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Integrated Transceiver Modules for WLAN 802.11 a/b/g/n, Bluetooth, Bluetooth Low Energy (BLE), and ANT

FEATURES

IEEE 802.11 a,b,g,n,d,e,I compliant

- Typical WLAN Transmit Power:
  - 18.3 dBm, 11 Mbps, CCK (b)
  - 14.4 dBm, 54 Mbps, OFDM (g)
  - 12.5 dBm, 65 Mbps, OFDM (n)
- Typical WLAN Sensitivity:
  - -88 dBm, 8% PER,11 Mbps
  - -74 dBm, 10% PER, 54 Mbps
  - -72 dBm, 10% PER, 65 Mbps
- Bluetooth 2.1+EDR, Power Class 1.5
- Full support for BLE 4.0 and ANT
- Miniature footprint: 18 mm x 13 mm
- Low height profile: 1.9 mm
- Terminal for PCB/Chip antenna feeds
- Worldwide acceptance: FCC (USA), IC (Canada), and CE (Europe)
- Modular certification allows reuse of LSR FCC ID and ETSI certification without repeating the expensive testing on your end product
- Compact design based on Texas Instruments WL1273L Transceiver
- Seamless integration with TI OMAP™ application processors
- SDIO Host data path interfaces
- Bluetooth Advanced Audio Interfaces
- Low power operation modes
- RoHS compliant
- Streamlined development with LSR Design Services

APPLICATIONS

- Security
- HVAC Control, Smart Energy
- Sensor Networks
- Medical

DESCRIPTION

The TiWi5 module is a high performance 2.4 /5.5 GHz IEEE 802.11 a/b/g/n, Bluetooth 2.1+EDR, and Bluetooth Low Energy (BLE) 4.0 radio in a cost effective, pre-certified footprint.

The module realizes the necessary PHY/MAC layers to support WLAN applications in conjunction with a host processor over a SDIO interface.

The module also provides a Bluetooth platform through the UART or btSPI HCI transport layer. Both WLAN and Bluetooth share the same antenna port.

TiWi5 is pin for pin compatible with the TiWi-R2 and TiWi-BLE modules. TiWi5 does not include the on module U.FL connector.

Need to get to market quickly? Not an expert in 802.11 or Bluetooth? Need a custom antenna? Would you like to own the design? Would you like a custom design? Not quite sure what you need? Do you need help with your host board? LSR Design Services will be happy to develop custom hardware or software, integrate the design, or license the design so you can manufacture yourself. Contact us at sales@lsr.com or call us at 262-375-4400.

ORDERING INFORMATION

Order Number	Description
450-0053	TiWi5 Module (Tray, SPQ = 100)
450-0053R	TiWi5 Module (Tape and Reel, SPQ = 1000)

Table 1 Orderable TiWi5 Part Numbers

MODULE ACCESSORIES

	Order Number	Description
	**001-0009**	2.4/5.5 GHz Dual-Band Dipole Antenna with Reverse Polarity SMA Connector
	**080-0001**	U.FL to Reverse Polarity SMA Bulkhead Cable 105mm

Table 2 Module Accessories

BLOCK DIAGRAM

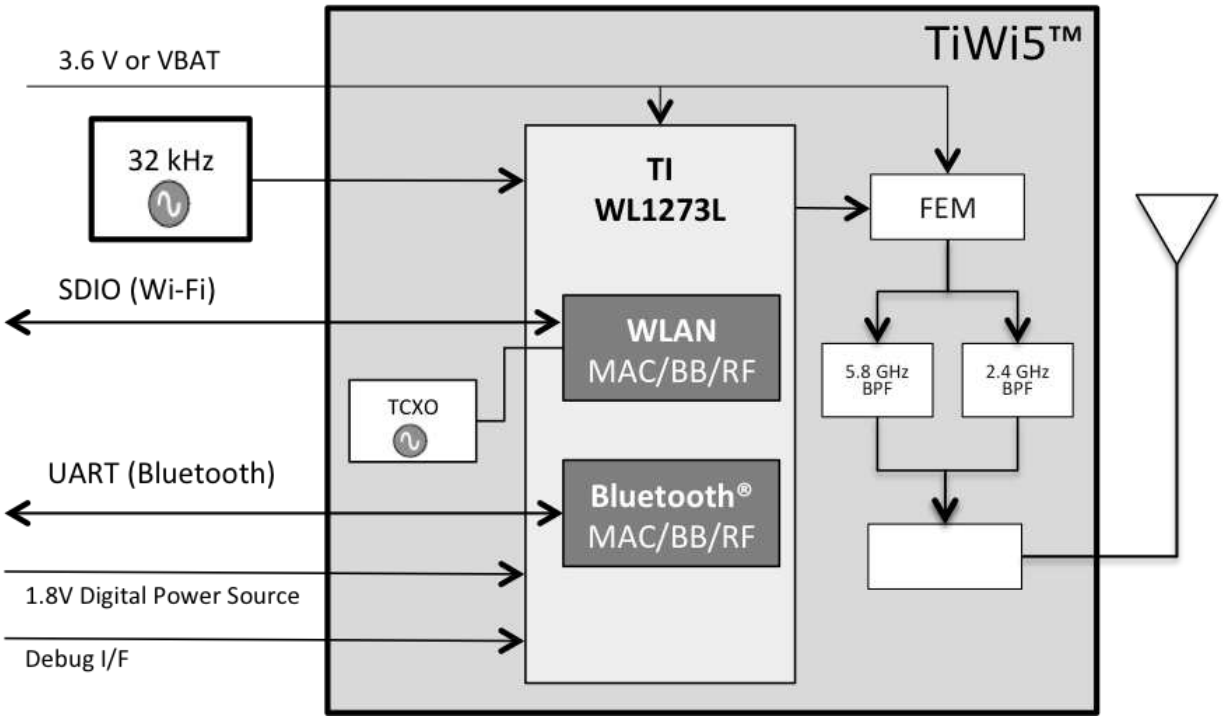

Figure 1 TiWi5 Module Block Diagram – Top-Level

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TIWI5 MODULE FOOTPRINT AND PIN DEFINITIONS

To apply the TiWi5 module, it is important to use the module pins in your application as they are designated in below and in the corresponding pin definition table found on pages 8 and 9. Not all the pins on the TiWi5 module may be used, as some are reserved for future functionality.

