ATWILC3000-MR110CA

IEEE 802.11 b/g/n Link Controller Module With Integrated Bluetooth 4.0

PRELIMINARY DATASHEET

Description

ATWILC3000-MR110 is an IEEE® 802.11 b/g/n RF/Baseband/MAC link controller and Bluetooth® 4.0 compliant module optimized for low-power mobile applications. The ATWILC3000-MR110 supports single stream 1x1 802.11n mode providing up to 72Mbps PHY rate. The ATWILC3000-MR110 module features small form factor while fully integrating Power Amplifier, LNA, Switch, Power Management, and PCB Antenna. Implemented in 65nm CMOS technology, the ATWILC3000-MR110 offers very low power consumption while simultaneously providing high performance and minimal bill of materials.

The ATWILC3000-MR110 utilizes highly optimized 802.11-Bluetooth coexistence protocols. The ATWILC3000-MR110 provides multiple peripheral interfaces including UART, SPI, I^2C, and SDIO. The only external clock sources needed for the ATWILC3000-MR110 a 32.768kHz clock for sleep operation.

Features

IEEE 802.11:

- IEEE 802.11 b/g/n RF/PHY/MAC SOC
- IEEE 802.11 b/g/n (1x1) for up to 72Mbps PHY rate
- Single spatial stream in 2.4GHz ISM band
- Integrated PA and T/R Switch
- Integrated Chip Antenna
- Superior Sensitivity and Range via advanced PHY signal processing
- Advanced Equalization and Channel Estimation
- Advanced Carrier and Timing Synchronization
- Wi-Fi Direct® and Soft-AP support
- Supports IEEE 802.11 WEP, WPA, and WPA2 Security
- Supports China WAPI security
- Superior MAC throughput via hardware accelerated two-level A-MSDU/A-MPDU frame aggregation and block acknowledgement
- On-chip memory management engine to reduce host load
- SPI, SDIO, I^2C, and UART host interfaces
- Operating temperature range of -40°C to +85°C

Bluetooth:

- Bluetooth 4.0 (Basic Rate, Enhanced Rate and BLE)
- Class 1 and 2 transmission
- Adaptive Frequency Hopping
- HCI (Host Control Interface) via high speed UART
- Integrated PA and T/R Switch
- Superior sensitivity and range
- UART host and audio interfaces
- PCM audio interface

Table of Contents

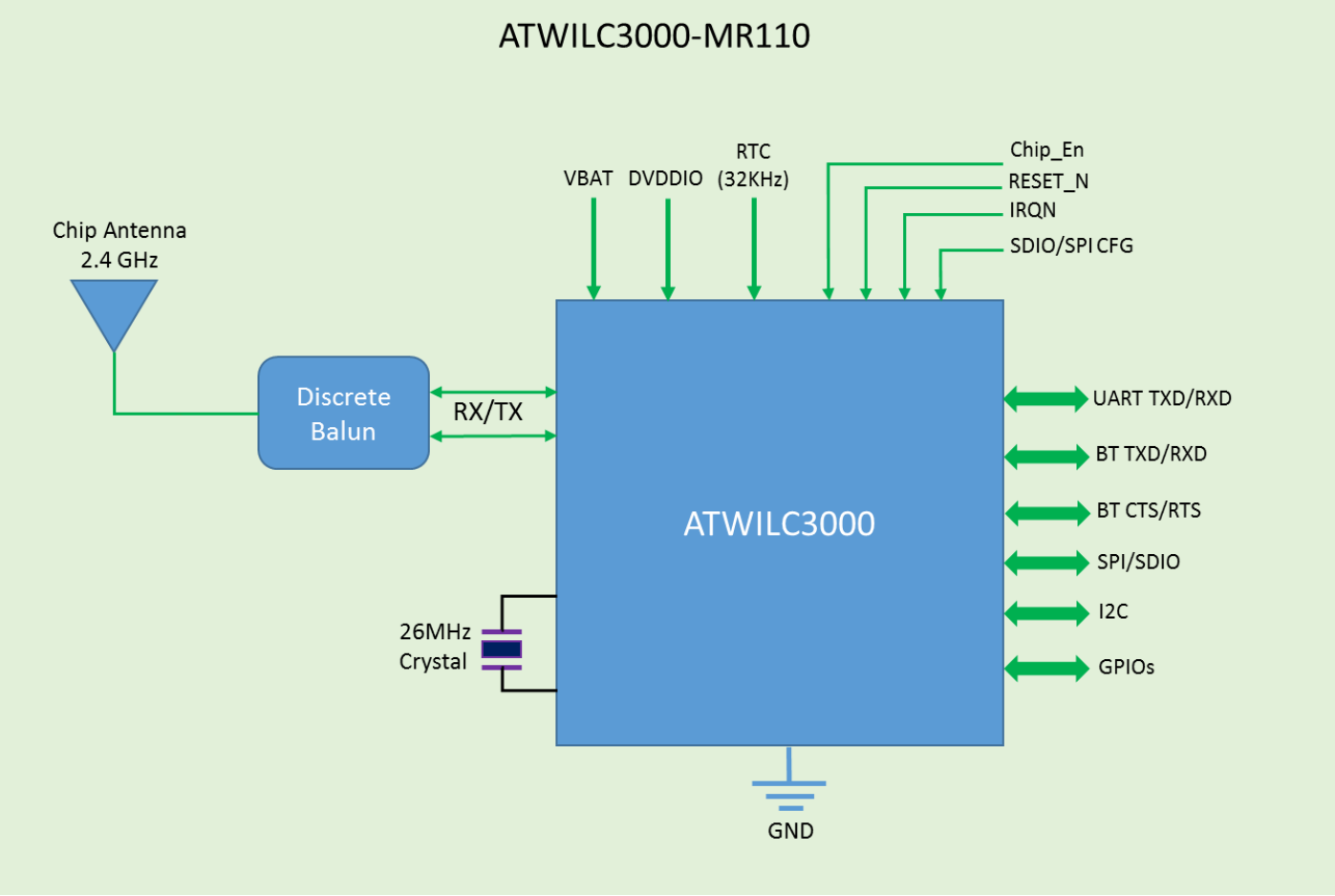
1 Ordering Information

Ordering Code	Package	Description
ATWILC3000-MR110CA	22 x 15mm	Chip Antenna

2 Block Diagram

This diagram provides a basic overview of the ATWILC3000-MR110.

