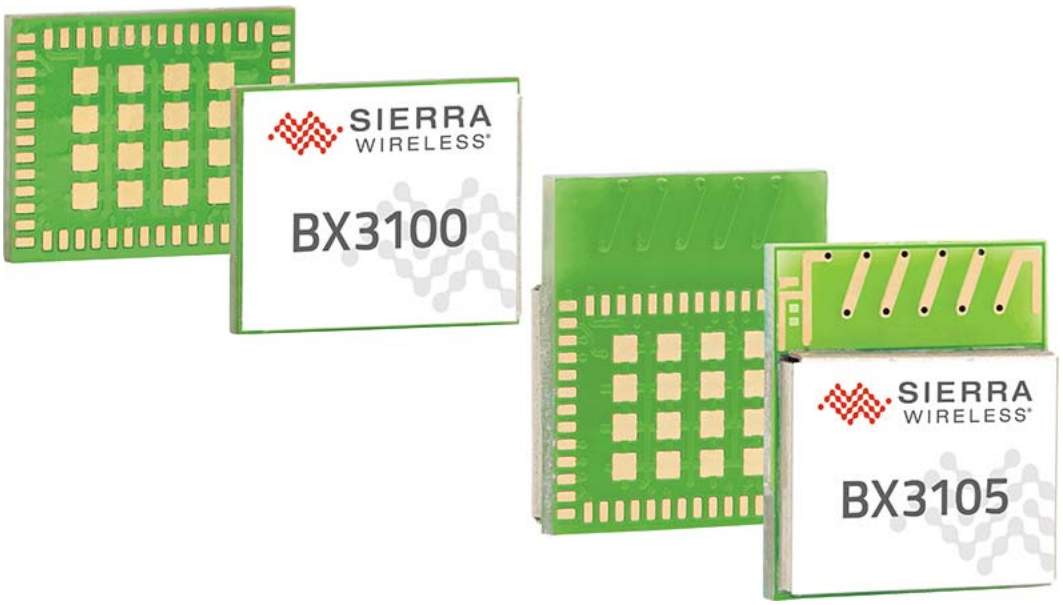
AirPrime BX3100/BX3105 Wi-Fi/BT Module

Hardware Integration Guide



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Revision History

Revision number	Release date	Changes
1	July 2018	Document created
2	July 2018	Updated Integrated PIFA gain
3	September 2018	Updated Regulatory text Updated Wi-Fi Radio Generic Radio Characteristics table values Updated Bluetooth Radio Generic Radio Characteristics table values

Contents

1: Introduction

This document defines and illustrates the AirPrime BX310x (BX3100, BX3105) Wi-Fi/BT Host-less module's high-level product features, interfaces, and hardware features (including electrical and mechanical performance criteria).

1.1 Module Variants

AirPrime BX310x module variants include:

- AirPrime BX3100—External antenna connection
- AirPrime BX3105—Embedded antenna

1.2 General RF/Software Features

The AirPrime BX310x is a low-power, small form-factor self-contained Wi-Fi/Bluetooth® (Wi-Fi/BT) module.

With an embedded software suite, the BX310x is an ideal solution for developers who want to quickly and cost-effectively integrate Wi-Fi/BT functionality into their products.

The following table summarizes the module's supported wireless frequencies and modes:

Table 1-1: Supported RF Frequencies

Technology	RF band	Notes
Wi-Fi	2.4GHz (2.400–2.485 GHz)	• 802.11b/g/n/e/i • Max data rate—MCS7 HT40 150 Mbps
Bluetooth		• v4.2 BR/EDR and BLE compliant

1.2.1 Wi-Fi

The AirPrime BX310x supports 2.4 GHz Wi-Fi operation. Key features include:

- TCP/IP
- 802.11 b/g/n/e/i
- Connection methods—BSS STA, SoftAP
- Transmit power—Adjustable, up to 20 dBm (maximum)

For a list of additional supported Wi-Fi functionality, protocols, and features, see Features on page 9.

1.2.2 Bluetooth

The AirPrime BX310x supports 2.4 GHz Bluetooth classic and BLE operation. Key features include:

- Bluetooth v4.2 BR/EDR and BLE compliant
- SPP (Serial Port Profile)

For a list of additional supported Bluetooth functionality, protocols, and features, see Features on page 9.

1.2.3 Interfaces

The AirPrime BX310x provides the following interfaces and peripheral connectivity:

- Power supply—See Power Supply Ratings on page 11.
- RF—See RF on page 12.
- UART serial link—See UART on page 15.
- ADC/Voltage measurement—See ADC/Voltage Measurement on page 16.
- I^2C—See I2C Interface on page 17.
- Digital audio (I^2S)—See I2S Interface (Digital Audio) on page 18.
- GPIOs—See General Purpose Input/Output (GPIO) on page 18.
- SPI bus—See SPI Bus on page 20.
- SDIO—See Secure Digital IO (SDIO) Interface on page 21.
- Module enable—See Module Enable on page 22.
- PWM—See PWM on page 22.

1.2.4 Configuration Utility

The AirPrime BX310x includes a browser-based utility for device configuration. For usage details, refer to [1] AirPrime BX310x AT Command Reference available at source.sierrawireless.com.

1.3 General Hardware Features

1.3.1 Physical Dimensions and Connection Interface

AirPrime BX310x modules are compact, robust, fully shielded and laser-marked modules with the dimensions noted in Table 1-2.

Table 1-2: AirPrime BX310x Dimensions[a]

Parameter	Nominal		Tolerance	Units
	BX3100[b]	BX3105		
Length	11.5	13.5	±0.10	mm
Width	9.5	11.5	±0.10	mm
Thickness	2.4	2.4	±0.20	mm
Weight	0.56	0.65	±0.10	g

a. Dimensions are accurate as of the release date of this document.
b. BX3100 is a CF3 xSmall module, which belongs to the Common Flexible Form Factor (CF3) family of WWAN modules

The AirPrime BX310x module is an LGA form factor device. All electrical and mechanical connections are made through the 70 Land Grid Array (LGA) pads on the bottom side of the PCB. (See Figure 7-1 on page 28 for details.)

