
WL18xxMOD WiLink™ 8 Single-Band Combo Module – Wi-Fi®, Bluetooth®, and Bluetooth Low Energy (BLE)

1 Device Overview

1.1 Features

- General
 - Single WLAN Module Integrates RF, Power Amps, Crystal, RF Switches, Filters, Passives, and Power Management
 - Direct Connect to Battery Using Integrated Switched-Mode Power Supplies (DC-DC)
 - Dual-Mode *Bluetooth* and BLE (WL183xMOD Only)
 - FCC, IC, ETSI/CE, and TELEC Certified with Chip Antenna
 - Hardware Design Guide and Files (COM8)
 - Host Controller Interface (HCI) Transport for *Bluetooth* Over UART and SDIO for WLAN
 - Temperature Compensation to Minimize Variation in RF Performance Over Entire Temperature Range
 - Operating Temperature: –20°C to 70°C
 - Small Form Factor: 13.3 × 13.4 × 2 mm
 - 100-pin MOC Package
- Wi-Fi
 - WLAN Baseband Processor and RF Transceiver Support of IEEE Std 802.11b, 802.11g, and 802.11n
 - 2.4-GHz MRC Support for Extended Range
 - Fully Calibrated: Production Calibration Not Required
 - 4-Bit SDIO Host Interface Support
 - 20-MHz 2 x 2 MIMO and 20- or 40- MHz SISO Channels for High Throughput: 80 Mbps (TCP), 100 Mbps (UDP)
 - Wi-Fi Direct Concurrent Operation (Multichannel, Multirole)
- SmartConfig™ Connects In-Home Devices to Wi-Fi in One Step
- *Bluetooth* and BLE (WL183xMOD Only)
 - *Bluetooth* 4.0 and CSA2 Support
 - Dedicated Audio Processor Support of SBC Encoding + A2DP
 - Royalty-Free Certified Stack From StoneStreet One
- Key Benefits
 - Reduces Design Overhead
 - 1.4X the Range Versus a Single Antenna
 - 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)
 - SmartConfig Technology Connects In-Home Devices 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
 - Available as Easy-to-Use FCC, ETSI, and Telec-Certified Module
 - Lower Manufacturing Costs Saves Board Space and Minimizes RF Expertise
 - AM335x Linux® and Android™ Reference Platform Accelerates Customer Development and Time to Market

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

The precertified WiLink 8 module from TI offers 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).

Device Information

ORDER NUMBER	PACKAGE	BODY SIZE
WL1801MOD	MOC (100)	13.3 mm x 13.4 mm x 2 mm
WL1805MOD	MOC (100)	13.3 mm x 13.4 mm x 2 mm
WL1831MOD	MOC (100)	13.3 mm x 13.4 mm x 2 mm
WL1835MOD	MOC (100)	13.3 mm x 13.4 mm x 2 mm

1.4 Functional Block Diagram

Figure 1-1 shows a functional block diagram of the WL1835 variant.

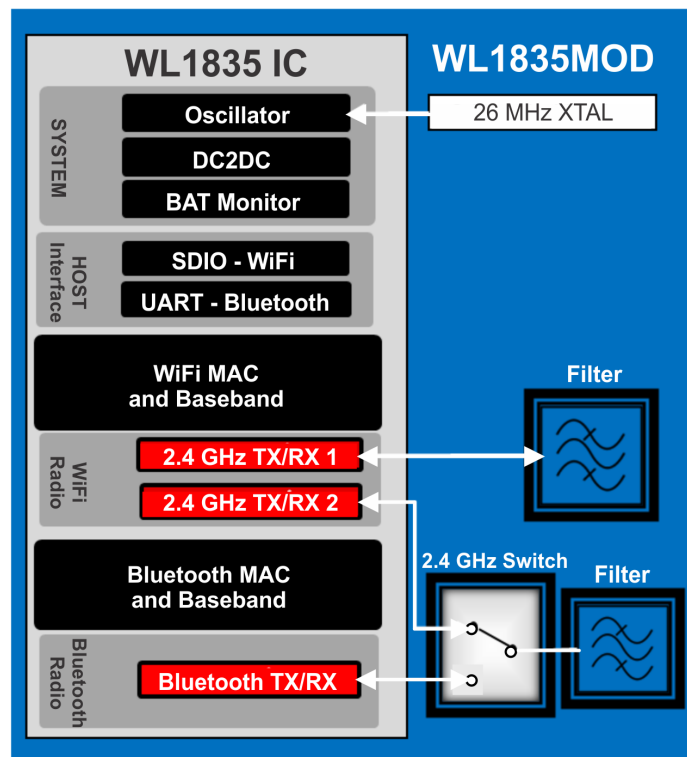


Figure 1-1. WL1835 Functional Block Diagram

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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 (February 2014) to Revision H	Page
• Changed body size from 7.1 mm x 7.1 mm in the <i>Device Information</i> table	2
• Changed Figure 12-1	34
• Added time at maximum temperature (T3) in Table 12-1	34
• Deleted number column in Table 12-1	34

3 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, this device is based on proven technology and offers four footprint-compatible, 2.4-GHz variants providing stand-alone and *Bluetooth* combo connectivity.

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 ⁽¹⁾	Bluetooth
WL1835MOD	√	√	√	√
WL1831MOD	√			√
WL1805MOD	√	√	√	
WL1801MOD	√			

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

Table 3-2. WLAN Performance Parameters

WLAN ⁽¹⁾	Specification (Typ)	Conditions
Maximum TX power	17.3 dBm	1 Mbps DSSS
Minimum sensitivity	−96.3 dBm	1 Mbps DSSS
Sleep current	160 μA	Leakage, firmware retained
Connected IDLE	750 μA	No traffic IDLE connect
RX search	54 mA	Search (SISO20)
RX current (SISO20)	65 mA	MCS7, 2.4 GHz
TX current (SISO20) ⁽²⁾	238 mA	MCS7, 2.4 GHz, +11.2 dBm
Maximum peak current consumption during calibration ⁽³⁾	850 mA	

- (1) System design power scheme must comply with both peak and average TX bursts.
- (2) WLAN maximum VBAT current draw of 725 mA with MIMO continues burst configuration.
- (3) Peak current VBAT 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 VBAT value is based on peak calibration consumption with a 30% margin.

Table 3-3. Bluetooth Performance Parameters

Bluetooth	Specification (Typ)	Conditions
Maximum TX power	12.7 dBm	GFSK
Minimum sensitivity	−92.2 dBm	GFSK
Sniff	178 μA	1 attempt, 1.28 s (+4 dBm)
Page or inquiry	253 μA	1.28-s interrupt, 11.25-ms scan window (+4 dBm)
A2DP	7.5 mA	MP3 high quality 192 kbps (+4 dBm)

Table 3-4. Shutdown and Sleep Currents

Parameter	Power Supply Current	Typ	Unit
Shutdown mode All functions shut down	VBAT	10	μA
	VIO	2	μA
WLAN sleep mode	VBAT	160	μA
Bluetooth sleep mode	VBAT	110	μA

Figure 3-1 shows a high-level view of the WL1835 module variant.

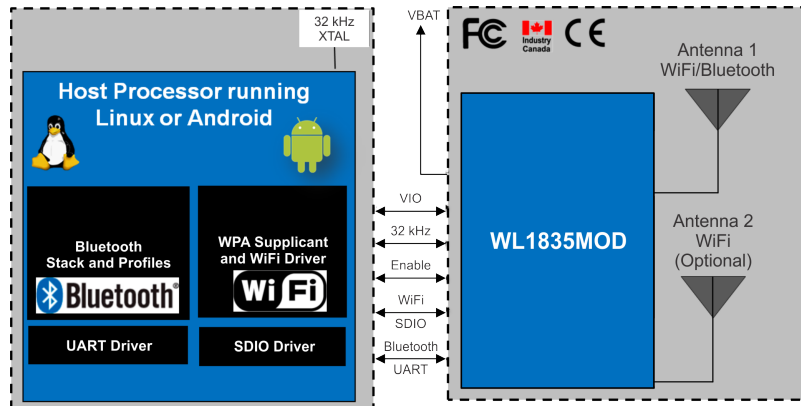


Figure 3-1. WL1835 High-Level System Diagram

3.1 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 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 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

