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

Check for Samples: WL1801MOD, WL1805MOD, WL1831MOD, WL1835MOD

1 TI Module Summary

1.1 Features

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

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1.2 Applications

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

1.3 Description

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

Table 1-1. TI WiLink8 Module Device Variants

Device	WLAN 2.4-GHz SISO (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 1-2 lists the WLAN performance parameters.

Table 1-2. WLAN Performance Parameters

WLAN	Specification	Conditions
Maximum TX power (1)	18.1 dBm	1 Mbps DSSS
Minimum TX sensitivity (1)	–97.1 dBm	1 Mbps DSSS
Sleep current	154 µA	Leakage, firmware retained
Connected IDLE	712 µA	No traffic IDLE connect
RX search	48 mA	Search (SISO20)
RX current (SISO20)	67 mA	MCS7, 2.4 GHz
TX current (SISO20)	238 mA	MCS7, 2.4 GHz, +13.7 dBm

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

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

Table 1-3. *Bluetooth* Performance Parameters

Bluetooth	Specification	Conditions
Maximum TX power (1)	13.5 dBm	GFSK
Minimum TX sensitivity (1)	–93 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)

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

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1.4 Functional Block Diagram

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

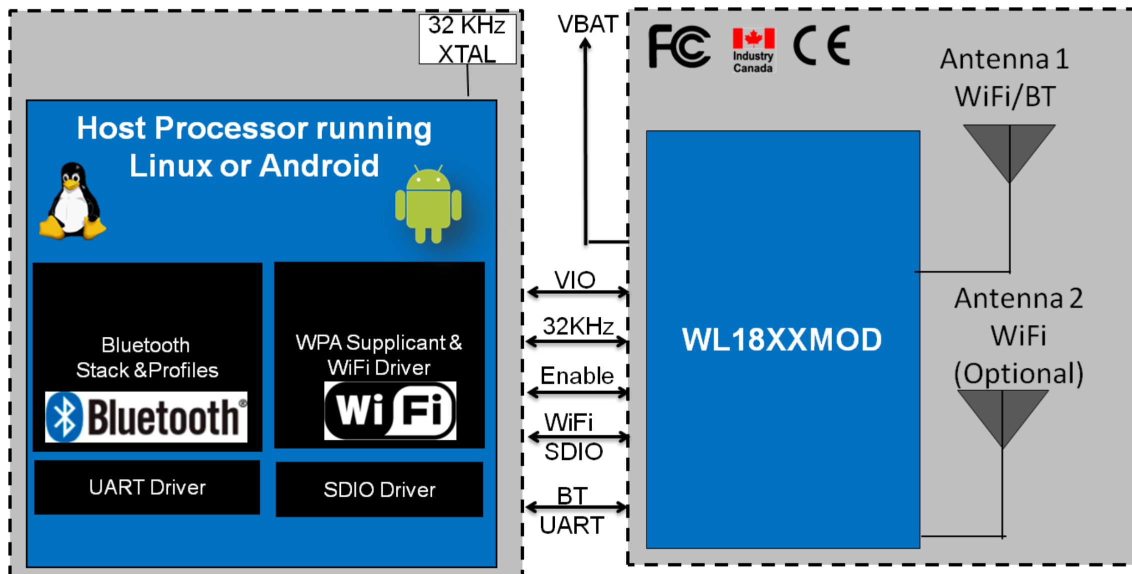

Figure 1-1. WL1835 High-Level System Diagram

Figure 1-2 shows the WL1835 functional block diagram.

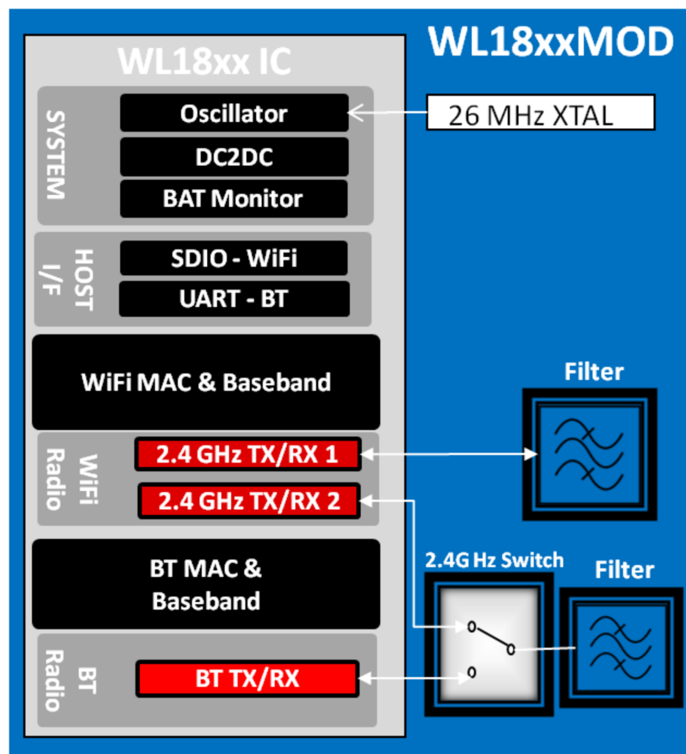

Figure 1-2. WL1835 Functional Block Diagram

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Revision History

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

Changes from Revision E (September 2013) to Revision F **Page**

- Deleted reference to IEEE Std 802.1x compliance 5

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2 Features

2.1 WLAN

The device supports the following WLAN features:

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

2.2 *Bluetooth*

The device supports the following *Bluetooth* features:

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

2.3 BLE

The device supports the following BLE features:

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

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3 Package Information

3.1 Module Outline

Figure 3-1 shows the device outline.

