**IEEE P802.15**

**Wireless Personal Area Networks**

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| Re: | Technical Guidance Document for 802.15.8 | |
| Abstract | This is the draft baseline of 802.15.8 Technical Guidance Document | |
| Purpose | To provide the technical guidance including functional and technical requirements to the P802.15 Working Group. | |
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| Patent Policy | The contributor is familiar with the IEEE-SA Patent Policy and Procedures:  <http://standards.ieee.org/guides/bylaws/sect6-7.html#6> and  <http://standards.ieee.org/guides/opman/sect6.html#6.3>.  Further information is located at <http://standards.ieee.org/board/pat/pat-material.html> and  <http://standards.ieee.org/board/pat>. | |

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# Overview

The 802.15.8 specification shall be developed according to the P802.15.8 Peer Aware Communication (PAC) project authorization request (PAR), as approved on 30th March 2012 [1], and Five Criteria document [2].

# Definition

Channel Availability Check Time: The time a system shall monitor a channel for presence of radar prior to initiating a communications link on that channel.

Interference Detection Threshold: The minimum signal level, assuming a 0dBi antenna, that can be detected by the system to trigger the move to another channel.

Channel Move Time: The time for the system to clear the channel and measured from the end of the radar burst to the end of the final transmission on the channel.

Non-Occupancy Time: A period of time after radar is detected on a channel that the channel may not be used.

# Regulations

## Overview

## Sub 1 GHz band

### US

#### 902 ~ 928 MHz

### EU

#### 863 ~ 870 MHz

### China

#### 779 ~ 787 MHz

**Maximum transmit power:**

Maximum transmit power is 10 mW EIRP

### Japan

#### 915 ~ 930 MHz

**Maximum transmit power:**

|  |  |  |
| --- | --- | --- |
| Regulatory mode | Maximum transmit power | Frequency |
| Middle Power mode | 250 mW | 920.5 ~ 923.5 MHz |
| Low Power mode (Basic regulation) | 20 mW | 920.5 ~ 928.1 MHz |
| Low Power mode (Extended regulation) | 20 mW | 920.5 ~ 923.5 MHz |
| Ultra Low Power mode (Basic regulation) | 1 mW | 915.9 ~ 928.1 MHz |
| Ultra Low Power mode (Extended regulation) | 1 mW | 928.1 ~ 929.7 MHz |

**Available channel width:**

Available channel widths are 200 kHz, 400 kHz, 600 kHz, 800 kHz and 1 MHz.

**Listen Before Transmission:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Regulatory mode | Minimum sensing time | CCA threshold | Maximum transmission on-time | Minimum transmission off-time after transmission |
| Middle Power mode | 128 usec | -80 dBm | 400 msec | 2 msec (if transmission time is larger than 6 msec) |
| Low Power mode (Basic) | 128 usec | -80 dBm | 400 msec | 2 msec (if transmission time is larger than 6 msec) |
| Low Power mode (Extended) | 5 msec | -80 dBm | 4 second | 50 msec |
| Ultra Low Power mode (Basic) | Not needed | -26 dBm | 100 msec | 100 msec |
| Ultra Low Power mode (Extended) | Not needed | -26 dBm | 50 msec | 50 msec |

**Spurious emission limit:**

|  |  |  |
| --- | --- | --- |
| Frequency | Spurious emission limit | Reference bandwidth |
| 915 ~ 923.3 MHz | -36 dBm | 100 kHz |
| 920.3 ~ 924.3 MHz | -36 dBm (transmit power ≤ 20 mW)  -29 dBm (transmit power > 20 mW) | 100 kHz |
| 924.3 ~ 928.1 MHz | -36 dBm | 100 kHz |
| 928.1 ~ 930 MHz | -36 dBm | 100 kHz |

### Korea

#### 917 ~ 923.5 MHz

**Channelization for RFID/USN:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Channel number | Center  frequency  (MHz) | Channel number | Center  frequency  (MHz) | Channel number | Center  frequency  (MHz) | Channel number | Center  frequency  (MHz) |
| 1 | 917.1 | 9 | 918.7 | 17 | 920.3 | 25 | 921.9 |
| 2 | 917.3 | 10 | 918.9 | 18 | 920.5 | 26 | 922.1 |
| 3 | 917.5 | 11 | 919.1 | 19 | 920.7 | 27 | 922.3 |
| 4 | 917.7 | 12 | 919.3 | 20 | 920.9 | 28 | 922.5 |
| 5 | 917.9 | 13 | 919.5 | 21 | 921.1 | 29 | 922.7 |
| 6 | 918.1 | 14 | 919.7 | 22 | 921.3 | 30 | 922.9 |
| 7 | 918.3 | 15 | 919.9 | 23 | 921.5 | 31 | 923.1 |
| 8 | 918.5 | 16 | 920.1 | 24 | 921.7 | 32 | 923.3 |