Figure 2-1. ATWILC3000-MR110CA Block Diagram



3 Pinout and Package Information

This package has an exposed paddle that must be connected to the system board ground. The module pin assignment is shown in Figure 3-1. The ATWILC3000-MR110 pins are described in Table 3-1.

Figure 3-1. ATWILC3000-MR110 Pin Assignment

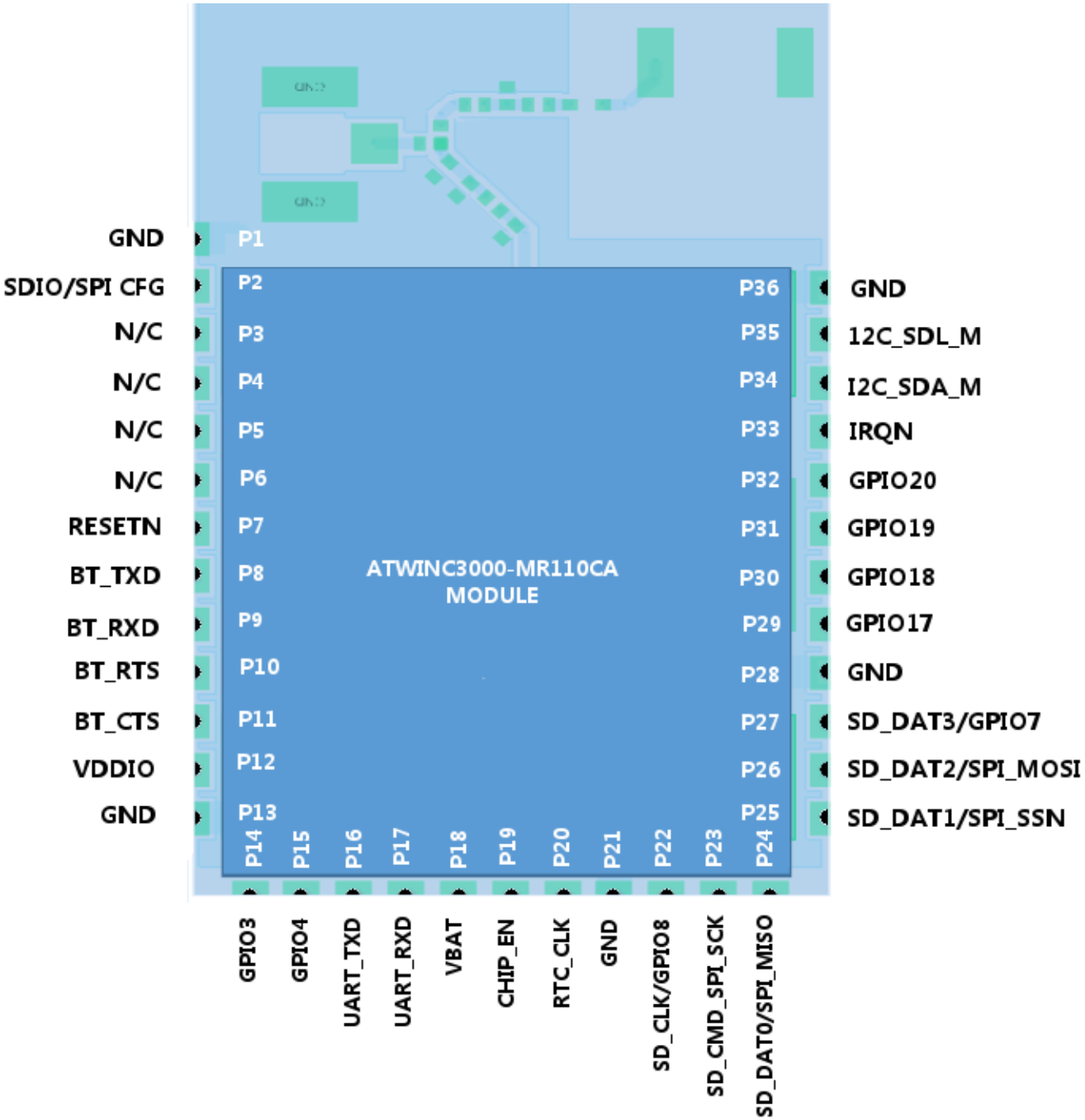


Table 3-1. ATWILC3000-MR110 Pin Description

Pin #	Pin Name	Pin Type	Description
1	GND	GND	Ground
2	SDIO/SPI CFG	Digital Input	Tie to VDDIO for SPI, GND for SDIO
3	N/C	None	No connect
4	N/C	None	No connect
5	N/C	None	No connect
6	N/C	None	No connect
7	RESETN	Digital Input	Active-Low Hard Reset
8	BT_TXD	Digital I/O, Programmable Pull-Up	GPIO_16/Bluetooth UART Transmit Data Output
9	BT_RXD	Digital I/O, Programmable Pull-Up	GPIO_15/Bluetooth UART Receive Data Input
10	BT_RTS	Digital I/O, Programmable Pull-Up	GPIO_14/Bluetooth UART RTS output/I^2C Slave Data
11	BT_CTS	Digital I/O, Programmable Pull-Up	GPIO_13/Bluetooth UART CTS Input/I^2C Slave Clock/WiFi® UART TxD Output
12	VDDIO	Power	Digital I/O Power Supply
13	GND	GND	Ground
14	GPIO3	Digital I/O, Programmable Pull-Up	GPIO_3/SPI Flash Clock Output
15	GPIO4	Digital I/O, Programmable Pull-Up	GPIO_4/SPI Flash SSN Output
16	UART_TXD	Digital I/O, Programmable Pull-Up	GPIO_5/WiFi UART TxD Output/SPI Flash Tx Output (MOSI)
17	UART_RXD	Digital I/O, Programmable Pull-Up	GPIO_6/WiFi UART RxD Input/SPI Flash Rx Input (MISO)
18	VBAT	Power	Battery Supply for DC/DC Converter AND PA
19	CHIP_EN	Analog	PMU Enable
20	RTC_CLK	Digital I/O, Programmable Pull-Up	RTC Clock Input/GPIO_1/WiFi UART RxD Input/WiFi UART TxD Output/BT UART CTS Input
