
WL18x7MOD WiLink™ 8 Dual-Band Industrial Module – Wi-Fi®, Bluetooth®, and Bluetooth Low Energy (LE)

1 Device Overview

1.1 Features

• General

- Integrates RF, Power Amplifiers (PAs), Clock, RF Switches, Filters, Passives, and Power Management
- Quick Hardware Design With TI Module Collateral and Reference Designs
- Operating Temperature: –40°C to 85°C Industrial Temperature Grade
- Small Form Factor: 13.3 × 13.4 × 2 mm
- 100-Pin MOC Package
- FCC, IC, ETSI/CE, and TELEC Certified With Chip Antennas

• Wi-Fi

- WLAN Baseband Processor and RF Transceiver Support of IEEE Std 802.11a, 802.11b, 802.11g, and 802.11n
- 20- and 40-MHz SISO and 20-MHz 2 × 2 MIMO at 2.4 GHz for High Throughput: 80 Mbps (TCP), 100 Mbps (UDP)
- 2.4-GHz MRC Support for Extended Range and 5-GHz Diversity Capable
- Fully Calibrated: Production Calibration Not Required
- 4-Bit SDIO Host Interface Support
- Wi-Fi Direct Concurrent Operation (Multichannel, Multirole)

• Bluetooth and Bluetooth LE (WL1837MOD Only)

- Bluetooth 4.1 Compliance and CSA2 Support
- Host Controller Interface (HCI) Transport for Bluetooth Over UART
- Dedicated Audio Processor Support of SBC Encoding + A2DP
- Dual-Mode Bluetooth and Bluetooth LE
- TI's Bluetooth- and Bluetooth LE-Certified Stack

• Key Benefits

- Reduces Design Overhead
- Differentiated Use-Cases by Configuring WiLink 8 Simultaneously in Two Roles (STA and AP) to Connect Directly With Other Wi-Fi Devices on Different RF Channel (Wi-Fi Networks)
- Best-in-Class Wi-Fi With High-Performance Audio and Video Streaming Reference Applications With Up to 1.4X the Range Versus One Antenna
- Different Provisioning Methods for In-Home Devices Connectivity to Wi-Fi in One Step
- Lowest Wi-Fi Power Consumption in Connected Idle (< 800 μA)
- Configurable Wake on WLAN Filters to Only Wake up the System
- Wi-Fi-Bluetooth Single Antenna Coexistence

1.2 Applications

- Internet of Things (IoT)
- 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

The certified WiLink 8 module from TI offers high throughput and extended range along with Wi-Fi and *Bluetooth* coexistence (WL1837MOD only) in a power-optimized design. The WL18x7MOD is a Wi-Fi, dual-band, 2.4- and 5-GHz module solution with two antennas supporting Industrial temperature grade. The device is FCC, IC, ETSI/CE, and TELEC certified for AP (with DFS support) and client. TI offers drivers for high-level operating systems, such as Linux® and Android™. Additional drivers, such as WinCE and RTOS, which includes QNX, Nucleus, ThreadX, and FreeRTOS, are supported through third parties.

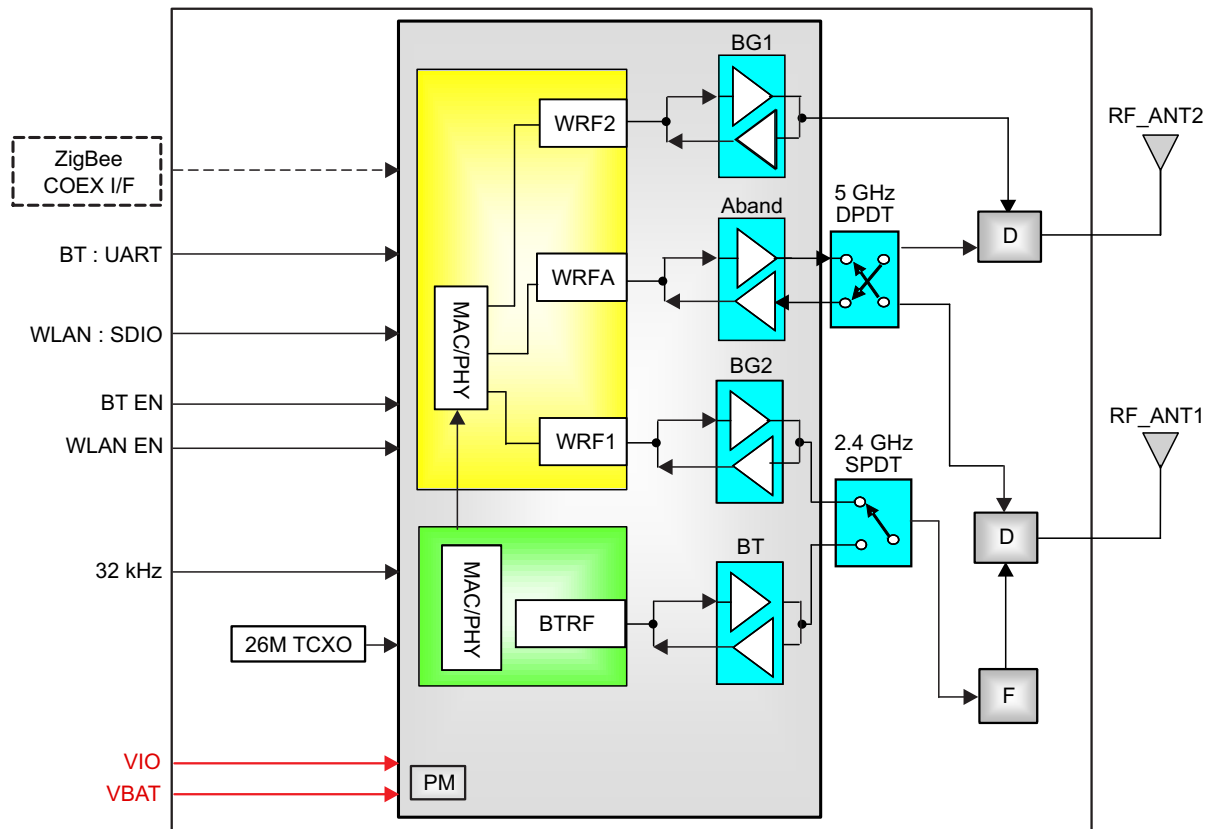
Device Information⁽¹⁾

| ORDER NUMBER | PACKAGE | BODY SIZE |
|--------------|-----------|--------------------------|
| WL1807MOD | MOC (100) | 13.3 mm x 13.4 mm x 2 mm |
| WL1837MOD | MOC (100) | 13.3 mm x 13.4 mm x 2 mm |

(1) For more information, see Section 9, Mechanical Packaging and Orderable Information.

1.4 Functional Block Diagram

Figure 1-1 shows a functional block diagram of the WL1837MOD variant.



NOTE: Dashed lines indicate optional configurations and are not applied by default.

Figure 1-1. WL1837MOD Functional Block Diagram

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2 Revision History

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

| Changes from Revision G (August 2015) to Revision H | Page |
|--|------|
| • Changed parameter headings from "2G4_ANT2_W + 2G4_ANT1_WB Pins" in Section 5.8 , <i>WLAN Performance: 2.4-GHz Transmitter Power</i> | 13 |
| • Added note 3 in Section 5.13 , <i>Bluetooth Transmitter, BR</i> | 17 |
| • Added note 3 in Section 5.14 , <i>Bluetooth Performance: Transmitter, EDR</i> | 17 |
| • Changed note 3 from "Assumes VBAT ADC measurement accuracy of 5%" in Section 5.18 , <i>Bluetooth LE Performance: Transmitter Characteristics</i> | 19 |
| • Changed minimum cycle time from 81.266 MHz in Table 5-6 | 27 |

3 Device Comparison

The TI WiLink 8 module offers two footprint-compatible dual-band 2.4- and 5-GHz industrial temperature grade variants providing stand-alone Wi-Fi and *Bluetooth* combo connectivity. [Table 3-1](#) compares the features of the module variants.

Table 3-1. TI WiLink 8 Module Variants

| DEVICE | WLAN 2.4-GHZ SISO ⁽¹⁾ | WLAN 2.4-GHZ MIMO ⁽¹⁾ | WLAN 2.4-GHZ MRC ⁽²⁾ | BLUETOOTH | WLAN 5-GHZ SISO ⁽¹⁾ |
|-----------|----------------------------------|----------------------------------|---------------------------------|-----------|--------------------------------|
| WL1837MOD | √ | √ | √ | √ | √ |
| WL1807MOD | √ | √ | √ | | √ |

(1) SISO: single input, single output; MIMO: multiple input, multiple output.

(2) MRC: maximum ratio combining; supported at 11 g,n only.

4 Terminal Configuration and Functions

Figure 4-1 shows the pin assignments for the 100-pin MOC package.

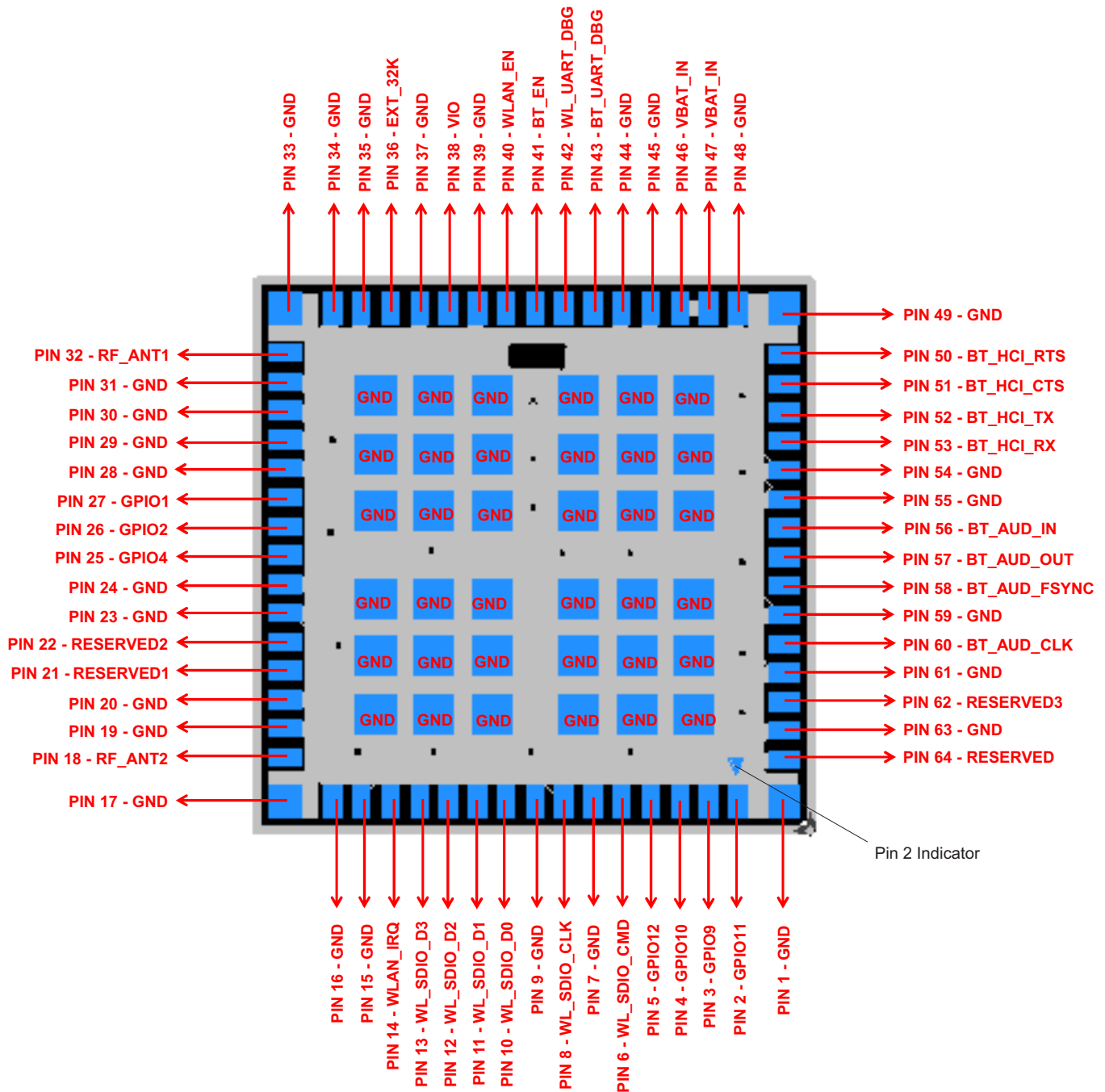
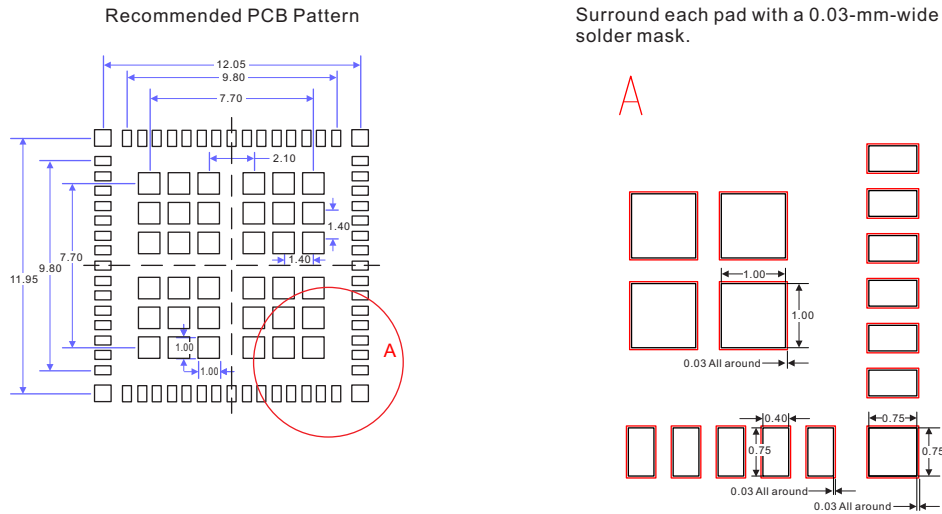


Figure 4-1. 100-Pin MOC Package (Bottom View)

Figure 4-2 shows the recommended PCB pattern of the 100-pin MOC package.



- NOTE: 1. Module size: 13.4 mm x 13.3 mm
 2. Signal pad size: 0.75 mm x 0.40 mm
 3. 4 x corner ground size: 0.75 mm x 0.75 mm
 4. Central ground pin size: 1.00 mm x 1.00 mm
 5. Pitch: 0.7 mm

Figure 4-2. Recommended PCB Pattern of 100-Pin MOC Package

Figure 4-3 shows the recommended stencil outline of the 100-pin MOC package.

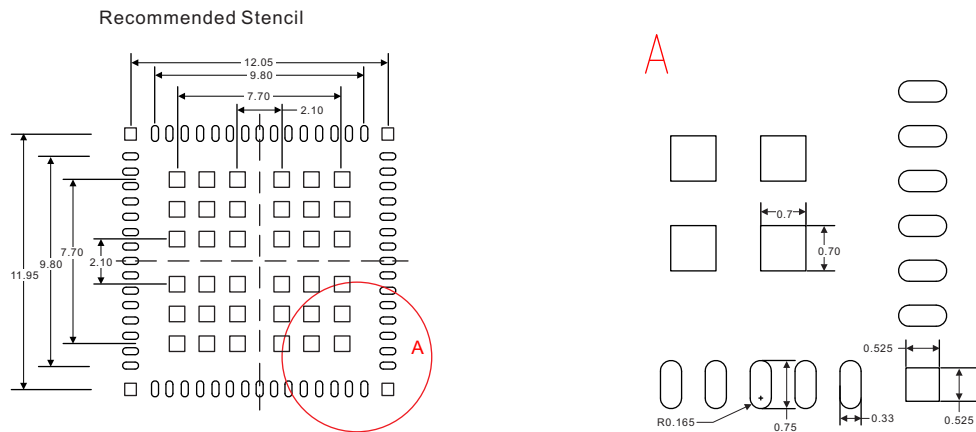


Figure 4-3. Recommended Stencil Outline of 100-Pin MOC Package

4.1 Pin Description

Table 4-1 describes the module pins.