The LGA pads have the following distribution:

Table 1-3: LGA Pad Types

Pad Type / Quantity		Dimensions	Pitch
Signal Pads	54 outer pads	0.75x0.35 mm	0.65 mm
Ground Pads	16 inner pads	1.0x1.0 mm	1.83 mm / 1.48 mm

2: Functional Specifications

2.1 Features

Table 2-1 summarizes the AirPrime BX310x module's RF (Wi-Fi and Bluetooth), Power, software, and hardware capabilities.

Note: Table contents are preliminary and subject to change.

Table 2-1: AirPrime BX310x Capabilities

Feature	Description
Module	• Secure boot • Secure update • FOTA (Firmware update Over The Air) • Sierra Wireless AirVantage support • CF3-compliant footprint (BX3100)

Wi-Fi	• Protocols:
	  ◦ 802.11 b/g/n/e/i
	  ◦ 802.11 n (2.4 GHz), up to 150 Mbps; MCS0-7 in 20/40 MHz bandwidths
	  ◦ Receiving STBC (Space-time Block Code) 2x1
	  ◦ 802.11 e: QoS for wireless multimedia technology
	  ◦ Additional 802.11i security features (pre-authentication, TSN, etc.)
	  ◦ WMM-PS, UAPSD
	  ◦ A-MPDU, A-MSDU aggregation
	  ◦ Block ACK (RTS/CTS/ACK/BA)
	  ◦ Fragmentation/defragmentation
	  ◦ CCMP (CBC-MAC, counter model), TKIP (MIC, RC4), WAPI (SMS4), WEP (RC4), CRC
	  ◦ Frame encapsulation (802.11h/RFC 1042)
	  ◦ Pre-authentication, TSN
	• Supported channels—1–14
	• Data transfer (HTTP, HTTPS, MQTT, TCP/UDP)
	• Autoconnection—After device reset, automatically connects to available AP based on previous configuration
	• Infrastructure BSS Station mode/SoftAP mode: AP mode, STA mode, concurrent AP/STA mode
	• Up to 8[a] simultaneous Wi-Fi clients
	• IP configuration—IP address in STA mode via DHCP or static assignment
	• Authentication (security) modes: WPA, WPA2, WPA/WPA2, WPA2 Enterprise
	• UMA-compliant and certified
	• Open interface for various upper layer authentication schemes over EAP (e.g. TLS, PEAP, LEAP, SIM, AKA, customer-specific)
	• Adaptive rate fallback algorithm
	• Automatic retransmission/response on slow hosts

Table 2-1: AirPrime BX310x Capabilities (Continued)

Feature	Description

Bluetooth	• Bluetooth v4.2 BR/EDR[b] and BLE compliant
	• Supported channels: BT Classic[b]—0–78; BLE—0–39
	• Supported v4.2 modes: BR[b] (Basic Rate); EDR[b] (Enhanced Data Rate); LE (Low Energy)
	• BT[b] classic mandatory features
	• BT low-energy mandatory features
	• Class 1/Class 2/Class 3 transmitter without external power amplifier
	• Class 1 operation without external PA
	• Enhanced power control (>30 dB dynamic control range)
	• +10 dBm transmitting power
	• NZIF receiver with -98 dBm sensitivity
	• Modulation—p/4 DQPSK[b], 8 DPSK[b]
	• ACL[b], SCO[b], eSCO[b]
	• Adaptive Frequency Hopping (AFH)
	• BT 4.2 controller and host stack[b]
	• Service Discover Protocol (SDP)[b]
	• General Access Profile (GAP)
	• Security Manage Protocol (SMP)[b]
	• Bluetooth Low Energy (BLE)
	• ATT/GATT
	• BLE Beacon[b]
	• SPP[b], RFCOMM
	• Profiles: Wi-Fi Autoconnection—After device reset, automatically connects to available AP based on previous configuration.
	• UART features: GATT profiles, Define personal services
	• Roles—Simultaneous Central (access point)/Peripheral (client)
	• Simultaneous connections:
	  ◦ Up to 7[a] (total) simultaneous connections, including up to 3[a] BLE connections
	  ◦ Simultaneous BT Classic[b] and BLE connections
	• PCM[b]/I2S[b]

Configuration	Device configuration methods: • Built-in web-based configuration utility. See Configuration Utility on page 7. • AT commands available over UART, Wi-Fi, and BT links. Refer to [1] AirPrime BX310x AT Command Reference at source.sierrawireless.com.
Security	• All standard IEEE802.11 security features, including WFA, WPA/WPA2, WAPI • Secure boot • Flash encryption • Cryptographic hardware acceleration: AES, HASH (SHA-2) library, RSA, ECC, Random Number Generator (RNG)
Power management	Multiple power modes[b] to reduce power consumption: Active, Radio off, Light sleep, Deep sleep, Hibernation Sleep Patterns: Association sleep pattern, ULP sensor-monitored pattern[b]

a. Subject to firmware support and RAM limitations.
b. Support pending firmware upgrade.

3: Technical Specifications

3.1 Environmental

The environmental specifications for operation and storage of the AirPrime BX310x are defined in Table 3-1.

Table 3-1: Environmental Specifications

Parameter	Range
Ambient Operating Temperature	-40°C to +85°C
Ambient Storage Temperature	-40°C to +105°C (Recommended)

3.2 Power Supply Ratings

DC power is supplied via the pins described in Table 3-2 on page 11.

Note: Operation above the maximum specified operating voltage (see Table 3-8 on page 14) is not recommended, and specified typical performance or functional operation of the device is neither implied nor guaranteed.

Table 3-2: Power Supply Pins

Pin	Name	Voltage	Direction	Function
33	VGPIO	3.3V	Output	Supply voltage reference for secondary I2C interface (pins 53/54)
50	VDD_3V3_RF	2.3–3.6V	Input	RF/Analog signal power supply
51	VDD_3V3_PA	2.3–3.6V	Input	Internal Power Amplifier power supply
52	VDD_PADS_BB	2.7–3.6V	Input	Baseband/Digital I/O power supply

3.3 Power Management

The AirPrime BX310x switches between several power modes to minimize current consumption.

Light Sleep and Deep Sleep modes are enabled via AT commands from the host. Refer to [1] AirPrime BX310x AT Command Reference for details.

Table 3-3 describes the AirPrime BX310x's supported power modes.