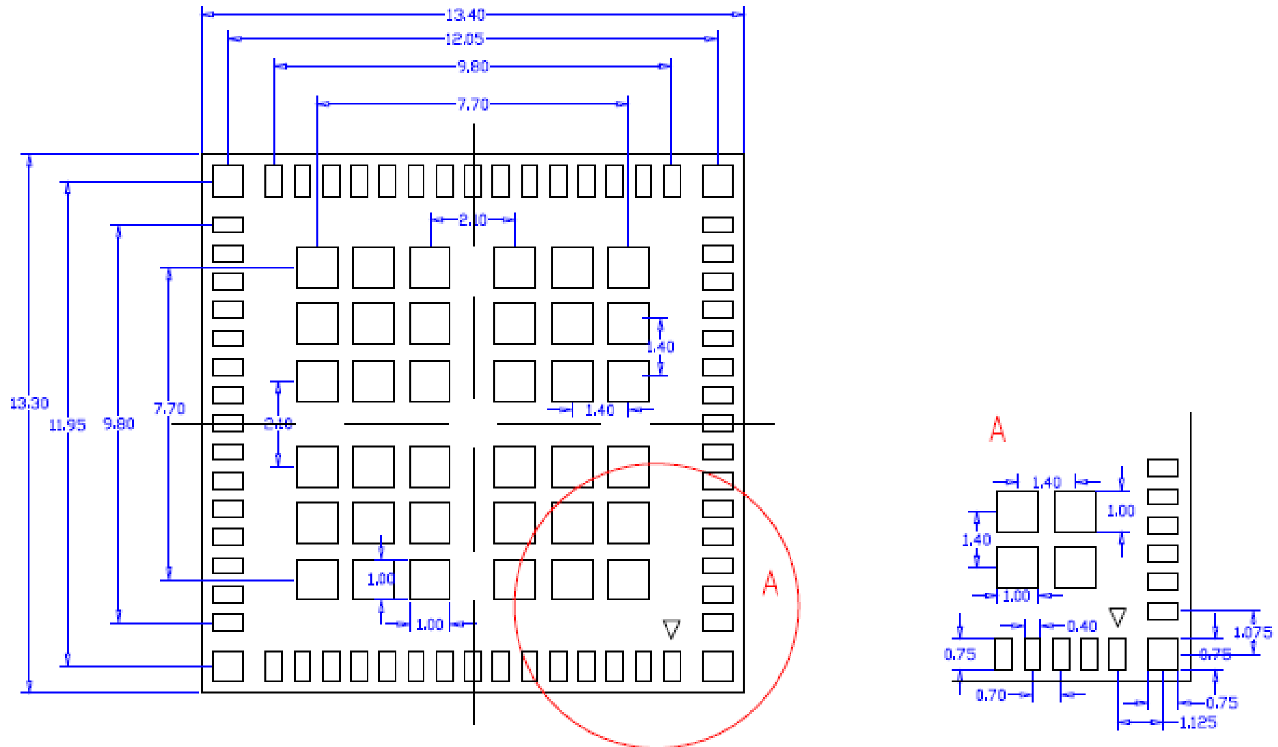

Figure 3-1. Module Outline

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3.2 Pin Description

Figure 3-2 shows the device pin designations.

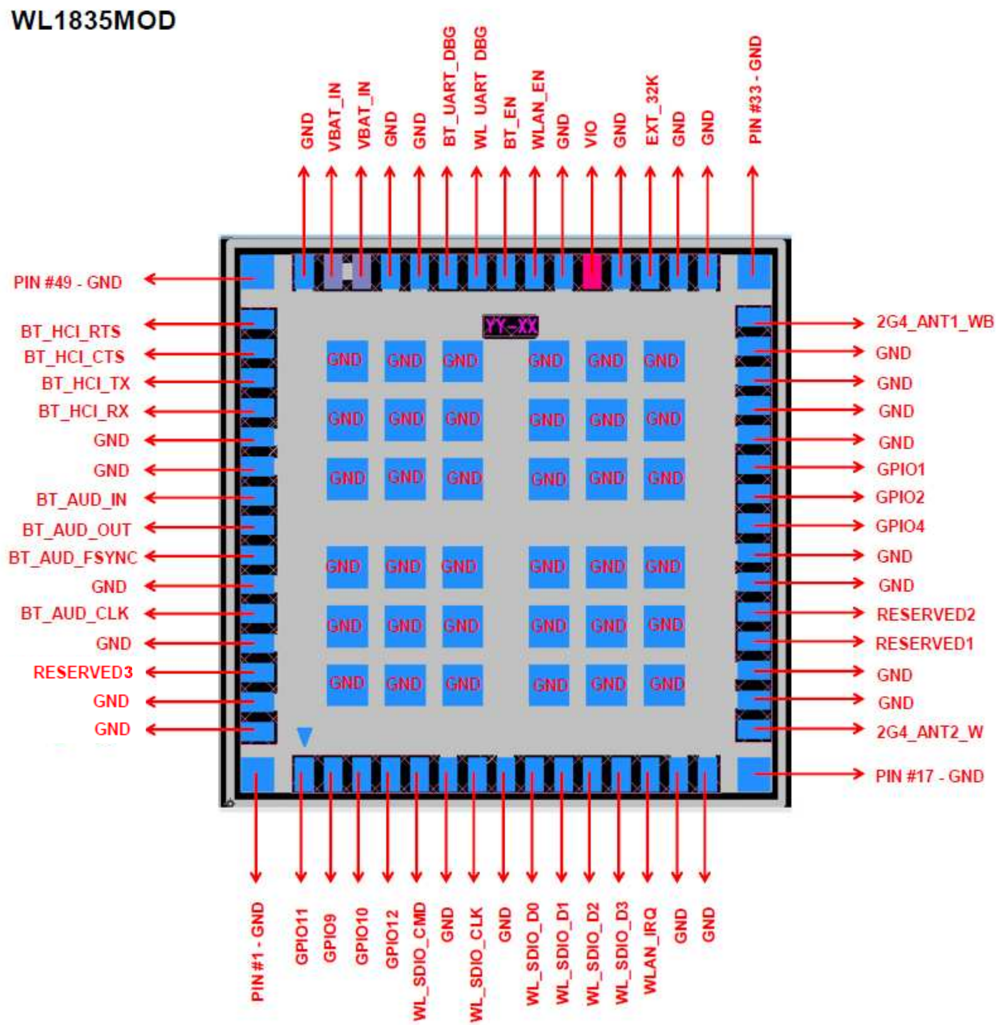

Figure 3-2. Pin Designations

Table 3-1 describes the device pins.

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Table 3-1. Pin Description

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

(1) PU = pull up; PD = pull down.
(2) v = connect; x = no connect.
(3) Host must provide PU using a 10-K resistor for all non-CLK SDIO signals.