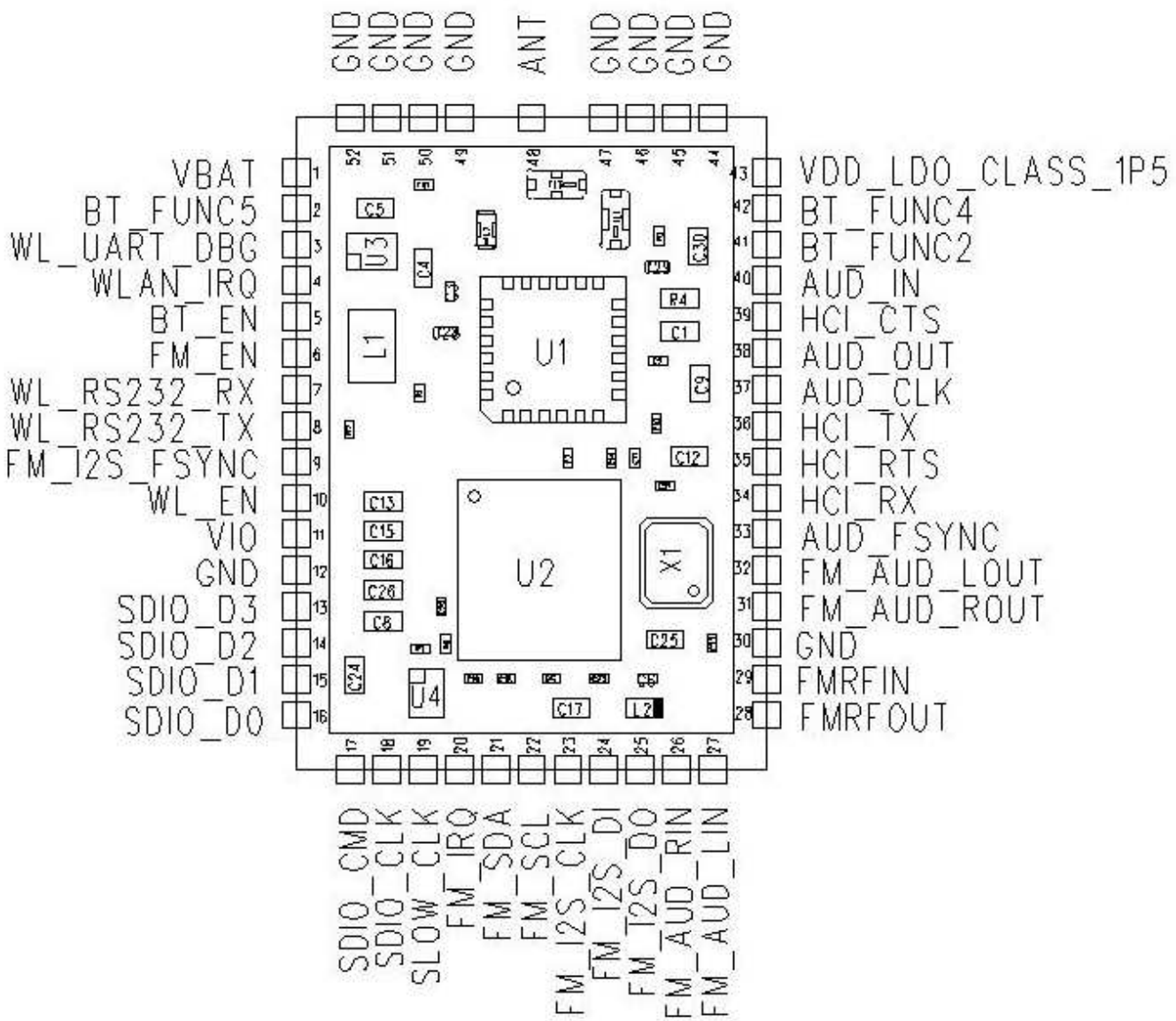


Figure 2 TiWi5 Pinout (Top View)