3.2 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

3.3 BLE

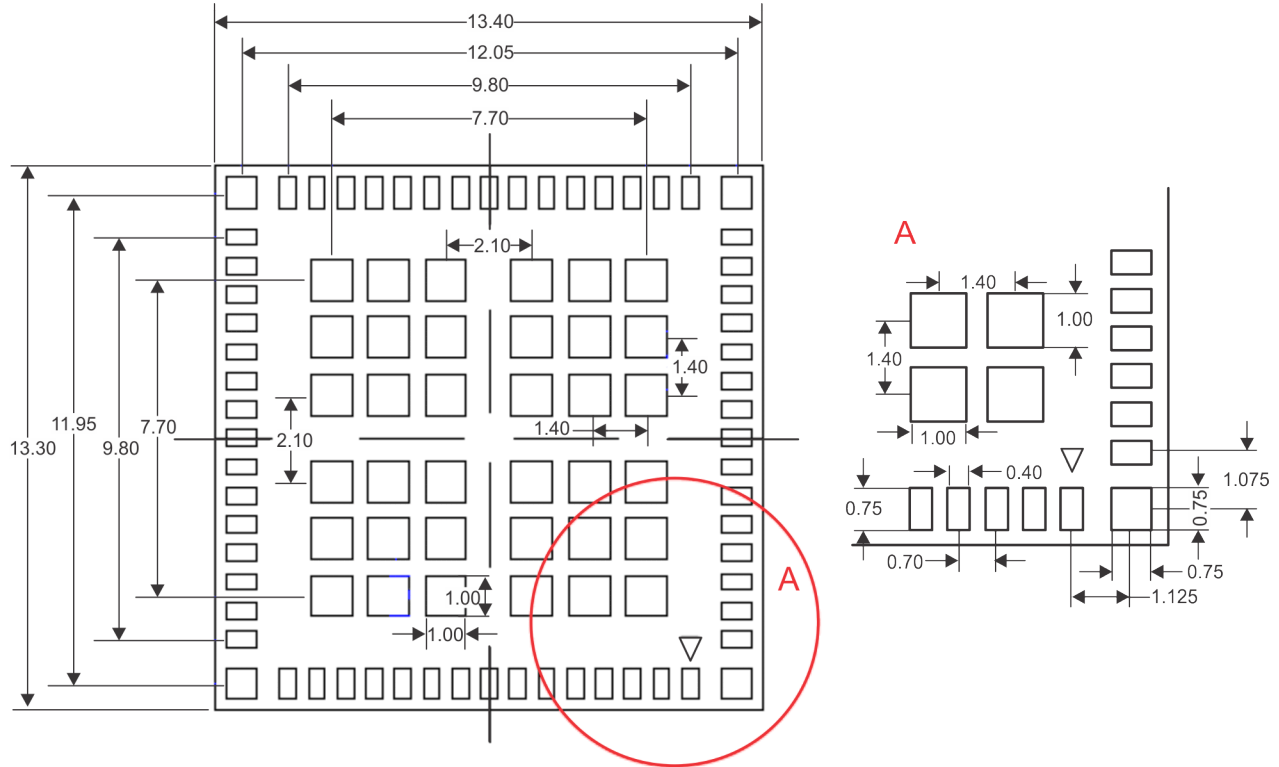
The device supports the following BLE features:

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

4 Package Information

4.1 Module Outline

Figure 4-1 shows the outline of the TI module.



- NOTE: 1. Module size: 13.4 x 13.3 mm
 2. Pad size: 0.75 x 0.40 mm
 3. Pitch: 0.7 mm

Figure 4-1. Outline of TI Module (Bottom View)

Table 4-1. Pin Description

Pin Name	Pin	Type/Dir	Shutdown State	After Power Up ⁽¹⁾	Voltage Level	Connectivity ⁽²⁾				Description
						1801	1805	1831	1835	
GND	1	GND			–	v	v	v	v	
GPIO11	2	I/O	PD	PD	1.8 V	v	v	v	v	Reserved for future use. NC if not used.
GPIO9	3	I/O	PD	PD	1.8 V	v	v	v	v	Reserved for future use. NC if not used.
GPIO10	4	I/O	PU	PU	1.8 V	v	v	v	v	Reserved for future use. NC if not used.
GPIO12	5	I/O	PU	PU	1.8 V	v	v	v	v	Reserved for future use. NC if not used.
WL_SDIO_CMD_1V8	6	I/O	Hi-Z	Hi-Z	1.8 V	v	v	v	v	WLAN SDIO command in ⁽³⁾
GND	7	GND			–	v	v	v	v	
WL_SDIO_CLK_1V8	8	I	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	I/O	Hi-Z	Hi-Z	1.8 V	v	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	v	v	WLAN SDIO data bit 1 ⁽³⁾
WL_SDIO_D2_1V8	12	IO	Hi-Z	Hi-Z	1.8 V	v	v	v	v	WLAN SDIO data bit 2 ⁽³⁾
WL_SDIO_D3_1V8	13	I/O	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	O	PD	0	1.8 V	v	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).
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	I	PD	PD	1.8 V	x	x	x	x	Reserved for future use. NC if not used.
RESERVED2	22	I	PD	PD	1.8 V	x	x	x	x	Reserved for future use. NC if not used.

(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.

Table 4-1. Pin Description (continued)

Pin Name	Pin	Type/ Dir	Shutdown State	After Power Up ⁽¹⁾	Voltage Level	Connectivity ⁽²⁾				Description
						1801	1805	1831	1835	
GND	23	GND			–	v	v	v	v	
GND	24	GND			–	v	v	v	v	
GPIO4	25	I/O	PD	PD	1.8 V	v	v	v	v	Reserved for future use. NC if not used.
GPIO2	26	I/O	PD	PD	1.8 V	v	v	v	v	WL_RS232_RX (when WLAN_IRQ = 1 at power up)
GPIO1	27	I/O	PD	PD	1.8 V	v	v	v	v	WL_RS232_TX (when WLAN_IRQ = 1 at 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: 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 external VIO
GND	39	GND			–	v	v	v	v	
WLAN_EN	40	I	PD	PD	1.8 V	v	v	v	v	Mode setting: high = enable
BT_EN	41	I	PD	PD	1.8 V	x	x	v	v	Mode setting: high = enable
WL_UART_DBG	42	O	PU	PU	1.8 V	v	v	v	v	Option: WLAN logger
BT_UART_DBG	43	O	PU	PU	1.8 V	x	x	v	v	Option: Bluetooth 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, 2.9 to 4.8 V
VBAT_IN	47	POW			VBAT	v	v	v	v	Power supply input, 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	O	PU	PU	1.8 V	x	x	v	v	UART RTS to host. NC if not used.
BT_HCI_CTS_1V8	51	I	PU	PU	1.8 V	x	x	v	v	UART CTS from host. NC if not used.
BT_HCI_TX_1V8	52	O	PU	PU	1.8 V	x	x	v	v	UART TX to host. NC if not used.
BT_HCI_RX_1V8	53	I	PU	PU	1.8 V	x	x	v	v	UART RX from host. NC if not used.
GND	54	GND			–	v	v	v	v	
GND	55	GND			–	v	v	v	v	
BT_AUD_IN	56	I	PD	PD	1.8 V	x	x	v	v	Bluetooth PCM/I2S bus. Data in. NC if not used.

Table 4-1. Pin Description (continued)

Pin Name	Pin	Type/Dir	Shutdown State	After Power Up ⁽¹⁾	Voltage Level	Connectivity ⁽²⁾				Description
						1801	1805	1831	1835	
BT_AUD_OUT	57	O	PD	PD	1.8 V	x	x	v	v	Bluetooth PCM/I2S bus. Data out. NC if not used.
BT_AUD_FSYNC	58	I/O	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	I/O	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	O	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	

5 Module Specifications

5.1 Absolute Maximum Ratings⁽¹⁾

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

Parameter	Value	Unit
VBAT	4.8 ⁽²⁾	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 ⁽³⁾	°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. The device can be reliably operated for 7 years at the quoted operating condition, assuming 25% active mode and 75% sleep mode (15,400 cumulative active power-on hours).

5.2 Handling Ratings

			VALUE	UNIT
T _{stg}	Storage temperature range		–40 to +85	°C
ESD stress voltage ⁽¹⁾	Human body model (HBM) ⁽²⁾	Device	>1000	V
	Charged device model (CDM) ⁽³⁾	Device	>250	

- ESD measures device sensitivity and immunity to damage caused by electrostatic discharges into the device.
- The 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 can actually have higher performance.
- The 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 250-V CDM is possible, if necessary precautions are taken. Pins listed as 250 V can actually have higher performance.