21	GND	GND	Ground
22	SD_CLK/GPIO8	Digital I/O, Programmable Pull-Up	SDIO Clock/GPIO_8/WiFi UART RxD Input/BT UART CTS Input
23	SD_CMD/SPI_SCK	Digital I/O, Programmable Pull-Up	SDIO Command/SPI Clock
24	SD_DAT0/SPI_MISO	Digital I/O, Programmable Pull-Up	SDIO Data0/SPI Tx Data
25	SD_DAT1/SPI_SSN	Digital I/O, Programmable Pull-Up	SDIO Data1/SPI Slave Select
26	SD_DAT2/SPI_MOSI	Digital I/O, Programmable Pull-Up	SDIO Data2/SPI Rx Data

Pin #	Pin Name	Pin Type	Description
27	SD_DAT3/GPIO7	Digital I/O, Programmable Pull-Up	SDIO Data3/GPIO_7/WiFi UART TxD output/BT UART RTS Output
28	GND	GND	Ground
29	GPIO17	Digital I/O, Programmable Pull-Down	GPIO_17/Bluetooth PCM CLOCK
30	GPIO18	Digital I/O, Programmable Pull-Down	GPIO_18/Bluetooth PCM SNYC
31	GPIO19	Digital I/O, Programmable Pull-Down	GPIO_19/Bluetooth PCM Data Input
32	GPIO20	Digital I/O, Programmable Pull-Down	GPIO_20/Bluetooth PCM Data Output
33	IRQN	Digital I/O, Programmable Pull-Up	Host Interrupt Request Output/WiFi UART RxD Input/BT UART RTS Output
34	I2C_SDA_M	Digital I/O, Programmable Pull-Up	GPIO_21/RTC Clock/WiFi UART RxD Input/WiFi UART TxD Output/BT UART RTS Output
35	I2C_SDL_M	Digital I/O, Programmable Pull-Up	SLEEP Mode Control/WiFi UART TxD output
36	GND	GND	Ground
49	PADDLE VSS	Power	Connect to System Board Ground

3.2 Package Description

This section provides physical details about the ATWINC3000-MR110CA module.

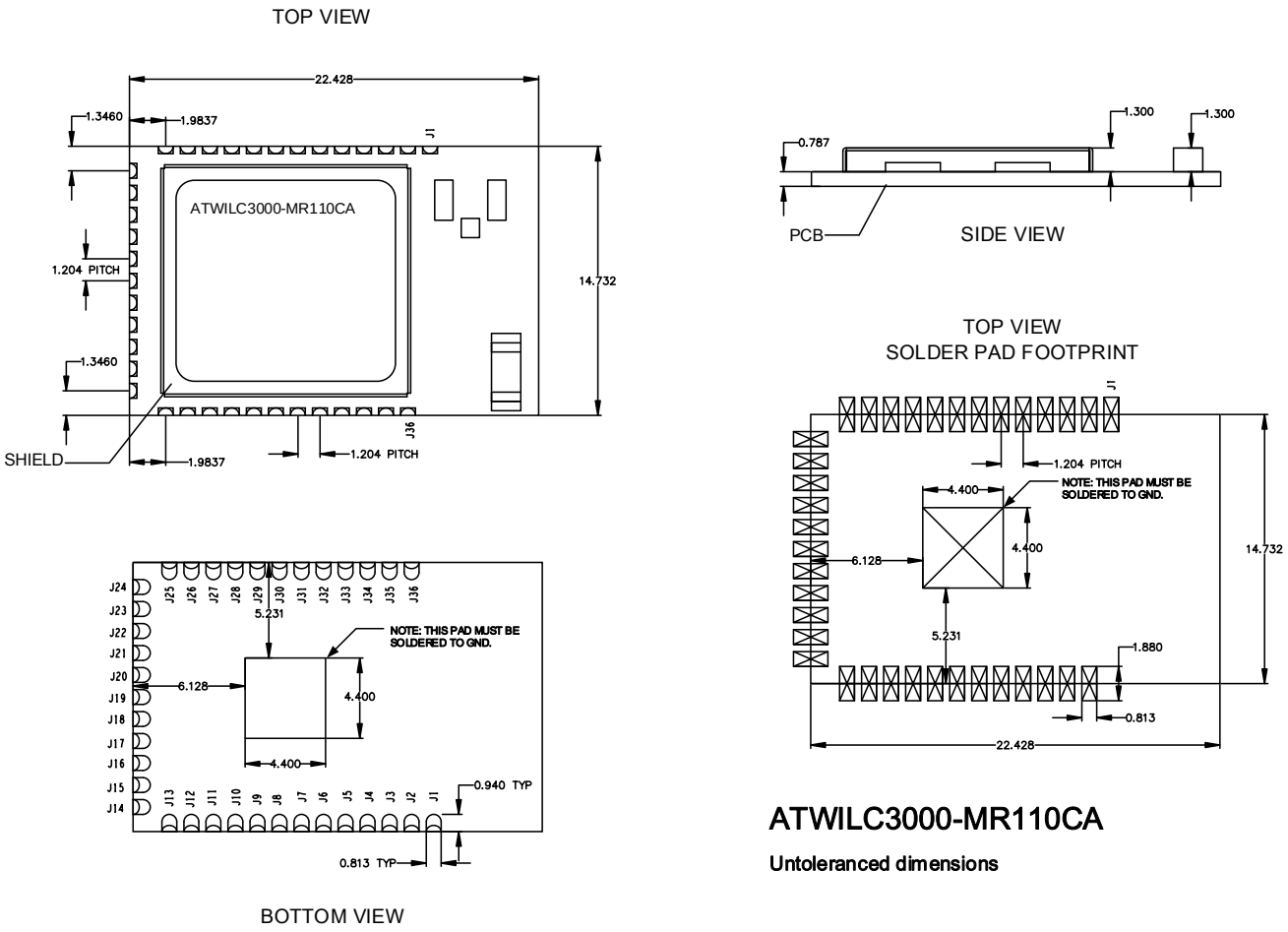
Figure 3-2 provides the package dimensions and Figure 3-3 provides details of the dimensioned layout of the ATWINC3000-MR110CA module.