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Table 3-1. Pin Description (continued)

WL183x Pin Name	Pin	Type/ Dir	Shutdown State	After Power Up(1)	Voltage Level	Connectivity(2)				Description
						1801	1805	1831	1835	
GPIO_2	26	I/O	PD	PD	–	v	v	v	v	WL_RS232_RX (when IRQ_WL = 1 at power up)
GPIO_1	27	I/O	PD	PD	–	v	v	v	v	WL_RS232_TX (when IRQ_WL = 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	In	PD	PD	–	v	v	v	v	Mode setting: high = enable
BT_EN	41	In	PD	PD	–	x	x	v	v	Mode setting: high = enable
WL_UART_DBG	42	Out	PU	PU	–	v	v	v	v	Option: WLAN logger
BT_UART_DBG	43	Out	PU	PU	–	x	x	v	v	Option: *Bluetooth* 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	Out	PU	PU	1.8 V	x	x	v	v	UART RTS to host. NC if not used.
BT_HCI_CTS_1V8	51	In	PU	PU	1.8 V	x	x	v	v	UART CTS from host. NC if not used.
BT_HCI_TX_1V8	52	Out	PU	PU	1.8 V	x	x	v	v	UART TX to host. NC if not used.
BT_HCI_RX_1V8	53	In	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	In	PD	PD	1.8 V	x	x	v	v	*Bluetooth* PCM/I2S bus. Data in. NC if not used.
BT_AUD_OUT	57	Out	PD	PD	1.8 V	x	x	v	v	*Bluetooth* PCM/I2S bus. Data out. NC if not used.

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Table 3-1. Pin Description (continued)

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

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4 Module Specifications

4.1 General Requirements and Operation

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

4.2 Absolute Maximum Ratings(1)

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

Parameter		Value	Unit
VBAT		–0.5 to 5.5(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
Storage temperature range		–55 to +125	°C
ESD stress voltage(4)	Human body model(5)	>1000	V
	Charged device model(6)	>250	V

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

4.3 Recommended Operating Conditions

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

Parameter	Condition	Sym	Min	Max	Unit
VBAT(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
	@ 1 mA		VDD_IO –0.112	VDD_IO	V
	@ 0.3 mA		VDD_IO –0.033	VDD_IO	V
Low-level output voltage	@ 4 mA	VOL	0	0.45	V
	@ 1 mA		0	0.112	V
	@ 0.09 mA		0	0.01	V
Input transitions time T_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

(1) 4.8 V is applicable only for 2.3 years (30% of the time). Otherwise, maximum VBAT must not exceed 4.3 V.
(2) Applies to all digital lines except SDIO, UART, I2C, PCM and slow clock lines

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Recommended Operating Conditions *(continued)*

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

Parameter	Condition	Sym	Min	Max	Unit
Output fall time from 10% to 90% (digital pins)[2]	CL < 25 pF	T_f		4.9	ns
Ambient operating temperature			–40	85	ºC
Maximum power dissipation	WLAN operation			2.8	W
	Bluetooth operation			0.2	W

4.4 External Digital Slow Clock Requirements

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

Parameter	Condition	Sym	Min	Typ	Max	Unit
Input slow clock frequency				32768		Hz
Input slow clock accuracy (Initial + temp + aging)	WLAN				±250	ppm
Input transition time T_r,T_f (10% to 90%)		T_r,T_f			100	%
Frequency input duty cycle			15	50	85	%
Input voltage limits	Square wave, DC-coupled	Vih	0.65 x VDD_IO		VDD_IO	V_{peak}
		Vil	0		0.35 x VDD_IO	
Input impedance			1			MΩ
Input capacitance					5	pF

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4.5 WLAN Performance

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

4.6 WLAN 2.4-GHz Receiver Characteristics

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

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

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4.7 WLAN 2.4-GHz Transmitter Power

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

(1) MIMO MCS15 until 65 °C

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4.8 WLAN Currents

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

4.9 *Bluetooth* Performance

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

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

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

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

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

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

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

4.11 *Bluetooth* Receiver Characteristics – General Blocking

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

Parameter	Condition	Min	Typ	*Bluetooth* Specification	Unit
Blocking performance over full range, according to *Bluetooth* specification[(1)]	30 to 2000 MHz	–6		–10	dBm
	2000 to 2399 MHz	–6		–27	dBm
	2484 to 3000 MHz	–6		–27	dBm
	3 to 12.75 GHz	–6		–10	dBm

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

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

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

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

(1) Except for frequencies in which [3 × F_BLOCKER] falls within the *Bluetooth* band (2400 to 2483.5 MHz)

4.13 *Bluetooth* Transmitter, BR

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

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

(1) Values reflect maximum power. Reduced power is available using a vendor-specific (VS) command.
(2) Assumes 3-dB insertion loss on external filter and traces

4.14 *Bluetooth* Transmitter, EDR

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

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

(1) Values reflect default maximum power. Max power can be changed using a VS command.
(2) Assumes 3-dB insertion loss on external filter and traces

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4.15 *Bluetooth* Modulation, BR

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

Characteristics	Condition [1]		Performances			Bluetooth Specification	Units
			Min	Typ	Max		
BR –20 dB Bandwidth				925	995	≤1000	kHz
BR modulation characteristics	Δf1avg	Mod data = 4 1s, 4 0s: 111100001111...		160		140 to 175	kHz
	Δf2max ≥ limit for at least 99.9% of all Δf2max	Mod data = 1010101...		130		> 115	kHz
	Δf2avg/Δf1avg			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	lfk+5 – fkl , k = 0 …. max				15	< 20	kHz/50 µs
BR initial carrier frequency tolerance [2]	f0–fTX		–25		25	< ±75	kHz

(1) Performance values reflect maximum power.
(2) This number is added on top of the reference clock frequency accuracy.

4.16 *Bluetooth* Modulation, EDR

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

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

(1) Performance values reflect maximum power.
(2) This number is added on top of the reference clock frequency accuracy.

4.17 *Bluetooth* BR, EDR Transceiver – Emissions

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

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

(1) Meets FCC and ETSI requirements with a suitable external filter
(2) Performance values reflect maximum power.