5.3 Recommended Operating Conditions

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

Parameter	Condition	Sym	Min	Max	Unit
VBAT ⁽¹⁾	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
Low-level output voltage	@ 4 mA	VOL	0	0.45	V
Input transitions time T _r , T _f from 10% to 90% (digital I/O) ⁽²⁾		T _r , T _f	1	10	ns
Output rise time from 10% to 90% (digital pins) ⁽²⁾	CL < 25 pF	T _r		5.3	ns
Output fall time from 10% to 90% (digital pins) ⁽²⁾	CL < 25 pF	T _f		4.9	ns
Ambient operating temperature			–20	70	°C
Maximum power dissipation	WLAN operation			2.8	W
	Bluetooth operation			0.2	

- 4.8 V is applicable only for 2.3 years (30% of the time). Otherwise, maximum VBAT must not exceed 4.3 V.
- Applies to all digital lines except SDIO, UART, I2C, PCM and slow clock lines

5.4 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	Sym	Min	Typ	Max	Unit
Input slow clock frequency				32768		Hz
Input slow clock accuracy (Initial + temp + aging)	WLAN, <i>Bluetooth</i>				±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}	$0.65 \times V_{DD_IO}$		V_{DD_IO}	V_{peak}
		V_{il}	0		$0.35 \times V_{DD_IO}$	
Input impedance			1			MΩ
Input capacitance					5	pF

5.5 WLAN Performance

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

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	2400		2480	MHz
Sensitivity: 20-MHz bandwidth. At < 10% PER limit	1 Mbps DSSS		–96.3		dBm
	2 Mbps DSSS		–93.2		
	5.5 Mbps CCK		–90.6		
	11 Mbps CCK		–87.9		
	6 Mbps OFDM		–92.0		
	9 Mbps OFDM		–90.4		
	12 Mbps OFDM		–89.5		
	18 Mbps OFDM		–87.2		
	24 Mbps OFDM		–84.1		
	36 Mbps OFDM		–80.7		
	48 Mbps OFDM		–76.5		
	54 Mbps OFDM		–74.9		
	MCS0 MM 4K		–90.4		
	MCS1 MM 4K		–87.6		
	MCS2 MM 4K		–85.9		
	MCS3 MM 4K		–82.8		
	MCS4 MM 4K		–79.4		
	MCS5 MM 4K		–75.2		
	MCS6 MM 4K		–73.5		
	MCS7 MM 4K		–72.4		
MCS32 MM 4K		–87.7			
MCS0 MM 4K 40 MHz		–86.7			
MCS7 MM 4K 40 MHz		–67.0			
MCS0 MM 4K MRC		–92.7			
MCS7 MM 4K MRC		–75.2			
MCS13 MM 4K		–73.7			
MCS14 MM 4K		–72.3			
MCS15 MM 4K		–71.0			

WLAN 2.4-GHz Receiver Characteristics (continued)

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

Parameter	Condition	Min	Typ	Max	Unit
Max Input Level At < 10% PER limit	OFDM (11g/n)	-19	-9		dBm
	DSSS	-4	-0		dBm
Adjacent channel rejection: Sensitivity level +3 dB for OFDM; Sensitivity level +6 dB for 11b	2 Mbps DSSS	42.7			dB
	11 Mbps CCK	37.9			dB
	54 Mbps OFDM	2.0			dB

WLAN 2.4-GHz Transmitter Power

Parameter	Condition	RF_IO2_BG_WL pin 2.4-GHz SISO			Unit
		Min	Typ	Max	
Output Power: Maximum RMS output power measured at 1 dB from IEEE spectral mask or EVM ⁽¹⁾	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 ⁽²⁾		12.6		
MCS0 MM 40 MHz		14.8			
MCS7 MM 40 MHz		11.3			
2G4_ANT2_W + 2G4_ANT1_WB 2.4-GHz MIMO					
	MCS12 (WL18x5)		18.5		dBm
	MCS13 (WL18x5)		17.4		
	MCS14 (WL18x5)		14.5		
	MCS15 (WL18x5) ⁽³⁾		13.4		
2G4_ANT2_W + 2G4_ANT1_WB Pins					
Operation frequency range		2412		2484	MHz
Return loss			-10.0		dB

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

- Channels 1, 11, 13 @ OFDM legacy and HT 20-MHz rates: 14 dBm
- Channels 1, 11, 13 @ HT 40-MHz rates: 12 dBm
- Channel 7 @ HT 40-MHz lower rates: 12 dBm
- Channel 5 @ HT 40-MHz upper rates: 12 dBm

(2) 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.

(3) MIMO MCS15 until 65 °C

WLAN 2.4-GHz Transmitter Power (continued)

Parameter	Condition	RF_IO2_BG_WL pin 2.4-GHz SISO	Unit
Reference input impedance		50.0	Ω

WLAN Currents

	Specifications 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	54	mA
	2.4-GHz RX search MIMO20	74	mA
	2.4-GHz RX search SISO40	59	mA
	2.4-GHz RX 20 M SISO 11 CCK	56	mA
	2.4-GHz RX 20 M SISO 6 OFDM	61	mA
	2.4-GHz RX 20 M SISO MCS7	65	mA
	2.4-GHz RX 20 M MRC 1 DSSS	74	mA
	2.4-GHz RX 20 M MRC 6 OFDM	81	mA
	2.4-GHz RX 20 M MRC 54 OFDM	85	mA
Transmitter	2.4-GHz TX 20 M SISO 6 OFDM 15.4 dBm	285	mA
	2.4-GHz TX 20 M SISO 11 CCK 15.4 dBm	273	mA
	2.4-GHz TX 20 M SISO 54 OFDM 12.7 dBm	247	mA
	2.4-GHz TX 20 M SISO MCS7 11.2 dBm	238	mA
	2.4-GHz TX 20 M MIMO MCS15 11.2 dBm	420	mA
	2.4-GHz TX 40 M SISO MCS7 8.2 dBm	243	mA

5.6 Bluetooth Performance

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

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 ⁽¹⁾ dirty TX on	BR, BER = 0.1%		-92.2		-70.0	dBm
	EDR2, BER = 0.01%		-91.7		-70.0	dBm
	EDR3, BER = 0.01%		-84.7		-70.0	dBm
Bluetooth EDR BER floor at sensitivity + 10 dB Dirty TX off (for 1,600,000 bits)	EDR2	1e-6			1e-5	
	EDR3	1e-6			1e-5	
Bluetooth BR, EDR maximum usable input power	BR, BER = 0.1%	-5.0			-20.0	dBm
	EDR2, BER = 0.1%	-15.0			-20.0	dBm
	EDR3, BER = 0.1%	-15.0			-20.0	dBm

(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 intermodulation	Level of interferers for n = 3, 4, and 5	-36.0	-30.0		-39.0	dBm	
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	11.0	dB	
	EDR, co-channel	EDR2			12	13.0	dB
		EDR3			20	21.0	dB
	BR, adjacent ±1 MHz				-3.0	0.0	dB
	EDR, adjacent ±1 MHz, (image)	EDR2			-3.0	0.0	dB
		EDR3			2.0	5.0	dB
	BR, adjacent +2 MHz				-33.0	-30.0	dB
	EDR, adjacent +2 MHz	EDR2			-33.0	-30.0	dB
		EDR3			-28.0	-25.0	dB
	BR, adjacent -2 MHz				-20.0	-20.0	dB
	EDR, adjacent -2 MHz	EDR2			-20.0	-20.0	dB
		EDR3			-13.0	-13.0	dB
	BR, adjacent ≥ ±3 MHz				-42.0	-40.0	dB
EDR, adjacent ≥ ±3 MHz	EDR2			-42.0	-40.0	dB	
	EDR3			-36.0	-33.0	dB	
Bluetooth BR, EDR RF return loss			-10.0			dB	

Bluetooth Transmitter, BR

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

Parameter	Min	Typ	Max	Bluetooth Specification	Unit
BR RF output power ⁽¹⁾	V _{BAT} ≥ 3 V	12.7			dBm
	V _{BAT} < 3 V		7.2		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		-43.0		≤ -20	dBm
BR adjacent channel power M-N > 2		-48.0		≤ -40	dBm

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

Bluetooth Transmitter, EDR

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

Parameter	Min	Typ	Max	Bluetooth Specification	Unit
EDR output power ⁽¹⁾	V _{bat} ≥ 3 V	7.2			dBm
	V _{bat} < 3 V		5.2		
EDR relative power				-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		-36		≤ -26	dBc
EDR adjacent channel power M-N = 2		-30		≤ -20	dBm
EDR adjacent channel power M-N > 2		-42		≤ -40	dBm

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

Bluetooth Modulation, BR

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

Characteristics	Condition ⁽¹⁾		Min	Typ	Max	Bluetooth Specification	Units
BR –20 dB bandwidth				925	995	≤1000	kHz
BR modulation characteristics	Δf1avg	Mod data = 4 1s, 4 0s: 111100001111.. .	145	160	170	140 to 175	kHz
		Δf2max ≥ limit for at least 99.9% of all Δf2max	120	130		> 115	kHz
	Δf2avg/Δf1avg		85	88		> 80	%
BR carrier frequency drift	One slot packet		–25		25	< ±25	kHz
	Three and five slot packet		–35		35	< ±40	kHz
BR drift rate	fk+5 – fk , k = 0 max				15	< 20	kHz/50 μs
BR initial carrier frequency tolerance ⁽²⁾	f0–fTX		±75		±75	< ±75	kHz

(1) Performance values reflect maximum power.