Table 3-3: Power Modes — Descriptions

Power Mode	CPU	Wi-Fi / BT radio / baseband	RTC	ULP co-processor	Notes
Active	On	On	On	On	Fully functional
Radio off[a]	On	Off	On	On	
Light sleep[a]	Pause	Off	On	On	Wake up events will wake the module.
Deep sleep[a]	Off	Off	On	On/Off	Connection data stored in RTC memory
Hibernate[a]	Off	Off	Off	Off	Only RTC timer or specific RTC GPIOs can wake the module.

a. Available in future firmware release.

3.4 RF

3.4.1 Generic Radio

Measurements conducted at 25°C ambient temperature.

Table 3-4: Generic Radio Characteristics

Description	Min	Typ	Max	Unit
BX3100 RF Port Impedance		50		Ω
Frequency Band	2.4	2.45	2.485	GHz
BX3105 Antenna Gain		0		dBi

3.4.2 Wi-Fi Radio

Measurements conducted at 25°C ambient temperature.

Table 3-5: Generic Radio Characteristics

Description	Min	Typ	Max	Unit
Transmit 802.11b, CCK 1 Mbps, Conducted Tx Power, EVM and Mask Compliant	14	15.5	17	dBm
Transmit 802.11g, OFDM 6 Mbps, Conducted Tx Power, EVM and Mask Compliant	14[a]	15.5[a]	17[a]	dBm
Transmit 802.11n, MCS0 HT20 6.5 Mbps, Conducted Tx Power, EVM and Mask Compliant	14[b]	15.5[b]	17[b]	dBm
Transmit 802.11n, MCS0 HT40 13.5 Mbps, Conducted Tx Power, EVM and Mask Compliant	14[c]	15.5[c]	17[c]	dBm
Conducted Receiver Sensitivity 11b DSSS, 1 Mbps	-98	-95	-93	dBm
Conducted Receiver Sensitivity 11b CCK, 11 Mbps	-90	-87	-84	dBm
Conducted Receiver Sensitivity 11g OFDM, 6 Mbps	-94	-91	-88	dBm

Table 3-5: Generic Radio Characteristics (Continued)

Description	Min	Typ	Max	Unit
Conducted Receiver Sensitivity 11g OFDM, 54 Mbps	-73	-71.5	-70	dBm
Conducted Receiver Sensitivity 11n HT20 OFDM, 72.2 Mbps	-73	-71	-69	dBm
Conducted Receiver Sensitivity 11n HT40 OFDM, 135 Mbps	-73	-71	-69	dBm
Conducted Harmonics 2F0	-	-42	-39	dBm
Conducted Harmonics 3F0	-	-54	-51	dBm

a. Channel 1&11 power is automatically reduced for FCC 15.205 band edge compliance, reduction is 2 dB.
b. Channel 1&11 power is automatically reduced for FCC 15.205 band edge compliance, reduction is 2.5 dB.
c. Channel 1&11 typical power is automatically reduced for FCC 15.205 band edge compliance, reduction is 3 dB.

3.4.3 Bluetooth Radio

Measurements conducted at 25°C ambient temperature.

Table 3-6: Generic Radio Characteristics

Description	Min	Typ	Max	Unit
Transmit Power BR 1 Mbps	7.5	9	10.5[a]	dBm
Transmit Power EDR 2 Mbps	7.5	9	10.5	dBm
Transmit Power EDR 3 Mbps	7.5	9	10.5	dBm
Transmit Power LE 1 Mbps	2.5	4	5.5	dBm
Receiver Sensitivity BR 1 Mbps	-89	-88	-87	dBm
Receiver Sensitivity EDR 2 Mbps	-87	-86	-85	dBm
Receiver Sensitivity EDR 3 Mbps	-81	-82.5	-84	dBm
Receiver Sensitivity LE 1 Mbps	-92.5	-91	-89	dBm
Out-of-band blocking performance 30 MHz~2000 MHz	-	-10	-	dBm
Out-of-band blocking performance 2000 MHz~2400 MHz	-	-27	-	dBm
Out-of-band blocking performance 2500 MHz~3000 MHz	-	-27	-	dBm
Out-of-band blocking performance 3000 MHz~12.5 GHz	-	-10	-	dBm

a. Maximum Output power is restricted by compliance to FCC 15.205 band edge to 5.5 dBm Max.

3.5 Electrical Specifications

3.5.1 Absolute Maximum Ratings

Table 3-7: Absolute Maximum Ratings

Parameter		Min	Max	Units
V_{IL}	Input low voltage	-0.3	$0.25 \times V_{IO}$	V
V_{IH}	Input high voltage	$0.75 \times V_{IO}$	3.6	V
I_{IL}	Input leakage current	-	50	nA
V_{OL}	Output low voltage	-	$0.1 \times V_{IO}$	V
V_{OH}	Output high voltage	$0.8 \times V_{IO}$	-	V
C_{pad}	Input pin capacitance	-	2	pF
V_{IO}	VDD_PADS_BB	2.7	3.6	V
I_{MAX}	GPIO maximum drive capability	-	12	mA
T_{STR}	Storage temperature range	-40	150	°C

Table 3-8: Recommended Operating Conditions

Parameter		Min	Typ	Max	Units
V_{DD}	Supply voltage (VDD_3V3_PA, VDD_3V3_RF)	2.3	3.3	3.6	V
V_{IO}	I/O supply voltage (VDD_PADS_BB)	2.7	3.3	3.6	V
T_{OPR}	Operating temperature range	-40	-	85	°C
V_{IL}	CMOS low level input voltage	0	-	$0.3 \times V_{IO}$	V
V_{IH}	CMOS high level input voltage	$0.7 \times V_{IO}$	-	V_{IO}	V
V_{TH}	CMOS threshold voltage	-	$0.5 \times V_{IO}$	-	V

4: Interfaces Specification

4.1 Overview

This section describes the interfaces supported by the AirPrime BX310x embedded module and provides specific voltage, timing, and circuit recommendations for each interface.

4.2 UART

The AirPrime BX310x provides one UART interface for asynchronous communication between the AirPrime BX310x module and a host device (e.g. a PC or host processor):

- UART0—4-wire, RS-232-compliant interface

Note: Up to two additional UART interfaces can be added by configuring GPIOs using AT commands.

Flow control is managed using:

- RTS/CTS signals (This method is required for higher UART interface speeds.)

  or
- Software XON/XOFF

Table 4-1 on page 15 describes the signals used for UART0.