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

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

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

(3) Except for frequencies that correspond to 2 × RF_FREQ / 3

4.18 *Bluetooth* BR, EDR Transceiver – Spurs

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

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

(1) Meets FCC and ETSI requirements with a suitable external filter
(2) Performance values reflect maximum power.
(3) Except for frequencies corresponding to 2 × RF_FREQ/3

4.19 *Bluetooth* EDR Transceiver – Spurs

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

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

(1) Meets FCC and ETSI requirements with a suitable external filter
(2) Performance values reflect maximum power.
(3) Except for frequencies corresponding to 2 × RF_FREQ/3

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Bluetooth EDR Transceiver – Spurs *(continued)*

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

Characteristics [1]	Condition [2]		Performances			Units
			Min	Typ	Max	
	1805 to 1880 MHz (DCS, WCDMA)			–76		dBm
	1930 to 1990 MHz (PCS)			–74		dBm
	2110 to 2170 MHz (WCDMA)			–63		dBm

4.20 *Bluetooth* LE Performance

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

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

Parameter	Condition [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			–94		≤ –70	dBm
Bluetooth LE maximum usable input power		–5			≥ –10	dBm
Bluetooth LE intermodulation characteristics	Level of interferers. For n = 3, 4, 5	–36	–30		≥ –50	dBm
Bluetooth LE C/I performance. Note: Numbers show wanted signal-to-interfering-signal ratio. Smaller numbers indicate better C/I performance.	LE, co-channel		8	12	≤ 21	dB
	LE, adjacent ±1 MHz		–5	0	≤ 15	
	LE, adjacent +2 MHz		–45	–38	≤ –17	
	LE, adjacent –2 MHz		–22	–15	≤ –15	
Image = –1 MHz	LE, adjacent ≥ |±3|MHz		–47	–40	≤ –27	

(1) BER of 0.1% corresponds to PER of 30.8% for a minimum of 1500 transmitted packets, according to the *Bluetooth* LE test specification.
(2) Sensitivity degradation of up to –3 dB can occur due to fast clock harmonics.

4.22 *Bluetooth* LE Receiver Characteristics – General Blocking

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

Parameter	Condition	Min	Typ	Max	BLE Specification	Unit
Bluetooth LE blocking performance over full range, according to the LE specification [1]	30 to 2000 MHz	–15			≥ –30	dBm
	2000 to 2399 MHz	–15			≥ –35	
	2484 to 3000 MHz	–15			≥ –35	
	3 to 12.75 GHz	–15			≥ –30	

(1) Exceptions taken out of the total 10 allowed for fbf_1, according to the *Bluetooth* LE specification

4.22.1 Bluetooth LE Receiver Characteristics – Blocking per Band

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

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

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4.23 *Bluetooth* LE Transmitter Characteristics

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

Parameter		Min	Typ	Max	*Bluetooth* LE Specification	Unit
Bluetooth LE RF output power(1)	VBAT ≥ 3 V		13.5		≤10	dBm
	VBAT < 3 V		8.0		≤10	dBm
Bluetooth LE adjacent channel power |M-N| = 2(2)			–51.0		≤ –20	dBm
Bluetooth LE adjacent channel power |M-N| > 2(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.
(2) Assumes 3-dB insertion loss on external filter and traces

4.24 *Bluetooth* LE Modulation Characteristics

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

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

(1) Performance values reflect maximum power.
(2) This number is added on top of the reference clock frequency accuracy.

4.24.1 *Bluetooth LE Transceiver – Emissions*

See Section 4.17, *Bluetooth BR, EDR Transceiver – Emissions*.

4.24.2 *Bluetooth LE Transceiver – Spurs*

See Section 4.18, *Bluetooth BR, EDR Transceiver – Spurs*.

4.25 *Bluetooth*-BLE Dynamic Currents

Current is measured at output power as follows:

- BR at 14.5 dBm
- EDR at 10 dBm

Use Case(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	uA
EDR A2DP EDR2 (master). SBC high quality – 345 Kbs	10.4	mA

(1) The role of *Bluetooth* in all scenarios except A2DP is slave.
(2) CL1P5 PA is connected to VBAT, 3.7 V.

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Use Case[1] [2]	Typ	Units
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 or inquiry 1.28 s/11.25 ms	253.0	mA
P&I scan (P = 1.28/I = 2.56)	332.0	mA

(3) ACL RX has the same current in all modulations.
(4) Full throughput assumes data transfer in one direction.

4.26 Bluetooth LE Currents

All current is measured at output power of 10 dBm.

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

(1) CL1p% PA is connected to VBAT, 3.7 V.
(2) Advertising in all three channels, 1.28-s advertising interval, 15 bytes advertise data
(3) Listening to a single frequency per window, 1.28-s scan interval, 11.25-ms scan window
(4) Zero slave connection latency, empty TX and RX LL packets

4.27 Shutdown and Sleep Currents

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

5 Host Interface Timing Characteristics

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

WLAN	Shared HCI for All Functional Blocks Except WLAN	*Bluetooth* Voice-Audio
WLAN HS SDIO	Over UART	*Bluetooth* PCM

5.1 WLAN SDIO Transport Layer

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

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

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

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5.1.1 SDIO Timing Specifications

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

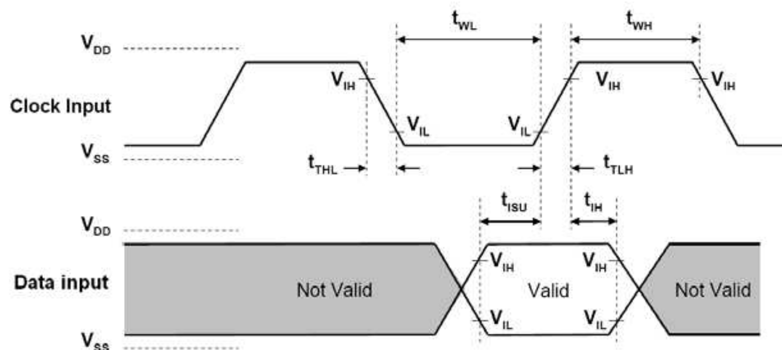

Figure 5-1. SDIO Default Input Timing

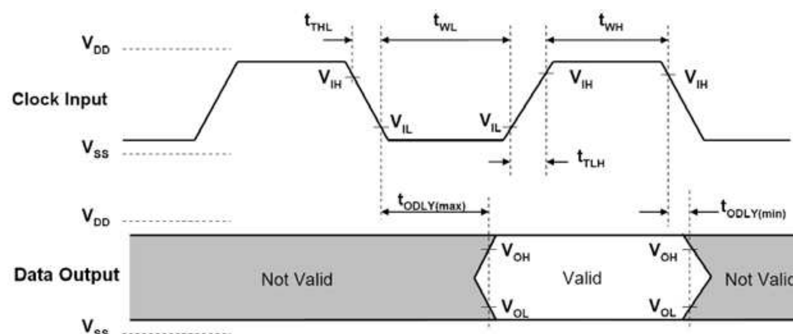

Figure 5-2. SDIO Default Output Timing

Table 5-1 lists the SDIO default timing characteristics.