Figure 3-2. ATWILC3000-MR110 Package Information

Parameter	Value	Units
Package Size	22.43 x 14.73	mm
Pad Count	36	
Total Thickness	2.09	mm
Pad Pitch	1.20	mm
Pad Width	0.81	mm
Exposed Pad size	4.4 x 4.4	mm

The ATWILC3000-MR110CA module package details are outlined in Figure 3-3. Dimensions are in mm.

Figure 3-3. ATWILC3000-MR110CA Module Package Dimensions



4 Power Management

4.1 Power Consumption

4.1.1 Description of Device States

ATWILC3000-MR110 has multiple device states, depending on the state of the 802.11 and Bluetooth subsystems. It is possible for both subsystems to be active at the same time. To simplify the device power consumption breakdown, the following basic states are defined, for which only one subsystem can be active at a time, as follows:

- WiFi_ON_Transmit - Device is actively transmitting an 802.11 signal
- WiFi_ON_Receive - Device is actively receiving an 802.11 signal
- BT_ON_Transmit - Device is actively transmitting a Bluetooth signal
- BT_ON_Receive - Device is actively receiving a Bluetooth signal
- Doze - Device is neither transmitting nor receiving (device state is retained)
- Power_Down - Device is powered down with CHIP_EN low and supplies connected

4.1.2 Controlling the Device States

Table 4-1 shows how to switch between the device states using the following:

- CHIP_EN - Device pin (pin #19) used to enable DC/DC Converter
- VDDIO - I/O supply voltage from external supply

Table 4-1. ATWILC3000-MR110 Various Device State Current Consumption

Device State	Code Rate	Output Power, dBm	Power Consumption[1,2]	
			I_{VBAT}	I_{VDDIO}
ON_WiFi_Transmit	802.11b 1Mbps	19.2	325 mA	2.7 mA
	802.11b 11Mbps	20.1	322 mA	2.7 mA
	802.11g 6Mbps	17.8	298 mA	2.7 mA
	802.11g 54Mbps	16.2	280 mA	2.7 mA
	802.11n MCS 0	19.5	295 mA	2.7 mA
	802.11n MCS 7	15.3	281 mA	2.7 mA
ON_WiFi_Receive	802.11b 1Mbps	N/A	83.7 mA	2.5 mA
	802.11b 11Mbps	N/A	84.9 mA	2.5 mA
	802.11g 6Mbps	N/A	85.8 mA	2.5 mA
	802.11g 54Mbps	N/A	90.1 mA	2.5 mA
	802.11n MCS 0	N/A	86 mA	2.5 mA
	802.11n MCS 7	N/A	91.8 mA	2.5 mA
ON_BT_Transmit	BLE 4.0 1Mbps	8	110 mA	<2.5 mA
ON_BT_Receive	BLE 4.0 1Mbps	N/A	<45mA	<2.5mA
Doze	N/A	N/A	<0.65mA	<7µA
Power_Down	N/A	N/A	<0.5µA	<0.2µA

Note: 1. Conditions: VBAT @3.6v, VDDIO @2.8V, 25°C

2. Power consumption numbers are preliminary

When no power is supplied to the device (the DC/DC Converter output and VDDIO are both off and at ground potential), a voltage cannot be applied to the ATWILC3000-MR110 pins because each pin contains an ESD diode from the pin to supply. This diode will turn on when the voltage higher than one diode-drop is supplied to the pin.

If a voltage must be applied to the signal pads while the chip is in a low power state, the VDDIO supply must be on, so the Power_Down state must be used. Similarly, to prevent the pin-to-ground diode from turning on, do not apply a voltage that is more than one diode-drop below ground to any pin.

4.2 Power-Up/Down Sequence

The power-up/down sequence for ATWILC3000-MR110 is shown in Figure 4-1. The timing parameters are provided in Table 4-2.