Table 4-1: UART0 Pins[a]

Pin	Interface	Name	Direction	Function	Voltage Level
2	UART0	UART0_RTS	I	Ready To Send, flow control	VDD_PADS_BB
3		UART0_CTS	O	Clear To Send, flow control	
4		UART0_TXD	I	Transmit Data	
5		UART0_RXD	O	Receive Data	

a. If UART0 pins are not used, leave open.

Note: UART signals are named with respect to the HOST, and directions are listed with respect to the module. For example, UART0_RXD is an output from the module to the host.

The UART interface is configurable via AT commands:

- Default configuration—115200 (baudrate), 8 bit, no parity, no handshaking
- Baudrate considerations:
  - Maximum supported—5 Mbaud
  - Maximum tested—3 Mbaud. This is the maximum baudrate supported by the BX310x Dev Kit FTDI converter IC.
  - HW handshaking is recommended above rates of 1 Mbaud and can be enabled via AT command (AT&K3).

- Common baud rates are supported—any baud rate in the supported range can be selected via AT+IPR=<uart_baud_rate> command. The device automatically configures the clock dividers appropriately for the chosen baud rate.
- Baud rates are persistent post-reset.
- Recommendation—Add series termination resistors close to the module in the UART lines for management of clock harmonics. 499Ω resistors are recommended.

4.3 ADC/Voltage Measurement

The AirPrime BX310x provides a general purpose ADC (Analog to Digital Converter) input, which can sample multiple inputs configured using AT commands.

Pins VDET_1, VDET_2, SENSOR_VP, and SENSOR_VN are used to measure single-ended analog voltages referenced to ground. The voltage on these pins is read via an AT command.

Noise can have a large impact on sensitive voltage measurements. To improve the accuracy of small voltage level measurements, a100 nF capacitor to ground is recommended on the input to the VDET_1, VDET_2, SENSOR_VP, and SENSOR_VN pins.

Table 4-2: ADC Interface Pins[a]

Pin	Signal name	Direction[b]	Function	Voltage Level
18	VDET_1	I	Analog to Digital Converter	VDD_PADS_BB
19	VDET_2	I		

a. Leave open any pins that are not used.
b. Signal direction with respect to the module.

Table 4-3: Voltage-measurement GPIO Pins[a]

Pin	Signal Name	Direction[b]	Voltage level
31	SENSOR_VP	I	VDD_PADS_BB
32	SENSOR_CAPP	I	
34	SENSOR_CAPN	I	
36	SENSOR_VN	I	

a. Leave open any pins that are not used.
b. Signal direction with respect to the module.

Access to a Hall effect sensor is supported via firmware, and is selected using AT commands.

The sensor pins (SENSOR_VP or SENSOR_VN) will trigger an input perturbation (glitch) lasting for 80 ns when the ADC or Hall sensor is initialized.

4.4 I²C Interface

The AirPrime BX310x module provides two I²C (Inter-Integrated Circuit) dedicated serial ports (bus interface) based on [2] The I2C Bus Specification, Version 2.1, January 2000 (Phillips Semiconductor document number 9398 393 40011).

The interfaces use the pins indicated in Table 4-4.

Table 4-4: I²C Interface Pins[a]

Pin	Signal name	Direction	Function	Voltage Level
9	I2C1_SCL	I/O	Primary I2C interface	VDD_PADS_BB
17	I2C1_SDA	I/O	Primary I2C interface	
53	I2C2_SDA	I/O	Secondary I2C interface	VGPIO
54	I2C2_SCL	I/O	Secondary I2C interface	

a. Leave open any pins that are not used.

This implementation of the I²C interface includes the following characteristics:

- Supported voltage:
  - Primary I2C (3.3 V, configurable)
  - Secondary I2C (3.3 V)
- Standard-mode interface—Data transfer rates up to 100 kbit/s
- Fast-mode interface—Data transfer rates up to 400 kbit/s)
- Master mode operation
- Addressing modes—7-bit; 10-bit; Dual addressing mode

External 2.2 kΩ pull-up resistors must be applied to I²C signals (see Figure 4-1 on page 17).

For I²C bus details, including I2C bus waveform and timing details, refer to the I2C Bus Specification.

4.4.1 Application

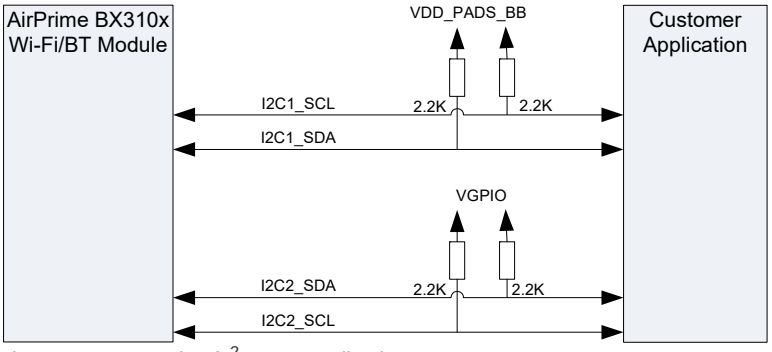

Figure 4-1: Example of I²C Bus Application

4.5 I2S Interface (Digital Audio)

Note: Interface support is forthcoming.

The AirPrime BX310x provides a 4-wire I^2S (digital audio) interface that can be used to transfer serial digital audio to or from an external stereo DAC/ADC, and supports the following features:

- Modes—Master, Slave
- Transmission format—Full duplex, Half duplex
- Resolution (bits per frame)—8, 16, 32, 40, 48
- Channels—Input, Output
- Bit clock—10 kHz–40 MHz
- Supported audio interfaces (forthcoming)—PDM (Pulse Density Modulation), BT PCM (Pulse Code Modulation)

The interface uses the pins indicated in Table 4-5.

Table 4-5: I2S Interface Pins[a]

Pin	Signal name	Direction[b]	Function	Voltage Level
16	I2S_MCLK	O	I2S MasterClock	VDD_PADS_BB
24	I2S_DO	O	I2S Data Out	
25	I2S_DI	I	I2S Data In	
26	I2S_LRCLK	I/O	I2S Left-Right Clock (Word Select)	
27	I2S_BCLK	I/O	I2S Bit Clock	

a. Leave open any pins that are not used.
b. Signal direction with respect to the module.

4.6 General Purpose Input/Output (GPIO)

The AirPrime BX310x defines several GPIOs for customer use, as described in Table 4-6 and Table 4-7.