Table 5-1. SDIO Default Timing Characteristics(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 ↑	3.0		ns
t_{IH}	Hold time, input valid after CLK ↑	2.0		ns
t_{ODLY}	Delay time, CLK ↓ to output valid	2.5	14.8	ns
C_l	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.

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5.1.2 SDIO Switching Characteristics – High Rate

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

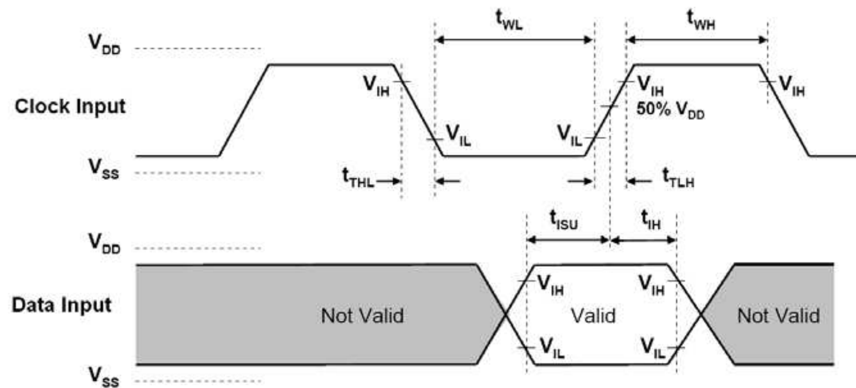

Figure 5-3. SDIO HS Input Timing

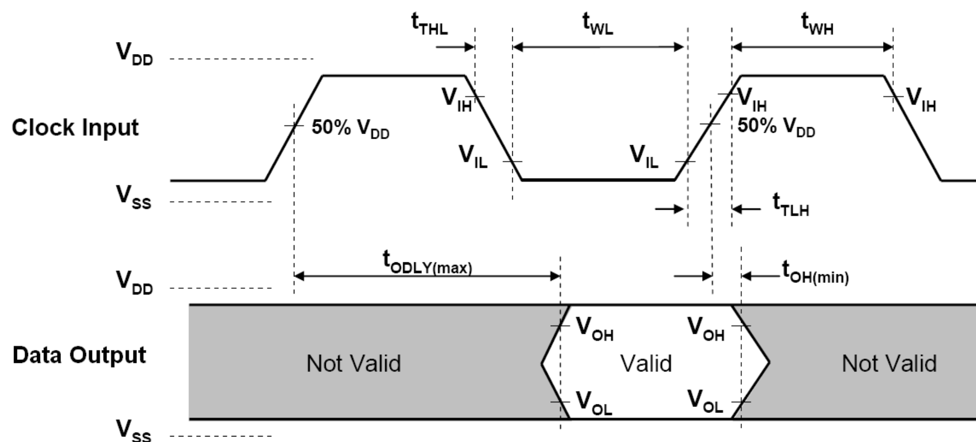

Figure 5-4. SDIO HS Output Timing

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

Table 5-2. SDIO HS Timing Characteristics

Parameter		Min	Max	Unit
f_{clock}	Clock frequency, CLK	0.0	50.0	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_{ISU}	Setup time, input valid before CLK ↑	3.0		ns
t_{IH}	Hold time, input valid after CLK ↑	2.0		ns
t_{ODLY}	Delay time, CLK ↑ to output valid	2.5	14.0	ns
C_l	Capacitive load on outputs		10.0	pF

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

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

HCI hardware includes the following features:

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

Table 5-3 lists the UART default settings.

Table 5-3. UART Default Setting

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

5.2.1 UART 4-Wire Interface – H4

The interface includes four signals:

- TXD
- RXD
- CTS
- RTS

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

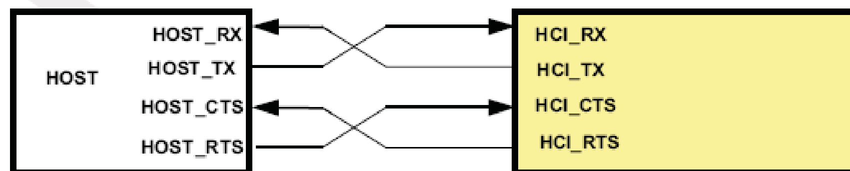

Figure 5-5. HCI UART Connection

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

Figure 5-6 shows the UART timing.

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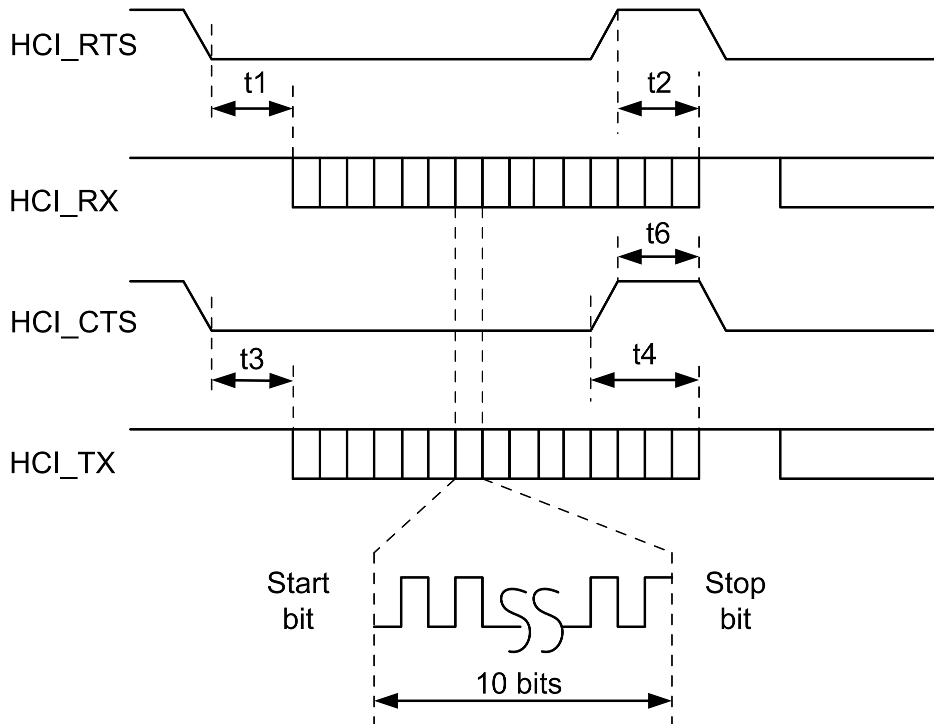


