

# **WiLink™ 8 Single-Band Combo Module – Wi-Fi®, Bluetooth® and Bluetooth Low Energy (BLE), Product Preview Rev. 1.0**

Check for Samples: [WL1801MOD](#), [WL1805MOD](#), [WL1831MOD](#), [WL1835MOD](#)

## **1 TI Module Summary**

### **1.1 Features**

- **General**
  - WLAN With Integrated RF Front-End Module (FEM), Power Amplifier (PA), Crystal, RF Switches, Filters, Passives, and Power Management on a Single Module
  - Efficient Direct Connection to Battery by Employing Several Integrated Switched Mode Power Supplies (DC-DC)
  - Dual-Mode *Bluetooth* and *Bluetooth* Low Energy (WL183xMOD Only)
  - FCC, IC, and CE Certified With Chip Antenna
  - Seamless Integration With TI Sitara™
  - Hardware Design Files and Design Guide Available from TI (COM8)
  - HCI Transport for *Bluetooth* over UART and SDIO for WLAN
  - Temperature Compensation Mechanism to Ensure Minimal Variation in RF Performance Over the Entire Temperature Range
  - Operating Temperature: –20°C to 70°C
  - Small Form Factor: 13.4 × 13.3 × 2 mm
  - Land Grid Array (LGA) Package
- **Wi-Fi**
  - WLAN Baseband Processor and RF Transceiver Supporting IEEE Std 802.11b, 802.11g, and 802.11n
  - 2.4-GHz MRC Support for Extended Range
  - Fully Calibrated System; Production Calibration not Required
  - Supports 4-Bit SDIO Host Interface, Including High-Speed (HS) and V3 Modes
  - 2x2 MIMO and 40-MHz Channels for High Throughput
  - Wi-Fi Direct Concurrent Operation (Multi-Channel, Multi-Role)
  - SmartConfig™ technology
- **Bluetooth-BLE (WL183xMOD Only)**
  - Support of *Bluetooth* 4.0 as well as CSA2
  - Includes Concurrent Operation and Built-In Coexisting and Prioritization Handling of *Bluetooth*-BLE and WLAN
  - Dedicated Audio Processor Supporting SBC Encoding + A2DP
  - Royalty-Free Certified Stack From StoneStreet One
- **Key Benefits**
  - Reduces Design Overhead: Single WiLink8 Module Scales Across Wi-Fi and *Bluetooth* (WL183xMOD)
  - *Bluetooth* 4.0 + BLE
  - Up to 100-Mbps Throughput and Up to 1.4X the Range Versus a Single Antenna Configuration With 2X2 MIMO, 40-MHz Channel Bandwidth and MRC
  - Differentiated Use-Cases by Configuring WiLink 8 in Two Different Roles (STA and AP) Simultaneously to Connect Directly With Other Wi-Fi Devices on Different RF Channel (Wi-Fi Networks)
  - SmartConfig technology, a One-Step Wi-Fi Setup Process That Allows Multiple In-Home Devices, Especially Those Without Displays or Keypads, to Connect to the Wi-Fi Network Quickly and Easily.
  - Lowest Wi-Fi Power Consumption in Connected Idle (< 800 uA)
  - Configurable Wake on WLAN Filters to Only Wake Up the System
  - Wi-Fi-*Bluetooth* Single Antenna Coexistence
  - Available as Easy to Use FCC, ETSI, and Telec Certified Module
  - Lower Manufacturing Costs, Saving Board Space and Minimizing RF Expertise
  - AM335x Linux® and Android™ Reference Platform Accelerates Customer Development and Time to Market

**PRODUCT PREVIEW**


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## 1.2 Applications

- Internet of Things
- Multimedia
- Home Electronics
- Home Appliances and White Goods
- Industrial and Home Automation
- Smart Gateway and Metering
- Video Conferencing
- Video Camera and Security

## 1.3 Description

Easily add Wi-Fi and *Bluetooth* (WL183x module only) to embedded applications based on TI's Sitara microprocessors. TI's WiLink 8 modules are pre-certified and offer high throughput and extended range along with Wi-Fi and *Bluetooth* coexistence (WL183x modules only) in a power-optimized design. Drivers for the Linux and Android high-level operating systems (HLOSs) are available free of charge from TI for the Sitara AM335x microprocessor (Linux and Android version restrictions apply).

**Table 1-1. TI WiLink8 Module Device Variants**

| Device    | WLAN 2.4-GHz SISO <sup>(1)</sup> | WLAN 2.4-GHz MIMO <sup>(1)</sup> | WLAN 2.4-GHz MRC <sup>(1)</sup> | <i>Bluetooth</i> |
|-----------|----------------------------------|----------------------------------|---------------------------------|------------------|
| WL1835MOD | √                                | √                                | √                               | √                |
| WL1831MOD | √                                |                                  |                                 | √                |
| WL1805MOD | √                                | √                                | √                               |                  |
| WL1801MOD | √                                |                                  |                                 |                  |

(1) SISO: single input, single output; MIMO: multiple input, multiple output; MRC: maximum ratio combining.

Table 1-2 lists the WLAN performance parameters.

**Table 1-2. WLAN Performance Parameters**

| WLAN                                  | Specification | Conditions                 |
|---------------------------------------|---------------|----------------------------|
| Maximum TX power <sup>(1)</sup>       | 18.1 dBm      | 1 Mbps DSSS                |
| Minimum TX sensitivity <sup>(1)</sup> | –97.1 dBm     | 1 Mbps DSSS                |
| Sleep current                         | 154 $\mu$ A   | Leakage, firmware retained |
| Connected IDLE                        | 712 $\mu$ A   | No traffic IDLE connect    |
| RX search                             | 48 mA         | Search (SISO20)            |
| RX current (SISO20)                   | 67 mA         | MCS7, 2.4 GHz              |
| TX current (SISO20)                   | 238 mA        | MCS7, 2.4 GHz, +13.7 dBm   |

(1) All RF measurements are preliminary data sheet product preview and can be revised at the module CZ end.

Table 1-3 lists the *Bluetooth* performance parameters.

**Table 1-3. Bluetooth Performance Parameters**

| <i>Bluetooth</i>                      | Specification | Conditions                                      |
|---------------------------------------|---------------|-------------------------------------------------|
| Maximum TX power <sup>(1)</sup>       | 13.5 dBm      | GFSK                                            |
| Minimum TX sensitivity <sup>(1)</sup> | –93 dBm       | GFSK                                            |
| Sniff                                 | 178 $\mu$ A   | 1 attempt, 1.28 s (+4 dBm)                      |
| Page or inquiry                       | 253 $\mu$ A   | 1.28-s interrupt, 11.25-ms scan window (+4 dBm) |
| A2DP                                  | 7.5 mA        | MP3 high quality 192 kbps (+4 dBm)              |

(1) All RF measurements are preliminary data sheet product preview and can be revised at the module CZ end.

## 1.4 Functional Block Diagram

Figure 1-1 shows a high-level view of the WL1835 module. The flexibility of the device enables easy integration with various host-system topologies. For more information on TI's wireless platform solutions, go to the [TI Wiki](#).

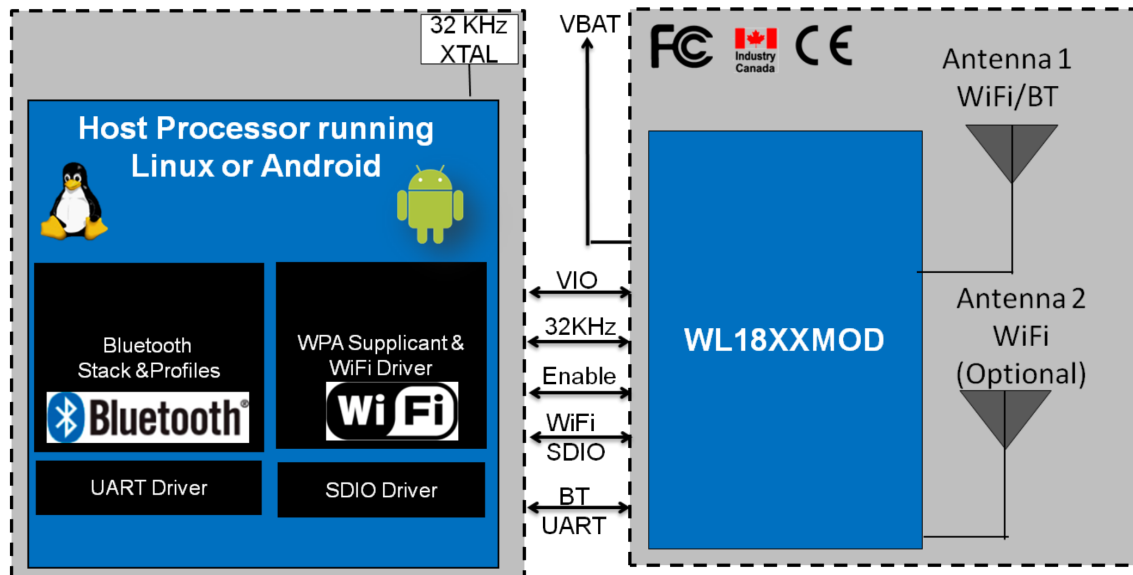


Figure 1-1. WL1835 High-Level System Diagram

Figure 1-2 shows the WL1835 functional block diagram.

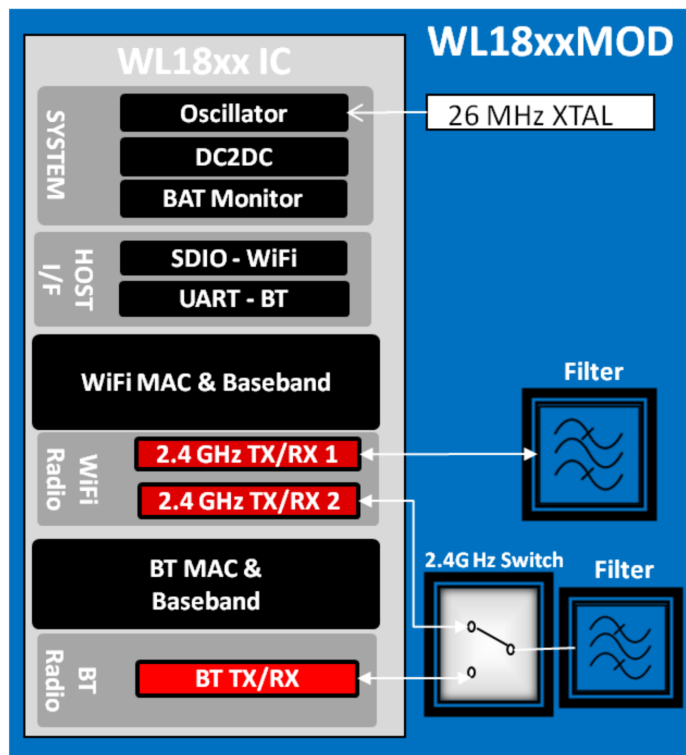


Figure 1-2. WL1835 Functional Block Diagram

|          |                                                                       |                           |           |                                                                          |                           |
|----------|-----------------------------------------------------------------------|---------------------------|-----------|--------------------------------------------------------------------------|---------------------------|
| <b>1</b> | <b>TI Module Summary</b>                                              | <b><a href="#">1</a></b>  | 4.16      | <i>Bluetooth</i> Modulation, EDR                                         | <a href="#">18</a>        |
| 1.1      | Features                                                              | <a href="#">1</a>         | 4.17      | <i>Bluetooth</i> BR, EDR Transceiver – Emissions                         | <a href="#">18</a>        |
| 1.2      | Applications                                                          | <a href="#">2</a>         | 4.18      | <i>Bluetooth</i> BR, EDR Transceiver – Spurs                             | <a href="#">19</a>        |
| 1.3      | Description                                                           | <a href="#">2</a>         | 4.19      | <i>Bluetooth</i> EDR Transceiver – Spurs                                 | <a href="#">19</a>        |
| 1.4      | Functional Block Diagram                                              | <a href="#">3</a>         | 4.20      | <i>Bluetooth</i> LE Performance                                          | <a href="#">20</a>        |
|          | <b>Revision History</b>                                               | <b><a href="#">4</a></b>  | 4.21      | <i>Bluetooth</i> LE Receiver Characteristics – In-Band Signals           | <a href="#">20</a>        |
| <b>2</b> | <b>Features</b>                                                       | <b><a href="#">5</a></b>  | 4.22      | <i>Bluetooth</i> LE Receiver Characteristics – General Blocking          | <a href="#">20</a>        |
| 2.1      | WLAN                                                                  | <a href="#">5</a>         | 4.23      | <i>Bluetooth</i> LE Transmitter Characteristics                          | <a href="#">21</a>        |
| 2.2      | <i>Bluetooth</i>                                                      | <a href="#">5</a>         | 4.24      | <i>Bluetooth</i> LE Modulation Characteristics                           | <a href="#">21</a>        |
| 2.3      | BLE                                                                   | <a href="#">5</a>         | 4.25      | <i>Bluetooth</i> -BLE Dynamic Currents                                   | <a href="#">21</a>        |
| <b>3</b> | <b>Package Information</b>                                            | <b><a href="#">6</a></b>  | 4.26      | <i>Bluetooth</i> LE Currents                                             | <a href="#">22</a>        |
| 3.1      | Module Outline                                                        | <a href="#">6</a>         | 4.27      | Shutdown and Sleep Currents                                              | <a href="#">22</a>        |
| 3.2      | Pin Description                                                       | <a href="#">7</a>         | <b>5</b>  | <b>Host Interface Timing Characteristics</b>                             | <b><a href="#">22</a></b> |
| <b>4</b> | <b>Module Specifications</b>                                          | <b><a href="#">11</a></b> | 5.1       | WLAN SDIO Transport Layer                                                | <a href="#">22</a>        |
| 4.1      | General Requirements and Operation                                    | <a href="#">11</a>        | 5.2       | HCI UART Shared Transport Layers for All Functional Blocks (Except WLAN) | <a href="#">25</a>        |
| 4.2      | Absolute Maximum Ratings                                              | <a href="#">11</a>        | 5.3       | <i>Bluetooth</i> Codec-PCM (Audio) Timing Specifications                 | <a href="#">26</a>        |
| 4.3      | Recommended Operating Conditions                                      | <a href="#">11</a>        | <b>6</b>  | <b>Clocks and Power Management</b>                                       | <b><a href="#">28</a></b> |
| 4.4      | External Digital Slow Clock Requirements                              | <a href="#">12</a>        | 6.1       | Reset-Power-Up System                                                    | <a href="#">28</a>        |
| 4.5      | WLAN Performance                                                      | <a href="#">13</a>        | 6.2       | WLAN Power-Up Sequence                                                   | <a href="#">28</a>        |
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| 4.7      | WLAN 2.4-GHz Transmitter Power                                        | <a href="#">14</a>        | <b>7</b>  | <b>Reference Schematics and Bill of Materials</b>                        | <b><a href="#">29</a></b> |
| 4.8      | WLAN Currents                                                         | <a href="#">15</a>        | 7.1       | TI Module Reference Design                                               | <a href="#">29</a>        |
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| 4.15     | <i>Bluetooth</i> Modulation, BR                                       | <a href="#">18</a>        |           |                                                                          |                           |

## Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision E (September 2013) to Revision F                                            | Page              |
|---------------------------------------------------------------------------------------------------|-------------------|
| <ul style="list-style-type: none"> <li>Deleted reference to IEEE Std 802.1x compliance</li> </ul> | <a href="#">5</a> |

## 2 Features

### 2.1 WLAN

The device supports the following WLAN features:

- Integrated 2.4-GHz power amplifiers (PAs) for a complete WLAN solution
- Baseband processor: IEEE Std 802.11b/g data rates and IEEE Std 802.11n data rates with 20- or 40-MHz SISO and 20-MHz MIMO
- Fully calibrated system (production calibration not required)
- Medium access controller (MAC)
  - Embedded ARM® central processing unit (CPU)
  - Hardware-based encryption-decryption using 64-, 128-, and 256-bit WEP, TKIP, or AES keys
  - Requirements for Wi-Fi-protected access (WPA and WPA2.0) and IEEE Std 802.11i (includes hardware-accelerated Advanced Encryption Standard [AES])
- New advanced coexistence scheme with *Bluetooth*-BLE
- 2.4-GHz radio
  - Internal LNA and PA
  - IEEE Std 802.11b, 802.11g, and 802.11n
- 4-bit SDIO host interface, including high speed (HS) and V3 modes

### 2.2 Bluetooth

The device supports the following *Bluetooth* features:

- *Bluetooth* 4.0 as well as CSA2
- Concurrent operation and built-in coexisting and prioritization handling of *Bluetooth*, BLE, audio processing, and WLAN
- Dedicated audio processor supporting on-chip SBC encoding + A2DP
  - Assisted A2DP (A3DP): SBC encoding implemented internally
  - Assisted WB-speech (AWBS): modified SBC codec implemented internally

### 2.3 BLE

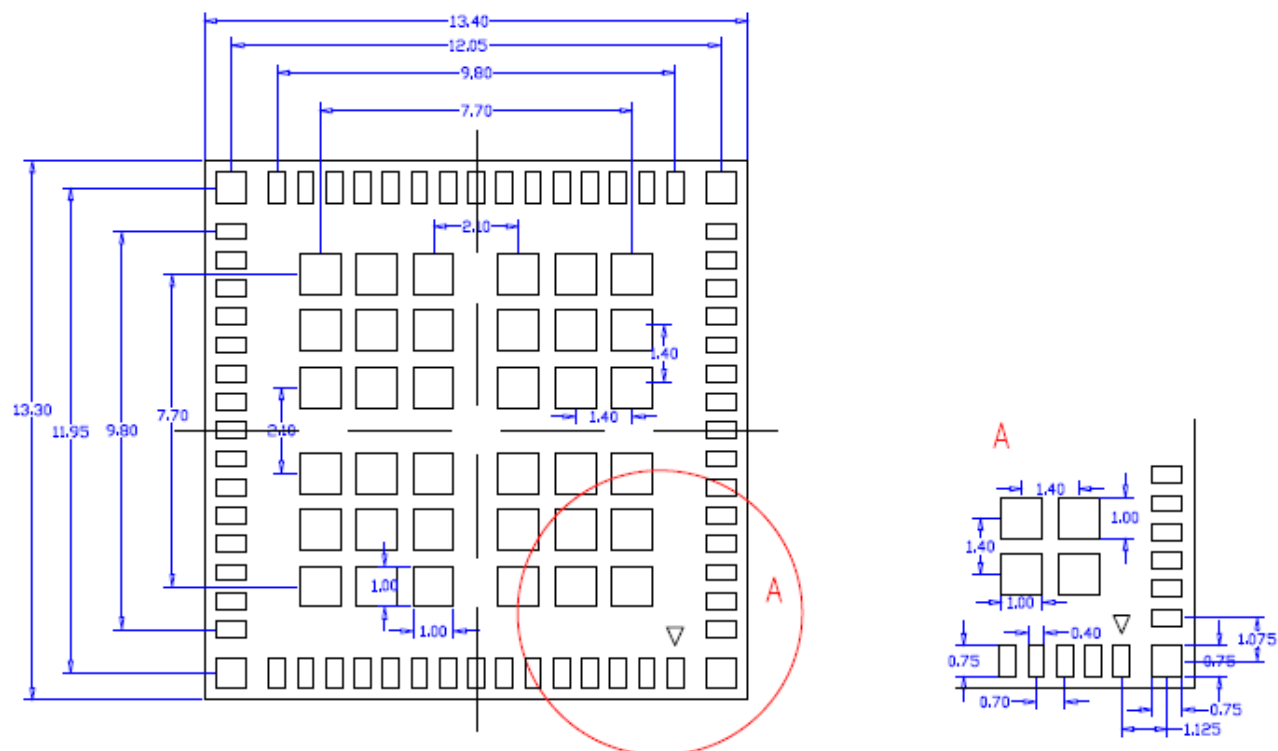
The device supports the following BLE features:

- *Bluetooth* 4.0 BLE dual-mode standard
- All roles and role combinations, mandatory as well as optional
- Up to 10 BLE connections
- Independent buffering for LE allowing a large number of multiple connections without affecting BR-EDR performance

### 3 Package Information

#### 3.1 Module Outline

Figure 3-1 shows the device outline.



Bottom View

Module Size: 13.4x13.3mm

PAD Size: 0.75x0.4mm

Pitch: 0.7mm

**Figure 3-1. Module Outline**

## 3.2 Pin Description

Figure 3-2 shows the device pin designations.

WL1835MOD

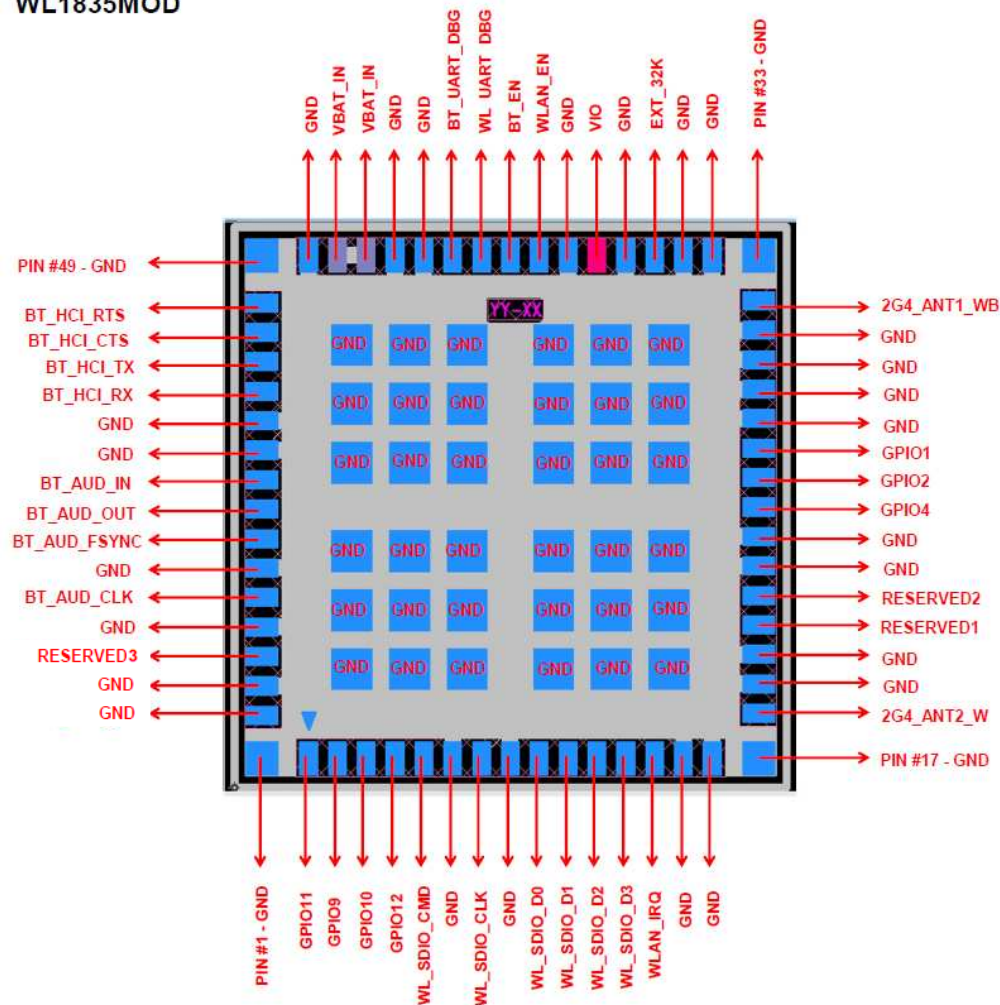


Figure 3-2. Pin Designations

Table 3-1 describes the device pins.

PRODUCT PREVIEW

Table 3-1. Pin Description

| WL183x Pin Name | Pin | Type/<br>Dir | Shutdown<br>State | After<br>Power<br>Up <sup>(1)</sup> | Voltage<br>Level | Connectivity <sup>(2)</sup> |      |      |      | Description                                                                                                                                   |
|-----------------|-----|--------------|-------------------|-------------------------------------|------------------|-----------------------------|------|------|------|-----------------------------------------------------------------------------------------------------------------------------------------------|
|                 |     |              |                   |                                     |                  | 1801                        | 1805 | 1831 | 1835 |                                                                                                                                               |
| GND             | 1   | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                                                                                                               |
| GPIO11          | 2   | I/O          | PU                | PU                                  | –                | v                           | v    | v    | v    | Reserved for future use. NC if not used.                                                                                                      |
| GPIO9           | 3   | I/O          | PU                | PU                                  | –                | v                           | v    | v    | v    | Reserved for future use. NC if not used.                                                                                                      |
| GPIO10          | 4   | I/O          | PU                | PU                                  | –                | v                           | v    | v    | v    | Reserved for future use. NC if not used.                                                                                                      |
| GPIO12          | 5   | I/O          | PU                | PU                                  | –                | v                           | v    | v    | v    | Reserved for future use. NC if not used.                                                                                                      |
| WL_SDIO_CMD_1V8 | 6   | IN           | Hi-Z              | Hi-Z                                | 1.8 V            | v                           | v    | v    | v    | WLAN SDIO command in <sup>(3)</sup>                                                                                                           |
| GND             | 7   | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                                                                                                               |
| WL_SDIO_CLK_1V8 | 8   | IN           | Hi-Z              | Hi-Z                                | 1.8 V            | v                           | v    | v    | v    | WLAN SDIO clock. Must be driven by the host.                                                                                                  |
| GND             | 9   | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                                                                                                               |
| WL_SDIO_D0_1V8  | 10  | IO           | Hi-Z              | Hi-Z                                | 1.8 V            | v                           | v    | v    | v    | WLAN SDIO data bit 0 <sup>(3)</sup>                                                                                                           |
| WL_SDIO_D1_1V8  | 11  | IO           | Hi-Z              | Hi-Z                                | 1.8 V            | v                           | v    | v    | v    | WLAN SDIO data bit 1 <sup>(3)</sup>                                                                                                           |
| WL_SDIO_D2_1V8  | 12  | IO           | Hi-Z              | Hi-Z                                | 1.8 V            | v                           | v    | v    | v    | WLAN SDIO data bit 2 <sup>(3)</sup>                                                                                                           |
| WL_SDIO_D3_1V8  | 13  | IO           | Hi-Z              | PU                                  | 1.8 V            | v                           | v    | v    | v    | WLAN SDIO data bit 3. Changes state to PU at WL_EN or BT_EN assertion for card detects. Later disabled by software during initialization. (1) |
| WL_IRQ_1V8      | 14  | OUT          | PD                | 0                                   | 1.8 V            | v                           | v    | v    | v    | SDIO available, interrupt out. Active high. (For WL_RS232_TX/RX pull up is at power up.)                                                      |
| GND             | 15  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                                                                                                               |
| GND             | 16  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                                                                                                               |
| GND             | 17  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                                                                                                               |
| 2G4_ANT2_W      | 18  | ANA          |                   |                                     | –                | x                           | v    | x    | v    | 2.4G ant2 TX, RX                                                                                                                              |
| GND             | 19  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                                                                                                               |
| GND             | 20  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                                                                                                               |
| RESERVED1       | 21  | In           | PD                | PD                                  | –                | x                           | x    | x    | x    | Reserved for future use. NC if not used.                                                                                                      |
| RESERVED2       | 22  | In           | PD                | PD                                  | –                | x                           | x    | x    | x    | Reserved for future use. NC if not used.                                                                                                      |
| GND             | 23  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                                                                                                               |
| GND             | 24  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                                                                                                               |
| GPIO_4          | 25  | I/O          | PD                | PD                                  | –                | v                           | v    | v    | v    | Reserved for future use. NC if not used.                                                                                                      |

(1) PU = pull up; PD = pull down.

(2) v = connect; x = no connect.

(3) Host must provide PU using a 10-K resistor for all non-CLK SDIO signals.