Figure 4-1. ATWILC3000-MR110 Power-Up/Down Sequence

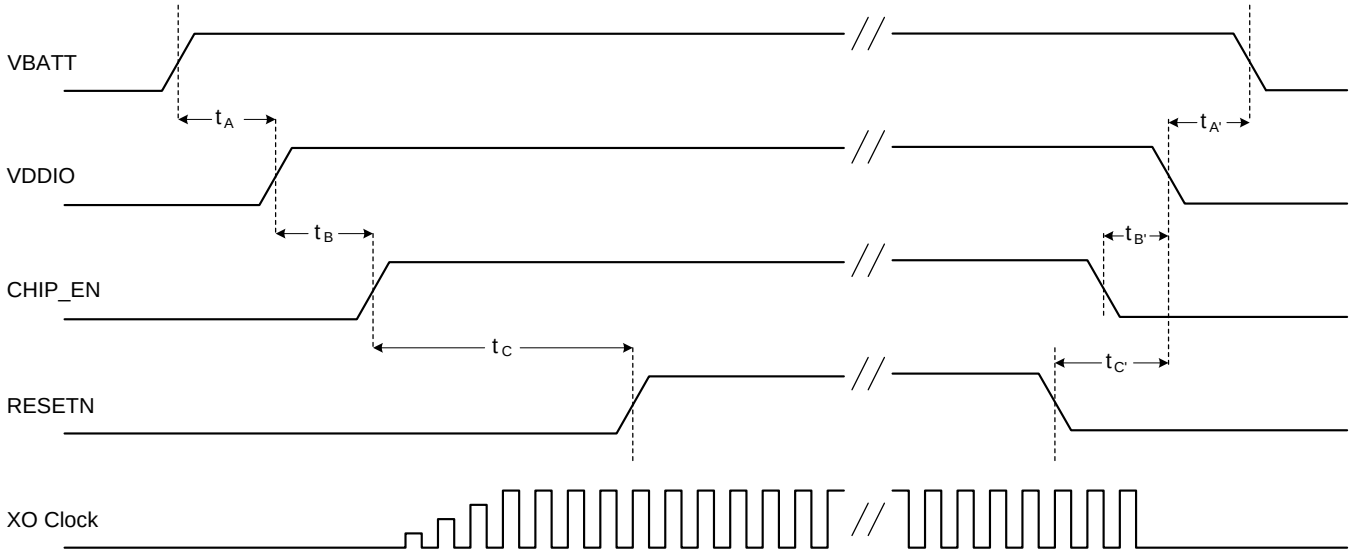


Table 4-2. ATWILC3000-MR110 Power-Up/Down Sequence Timing

Parameter	Min.	Max.	Units	Description	Notes
t_A	0		ms	VBAT rise to VDDIO rise	VBAT and VDDIO can rise simultaneously or can be tied together. VDDIO must not rise before VBAT.
t_B	0		ms	VDDIO rise to CHIP_EN rise	CHIP_EN must not rise before VDDIO. CHIP_EN must be driven high or low, not left floating.
t_C	5		ms	CHIP_EN rise to RE-SETN rise	This delay is needed because XO clock must stabilize before RESETN removal. RESETN must be driven high or low, not left floating.
$t_{A'}$	0		ms	VDDIO fall to VBAT fall	VBAT and VDDIO can fall simultaneously or can be tied together. VBAT must not fall before VDDIO.
$t_{B'}$	0		ms	CHIP_EN fall to VDDIO fall	VDDIO must not fall before CHIP_EN. CHIP_EN and RESETN can fall simultaneously.
$t_{C'}$	0		ms	RESETN fall to VDDIO fall	VDDIO must not fall before RESETN. RESETN and CHIP_EN can fall simultaneously.

4.3 Digital I/O Pin Behavior During Power-Up Sequences

Table 4-3 represents digital I/O Pin states corresponding to device power modes.

Table 4-3. Digital I/O Pin Behavior in Different Device States

Device State	VDDIO	CHIP_EN	RESETN	Output Driver	Input Driver	Pull Up/Down Resistor (96 kΩ)
Power_Down: core supply off	High	Low	Low	Disabled (Hi-Z)	Disabled	Disabled
Power-On Reset: core supply on, hard reset on	High	High	Low	Disabled (Hi-Z)	Disabled	Enabled
Power-On Default: core supply on, device out of reset but not programmed yet	High	High	High	Disabled (Hi-Z)	Enabled	Enabled
On_Doze/ On_Transmit/ On_Receive: core supply on, device programmed by firmware	High	High	High	Programmed by firmware for each pin: Enabled or Disabled	Opposite of Output Driver state	Programmed by firmware for each pin: Enabled or Disabled

5 Clocking

5.1 Crystal Oscillation

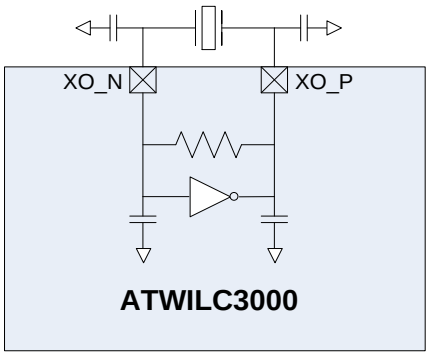
Table 5-1. ATWILC3000-MR110 Crystal Oscillator Parameters

Parameter	Min.	Typ.	Max.	Units
Crystal Resonant Frequency		26		MHz
Crystal Equivalent Series Resistance		50	150	Ω
Stability - Initial Offset (1)	-100		100	ppm
Stability - Temperature and Aging	-20		20	ppm

Note: 1. Initial offset must be calibrated to maintain ±25ppm in all operating conditions. This calibration is performed during final production testing.

The block diagram in Figure 5-1 below shows the internal Crystal Oscillator circuit that is contained within the module.

Figure 5-1. Internal Crystal Oscillator



5.2 Low Power Oscillator

ATWILC3000-MR110 requires an external 32.768kHz clock to be used for sleep operation, which is provided through Pin J20. The frequency accuracy of the external clock has to be within ±500ppm.