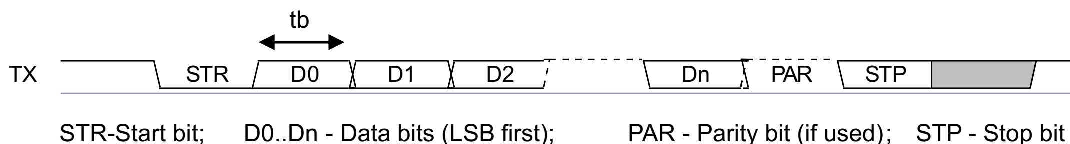
Figure 5-6. UART Timing Diagram

Table 5-4 lists the UART timing characteristics.

Table 5-4. UART Timing Characteristics

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

Figure 5-7 shows the UART data frame.



STR-Start bit; D0..Dn - Data bits (LSB first); PAR - Parity bit (if used); STP - Stop bit

Figure 5-7. UART Data Frame

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

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

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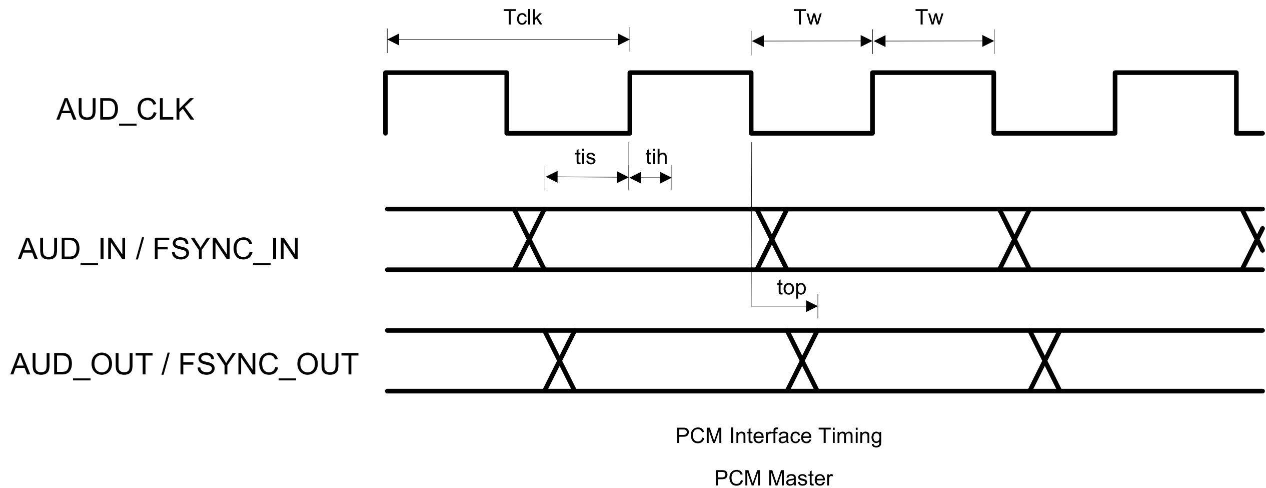

Figure 5-8. *Bluetooth* Codec-PCM (Audio) Master Timing Diagram

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

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

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

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

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

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

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6 Clocks and Power Management