(2) Numbers include XTAL frequency drift over temperature and aging.

Bluetooth Modulation, EDR

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

Parameter ⁽¹⁾	Condition	Min	Typ	Max	Bluetooth Specification	Unit
EDR carrier frequency stability		–5		5	≤10	kHz
EDR initial carrier frequency tolerance ⁽²⁾		±75		±75	±75	kHz
EDR RMS DEVM	EDR2		4	15	20	%
	EDR3		4	10	13	%
EDR 99% DEVM	EDR2			30		%
	EDR3			20		%
EDR peak DEVM	EDR2		9	25	35	%
	EDR3		9	18	25	%

(1) Performance values reflect maximum power.

(2) Numbers include XTAL frequency drift over temperature and aging.

5.7 Bluetooth LE Performance

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

Bluetooth LE Receiver Characteristics – In-Band Signals

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

Parameter	Condition ⁽¹⁾	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 ⁽²⁾ Dirty TX on			–92.2		≤ –70	dBm

(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.

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

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

Parameter	Condition ⁽¹⁾	Min	Typ	Max	BLE Specification	Unit
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. Note: Numbers show wanted signal-to-interfering-signal ratio. Smaller numbers indicate better C/I performance.	LE, co-channel			12	≤ 21	dB
	LE, adjacent ±1 MHz			0	≤ 15	
	LE, adjacent +2 MHz			-38	≤ -17	
	LE, adjacent -2 MHz			-15	≤ -15	
Image = -1 MHz	LE, adjacent ≥ ±3 MHz			-40	≤ -27	

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 ⁽¹⁾	VBAT ≥ 3 V		10.0		≤ 10	dBm
	VBAT < 3 V		7.2		≤ 10	dBm
Bluetooth LE adjacent channel power M-N = 2			-51.0		≤ -20	dBm
Bluetooth LE adjacent channel power M-N > 2			-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.

Bluetooth LE Modulation Characteristics

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

Characteristics	Condition ⁽¹⁾		Min	Typ	Max	Bluetooth Specification	Units
Bluetooth LE modulation characteristics	Δf1avg	Mod data = 4 1s, 4 0s: 111100001111...	240	250	260	225 to 275	kHz
	Δf2max ≥ limit for at least 99.9% of all Δf2max	Mod data = 1010101...	195	215		≥ 185	kHz
	Δf2avg/Δf1avg		85	90		≥ 80	%
Bluetooth LE carrier frequency drift	f0 - fnl , n = 2,3 ... K		-25		25	≤ ±50	kHz
Bluetooth LE drift rate	f1 - f0l and fn - fn-5l , n = 6,7 ... K				15	≤ 20	kHz/50 μs
LE initial carrier frequency tolerance ⁽²⁾	fn - fTX		±75		±75	≤ ±100	kHz

(1) Performance values reflect maximum power.

(2) Numbers include XTAL frequency drift over temperature and aging.

5.8 Bluetooth-BLE Dynamic Currents

Current is measured at output power as follows:

- BR at 12.7 dBm
- EDR at 7.2 dBm

Use Case ^{(1) (2)}	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
EDR A2DP EDR2 (master). MP3 high quality – 192 Kbs	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
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

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

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

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

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

5.9 Bluetooth LE Currents

All current measured at output power of 7.2 dBm

Use Case ⁽¹⁾	Typ	Units
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 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

6 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 Except WLAN	Bluetooth Voice-Audio
WLAN HS SDIO	Over UART	Bluetooth PCM

6.1 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

6.1.1 SDIO Timing Specifications

Figure 6-1 and Figure 6-2 show the SDIO switching characteristics over recommended operating conditions and with the default rate for input and output.

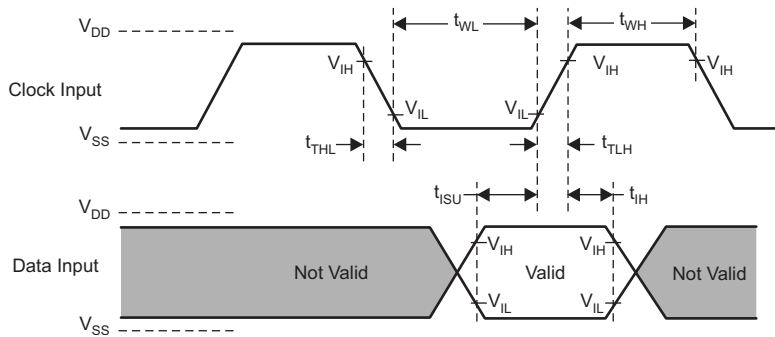


Figure 6-1. SDIO Default Input Timing

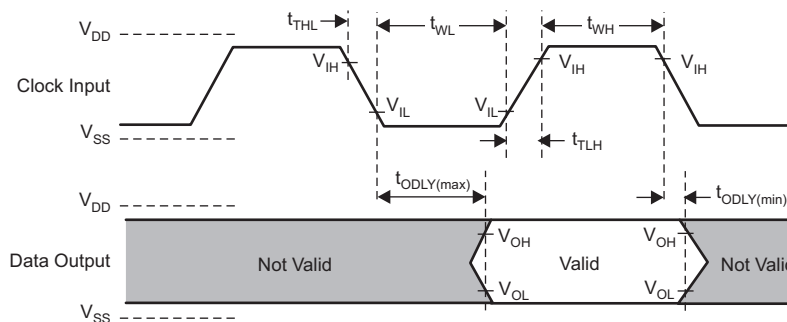


Figure 6-2. SDIO Default Output Timing

Table 6-1 lists the SDIO default timing characteristics.

Table 6-1. 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.

6.1.2 SDIO Switching Characteristics – High Rate

Figure 6-3 and Figure 6-4 show the parameters for maximum clock frequency.

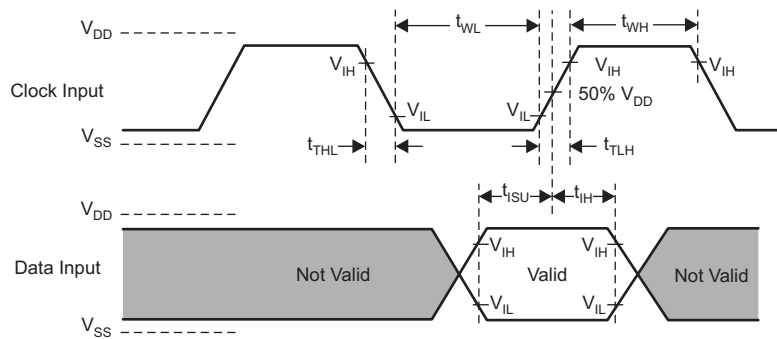


Figure 6-3. SDIO HS Input Timing

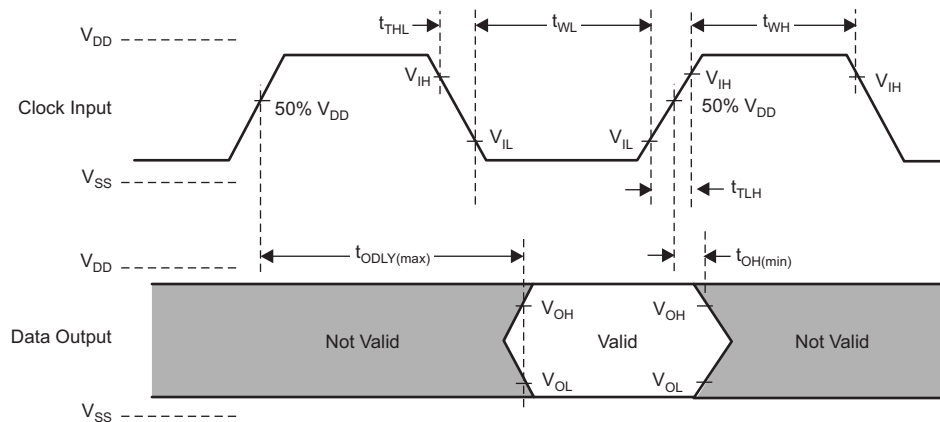


Figure 6-4. SDIO HS Output Timing

Table 6-2 lists the SDIO high-rate timing characteristics.