Table 4-1. Pin Description

| PIN NAME | PIN | TYPE/ DIR | SHUTDOWN STATE(1) | AFTER POWER UP(1) | VOLTAGE LEVEL | CONNECTIVITY(2) | | DESCRIPTION |
|---------------------------------|-----|--------------|----------------------|-------------------------|------------------|-----------------|------|--|
| | | | | | | 1807 | 1837 | |
| Clocks and Reset Signals | | | | | | | | |
| WL_SDIO_CLK_1V8 | 8 | I | Hi-Z | Hi-Z | 1.8 V | v | v | WLAN SDIO clock. Must be driven by the host. |
| EXT_32K | 36 | ANA | | | – | v | v | Input sleep clock: 32.768 kHz |
| WLAN_EN | 40 | I | PD | PD | 1.8 V | v | v | Mode setting: high = enable |
| BT_EN | 41 | I | PD | PD | 1.8 V | x | v | Mode setting: high = enable. If <i>Bluetooth</i> is not used, connect to ground. |
| Power-Management Signals | | | | | | | | |
| VIO_IN | 38 | POW | PD | PD | 1.8 V | v | v | Connect to 1.8-V external VIO |
| VBAT_IN | 46 | POW | | | VBAT | v | v | Power supply input, 2.9 to 4.8 V |
| VBAT_IN | 47 | POW | | | VBAT | v | v | Power supply input, 2.9 to 4.8 V |
| TI Reserved | | | | | | | | |
| GPIO11 | 2 | I/O | PD | PD | 1.8 V | v | v | Reserved for future use. NC if not used. |
| GPIO9 | 3 | I/O | PD | PD | 1.8 V | v | v | Reserved for future use. NC if not used. |
| GPIO10 | 4 | I/O | PU | PU | 1.8 V | v | v | Reserved for future use. NC if not used. |
| GPIO12 | 5 | I/O | PU | PU | 1.8 V | v | v | Reserved for future use. NC if not used. |
| RESERVED1 | 21 | I | PD | PD | 1.8 V | x | x | Reserved for future use. NC if not used. |
| RESERVED2 | 22 | I | PD | PD | 1.8 V | x | x | Reserved for future use. NC if not used. |
| GPIO4 | 25 | I/O | PD | PD | 1.8 V | v | v | Reserved for future use. NC if not used. |
| RESERVED3 | 62 | O | PD | PD | 1.8 V | x | x | Reserved for future use. NC if not used. Option: External TCXO. |
| RESERVED | 64 | GND | | | – | v | v | Reserved for future use. Connect to ground if not used. |

Table 4-1. Pin Description (continued)

| PIN NAME | PIN | TYPE/ DIR | SHUTDOWN STATE(1) | AFTER POWER UP(1) | VOLTAGE LEVEL | CONNECTIVITY(2) | | DESCRIPTION |
|---|-----|--------------|----------------------|-------------------------|------------------|-----------------|------|--|
| | | | | | | 1807 | 1837 | |
| WLAN Functional Block: Int Signals | | | | | | | | |
| WL_SDIO_CMD_1V8 | 6 | I/O | Hi-Z | Hi-Z | 1.8 V | v | v | WLAN SDIO command(3) |
| WL_SDIO_D0_1V8 | 10 | I/O | Hi-Z | Hi-Z | 1.8 V | v | v | WLAN SDIO data bit 0(3) |
| WL_SDIO_D1_1V8 | 11 | I/O | Hi-Z | Hi-Z | 1.8 V | v | v | WLAN SDIO data bit 1(3) |
| WL_SDIO_D2_1V8 | 12 | I/O | Hi-Z | Hi-Z | 1.8 V | v | v | WLAN SDIO data bit 2(3) |
| WL_SDIO_D3_1V8 | 13 | I/O | Hi-Z | PU | 1.8 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.(3) |
| WL_IRQ_1V8 | 14 | O | PD | 0 | 1.8 V | v | v | SDIO available, interrupt out. Active high. (For WL_RS232_TX/RX pullup is at power up.) Set to rising edge (active high) on power up. The Wi-Fi interrupt line can be configured by the driver according to the IRQ configuration (polarity/level/edge). |
| RF_ANT2 | 18 | ANA | | | – | v | v | 5G ANT diversity TX/RX , 2.4G Secondary antenna MRC/MIMO only |
| GPIO2 | 26 | I/O | PD | PD | 1.8 V | v | v | WL_RS232_RX (when WLAN_IRQ = 1 at power up) |
| GPIO1 | 27 | I/O | PD | PD | 1.8 V | v | v | WL_RS232_TX (when WLAN_IRQ = 1 at power up) |
| RF_ANT1 | 32 | ANA | | | – | v | v | 5G main ANT TX/RX, 2.4G WLAN main antenna SISO, <i>Bluetooth</i> |
| WL_UART_DBG | 42 | O | PU | PU | 1.8 V | v | v | Option: WLAN logger |

Table 4-1. Pin Description (continued)

| PIN NAME | PIN | TYPE/ DIR | SHUTDOWN STATE(1) | AFTER POWER UP(1) | VOLTAGE LEVEL | CONNECTIVITY(2) | | DESCRIPTION |
|--|---|--------------|----------------------|-------------------------|------------------|-----------------|------|---|
| | | | | | | 1807 | 1837 | |
| Bluetooth Functional Block: Int Signals | | | | | | | | |
| BT_UART_DBG | 43 | O | PU | PU | 1.8 V | x | v | Option: <i>Bluetooth</i> logger |
| BT_HCI_RTS_1V8 | 50 | O | PU | PU | 1.8 V | x | v | UART RTS to host. NC if not used. |
| BT_HCI_CTS_1V8 | 51 | I | PU | PU | 1.8 V | x | v | UART CTS from host. NC if not used. |
| BT_HCI_TX_1V8 | 52 | O | PU | PU | 1.8 V | x | v | UART TX to host. NC if not used. |
| BT_HCI_RX_1V8 | 53 | I | PU | PU | 1.8 V | x | v | UART RX from host. NC if not used. |
| BT_AUD_IN | 56 | I | PD | PD | 1.8 V | x | v | <i>Bluetooth</i> PCM/I2S bus. Data in. NC if not used. |
| BT_AUD_OUT | 57 | O | PD | PD | 1.8 V | x | v | <i>Bluetooth</i> PCM/I2S bus. Data out. NC if not used. |
| BT_AUD_FSYNC | 58 | I/O | PD | PD | 1.8 V | x | v | <i>Bluetooth</i> PCM/I2S bus. Frame sync. NC if not used. |
| BT_AUD_CLK | 60 | I/O | PD | PD | 1.8 V | x | v | <i>Bluetooth</i> PCM/I2S bus. NC if not used. |
| Ground Pins | | | | | | | | |
| GND | 1, 7, 9, 15, 16, 17, 19, 20, 23, 24, 28, 29, 30, 31, 33, 34, 35, 37, 39, 44, 45, 48, 49, 54, 55, 59, 61, 63, G1-G36 | GND | | | – | v | v | |

(1) PU = pullup; PD = pulldown.

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

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

5 Specifications

All specifications are measured at the module pins using the TI WL1837MODCOM8I evaluation board. All measurements are performed with $V_{BAT} = 3.7\text{ V}$, $V_{IO} = 1.8\text{ V}$, 25°C for typical values with matched RF antennas, unless otherwise indicated.

NOTE

For level-shifting I/Os with the TI WL18x7MOD, see *Level Shifting WL18xx I/Os Application Report (SWRA448)*.

NOTE

This device as presently configured has been granted US Federal Communications Commission (FCC) equipment authorization (reference number Z64-WL18DBMOD). Any modifications to the device software or configuration, including but not limited to the init files, can cause device performance to vary beyond the scope of the currently referenced FCC authorization. Accordingly, if any user modifications are sought to be made to the device software or configuration, the user may be required to independently seek fresh FCC and other regulatory authorizations as relevant before distributing or marketing the devices or products incorporating the same.

5.1 Absolute Maximum Ratings⁽¹⁾

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

| PARAMETER | VALUE | UNIT |
|-------------------------------------|--------------------------|------|
| V_{BAT} | 4.8 ⁽²⁾ | V |
| V_{IO} | –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 | –40 to 85 ⁽³⁾ | °C |
| Storage temperature, T_{stg} | –40 to +85 | °C |

- 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.
- 4.8 V cumulative to 2.33 years, including charging dips and peaks
- Operating free-air temperature range at which the device can operate reliably for 15K cumulative active TX power-on hours (assuming a maximum junction temperature of (T_j) of 125°C). [Section 5.3, Power-On Hours \(POH\)](#), describes the correlation between T_j and PoH. In the WL18xx system, a control mechanism automatically ensures $T_j < 125^\circ\text{C}$. Whenever T_j approaches the threshold, this mechanism controls the transmitter patterns.

5.2 ESD Ratings

| | | VALUE | UNIT |
|-------------------------------------|--|-------|------|
| $V_{(ESD)}$ Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾ | ±1000 | V |
| | Charged device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾ | ±250 | |

- JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

5.3 Power-On Hours (POH)⁽¹⁾

| OPERATING JUNCTION TEMPERATURE (°C) | POH |
|-------------------------------------|--------|
| 125 | 15,000 |
| 120 | 20,000 |
| 115 | 27,000 |

- This information is provided solely to give the customer an estimation of the POH under certain specified conditions and does not extend the warranty for the device under TI's Standard Terms and Conditions.

Power-On Hours (POH)⁽¹⁾ (continued)

| OPERATING JUNCTION TEMPERATURE (°C) | POH |
|-------------------------------------|--------|
| 110 | 37,000 |
| 105 | 50,000 |

5.4 Recommended Operating Conditions

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

| | | | MIN | TYP | MAX | UNIT |
|---------------------------------|---|------------------------|--------------------------|--------------------------|-------------------|------|
| V _{BAT} ⁽¹⁾ | DC supply range for all modes | | 2.9 | 3.7 | 4.8 | V |
| V _{IO} | 1.8-V I/O ring power supply voltage | | 1.62 | 1.8 | 1.95 | V |
| V _{IH} | I/O high-level input voltage | | 0.65 x VDD _{IO} | | VDD _{IO} | V |
| V _{IL} | I/O low-level input voltage | | 0 | 0.35 x VDD _{IO} | | V |
| V _{IH_EN} | Enable inputs high-level input voltage | | 1.365 | | VDD _{IO} | V |
| V _{IL_EN} | Enable inputs low-level input voltage | | 0 | | 0.4 | V |
| V _{OH} | High-level output voltage | @ 4 mA | VDD _{IO} – 0.45 | | VDD _{IO} | V |
| V _{OL} | Low-level output voltage | @ 4 mA | 0 | | 0.45 | V |
| T _r , T _f | Input transitions time T _r , T _f from 10% to 90% (digital I/O) ⁽²⁾ | | 1 | | 10 | ns |
| T _r | Output rise time from 10% to 90% (digital pins) ⁽²⁾ | C _L < 25 pF | | | 5.3 | ns |
| T _f | Output fall time from 10% to 90% (digital pins) ⁽²⁾ | C _L < 25 pF | | | 4.9 | ns |
| | Ambient operating temperature | | –40 | | 85 | °C |
| Maximum power dissipation | WLAN operation | | | | 2.8 | W |
| | Bluetooth operation | | | | 0.2 | |

(1) 4.8 V is applicable only for 2.33 years (30% of the time). Otherwise, maximum V_{BAT} must not exceed 4.3 V.

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

5.5 External Digital Slow Clock Requirements

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

| PARAMETER | CONDITION | SYMBOL | MIN | TYP | MAX | UNIT |
|--|-------------------------|---------------------------------|--------------------------|-------|--------------------------|-------------------|
| Input slow clock frequency | | | | 32768 | | Hz |
| Input slow clock accuracy (Initial + temp + aging) | WLAN, Bluetooth | | | | ±250 | ppm |
| Input transition time T _r , T _f (10% to 90%) | | T _r , T _f | | | 200 | ns |
| Frequency input duty cycle | | | 15% | 50% | 85% | |
| Input voltage limits | Square wave, DC-coupled | V _{IH} | 0.65 x VDD _{IO} | | VDD _{IO} | V _{peak} |
| | | V _{IL} | 0 | | 0.35 x VDD _{IO} | |
| Input impedance | | | 1 | | | MΩ |
| Input capacitance | | | | | 5 | pF |

5.6 Thermal Characteristics for MOC 100-Pin Package

| AIR FLOW | | |
|-----------------|-------------------------------------|-----------------------|
| NAME | DESCRIPTION | (°C/W) ⁽¹⁾ |
| θ _{JA} | Junction to free air ⁽²⁾ | 16.6 |
| θ _{JB} | Junction to board | 6.06 |
| θ _{JC} | Junction to case ⁽³⁾ | 5.13 |

(1) °C/W = degrees Celsius per watt

(2) According to the JEDEC EIA/JESD 51 document

(3) Modeled using the JEDEC 2s2p thermal test board with 36 thermal vias

5.7 WLAN Performance: 2.4-GHz Receiver Characteristics

over operating free-air temperature range (unless otherwise noted). All RF and performance numbers are aligned to the module pin.

| PARAMETER | CONDITION | MIN | TYP | MAX | UNIT |
|---|-------------------|-------|-------|------|------|
| RF_ANT1 pin 2.4-GHz SISO | | | | | |
| Operation frequency range | | 2412 | | 2484 | MHz |
| Sensitivity: 20-MHz bandwidth. At < 10% PER limit | 1 Mbps DSSS | | -95.0 | | dBm |
| | 2 Mbps DSSS | | -92.0 | | |
| | 5.5 Mbps CCK | | -89.2 | | |
| | 11 Mbps CCK | | -86.3 | | |
| | 6 Mbps OFDM | | -91.0 | | |
| | 9 Mbps OFDM | | -89.0 | | |
| | 12 Mbps OFDM | | -88.0 | | |
| | 18 Mbps OFDM | | -85.5 | | |
| | 24 Mbps OFDM | | -82.5 | | |
| | 36 Mbps OFDM | | -79.0 | | |
| | 48 Mbps OFDM | | -74.0 | | |
| | 54 Mbps OFDM | | -72.5 | | |
| | MCS0 MM 4K | | -89.3 | | |
| | MCS1 MM 4K | | -86.5 | | |
| | MCS2 MM 4K | | -84.5 | | |
| | MCS3 MM 4K | | -81.5 | | |
| | MCS4 MM 4K | | -78.0 | | |
| | MCS5 MM 4K | | -73.5 | | |
| | MCS6 MM 4K | | -71.5 | | |
| | MCS7 MM 4K | | -70.0 | | |
| | MCS0 MM 4K 40 MHz | | -86.0 | | |
| MCS7 MM 4K 40 MHz | | -66.3 | | | |
| MCS0 MM 4K MRC | | -91.0 | | | |
| MCS7 MM 4K MRC | | -73.0 | | | |
| MCS13 MM 4K | | -70.0 | | | |
| MCS14 MM 4K | | -69.0 | | | |
| MCS15 MM 4K | | -68.3 | | | |
| Maximum input level | OFDM | -20.0 | -10.0 | | dBm |
| | CCK | -10.0 | -6.0 | | |
| | DSSS | -4.0 | -1.0 | | |
| Adjacent channel rejection: Sensitivity level +3 dB for OFDM; Sensitivity level +6 dB for 11b | 2 Mbps DSSS | 42.0 | | | dB |
| | 11 Mbps CCK | 38.0 | | | |
| | 54 Mbps OFDM | 2.0 | | | |
| RX leakage | | | -70 | | dBm |
| PER floor | | | 1.0% | | |
| RSSI accuracy | | | | ±3 | dB |

5.8 WLAN Performance: 2.4-GHz Transmitter Power

over operating free-air temperature range (unless otherwise noted). All RF and performance numbers are aligned to the module pin.