6 CPU and Memory Subsystem

6.1 Processor

ATWILC3000-MR110 has a Cortus APS3 32-bit processor. In 802.11 mode, the processor performs many of the MAC functions, including but not limited to association, authentication, power management, security key management, and MSDU aggregation/de-aggregation. In addition, the processor provides flexibility for various modes of operation, such as STA and AP modes. In Bluetooth mode, the processor handles multiple tasks of the Bluetooth protocol stack.

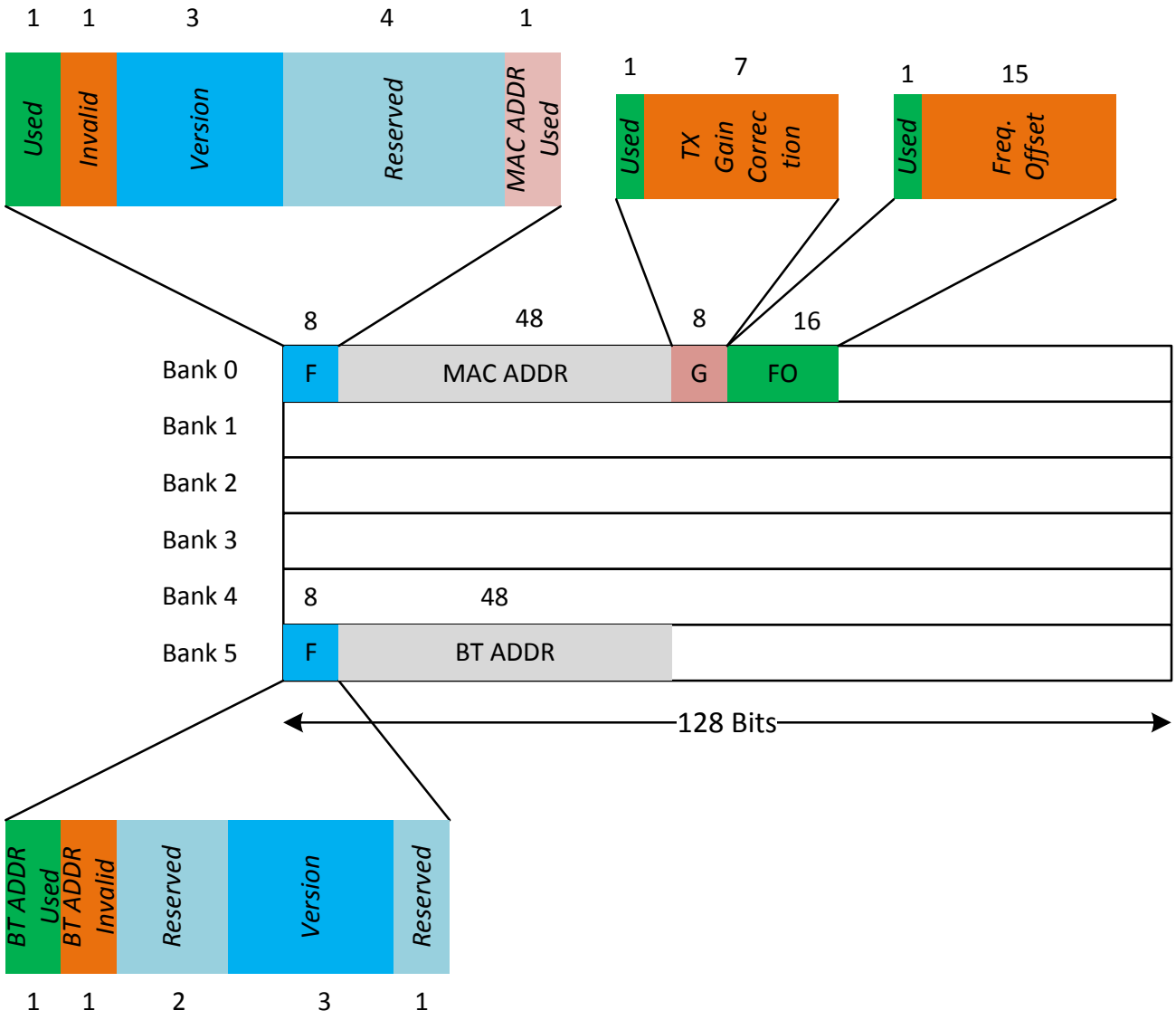
6.2 Memory Subsystem

The APS3 core uses a 256kB instruction/boot ROM (160kB for 802.11 and 96kB for Bluetooth) along with a 420KkB instruction RAM (128kB for 802.11 and 292kB for Bluetooth), and a 128kB data RAM (64kB for 802.11 and 64kB for Bluetooth). In addition, the device uses a 160kB shared/exchange RAM (128kB for 802.11 and 32kB for Bluetooth), accessible by the processor and MAC, which allows the processor to perform various data management tasks on the TX and RX data packets.

6.3 Non-Volatile Memory

ATWILC3000-MR110 has 768 bits of non-volatile eFuse memory that can be read by the CPU after device reset. This non-volatile one-time-programmable memory can be used to store customer-specific parameters, such as 802.11 MAC address, Bluetooth address, various calibration information, such as TX power, crystal frequency offset, etc., as well as other software-specific configuration parameters. The eFuse is partitioned into six 128-bit banks. The bit map of the first and last banks is shown in Figure 6-1. The purpose of the first 80 bits in bank 0 and the first 56 bits in bank 5 is fixed, and the remaining bits are general-purpose software dependent bits, or reserved for future use. Currently the Bluetooth address is derived from the Wi-Fi MAC address (BT_ADDR=MAC_ADDR+1). This eliminates the need to program the first 56 bits in bank 5. Since each bank and each bit can be programmed independently, this allows for several updates of the device parameters following the initial programming, e.g. updating 802.11 MAC address or Bluetooth address (this can be done by invalidating the last programmed bank and programming a new bank). Refer to ATWILC3000-MR110 Programming Guide for the eFuse programming instructions.