Note: The pins carrying the 'Alternate function' GPIOs are multi-function. The alternate interfaces (SDIO or SPI) can be selected via an AT command.

Table 4-6: GPIO Pins (Dedicated)[a]

Pin	Signal Name	Direction	Default State	Function	Voltage Level
14	GPIO(5)	I/O	Pull high[b]	General purpose I/O	VDD_PADS_BB
35	GPIO(27)	I/O	No pull[c]		

a. Leave open any pins that are not used.
b. Pulled high internally
c. Internal configuration—no internal pull-ups

Table 4-7: GPIO Pins (Alternate function)[a]

Pin	Signal Name	Direction	Default State	Function	Voltage Level
9	GPIO(23)	I/O	No pull[b]	General purpose I/O	VDD_PADS_BB
16	GPIO(0)		Pull high[c]		
17	GPIO(25)		No pull[b]		
18	GPIO(34)		No pull[b]		
19	GPIO(35)		No pull[b]		
24	GPIO(32)		No pull[b]		
25	GPIO(33)		No pull[b]		
26	GPIO(18)		No pull[b]		
27	GPIO(26)		No pull[b]		
31	GPIO(36)		No pull[b]		
32	GPIO(37)		No pull[b]		
34	GPIO(38)		No pull[b]		
36	GPIO(39)		No pull[b]		
42	GPIO(15)		Pull high[c] [d]		
43	GPIO(12)		Pull low[e]		
44	GPIO(14)		Pull high[c]		
45	GPIO(13)		Pull high[c]		
46	GPIO(2)		Pull low[e]		
47	GPIO(4)		Pull low[e]		
53	GPIO(16)		No pull[b]		
54	GPIO(17)		No pull[b]		

a. Leave open any pins that are not used.
b. Internal configuration—no internal pull-ups
c. Pulled high internally
d. GPIO(15) default state (pull HIGH) enables UART boot messaging. To disable UART boot messages, drive GPIO(15) LOW prior to boot.
e. Pulled low internally

4.7 Bootstrap Pins

The GPIOs listed in Table 4-8 are used as Bootstrap pins during start-up.

Table 4-8: GPIO Bootstrap Functions

GPIO	Function	Default State	Default Function	Alternative
0	Boot Source	High, Internal pull 45 kΩ	Boot from Internal Flash	Download to Flash (Disabled)
2	Boot Source	High, Internal pull 45 kΩ		
5	SDIO Slave Timing	High, Internal pull 45 kΩ	Rising Edge Input & Output	See Table 4-9.
15 (MTDO)		High, Internal pull 45 kΩ		
12 (MTDI)	SDIO Interface Voltage	Low, Internal pull 45 kΩ	3.3V	1.8V (Not supported)

Table 4-9: SDIO Slave Timing Configuration

GPIO(5)	GPIO(15)	Configuration
Low	Low	Falling Edge Input & Output
Low	High	Rising Edge Input, Falling Edge Output
High	Low	Falling Edge Input, Rising Edge Output
High	High	Rising Edge Input & Output

4.8 SPI Bus

Note: Interface support is forthcoming.

The AirPrime BX310x provides one 6-wire Serial Flash SPI-compatible interface (SPI Master).

Note: Traditional 5-wire (MOSI/MISO/SCLK/CS/SRDY) SPI Slave interface can also be implemented over this same interface.

Table 4-10 describes the SPI interface pins for both configurations (5- and 6-wire).

Note: The pins carrying the SPI interface are multi-function. The alternate interfaces (SDIO or GPIO) can be selected via an AT command.

Table 4-10: SPI Pin Descriptions[a]

Pin	SPI Master	SPI Slave	Direction[b]		Function
	6-Wire Signal Name	5-Wire Signal Name	Master	Slave	
42	HSPICS0	CS	O	I	SPI Chip Select
43	HSPIQ	MISO	I	O	MISO
44	HSPICLK	SCLK	O	I	SPI Clock

Table 4-10: SPI Pin Descriptions[a] (Continued)

Pin	SPI Master	SPI Slave	Direction[b]		Function
	6-Wire Signal Name	5-Wire Signal Name	Master	Slave	
45	HSPID	MOSI	O	I	MOSI
46	HSPIWP	-	O	-	Write Protect (M)
47	HSPIHD	SRDY	O	O	Hold

a. Leave open any pins that are not used.
b. Signal direction with respect to the module.

4.9 Secure Digital IO (SDIO) Interface

Note: Interface support is forthcoming.

The AirPrime BX310x defines one SDIO slave-controller interface (SD 2.0-compliant), which supports connections to SD memory and I/O cards.

The following features are supported:
- SPI/1-bit/4-bit modes
- Data transfer rates—0–50 MHz
- Block size—Up to 512 bytes
- Interrupts—Module-initiated and host-initiated
- Module-initiated data transfer via host interrupt
- Configurable features—Sampling, driving clock edge
- Registers for direct access by host

Table 4-11 describes the signals used for SDIO.

Note: The pins carrying the SDIO interface are multi-function. The alternate interfaces (GPIO or SPI) can be selected via an AT command.

Table 4-11: SDIO Pin Descriptions[a]

Pin	Signal Name	Direction	Function
42	SD_CMD	I/O	SDIO command
43	SD_DATA2	I/O	SDIO data bit 2
44	SD_CLK	O	SDIO clock
45	SD_DATA3	I/O	SDIO data bit 3
46	SD_DATA0	I/O	SDIO data bit 0
47	SD_DATA1	I/O	SDIO data bit 1

a. Leave open any pins that are not used.

SDIO is particularly susceptible to tracking impedance and length variations between the SDIO tracks. Ensure that controlled impedance tracking is used, and minimize tracking length between the module and SD slave device. Add series resistor footprints at the host end to decrease the drive current and reduce potential interference, and match the length of all the SD tracks to within 1 mm.

SDIO tracking can cause significant radiated interference at integer multiples of the SD clock frequency, which can be picked up by the BX310x antenna. Bury SDIO tracks between ground planes and ensure stitching ground vias are placed throughout the board surrounding the SDIO tracking.

SDIO timing during the boot process is provided by GPIO(5) and GPIO(15). See Table 4-9 on page 20 for details.

