will sense the air before transmit in order not to interfere with the on-going transmission.

(l) Transmit Power Control (TPC)

The transmitter will adjust the transmit power to the level just sufficient for the successful transmission. This will prevent transmitter to transmit excessive power and causing interference to other wireless system in the vicinity.

(m) Dynamic Frequency Selection (DFS)

The transmitter will sense the channel before transmit. When the channel is occupied, the transmitter will re-select other vacant channels for transmission.

4.7. Testing for Compliance with Technical Requirements

The UWB device shall be tested for compliance with the applicable technical requirements stipulated in Figure 1 and Table 1 of this Specification, following the appropriate techniques for measuring UWB transmissions given in ETSI EN 302 065, EN 302 066 or ITU-R SM.1754. The UWB device shall comply with the relevant requirements of this Specification on all the permitted frequencies which it is intended to operate.

Table 1: Technical Requirements for Ultra-Wideband (UWB) Devices

<table>
<tr><td>References</td><td>ETSI EN 302 065 and ECC/DEC/(06)04 amended 6 July 2007</td><td>ITU-R SM.1756, ECC/DEC/(04)03 and ECC/DEC/(04)10</td><td>ETSI EN 302 066 and ECC/DEC/(06)08</td></tr>
<tr><td>Typical Applications</td><td>Generic UWB Devices e.g. standalone or plug-in radio devices for host systems</td><td>Automotive Short-Range Radar (SRR) systems that are vehicular radar systems intended for collision mitigation and traffic safety applications</td><td>Ground and Wall Probing Radar (GPR and WPR) systems used in survey and detection applications</td></tr>
<tr><td>Typical Operating Bands</td><td>Operating in all or any part of the frequency bands:
3.4 – 4.8 GHz
4.2 – 4.8 GHz
6 – 8.5 GHz (1)</td><td>Operating in the 24 GHz and/or 79 GHz bands</td><td>Operating in all or any part of the frequency band from 30 MHz to 12.4 GHz</td></tr>
<tr><td>Radiated emission limits</td><td>
<table>
<tr><th>Frequency Range (GHZ)</th><th>Max mean e.i.r.p. density (dBm/MHz)</th><th>Max peak e.i.r.p. density (dBM/50 MHz)</th></tr>
<tr><td>Below 1.60</td><td>- 90</td><td>- 50</td></tr>
<tr><td>1.60 – 2.70</td><td>- 85</td><td>- 45</td></tr>
<tr><td>2.70 – 3.40</td><td>- 70</td><td>- 36</td></tr>
<tr><td>3.40 – 4.20</td><td>- 70 (2)</td><td>- 30</td></tr>
<tr><td rowspan="2">4.20 – 4.80</td><td>- 41.3</td><td>0</td></tr>
<tr><td colspan="2">(To be replaced by more restrictive conditions beyond 31 Dec 2010.)</td></tr>
<tr><td>4.80 – 6.00</td><td>- 70</td><td>- 30</td></tr>
<tr><td>6.00 – 8.50 (1)</td><td>- 41.3</td><td>0</td></tr>
<tr><td>8.50 – 10.60</td><td>- 65</td><td>- 25</td></tr>
<tr><td>10.60 – 21.65</td><td>- 85</td><td>- 45</td></tr>
<tr><td>21.65 – 29.50</td><td>- 41.3</td><td>0</td></tr>
<tr><td>29.50 – 77.00</td><td>- 85</td><td>- 45</td></tr>
<tr><td>77.00 – 81.00</td><td>- 3</td><td>55</td></tr>
<tr><td>Above 81.00</td><td>- 85</td><td>- 45</td></tr>
</table>
(1) The extension of this band from 6.0 to 9 GHz is also acceptable in the light of potential new applications.

(2) UWB devices with mitigation techniques are allowed to operate at a level of -41.3 dBm/MHz in the band from 3.4 to 4.2 GHz (with peak level emissions in 50 MHz bandwidth not exceeding 0 dB e.i.r.p.). Otherwise, the emission limit is capped at 70 dBm/MHz.</td><td>
<table>
<tr><th>Frequency Range (MHZ)</th><th>Max mean e.i.r.p. density (dBm/MHz)</th><th>Max peak e.i.r.p. density (dBM/50 MHz)</th></tr>
<tr><td>21650 –26650 (3, 4 & 5)</td><td>- 41.3</td><td>0</td></tr>
<tr><td>77000 –81000</td><td>- 3</td><td>55</td></tr>
</table>
(3) The extension of this band from 21650 to 29500 MHz is acceptable.