| PARAMETER | CONDITION ⁽¹⁾ | MIN | TYP | MAX | UNIT |
|---|--------------------------|------|-------|------|------|
| RF_ANT1 Pin 2.4-GHz SISO | | | | | |
| Output Power: Maximum RMS output power measured at 1 dB from IEEE spectral mask or EVM ⁽²⁾ | 1 Mbps DSSS | | 17.3 | | dBm |
| | 2 Mbps DSSS | | 17.3 | | |
| | 5.5 Mbps CCK | | 17.3 | | |
| | 11 Mbps CCK | | 17.3 | | |
| | 6 Mbps OFDM | | 17.1 | | |
| | 9 Mbps OFDM | | 17.1 | | |
| | 12 Mbps OFDM | | 17.1 | | |
| | 18 Mbps OFDM | | 17.1 | | |
| | 24 Mbps OFDM | | 16.2 | | |
| | 36 Mbps OFDM | | 15.3 | | |
| | 48 Mbps OFDM | | 14.6 | | |
| | 54 Mbps OFDM | | 13.8 | | |
| | MCS0 MM | | 16.1 | | |
| | MCS1 MM | | 16.1 | | |
| | MCS2 MM | | 16.1 | | |
| | MCS3 MM | | 16.1 | | |
| | MCS4 MM | | 15.3 | | |
| | MCS5 MM | | 14.6 | | |
| | MCS6 MM | | 13.8 | | |
| | MCS7 MM ⁽³⁾ | | 12.6 | | |
| MCS0 MM 40 MHz | | 14.8 | | | |
| MCS7 MM 40 MHz | | 11.3 | | | |
| RF_ANT1 + RF_ANT2 MIMO | | | | | |
| | MCS12 (WL18x5) | | 18.5 | | dBm |
| | MCS13 (WL18x5) | | 17.4 | | |
| | MCS14 (WL18x5) | | 14.5 | | |
| | MCS15 (WL18x5) | | 13.4 | | |
| RF_ANT1 + RF_ANT2 | | | | | |
| Operation frequency range | | 2412 | | 2484 | MHz |
| Return loss | | | -10.0 | | dB |
| Reference input impedance | | | 50.0 | | Ω |

(1) Maximum transmitter power (TP) degradation of up to 30% is expected, starting from 80°C ambient temperature on MIMO operation

(2) Regulatory constraints limit TI module output power to the following:

- Channel 14 is used only in Japan; to keep the channel spectral shaping requirement, the power is limited: 14.5 dBm.
- Channels 1, 11 @ OFDM legacy and HT 20-MHz rates: 12 dBm
- Channels 1, 11 @ HT 40-MHz rates: 10 dBm
- Channel 7 @ HT 40-MHz lower rates: 10 dBm
- Channel 5 @ HT 40-MHz upper rates: 10 dBm
- All 11B rates are limited to 16 dBm to comply with the ETSI PSD 10 dBm/MHz limit.
- All OFDM rates are limited to 16.5 dBm to comply with the ETSI EIRP 20 dBm limit.
- For clarification regarding power limitation, see the [WL18xx .INI File Application Report \(SWRU422\)](#).

(3) To ensure compliance with the EVM conditions specified in the PHY chapter of IEEE Std 802.11™ – 2012:

- MCS7 20 MHz channel 12 output power is 2 dB lower than the typical value.
- MCS7 20 MHz channel 8 output power is 1 dB lower than the typical value.

5.9 WLAN Performance: 5-GHz Receiver Characteristics

over operating free-air temperature range (unless otherwise noted). All RF and performance numbers are aligned to the module pin.

| PARAMETER | CONDITION | MIN | TYP | MAX | UNIT |
|---|-------------------|---------------------------|-------|--------|------|
| | | RF_ANT1 or RF_ANT2 | | | |
| Operation frequency range | | 4910.0 | | 5825.0 | MHz |
| Sensitivity: 20-MHz bandwidth. At < 10% PER limit | 6 Mbps OFDM 1K | | -92.5 | | dBm |
| | 9 Mbps OFDM 1K | | -90.5 | | |
| | 12 Mbps OFDM 1K | | -90.0 | | |
| | 18 Mbps OFDM 1K | | -87.5 | | |
| | 24 Mbps OFDM 1K | | -84.5 | | |
| | 36 Mbps OFDM 1K | | -81.0 | | |
| | 48 Mbps OFDM 1K | | -76.5 | | |
| | 54 Mbps OFDM 1K | | -74.6 | | |
| | MCS0 MM 4K | | -91.4 | | |
| | MCS1 MM 4K | | -88.0 | | |
| | MCS2 MM 4K | | -86.0 | | |
| | MCS3 MM 4K | | -83.0 | | |
| | MCS4 MM 4K | | -79.8 | | |
| | MCS5 MM 4K | | -75.5 | | |
| | MCS6 MM 4K | | -74.0 | | |
| | MCS7 MM 4K | | -72.4 | | |
| | MCS0 MM 4K 40 MHz | | -88.5 | | |
| | MCS7 MM 4K 40 MHz | | -69.3 | | |
| Maximum input level | OFDM | -30.0 | -15.0 | | dBm |
| Adjacent channel rejection sensitivity +3 dB | OFDM54 | 2.0 | | | dBm |
| RX LO leakage | | | -52.0 | | dBm |
| PER floor | | | 1.0% | 2.0% | |
| RSSI accuracy | | | ±3 | | dB |

5.10 WLAN Performance: 5-GHz Transmitter Power⁽¹⁾

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

| PARAMETER | CONDITION ⁽²⁾ | MIN | TYP | MAX | UNIT |
|--|--------------------------|------|-------|------|------|
| RF_ANT1 or RF_ANT2 | | | | | |
| Operation frequency range | | 4920 | | 5825 | MHz |
| RMS output power complies with IEEE mask and EVM requirements ⁽³⁾ | 6 Mbps OFDM | | 18.0 | | |
| | 9 Mbps OFDM | | 18.0 | | |
| | 12 Mbps OFDM | | 18.0 | | |
| | 18 Mbps OFDM | | 18.0 | | |
| | 24 Mbps OFDM | | 17.4 | | |
| | 36 Mbps OFDM | | 16.5 | | |
| | 48 Mbps OFDM | | 15.8 | | |
| | 54 Mbps OFDM | | 14.5 | | |
| | MCS0 MM | | 18.0 | | |
| | MCS1 MM 4K | | 18.0 | | |
| | MCS2 MM 4K | | 18.0 | | |
| | MCS3 MM 4K | | 18.0 | | |
| | MCS4 MM 4K | | 16.5 | | |
| | MCS5 MM 4K | | 15.8 | | |
| | MCS6 MM 4K | | 14.5 | | |
| | MCS7 MM 4K | | 13.0 | | |
| MCS0 MM 40 MHz | | 16.5 | | | |
| MCS7 MM 40 MHz | | 12.0 | | | |
| Output power resolution | | | 0.125 | | dB |
| Return loss | | | -10.0 | | dB |
| Reference input impedance | | | 50.0 | | Ω |

(1) All RF and performance numbers are aligned to the module pin.

(2) Maximum TP degradation of up to 30% is expected, starting from 80°C ambient temperature on 5-GHz TX operation.

(3) For further clarification regarding power limitation, see the [INI Guide](#).

5.11 WLAN Performance: Currents⁽¹⁾

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

| | SPECIFICATION ITEMS | TYP (AVG) – 25°C | UNITS |
|----------------------------|---|------------------|-------|
| Receiver | Low-power mode (LPM) 2.4-GHz RX SISO20 single chain | 49 | mA |
| | 2.4 GHz RX search SISO20 | 58 | |
| | 2.4-GHz RX search MIMO20 | 74 | |
| | 2.4-GHz RX search SISO40 | 63 | |
| | 2.4-GHz RX 20 M SISO 11 CCK | 60 | |
| | 2.4-GHz RX 20 M SISO 6 OFDM | 61 | |
| | 2.4-GHz RX 20 M SISO MCS7 | 69 | |
| | 2.4-GHz RX 20 M MRC 1 DSSS | 74 | |
| | 2.4-GHz RX 20 M MRC 6 OFDM | 81 | |
| | 2.4-GHz RX 20 M MRC 54 OFDM | 85 | |
| | 2.4-GHz RX 40 MHz MCS7 | 81 | |
| | 5-GHz RX 20 MHz OFDM6 | 68 | |
| | 5-GHz RX 20 MHz MCS7 | 77 | |
| | 5-GHz RX 40 MHz MCS7 | 85 | |
| Transmitter ⁽²⁾ | 2.4-GHz TX 20 M SISO 6 OFDM | 285 | mA |
| | 2.4-GHz TX 20 M SISO 11 CCK | 283 | |
| | 2.4-GHz TX 20 M SISO 54 OFDM | 247 | |
| | 2.4-GHz TX 20 M SISO MCS7 | 238 | |
| | 2.4-GHz TX 20 M MIMO MCS15 | 510 | |
| | 2.4-GHz TX 40 M SISO MCS7 | 243 | |
| | 5-GHz TX 20 M SISO 6 OFDM | 366 | |
| | 5-GHz TX 20 M SISO 54 OFDM | 329 | |
| | 5-GHz TX 20 M SISO MCS7 | 324 | |
| 5-GHz TX 40 M SISO MCS7 | 332 | | |

(1) All RF and performance numbers are aligned to the module pin.

(2) Numbers reflect the typical current consumption at maximum output power per rate.

5.12 Bluetooth Performance: BR, EDR Receiver Characteristics—In-Band Signals⁽¹⁾

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

| PARAMETER | CONDITION | MIN | TYP | MAX | 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 ⁽²⁾ dirty TX on | BR, BER = 0.1% | | -92.2 | | dBm |
| | EDR2, BER = 0.01% | | -91.7 | | |
| | EDR3, BER = 0.01% | | -84.7 | | |
| Bluetooth EDR BER floor at sensitivity + 10 dB Dirty TX off (for 1,600,000 bits) | EDR2 | 1e-6 | | | |
| | EDR3 | 1e-6 | | | |
| Bluetooth BR, EDR maximum usable input power | BR, BER = 0.1% | | -5.0 | | dBm |
| | EDR2, BER = 0.1% | | -15.0 | | |
| | EDR3, BER = 0.1% | | -15.0 | | |
| Bluetooth BR intermodulation | Level of interferers for n = 3, 4, and 5 | -36.0 | -30.0 | | dBm |

(1) All RF and performance numbers are aligned to the module pin.

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

Bluetooth Performance: BR, EDR Receiver Characteristics—In-Band Signals⁽¹⁾ (continued)

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

| PARAMETER | CONDITION | | MIN | TYP | MAX | UNIT |
|--|-------------------------------|------|-----|-------|-------|------|
| Bluetooth BR, EDR C/I performance Numbers show wanted signal-to-interfering-signal ratio. Smaller numbers indicate better C/I performances (Image frequency = -1 MHz) | BR, co-channel | | | | 10 | dB |
| | EDR, co-channel | EDR2 | | | 12 | |
| | | EDR3 | | | 20 | |
| | BR, adjacent ±1 MHz | | | | -3.0 | |
| | EDR, adjacent ±1 MHz, (image) | EDR2 | | | -3.0 | |
| | | EDR3 | | | 2.0 | |
| | BR, adjacent +2 MHz | | | | -33.0 | |
| | EDR, adjacent +2 MHz | EDR2 | | | -33.0 | |
| | | EDR3 | | | -28.0 | |
| | BR, adjacent -2 MHz | | | | -20.0 | |
| | EDR, adjacent -2 MHz | EDR2 | | | -20.0 | |
| | | EDR3 | | | -13.0 | |
| | BR, adjacent ≥ ±3 MHz | | | | -42.0 | |
| | EDR, adjacent ≥ ±3 MHz | EDR2 | | | -42.0 | |
| EDR3 | | | | -36.0 | | |
| Bluetooth BR, EDR RF return loss | | | | -10.0 | | dB |

5.13 Bluetooth Performance: Transmitter, BR⁽¹⁾

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

| PARAMETER | MIN | TYP | MAX | UNIT |
|-------------------------------------|--------------------------|-------|-----|------|
| BR RF output power ⁽²⁾ | $V_{BAT} \geq 3 V^{(3)}$ | 11.7 | | dBm |
| | $V_{BAT} < 3 V^{(3)}$ | 7.2 | | |
| BR gain control range | | 30.0 | | dB |
| BR power control step | | 5.0 | | dB |
| BR adjacent channel power M-N = 2 | | -43.0 | | dBm |
| BR adjacent channel power M-N > 2 | | -48.0 | | dBm |

(1) All RF and performance numbers are aligned to the module pin.

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

(3) VBAT is measured with an on-chip ADC that has an accuracy error of up to 5%.

5.14 Bluetooth Performance: Transmitter, EDR⁽¹⁾

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

| PARAMETER | MIN | TYP | MAX | UNIT |
|--------------------------------------|--------------------------|-----|-----|------|
| EDR output power ⁽²⁾ | $V_{BAT} \geq 3 V^{(3)}$ | 7.2 | | dBm |
| | $V_{BAT} < 3 V^{(3)}$ | 5.2 | | |
| EDR gain control range | | 30 | | dB |
| EDR power control step | | 5 | | dB |
| EDR adjacent channel power M-N = 1 | | -36 | | dBc |
| EDR adjacent channel power M-N = 2 | | -30 | | dBm |
| EDR adjacent channel power M-N > 2 | | -42 | | dBm |

(1) All RF and performance numbers are aligned to the module pin.

(2) Values reflect default maximum power. Maximum power can be changed using a VS command.

(3) VBAT is measured with an on-chip ADC that has an accuracy error of up to 5%.

5.15 Bluetooth Performance: Modulation, BR⁽¹⁾

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

| CHARACTERISTICS | CONDITION ⁽²⁾ | | MIN | TYP | MAX | UNIT |
|---|--|---|----------|-----|----------|----------------|
| BR –20 dB bandwidth | | | | 925 | 995 | kHz |
| BR modulation characteristics | $\Delta f1_{avg}$ | Mod data = 4 1s, 4 0s: 111100001111... | 145 | 160 | 170 | kHz |
| | $\Delta f2_{max} \geq$ limit for at least 99.9% of all $\Delta f2_{max}$ | Mod data = 1010101... | 120 | 130 | | kHz |
| | $\Delta f2_{avg}, \Delta f1_{avg}$ | | 85% | 88% | | |
| BR carrier frequency drift | One-slot packet | | –25 | | 25 | kHz |
| | Three- and five-slot packet | | –35 | | 35 | kHz |
| BR drift rate | $ fk+5 - fk , k = 0 \dots max$ | | | | 15 | kHz/50 μ s |
| BR initial carrier frequency tolerance ⁽³⁾ | f0–fTX | | ± 75 | | ± 75 | kHz |

- (1) All RF and performance numbers are aligned to the module pin.
- (2) Performance values reflect maximum power.
- (3) Numbers include XTAL frequency drift over temperature and aging.

5.16 Bluetooth Performance: Modulation, EDR⁽¹⁾

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

| PARAMETER ⁽²⁾ | CONDITION | MIN | TYP | MAX | UNIT |
|--|-----------|----------|-----|----------|------|
| EDR carrier frequency stability | | –5 | | 5 | kHz |
| EDR initial carrier frequency tolerance ⁽³⁾ | | ± 75 | | ± 75 | kHz |
| EDR RMS DEVM | EDR2 | | 4% | 15% | |
| | EDR3 | | 4% | 10% | |
| EDR 99% DEVM | EDR2 | | | 30% | |
| | EDR3 | | | 20% | |
| EDR peak DEVM | EDR2 | | 9% | 25% | |
| | EDR3 | | 9% | 18% | |

- (1) All RF and performance numbers are aligned to the module pin.
- (2) Performance values reflect maximum power.
- (3) Numbers include XTAL frequency drift over temperature and aging.

5.17 Bluetooth LE Performance: Receiver Characteristics – In-Band Signals⁽¹⁾

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

| PARAMETER | CONDITION ⁽²⁾ | MIN | TYP | MAX | UNIT |
|--|--|------|-------|------|----------|
| Bluetooth LE operation frequency range | | 2402 | | 2480 | MHz |
| Bluetooth LE channel spacing | | | 2 | | MHz |
| Bluetooth LE input impedance | | | 50 | | Ω |
| Bluetooth LE sensitivity ⁽³⁾ Dirty TX on | | | –92.2 | | dBm |
| Bluetooth LE maximum usable input power | | –5 | | | dBm |
| Bluetooth LE intermodulation characteristics | Level of interferers. For n = 3, 4, 5 | –36 | –30 | | dBm |

- (1) All RF and performance numbers are aligned to the module pin.
- (2) BER of 0.1% corresponds to PER of 30.8% for a minimum of 1500 transmitted packets, according to the Bluetooth LE test specification.
- (3) Sensitivity degradation of up to –3 dB can occur due to fast clock harmonics.