Table 6-2. 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

Table 6-2. SDIO HS Timing Characteristics (continued)

Parameter		Min	Max	Unit
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 \uparrow to output valid	7.0	10.0	ns
C_I	Capacitive load on outputs		10.0	pF

6.2 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 6-3](#) lists the UART default settings.

Table 6-3. UART Default Setting

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

6.2.1 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.

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 6-5](#) shows the UART timing.

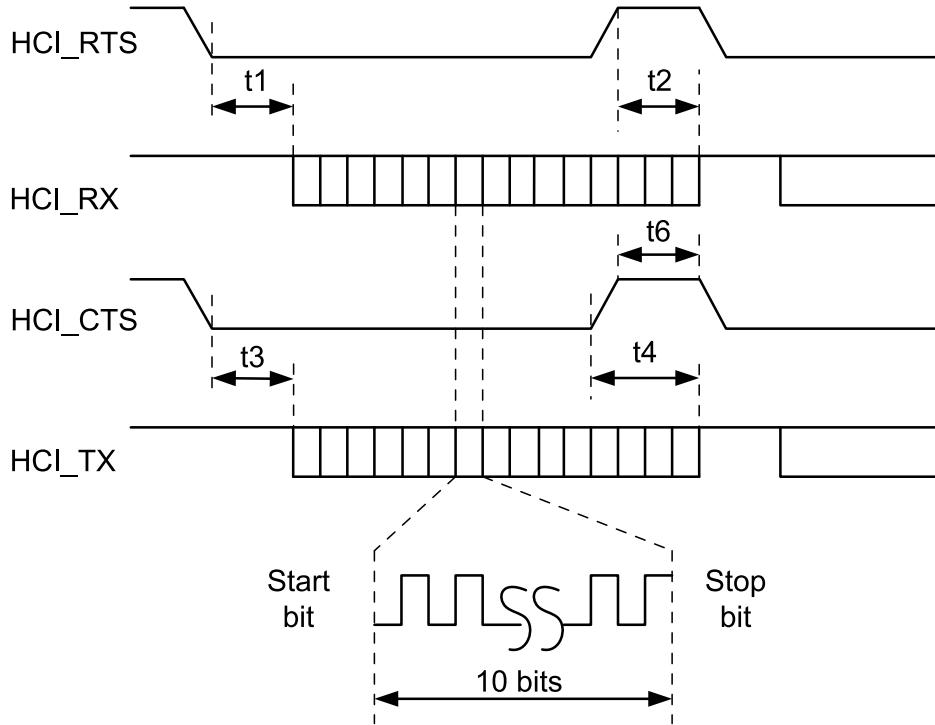


Figure 6-5. UART Timing Diagram

Table 6-4 lists the UART timing characteristics.

Table 6-4. 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 6-6 shows the UART data frame.

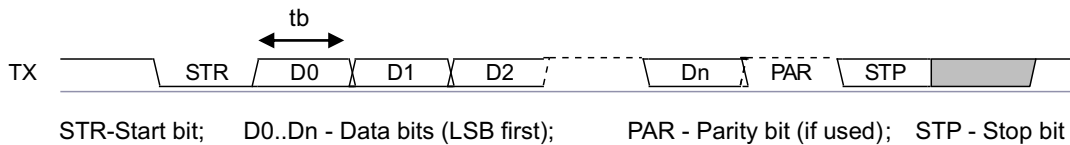


Figure 6-6. UART Data Frame

6.3 Bluetooth Codec-PCM (Audio) Timing Specifications

Figure 6-7 shows the Bluetooth codec-PCM (audio) timing diagram.

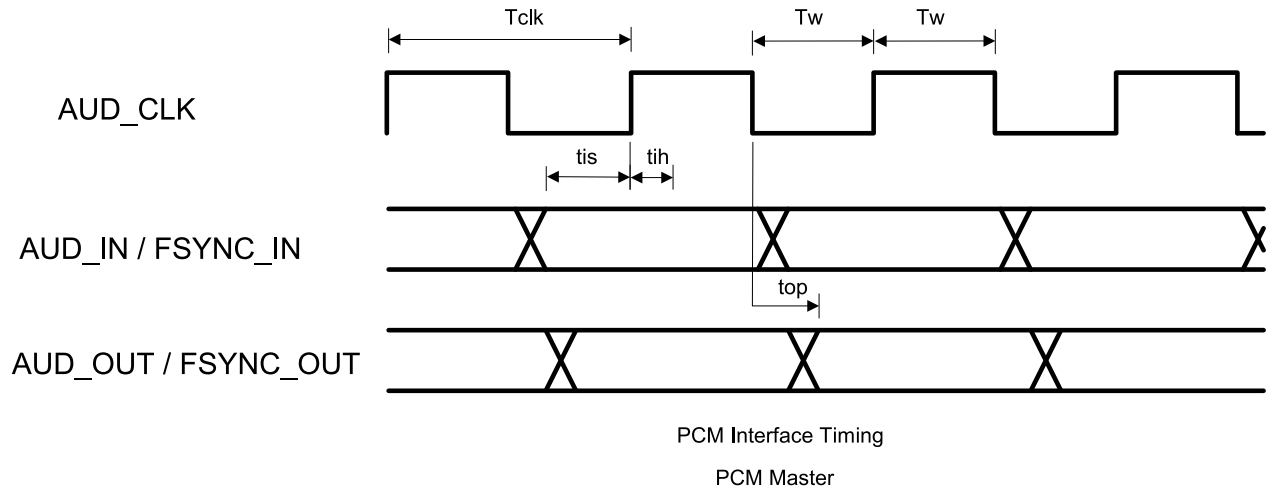


Figure 6-7. Bluetooth Codec-PCM (Audio) Master Timing Diagram

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

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

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

Parameter	Symbol	Min	Max	Unit
Cycle time	T_{clk}	81.38 (12.266 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

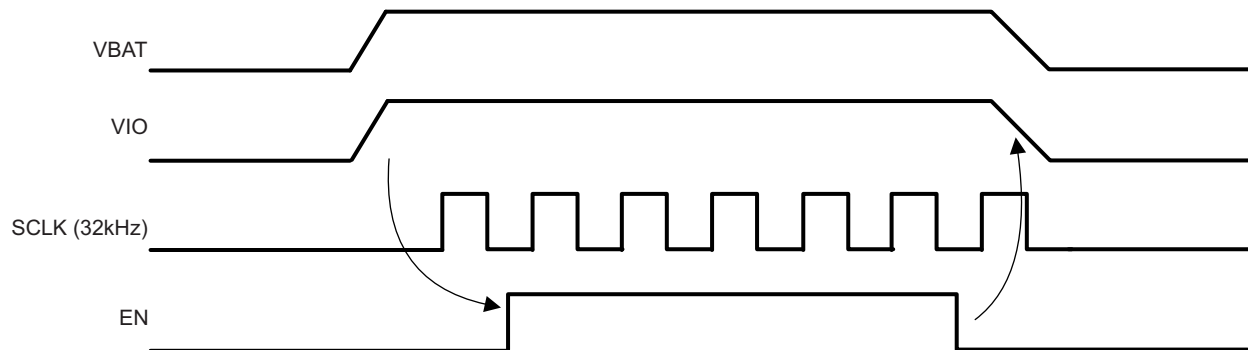
7 Clocks and Power Management

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.

7.1 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.

Figure 7-1) shows the general power scheme for the module, including the power-down sequence.



- NOTE: 1. Either VBAT or VIO can come up first.
 2. VBAT and VIO supplies and slow clock (SCLK) must be stable at 32 kHz before EN is asserted.
 3. EN must be deasserted before VBAT or VIO supply can be lowered. (Either supply can go low first.)
 4. At least 60 μ s is required between two adjacent enable signals.

Figure 7-1. Power-Up System

7.2 WLAN Power-Up Sequence

Figure 7-2 shows the WLAN power-up sequence.

NOTE

The power-up sequence in Figure 7-2 shows WLAN_IRQ set to a rising edge (active high). The Wi-Fi interrupt line can be configured by the driver according to the IRQ configuration (polarity, level, and edge).