PIN DESCRIPTIONS

Module Pin	Name	I/O Type	Buffer Type	Logic Level	Description
1	VBAT	PI	-	-	Battery Voltage 3.6 VDC Nominal (3.0-4.8 VDC)
2	BT_FUNC5	DO	4 mA	1.8 VDC	HOST_WU (*)
3	WL_UART_DBG	DIO	4 mA	1.8 VDC	WL_UART_DBG
4	WLAN_IRQ	DO	4 mA	1.8 VDC	WLAN Interrupt Request
5	BT_EN	DI	-	1.8 VDC	Bluetooth Enable
6	FM_EN	DI	-	1.8 VDC	NOT SUPPORTED, CONNECT TO GND
7	WL_RS232_RX	DI	-	1.8 VDC	WLAN TEST UART RX (*)
8	WL_RS232_TX	DO	4 mA	1.8 VDC	WLAN TEST UART TX (*)
9	FM_I2S_FSYNC	DO	4 mA	1.8 VDC	NOT SUPPORTED, NO CONNECT
10	WL_EN	DI	-	1.8 VDC	WLAN Enable
11	VIO	PI	-	-	POWER SUPPLY FOR 1.8 VDC DIGITAL DOMAIN
12	GND	GND	-	-	Ground
13	SDIO_D3	DIO	8 mA	1.8 VDC	SDIO INTERFACE, HOST PULL UP
14	SDIO_D2	DIO	8 mA	1.8 VDC	SDIO INTERFACE, HOST PULL UP
15	SDIO_D1	DIO	8 mA	1.8 VDC	SDIO INTERFACE, HOST PULL UP
16	SDIO_D0	DIO	8 mA	1.8 VDC	SDIO INTERFACE, HOST PULL UP
17	SDIO_CMD	DIO	8 mA	1.8 VDC	HOST PULL UP
18	SDIO_CLK	DI	-	1.8 VDC	HOST PULL UP
19	SLOW_CLK	DI	-	1.8 VDC	SLEEP CLOCK (32 kHz)
20	FM_IRQ	DO	4 mA	1.8 VDC	NOT SUPPORTED, NO CONNECT
21	FM_SDA	DO	4 mA	1.8 VDC	NOT SUPPORTED, NO CONNECT
22	FM_SCL	DO	4 mA	1.8 VDC	NOT SUPPORTED, NO CONNECT
23	FM_I2S_CLK	DO	4 mA	1.8 VDC	NOT SUPPORTED, NO CONNECT
24	FM_I2S_DI	DI	4 mA	1.8 VDC	NOT SUPPORTED, CONNECT TO GND
25	FM_I2S_DO	DO	4 mA	1.8 VDC	NOT SUPPORTED, NO CONNECT
26	FM_AUD_RIN	AI	-	-	NOT SUPPORTED, CONNECT TO GND
27	FM_AUD_LIN	AI	-	-	NOT SUPPORTED, CONNECT TO GND
28	FMRFOUT	AO	-	-	NOT SUPPORTED, NO CONNECT
29	FMRFIN	AI	-	-	NOT SUPPORTED, CONNECT TO GND
30	GND	GND	-	-	Ground

Module Pin	Name	I/O Type	Buffer Type	Logic Level	Description
31	FM_AUD_ROUT	AO	-	-	NOT SUPPORTED, NO CONNECT
32	FM_AUD_LOUT	AO	-	-	NOT SUPPORTED, NO CONNECT
33	AUD_FSYNC	DIO	4 mA	1.8 VDC	PCM I/F
34	HCI_RX	DI	8 mA	1.8 VDC	Bluetooth HCI UART RX (*)
35	HCI_RTS	DO	4 mA	1.8 VDC	Bluetooth HCI UART RTS (*)
36	HCI_TX	DIO	8 mA	1.8 VDC	Bluetooth HCI UART TX
37	AUD_CLK	DO	4 mA	1.8 VDC	PCM I/F (*)
38	AUD_OUT	DO	4 mA	1.8 VDC	PCM I/F (*)
39	HCI_CTS	DI	4 mA	1.8 VDC	Bluetooth HCI UART CTS (*)
40	AUD_IN	DI	4 mA	1.8 VDC	PCM I/F (*)
41	BT_FUNC2	DI	4 mA	1.8 VDC	Bluetooth Wakeup[DI] / DC2DC mode[DO](*)
42	BT_FUNC4	DO	4 mA	1.8 VDC	BT_UARTD (DEBUG) (*)
43	VDD_LDO_CLASS_1P5	NC	-	-	VBAT VOLTAGE PRESENT, NO CONNECT
44	GND	GND	-	-	Ground
45	GND	GND	-	-	Ground
46	GND	GND	-	-	Ground
47	GND	GND	-	-	Ground
48	ANT	RF		-	Antenna terminal for WLAN and Bluetooth (note [1])
49	GND	GND	-	-	Ground
50	GND	GND	-	-	Ground
51	GND	GND	-	-	Ground
52	GND	GND	-	-	Ground

PI = Power Input PO = Power Output DI = Digital Input (1.8 VDC Logic Level) DO = Digital Output (1.8 VDC Logic Level)
AI = Analog Input AO = Analog Output AIO = Analog Input/Output RF = RF Port GND = Ground

Note[1]: Antenna terminal presents DC short circuit to ground.

(*) indicates that pin is capable of bidirectional operation, but is used as the type shown.

Table 3 TiWi5 Module Pin Descriptions

All digital I/O signals use 1.8V logic. If the host microcontroller does not support 1.8V logic, then level shifters MUST be used.

BT_FUNC2 and BT_FUNC5 Pins

When BT is awake and active, BT_WU (BT_FUNC2) is high (from host to module). This is an active high signal. The host puts the BT section to sleep by de-asserting (logic low level) the BT_WU signal (input to the module). The module then drives HOST_WU (BT_FUNC5) low to acknowledge to the host that it is has been put into sleep mode.

Using these pins is optional.

BT_FUNC4 Pin

The BT_FUNC4 (BT_UARTD) pin is a debug pin. It is a 1.8V logic UART TX line. This pin should never need to be used in normal operation. It may be useful to terminate this pin to a test point or header in case it is needed.

WL_UART_DBG Pin

The WL_UART_DBG pin is a debug pin. It is a 1.8V logic UART TX line. This pin should never need to be used in normal operation. It may be useful to terminate this pin to a test point or header in case it is needed.

WL_RS232_RX and WL_RS232_TX Pins

This pins are used for a WLAN test mode interface. Both pins are 1.8V logic level UART pins. These pins should be brought out to a header on the host PCB. The WLAN test interface can be used to place the module into constant packet transmit and constant packet receive modes. These modes can be useful for antenna and sensitivity testing.

INI FILE RADIO PARAMETERS

There is an ini file that contains WLAN radio parameters which are critical to both the RF performance and EMC compliance of the module.