**Table 3-1. Pin Description (continued)**

| WL183x Pin Name | Pin | Type/<br>Dir | Shutdown<br>State | After<br>Power<br>Up <sup>(1)</sup> | Voltage<br>Level | Connectivity <sup>(2)</sup> |      |      |      | Description                                            |
|-----------------|-----|--------------|-------------------|-------------------------------------|------------------|-----------------------------|------|------|------|--------------------------------------------------------|
|                 |     |              |                   |                                     |                  | 1801                        | 1805 | 1831 | 1835 |                                                        |
| GPIO_2          | 26  | I/O          | PD                | PD                                  | –                | v                           | v    | v    | v    | WL_RS232_RX<br>(when IRQ_WL = 1 at<br>power up)        |
| GPIO_1          | 27  | I/O          | PD                | PD                                  | –                | v                           | v    | v    | v    | WL_RS232_TX<br>(when IRQ_WL = 1 at<br>power up)        |
| GND             | 28  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| GND             | 29  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| GND             | 30  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| GND             | 31  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| 2G4_ANT1_WB     | 32  | ANA          |                   |                                     | –                | v                           | v    | v    | v    | 2.4G ant1 TX, RX                                       |
| GND             | 33  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| GND             | 34  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| GND             | 35  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| EXT_32K         | 36  | ANA          |                   |                                     | –                | v                           | v    | v    | v    | Input sleep clock:<br>32.768 kHz                       |
| GND             | 37  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| VIO_IN          | 38  | POW          | PD                | PD                                  | 1.8 V            | v                           | v    | v    | v    | Connect to 1.8-V<br>external VIO                       |
| GND             | 39  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| WLAN_EN         | 40  | In           | PD                | PD                                  | –                | v                           | v    | v    | v    | Mode setting: high =<br>enable                         |
| BT_EN           | 41  | In           | PD                | PD                                  | –                | x                           | x    | v    | v    | Mode setting: high =<br>enable                         |
| WL_UART_DBG     | 42  | Out          | PU                | PU                                  | –                | v                           | v    | v    | v    | Option: WLAN logger                                    |
| BT_UART_DBG     | 43  | Out          | PU                | PU                                  | –                | x                           | x    | v    | v    | Option: Bluetooth<br>logger                            |
| GND             | 44  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| GND             | 45  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| VBAT_IN         | 46  | POW          |                   |                                     | VBAT             | v                           | v    | v    | v    | Power supply input,<br>2.9 to 4.8 V                    |
| VBAT_IN         | 47  | POW          |                   |                                     | VBAT             | v                           | v    | v    | v    | Power supply input,<br>2.9 to 4.8 V                    |
| GND             | 48  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| GND             | 49  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| BT_HCI_RTS_1V8  | 50  | Out          | PU                | PU                                  | 1.8 V            | x                           | x    | v    | v    | UART RTS to host.<br>NC if not used.                   |
| BT_HCI_CTS_1V8  | 51  | In           | PU                | PU                                  | 1.8 V            | x                           | x    | v    | v    | UART CTS from<br>host. NC if not used.                 |
| BT_HCI_TX_1V8   | 52  | Out          | PU                | PU                                  | 1.8 V            | x                           | x    | v    | v    | UART TX to host. NC<br>if not used.                    |
| BT_HCI_RX_1V8   | 53  | In           | PU                | PU                                  | 1.8 V            | x                           | x    | v    | v    | UART RX from host.<br>NC if not used.                  |
| GND             | 54  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| GND             | 55  | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                        |
| BT_AUD_IN       | 56  | In           | PD                | PD                                  | 1.8 V            | x                           | x    | v    | v    | Bluetooth PCM/I2S<br>bus. Data in. NC if<br>not used.  |
| BT_AUD_OUT      | 57  | Out          | PD                | PD                                  | 1.8 V            | x                           | x    | v    | v    | Bluetooth PCM/I2S<br>bus. Data out. NC if<br>not used. |

Table 3-1. Pin Description (continued)

| WL183x Pin Name | Pin    | Type/<br>Dir | Shutdown<br>State | After<br>Power<br>Up <sup>(1)</sup> | Voltage<br>Level | Connectivity <sup>(2)</sup> |      |      |      | Description                                        |
|-----------------|--------|--------------|-------------------|-------------------------------------|------------------|-----------------------------|------|------|------|----------------------------------------------------|
|                 |        |              |                   |                                     |                  | 1801                        | 1805 | 1831 | 1835 |                                                    |
| BT_AUD_FSYNC    | 58     | Out          | PD                | PD                                  | 1.8 V            | x                           | x    | v    | v    | Bluetooth PCM/I2S bus. Frame sync. NC if not used. |
| GND             | 59     | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                    |
| BT_AUD_CLK      | 60     | Out          | PD                | PD                                  | 1.8 V            | x                           | x    | v    | v    | Bluetooth PCM/I2S bus. NC if not used.             |
| GND             | 61     | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                    |
| RESERVED3       | 62     | Out          | PD                | PD                                  | 1.8 V            | x                           | x    | x    | x    | Reserved for future use. NC if not used.           |
| GND             | 63     | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                    |
| GND             | 64     | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                    |
| GND             | G1-G36 | GND          |                   |                                     | –                | v                           | v    | v    | v    |                                                    |

## 4 Module Specifications

### 4.1 General Requirements and Operation

All specifications are over temperature and process, unless indicated otherwise.

### 4.2 Absolute Maximum Ratings<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

| Parameter                           |                                     | Value                      | Unit |
|-------------------------------------|-------------------------------------|----------------------------|------|
| VBAT                                |                                     | –0.5 to 5.5 <sup>(2)</sup> | V    |
| VIO                                 |                                     | –0.5 to 2.1                | V    |
| Input voltage to analog pins        |                                     | –0.5 to 2.1                | V    |
| Input voltage limits (CLK_IN)       |                                     | –0.5 to VDD_IO             | V    |
| Input voltage to all other pins     |                                     | –0.5 to (VDD_IO + 0.5 V)   | V    |
| Operating ambient temperature range |                                     | –20 to +70 <sup>(3)</sup>  | °C   |
| Storage temperature range           |                                     | –55 to +125                | °C   |
| ESD stress voltage <sup>(4)</sup>   | Human body model <sup>(5)</sup>     | >1000                      | V    |
|                                     | Charged device model <sup>(6)</sup> | >250                       | V    |

- (1) Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) 5.5 V up to 10 s cumulative in 7 years, 5 V cumulative to 250 s, 4.8 V cumulative to 2.33 years - all include charging dips and peaks.
- (3) Operating free-air temperature range. The device can be reliably operated for 7 years at ambient of 70°C, assuming 25% active mode and 75% sleep mode (15,400 cumulative active power-on hours).
- (4) Electrostatic discharge (ESD) to measure device sensitivity/immunity to damage caused by electrostatic discharges into device.
- (5) Level listed is the passing level per ANSI/ESDA/JEDEC JS-001. JEDEC document JEP155 states that 500 V HBM allows safe manufacturing with a standard ESD control process, and manufacturing with less than 500 V HBM is possible if necessary precautions are taken. Pins listed as 1000 V may actually have higher performance.
- (6) Level listed is the passing level per EIA-JEDEC JESD22-C101E. JEDEC document JEP157 states that 250 V CDM allows safe manufacturing with a standard ESD control process, and manufacturing with less than 250V CDM is possible if necessary precautions are taken. Pins listed as 250 V may actually have higher performance.

### 4.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

| Parameter                                                                                           | Condition                     | Sym                             | Min           | Max           | Unit |
|-----------------------------------------------------------------------------------------------------|-------------------------------|---------------------------------|---------------|---------------|------|
| VBAT <sup>(1)</sup>                                                                                 | DC supply range for all modes |                                 | 2.9           | 4.8           | V    |
| 1.8-V I/O ring power supply voltage                                                                 |                               |                                 | 1.62          | 1.95          | V    |
| I/O high-level input voltage                                                                        |                               | VIH                             | 0.65 x VDD_IO | VDD_IO        | V    |
| I/O low-level input voltage                                                                         |                               | VIL                             | 0             | 0.35 x VDD_IO | V    |
| Enable inputs high-level input voltage                                                              |                               | VIH_EN                          | 1.365         | VDD_IO        | V    |
| Enable inputs low-level input voltage                                                               |                               | VIL_EN                          | 0             | 0.4           | V    |
| High-level output voltage                                                                           | @ 4 mA                        | VOH                             | VDD_IO –0.45  | VDD_IO        | V    |
|                                                                                                     | @ 1 mA                        |                                 | VDD_IO –0.112 | VDD_IO        | V    |
|                                                                                                     | @ 0.3 mA                      |                                 | VDD_IO –0.033 | VDD_IO        | V    |
| Low-level output voltage                                                                            | @ 4 mA                        | VOL                             | 0             | 0.45          | V    |
|                                                                                                     | @ 1 mA                        |                                 | 0             | 0.112         | V    |
|                                                                                                     | @ 0.09 mA                     |                                 | 0             | 0.01          | V    |
| Input transitions time T <sub>r</sub> , T <sub>f</sub> from 10% to 90% (digital I/O) <sup>(2)</sup> |                               | T <sub>r</sub> , T <sub>f</sub> | 1             | 10            | ns   |
| Output rise time from 10% to 90% (digital pins) <sup>(2)</sup>                                      | CL < 25 pF                    | T <sub>r</sub>                  |               | 5.3           | ns   |

(1) 4.8 V is applicable only for 2.3 years (30% of the time). Otherwise, maximum VBAT must not exceed 4.3 V.

(2) Applies to all digital lines except SDIO, UART, I2C, PCM and slow clock lines

**Recommended Operating Conditions (continued)**

over operating free-air temperature range (unless otherwise noted)

| Parameter                                                      | Condition           | Sym            | Min | Max | Unit |
|----------------------------------------------------------------|---------------------|----------------|-----|-----|------|
| Output fall time from 10% to 90% (digital pins) <sup>(2)</sup> | CL < 25 pF          | T <sub>f</sub> |     | 4.9 | ns   |
| Ambient operating temperature                                  |                     |                | –40 | 85  | °C   |
| Maximum power dissipation                                      | WLAN operation      |                |     | 2.8 | W    |
|                                                                | Bluetooth operation |                |     | 0.2 | W    |

**4.4 External Digital Slow Clock Requirements**

The supported digital slow clock is 32.768 kHz digital. All core functions share a single input.

| Parameter                                                          | Condition               | Sym                             | Min           | Typ   | Max           | Unit              |
|--------------------------------------------------------------------|-------------------------|---------------------------------|---------------|-------|---------------|-------------------|
| Input slow clock frequency                                         |                         |                                 |               | 32768 |               | Hz                |
| Input slow clock accuracy (Initial + temp + aging)                 | WLAN                    |                                 |               |       | ±250          | ppm               |
| Input transition time T <sub>r</sub> , T <sub>f</sub> (10% to 90%) |                         | T <sub>r</sub> , T <sub>f</sub> |               |       | 100           | %                 |
| Frequency input duty cycle                                         |                         |                                 | 15            | 50    | 85            | %                 |
| Input voltage limits                                               | Square wave, DC-coupled | V <sub>ih</sub>                 | 0.65 × VDD_IO |       | VDD_IO        | V <sub>peak</sub> |
|                                                                    |                         | V <sub>il</sub>                 | 0             |       | 0.35 × VDD_IO |                   |
| Input impedance                                                    |                         |                                 | 1             |       |               | MΩ                |
| Input capacitance                                                  |                         |                                 |               |       | 5             | pF                |

## 4.5 WLAN Performance

All RF measurements refer to module output (preliminary data sheet product preview and can be revised at module CZ end).

## 4.6 WLAN 2.4-GHz Receiver Characteristics

over operating free-air temperature range (unless otherwise noted)

| Parameter                                                                                     | Condition             | Min  | Typ   | Max | Unit |
|-----------------------------------------------------------------------------------------------|-----------------------|------|-------|-----|------|
| Operation frequency range                                                                     | 2400 to 2480          |      |       |     | MHz  |
| Sensitivity: 20-MHz bandwidth. At < 10% PER limit                                             | 1 Mbps DSSS           |      | –97.1 |     | dBm  |
|                                                                                               | 2 Mbps DSSS           |      | –94.0 |     |      |
|                                                                                               | 5.5 Mbps CCK          |      | –91.4 |     |      |
|                                                                                               | 11 Mbps CCK           |      | –88.7 |     |      |
|                                                                                               | 6 Mbps OFDM           |      | –92.8 |     |      |
|                                                                                               | 9 Mbps OFDM           |      | –91.2 |     |      |
|                                                                                               | 12 Mbps OFDM          |      | –90.3 |     |      |
|                                                                                               | 18 Mbps OFDM          |      | –88.0 |     |      |
|                                                                                               | 24 Mbps OFDM          |      | –84.9 |     |      |
|                                                                                               | 36 Mbps OFDM          |      | –81.5 |     |      |
|                                                                                               | 48 Mbps OFDM          |      | –77.3 |     |      |
|                                                                                               | 54 Mbps OFDM          |      | –75.7 |     |      |
|                                                                                               | MCS0 MM 4K            |      | –91.2 |     |      |
|                                                                                               | MCS1 MM 4K            |      | –88.4 |     |      |
|                                                                                               | MCS2 MM 4K            |      | –86.7 |     |      |
|                                                                                               | MCS3 MM 4K            |      | –83.6 |     |      |
|                                                                                               | MCS4 MM 4K            |      | –80.2 |     |      |
|                                                                                               | MCS5 MM 4K            |      | –76.0 |     |      |
|                                                                                               | MCS6 MM 4K            |      | –74.3 |     |      |
|                                                                                               | MCS7 MM 4K            |      | –73.2 |     |      |
|                                                                                               | MCS32 MM 4K           |      | –88.5 |     |      |
|                                                                                               | MCS0 MM 4K 40 MHz     |      | –87.5 |     |      |
|                                                                                               | MCS7 MM 4K 40 MHz     |      | –69.6 |     |      |
|                                                                                               | MCS0 MM 4K MRC        |      | –93.5 |     |      |
|                                                                                               | MCS7 MM 4K MRC        |      | –76.0 |     |      |
|                                                                                               | MCS13 MM 4K           |      | –74.5 |     |      |
|                                                                                               | MCS14 MM 4K           |      | –73.1 |     |      |
|                                                                                               | MCS15 MM 4K           |      | –71.8 |     |      |
| Max Input Level At < 10% PER limit                                                            | OFDM (11g/n)          | –19  | –9    |     | dBm  |
|                                                                                               | CCK                   | –4   | –0    |     | dBm  |
| Adjacent channel rejection: Sensitivity level +3 dB for OFDM; Sensitivity level +6 dB for 11b | 2 Mbps DSSS           | 42.7 |       |     | dBm  |
|                                                                                               | 11 Mbps CCK           | 37.9 |       |     | dBm  |
|                                                                                               | 54 Mbps OFDM          | 2.0  |       |     | dBm  |
| LO leakage                                                                                    |                       |      | –80   |     | dBm  |
| PER floor                                                                                     |                       |      | 1.0   | 2.0 | %    |
| RSSI                                                                                          | Sensitivity ÷ –50 dBm |      |       | ±2  | dB   |
|                                                                                               | –50 dBm ÷ –20 dBm     |      |       | ±3  | dB   |