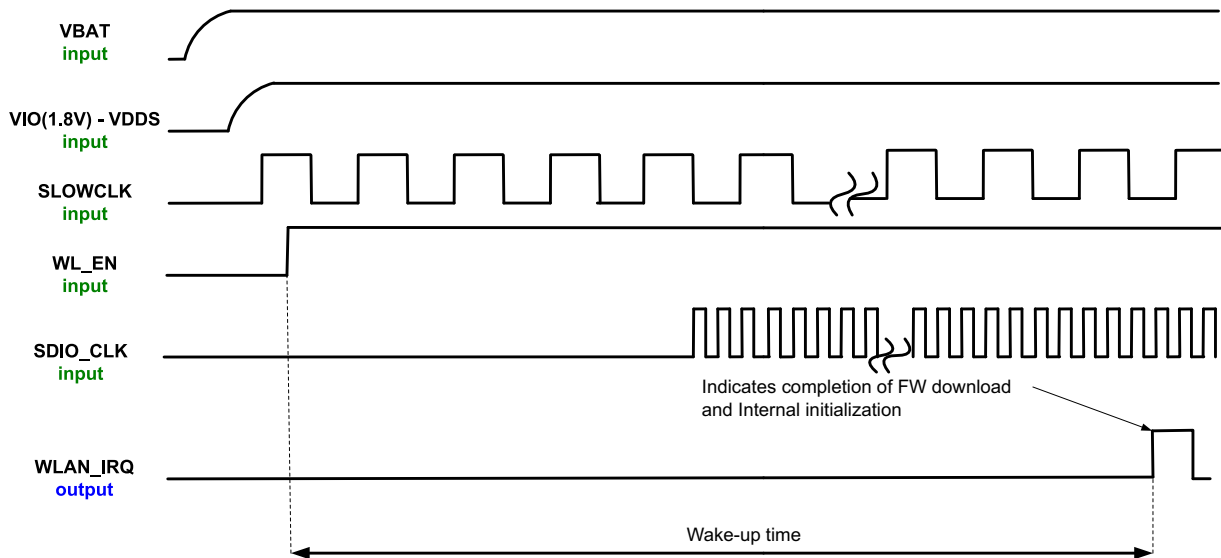


Figure 7-2. WLAN Power-Up Sequence

7.3 Bluetooth-BLE Power-Up Sequence

Figure 7-3 shows the Bluetooth-BLE power-up sequence.

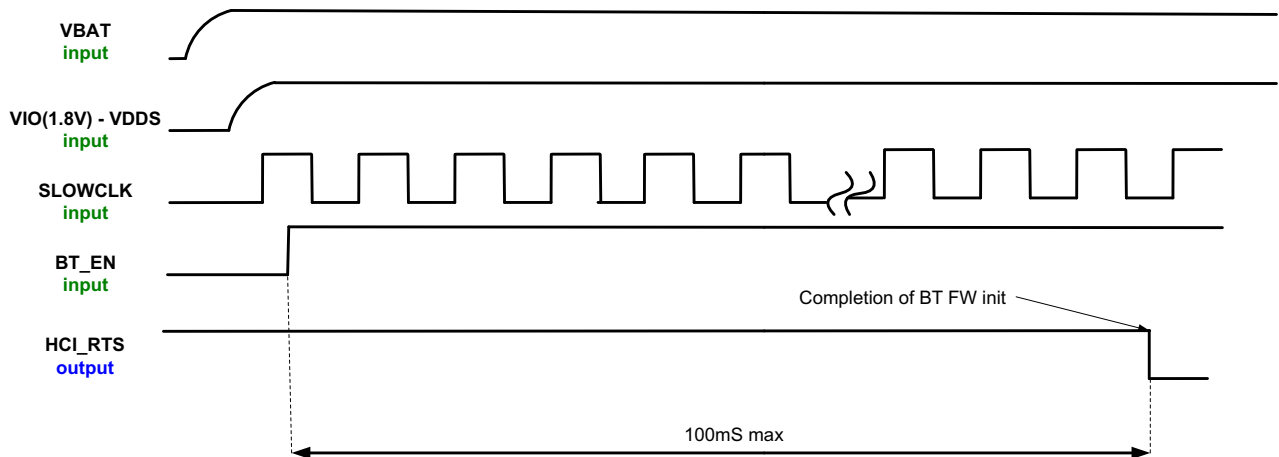


Figure 7-3. Bluetooth-BLE Power-Up Sequence

8 Reference Schematics and Bill of Materials

8.1 TI Module Reference Design

Figure 8-1 shows the TI module reference design.

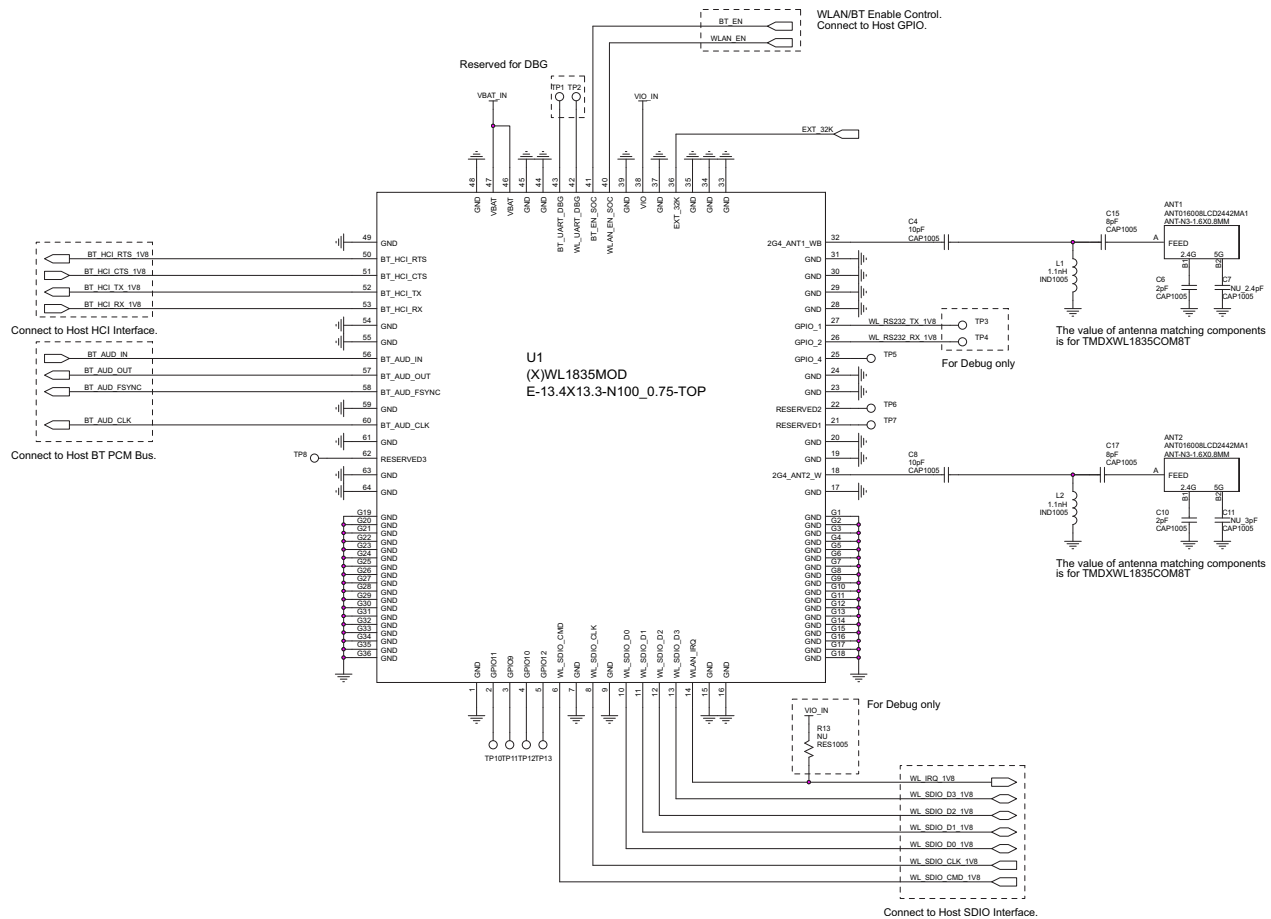


Figure 8-1. TI Module Reference Schematics

8.2 Bill of Materials

Table 8-1 lists the bill materials (BOM).

Table 8-1. 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

9 Design Recommendations

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

Table 9-1 summarizes the layout recommendations.