4.10 Module Enable

The AirPrime BX310x uses the ENABLE (Module Enable) signal to turn the module on/off:

- Turn module on—Drive ENABLE high (to VDD_PADS_BB)
- Turn module off—Drive ENABLE low (to 0V)

Table 4-12: Enable Pin Description

Pin	Signal Name	Direction[a]	Function	Voltage Level
37[b]	ENABLE	I	Start/stop module	VDD_PADS_BB

a. Signal direction with respect to the module.
b. Do not leave this pin unconnected.

To avoid a possible implementation-dependent issue where enabling/disabling Wi-Fi functionality could cause a perturbation (glitch) on the power supply rails that impacts module operations, a short delay (1 ms recommended) is required for the power supply to stabilize before enabling the module.

If ENABLE is controlled by the Host, the host implements the delay (from the time the supply is present) before driving ENABLE high.

If ENABLE is hard-wired to the supply (VDD_PADS_BB), an RC circuit (10kΩ & 0.1uF) is required. The RC circuit will create the required delay, allowing the supply to stabilize before ENABLE is pulled high.

Do not leave this pin unconnected.

4.11 PWM

The AirPrime BX310x supports the use of PWM functionality on GPIOs (GPIO(5) and GPIO(27)) via AT command configuration. Refer to [1] AirPrime BX310x AT Command Reference for details.

5: General Layout Recommendations

In addition to specific requirements for the antenna implementation and clearance of the BX3105 detailed in this document, good mixed-signal layout practices should be followed:

- Avoid tracking of high frequency signals near the RF sections of the module.
- Ensure plenty of ground vias throughout the application board.
- Tightly tie ground planes together throughout the application board.
- BX3100 RF tracking to application board antenna or RF connector:
  - Use 50 Ω impedance controlled tracks.
  - Do not track near sources of digital interference.
  - Provide continuous unbroken ground plane reference.
  - Avoid multiple layer changes.
- Supply decoupling should be placed as close to the supply pins as possible.
- Avoid long digital tracks on surface layers—they may support significant RF harmonic content.

6: Regulatory Compliance

Caution: *Unauthorized modifications or changes not expressly approved by Sierra Wireless could void compliance with regulatory rules, and thereby your authority to use this equipment.*

The BX3100/BX3105 module is designed to meet the requirements of the following regulatory bodies and regulations, where applicable:

- Federal Communications Commission (FCC) of the United States
- Innovation, Science and Economic Development Canada (ISED)
- Ministry of Internal Affairs and Communications (MIC) of Japan
- Radio Equipment Directive of the European Union
- Ministry of Industry and Information Technology (People's Republic of China)
- The National Communications Commission (NCC) of Taiwan, Republic of China
- The National Telecommunications Agency (ANATEL)
- National Radio Research Agency (South Korea)

Note: To determine whether specific approvals have been received or to obtain the anticipated schedule for approvals, please contact your Sierra Wireless account representative.

Upon commercial release, the following industry certification will have been obtained, where applicable:

- Bluetooth SIG

Additional certifications and details on specific country approvals may be obtained upon customer request — contact your Sierra Wireless account representative for details.

Additional testing and certification may be required for the end product with an embedded BX3100/BX3105 module and are the responsibility of the OEM. Sierra Wireless offers professional services-based assistance to OEMs with the testing and certification process, if required.

6.1 United States

FCC ID: N7NBX31A

The BX3100/BX3105 module has been certified by the Federal Communications Commission under FCC ID: N7NBX31A. The BX3105 module is certified with an on-board antenna, while the BX3100 module is certified with an external antenna.

Integrators may use the BX3100/BX3105 modules in their end products without additional FCC certification if they meet the following conditions. Otherwise, additional FCC approval must be obtained.

1. Only antennas of the same type and with equal or less gains as shown in Table 6-1 may be used. Other types of antennas and/or higher gain antennas may require additional authorization for operation.
2. The end product integrating the BX3100 module must use the RF trace design approved with the BX3100 module. Details of the trace design can be obtained from Sierra Wireless upon request.
3. At least 6 cm separation distance between the antenna and the user's body, or 2.5 cm separation distance when the end product is designed or intended for use

on extremities, or mainly operated in extremity-only exposure conditions, i.e., hands, wrists, feet and ankles, must be maintained at all times.

4. The regulatory label on the end product must include the text “Contains FCC ID: N7NBX31A” and the following compliance statement:

   This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

5. A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

6. End users must not be provided with access to configuration options to change technical parameters of the BX3100/BX3105 module, except as permitted by the FCC rules.

The end product with an embedded BX3100/BX3105 module may also need to meet the requirements in FCC Part 15 Subpart B for unintentional radiators and be properly authorized.

Table 6-1: Antenna Specifications

Module	Antenna Type	Maximum Gain
BX3105	Integrated PIFA	-1.65 dBi
BX3100	Monopole	0 dBi
	Dipole	2.5 dBi @ 2.4 GHz

6.2 Canada

IC: 2417C-BX31A

This radio transmitter IC: 2417C-BX31A has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissable gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Integrators may use the BX3100/BX3105 modules in their end products without additional ISED certification if they meet the following conditions. Otherwise, additional ISED approval must be obtained.

1. Only antennas of the same type and with equal or less gains as shown in Table 6-1 may be used. Other types of antennas and/or higher gain antennas may require additional authorization for operation.

2. The end product integrating the BX3100 module must use the RF trace design approved with the BX3100 module. Details of the trace design can be obtained from Sierra Wireless upon request.

3. At least 4.5 cm separation distance between the antenna and the user’s body, or 3 cm separation distance when the end product is designed or intended for use on extremities, or mainly operated in extremity-only exposure conditions, i.e., hands, wrists, feet and ankles, must be maintained at all times.

4. The regulatory label on the end product must include the text “Contains IC: 2417C-BX31A” and the following compliance statement:

   This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) This device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

   Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

5. A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current ISED RF exposure guidelines.

6. End users must not be provided with access to configuration options to change technical parameters of the BX3100/BX3105 module, except as permitted by the ISED rules.

7: Pinout

The system interface of the AirPrime BX310x is through the LGA pattern on the bottom of the PCB.

AirPrime BX310x pins are divided into three functional categories:

- Core functions and associated pins—Cover all the mandatory features for M2M connectivity and will be available by default across all CF3 family of modules. These Core functions are always available and always at the same physical pin locations. A customer platform using only these functions and associated pins is guaranteed to be forward and/or backward compatible with the next generation of CF3 modules.
- Extension functions and associated pins—Bring additional capabilities to the customer. Whenever an Extension function is available on a module, it is always at the same pin location.
- Custom functions and associated pins—These are module-specific and make use of specific chipset functions and I/Os.