Bluetooth LE Performance: Receiver Characteristics – In-Band Signals⁽¹⁾ (continued)

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

| PARAMETER | CONDITION ⁽²⁾ | MIN | TYP | MAX | UNIT |
|---|--------------------------|-----|-----|-----|------|
| Bluetooth LE C/I performance. Note: Numbers show wanted signal-to-interfering-signal ratio. Smaller numbers indicate better C/I performance. Image = -1 MHz | LE, co-channel | | | 12 | dB |
| | LE, adjacent ±1 MHz | | | 0 | |
| | LE, adjacent +2 MHz | | | -38 | |
| | LE, adjacent -2 MHz | | | -15 | |
| | LE, adjacent ≥ ±3 MHz | | | -40 | |

5.18 Bluetooth LE Performance: Transmitter Characteristics⁽¹⁾

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

| PARAMETER | | MIN | TYP | MAX | UNIT |
|---|---------------------------------------|-----|-------|-----|------|
| Bluetooth LE RF output power ⁽²⁾ | V _{BAT} ≥ 3 V ⁽³⁾ | | 7.0 | | dBm |
| | V _{BAT} < 3 V ⁽³⁾ | | 7.0 | | |
| Bluetooth LE adjacent channel power M-N = 2 | | | -51.0 | | dBm |
| Bluetooth LE adjacent channel power M-N > 2 | | | -54.0 | | dBm |

- (1) All RF and performance numbers are aligned to the module pin.
- (2) Bluetooth LE power is restricted to comply with the ETSI 10-dBm EIRP limit requirement.
- (3) V_{BAT} is measured with an on-chip ADC that has an accuracy error of up to 5%.

5.19 Bluetooth LE Performance: Modulation Characteristics⁽¹⁾

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

| CHARACTERISTICS | CONDITION ⁽²⁾ | | MIN | TYP | MAX | UNIT |
|---|---|---|-----|-----|-----|-----------|
| Bluetooth LE modulation characteristics | Δf1avg | Mod data = 4 1s, 4 0s: 111100001111... | 240 | 250 | 260 | kHz |
| | Δf2max ≥ limit for at least 99.9% of all Δf2max | Mod data = 1010101... | 195 | 215 | | |
| | Δf2avg, Δf1avg | | 85% | 90% | | |
| Bluetooth LE carrier frequency drift | f0 - fnl , n = 2,3 K | | -25 | | 25 | kHz |
| Bluetooth LE drift rate | f1 - f0l and fn - fn-5l , n = 6,7 K | | | | 15 | kHz/50 μs |
| Bluetooth LE initial carrier frequency tolerance ⁽³⁾ | fn - fTX | | ±75 | | ±75 | kHz |

- (1) All RF and performance numbers are aligned to the module pin.
- (2) Performance values reflect maximum power.
- (3) Numbers include XTAL frequency drift over temperature and aging.

5.20 Bluetooth BR and EDR Dynamic Currents

Current is measured at output power as follows: BR at 11.7 dBm; EDR at 7.2 dBm.

| USE CASE ⁽¹⁾ (2) | TYP | UNIT |
|---|-------|------|
| 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 kbps | 10.4 | mA |
| EDR A2DP EDR2 (master). MP3 high quality – 192 kbps | 7.5 | mA |
| Full throughput ACL RX: RX-2DH5 ⁽³⁾ (4) | 18.0 | mA |
| Full throughput BR ACL TX: TX-DH5 ⁽⁴⁾ | 50.0 | mA |
| Full throughput EDR ACL TX: TX-2DH5 ⁽⁴⁾ | 33.0 | mA |

- (1) The role of Bluetooth in all scenarios except A2DP is slave.
- (2) CL1P5 PA is connected to V_{BAT}, 3.7 V.
- (3) ACL RX has the same current in all modulations.
- (4) Full throughput assumes data transfer in one direction.

Bluetooth BR and EDR Dynamic Currents (continued)

Current is measured at output power as follows: BR at 11.7 dBm; EDR at 7.2 dBm.

| USE CASE ^{(1) (2)} | TYP | UNIT |
|---|-------|------|
| Page scan or inquiry scan (scan interval is 1.28 s or 11.25 ms, respectively) | 253.0 | μA |
| Page scan and inquiry scan (scan interval is 1.28 s and 2.56 s, respectively) | 332.0 | μA |

5.21 Bluetooth LE Currents

All current measured at output power of 6.5 dBm

| USE CASE ⁽¹⁾ | TYP | UNIT |
|--|-----|------|
| Advertising, not connectable ⁽²⁾ | 131 | μA |
| Advertising, discoverable ⁽²⁾ | 143 | μA |
| Scanning ⁽³⁾ | 266 | μA |
| Connected, master role, 1.28-s connect interval ⁽⁴⁾ | 124 | μA |
| Connected, slave role, 1.28-s connect interval ⁽⁴⁾ | 132 | μA |

- (1) CL1p% PA is connected to V_{BAT}, 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

5.22 Timing and Switching Characteristics

5.22.1 Power Management

5.22.1.1 Block Diagram – Internal DC2DCs

The device incorporates three internal DC2DCs (switched-mode power supplies) to provide efficient internal supplies, derived from V_{BAT}.

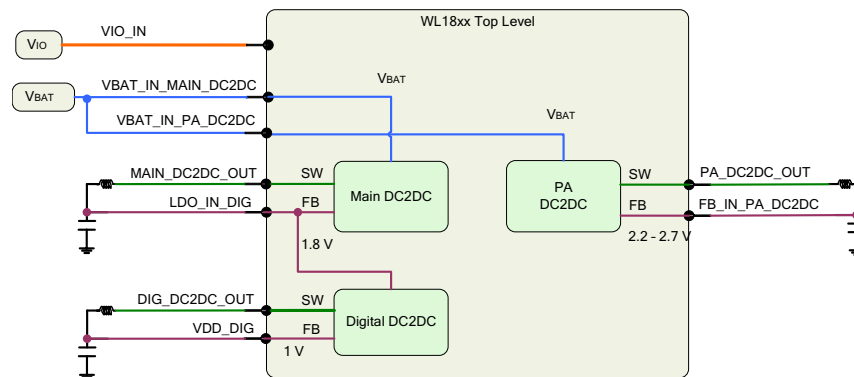


Figure 5-1. Internal DC2DCs

5.22.2 Power-Up and Shut-Down States

The correct power-up and shut-down sequences must be followed to avoid damage to the device.

While V_{BAT} or V_{IO} or both are deasserted, no signals should be driven to the device. The only exception is the slow clock that is a fail-safe I/O.

While V_{BAT}, V_{IO}, and slow clock are fed to the device, but WL_EN is deasserted (low), the device is in SHUTDOWN state. In SHUTDOWN state all functional blocks, internal DC2DCs, clocks, and LDOs are disabled.

To perform the correct power-up sequence, assert (high) WL_EN. The internal DC2DCs, LDOs, and clock start to ramp and stabilize. Stable slow clock, V_{IO}, and V_{BAT} are prerequisites to the assertion of one of the enable signals.

To perform the correct shut-down sequence, deassert (low) WL_EN while all the supplies to the device (V_{BAT} , V_{IO} , and slow clock) are still stable and available. The supplies to the chip (V_{BAT} and V_{IO}) can be deasserted only after both enable signals are deasserted (low).

Figure 5-2 shows the general power scheme for the module, including the power-down sequence.

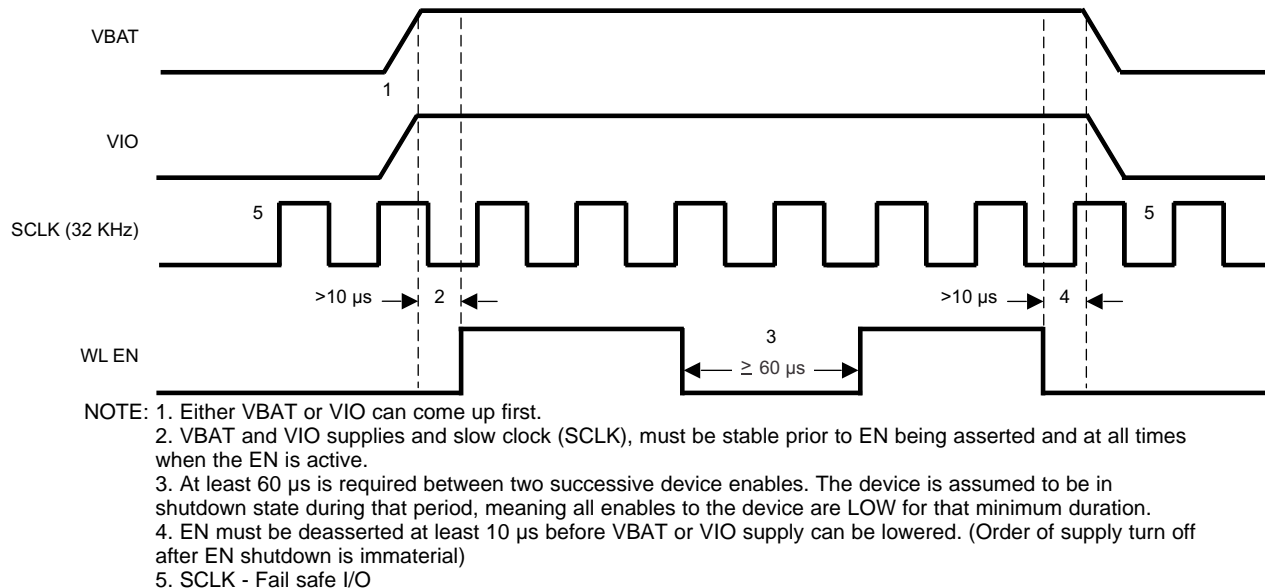


Figure 5-2. Power-Up System

5.22.3 Chip Top-level Power-Up Sequence

Figure 5-3 shows the top-level power-up sequence for the chip.

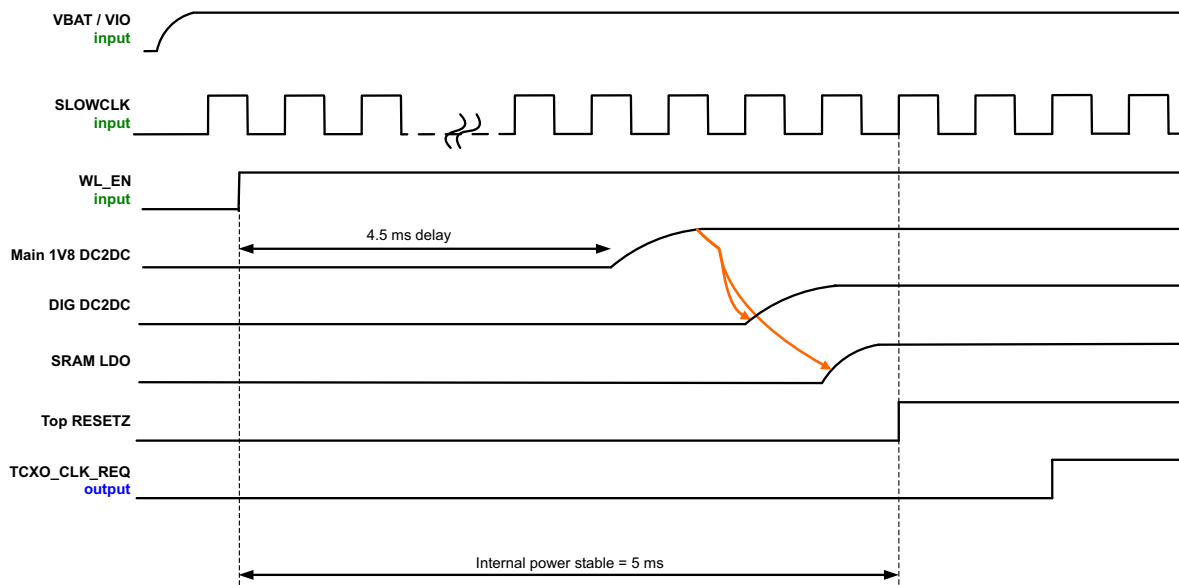


Figure 5-3. Chip Top-Level Power-Up Sequence

5.22.4 WLAN Power-Up Sequence

Figure 5-4 shows the WLAN power-up sequence.

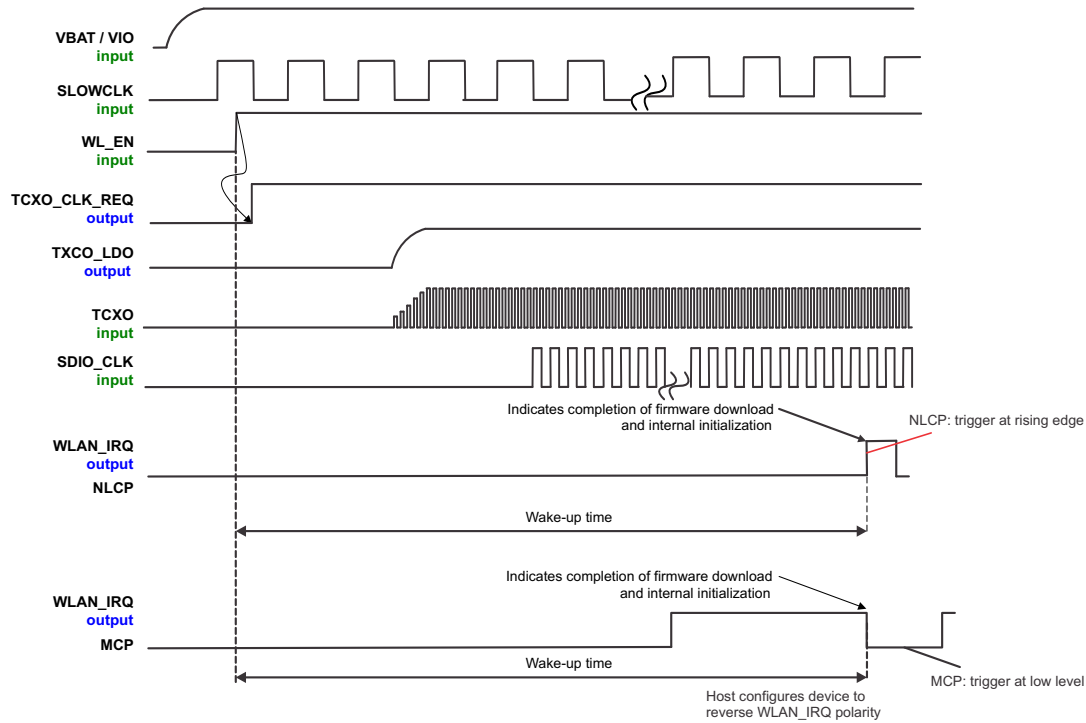


Figure 5-4. WLAN Power-Up Sequence

5.22.5 Bluetooth-Bluetooth LE Power-Up Sequence

Figure 5-5 shows the Bluetooth-Bluetooth LE power-up sequence.

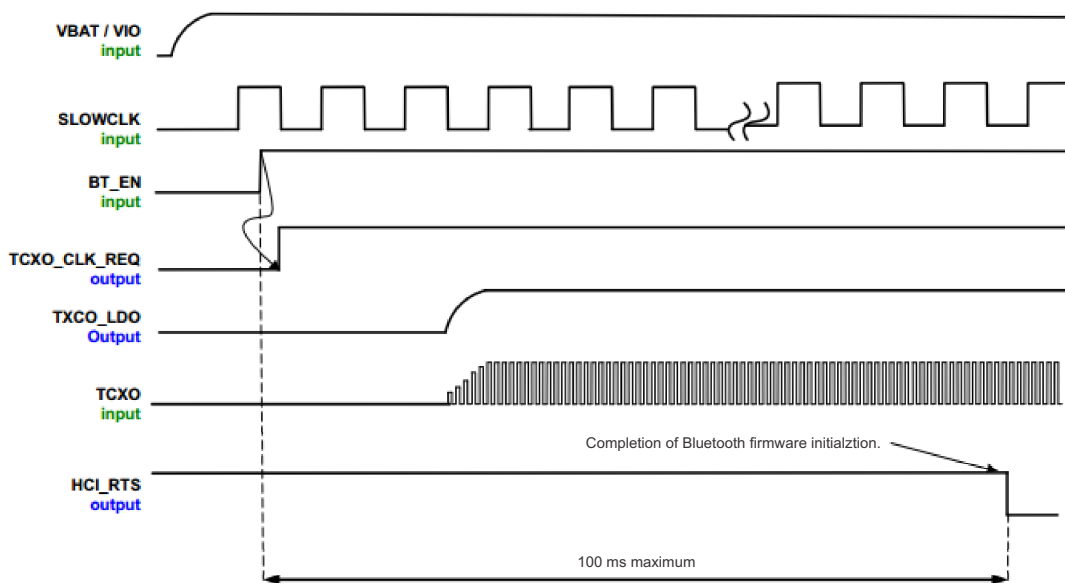


Figure 5-5. Bluetooth-Bluetooth LE Power-Up Sequence

5.2.2.6 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

5.2.2.6.1 SDIO Timing Specifications

Figure 5-6 and Figure 5-7 show the SDIO switching characteristics over recommended operating conditions and with the default rate for input and output.