Table 9-1. 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 IF	
14	The power trace for VBAT 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.
17	If possible, shield VBAT 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.

9.1 RF Trace and Antenna Layout Recommendations

Figure 9-1 shows the location of the antenna on the WL1835MODCOM8 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.

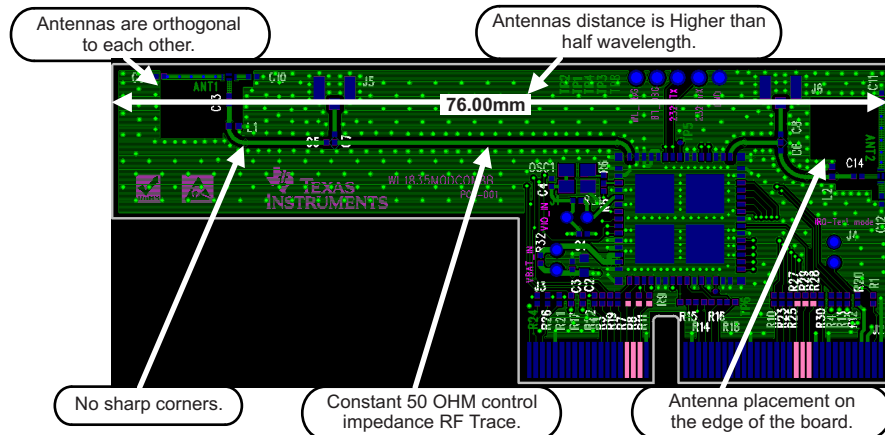


Figure 9-1. Location of Antenna and RF Trace Routing on the TMDXWL1835COM8T Board

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.

9.2 Module Layout Recommendations

Figure 9-2 shows layer 1 and layer 2 of the TI module layout:

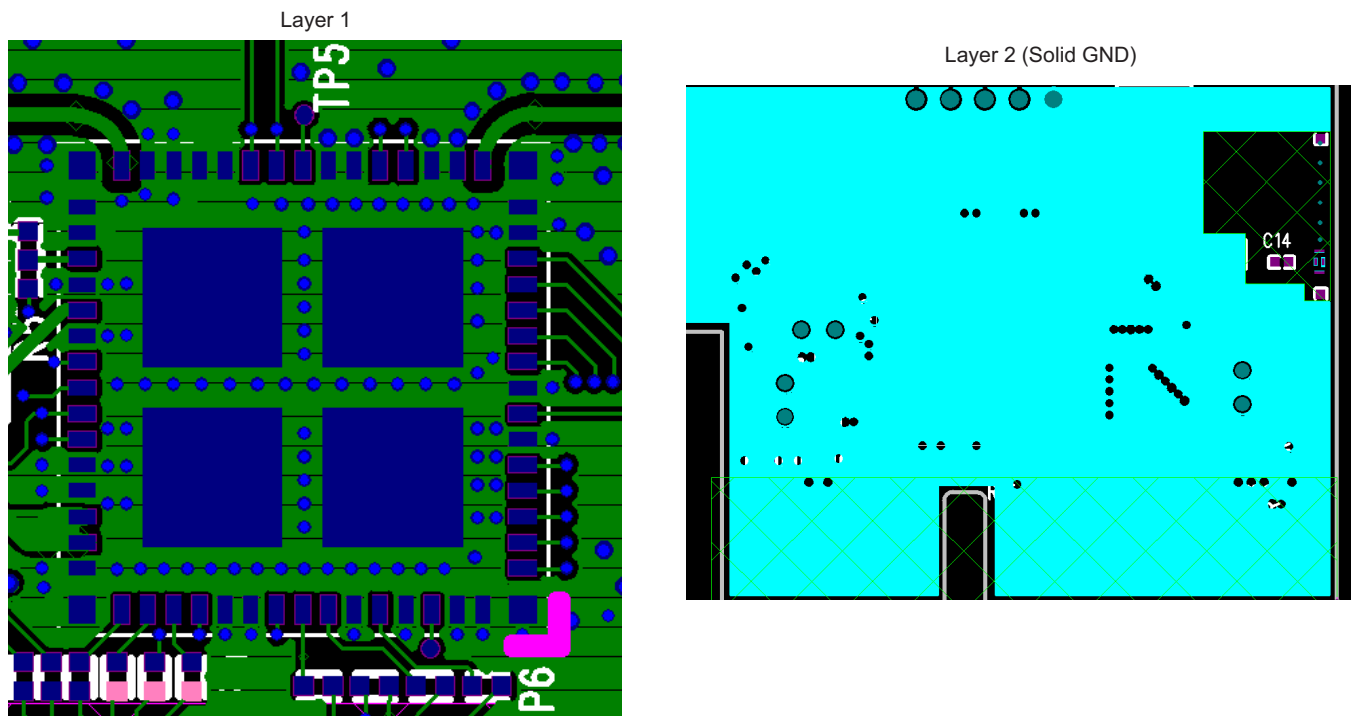


Figure 9-2. TI Module Layout

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.

9.3 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 9-3](#)).

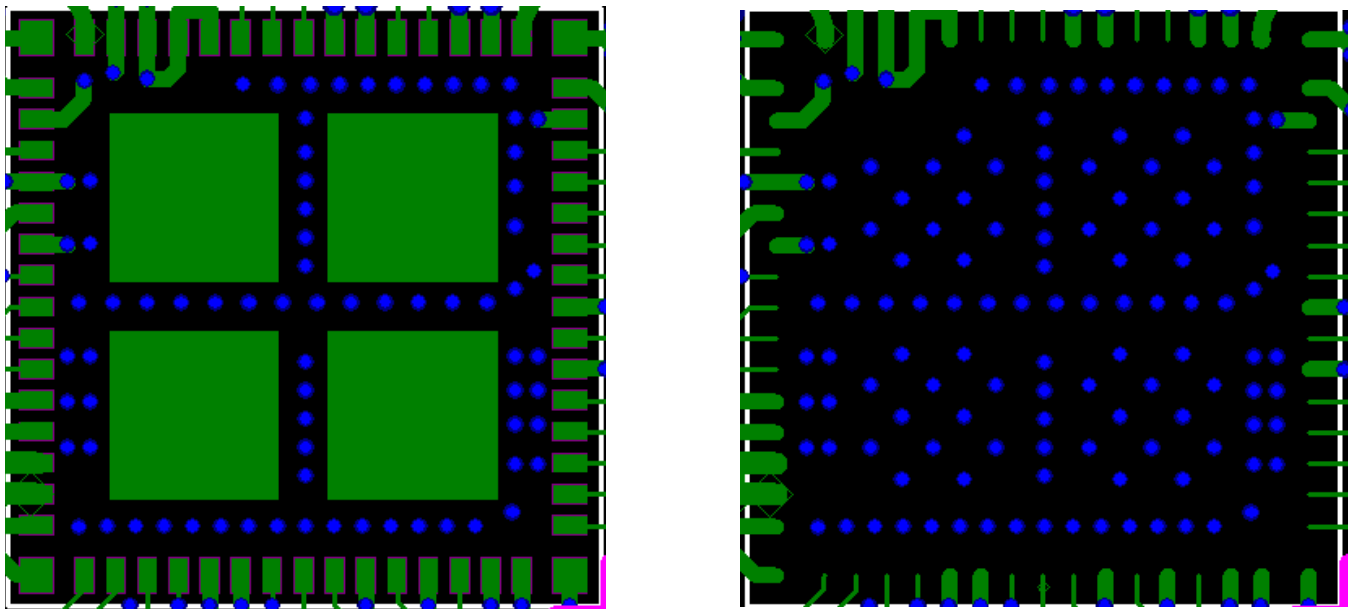
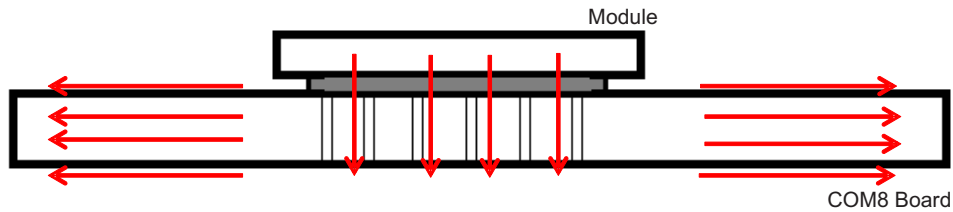


Figure 9-3. Block of Ground Pads on Bottom Side of Package

[Figure 9-4](#) 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 9-4. Via Array Patterns

The TI module can operate up to a package ambient temperature of 70°C commercial. In these settings, die temperature is usually maintained in the permitted range without intervention. Beyond that, an internal mechanism monitors and controls die temperature to guarantee reliable operation over time. This mechanism reads the temperature from sensors located on the die and maintains the temperature in the desired range. In extreme scenarios, the TX functionality of the device is limited to using only one TX chain, which means only SISO rates are used and MIMO transmission is disabled. This limitation occurs periodically based on die temperature monitoring and has impact only at high temperatures and high TX duty cycle.