#### 4.7 WLAN 2.4-GHz Transmitter Power

| Parameter                                                                                             | Condition      | RF_IO2_BG_WL pin 2.4-GHz SISO |                                          |      | Unit |  |
|-------------------------------------------------------------------------------------------------------|----------------|-------------------------------|------------------------------------------|------|------|--|
|                                                                                                       |                | Min                           | Typ                                      | Max  |      |  |
| Output Power:<br>Maximum RMS<br>output power<br>measured at 1 dB<br>from IEEE spectral<br>mask or EVM | 1 Mbps DSSS    |                               | 18.1                                     |      | dBm  |  |
|                                                                                                       | 2 Mbps DSSS    |                               | 18.1                                     |      |      |  |
|                                                                                                       | 5.5 Mbps CCK   |                               | 18.1                                     |      |      |  |
|                                                                                                       | 11 Mbps CCK    |                               | 18.1                                     |      |      |  |
|                                                                                                       | 6 Mbps OFDM    |                               | 17.9                                     |      |      |  |
|                                                                                                       | 9 Mbps OFDM    |                               | 17.9                                     |      |      |  |
|                                                                                                       | 12 Mbps OFDM   |                               | 17.9                                     |      |      |  |
|                                                                                                       | 18 Mbps OFDM   |                               | 17.9                                     |      |      |  |
|                                                                                                       | 24 Mbps OFDM   |                               | 17.0                                     |      |      |  |
|                                                                                                       | 36 Mbps OFDM   |                               | 16.1                                     |      |      |  |
|                                                                                                       | 48 Mbps OFDM   |                               | 15.4                                     |      |      |  |
|                                                                                                       | 54 Mbps OFDM   |                               | 14.6                                     |      |      |  |
|                                                                                                       | MCS0 MM        |                               | 16.9                                     |      |      |  |
|                                                                                                       | MCS1 MM        |                               | 16.9                                     |      |      |  |
|                                                                                                       | MCS2 MM        |                               | 16.9                                     |      |      |  |
|                                                                                                       | MCS3 MM        |                               | 16.9                                     |      |      |  |
|                                                                                                       | MCS4 MM        |                               | 16.1                                     |      |      |  |
|                                                                                                       | MCS5 MM        |                               | 15.4                                     |      |      |  |
|                                                                                                       | MCS6 MM        |                               | 14.6                                     |      |      |  |
|                                                                                                       | MCS7 MM        |                               | 13.4                                     |      |      |  |
|                                                                                                       | MCS0 MM 40 MHz |                               | 15.6                                     |      |      |  |
|                                                                                                       | MCS7 MM 40 MHz |                               | 13.0                                     |      |      |  |
|                                                                                                       |                | Condition                     | RF_IO1_BG_WL + RF_IO2_BG_WL 2.4-GHz MIMO |      |      |  |
|                                                                                                       |                |                               | Min                                      | Typ  | Max  |  |
|                                                                                                       |                | MCS12 (WL18x5)                |                                          | 19.3 |      |  |
|                                                                                                       |                | MCS13 (WL18x5)                |                                          | 18.2 |      |  |
|                                                                                                       |                | MCS14 (WL18x5)                |                                          | 17.3 |      |  |
|                                                                                                       |                | MCS15 (WL18x5) <sup>(1)</sup> |                                          | 16.4 |      |  |
|                                                                                                       | Condition      | RF_IO1/2_BG_WL Pins           |                                          |      | Unit |  |
|                                                                                                       |                | Min                           | Typ                                      | Max  |      |  |
| Output power accuracy                                                                                 |                | −1.5                          |                                          | +1.5 | dB   |  |
| Output power resolution                                                                               |                |                               | 0.125                                    |      | dB   |  |
| Operation frequency range                                                                             | 2412 to 2484   |                               |                                          |      | MHz  |  |
| Return loss                                                                                           |                |                               | −10.0                                    |      | dB   |  |
| Reference input impedance                                                                             |                |                               | 50.0                                     |      | Ω    |  |

(1) MIMO MCS15 until 65 °C

## 4.8 WLAN Currents

|             | Specifications Items                  | Typ (avg) – 25°C | Units |
|-------------|---------------------------------------|------------------|-------|
| LPM         | 2.4 GHz RX LPM                        | 43               | mA    |
| Receiver    | 2.4 GHz RX search SISO20              | 48               | mA    |
|             | 2.4 GHz RX search MIMO20              | 68               | mA    |
|             | 2.4 GHz RX search SISO40              | 53               | mA    |
|             | 5 GHz RX search SISO20                | 54               | mA    |
|             | 5 GHz RX search SISO40                | 58               | mA    |
|             | 2.4 GHz RX 20 M SISO 11 CCK           | 50               | mA    |
|             | 2.4 GHz RX 20 M SISO 6 OFDM           | 55               | mA    |
|             | 2.4 GHz RX 20 M SISO MCS7             | 59               | mA    |
|             | 2.4 GHz RX 20 M MRC 1 DSSS            | 68               | mA    |
|             | 2.4 GHz RX 20 M MRC 6 OFDM            | 75               | mA    |
|             | 2.4 GHz RX 20 M MRC 54 OFDM           | 79               | mA    |
|             | 2.4 GHz RX 40 MHz MCS7                | 71               | mA    |
|             | 5 GHz RX 20 MHz OFDM6                 | 62               | mA    |
|             | 5 GHz RX 20 MHz MCS7                  | 67               | mA    |
|             | 5 GHz RX 40 MHz MCS7                  | 79               | mA    |
| Transmitter | 2.4 GHz TX 20 M SISO 6 OFDM 18.2 dBm  | 285              | mA    |
|             | 2.4 GHz TX 20 M SISO 11 CCK 18.2 dBm  | 273              | mA    |
|             | 2.4 GHz TX 20 M SISO 54 OFDM 15.5 dBm | 247              | mA    |
|             | 2.4 GHz TX 20 M SISO MCS7 14 dBm      | 238              | mA    |
|             | 2.4 GHz TX 20 M MIMO MCS15 11 dBm     | 420              | mA    |
|             | 2.4 GHz TX 40 M SISO MCS7 11 dBm      | 243              | mA    |
|             | 5 GHz TX 20 M SISO 6 OFDM 18.2 dBm    | 366              | mA    |
|             | 5 GHz TX 20 M SISO 54 OFDM 15.5 dBm   | 329              | mA    |
|             | 5 GHz TX 20 M SISO MCS7 14 dBm        | 324              | mA    |
|             | 5 GHz TX 40 M SISO MCS7 11 dBm        | 332              | mA    |

## 4.9 Bluetooth Performance

### 4.10 Bluetooth BR, EDR Receiver Characteristics—In-Band Signals

over operating free-air temperature range (unless otherwise noted)

| Parameter                                                                           | Condition         | Min  | Typ   | Max  | Bluetooth Specification | Unit |
|-------------------------------------------------------------------------------------|-------------------|------|-------|------|-------------------------|------|
| Bluetooth BR, EDR operation frequency range                                         |                   | 2402 |       | 2480 |                         | MHz  |
| Bluetooth BR, EDR channel spacing                                                   |                   |      | 1     |      |                         | MHz  |
| Bluetooth BR, EDR input impedance                                                   |                   |      | 50    |      |                         | Ω    |
| Bluetooth BR, EDR sensitivity <sup>(1)</sup><br>Dirty TX on                         | BR, BER = 0.1%    |      | –93.0 |      | –70.0                   | dBm  |
|                                                                                     | EDR2, BER = 0.01% |      | –92.5 |      | –70.0                   | dBm  |
|                                                                                     | EDR3, BER = 0.01% |      | –85.5 |      | –70.0                   | dBm  |
| Bluetooth EDR BER floor at sensitivity + 10 dB<br>Dirty TX off (for 1,600,000 bits) | EDR2              | 1e-6 |       |      | 1e-5                    |      |
|                                                                                     | EDR3              | 1e-6 |       |      | 1e-5                    |      |

(1) Sensitivity degradation up to –3 dB may occur due to fast clock harmonics with dirty TX on.

**Bluetooth BR, EDR Receiver Characteristics—In-Band Signals (continued)**

over operating free-air temperature range (unless otherwise noted)

| Parameter                                                                                                                                                                | Condition                                | Min   | Typ   | Max | Bluetooth Specification | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|-------|-------|-----|-------------------------|------|
| Bluetooth BR, EDR maximum useable input power                                                                                                                            | BR, BER = 0.1%                           | –5.0  |       |     | –20.0                   | dBm  |
|                                                                                                                                                                          | EDR2, BER = 0.1%                         | –10.0 |       |     | –20.0                   | dBm  |
|                                                                                                                                                                          | EDR3, BER = 0.1%                         | –10.0 |       |     | –20.0                   | dBm  |
| Bluetooth BR intermodulation                                                                                                                                             | Level of interferers for n = 3, 4, and 5 | –36.0 | –30.0 |     | –39.0                   | dBm  |
| Bluetooth BR, EDR C/I performance<br>Numbers show wanted signal-to-interfering-signal ratio. Smaller numbers indicate better C/I performances (Image frequency = –1 MHz) | BR, co-channel                           |       | 8.0   |     | 11.0                    | dB   |
|                                                                                                                                                                          | EDR, co-channel                          | EDR2  | 9.5   |     | 13.0                    | dB   |
|                                                                                                                                                                          |                                          | EDR3  | 16.5  |     | 21.0                    | dB   |
|                                                                                                                                                                          | BR, adjacent ±1 MHz                      |       | –10.0 |     | 0.0                     | dB   |
|                                                                                                                                                                          | EDR, adjacent ±1 MHz, (image)            | EDR2  | –10.0 |     | 0.0                     | dB   |
|                                                                                                                                                                          |                                          | EDR3  | –5.0  |     | 5.0                     | dB   |
|                                                                                                                                                                          | BR, adjacent +2 MHz                      |       | –38.0 |     | –30.0                   | dB   |
|                                                                                                                                                                          | EDR, adjacent +2 MHz                     | EDR2  | –38.0 |     | –30.0                   | dB   |
|                                                                                                                                                                          |                                          | EDR3  | –38.0 |     | –25.0                   | dB   |
|                                                                                                                                                                          | BR, adjacent –2 MHz                      |       | –28.0 |     | –20.0                   | dB   |
|                                                                                                                                                                          | EDR, adjacent –2 MHz                     | EDR2  | –28.0 |     | –20.0                   | dB   |
|                                                                                                                                                                          |                                          | EDR3  | –22.0 |     | –13.0                   | dB   |
|                                                                                                                                                                          | BR, adjacent ≥ ±3  MHz                   |       | –45.0 |     | –40.0                   | dB   |
|                                                                                                                                                                          | EDR, adjacent ≥ ±3  MHz                  | EDR2  | –45.0 |     | –40.0                   | dB   |
|                                                                                                                                                                          |                                          | EDR3  | –44.0 |     | –33.0                   | dB   |
| Bluetooth BR, EDR RF return loss                                                                                                                                         |                                          |       | –10.0 |     |                         | dB   |

**4.11 Bluetooth Receiver Characteristics – General Blocking**

over operating free-air temperature range (unless otherwise noted)

| Parameter                                                                                 | Condition        | Min | Typ | Bluetooth Specification | Unit |
|-------------------------------------------------------------------------------------------|------------------|-----|-----|-------------------------|------|
| Blocking performance over full range, according to Bluetooth specification <sup>(1)</sup> | 30 to 2000 MHz   | –6  |     | –10                     | dBm  |
|                                                                                           | 2000 to 2399 MHz | –6  |     | –27                     | dBm  |
|                                                                                           | 2484 to 3000 MHz | –6  |     | –27                     | dBm  |
|                                                                                           | 3 to 12.75 GHz   | –6  |     | –10                     | dBm  |

(1) Exceptions taken out of the total 24 allowed in the Bluetooth specification.

## 4.12 Bluetooth Receiver Characteristics – BR, EDR Blocking per Band

over operating free-air temperature range (unless otherwise noted)

| Parameter                                                                                                                                                                                                          | Band                                       | Min | Typ | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-----|-----|------|
| Blocking performance for various cellular bands Hopping on.<br>Wanted signal: –3 dB from sensitivity, with modulated continuous blocking signal.<br>BER = 0.1% for Bluetooth BR, 0.01% for Bluetooth EDR. PER = 1% | 776 to 794 MHz (CDMA)                      |     | –12 | dBm  |
|                                                                                                                                                                                                                    | 824 to 849 MHz (GMSK) <sup>(1)</sup>       |     | –3  |      |
|                                                                                                                                                                                                                    | 824 to 849 MHz (EDGE) <sup>(1)</sup>       |     | –11 |      |
|                                                                                                                                                                                                                    | 824 to 849 MHz (CDMA, QPSK) <sup>(1)</sup> |     | –12 |      |
|                                                                                                                                                                                                                    | 880 to 915 MHz (GMSK)                      |     | –14 |      |
|                                                                                                                                                                                                                    | 880 to 915 MHz (EDGE)                      |     | –15 |      |
|                                                                                                                                                                                                                    | 1710 to 1785 MHz (GMSK)                    |     | –4  |      |
|                                                                                                                                                                                                                    | 1710 to 1785 MHz (EDGE)                    |     | –18 |      |
|                                                                                                                                                                                                                    | 1850 to 1910 MHz (GMSK)                    |     | –18 |      |
|                                                                                                                                                                                                                    | 1850 to 1910 MHz (EDGE)                    |     | –20 |      |
|                                                                                                                                                                                                                    | 1850 to 1910 MHz (CDMA, QPSK)              |     | –20 |      |
|                                                                                                                                                                                                                    | 1850 to 1910 MHz (WCDMA, QPSK)             |     | –16 |      |
|                                                                                                                                                                                                                    | 1920 to 1980 MHz (WCDMA, QPSK)             |     | –17 |      |

(1) Except for frequencies in which  $[3 \times F\_BLOCKER]$  falls within the Bluetooth band (2400 to 2483.5 MHz)

## 4.13 Bluetooth Transmitter, BR

over operating free-air temperature range (unless otherwise noted)

| Parameter                                   | Min        | Typ   | Max | Bluetooth Specification | Unit |
|---------------------------------------------|------------|-------|-----|-------------------------|------|
| BR RF output power <sup>(1)</sup>           | VBAT ≥ 3 V | 13.5  |     |                         | dBm  |
|                                             | VBAT < 3 V | 8.0   |     |                         | dBm  |
| BR gain control range                       |            | 30.0  |     |                         | dB   |
| BR power control step                       |            | 5.0   |     | 2 to 8                  | dB   |
| BR adjacent channel power $ M-N  = 2^{(2)}$ |            | –43.0 |     | ≤ –20                   | dBm  |
| BR adjacent channel power $ M-N  > 2^{(2)}$ |            | –48.0 |     | ≤ –40                   | dBm  |

(1) Values reflect maximum power. Reduced power is available using a vendor-specific (VS) command.