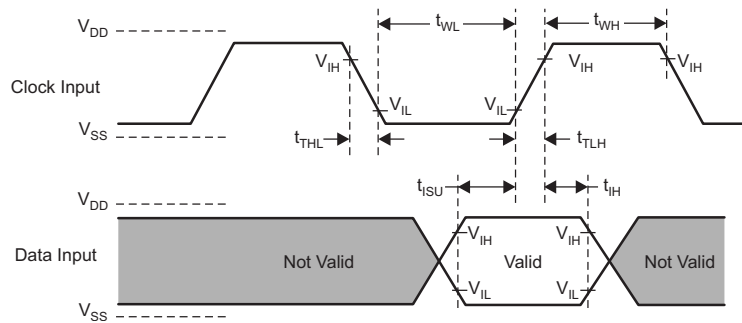


Figure 5-6. SDIO Default Input Timing

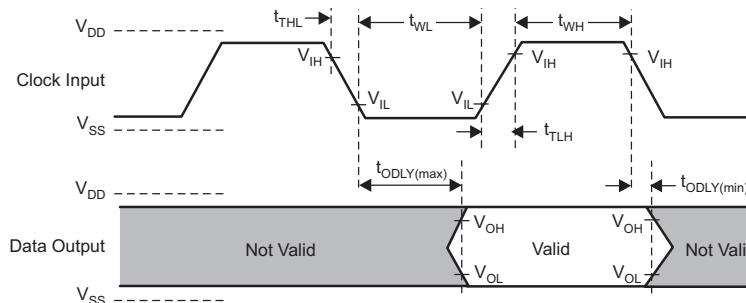


Figure 5-7. SDIO Default Output Timing

Table 5-1 lists the SDIO default timing characteristics.

Table 5-1. SDIO Default Timing Characteristics⁽¹⁾

| PARAMETER ⁽²⁾ | | MIN | MAX | UNIT |
|--------------------------|---|-------|-------|------|
| f_{clock} | Clock frequency, CLK | 0.0 | 26.0 | MHz |
| DC | Low, high duty cycle | 40.0% | 60.0% | |
| t_{TLH} | Rise time, CLK | | 10.0 | ns |
| t_{THL} | Fall time, CLK | | 10.0 | ns |
| t_{ISU} | Setup time, input valid before CLK \uparrow | 3.0 | | ns |
| t_{IH} | Hold time, input valid after CLK \uparrow | 2.0 | | ns |
| t_{ODLY} | Delay time, CLK \downarrow to output valid | 7.0 | 10.0 | ns |
| C_1 | 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.

5.22.6.2 SDIO Switching Characteristics – High Rate

Figure 5-8 and Figure 5-9 show the parameters for maximum clock frequency.

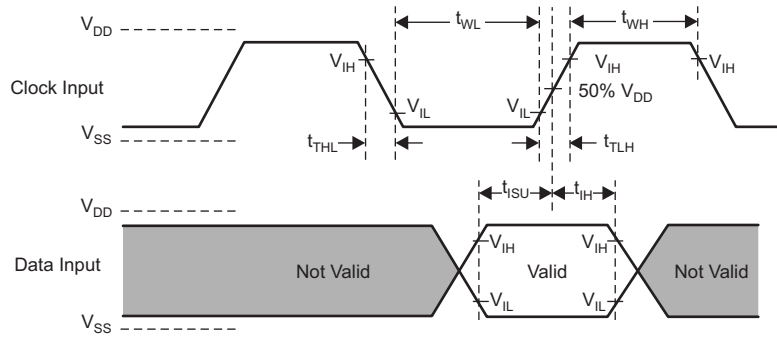


Figure 5-8. SDIO HS Input Timing

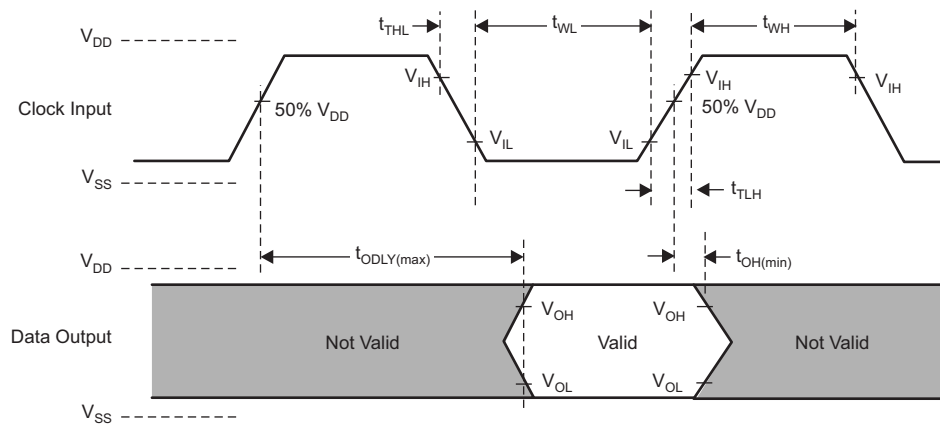


Figure 5-9. SDIO HS Output Timing

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

Table 5-2. SDIO HS Timing Characteristics

| PARAMETER | | MIN | MAX | UNIT |
|-------------|---|-------|-------|------|
| f_{clock} | Clock frequency, CLK | 0.0 | 52.0 | MHz |
| DC | Low, high duty cycle | 40.0% | 60.0% | |
| t_{TLH} | Rise time, CLK | | 3.0 | ns |
| t_{THL} | Fall time, CLK | | 3.0 | ns |
| t_{SU} | Setup time, input valid before CLK \uparrow | 3.0 | | ns |
| t_{H} | Hold time, input valid after CLK \uparrow | 2.0 | | ns |
| t_{ODLY} | Delay time, CLK \uparrow to output valid | 7.0 | 10.0 | ns |
| C_I | Capacitive load on outputs | | 10.0 | pF |

5.22.7 HCI UART Shared-Transport Layers for All Functional Blocks (Except WLAN)

The device includes a UART module dedicated to the *Bluetooth* shared-transport, host controller interface (HCI) transport layer. The HCI 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 EXCEPT WLAN | BLUETOOTH VOICE-AUDIO |
|--------------|--|-----------------------|
| WLAN HS SDIO | Over UART | <i>Bluetooth</i> PCM |

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 |

5.22.7.1 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.

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 5-10 shows the UART timing.

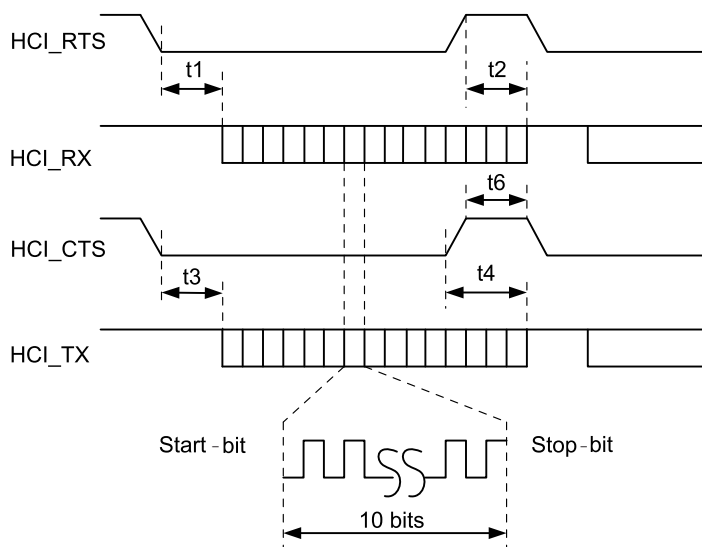


Figure 5-10. UART Timing Diagram

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 5-11 shows the UART data frame.

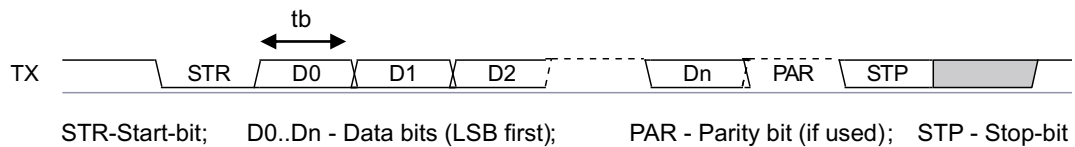


Figure 5-11. UART Data Frame

5.22.8 Bluetooth Codec-PCM (Audio) Timing Specifications

Figure 5-12 shows the Bluetooth codec-PCM (audio) timing diagram.

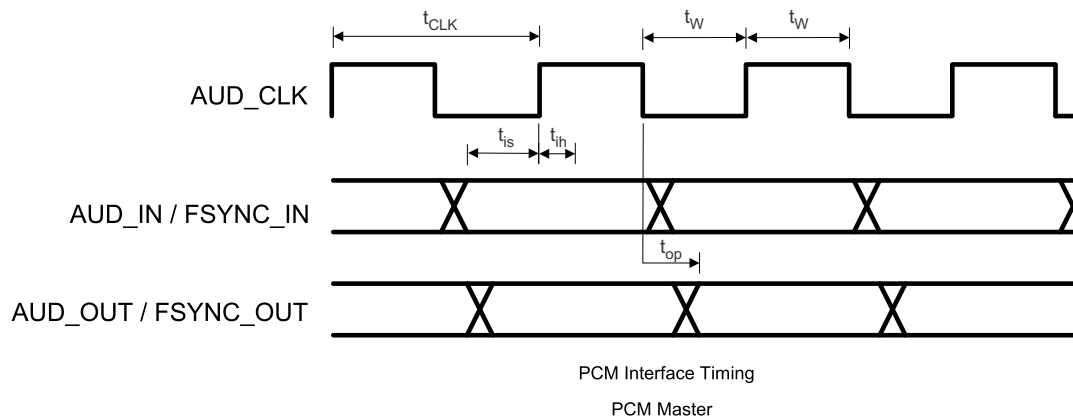


Figure 5-12. Bluetooth Codec-PCM (Audio) Master Timing Diagram

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} | 162.76 (6.144 MHz) | 15625 (64 kHz) | ns |
| High or low pulse width | T_w | 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} | 81.38 (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 Detailed Description

The WiLink 8 module is a self-contained connectivity solution based on WiLink 8 connectivity. As the eighth-generation connectivity combo chip from TI, the WiLink 8 module is based on proven technology.

Figure 6-1 shows a high-level view of the WL1837MOD variant.

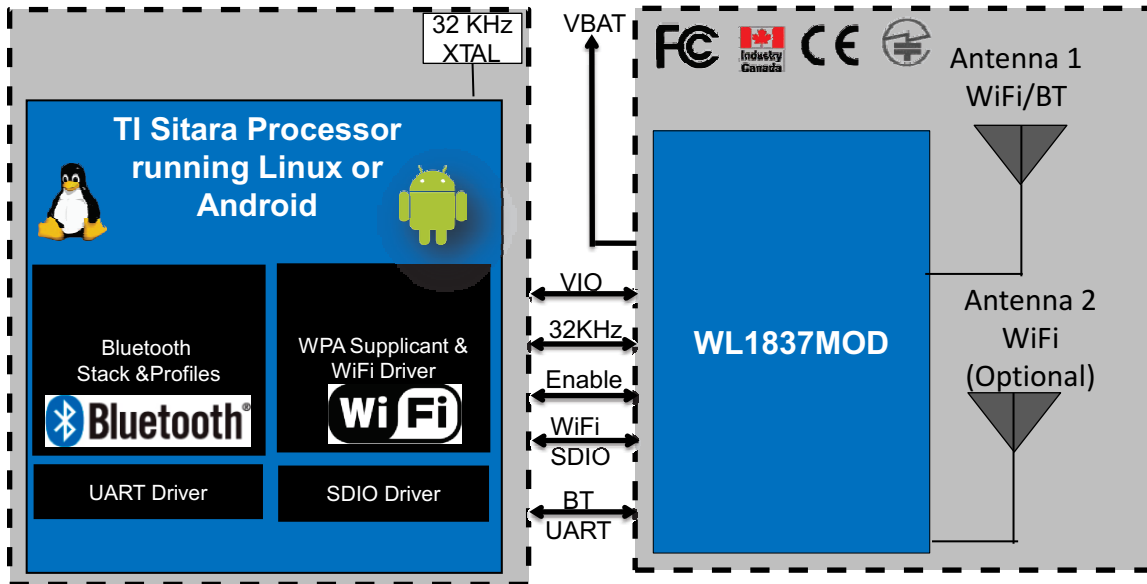


Figure 6-1. WL1837MOD High-Level System Diagram

Table 6-1 through Table 6-3 list performance parameters along with shutdown and sleep currents.

Table 6-1. WLAN Performance Parameters

| WLAN ⁽¹⁾ | SPECIFICATION (TYP) | CONDITIONS |
|--|---------------------|----------------------------|
| Maximum TX power, 5 GHz (OFDM6) | 18 dBm | 6 Mbps OFDM |
| Maximum TX power, 2.4 GHz (1DSSS) | 16.5 dBm | 1 Mbps DSSS |
| Minimum sensitivity, 5 GHz (OFDM6) | -92.5dBm | 6 Mbps OFDM |
| Minimum sensitivity, 2.4GHz (1DSSS) | -95 dBm | 1 Mbps DSSS |
| Sleep current | 160 μ A | Leakage, firmware retained |
| Connected IDLE | 750 μ A | No traffic IDLE connect |
| RX search | 58 mA | 2.4GHz SISO 20 |
| RX current (SISO20) | 69 mA | MCS7, 2.4 GHz |
| RX current (SISO20) | 77 mA | MCS7, 5 GHz |
| TX current (SISO20) | 238 mA | MCS7, 2.4 GHz |
| TX current (SISO20) | 324 mA | MCS7, 5 GHz |
| Maximum peak current consumption during calibration ⁽²⁾ | 850 mA | |

- (1) System design power scheme must comply with both peak and average TX bursts.
- (2) Peak current V_{BAT} can hit 850 mA during device calibration.
 - At wakeup, the WiLink 8 module performs the entire calibration sequence at the center of the 2.4-GHz band.
 - Once a link is established, calibration is performed periodically (every 5 minutes) on the specific channel tuned.
 - The maximum V_{BAT} value is based on peak calibration consumption with a 30% margin.