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

6.1 Reset-Power-Up System

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

6.2 WLAN Power-Up Sequence

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

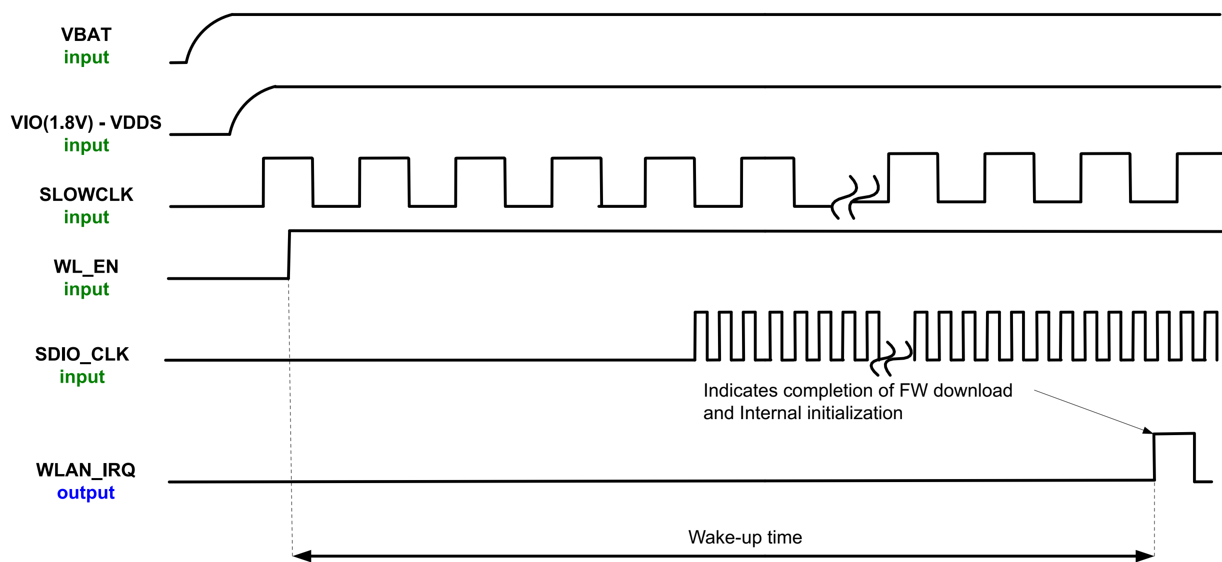

Figure 6-1. WLAN Power-Up Sequence

6.3 *Bluetooth*-BLE Power-Up Sequence

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

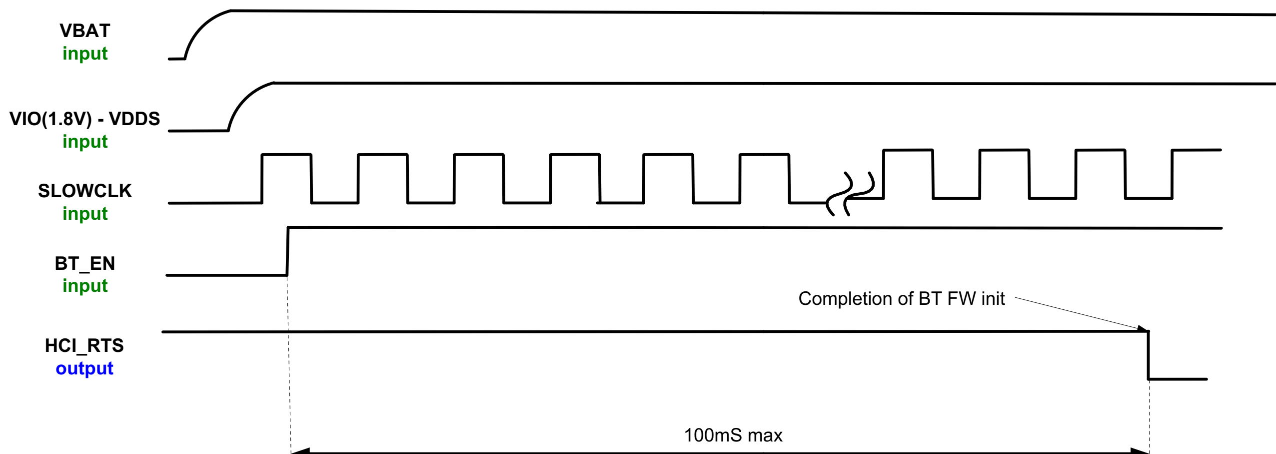

Figure 6-2. *Bluetooth*-BLE Power-Up Sequence

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7 Reference Schematics and Bill of Materials

7.1 TI Module Reference Design

Figure 7-1 shows the TI module reference design.