Warning: *Custom features should be used with caution as there is no guarantee that the custom functions available on a given module will be available on other CF3 modules.*

Pins marked as "Leave open" or "Reserved" should not be used or connected.

7.1 Pin Configuration

Figure 7-1 illustrates the pin configuration of the AirPrime BX310x module.

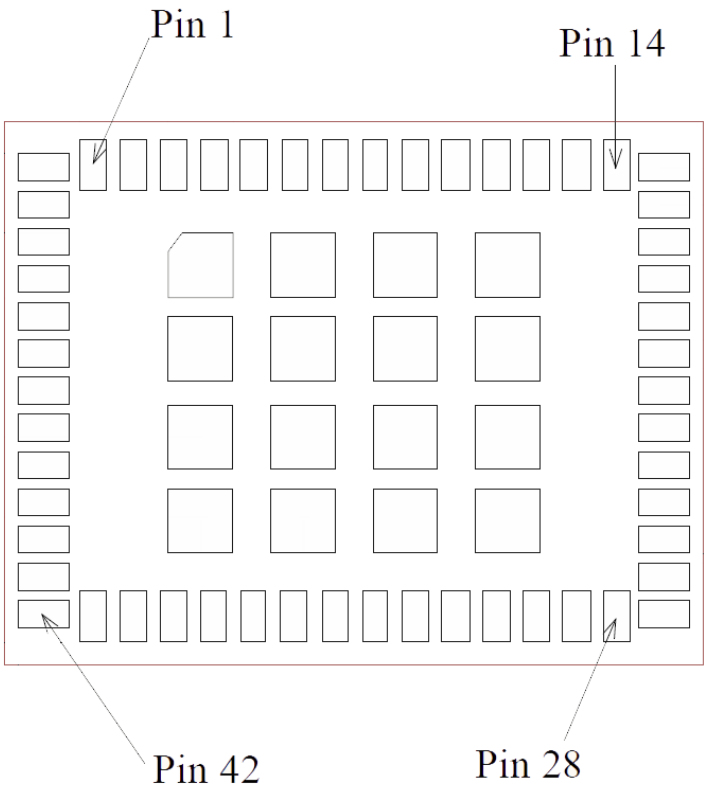

Figure 7-1: Pin Configuration (Bottom View)

7.2 Pin Description

Table 7-1 on page 28 lists detailed information for the LGA pins.

Important: *Leave open all pins that are not used.*

Table 7-1: Pin Definitions

Pin	Signal name	Group	I/O[a]	Voltage	PU/ PD[b]	Active[c]	Function	Type[d]
1	Reserved	NoConnect		-	-	-	-	E
2	UART0_RTS_GPIO(22)	UART0	I	VDD_PADS_BB	PU	L	UART0 Request To Send	C
3	UART0_CTS_GPIO(19)	UART0	O	VDD_PADS_BB	PU	L	UART0 Clear To Send	C
4	UART0_TXD	UART0	I	VDD_PADS_BB	PU	L	UART0 Transmit Data	C
5	UART0_RXD	UART0	O	VDD_PADS_BB	PU	L	UART0 Receive Data	C
6	Reserved	NoConnect	-	-	-	-	-	E

Table 7-1: Pin Definitions (Continued)

Pin	Signal name	Group	I/O[a]	Voltage	PU/ PD[b]	Active[c]	Function	Type[d]
7	Reserved	NoConnect	-	-	-	-	-	E
8	Reserved	NoConnect	-	-	-	-	-	E
9	GPIO(23)	GPIO	I/O	VDD_PADS_BB	NP	SW	General Purpose I/O	C
	I2C1_SCL	I2C1	I/O		PUE	L	Primary I2C interface—Clock	
10	Reserved	NoConnect	-	-	-	-	-	C
11	Reserved	NoConnect	-	-	-	-	-	C
12	Reserved	NoConnect	-	-	-	-	-	C
13	Reserved	NoConnect	-	-	-	-	-	C
14	GPIO(5)	GPIO	I/O	VDD_PADS_BB	NP	SW	General Purpose I/O	E
15	Reserved	NoConnect	-	-	-	-	-	E
16	I2S_MCLK	I2S	O	VDD_PADS_BB	NP	H	I2S Master Clock	E
	GPIO(0)	GPIO	I/O		NP	SW	General Purpose I/O	
17	GPIO(25)	GPIO	I/O	VDD_PADS_BB	NP	SW	General Purpose I/O	E
	I2C1_SDA	I2C1	I/O		PUE	L	Primary I2C interface—Data	
18	VDET_1	VoltMeasure	I	VDD_PADS_BB	NP	H	ADC input for voltage measurement	C
	GPIO(34)	GPIO	I/O		NP	SW	General Purpose I/O	
19	VDET_2	VoltMeasure	I	VDD_PADS_BB	NP	H	ADC input for voltage measurement	C
	GPIO(35)	GPIO	I/O		NP	SW	General Purpose I/O	
20	Reserved	NoConnect	-	-	-	-	-	C
21	Reserved	NoConnect	-	-	-	-	-	C
22	Reserved	NoConnect	-	-	-	-	-	C
23	Reserved	NoConnect	-	-	-	-	-	C
24	I2S_DO	I2S	O	VDD_PADS_BB	PD	H	I2S Data Out	C
	GPIO(32)	GPIO	I/O		NP	SW	General Purpose I/O	
25	I2S_DI	I2S	I	VDD_PADS_BB	PD	H	I2S Data In	C
	GPIO(33)	GPIO	I/O		NP	SW	General Purpose I/O	
26	I2S_LRCLK	I2S	I/O	VDD_PADS_BB	PD	L/H	I2S Left-Right Clock (Word Select)	C
	GPIO(18)	GPIO	I/O		NP	SW	General Purpose I/O	
27	I2S_BCLK	I2S	I/O	VDD_PADS_BB	PD	H	I2S Bit Clock	C
	GPIO(26)	GPIO	I/O		NP	SW	General Purpose I/O	
28	GND	Ground	0V	0V	-	-	Ground	C
29	Reserved	NoConnect	-	-	-	-	-	E