Table 6-2. Bluetooth Performance Parameters

| BLUETOOTH | SPECIFICATION (TYP) | CONDITIONS |
|---------------------|---------------------|------------|
| Maximum TX power | 11.7 dBm | GFSK |
| Minimum sensitivity | -92.2 dBm | GFSK |

Table 6-2. Bluetooth Performance Parameters (continued)

| BLUETOOTH | SPECIFICATION (TYP) | CONDITIONS |
|-----------------|---------------------|---|
| Sniff | 178 μ A | 1 attempt, 1.28 s (+4 dBm) |
| Page or inquiry | 253 μ A | 1.28-s interrupt, 11.25-ms scan window (+4 dBm) |
| A2DP | 7.5 mA | MP3 high quality 192 kbps (+4 dBm) |

Table 6-3. Shutdown and Sleep Currents

| PARAMETER | POWER SUPPLY CURRENT | TYP | UNIT |
|--|----------------------|-----|---------|
| Shutdown mode All functions shut down | VBAT | 10 | μ A |
| | VIO | 2 | |
| WLAN sleep mode | VBAT | 160 | μ A |
| | VIO | 60 | |
| Bluetooth sleep mode | VBAT | 110 | μ A |
| | VIO | 60 | |

6.1 WLAN Features

The device supports the following WLAN features:

- Integrated 2.4-GHz power amplifiers (PAs) for a complete WLAN solution
- Baseband processor: IEEE Std 802.11a, 802.11b/g, 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* and *Bluetooth* LE wireless technology
- 2.4- and 5-GHz radio
 - Internal LNA and PA
 - IEEE Std 802.11a, 802.11b, 802.11g, and 802.11n
- 4-bit SDIO host interface, including high speed (HS) and V3 modes

6.2 Bluetooth Features

The device supports the following *Bluetooth* features:

- *Bluetooth* 4.1 as well as CSA2
- Concurrent operation and built-in coexisting and prioritization handling of *Bluetooth* and *Bluetooth* LE wireless technology, 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

6.3 Bluetooth LE Features

The device supports the following *Bluetooth* LE features:

- *Bluetooth* 4.0 LE dual-mode standard
- All roles and role combinations, mandatory as well as optional
- Up to 10 LE connections
- Independent LE buffering allowing many multiple connections with no affect on BR-EDR performance

6.4 WiLink 8 Module Markings

Figure 6-2 shows the markings for the TI WiLink 8 module.

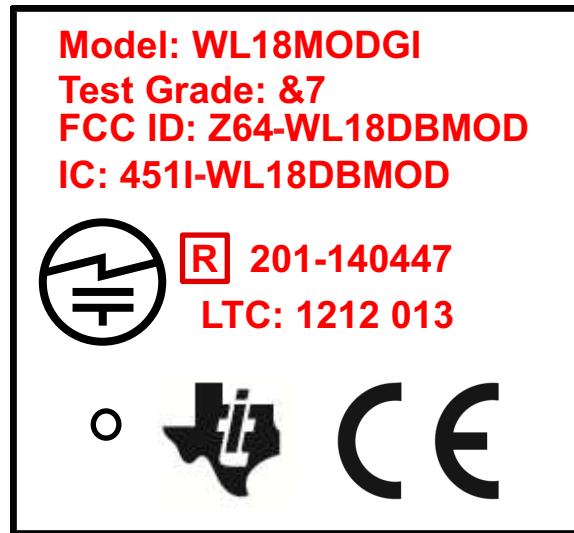


Figure 6-2. WiLink 8 Module Markings

Table 6-4 describes the WiLink 8 module markings.

Table 6-4. Description of WiLink 8 Module Markings

| MARKING | DESCRIPTION |
|----------------|--|
| WL18 MODGI | Model |
| &7 | Test grade (for more information, see Section 6.5, Test Grades) |
| Z64-WL18DBMOD | FCC ID: single modular FCC grant ID |
| 451I-WL18DBMOD | IC: single modular IC grant ID |
| 201-140447 | R: single modular TELEC grant ID |
| YYWW SSF | LTC (lot trace code): <ul style="list-style-type: none"> • YY = year (for example, 12 = 2012) • WW = week • SS = serial number (01 to 99) matching manufacturer lot number • F = Reserved for internal use |
| | TELEC compliance mark |
| CE | CE compliance mark |

6.5 Test Grades

To minimize delivery time, 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 WL1807MOD, the part shipped can be marked with a test grade of 37, 07 (see [Table 6-5](#)).

Table 6-5. Test Grade Markings

| MARK | WLAN 2.4 and 5 GHz | BLUETOOTH |
|------|--------------------|-----------|
| 07 | Tested | – |
| 37 | Tested | Tested |

7 Applications and Implementation

NOTE

Information in the following Applications section is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

7.1 Application Information

7.1.1 Typical Application – WL1837MOD Reference Design

Figure 7-1 shows the TI WL1837MOD reference design.

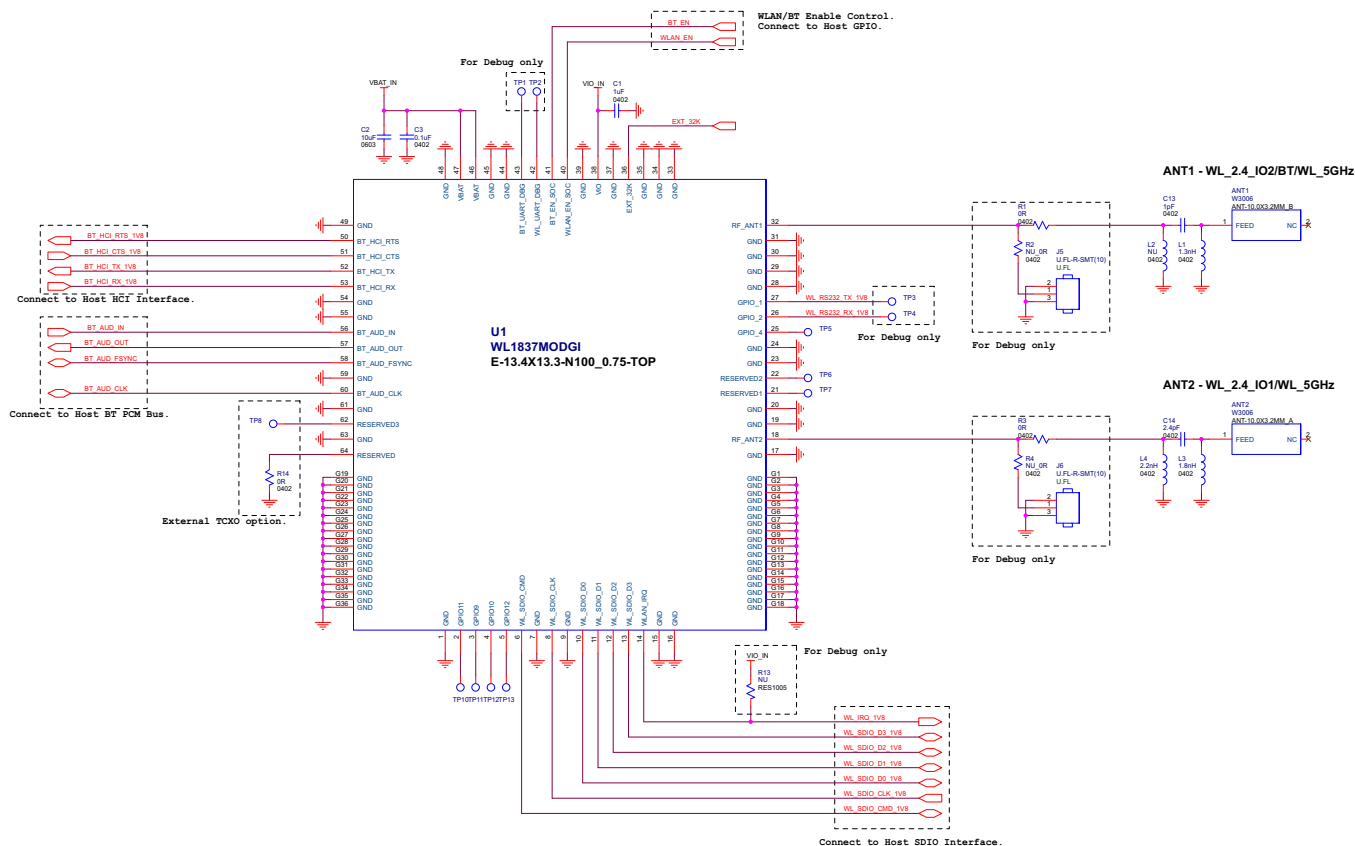


Figure 7-1. TI Module Reference Schematics

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

Table 7-1. Bill of Materials

| ITEM | DESCRIPTION | PART NO. | PACKAGE | REFERENCE | QTY | MFR |
|------|---|--------------------|----------------------|------------|-----|--------|
| 1 | WL1837 Wi-Fi/Bluetooth module | WL1837MODGI | 13.4 × 13.3 × 2.0 mm | U1 | 1 | TI |
| 2 | XOSC 3225/32.768 kHz/1.8 V/±50 ppm | 7XZ3200005 | 3.2 × 2.5 × 1.0 mm | OSC1 | 1 | TXC |
| 3 | ANT/Chip/2.4 GHz and 5 GHz ⁽¹⁾ | W3006 | 10.0 × 3.2 × 1.5 mm | ANT1, ANT2 | 2 | Pulse |
| 4 | Mini-RF header receptacle | U.FL-R-SMT-1 (10) | 3.0 × 2.6 × 1.25 mm | J5, J6 | 2 | Hirose |
| 5 | Inductor 0402/1.3 nH/±0.1 nH/SMD | LQP15MN1N3B02 | 0402 | L1 | 1 | Murata |
| 6 | Inductor 0402/1.8 nH/±0.1 nH/SMD | LQP15MN1N8B02 | 0402 | L3 | 1 | Murata |
| 7 | Inductor 0402/2.2 nH/±0.1 nH/SMD | LQP15MN2N2B02 | 0402 | L4 | 1 | Murata |
| 8 | Capacitor 0402/1 pF/50 V/C0G/±0.1 pF | GJM1555C1H1R0BB01 | 0402 | C13 | 1 | Murata |
| 9 | Capacitor 0402/2.4 pF/50 V/C0G/±0.1 pF | GJM1555C1H2R4BB01 | 0402 | C14 | 1 | Murata |
| 10 | Capacitor 0402/0.1 μF/10 V/X7R/±10% | 0402B104K100CT | 0402 | C3 | 1 | Walsin |
| 11 | Capacitor 0402/1 μF/6.3 V/X5R/±10%/HF | GRM155R60J105KE19D | 0402 | C1 | 1 | Murata |
| 12 | Capacitor 0603/10 μF/6.3 V/X5R/±20% | C1608X5R0J106M | 0603 | C2 | 1 | TDK |
| 13 | Resistor 0402/0R/±5% | WR04X000 PTL | 0402 | R1, R3 | 2 | Walsin |

(1) For more information, see productfinder.pulseeng.com/product/W3006.

7.1.2 Design Recommendations

This section describes the layout recommendations for the WL1837 module, RF trace, and antenna.

Table 7-2 summarizes the layout recommendations.

Table 7-2. Layout Recommendations Summary

| ITEM | DESCRIPTION |
|------|---|
| | Thermal |
| 1 | The proximity of ground vias must be close to the pad. |
| 2 | Signal traces must not be run underneath the module on the layer where the module is mounted. |
| 3 | Have a complete ground pour in layer 2 for thermal dissipation. |
| 4 | Have a solid ground plane and ground vias under the module for stable system and thermal dissipation. |
| 5 | Increase the ground pour in the first layer and have all of the traces from the first layer on the inner layers, if possible. |
| 6 | Signal traces can be run on a third layer under the solid ground layer, which is below the module mounting layer. |
| | RF Trace and Antenna Routing |
| 7 | The RF trace antenna feed must be as short as possible beyond the ground reference. At this point, the trace starts to radiate. |
| 8 | The RF trace bends must be gradual with an approximate maximum bend of 45 degrees with trace mitered. RF traces must not have sharp corners. |
| 9 | RF traces must have via stitching on the ground plane beside the RF trace on both sides. |
| 10 | RF traces must have constant impedance (microstrip transmission line). |
| 11 | For best results, the RF trace ground layer must be the ground layer immediately below the RF trace. The ground layer must be solid. |
| 12 | There must be no traces or ground under the antenna section. |
| 13 | RF traces must be as short as possible. The antenna, RF traces, and modules must be on the edge of the PCB product. The proximity of the antenna to the enclosure and the enclosure material must also be considered. |
| | Supply and Interface |
| 14 | The power trace for V _{BAT} must be at least 40-mil wide. |
| 15 | The 1.8-V trace must be at least 18-mil wide. |
| 16 | Make VBAT traces as wide as possible to ensure reduced inductance and trace resistance. |

Table 7-2. Layout Recommendations Summary (continued)

| ITEM | DESCRIPTION |
|------|--|
| 17 | If possible, shield V_{BAT} traces with ground above, below, and beside the traces. |
| 18 | SDIO signals traces (CLK, CMD, D0, D1, D2, and D3) must be routed in parallel to each other and as short as possible (less than 12 cm). In addition, every trace length must be the same as the others. There should be enough space between traces – greater than 1.5 times the trace width or ground – to ensure signal quality, especially for the SDIO_CLK trace. Remember to keep these traces away from the other digital or analog signal traces. TI recommends adding ground shielding around these buses. |
| 19 | SDIO and digital clock signals are a source of noise. Keep the traces of these signals as short as possible. If possible, maintain a clearance around them. |

7.1.3 RF Trace and Antenna Layout Recommendations

Figure 7-2 shows the location of the antenna on the WL1837MODCOM8I board as well as the RF trace routing from the WL1837 module (TI reference design). The Pulse 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.

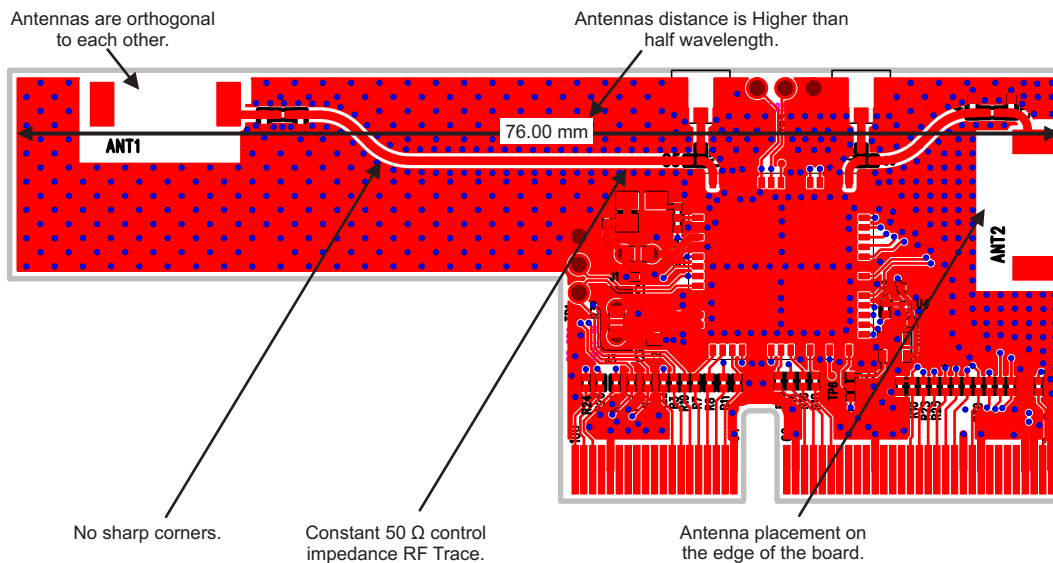


Figure 7-2. Location of Antenna and RF Trace Routing on the WL1837MODCOM8I Board

Follow these 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.

7.1.4 Module Layout Recommendations

Figure 7-3 and Figure 7-4 show layer 1 and layer 2 of the TI module layout.