The ini file available on the LSR wiki is only intended to be used with the LSR WLAN Eval Tool. Note that this ini file will not work when using the TiWi5 module in normal operation which typically involves an operating system. To use the TiWi5 module in normal operation, refer to specifics contained in the TiWi Family INI File Radio Parameter User Guide which is also available for download on the LSR website.

The settings specified in the appropriate ini file must be used to operate the module in compliance with the modular certification for FCC or ETSI. There is a unique ini file for operating the module in compliance with FCC regulations, and a different ini file for operating the module in compliance with the ETSI regulations.

5 GHZ AP MODE

The TiWi5 module was not certified as a DFS Master, and therefore the AP mode is not allowed in the 5 GHz bands. The AP mode is allowed to be used in the 2.4 GHz band. Software cannot prevent the usage of the AP mode in the 5 GHz band, so it is the module-integrators responsibility to ensure the 5 GHz AP mode is not used.

ELECTRICAL SPECIFICATIONS

The majority of these characteristics are based on controlling and conditioning the tests using the TiWi5 control software application. Other control conditions may require these values to be re-characterized by the customer.

Absolute Maximum Ratings

Parameter	Min	Max	Unit
Power supply voltage (VBAT)[4][5]	-0.5	+5.5	V
Digital supply voltage (VIO)	-0.5	2.1	V
Voltage on any GPIO	-0.5	VIO + 0.5	V
Voltage on any Analog Pins[3]	-0.5	2.1	V
RF input power, antenna port		+10	dBm
Operating temperature[6]	-40	+85	ºC
Storage temperature	-55	+125	ºC

1. Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device and are not covered by the warranty. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
2. All parameters are measured as follows unless stated otherwise: VDD_IN=1.8V, VDDIO_1.8V=1.8V, VDD_LDO_CLASS1P5=3.6V
3. Analog pins: XTALP, XTALM, RFIOBT, DRPWRXBM, DRPWRXBP, DRPWTXB, and also FMRFINP, FMRFINM, FMRFINM, FMAUDLIN, FMAUDRIN, FMAUDLOUT, FMAUDROUT
4. The following signals are from the VBAT group, PMS_VBAT and VDD_LDO_CLASS1P5 (if BT class 1.5 direct VBAT is used).
5. Maximum allowed depends on accumulated time at that voltage; 4.8V for 7 years lifetime, 5.5V for 6 hours cumulative.
6. The device can be reliably operated for 5,000 active-WLAN cumulative hours at T_A of 85ºC.

Table 4 Absolute Maximum Ratings

Recommended Operating Conditions

Parameter	Min	Typ	Max	Unit
V_{BAT}	3.0	3.6	4.8	V
VIO	1.62	1.8	1.92	V
V_{IH}	0.65 x VIO	-	VIO	V
V_{IL}	0	-	0.35 x VIO	V
V_{OH} @ 4, 8 mA	VIO - 0.45	-	VIO	V
V_{OL} @ 4, 8 mA	0	-	0.45	V
Ambient temperature range	-40	25	85	ºC

Table 5 Recommended Operating Conditions

General Characteristics

Parameter	Min	Typ	Max	Unit
WLAN RF frequency range 1	2412		2472	MHz
WLAN RF frequency range 2	4910		5835	MHz
WLAN RF data rate	1	802.11 a/b/g/n rates supported	65	Mbps
BT RF frequency Range	2402		2480	MHz

Table 6 General Characteristics

Power Consumption – WLAN 2.4 GHz

Parameter	Test Conditions	Min	Typ	Max	Unit
CCK (802.11b) TX Current	2437 MHz, V_{BAT} =3.6V, T_{amb}=+25°C Po=18.3 dBm, 11 Mbps CCK L=1200 bytes, t_{delay} (idle)=4 □S	-	247	-	mA
OFDM (802.11g) TX Current	2437 MHz, V_{BAT} =3.6V, T_{amb}=+25°C Po=14.4 dBm, 54 Mbps OFDM L=1200 bytes, t_{delay} (idle)=4 □S	-	180	-	mA
OFDM (802.11n) TX Current	2437 MHz, V_{BAT} =3.6V, T_{amb}=+25°C Po=12.5 dBm, 65 Mbps OFDM L=1200 bytes, t_{delay} (idle)=4 □S	-	166	-	mA
CCK (802.11b) RX Current		-	93	-	mA
OFDM (802.11g) RX Current		-	93	-	mA
OFDM (802.11n) RX Current		-	93	-	mA
Dynamic Mode [1]		-	<1.2	-	mA

[1] Total Current from V_{BAT} for reception of Beacons with DTIM=1 TBTT=100 mS, Beacon duration 1.6ms, 1 Mbps beacon reception in Listen Mode.

Table 7 2.4 GHz WLAN Power Consumption

Power Consumption – WLAN 5 GHz

Parameter	Test Conditions	Min	Typ	Max	Unit
OFDM 9 Mbps (802.11a) TX Current	5745 MHz, V_{BAT} =3.6V, T_{amb}=+25°C Po=17.6 dBm, 9 Mbps OFDM L=1200 bytes, t_{delay} (idle)=4 ?S	-	296	-	mA
OFDM 54 Mbps (802.11a) TX Current	5745 MHz, V_{BAT} =3.6V, T_{amb}=+25°C Po=15.0 dBm, 54 Mbps OFDM L=1200 bytes, t_{delay} (idle)=4 ?S	-	235	-	mA
MCS0 6.5 Mbps (802.11a) TX Current	5745 MHz, V_{BAT} =3.6V, T_{amb}=+25°C Po=18.0 dBm, MCS0 OFDM L=1200 bytes, t_{delay} (idle)=4 ?S	-	298	-	mA
MCS7 65 Mbps (802.11a) TX Current	5745 MHz, V_{BAT} =3.6V, T_{amb}=+25°C Po=13.2 dBm, MCS7 OFDM L=1200 bytes, t_{delay} (idle)=4 ?S	-	219	-	mA
54/65 Mbps (802.11a/n) RX Current		-	100	-	mA
Dynamic Mode [1]		-	<1.2	-	mA

[1] Total Current from V_{BAT} for reception of Beacons with DTIM=1 TBTT=100 mS, Beacon duration 1.6ms, 1 Mbps beacon reception in Listen Mode.