(2) Assumes 3-dB insertion loss on external filter and traces

## 4.14 Bluetooth Transmitter, EDR

over operating free-air temperature range (unless otherwise noted)

| Parameter                                    | Min        | Typ | Max | Bluetooth Specification | Unit |
|----------------------------------------------|------------|-----|-----|-------------------------|------|
| EDR output power <sup>(1)</sup>              | Vbat ≥ 3 V | 8   |     |                         | dBm  |
|                                              | Vbat < 3 V | 6   |     |                         |      |
| EDR relative power                           | –2         |     | 1   | –4 to +1                | dB   |
| EDR gain control range                       |            | 30  |     |                         | dB   |
| EDR power control step                       |            | 5   |     | 2 to 8                  | dB   |
| EDR adjacent channel power $ M-N  = 1^{(2)}$ |            | –36 |     | ≤ –26                   | dBc  |
| EDR adjacent channel power $ M-N  = 2^{(2)}$ |            | –30 | –   | ≤ –20                   | dBm  |
| EDR adjacent channel power $ M-N  > 2^{(2)}$ |            | –42 | –   | ≤ –40                   | dBm  |

(1) Values reflect default maximum power. Max power can be changed using a VS command.

(2) Assumes 3-dB insertion loss on external filter and traces

#### 4.15 Bluetooth Modulation, BR

over operating free-air temperature range (unless otherwise noted)

| Characteristics                                          | Condition <sup>(1)</sup>                                 |                                                  | Performances |     |     | Bluetooth Specification | Units     |
|----------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------|--------------|-----|-----|-------------------------|-----------|
|                                                          |                                                          |                                                  | Min          | Typ | Max |                         |           |
| BR –20 dB Bandwidth                                      |                                                          |                                                  |              | 925 | 995 | ≤1000                   | kHz       |
| BR modulation characteristics                            | Δf1avg                                                   | Mod data = 4<br>1s, 4 0s:<br>111100001111..<br>. |              | 160 |     | 140 to 175              | kHz       |
|                                                          | Δf2max ≥ limit<br>for at least<br>99.9% of all<br>Δf2max | Mod data =<br>1010101...                         |              | 130 |     | > 115                   | kHz       |
|                                                          | Δf2avg/Δf1avg                                            |                                                  |              | 88  |     | > 80                    | %         |
| BR carrier frequency drift                               | One slot packet                                          |                                                  | –25          |     | 25  | < ±25                   | kHz       |
|                                                          | Three and five<br>slot packet                            |                                                  | –35          |     | 35  | < ±40                   | kHz       |
| BR drift rate                                            | lfk+5 – fkl, k =<br>0 .... max                           |                                                  |              |     | 15  | < 20                    | kHz/50 μs |
| BR initial carrier frequency<br>tolerance <sup>(2)</sup> | f0–fTX                                                   |                                                  | –25          |     | 25  | < ±75                   | kHz       |

(1) Performance values reflect maximum power.

(2) This number is added on top of the reference clock frequency accuracy.

#### 4.16 Bluetooth Modulation, EDR

over operating free-air temperature range (unless otherwise noted)

| Parameter <sup>(1)</sup>                                  | Condition | Min | Typ | Max | Bluetooth Specification | Unit |
|-----------------------------------------------------------|-----------|-----|-----|-----|-------------------------|------|
| EDR carrier frequency stability                           |           | –5  |     | 5   | ≤10                     | kHz  |
| EDR initial carrier frequency<br>tolerance <sup>(2)</sup> |           | –25 |     | 25  | ±75                     | kHz  |
| EDR RMS DEVM                                              | EDR2      |     | 4   |     | 20                      | %    |
|                                                           | EDR3      |     | 4   |     | 13                      | %    |
| EDR 99% DEVM                                              | EDR2      |     |     | 30  |                         | %    |
|                                                           | EDR3      |     |     | 20  |                         | %    |
| EDR peak DEVM                                             | EDR2      |     | 9   |     | 35                      | %    |
|                                                           | EDR3      |     | 9   |     | 25                      | %    |

(1) Performance values reflect maximum power.

(2) This number is added on top of the reference clock frequency accuracy.

#### 4.17 Bluetooth BR, EDR Transceiver – Emissions

over operating free-air temperature range (unless otherwise noted)

| Characteristics <sup>(1)</sup>    | Condition <sup>(2)</sup>       |         | Performances |      |     | Units  |
|-----------------------------------|--------------------------------|---------|--------------|------|-----|--------|
|                                   |                                |         | Min          | Typ  | Max |        |
| Bluetooth out-of-band<br>emission | 746 to 768 MHz (CDMA)          | BR, EDR |              | –151 |     | dBm/Hz |
|                                   | 869 to 894 MHz (WCDMA,<br>GSM) |         |              | –149 |     | dBm/Hz |
|                                   | 925 to 960 MHz (E-GSM)         |         |              | –148 |     | dBm/Hz |
|                                   | 1570 to 1580 MHz (GPS)         |         |              | –145 |     | dBm/Hz |

(1) Meets FCC and ETSI requirements with a suitable external filter

(2) Performance values reflect maximum power.

### Bluetooth BR, EDR Transceiver – Emissions (continued)

over operating free-air temperature range (unless otherwise noted)

| Characteristics <sup>(1)</sup> | Condition <sup>(2)</sup>                  |     | Performances |      |     | Units  |
|--------------------------------|-------------------------------------------|-----|--------------|------|-----|--------|
|                                |                                           |     | Min          | Typ  | Max |        |
|                                | 1598 to 1607 MHz (GLONASS) <sup>(3)</sup> |     |              | –145 |     | dBm/Hz |
|                                | 1805 to 1880 MHz (DCS, WCDMA)             |     |              | –141 |     | dBm/Hz |
|                                | 1930 to 1990 MHz (PCS)                    |     |              | –139 |     | dBm/Hz |
|                                | 2110 to 2170 MHz (WCDMA)                  | BR  |              | –134 |     | dBm/Hz |
|                                |                                           | EDR |              | –129 |     | dBm/Hz |
| Bluetooth harmonics            | Second harmonic                           |     |              | 1.5  |     | dBm    |
|                                | Third harmonic                            |     |              | –4   |     | dBm    |
|                                | Fourth harmonic                           |     |              | –10  |     | dBm    |

(3) Except for frequencies that correspond to  $2 \times \text{RF\_FREQ} / 3$

### 4.18 Bluetooth BR, EDR Transceiver – Spurs

over operating free-air temperature range (unless otherwise noted)

| Characteristics <sup>(1)</sup> | Condition <sup>(2)</sup>                  |    | Performances |     |     | Units |
|--------------------------------|-------------------------------------------|----|--------------|-----|-----|-------|
|                                |                                           |    | Min          | Typ | Max |       |
| Bluetooth out-of-band spurs    | 76 to 108 MHz (FM)                        | BR |              | –77 |     | dBm   |
|                                | 746 to 768 MHz (WCDMA)                    |    |              | –79 |     | dBm   |
|                                | 869 to 894 MHz (WCDMA, GSM)               |    |              | –77 |     | dBm   |
|                                | 925 to 960 MHz (E to GSM)                 |    |              | –77 |     | dBm   |
|                                | 1570 to 1580 MHz (GPS)                    |    |              | –72 |     | dBm   |
|                                | 1598 to 1607 MHz (GLONASS) <sup>(3)</sup> |    |              | –74 |     | dBm   |
|                                | 1805 to 1880 MHz (DCS, WCDMA)             |    |              | –72 |     | dBm   |
|                                | 1930 to 1990 MHz (PCS)                    |    |              | –70 |     | dBm   |
|                                | 2110 to 2170 MHz (WCDMA)                  |    |              | –59 |     | dBm   |

(1) Meets FCC and ETSI requirements with a suitable external filter

(2) Performance values reflect maximum power.

(3) Except for frequencies corresponding to  $2 \times \text{RF\_FREQ}/3$

### 4.19 Bluetooth EDR Transceiver – Spurs

over operating free-air temperature range (unless otherwise noted)

| Characteristics <sup>(1)</sup> | Condition <sup>(2)</sup>                  |     | Performances |     |     | Units |
|--------------------------------|-------------------------------------------|-----|--------------|-----|-----|-------|
|                                |                                           |     | Min          | Typ | Max |       |
| Bluetooth out-of-band spurs    | 76 to 108 MHz (FM)                        | EDR |              | –82 |     | dBm   |
|                                | 746 to 768 MHz (WCDMA)                    |     |              | –87 |     | dBm   |
|                                | 869 to 894 MHz (WCDMA, GSM)               |     |              | –85 |     | dBm   |
|                                | 925 to 960 MHz (E to GSM)                 |     |              | –84 |     | dBm   |
|                                | 1570 to 1580 MHz (GPS)                    |     |              | –79 |     | dBm   |
|                                | 1598 to 1607 MHz (GLONASS) <sup>(3)</sup> |     |              | –78 |     | dBm   |

(1) Meets FCC and ETSI requirements with a suitable external filter

(2) Performance values reflect maximum power.

(3) Except for frequencies corresponding to  $2 \times \text{RF\_FREQ}/3$

### Bluetooth EDR Transceiver – Spurs (continued)

over operating free-air temperature range (unless otherwise noted)

| Characteristics <sup>(1)</sup> | Condition <sup>(2)</sup>      | Performances |     |     | Units |
|--------------------------------|-------------------------------|--------------|-----|-----|-------|
|                                |                               | Min          | Typ | Max |       |
|                                | 1805 to 1880 MHz (DCS, WCDMA) |              | –76 |     | dBm   |
|                                | 1930 to 1990 MHz (PCS)        |              | –74 |     | dBm   |
|                                | 2110 to 2170 MHz (WCDMA)      |              | –63 |     | dBm   |

## 4.20 Bluetooth LE Performance

### 4.21 Bluetooth LE Receiver Characteristics – In-Band Signals

over operating free-air temperature range (unless otherwise noted)

| Parameter                                                                                                                                       | Condition <sup>(1)</sup>              | Min  | Typ | Max  | BLE Specification | Unit |
|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|------|-----|------|-------------------|------|
| Bluetooth LE operation frequency range                                                                                                          |                                       | 2402 |     | 2480 |                   | MHz  |
| Bluetooth LE channel spacing                                                                                                                    |                                       |      | 2   |      |                   | MHz  |
| Bluetooth LE input impedance                                                                                                                    |                                       |      | 50  |      |                   | Ω    |
| Bluetooth LE sensitivity <sup>(2)</sup><br>Dirty TX on                                                                                          |                                       |      | –94 |      | ≤ –70             | dBm  |
| Bluetooth LE maximum usable input power                                                                                                         |                                       | –5   |     |      | ≥ –10             | dBm  |
| Bluetooth LE intermodulation characteristics                                                                                                    | Level of interferers. For n = 3, 4, 5 | –36  | –30 |      | ≥ –50             | dBm  |
| Bluetooth LE C/I performance.<br>Note: Numbers show wanted signal-to-interfering-signal ratio. Smaller numbers indicate better C/I performance. | LE, co-channel                        |      | 8   | 12   | ≤ 21              | dB   |
|                                                                                                                                                 | LE, adjacent ±1 MHz                   |      | –5  | 0    | ≤ 15              |      |
|                                                                                                                                                 | LE, adjacent +2 MHz                   |      | –45 | –38  | ≤ –17             |      |
|                                                                                                                                                 | LE, adjacent –2 MHz                   |      | –22 | –15  | ≤ –15             |      |
| Image = –1 MHz                                                                                                                                  | LE, adjacent ≥  ±3 MHz                |      | –47 | –40  | ≤ –27             |      |

(1) BER of 0.1% corresponds to PER of 30.8% for a minimum of 1500 transmitted packets, according to the Bluetooth LE test specification.

(2) Sensitivity degradation of up to –3 dB can occur due to fast clock harmonics.

### 4.22 Bluetooth LE Receiver Characteristics – General Blocking

over operating free-air temperature range (unless otherwise noted)

| Parameter                                                                                           | Condition        | Min | Typ | Max | BLE Specification | Unit |
|-----------------------------------------------------------------------------------------------------|------------------|-----|-----|-----|-------------------|------|
| Bluetooth LE blocking performance over full range, according to the LE specification <sup>(1)</sup> | 30 to 2000 MHz   | –15 |     |     | ≥ –30             | dBm  |
|                                                                                                     | 2000 to 2399 MHz | –15 |     |     | ≥ –35             |      |
|                                                                                                     | 2484 to 3000 MHz | –15 |     |     | ≥ –35             |      |
|                                                                                                     | 3 to 12.75 GHz   | –15 |     |     | ≥ –30             |      |

(1) Exceptions taken out of the total 10 allowed for bfb\_1, according to the Bluetooth LE specification

#### 4.22.1 Bluetooth LE Receiver Characteristics – Blocking per Band

The characteristics for the Bluetooth LE receiver are the same as for Bluetooth BR (see [Section 4.12, Bluetooth Receiver Characteristics – BR, EDR Blocking per Band](#)), with the following conditions:

- Hopping off
- Desired signal –3 dB from sensitivity, with modulated continuous blocking signal. PER = 30.8%

## 4.23 Bluetooth LE Transmitter Characteristics

over operating free-air temperature range (unless otherwise noted)

| Parameter                                                    |            | Min | Typ   | Max | Bluetooth LE Specification | Unit |
|--------------------------------------------------------------|------------|-----|-------|-----|----------------------------|------|
| Bluetooth LE RF output power <sup>(1)</sup>                  | VBAT ≥ 3 V |     | 13.5  |     | ≤10                        | dBm  |
|                                                              | VBAT < 3 V |     | 8.0   |     | ≤10                        | dBm  |
| Bluetooth LE adjacent channel power  M-N  = 2 <sup>(2)</sup> |            |     | -51.0 |     | ≤ -20                      | dBm  |
| Bluetooth LE adjacent channel power  M-N  > 2 <sup>(2)</sup> |            |     | -54.0 |     | ≤ -30                      | dBm  |

(1) To reduce the maximum BLE power, use a VS command. The optional extra margin is offered to compensate for design losses, such as trace and filter losses, and to achieve the maximum allowed output power at system level.