Figure 6-1. ATWILC3000-MR110 eFuse Bit Map



7 WLAN Subsystem

The WLAN subsystem is composed of the Media Access Controller (MAC) and the Physical Layer (PHY). The following two Sections describe the MAC and PHY in detail.

7.1 MAC

7.1.1 Features

The ATWILC3000-MR110 IEEE802.11 MAC supports the following functions:

- IEEE 802.11b/g/n
- IEEE 802.11e WMM QoS EDCA/HCCA/PCF multiple access categories traffic scheduling
- Advanced IEEE 802.11n features:
  - Transmission and reception of aggregated MPDUs (A-MPDU)
  - Transmission and reception of aggregated MSDUs (A-MSDU)
  - Immediate Block Acknowledgement
  - Reduced Interframe Spacing (RIFS)
- Support for IEEE802.11i and WFA security with key management
  - WEP 64/128
  - WPA-TKIP
  - 128-bit WPA2 CCMP (AES)
- Support for WAPI security
- Advanced power management
  - Standard 802.11 Power Save Mode
  - Wi-Fi Alliance WMM-PS (U-APSD)
- RTS-CTS and CTS-self support
- Supports either STA or AP mode in the infrastructure basic service set mode
- Supports independent basic service set (IBSS)

7.1.2 Description

The ATWILC3000-MR110 MAC is designed to operate at low power while providing high data throughput. The IEEE 802.11 MAC functions are implemented with a combination of dedicated datapath engines, hardwired control logic, and a low-power, high-efficiency microprocessor. The combination of dedicated logic with a programmable processor provides optimal power efficiency and real-time response while providing the flexibility to accommodate evolving standards and future feature enhancements.

Dedicated datapath engines are used to implement data path functions with heavy computational requirements. For example, an FCS engine checks the CRC of the transmitting and receiving packets, and a cipher engine performs all the required encryption and decryption operations for the WEP, WPA-TKIP, WPA2 CCMP-AES, and WAPI security requirements.

Control functions, which have real-time requirements, are implemented using hardwired control logic modules. These logic modules offer real-time response while maintaining configurability via the processor. Examples of hardwired control logic modules are the channel access control module (implements EDCA/HCCA, Beacon TX control, interframe spacing, etc.), protocol timer module (responsible for the Network Access Vector, back-off timing, timing synchronization function, and slot management), MPDU handling module, aggregation/de-aggregation module, block ACK controller (implements the protocol requirements for burst block communication), and TX/RX control FSMs (coordinate data movement between PHY-MAC interface, cipher engine, and the DMA interface to the TX/RX FIFOs).

The MAC functions implemented solely in software on the microprocessor have the following characteristics:

- Functions with high memory requirements or complex data structures. Examples are association table management and power save queuing.
- Functions with low computational load or without critical real-time requirements. Examples are authentication and association.
- Functions, which need flexibility and upgradeability. Examples are beacon frame processing and QoS scheduling.

7.2 PHY

7.2.1 Features

The ATWILC3000-MR110 IEEE802.11 PHY supports the following functions:

- Single antenna 1x1 stream in 20MHz channels
- Supports IEEE 802.11b DSSS-CCK modulation: 1, 2, 5.5, and 11Mbps
- Supports IEEE 802.11g OFDM modulation: 6, 9, 12,18, 24, 36, 48, and 54Mbps
- Supports IEEE 802.11n HT modulations MCS0-7, 20MHz, 800 and 400ns guard interval: 6.5, 7.2, 13.0, 14.4, 19.5, 21.7, 26.0, 28.9, 39.0, 43.3, 52.0, 57.8, 58.5, 65.0, 72.2Mbps
- IEEE 802.11n mixed mode operation
- Per packet TX power control
- Advanced channel estimation/equalization, automatic gain control, CCA, carrier/symbol recovery, and frame detection

7.2.2 Description

The ATWILC3000-MR110 WLAN PHY is designed to achieve reliable and power-efficient physical layer communication specified by IEEE 802.11 b/g/n in single stream mode with 20MHz bandwidth. Advanced algorithms have been employed to achieve maximum throughput in a real world communication environment with impairments and interference. The PHY implements all the required functions such as FFT, filtering, FEC (Viterbi decoder), frequency and timing acquisition and tracking, channel estimation and equalization, carrier sensing and clear channel assessment, as well as the automatic gain control.

8 Electrical Characteristics

8.1 Absolute Maximum Ratings

Table 8-1. ATWILC3000-MR110 Absolute Maximum Ratings

Characteristic	Symbol	Min.	Max.	Unit
Core Supply Voltage	VDDC	-0.3	1.5	V
I/O Supply Voltage	VDDIO	-0.3	5.0	
Battery Supply Voltage	VBAT	-0.3	5.0	
Digital Input Voltage	V_{IN}	-0.3	VDDIO	
Analog Input Voltage	V_{AIN}	-0.3	1.5	
ESD Human Body Model	V_{ESDHBM}	-1000, -2000 (see notes below)	+1000, +2000 (see notes below)	
Storage Temperature	T_A	-65	150	ºC
Junction Temperature			125	
RF input power max.			23	dBm

Notes:
1. V_{IN} corresponds to all the digital pins.
2. V_{AIN} corresponds to the following analog pins:
3. For V_{ESDHBM}, each pin is classified as Class 1, or Class 2, or both:
   - The Class 1 pins include all the pins (both analog and digital)
   - The Class 2 pins include all digital pins only
   - V_{ESDHBM} is ±1kV for Class1 pins. V_{ESDHBM} is ±2kV for Class2 pins

8.2 Recommended Operating Conditions

Table 8-2. ATWILC3000-MR110 Recommended Operating Conditions

Characteristic	Symbol	Min.	Typ.	Max.	Units
I/O Supply Voltage Low Range	$VDDIO_L$(2)	1.62	1.80	2.00	V
I/O Supply Voltage Mid Range	$VDDIO_M$(2)	2.00	2.50	3.00	
I/O Supply Voltage High Range	$VDDIO_H$(2)	3.00	3.30	3.60	
Battery Supply Voltage	VBAT	2.5(2)	3.60	4.20	
Operating Temperature		-40		85	˚C

Notes:
1. Battery supply voltage is applied to following pins: VBAT
2. ATWILC3000-MR110 is functional across this range of voltages; however, optimal RF performance is guaranteed for VBAT in the range ≥ 3.0V VBAT ≤ 4.2V.