Table 8 5 GHz WLAN Power Consumption

Power Consumption - Bluetooth

Parameter	Test Conditions	Min	Typ	Max	Unit
GFSK TX Current	Constant Transmit, 1DH5, PRBS9	-	45	-	mA
EDR TX Current	Constant Transmit, 2DH5,3DH5, PRBS9	-	43	-	mA
GFSK RX Current	Constant Receive, 1DH1	-	35	-	mA
EDR RX Current	Constant Receive, 2DH5, 3DH5	-	41	-	mA
Deep Sleep Current	Deep Sleep Mode	-	70	-	µA

Table 9 Bluetooth Power Consumption

DC Characteristics – General Purpose I/O

Parameter	Test Conditions	Min	Typ	Max	Unit
VIO Current			-	16	mA
Logic input low, V_{IL}		0	-	0.35 x VIO	V
Logic input high, V_{IH}		0.65 x VIO	-	VIO	V
Logic output low, V_{OL} (Full Drive)	Iout = 8 mA	0	-	0.45	V
	Iout = 4 mA	0	-	0.45	V
Logic output low, V_{OL} (Reduced Drive)	Iout = 1 mA	0	-	0.112	V
	Iout = 0.09 mA	0	-	0.01	V
Logic output high, V_{OH} (Full Drive)	Iout = -8 mA	VIO - 0.45	-	VIO	V
	Iout = -4 mA	VIO - 0.45	-	VIO	V
Logic output high, V_{OH} (Reduced Drive)	Iout = -1 mA	VIO - 0.112	-	VIO	V
	Iout = -0.3 mA	VIO - 0.033	-	VIO	V

Table 10 DC Characteristics General Purpose I/O

WLAN RF Characteristics

WLAN Transmitter Characteristics 2.4 GHz (TA=25°C, VBAT=3.6 V)

Parameter	Test Conditions	Typ EVM	Min	Typ	Max	Unit
11 Mbps CCK (802.11b) TX Output Power	11 Mbps CCK , 802.11(b) Mask Compliance, 35% EVM RMS power over TX packet	1.1	-	18.3	-	dBm
9 Mbps OFDM (802.11g) TX Output Power	9 Mbps OFDM , 802.11(g) Mask Compliance, -8 dB EVM RMS power over TX packet	-24	-	18.0	-	dBm
54 Mbps OFDM (802.11g) TX Output Power	54 Mbps OFDM, 802.11(g) Mask Compliance, -25 dB EVM RMS power over TX packet	-34	-	14.4	-	dBm
6.5 Mbps OFDM (802.11n) TX Output Power	6.5 Mbps OFDM, 802.11(n) Mask Compliance, -5 dB EVM RMS power over TX packet	-24	-	18.2	-	dBm
65 Mbps OFDM (802.11n) TX Output Power	65 Mbps OFDM, 802.11(n) Mask Compliance, -28 dB EVM RMS power over TX packet	-35	-	12.5	-	dBm

Table 11 WLAN 2.4 GHz Transmitter RF Characteristics

WLAN Transmitter Characteristics 5 GHz (TA=25°C, VBAT=3.6 V)

Parameter	Test Conditions	Typ EVM	Start Freq	Min	Typ	Max	End Freq	Unit
9 Mbps TX Output Power	9 Mbps OFDM , 802.11(a) Mask Compliance, -8 dB EVM RMS power over TX packet	-31	5170	-	13.0	-	5240	dBm
		-28	5260		15.6		5700	
		-21	5745		17.8		5825	
54 Mbps TX Output Power	54 Mbps OFDM , 802.11(a) Mask Compliance, -25 dB EVM RMS power over TX packet	-31	5170	-	13.0	-	5240	dBm
		-30	5260		14.6		5700	
		-28	5745		15.2		5825	
MCS0 6.5 Mbps TX Output Power	MCS0 OFDM , 802.11(a) Mask Compliance, -5 dB EVM RMS power over TX packet	-31	5170	-	13.1	-	5240	dBm
		-28	5260		15.7		5700	
		-21	5745		18.2		5825	
MCS7 65 Mbps TX Output Power	MCS7 OFDM , 802.11(a) Mask Compliance, -27 dB EVM RMS power over TX packet	-31	5170	-	12.5	-	5240	dBm
		-31	5260		12.8		5700	
		-29	5745		13.5		5825	

Table 12 WLAN 5 GHz Transmitter RF Characteristics

WLAN Receiver Characteristics 2.4 GHz (TA=25°C, VBAT=3.6 V) [1]

Parameter	Test Conditions	Min	Typ	Max	Unit
1 Mbps CCK (802.11b) RX Sensitivity	8% PER	-	-97	-	dBm
11 Mbps CCK (802.11b) RX Sensitivity	8% PER	-	-88	-	dBm
9 Mbps OFDM (802.11g) RX Sensitivity	10% PER	-	-89	-	dBm
54 Mbps OFDM (802.11g) RX Sensitivity	10% PER	-	-74	-	dBm
6.5 Mbps OFDM (802.11n) RX Sensitivity	10% PER	-	-89	-	dBm
65 Mbps OFDM (802.11n) RX Sensitivity	10% PER	-	-72	-	dBm
11 Mbps CCK (802.11b) RX Overload Level	8% PER	-	-	-10	dBm
9 Mbps OFDM (802.11g) RX Overload Level	10% PER	-	-	-17	dBm
54 Mbps OFDM (802.11g) RX Overload Level	10% PER	-	-	-17	dBm
65 Mbps OFDM (802.11n) RX Overload Level	10% PER	-	-	-17	dBm

[1] Up to 2 dB degradation at Channel 13 for 11g/n modes and up to 2 dB degradation at Channel 14 for 11b/g/n modes.