(2) Assumes 3-dB insertion loss on external filter and traces

## 4.24 Bluetooth LE Modulation Characteristics

over operating free-air temperature range (unless otherwise noted)

| Characteristics                                       | Condition <sup>(1)</sup>                        |                                       | Performances |     |     | Bluetooth Specification | Units     |
|-------------------------------------------------------|-------------------------------------------------|---------------------------------------|--------------|-----|-----|-------------------------|-----------|
|                                                       |                                                 |                                       | Min          | Typ | Max |                         |           |
| Bluetooth LE modulation characteristics               | Δf1avg                                          | Mod data = 4 1s, 4 0s: 111100001111.. |              | 250 |     | 225 to 275              | kHz       |
|                                                       | Δf2max ≥ limit for at least 99.9% of all Δf2max | Mod data = 1010101...                 |              | 215 |     | ≥185                    | kHz       |
|                                                       | Δf2avg/Δf1avg                                   |                                       |              | 90  |     | ≥80                     | %         |
| Bluetooth LE carrier frequency drift                  | lf0 – fnl , n = 2,3 .... K                      |                                       | -25          |     | 25  | ≤±50                    | kHz       |
| Bluetooth LE drift rate                               | lf1 – f0l and lf n – fn-5l , n = 6,7 .... K     |                                       |              |     | 15  | ≤20                     | kHz/50 μs |
| LE initial carrier frequency tolerance <sup>(2)</sup> | fn – fTX                                        |                                       | -25          |     | 25  | ≤±100                   | kHz       |

(1) Performance values reflect maximum power.

(2) This number is added on top of the reference clock frequency accuracy.

### 4.24.1 Bluetooth LE Transceiver – Emissions

See [Section 4.17](#), Bluetooth BR, EDR Transceiver – Emissions.

### 4.24.2 Bluetooth LE Transceiver – Spurs

See [Section 4.18](#), Bluetooth BR, EDR Transceiver – Spurs.

## 4.25 Bluetooth-BLE Dynamic Currents

Current is measured at output power as follows:

- BR at 14.5 dBm
- EDR at 10 dBm

| Use Case <sup>(1) (2)</sup>                        | Typ   | Units |
|----------------------------------------------------|-------|-------|
| BR voice HV3 + sniff                               | 11.6  | mA    |
| EDR voice 2-EV3 no retransmission + sniff          | 5.9   | mA    |
| Sniff 1 attempt 1.28 s                             | 178.0 | μA    |
| EDR A2DP EDR2 (master). SBC high quality – 345 Kbs | 10.4  | mA    |

(1) The role of Bluetooth in all scenarios except A2DP is slave.

(2) CL1P5 PA is connected to VBAT, 3.7 V.

| Use Case <sup>(1)</sup> <sup>(2)</sup>             | Typ   | Units |
|----------------------------------------------------|-------|-------|
| EDR A2DP EDR2 (master). MP3 high quality – 192 Kbs | 7.5   | mA    |
| Full throughput ACL RX: RX-2DH5 <sup>(3)(4)</sup>  | 18.0  | mA    |
| Full throughput BR ACL TX: TX-DH5 <sup>(4)</sup>   | 50.0  | mA    |
| Full throughput EDR ACL TX: TX-2DH5 <sup>(4)</sup> | 33.0  | mA    |
| Page or inquiry 1.28 s/11.25 ms                    | 253.0 | mA    |
| P&I scan (P = 1.28/I = 2.56)                       | 332.0 | mA    |

(3) ACL RX has the same current in all modulations.

(4) Full throughput assumes data transfer in one direction.

## 4.26 Bluetooth LE Currents

All current is measured at output power of 10 dBm.

| Use Case <sup>(1)</sup>                                        | Output [dBm] | Typ | Units |
|----------------------------------------------------------------|--------------|-----|-------|
| Advertising, not connectable <sup>(2)</sup>                    | 10           | 131 | μA    |
| Advertising, discoverable <sup>(2)</sup>                       | 10           | 143 | μA    |
| Scanning <sup>(3)</sup>                                        | 10           | 266 | μA    |
| Connected, master role, 1.28-s connect interval <sup>(4)</sup> | 10           | 124 | μA    |
| Connected, slave role, 1.28-s connect interval <sup>(4)</sup>  | 10           | 132 | μA    |

(1) CL1p% PA is connected to VBAT, 3.7 V.

(2) Advertising in all three channels, 1.28-s advertising interval, 15 bytes advertise data

(3) Listening to a single frequency per window, 1.28-s scan interval, 11.25-ms scan window

(4) Zero slave connection latency, empty TX and RX LL packets

## 4.27 Shutdown and Sleep Currents

| Parameter                                | Power Supply Current | Typ | Unit |
|------------------------------------------|----------------------|-----|------|
| Shutdown mode<br>All functions shut down | VBAT                 | 10  | μA   |
|                                          | VIO                  | 2   | μA   |
| WLAN sleep mode                          | VBAT                 | 154 | μA   |
| Bluetooth sleep mode                     | VBAT                 | 110 | μA   |

## 5 Host Interface Timing Characteristics

The device incorporates a UART module dedicated to the *Bluetooth* shared-transport, host controller interface (HCI) transport layer. The HCI interface transports commands, events, and ACL between the *Bluetooth* device and its host using HCI data packets, acting as a shared transport for all functional blocks except WLAN.

| WLAN         | Shared HCI for All Functional Blocks<br>Except WLAN | Bluetooth Voice-Audio |
|--------------|-----------------------------------------------------|-----------------------|
| WLAN HS SDIO | Over UART                                           | Bluetooth PCM         |

### 5.1 WLAN SDIO Transport Layer

The SDIO is the host interface for WLAN. The interface between the host and the WL18xx module uses an SDIO interface and supports a maximum clock rate of 50 MHz.

The device SDIO also supports the following features of the SDIO V3 specification:

- 4-bit data bus
- Synchronous and asynchronous in-band interrupt
- Default and high-speed (HS, 50 MHz) timing
- Sleep and wake commands

### 5.1.1 SDIO Timing Specifications

Figure 5-1 and Figure 5-2 show the SDIO switching characteristics over recommended operating conditions and with the default rate for input and output.

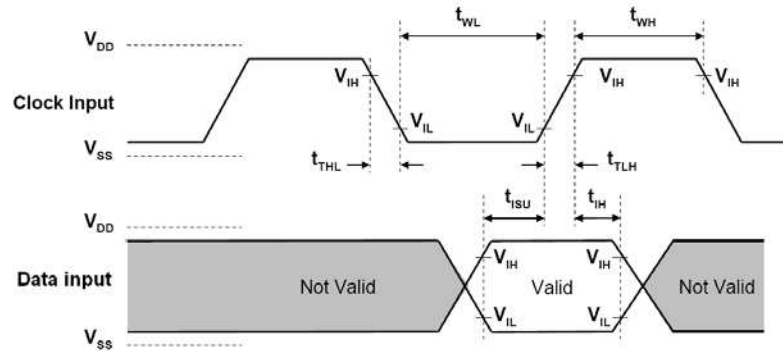


Figure 5-1. SDIO Default Input Timing

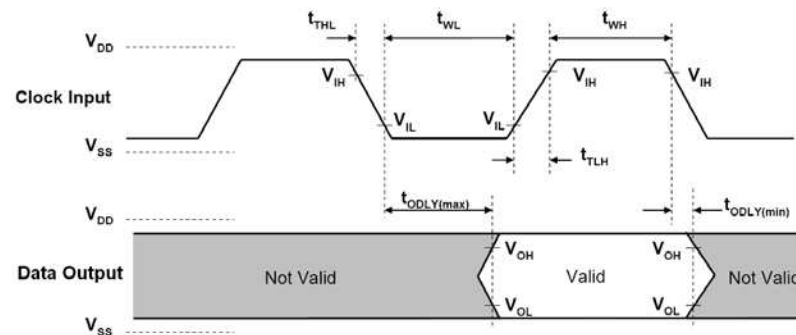


Figure 5-2. SDIO Default Output Timing

Table 5-1 lists the SDIO default timing characteristics.

Table 5-1. SDIO Default Timing Characteristics<sup>(1)</sup>

|                    | Parameter <sup>(2)</sup>                      | Min  | Max  | Unit |
|--------------------|-----------------------------------------------|------|------|------|
| $f_{\text{clock}}$ | Clock frequency, CLK                          | 0.0  | 26.0 | MHz  |
| DC                 | Low, high duty cycle                          | 40.0 | 60.0 | %    |
| $t_{\text{TLH}}$   | Rise time, CLK                                |      | 10.0 | ns   |
| $t_{\text{THL}}$   | Fall time, CLK                                |      | 10.0 | ns   |
| $t_{\text{ISU}}$   | Setup time, input valid before CLK $\uparrow$ | 3.0  |      | ns   |
| $t_{\text{IH}}$    | Hold time, input valid after CLK $\uparrow$   | 2.0  |      | ns   |
| $t_{\text{ODLY}}$  | Delay time, CLK $\downarrow$ to output valid  | 2.5  | 14.8 | ns   |
| $C_{\text{I}}$     | Capacitive load on outputs                    |      | 15.0 | pF   |

(1) To change the data out clock edge from the falling edge (default) to the rising edge, set the configuration bit.

(2) Parameter values reflect maximum clock frequency.

### 5.1.2 SDIO Switching Characteristics – High Rate

Figure 5-3 and Figure 5-4 show the parameters for maximum clock frequency.

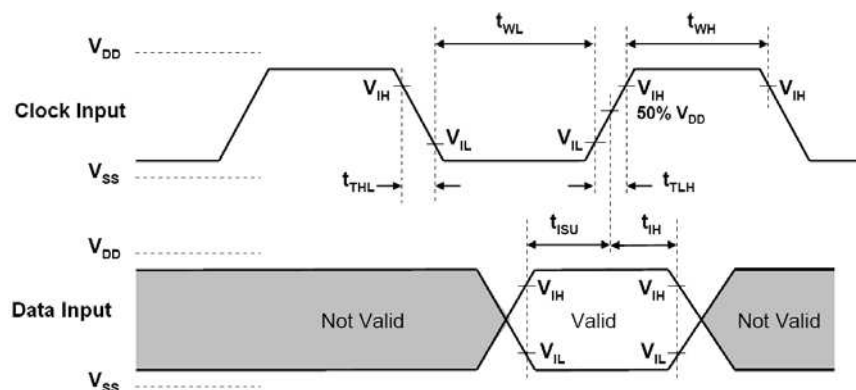


Figure 5-3. SDIO HS Input Timing

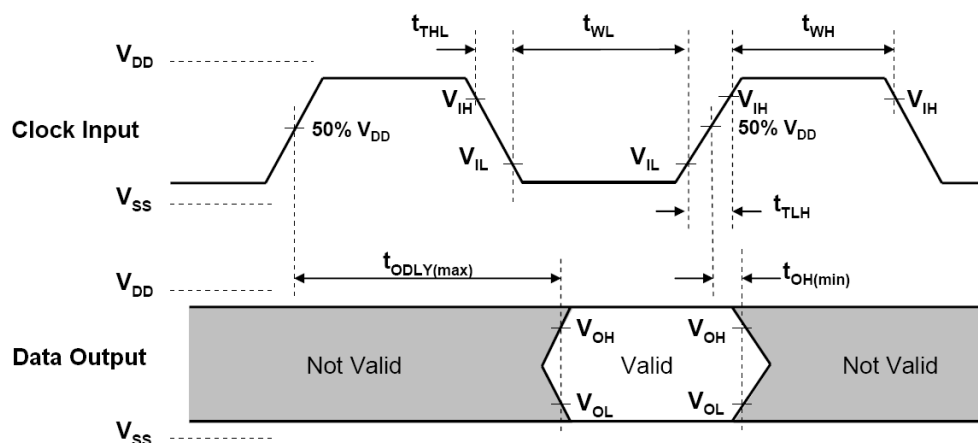


Figure 5-4. SDIO HS Output Timing

Table 5-2 lists the SDIO high-rate timing characteristics.

Table 5-2. SDIO HS Timing Characteristics

| Parameter          |                                               | Min  | Max  | Unit |
|--------------------|-----------------------------------------------|------|------|------|
| $f_{\text{clock}}$ | Clock frequency, CLK                          | 0.0  | 50.0 | MHz  |
| DC                 | Low, high duty cycle                          | 40.0 | 60.0 | %    |
| $t_{\text{TLH}}$   | Rise time, CLK                                |      | 3.0  | ns   |
| $t_{\text{THL}}$   | Fall time, CLK                                |      | 3.0  | ns   |
| $t_{\text{ISU}}$   | Setup time, input valid before CLK $\uparrow$ | 3.0  |      | ns   |
| $t_{\text{IH}}$    | Hold time, input valid after CLK $\uparrow$   | 2.0  |      | ns   |
| $t_{\text{ODLY}}$  | Delay time, CLK $\uparrow$ to output valid    | 2.5  | 14.0 | ns   |
| $C_i$              | Capacitive load on outputs                    |      | 10.0 | pF   |

## 5.2 HCI UART Shared Transport Layers for All Functional Blocks (Except WLAN)

The HCI UART supports most baud rates (including all PC rates) for all fast-clock frequencies up to a maximum of 4 Mbps. After power up, the baud rate is set for 115.2 kbps, regardless of the fast-clock frequency. The baud rate can then be changed using a VS command. The device responds with a Command Complete Event (still at 115.2 kbps), after which the baud rate change occurs.

HCI hardware includes the following features:

- Receiver detection of break, idle, framing, FIFO overflow, and parity error conditions
- Receiver-transmitter underflow detection
- CTS, RTS hardware flow control
- 4 wire (H4)

Table 5-3 lists the UART default settings.