Figure 9-5 shows the expected impact on throughput at variant ambient conditions for the module. The X axis represents oven temperature (T ambient); at typical temperature the module can sustain up to a 100-Mbps UDP connection. The safeguard control is enabled starting at 60°C. The heating effect throughput continues as the safeguard controls transmit mechanisms and prevents overheating.

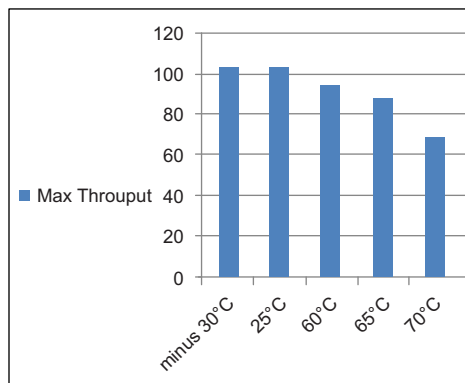


Figure 9-5. Throughput at Variant Ambient Conditions (2.4-GHz MIMO Module)

10 Device and Documentation Support

10.1 Device Support

10.1.1 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.

10.1.2 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.

10.2 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 10-1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
WL1801MOD	Click here	Click here	Click here	Click here	Click here
WL1805MOD	Click here	Click here	Click here	Click here	Click here
WL1831MOD	Click here	Click here	Click here	Click here	Click here
WL1835MOD	Click here	Click here	Click here	Click here	Click here

10.3 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 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.

10.4 Trademarks

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 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.

10.5 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.

10.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms and definitions.

11 Mechanical Information

Figure 11-1 shows the mechanical outline for the device.

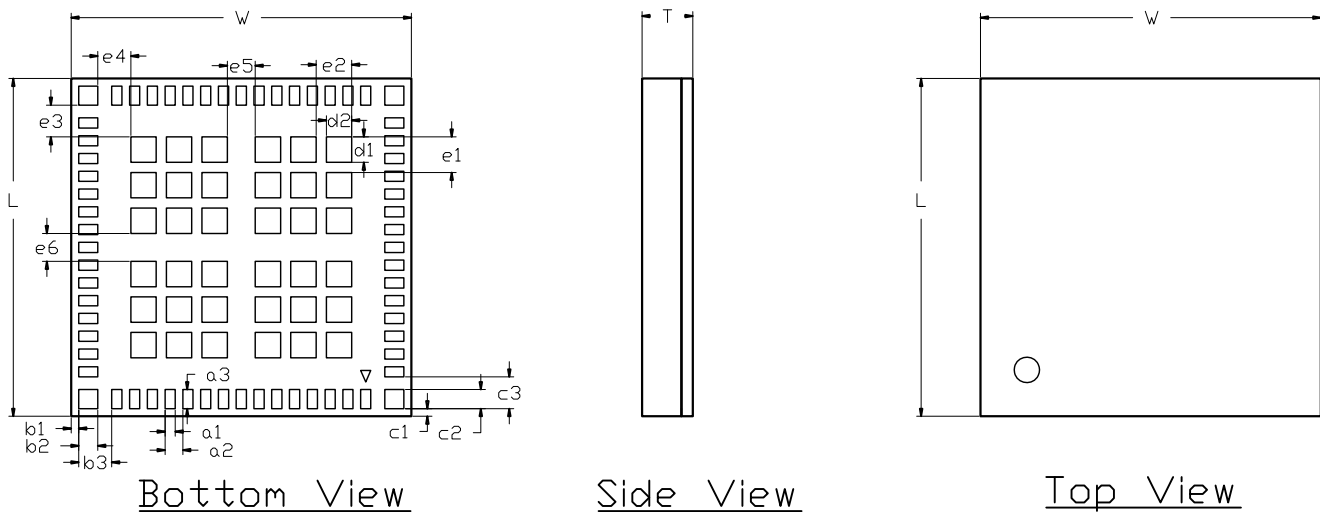


Figure 11-1. TI Module Mechanical Outline

Table 11-1 lists the dimensions for the mechanical outline of the device.

Table 11-1. 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

12 Baking and SMT Recommendations

12.1 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 being mounted.
- If baking is required, bake devices for 8 hours at 125 °C.

12.2 SMT Recommendations

Figure 12-1 shows the recommended reflow profile for the WiLink 8 module.

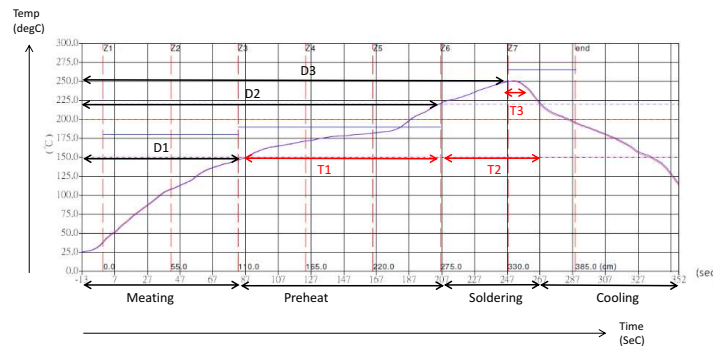


Figure 12-1. Reflow Profile for the WiLink 8 Module

Table 12-1 lists the temperature values for the profile shown in Figure 12-1.

Table 12-1. 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 max	T3: 10

13 Module Markings and Test Grades

13.1 WiLink 8 Module Markings

Figure 13-1 shows the markings for the TI WiLink 8 module.

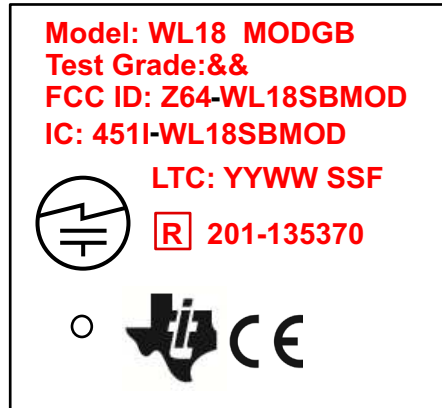



Figure 13-1. WiLink 8 Module Markings

Table 13-1 describes the WiLink 8 module markings.

Table 13-1. WiLink 8 Module Markings

Marking	Description
WL18 MODGB	Model
&&	Test grade (for more information, see Section 13.2, Test Grades)
Z64-WL18SBMOD	FCC ID: single modular FCC grant ID
451I-WL18SBMOD	IC: single modular IC grant ID
YYWWSSF	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
201-135370	R: single modular TELEC grant ID
	TELEC compliance mark
CE	CE compliance mark

13.2 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 WL1801MOD, the part shipped can be marked with a test grade of 35, 31, 05, or 01 (see [Table 13-2](#)).

Table 13-2. Test Grade Markings

Mark 1	WLAN	Bluetooth
0&	Tested	–
3&	Tested	Tested
Mark 2	WLAN 2.4 GHz	MIMO 2.4 GHz
&1	Tested	–
&5	Tested	Tested

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
WL1801MODGBMOCR	ACTIVE			100	1200	TBD	Call TI	Call TI	-20 to 70		Samples
WL1801MODGBMOCT	ACTIVE			100	250	TBD	Call TI	Call TI	-20 to 70		Samples
WL1805MODGBMOCR	ACTIVE			100	1200	TBD	Call TI	Call TI	-20 to 70		Samples
WL1805MODGBMOCT	ACTIVE			100	250	TBD	Call TI	Call TI	-20 to 70		Samples
WL1831MODGBMOCR	ACTIVE			100	1200	TBD	Call TI	Call TI	-20 to 70		Samples
WL1831MODGBMOCT	ACTIVE			100	250	TBD	Call TI	Call TI	-20 to 70		Samples
WL1835MODGBMOCR	ACTIVE			100	1200	TBD	Call TI	Call TI	-20 to 70		Samples
WL1835MODGBMOCT	ACTIVE			100	250	TBD	Call TI	Call TI	-20 to 70		Samples
XWL1835MODGAMOCT	ACTIVE			100		TBD	Call TI	Call TI	-20 to 70		Samples

(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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