Table 13 2.4 GHz WLAN Receiver RF Characteristics

WLAN Receiver Characteristics 5 GHz (TA=25°C, VBAT=3.6 V) [1]

Parameter	Test Conditions	Min	Typ	Max	Unit
9 Mbps (802.11a) RX Sensitivity	10% PER	-	-87	-	dBm
54 Mbps (802.11a) RX Sensitivity	10% PER	-	-72	-	dBm
MCS0 6.5 Mbps (802.11a) RX Sensitivity	10% PER	-	-88	-	dBm

MCS7 65 Mbps (802.11a) RX Sensitivity	10% PER	-	-70	-	dBm
Max Input Level (3) OFDM (11a or 11n)	<10% PER	-	-	-17	dBm

Table 14 5 GHz WLAN Receiver RF Characteristics

Bluetooth RF Characteristics

Bluetooth Transmitter GFSK and EDR Characteristics, Class 1.5 (TA=25°C, VBAT=3.6 V)

Parameter	Test Conditions	Min	Typ	Max	Bluetooth Spec	Unit
GFSK RF Output Power		-	9.5	-	-	dBm
EDR RF Output Power		-	7.3	-		dBm
Power Control Step Size		2	5	8	2-8	dB
EDR Relative Power		-2		1	-4/+1	dB

Table 15 Bluetooth Transmitter RF Characteristics

Bluetooth Receiver Characteristics (TA=25°C, VBAT=3.6 V)

Parameter	Test Conditions	Min	Typ	Max	Bluetooth Spec	Unit
GFSK Sensitivity	BER=0.1%	-	-91	-	-70	dBm
EDR 2 Mbps Sensitivity	BER=0.01%	-	-90	-	-70	dBm
EDR 3 Mbps Sensitivity	BER=0.01%	-	-83	-	-70	dBm
GFSK Maximum Input Level	BER=0.1%	-	-	-5	-20	dBm
EDR 2 Maximum Input Level	BER=0.1%	-	-	-10	-	dBm
EDR 3 Maximum Input Level	BER=0.1%	-	-	-10	-	dBm

Table 16 Bluetooth Receiver RF Characteristics

Bluetooth Low Energy RF Characteristics

Bluetooth BLE Transmitter GMSK and EDR Characteristics, Class 1.5 (TA=25°C, VBAT=3.6 V)

Parameter	Test Conditions	Min	Typ	Max	Bluetooth Spec	Unit
GMSK RF Output Power		-	10	-	-	dBm
Power Control Step Size		2	5	8	2-8	dB

(1) BLE spec = 10dBm max can be achieved using normal system losses due to filters etc, or by reducing value through VS command.

Table 17 Bluetooth Low Energy Transmitter RF Characteristics

Bluetooth BLE Receiver Characteristics (TA=25°C, VBAT=3.6 V)

Parameter	Test Conditions	Min	Typ	Max	Bluetooth Spec	Unit
GMSK Sensitivity	PER = 30.8%	-	-90	-	-70	dBm
GMSK Maximum Input Level	PER = 30.8%	-	-5	-	-20	dBm

Table 18 Bluetooth Low Energy Receiver RF Characteristics

WLAN POWER-UP SEQUENCE

The following sequence describes device power-up from shutdown. Only the WLAN Core is enabled; the Bluetooth and FM cores are disabled.