**Table 5-3. UART Default Setting**

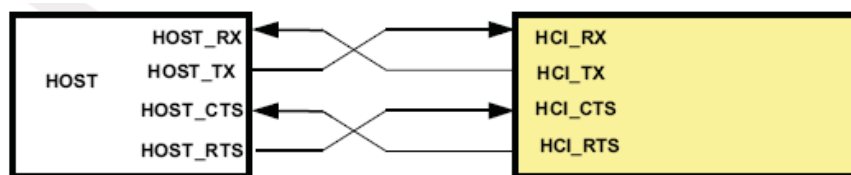
| Parameter   | Value      |
|-------------|------------|
| Bit rate    | 115.2 kbps |
| Data length | 8 bits     |
| Stop bit    | 1          |
| Parity      | None       |

### 5.2.1 UART 4-Wire Interface – H4

The interface includes four signals:

- TXD
- RXD
- CTS
- RTS

Flow control between the host and the device is byte-wise by hardware (see Figure 5-5).



**Figure 5-5. HCI UART Connection**

When the UART RX buffer of the device passes the flow-control threshold, the buffer sets the UART\_RTS signal high to stop transmission from the host. When the UART\_CTS signal is set high, the device stops transmitting on the interface. If HCI\_CTS is set high in the middle of transmitting a byte, the device finishes transmitting the byte and stops the transmission.

Figure 5-6 shows the UART timing.

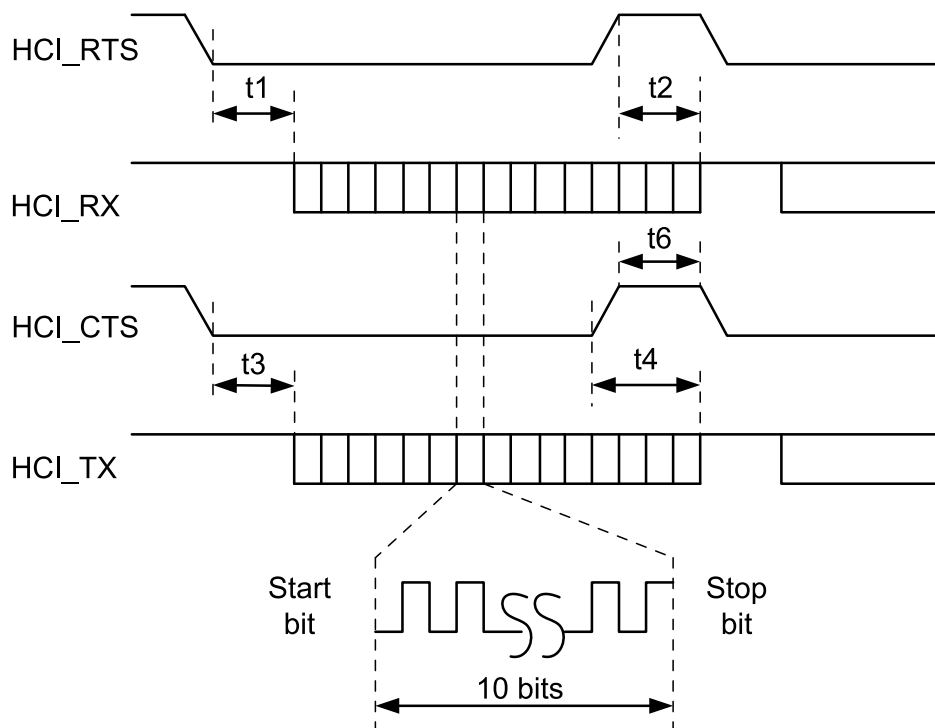


Figure 5-6. UART Timing Diagram

Table 5-4 lists the UART timing characteristics.

Table 5-4. UART Timing Characteristics

| Parameter                   | Condition                 | Symbol | Min   | Typ | Max   | Unit  |
|-----------------------------|---------------------------|--------|-------|-----|-------|-------|
| Baud rate                   |                           |        | 37.5  |     | 4364  | Kbps  |
| Baud rate accuracy per byte | Receive-transmit          |        | -2.5  |     | +1.5  | %     |
| Baud rate accuracy per bit  | Receive-transmit          |        | -12.5 |     | +12.5 | %     |
| CTS low to TX_DATA on       |                           | t3     | 0.0   | 2.0 |       | μs    |
| CTS high to TX_DATA off     | Hardware flow control     | t4     |       |     | 1.0   | Byte  |
| CTS high pulse width        |                           | t6     | 1.0   |     |       | Bit   |
| RTS low to RX_DATA on       |                           | t1     | 0.0   | 2.0 |       | μs    |
| RTS high to RX_DATA off     | Interrupt set to 1/4 FIFO | t2     |       |     | 16.0  | Bytes |

Figure 5-7 shows the UART data frame.

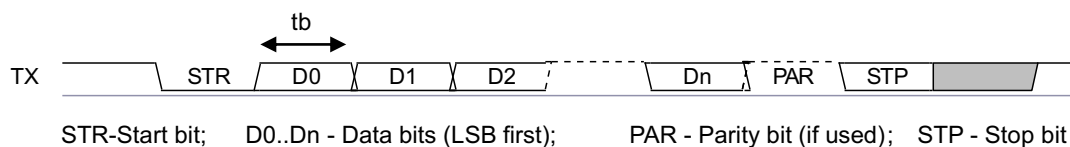


Figure 5-7. UART Data Frame

### 5.3 Bluetooth Codec-PCM (Audio) Timing Specifications

Figure 5-8 shows the Bluetooth codec-PCM (audio) timing diagram.

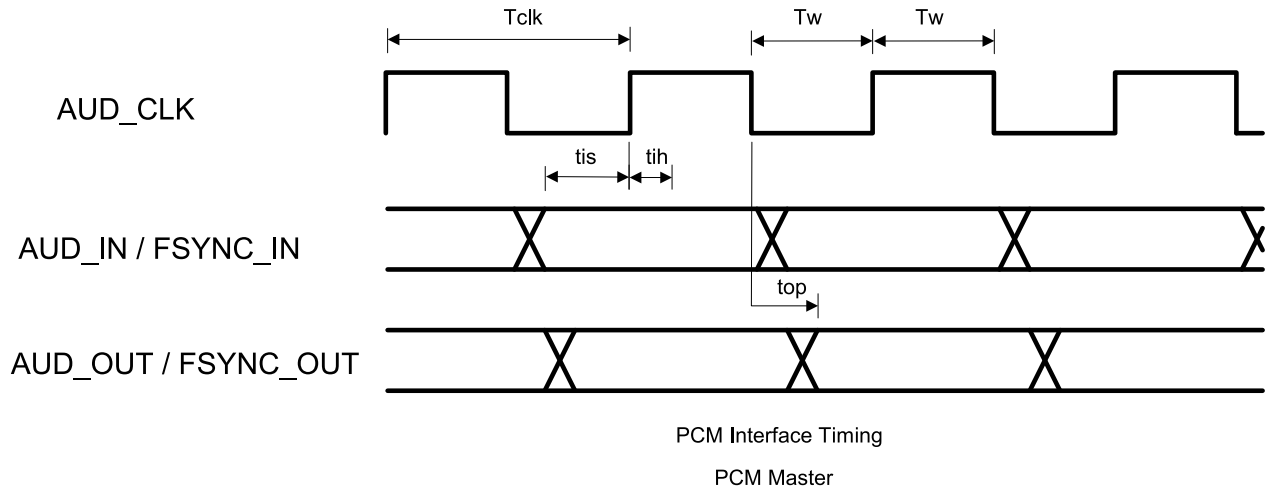


Figure 5-8. Bluetooth Codec-PCM (Audio) Master Timing Diagram

Table 5-5 lists the Bluetooth codec-PCM master timing characteristics.

Table 5-5. Bluetooth Codec-PCM Master Timing Characteristics

| Parameter                     | Symbol    | Min                  | Max            | Unit |
|-------------------------------|-----------|----------------------|----------------|------|
| Cycle time                    | $T_{clk}$ | 166.67 (6.144 MHz)   | 15625 (64 kHz) | ns   |
| High or low pulse width       | $T_s$     | 35% of $T_{clk}$ min |                |      |
| AUD_IN setup time             | $t_{is}$  | 10.6                 |                |      |
| AUD_IN hold time              | $t_{ih}$  | 0                    |                |      |
| AUD_OUT propagation time      | $t_{op}$  | 0                    | 15             |      |
| FSYNC_OUT propagation time    | $t_{op}$  | 0                    | 15             |      |
| Capacitive loading on outputs | $C_l$     |                      | 40             | pF   |

Table 5-6 lists the Bluetooth codec-PCM slave timing characteristics.

Table 5-6. Bluetooth Codec-PCM Slave Timing Characteristics

| Parameter                     | Symbol    | Min                  | Max | Unit |
|-------------------------------|-----------|----------------------|-----|------|
| Cycle time                    | $T_{clk}$ | 81 (12.288 MHz)      |     | ns   |
| High or low pulse width       | $T_w$     | 35% of $T_{clk}$ min |     |      |
| AUD_IN setup time             | $t_{is}$  | 5                    |     |      |
| AUD_IN hold time              | $t_{ih}$  | 0                    |     |      |
| AUD_FSYNC setup time          | $t_{is}$  | 5                    |     |      |
| AUD_FSYNC hold time           | $t_{ih}$  | 0                    |     |      |
| AUD_OUT propagation time      | $t_{op}$  | 0                    | 19  |      |
| Capacitive loading on outputs | $C_l$     |                      | 40  | pF   |

## 6 Clocks and Power Management

The slow clock is a free-running, 32.768 kHz clock supplied from an external clock source. The clock is connected to the RTC\_CLK pin and is a digital square-wave signal in the range of 0 to 1.8 V nominal.

### 6.1 Reset-Power-Up System

After VBAT and VIO are fed to the device and while BT\_EN and WL\_EN are deasserted (low), the device is in SHUTDOWN state, during which functional blocks, internal DC-DCs, and LDOs are disabled. The power supplied to the functional blocks is cut off. When one of the signals (BT\_EN or WL\_EN) are asserted (high), a power-on reset (POR) is performed. Stable slow clock, VIO, and VBAT are prerequisites for a successful POR.

### 6.2 WLAN Power-Up Sequence

Figure 6-1 shows the WLAN power-up sequence.

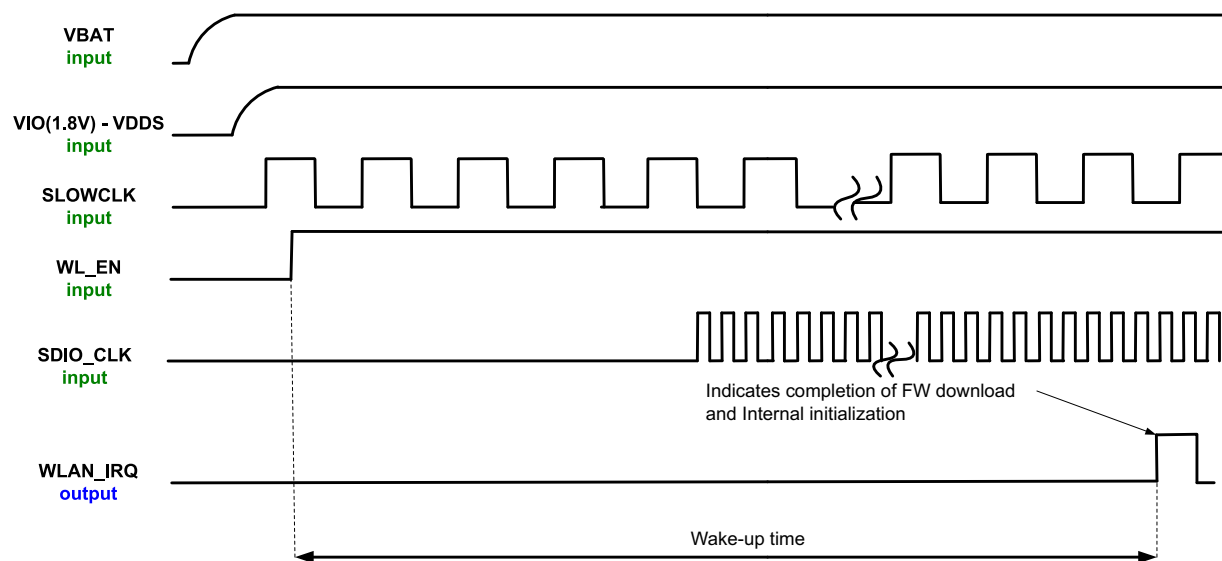


Figure 6-1. WLAN Power-Up Sequence

### 6.3 Bluetooth-BLE Power-Up Sequence

Figure 6-2 shows the Bluetooth-BLE power-up sequence.