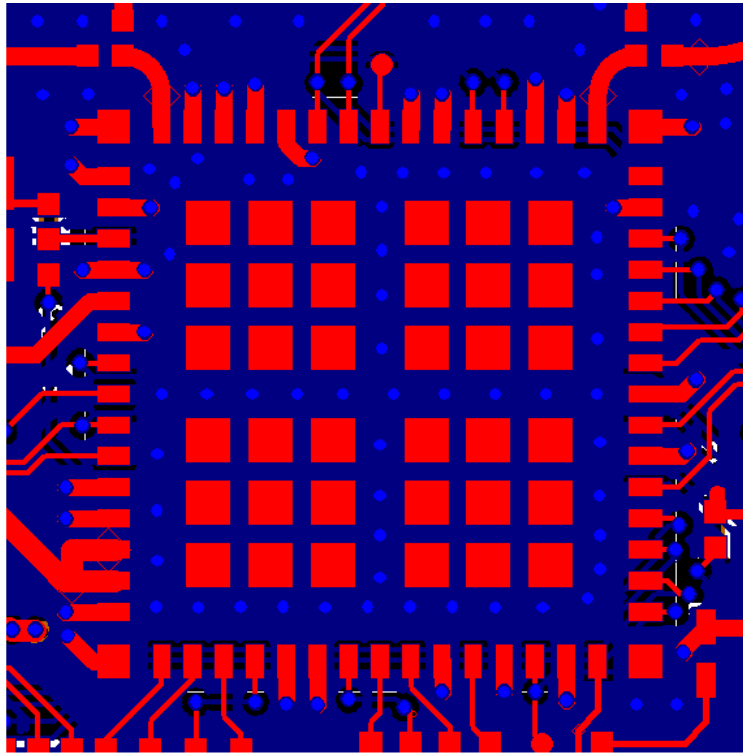


Figure 7-3. TI Module Layout: Layer 1

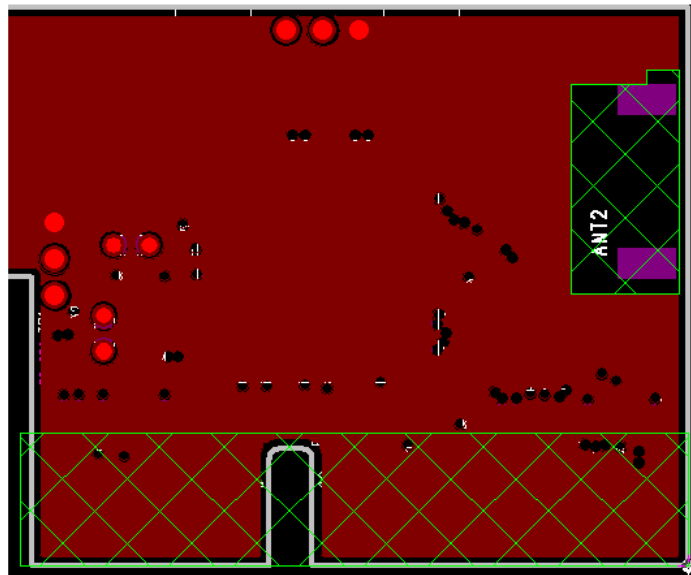


Figure 7-4. TI Module Layout: Layer 2 (Solid GND)

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.

7.1.5 Thermal Board Recommendations

The TI module uses μ vias for layers 1 through 6 with full copper filling, providing heat flow all the way to the module ground pads.

TI recommends using one big ground pad under the module with vias all the way to connect the pad to all ground layers (see [Figure 7-5](#)).

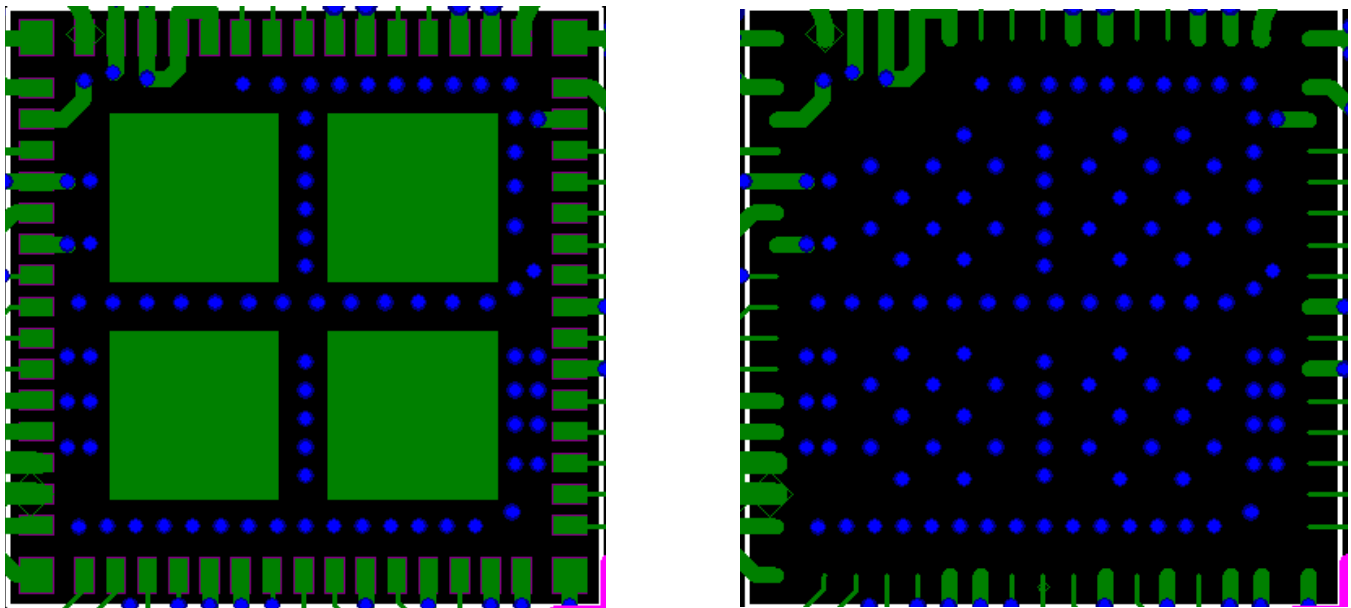
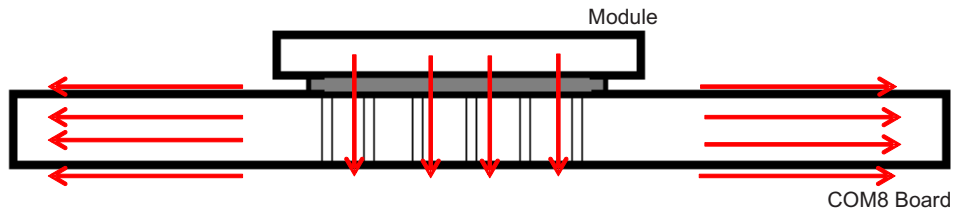


Figure 7-5. Block of Ground Pads on Bottom Side of Package

Figure 7-6 shows via array patterns, which are applied wherever possible to connect all of the layers to the TI module central or main ground pads.



Figure 7-6. Via Array Patterns

7.1.6 Baking and SMT Recommendations

7.1.6.1 Baking Recommendations

Follow these baking guidelines for the WiLink 8 module:

- Follow MSL level 3 to perform the baking process.
- After the bag is open, devices subjected to reflow solder or other high temperature processes must be mounted within 168 hours of factory conditions (< 30°C/60% RH) or stored at <10% RH.
- If the Humidity Indicator Card reads >10%, devices require baking before they are mounted.
- If baking is required, bake devices for 8 hours at 125°C.

7.1.6.2 SMT Recommendations

Figure 7-7 shows the recommended reflow profile for the WiLink 8 module.

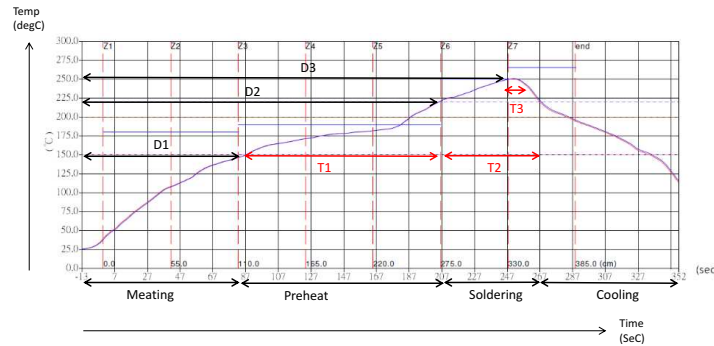


Figure 7-7. Reflow Profile for the WiLink 8 Module

Table 7-3 lists the temperature values for the profile shown in Figure 7-7.

Table 7-3. Temperature Values for Reflow Profile

| ITEM | TEMPERATURE (°C) | TIME (s) |
|------------------|------------------------------------|-----------------------------|
| Preheat | D1 to approximately D2: 140 to 200 | T1: 80 to approximately 120 |
| Soldering | D2: 220 | T2: 60 ±10 |
| Peak temperature | D3: 250 maximum | T3: 10 |

NOTE

TI does not recommend the use of conformal coating or similar material on the WiLink 8 module. This coating can lead to localized stress on the WCSP solder connections inside the module and impact the device reliability. Care should be taken during module assembly process to the final PCB to avoid the presence of foreign material inside the module.

8 Device and Documentation Support

8.1 Device Support

8.1.1 Development Support

For a complete listing of development-support tools, visit the Texas Instruments [WL18xx Wiki](#). For information on pricing and availability, contact the nearest TI field sales office or authorized distributor.

8.1.2 Device Support Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to the part numbers. These prefixes represent evolutionary stages of product development from engineering prototypes through fully qualified production devices.

- X Experimental, preproduction, sample or prototype device. Device may not meet all product qualification conditions and may not fully comply with TI specifications. Experimental/Prototype devices are shipped against the following disclaimer: "This product is still in development and is intended for internal evaluation purposes." Notwithstanding any provision to the contrary, TI makes no warranty expressed, implied, or statutory, including any implied warranty of merchantability of fitness for a specific purpose, of this device.
- null Device is qualified and released to production. TI's standard warranty applies to production devices.

8.2 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 8-1. Related Links

| PARTS | PRODUCT FOLDER | SAMPLE & BUY | TECHNICAL DOCUMENTS | TOOLS & SOFTWARE | SUPPORT & COMMUNITY |
|-----------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| WL1807MOD | Click here | Click here | Click here | Click here | Click here |
| WL1837MOD | Click here | Click here | Click here | Click here | Click here |

8.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

TI Embedded Processors Wiki *Texas Instruments Embedded Processors Wiki*. Established to help developers get started with Embedded Processors from Texas Instruments and to foster innovation and growth of general knowledge about the hardware and software surrounding these devices.

8.4 Trademarks

WiLink, E2E are trademarks of Texas Instruments.
 ARM is a registered trademark of ARM Physical IP, Inc.
Bluetooth is a registered trademark of Bluetooth SIG, Inc..
 Android is a trademark of Google, Inc.
 IEEE Std 802.11 is a trademark of IEEE.
 Linux is a registered trademark of Linus Torvalds.
 Wi-Fi is a registered trademark of Wi-Fi Alliance.
 All other trademarks are the property of their respective owners.

8.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

8.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

9 Mechanical Packaging and Orderable Information

9.1 TI Module Mechanical Outline

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

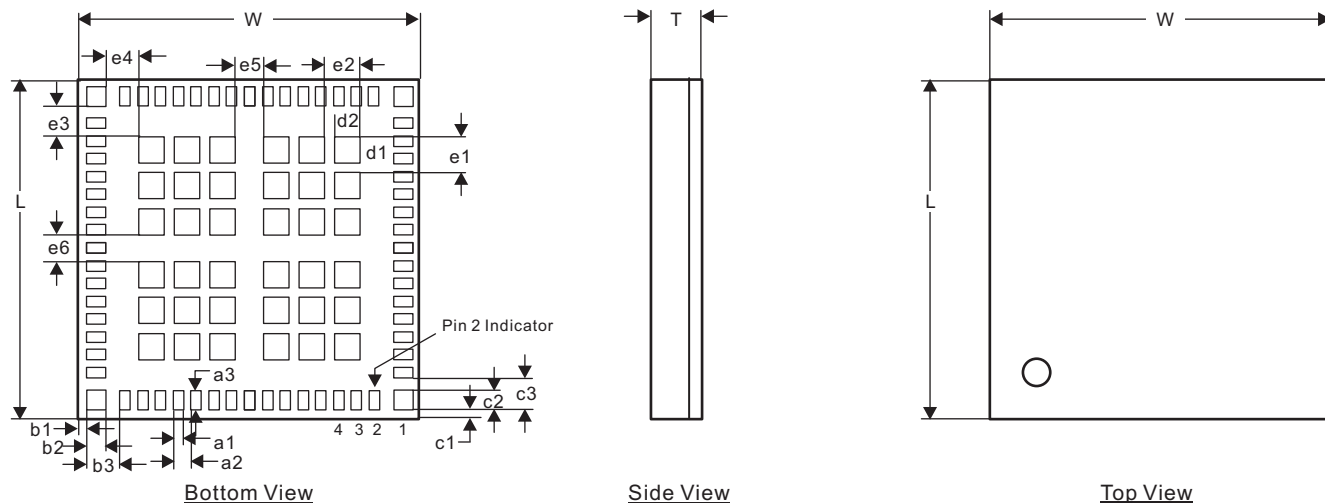


Figure 9-1. TI Module Mechanical Outline

Table 9-1 lists the dimensions for the mechanical outline of the device.

NOTE

The TI module weighs 0.684 g (± 0.005 g).

Table 9-1. Dimensions for TI Module Mechanical Outline

| MARKING | MIN (mm) | NOM (mm) | MAX (mm) | MARKING | MIN (mm) | NOM (mm) | MAX (mm) |
|---------------|----------|----------|----------|---------|----------|----------|----------|
| L (body size) | 13.20 | 13.30 | 13.40 | c2 | 0.65 | 0.75 | 0.85 |
| W (body size) | 13.30 | 13.40 | 13.50 | c3 | 1.15 | 1.25 | 1.35 |
| T (thickness) | 1.90 | | 2.00 | d1 | 0.90 | 1.00 | 1.10 |
| a1 | 0.30 | 0.40 | 0.50 | d2 | 0.90 | 1.00 | 1.10 |
| a2 | 0.60 | 0.70 | 0.80 | e1 | 1.30 | 1.40 | 1.50 |
| a3 | 0.65 | 0.75 | 0.85 | e2 | 1.30 | 1.40 | 1.50 |
| b1 | 0.20 | 0.30 | 0.40 | e3 | 1.15 | 1.25 | 1.35 |
| b2 | 0.65 | 0.75 | 0.85 | e4 | 1.20 | 1.30 | 1.40 |
| b3 | 1.20 | 1.30 | 1.40 | e5 | 1.00 | 1.10 | 1.20 |
| c1 | 0.20 | 0.30 | 0.40 | e6 | 1.00 | 1.10 | 1.20 |

9.2 Tape and Reel Information

Emboss taping specification for MOC 100 pin.

9.2.1 Tape and Reel Specification

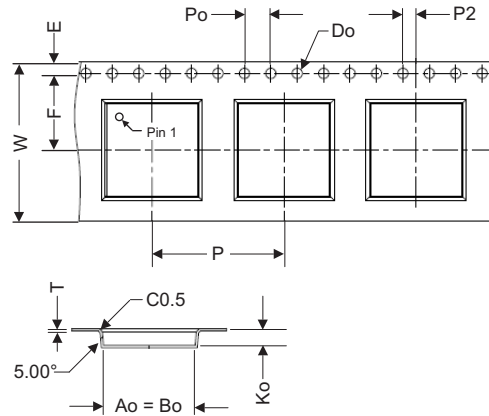


Figure 9-2. Tape Specification

Table 9-2. Dimensions for Tape Specification

| ITEM | W | E | F | P | Po | P2 | Do | T | Ao | Bo | Ko |
|-----------------------|------------------|-----------------|------------------|------------------|-----------------|-----------------|-----------------|-----------------|------------------|------------------|-----------------|
| DIMENSION (mm) | 24.00 (±0.30) | 1.75 (±0.10) | 11.50 (±0.10) | 20.00 (±0.10) | 4.00 (±0.10) | 2.00 (±0.10) | 2.00 (±0.10) | 0.35 (±0.05) | 13.80 (±0.10) | 13.80 (±0.10) | 2.50 (±0.10) |

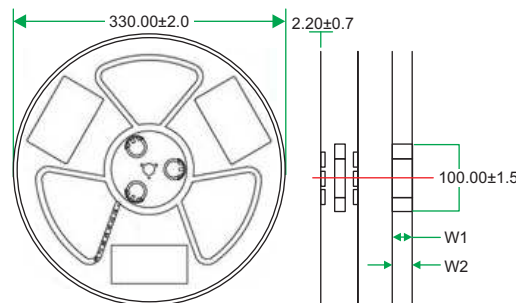


Figure 9-3. Reel Specification

Table 9-3. Dimensions for Reel Specification

| ITEM | W1 | W2 |
|-----------------------|-------------------|----------------|
| DIMENSION (mm) | 24.4 (+1.5, -0.5) | 30.4 (maximum) |

9.2.2 Packing Specification

9.2.2.1 Reel Box

The reel is packed in a moisture barrier bag fastened by heat-sealing. Each moisture-barrier bag is packed into a reel box, as shown in Figure 9-4.