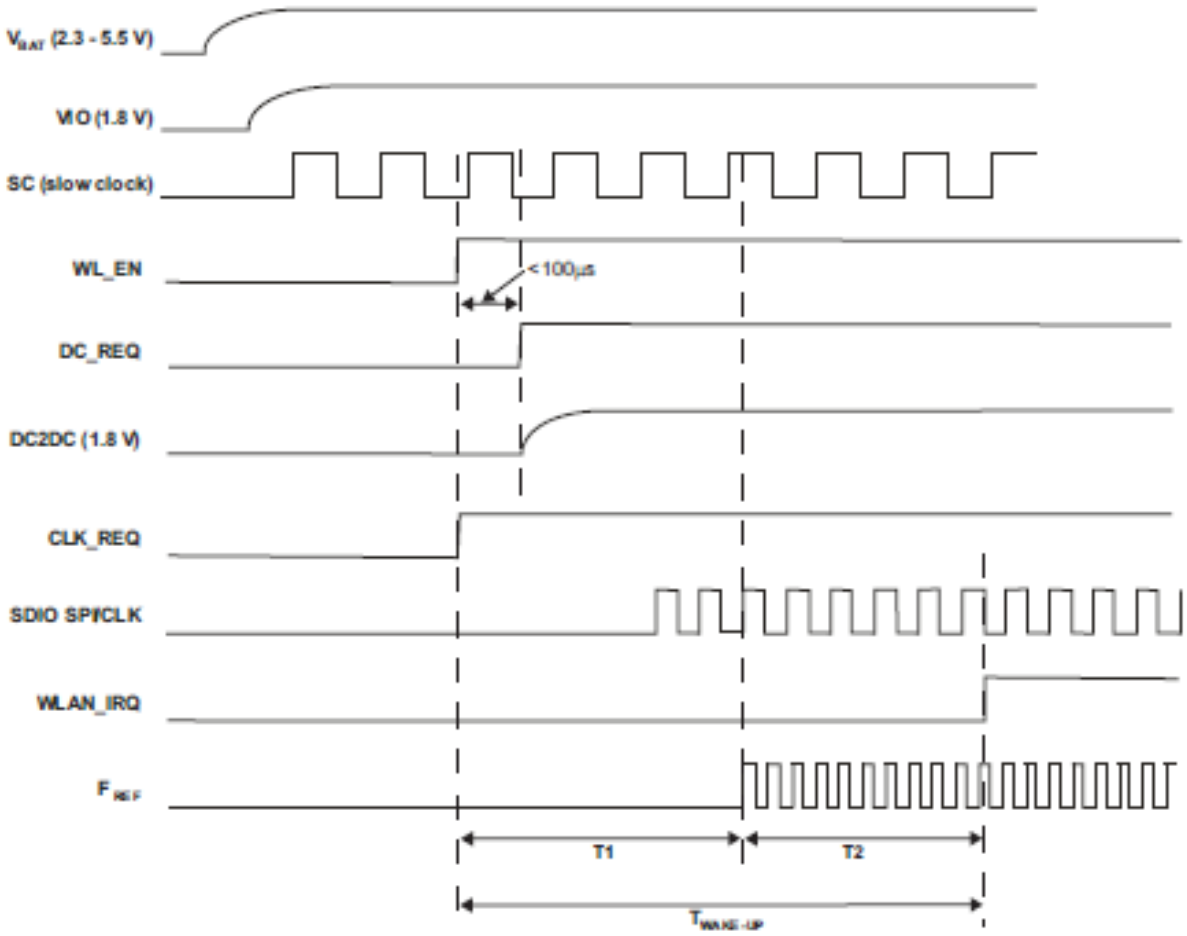


Figure 3 TiWi5 Power-up Sequence Requirements

1. No signals are allowed on the IO pins if no IO power is supplied, because the IOs are not 'failsafe'. Exceptions are CLK_REQ_OUT, SLOWCLK, XTALP, and AUD_xxx, which are failsafe and can tolerate external voltages with no VDDS and DC2DC.

2. VBAT, VIO, and SLOWCLK must be available before WL_EN.

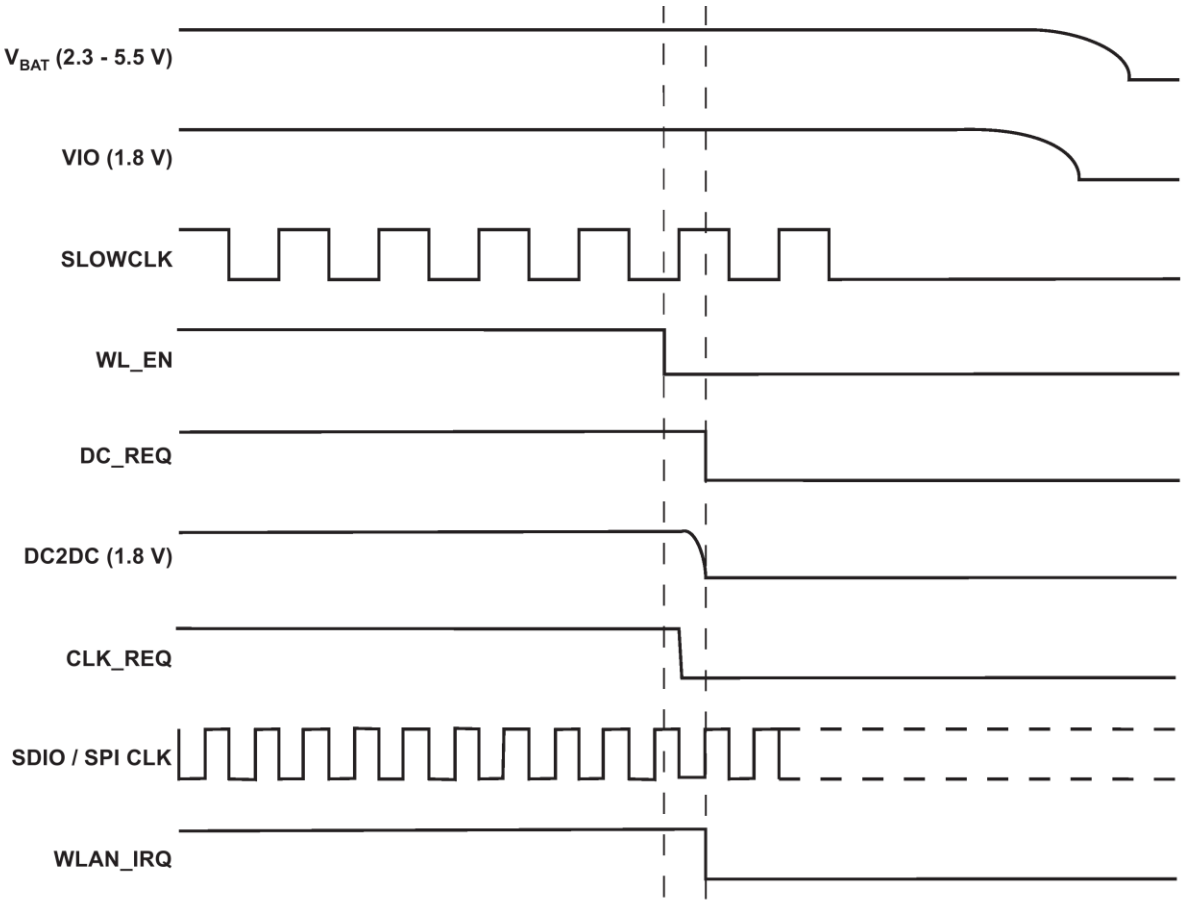
3. Twakeup = T1 + T2

The duration of T1 is defined as the time from WL_EN=high until Fref is valid for the SoC. T1=~55ms