**Maximum transmit power:**

|  |  |  |
| --- | --- | --- |
| Device type | Maximum transmit power | Channel |
| High power RFID reader | 4 W (EIRP) | 2,5,8,11,13,17 |
| 200 mW (EIRP) | 20,21,22,23,24,25,26,27,28,29,30,31,32 |
| RFID/USN device | 10 mW (EIRP) | 2,5,8,11,14,17,19,20,21,22,23,24,25,26,27,28,29,30,31,32 |
| 3 mW (EIRP) | 1,3,4,6,7,9,10,12,13,15,16,18 |

**Frequency hopping (FH):**

Number of hopping channels ≥ 16

Dwell time in one channel ≤ 0.4 sec

**Listen Before Transmission (LBT):**

Minimum sensing time ≥ 5 msec

CCA threshold: -65 dBm

Maximum transmission on-time ≤ 4 sec

Minimum transmission off-time after transmission ≥ 50 msec

**Techniques other than FH and LBT:**

Duty cycle ≤ 2% for 20 sec period of time

## 2.4 GHz ISM band

### US

#### 2400 ~ 2483.5 MHz

### EU

### China

### Japan

#### 2400 ~ 2483.5 MHz

**Maximum transmit power:**

|  |  |  |
| --- | --- | --- |
| Frequency | Operating mode | Maximum transmit power |
| 2400 ~ 2427 MHz | FH, FH + DS, FH + OFDM | 10 mW/MHz |
| OFDM (Band width < 26 MHz) | 10 mW/MHz |
| OFDM (Band width > 26 MHz) | 5 mW/MHz |
| 2427 ~ 2470.75 MHz | FH, FH + DS, FH + OFDM | 3 mW/MHz |
| DS | 10 mW/MHz |
| 2470.75 ~ 2483.5 MHz | FH, FH + DS, FH + OFDM | 10 mW/MHz |
| OFDM (Band width < 26 MHz) | 10 mW/MHz |
| OFDM (Band width > 26 MHz) | 5 mW/MHz |

**Maximum bandwidth:**

Maximum bandwidth is 38 MHz for OFDM or 26 MHz for others.

#### 2471 ~ 2497 MHz

### Korea

#### 2400 ~ 2483.5 MHz

A set of regulatory requirements for device using Direct Sequence Spread Spectrum (DSSS), Chirp Spread Spectrum (CSS), or Orthogonal Frequency Division Multiplexing (OFDM) in 2400 ~ 2483.5 MHz band is listed as follows:

**Maximum transmit power:**

|  |  |  |
| --- | --- | --- |
| Bandwidth | Maximum transmit power | Maximum antenna gain |
| 0.5 MHz ~ 26 MHz | 10mW/MHz | 6 dBi |
| 26 MHz ~ 40 MHz | 5mW/MHz |
| 40 MHz ~ 60 MHz | 0.1mW/MHz |

**Maximum frequency tolerance:**

Maximum frequency tolerance is ±50 \* 10-6.

**Spurious emission limit:**

Out-of-band spurious emission limit is -30dBm with 100kHz resolution bandwidth measurement.

## 5 GHz ISM band

### US

#### 5.15 ~ 5.25 GHz

Within the 5.15-5.25 GHz band, U-NII devices will be restricted to indoor operations to reduce any potential for harmful interference to co-channel MSS operations.

**Maximum conducted output power:**

Maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or 4 dBm + 10 log B, where B is the 26 dB emission bandwidth in MHz.

**Peak power spectral density:**

Peak power spectral density shall not exceed 4 dBm in any 1 MHz band.

If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**Undesirable emission limits:**

All emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.

#### 5.25 ~ 5.35 GHz

**Maximum conducted output power:**

Maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in MHz.

**Peak power spectral density:**

Peak power spectral density shall not exceed 11 dBm in any 1 MHz band.

If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**Undesirable emission limits:**

All emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.

**Transmitter power control (TPC):**

Device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm.

**Dynamic frequency selection (DFS):**

|  |  |
| --- | --- |
| Interference detection threshold | * Transmit power < 200 mW EIRP: -62 dBm * 200 mW EIRP ≤ Transmit power ≤ 1 W EIRP: -64 dBm |
| Channel availability check time | Over 60 seconds |
| Channel move time | Under 10 seconds |
| Non occupancy period | Over 30 minutes |

#### 5.47 ~ 5.725 GHz

**Maximum conducted output power:**

Maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in MHz.

**Peak power spectral density:**

Peak power spectral density shall not exceed 11 dBm in any 1 MHz band.

If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**Undesirable emission limits:**

All emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.

**Transmitter power control (TPC):**

Device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm.

**Dynamic frequency selection (DFS):**

|  |  |
| --- | --- |
| Interference detection threshold | * Transmit power < 200 mW EIRP: -62 dBm * 200 mW EIRP ≤ Transmit power ≤ 1 W EIRP: -64 dBm |
| Channel availability check time | Over 60 seconds |
| Channel move time | Under 10 seconds |
| Non occupancy period | Over 30 minutes |

#### 5.725 ~ 5.825 GHz

**Maximum conducted output power:**

Maximum conducted output power over the frequency band of operation shall not exceed the lesser of 1 W or 17 dBm + 10 log B, where B is the 26 dB emission bandwidth in MHz.