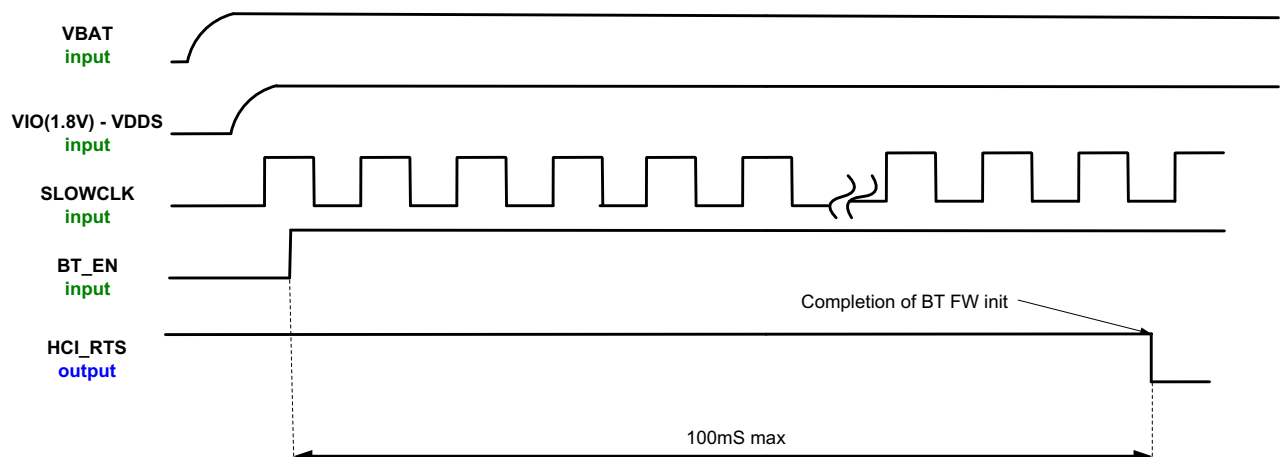
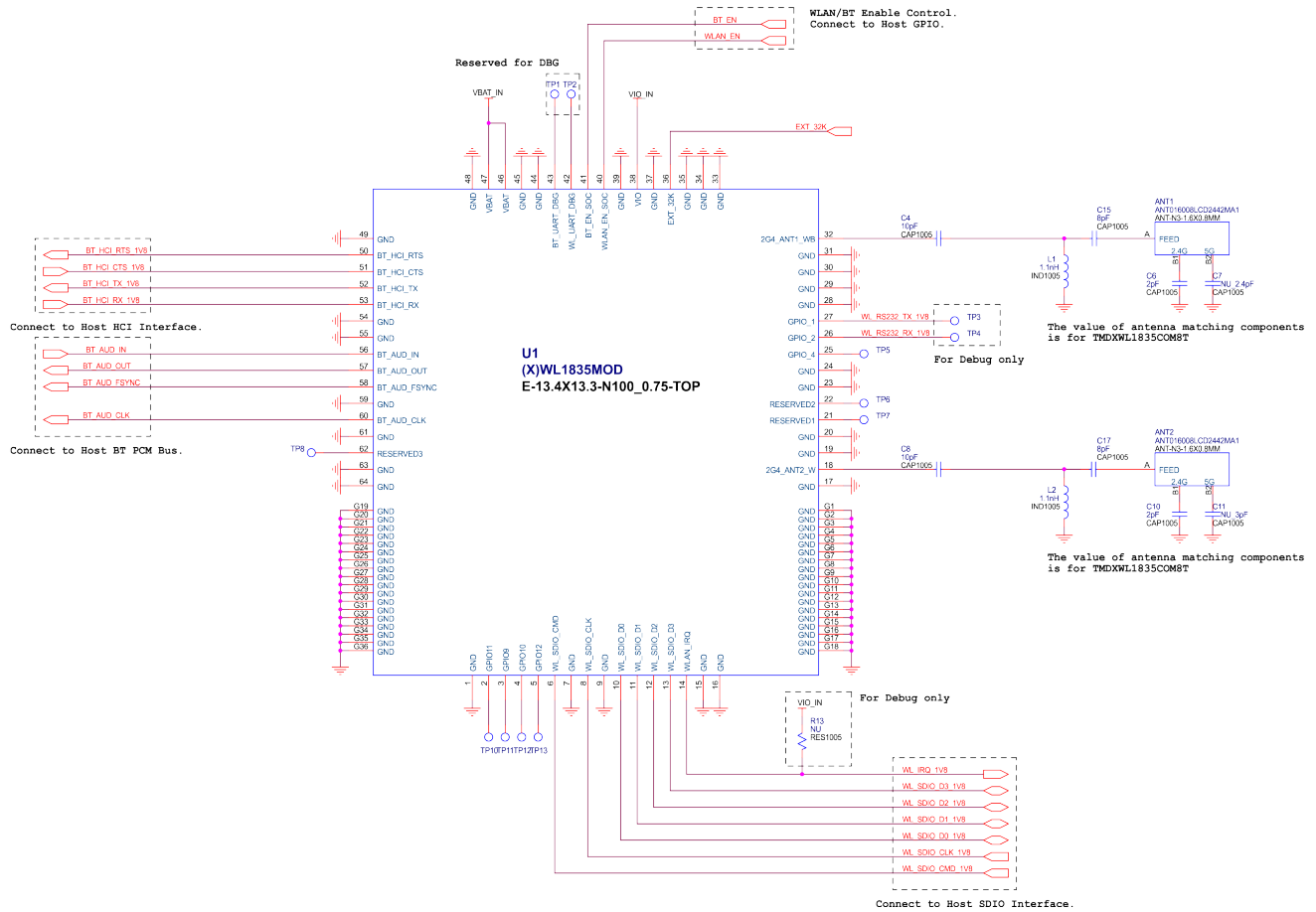


Figure 6-2. Bluetooth-BLE Power-Up Sequence

## 7 Reference Schematics and Bill of Materials

### 7.1 TI Module Reference Design

Figure 7-1 shows the TI module reference design.



**Figure 7-1. TI Module Reference Schematics**

### 7.2 Bill of Materials

Table 7-1 lists the bill materials (BOM).

**Table 7-1. Bill of Materials**

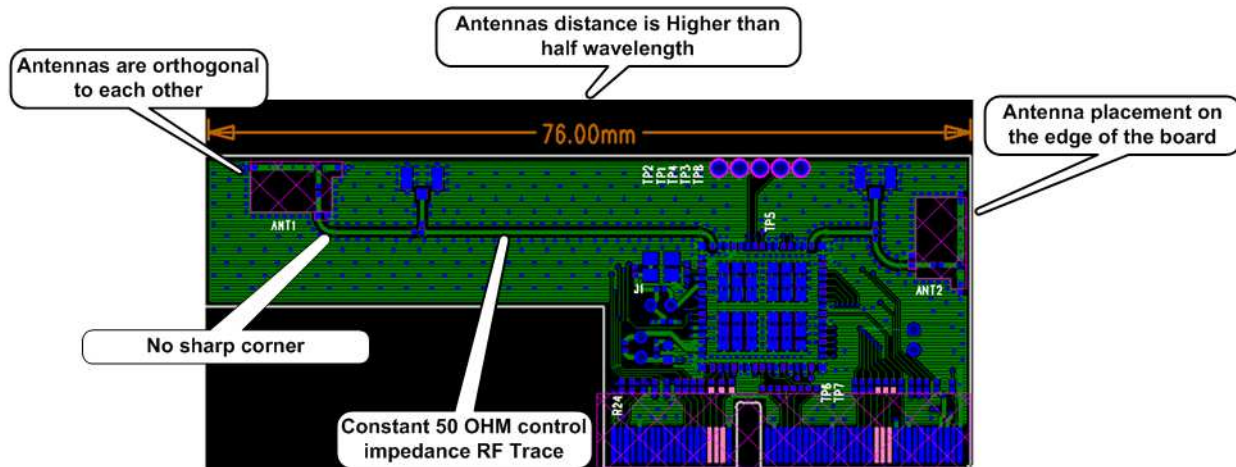
| Description                           | Part Number         | Package         | Reference  | Qty | Manufacturer      |
|---------------------------------------|---------------------|-----------------|------------|-----|-------------------|
| TI WL 1835 WiFi/BT Module             | (X)WL1835MOD        | 13.4x13.3x2.0mm | U1         | 1   | Texas Instruments |
| ANT/Chip/2.4, 5 GHz/Peak Gain > 5 dBi | ANT016008LCD2442MA1 | 1.6 mm x 0.8 mm | ANT1, ANT2 | 2   | TDK               |
| IND 0402/1.2 nH/±0.3/0.12 Ω/300 mA    | HI1005-1C1N2SMT     | 0402            | L1, L2     | 2   | ACX               |
| CAP 0402/2.0 pF/50 V/C0G/±0.25 pF     | C1005C0G1H020C      | 0402            | C8, C10    | 2   | Walsin            |
| CAP 0402/8.2 pF/50 V/NPO/±0.5 pF      | 0402N8R2D500        | 0402            | C15, C17   | 2   | Walsin            |
| CAP 0402/10 pF/50 V/NPO/±5%           | 0402N100J500LT      | 0402            | C4, C6     | 2   | Walsin            |
| RES 0402/10K/±5% (for debug only)     | WR04X103 JTL        | 0402            | R13        | 1   | Walsin            |

## 8 Design Recommendations

This section describes the layout recommendations for the (X)WL1835 module, RF trace, and antenna.

### 8.1 RF Trace and Antenna Layout Recommendations

Figure 8-1 shows the location of the antenna on the TMDXWL1835COM8T board as well as the RF trace routing from the (X)WL1835 module (TI reference design). The TDK chip multilayer antennas are mounted on the board with a specific layout and matching circuit for the radiation test conducted in FCC, CE, and IC certifications.



**Figure 8-1. Location of Antenna and RF Trace Routing on the TMDXWL1835COM8T Board**

Follow these following RF trace routing recommendations:

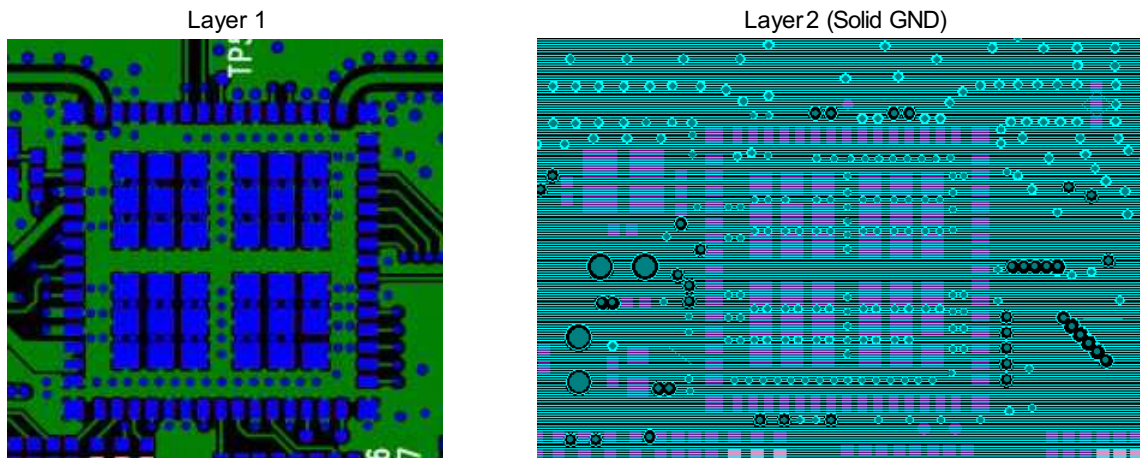
- RF traces must have 50-Ω impedance.
- RF traces must not have sharp corners.
- RF traces must have via stitching on the ground plane beside the RF trace on both sides.
- RF traces must be as short as possible. The antenna, RF traces, and module must be on the edge of the PCB product in consideration of the product enclosure material and proximity.

### 8.2 Module Layout Recommendations

Follow these module layout recommendations:

- Ensure a solid ground plane and ground vias under the module for stable system and thermal dissipation.
- Do not run signal traces underneath the module on a layer where the module is mounted.
- Signal traces can be run on a third layer under the solid ground layer and beneath the module mounting.
- Run the host interfaces with ground on the adjacent layer to improve the return path.
- TI recommends routing the signals as short as possible to the host.

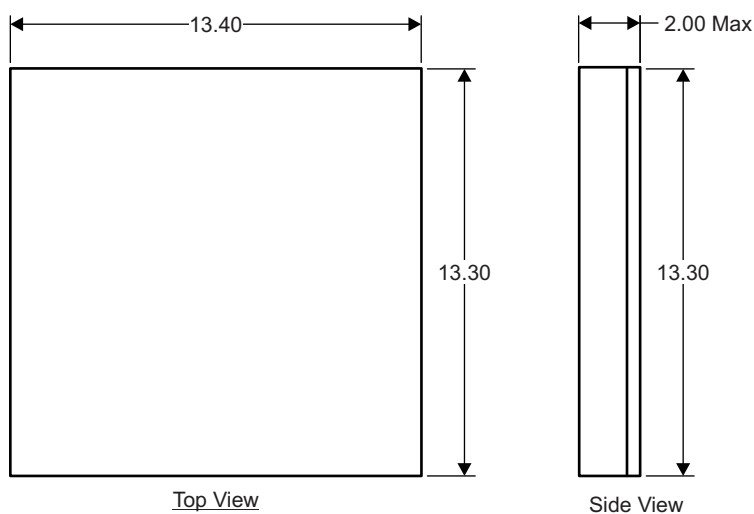
Figure 8-2 shows layer 1 and layer 2 of the TI module layout:



**Figure 8-2. TI Module Layout**

## 9 Mechanical Information

Figure 9-1 shows the mechanical outline for the device.



**Figure 9-1. TI Module Mechanical Outline**

PRODUCT PREVIEW

## 10 Packaging Information

[Table 10-1](#) lists the available TI module part numbers.

**Table 10-1. TI Module Part Numbers**

| Part Number <sup>(1)</sup> | Status <sup>(2)</sup> | Package Type | Minimum Orderable Quantity |
|----------------------------|-----------------------|--------------|----------------------------|
| XWL1835MODGAMOCT           | Preview               | LGA          | 250                        |
| XWL1805MODGAMOCT           | Preview               | LGA          |                            |
| XWL1831MODGAMOCT           | Preview               | LGA          |                            |
| XWL1801MODGAMOCT           | Preview               | LGA          |                            |

(1) Part number marking key:

- X – experimental (before qualification)
- WL18xx – module variant (see [Table 1-1](#))
- MODGx – module marking (26-MHz commercial revision A or B)
- MOCx – module package designator (R: tape/reel; T: small reel)

For example, XWL1835MODGAMOCT = experimental WL1835 module, revision A, small reel.

(2) This device has been announced but is not in production. Samples may not be available. Contact your TI representative.

To minimize delivery time to customer for small quantities, TI may ship the device ordered or an equivalent device currently available that contains at least the functions of the part ordered. From all aspects, this device will behave exactly the same as the part ordered. For example, if a customer orders device XWL1801MODGA, the part shipped may be XWL1801MODGA, XWL1805MODGA, XWL1831MODGA, or XWL1835MODGA.

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|-------------------------|----------------------|--------------|-------------------------|---------|
| XWL1801MODGAMOCT | PREVIEW       |              |                    | 100  | 250            | TBD             | Call TI                 | Call TI              | -20 to 70    |                         |         |
| XWL1805MODGAMOCT | PREVIEW       |              |                    | 100  | 250            | TBD             | Call TI                 | Call TI              | -20 to 70    |                         |         |
| XWL1831MODGAMOCT | PREVIEW       |              |                    | 100  | 250            | TBD             | Call TI                 | Call TI              | -20 to 70    |                         |         |
| XWL1835MODGAMOCT | PREVIEW       |              |                    | 100  | 250            | TBD             | Call TI                 | Call TI              | -20 to 70    |                         |         |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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