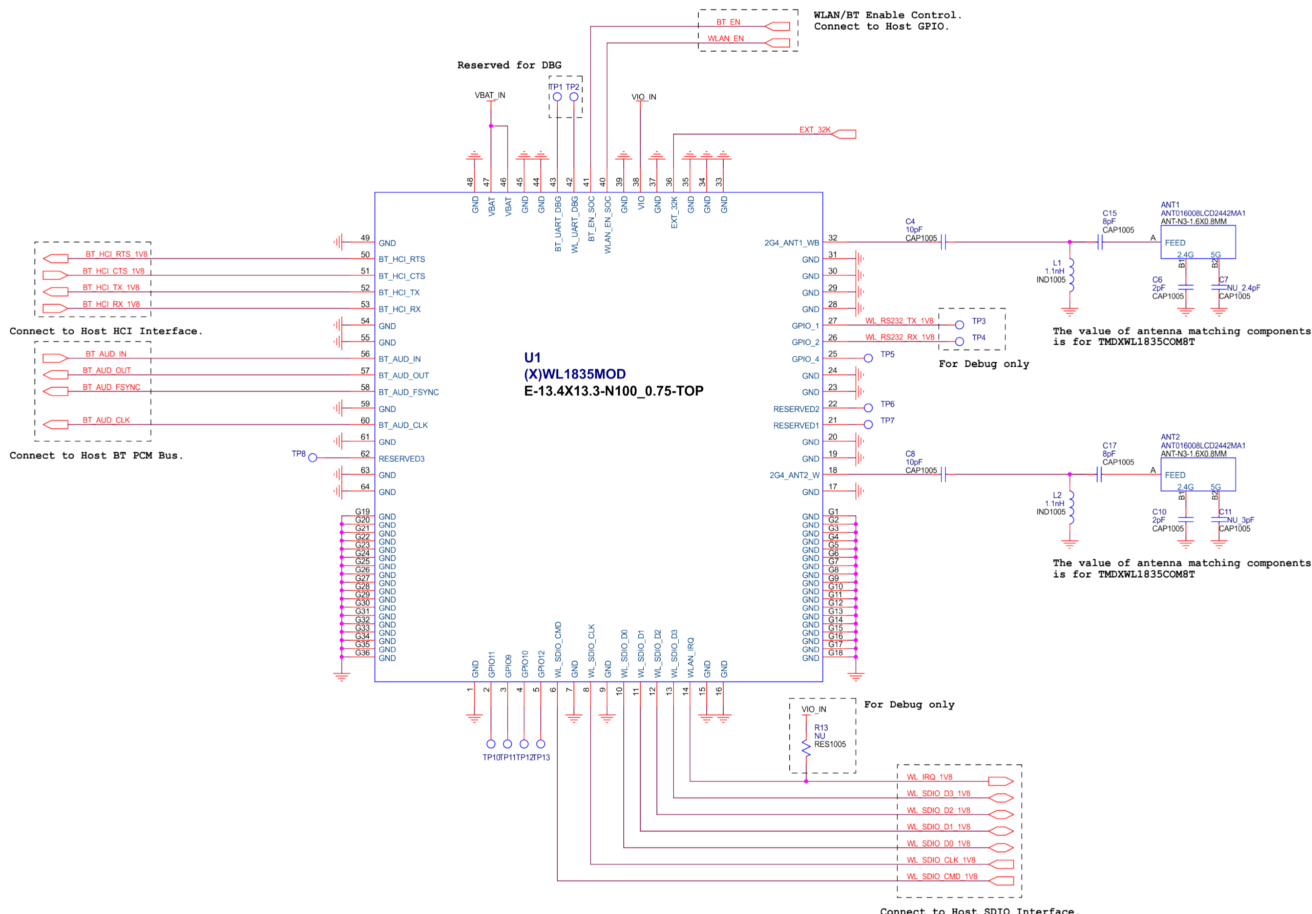

Figure 7-1. TI Module Reference Schematics

7.2 Bill of Materials

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

Table 7-1. Bill of Materials

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

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8 Design Recommendations

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

8.1 RF Trace and Antenna Layout Recommendations

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

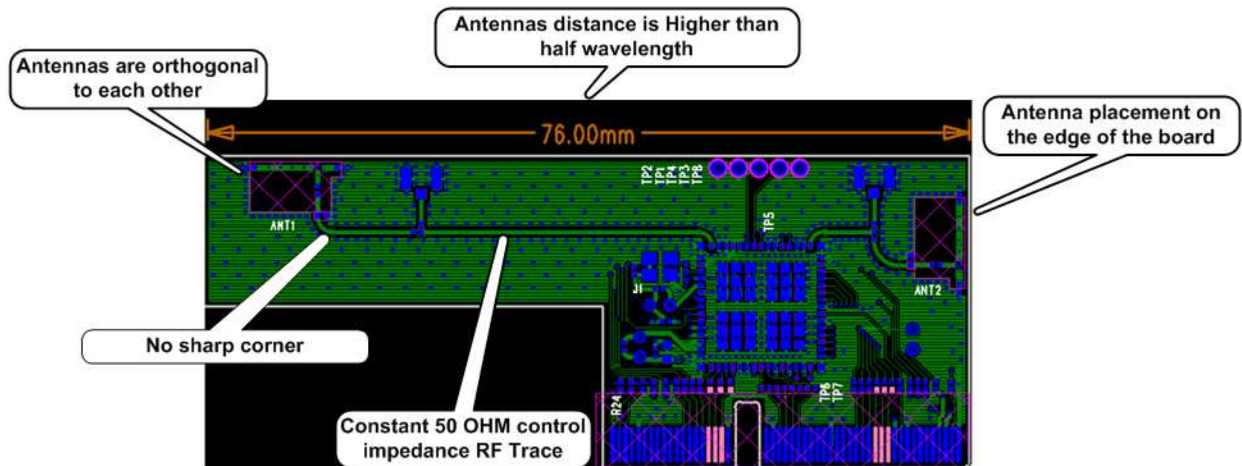

Figure 8-1. Location of Antenna and RF Trace Routing on the TMDXWL1835COM8T Board

Follow these following RF trace routing recommendations:

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

8.2 Module Layout Recommendations

Follow these module layout recommendations:

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

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

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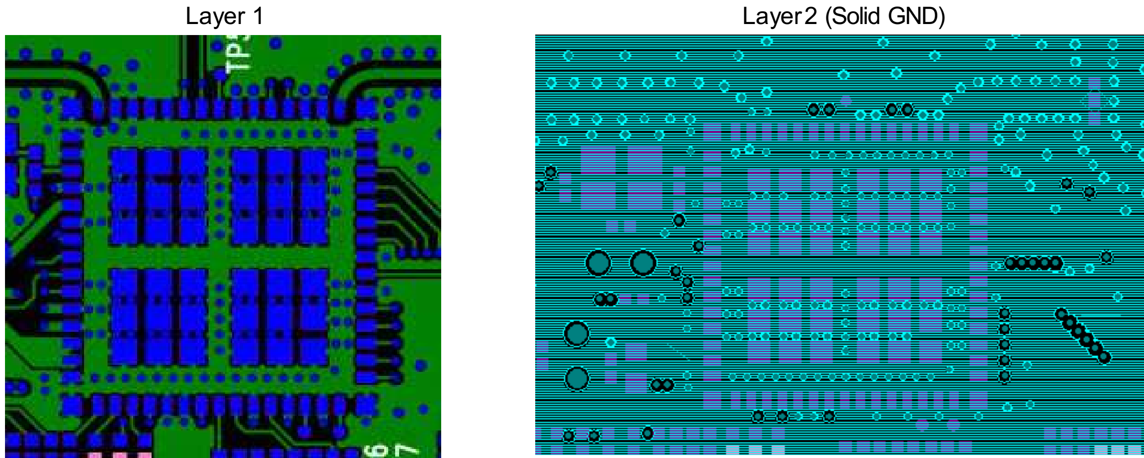

Figure 8-2. TI Module Layout

9 Mechanical Information

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

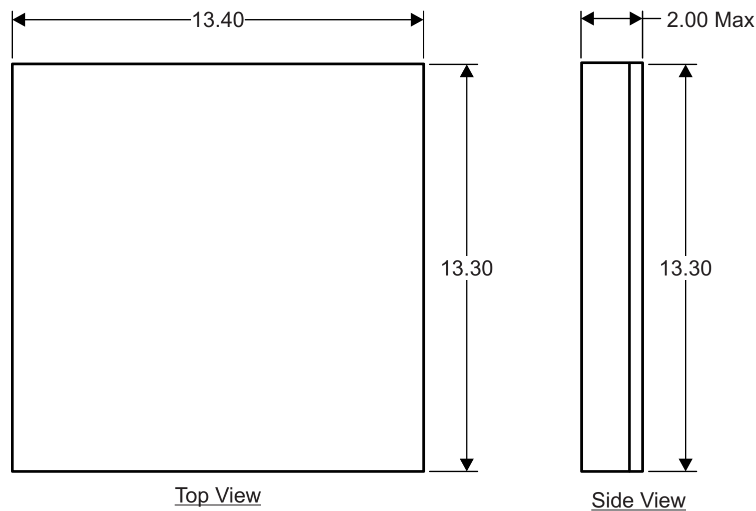

Figure 9-1. TI Module Mechanical Outline

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10 Packaging Information

Table 10-1 lists the available TI module part numbers.

Table 10-1. TI Module Part Numbers

Part Number (1)	Status (2)	Package Type	Minimum Orderable Quantity
XWL1835MODGAMOCT	Preview	LGA	250
XWL1805MODGAMOCT	Preview	LGA	
XWL1831MODGAMOCT	Preview	LGA	
XWL1801MODGAMOCT	Preview	LGA	

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

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

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

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

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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
XWL1801MODGAMOCT	PREVIEW			100	250	TBD	Call TI	Call TI	-20 to 70		
XWL1805MODGAMOCT	PREVIEW			100	250	TBD	Call TI	Call TI	-20 to 70		
XWL1831MODGAMOCT	PREVIEW			100	250	TBD	Call TI	Call TI	-20 to 70		
XWL1835MODGAMOCT	PREVIEW			100	250	TBD	Call TI	Call TI	-20 to 70		

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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

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

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

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