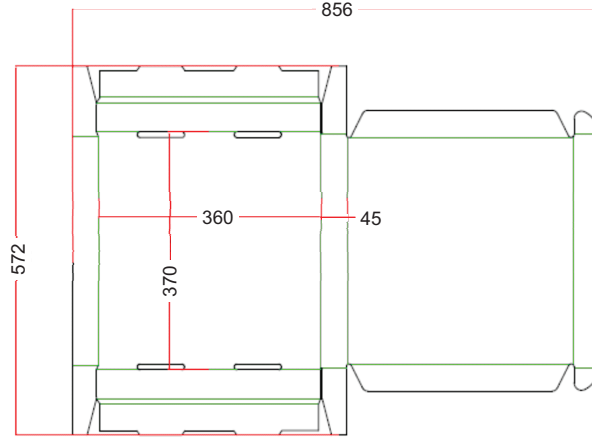


Figure 9-4. Reel Box

The reel box is made of corrugated fiberboard.

9.2.2.2 Shipping Box

Figure 9-5 shows a typical shipping box. If the shipping box has excess space, filler (such as cushion) is added.

NOTE

The size of the shipping box may vary depending on the number of reel boxes packed.

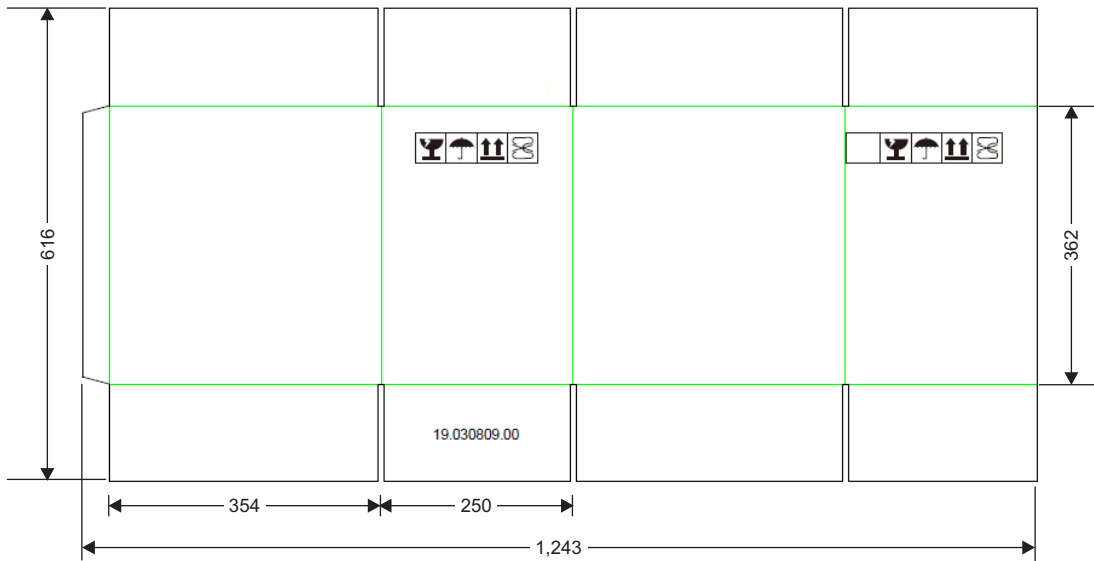


Figure 9-5. Shipping Box

The shipping box is made of corrugated fiberboard.

9.3 Packaging Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGE OPTION ADDENDUM

| Orderable Device | Status(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan(2) | Lead/Ball Finish | MSL Peak Temp (°C) (3) | Op Temp (°C) |
|------------------|-----------|--------------|-----------------|------|-------------|----------------|------------------|------------------------|--------------|
| WL1807MODGIMOCR | ACTIVE | Module | MOC | 100 | 1200 | RoHS Compliant | NiPdAu | 250 | -40 to 85 |
| WL1807MODGIMOCT | ACTIVE | Module | MOC | 100 | 250 | RoHS Compliant | NiPdAu | 250 | -40 to 85 |
| WL1837MODGIMOCR | ACTIVE | Module | MOC | 100 | 1200 | RoHS Compliant | NiPdAu | 250 | -40 to 85 |
| WL1837MODGIMOCT | ACTIVE | Module | MOC | 100 | 250 | RoHS Compliant | NiPdAu | 250 | -40 to 85 |

(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.

PRE_PROD Unannounced device, not in production, not available for mass market, nor on the web, samples not available.

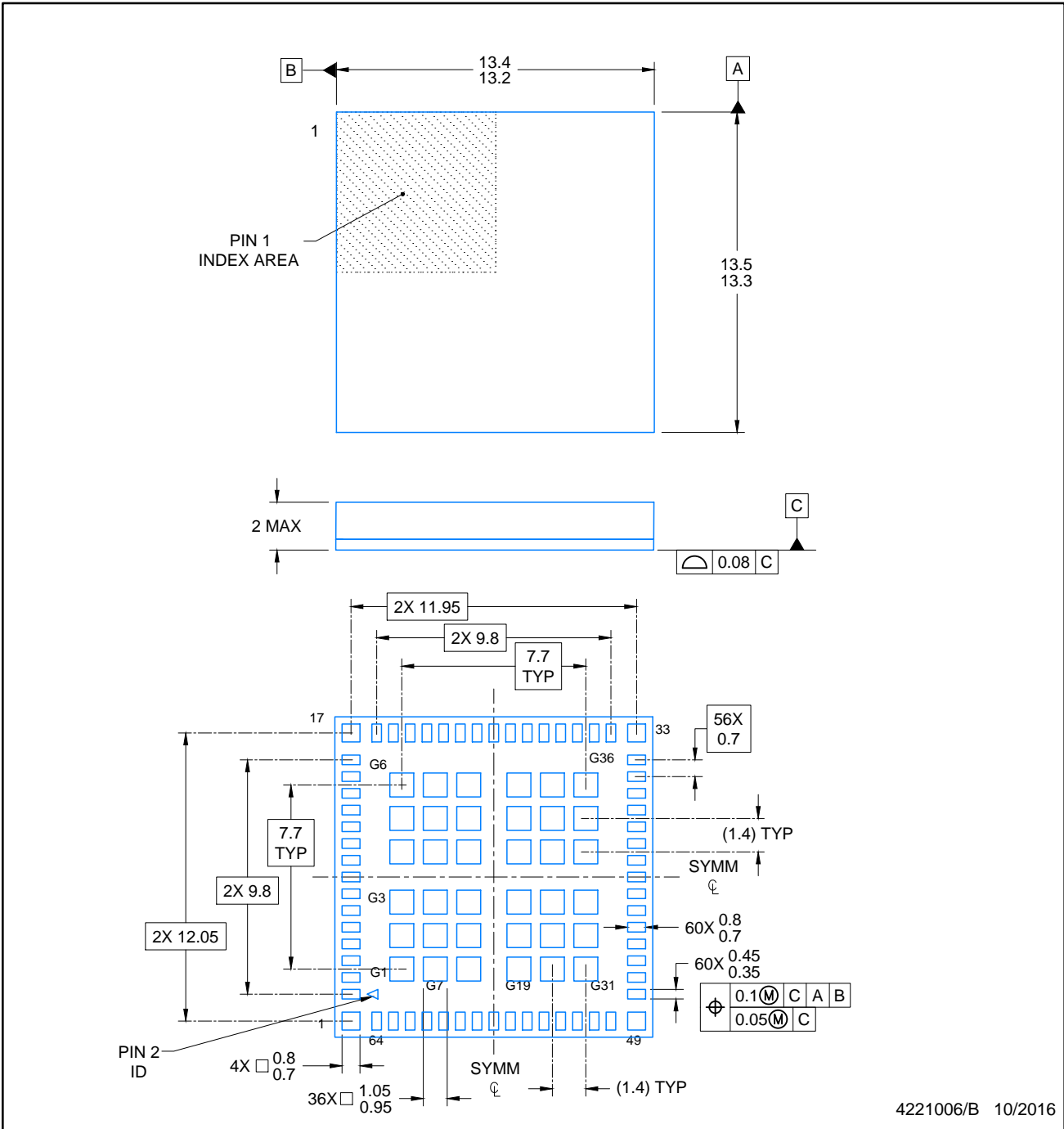
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBsolete: TI has discontinued the production of the device.

(2) RoHS Compliance: This product has an RoHS exemption for one or more subcomponent(s). The product is otherwise considered Pb-Free (RoHS compatible) as defined above.

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

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NOTES:

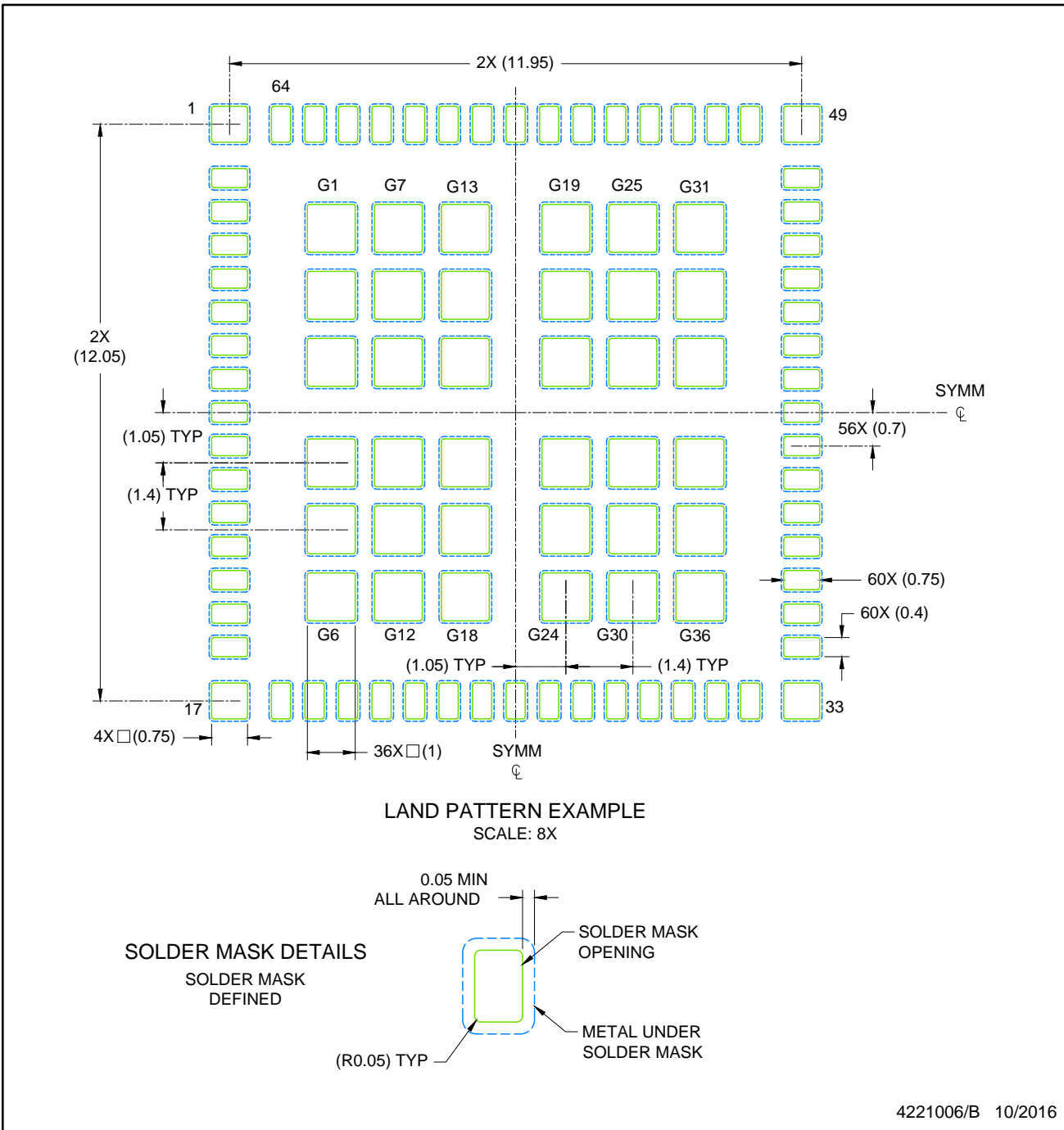
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pads must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

QFM - 2.0 mm max height

MOC0100A

QUAD FLAT MODULE



NOTES: (continued)

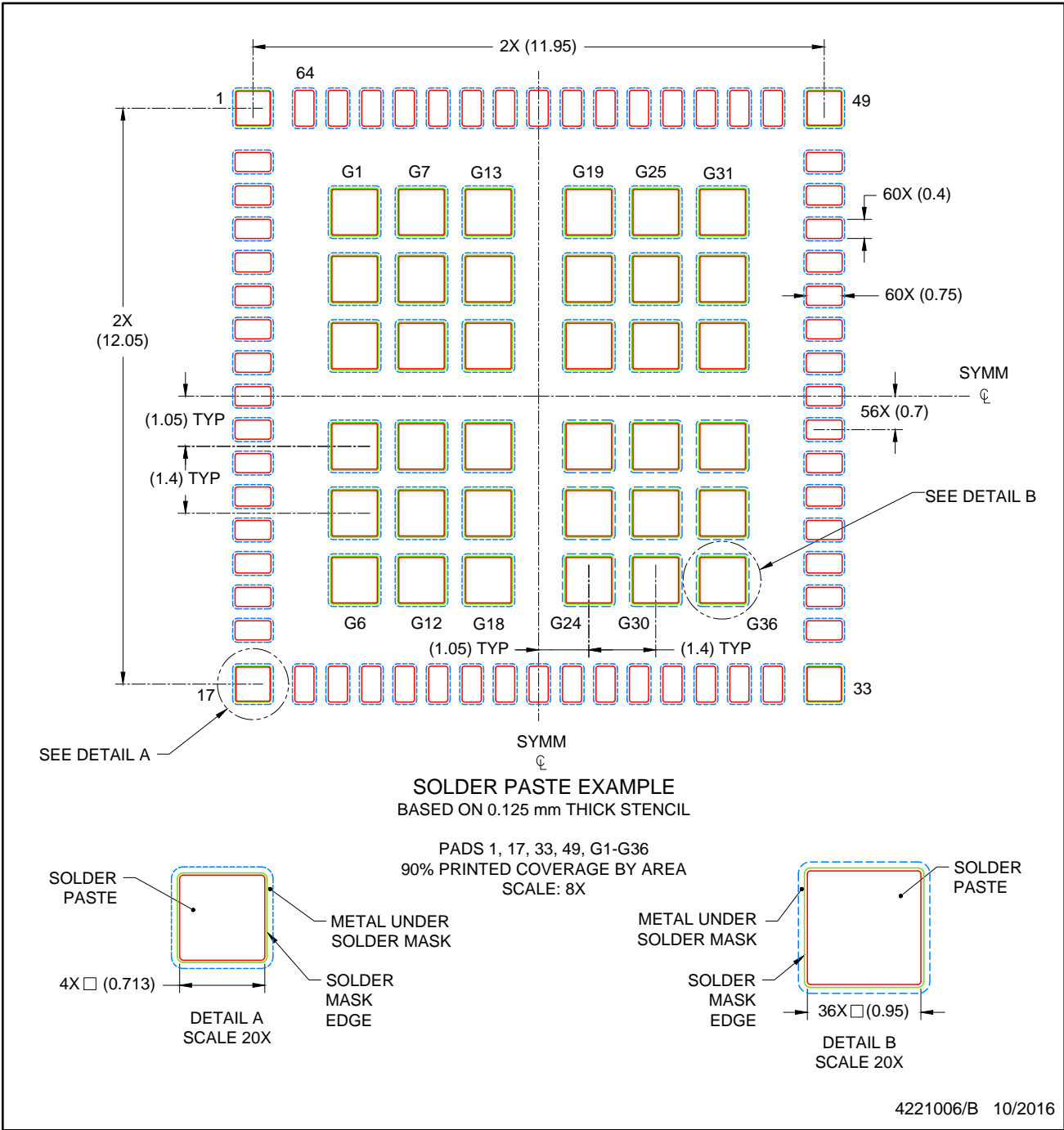
4. This package is designed to be soldered to thermal pads on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
6. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, it is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

QFM - 2.0 mm max height

MOC0100A

QUAD FLAT MODULE



NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations..

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