Table 7-1: Pin Definitions (Continued)

Pin	Signal name	Group	I/O[a]	Voltage	PU/ PD[b]	Active[c]	Function	Type[d]
30	GND	Ground	0V	0V	-	-	Ground	C
31	GPIO(36)	GPIO	I/O	VDD_PADS_BB	NP	SW	General Purpose I/O	C
	SENSOR_VP	VoltMeasure	I		NP	H	ADC input for voltage measurement	
32	GPIO(37)	GPIO	I/O	VDD_PADS_BB	NP	SW	General Purpose I/O	C
	SENSOR_CAPP	VoldMeasure	I		NP	H	ADC input for voltage measurement	
33	VGPIO	Power	O	3.3V			Reference voltage output	C
34	GPIO(38)	GPIO	I/O	VDD_PADS_BB	NP	SW	General Purpose I/O	C
	SENSOR_CAPN	VoltMeasure	I		NP	H	ADC input for voltage measurement	
35	GPIO(27)	GPIO	I/O	VDD_PADS_BB	NP	L	General Purpose I/O	E
36	GPIO(39)	GPIO	I/O	VDD_PADS_BB	NP	SW	General Purpose I/O	C
	SENSOR_VN	VoltMeasure	I		NP	H	ADC input for voltage measurement	
37	ENABLE	Control	I	VDD_PADS_BB		L	Turn module on/off	C
38	Reserved	NoConnect	-	-	-	-	-	E
39	GND	Ground	0V	0V	-	-	Ground	C
40	RF_MAIN	RF	I/O		-	-	(BX3100) RF antenna, DC blocked (BX3105) Leave pin unconnected	C
41	GND	Ground	0V	0V	-	-	Ground	C
42	SD_CMD	SDIO	I/O	VDD_PADS_BB	NP	H	SDIO Command	E
	HSPICS0	SPI	I/O		NP	SW	SPI Chip Select	C
	GPIO(15)	GPIO	I/O		NP	SW	General Purpose I/O	E
43	SD_DATA2	SDIO	I/O	VDD_PADS_BB	NP	H	SDIO Data bit 2	E
	HSPIQ	SPI	I/O		NP	SW	SPI Data In	C
	GPIO(12)	GPIO	I/O		NP	SW	General Purpose I/O	E
44	SD_CLK	SDIO	I/O	VDD_PADS_BB	NP	H	SDIO Clock	E
	HSPICLK	SPI	I/O		NP	SW	SPI Clock (output from Master)	C
	GPIO(14)	GPIO	I/O		NP	SW	General Purpose I/O	E
45	SD_DATA3	SDIO	I/O	VDD_PADS_BB	NP	H	SDIO Data bit 3	E
	HSPID	SPI	I/O		NP	SW	SPI Data Out	C
	GPIO(13)	GPIO	I/O		NP	SW	General Purpose I/O	E
46	SD_DATA0	SDIO	I/O	VDD_PADS_BB	NP	H	SDIO Data bit 0	E
	HSPIWP	SPI	O		NP	SW	SPI Write Protect	E
	GPIO(2)	GPIO	I/O		NP	SW	General Purpose I/O	E

Table 7-1: Pin Definitions (Continued)

Pin	Signal name	Group	I/O[a]	Voltage	PU/PD[b]	Active[c]	Function	Type[d]
47	SD_DATA1	SDIO	I/O	VDD_PADS_BB	NP	H	SDIO Data bit 1	E
	HSPIHD	SPI	O		NP	SW	SPI Hold	E
	GPIO(4)	GPIO	I/O		NP	SW	General Purpose I/O	E
48	Reserved	NoConnect	-	-	-	-	-	E
49	Reserved	NoConnect	-	-	-	-	-	E
50	VDD_3V3_RF	Power	I	2.8 (Min) 3.3V (Typ) 3.6 (Max)	-	-	3.3v nominal supply for Analog/RF	C
51	VDD_3V3_PA	Power	I	2.8 (Min) 3.3V (Typ) 3.6 (Max)	-	-	3.3v nominal supply for Internal Power Amplifier	C
52	VDD_PADS_BB	Power	I	2.7 (Min) 3.3V (Typ) 3.6 (Max)	-	-	3.3v nominal supply for Baseband and Digital I/O	C
53	GPIO(16)	GPIO	I/O	VGPIO	NP	SW	General Purpose I/O	C
	I2C2_SDA	I2C2	I/O		PUE	L	Primary I2C interface—Data	
54	GPIO(17)	GPIO	I/O	VDD_PADS_BB	NP	SW	General Purpose I/O	C
	I2C2_SCL	I2C2	I/O		PUE	L	Primary I2C interface—Clock	
G1–G16	Ground	Ground	0V	0V	-	-	Ground	C

a. I/O: Signal direction with respect to the module
b. PU/PD: NP—No Pull; PD—Pull Down; PU—Pull Up; PUE—Pull Up External
c. Active: H—High; L—Low; SW—Software defined
d. Type: C—Core; E—Extended; K—Custom

8: References

8.1 Web Site Support

Check http://source.sierrawireless.com for the latest documentation available for the AirPrime BX310x.

8.2 Reference Documents

[1] AirPrime BX310x AT Command Reference
Reference number: 41111445

[2] The I^2C Bus Specification, Version 2.1, January 2000 (Phillips Semiconductor document number 9398 393 40011)

9: Abbreviations

Table 9-1: Acronyms and Definitions

Acronym or term	Definition
AFH	Adaptive Frequency Rate Hopping
AP	Access Point
BLE	Bluetooth Low Energy
BR	Basic Rate
BSS	Basic Service Set
BT	Bluetooth (Classic)
EDR	Enhanced Data Rate
EDR	Enhanced Data Rate
GAP	Generic Access Profile
GAP	General Access Profile
GATT	General Attribute Profile
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
LE	Low Energy
MQTT	Message Queuing Telemetry Transport
PAN	Personal Area Network
RFCOMM	Radio Frequency Communication
SDP	Service Discover Protocol
SMP	Security Manage Protocol
SPP	Bluetooth Serial Port Profile
STA	Station (client)
UART	Universal Asynchronous Receiver-Transmitter
Wi-Fi	Wireless Networking
WPA	Wi-Fi Protected Access
WPA2	Wi-Fi Protected Access 2
WPS	Wi-Fi Protected Setup