(4) For the 24050 to 24250 MHz range, narrow-band emission mode/component with a maximum peak power of 20dBm e.i.r.p and a duty cycle limited to 10% for peak emissions higher than -10 dBm e.i.r.p. is allowed.

(5) Emissions within the 23.6 to 24 GHz band that appear 30° or greater above the horizontal plane shall be attenuated by at least 25 dB up to year 2010 and 30 dB up to 1 July 2013.</td><td>
<table>
<tr><th>Frequency Range (MHz)</th><th>Max mean e.i.r.p. density (dBm/MHz)</th></tr>
<tr><td>< 230</td><td rowspan="8">Refer to Figure 1 of this Specification for the UWB emission limits.</td></tr>
<tr><td>230 – 1000</td></tr>
<tr><td>1000 – 1600</td></tr>
<tr><td>1600 – 3400</td></tr>
<tr><td>3400 – 5000</td></tr>
<tr><td>5000 – 6000</td></tr>
<tr><td>> 6000</td></tr>
</table>
(6) GPR and WPR imaging systems shall be designed to operate while in contact with or close to the ground or wall, and their emissions being directed into the ground.

(7) GPR and WPR equipment shall have a deactivation mechanism to deactivate the equipment when normal use is interrupted.</td></tr>
</table>

Annex A

Technical Requirements for Ultra-Wideband (UWB) Imaging Systems based on FCC Part 15 Subpart F (In this Table, unless otherwise stated, the unit of frequency is MHz and the unit of e.i.r.p. is dBm/MHz.)						
Systems / Applications	**GPR and wall imaging**		**Through-wall imaging**		**Surveillance imaging**	**Medical imaging**
Operating bands	Below 960 MHz	Between 3400 and 10600 MHz	Below 960 MHz	Between 3400 MHz and 10600 MHz	Between 3400 MHz and 10600 MHz.	Between 3400 MHz and 10600 MHz.
Radiated emission limits of resolution bandwidth of 1 MHz	See FCC Part 15 § 15.209 for emission limits	*Frequency e.i.r.p.* 960-1610 –65.3 1610-1990 –53.3 1990-3100 –51.3 3100-10600 –41.3 Above 10600 –51.3	*Frequency e.i.r.p.* 960-1610 –65.3 1610-1990 –53.3 Above 1990 –51.3	*Frequency e.i.r.p.* 960-1610 –46.3 1610-1990 –41.3 Above 1990 –51.3	*Frequency e.i.r.p.* 960-1610 –53.3 1610-1990 –51.3 1990-10600 –41.3 Above 10600 –51.3	*Frequency e.i.r.p.* 960-1610 –65.3 1610-1990 –53.3 1990-3100 –51.3 3100-10600 –41.3 Above 10600 –51.3
Limits for resolution bandwidth of no less than 1 kHz		*Frequency e.i.r.p.* 1164-1240 –75.3 1559-1610 –75.3	*Frequency e.i.r.p.* 1164-1240 –75.3 1559-1610 –75.3	*Frequency e.i.r.p.* 1164-1240 –56.3 1559-1610 –56.3	*Frequency e.i.r.p.* 1164-1240 –63.3 1559-1610 –63.3	*Frequency e.i.r.p.* 1164-1240 –75.3 1559-1610 –75.3
Peak level emissions in 50 MHz bandwidth		0 dBm e.i.r.p.	0 dBm e.i.r.p.	0 dBm e.i.r.p.	0 dBm e.i.r.p.	0 dBm e.i.r.p.
Remarks	**The use of UWB imaging system with peak emission below the 960 MHz or in the 3400 to 10600 MHz band shall be approved on an exceptional basis.**					

Annex B

Corrigendum / Addendum

Revised TS		Items Changed	Date of Issue
Page	Section		
Changes to IDA TS UWB Issue 1 Rev 1, May 2011			
4	§3.2	The IMDA TS UWB Issue 1 (October 2016) has replaced the IDA TS UWB Issue 1 Rev 1 (May 2011). Changes are largely editorial to provide updates and clarity in the application of EMC requirements, in line with standards development that has taken place in the Standards Development Organisations concerned.	1 Oct 16

Page	TS Ref.	Items Changed	Effective Date
Changes to IDA TS UWB Issue 1, Dec 07			
		Change of IDA's address at cover page to Mapletree Business City.	1 May 11