The duration of T2 depends on:
– Operating system
– Host enumeration for the SDIO/WSPI
– PLL configuration
– Firmware download
– Releasing the core from reset

– Firmware initialization

WLAN POWER-DOWN SEQUENCE



Notes:
1. The DC2DC(1.8V) signal can be monitored on BT_FUNC2 Module Pin (#41)
2. DC_REQ and CLK_REQ are internal signals shown for reference only

Figure 4 TiWi5 Module Power-down Sequence Requirements

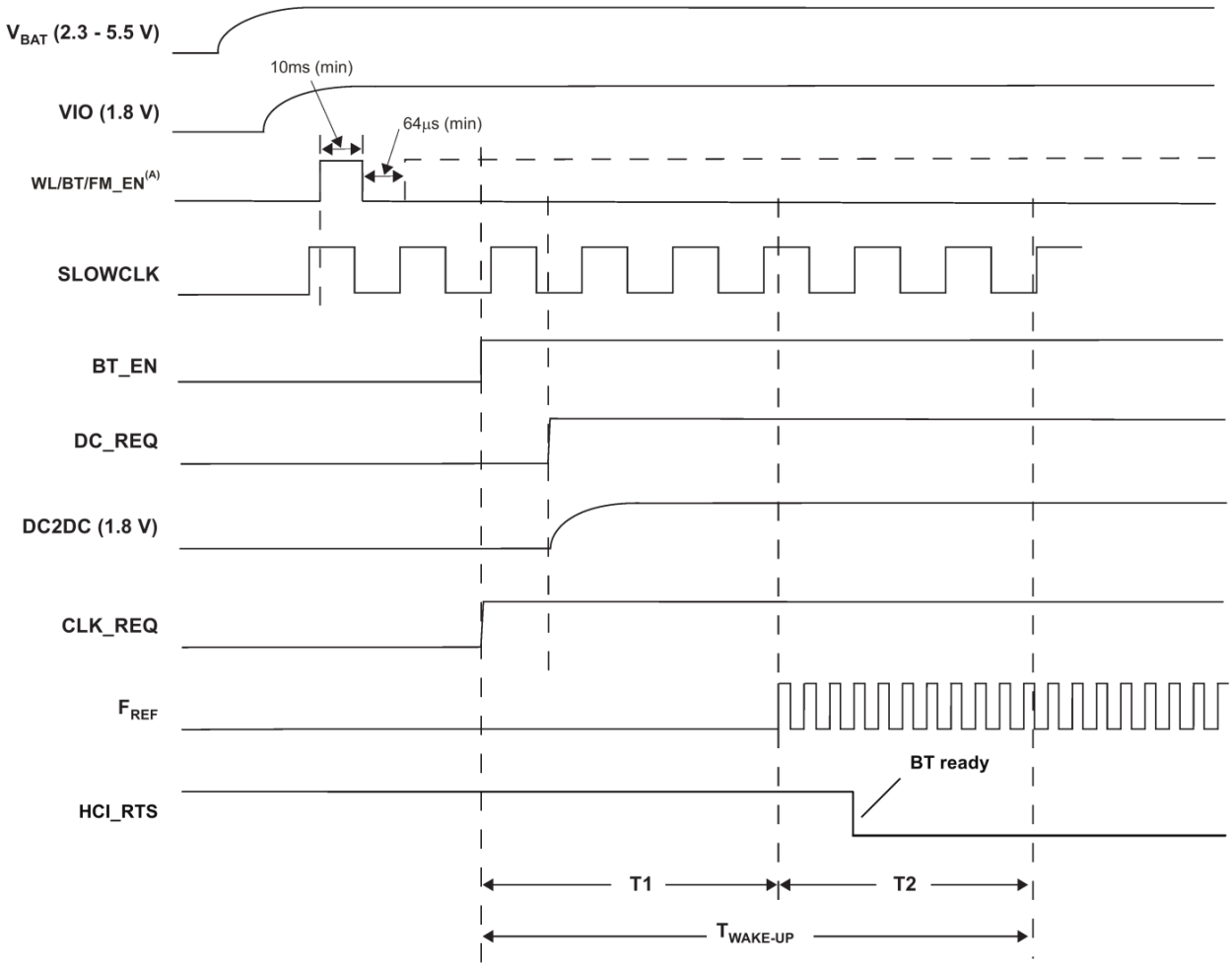
1. DC_REQ will go low only if WLAN is the only core working. Otherwise if another core is working (e.g BT) it will stay high.

2. CLK_REQ will go low only if WLAN is the only core working. Otherwise if another core is working and using the F_{REF} (e.g BT) it will stay high.

3. If WLAN is the only core that is operating, WL_EN must remain de-asserted for at least 64□sec before it is re-asserted.

BLUETOOTH POWER-UP SEQUENCE

The following sequence describes device power up from shutdown. Only the Bluetooth core is enabled; the WLAN core is disabled.



Notes:
1. (A) After this sequence is completed, the device is in the low VIO-leakage state while in shutdown
2. The DC2DC(1.8V) signal can be monitored on BT_FUNC2 Module Pin (#41)
3. DC_REQ, CLK_REQ, and F_{REF} are internal signals shown for reference only

Figure 5 Bluetooth Power-up Sequence

Power up requirements:

1. No signals are allowed on the IO pins if no IO power supplied, because the IOs are not 'failsafe'. Exceptions are CLK_REQ_OUT, SLOWCLK, XTALP, and AUD_xxx, which are failsafe and can tolerate external voltages with no VDDS and DC2DC.

2. VDDS and SLOWCLK must be stable before releasing BT_EN.

3. Fast clock must be stable maximum 55 ms after BT_EN goes HIGH.