**Peak power spectral density:**

Peak power spectral density shall not exceed 11 dBm in any 1 MHz band.

**Undesirable emission limits:**

All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an EIRP of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of -27 dBm/MHz.

### EU

### China

### Japan

### Korea

#### 5.15 ~ 5.25 GHz

A set of regulatory requirements for device operating in 5.15 ~ 5.25 GHz band is listed as follows:

**Maximum transmit power:**

|  |  |  |
| --- | --- | --- |
| Bandwidth | Maximum transmit power | Maximum antenna gain |
| 0.5 MHz ~ 40 MHz | 2.5mW/MHz | 6 dBi |

**Maximum frequency tolerance:**

Maximum frequency tolerance is ±20 \* 10-6.

**Maximum bandwidth:**

Maximum bandwidth is 40 MHz

**Spurious emission limit:**

Out-of-band spurious emission limit is -27dBm.

#### 5.25 ~ 5.35 GHz, 5.47 ~ 5.65 GHz

A set of regulatory requirements for device operating in 5.25 ~ 5.35 GHz band or 5.47 ~ 5.65 GHz is listed as follows:

**Maximum transmit power:**

|  |  |  |
| --- | --- | --- |
| Bandwidth | Maximum transmit power | Maximum antenna gain |
| 0.5 MHz ~ 20 MHz | 10mW/MHz | 7 dBi |
| 20 MHz ~ 40 MHz | 5mW/MHz |

**Maximum frequency tolerance:**

Maximum frequency tolerance is ±20 \* 10-6.

**Maximum bandwidth:**

Maximum bandwidth is 40 MHz

**Spurious emission limit:**

Out-of-band spurious emission limit is -27dBm.

**Transmitter power control (TPC):**

A device which has average transmit power over 25mW/MHz should be capable of degrading transmit power under 12.5 mW/MHz

**Dynamic frequency selection (DFS):**

|  |  |
| --- | --- |
| Interference detection threshold | * Transmit power < 10mW/MHz: -62dBm * 10mW/MHz ≤ Transmit power ≤ 50mW/MHz: -64dBm |
| Channel availability check time | Over 60 seconds |
| Channel move time | Under 10 seconds |
| Non occupancy period | Over 30 minutes |

#### 5.725 ~ 5.825 GHz

A set of regulatory requirements for device using Direct Sequence Spread Spectrum (DSSS), Chirp Spread Spectrum (CSS), or Orthogonal Frequency Division Multiplexing (OFDM) in 5.725 ~ 5.825 GHz band is listed as follows:

**Maximum transmit power:**

|  |  |  |
| --- | --- | --- |
| Bandwidth | Tx. power | Max. antenna gain |
| 0.5 MHz ~ 26 MHz | 10mW/MHz | 6 dBi |
| 26 MHz ~ 40 MHz | 5mW/MHz |

**Maximum frequency tolerance:**

Maximum frequency tolerance is ±50 \* 10-6.

**Spurious emission limit:**

Out-of-band spurious emission limit is -30dBm with 100kHz resolution bandwidth measurement.

## 6 ~ 11 GHz UWB

### US

#### 5.925 ~ 7.25 GHz

### EU

### China

### Japan

### Korea

#### 3.1 ~ 4.8 GHz, 7.2 ~ 10.2 GHz

A set of regulatory requirements for device operating in 3.1 ~ 4.8 GHz UWB band or 7.2 ~ 10.2 GHz UWB band is listed as follows:

**Maximum transmit power:**

|  |  |  |
| --- | --- | --- |
| Bandwidth | Average power | Peak power |
| > 450 MHz | -41.3 dBm/MHz | 0 dBm/50MHz |

**Minimum bandwidth:**

Minimum bandwidth is 450 MHz

**Spurious emission limit:**

|  |  |
| --- | --- |
| Frequency band | Average power |
| ~ 1.6 GHz | ≤ -90 dBm/MHz |
| 1.6 GHz ~ 2.7 GHz | ≤ -85 dBm/MHz |
| 2.7 GHz ~ 3.1 GHz | ≤ -70 dBm/MHz |
| 3.1 GHz ~ 4.8 MHz | ≤ -51.3 dBm/MHz |
| 4.8 GHz ~ 7.2 GHz | ≤ -70 dBm/MHz |
| 7.2 GHz ~ 10.2 GHz | ≤ -51.3 dBm/MHz |
| 10.2 GHz ~ | ≤ -70 dBm/MHz |

# References

[1] 11-11-0957-02-00ah-s1g-spectrum-regulations-in-china

[2] 11-11-0685-00-00ah-s1g-spectrum-regulations

[3] 15-11-0510-04-004g-introduction-of-new-frequency-regulation-for-smart-utility-network-in-japan

[4] 11-04-0033-02-000n-japanese-frequency-regulations-related-to-tgn-functional-requirements