8.3 DC Characteristics

Table 8-3 provides the DC characteristics for the ATWILC3000-MR110 digital pads.

Table 8-3. ATWILC3000-MR110 DC Electrical Characteristics

VDDIO Condition	Characteristic	Min.	Max.	Unit
$VDDIO_L$	Input Low Voltage V_{IL}	-0.30	0.60	V
	Input High Voltage V_{IH}	VDDIO-0.60	VDDIO+0.30	
	Output Low Voltage V_{OL}		0.45	
	Output High Voltage V_{OH}	VDDIO-0.50		
$VDDIO_M$	Input Low Voltage V_{IL}	-0.30	0.63	
	Input High Voltage V_{IH}	VDDIO-0.60	VDDIO+0.30	
	Output Low Voltage V_{OL}		0.45	
	Output High Voltage V_{OH}	VDDIO-0.50		
$VDDIO_H$	Input Low Voltage V_{IL}	-0.30	0.65	
	Input High Voltage V_{IH}	VDDION-0.60	VDDIO+0.30 (up to 3.60)	
	Output Low Voltage V_{OL}		0.45	
	Output High Voltage V_{OH}	VDDIO-0.50		
All	Output Loading		20	pF
	Digital Input Load		6	

8.4 802.11 b/g/n Radio Performance

8.4.1 Receiver Performance

Radio Performance under nominal conditions: VBAT = 3.3V; VDDIO=3.3V; Temp: 25°C; 50 ohm load/source.

Table 8-4. ATWILC3000-MR110 802.11 Conducted Receiver Performance

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency		2.412		2.484	MHz
Sensitivity 802.11b	1Mbps DSS		-98.0		dBm
	2Mbps DSS		-95.0		
	5.5Mbps DSS		-93.0		
	11Mbps DSS		-89.0		
Sensitivity 802.11g	6Mbps OFDM		-90.6		
	9Mbps OFDM		-89.0		
	12Mbps OFDM		-87.9		
	18Mbps OFDM		-86.0		
	24Mbps OFDM		-83.0		dBm
	36Mbps OFDM		-79.8		
	48Mbps OFDM		-76.0		

Parameter	Description	Min.	Typ.	Max.	Unit
	54Mbps OFDM		-74.3		
Sensitivity 802.11n (BW=20MHz)	MCS 0		-89.0		
	MCS 1		-86.9		
	MCS 2		-84.9		
	MCS 3		-82.4		
	MCS 4		-79.2		
	MCS 5		-75.0		
	MCS 6		-73.2		
	MCS 7		-71.2		
Maximum Receive Signal Level	1-11Mbps DSS	-10	5		
	6-54Mbps OFDM	-10	-3		
	MCS 0 - 7	-10	-3		
Adjacent Channel Rejection	1Mbps DSS (30MHz offset)		50		dB
	11Mbps DSS (25MHz offset)		43		
	6Mbps OFDM (25MHz offset)		40		
	54Mbps OFDM (25MHz offset)		25		
	MCS 0 – 20MHz BW (25MHz offset)		40		
	MCS 7 – 20MHz BW (25MHz offset)		20		

8.4.2 Transmitter Performance

Radio Performance under nominal conditions: VBAT = 3.3V; VDDIO=3.3V; Temp: 25°C; 50Ω load/source.

Table 8-5. ATWILC3000-MR110 802.11 Transmitter Performance

Parameter	Description	Minimum	Typical	Max.	Unit
Frequency		2.412		2.484	MHz
Output Power	802.11b DSSS 1-11Mbps		19(1)		dBm
	802.11g OFDM 6-54Mbps		17.0(1)		
	802.11n HT20 MCS 0-7		16(1)		
Tx Power Accuracy			±1.5(2)		dB
Carrier Suppression			30.0		dBc

Notes: 1. Measured at 802.11 spec compliant EVM/Spectral Mask.
2. Measured with 50Ω differential balun.

8.5 Bluetooth Subsystem

The Bluetooth subsystem implements all the mission critical real-time functions. It encodes/decodes HCI packets, constructs baseband data packages, manages, and monitors connection status, slot usage, data flow, routing, segmentation, and buffer control. The Bluetooth subsystem supports both conventional Bluetooth as well as Bluetooth Low Energy (BLE) modes of operation.

The Bluetooth Subsystem performs Link Control Layer management supporting the following states:

- Standby
- Connection
- Page and Page Scan
- Inquiry and Inquiry Scan
- Sniff

8.5.1 Bluetooth 4.0

Features:

- Extended Inquiry Response (EIR)
- Encryption Pause/Resume (EPR)
- Sniff Sub-Rating (SSR)
- Secure Simple Pairing (SSP)
- Link Supervision Time Out (LSTO)
- Link Management Protocol (LMP)
- Quality of Service (QOS)

8.5.2 Bluetooth Low Energy (BLE)

Supports BLE profiles allowing connection to advanced low energy application such as:

- Smart Energy
- Consumer Wellness
- Home Automation
- Security
- Proximity Detection
- Entertainment
- Sports and Fitness
- Automotive

8.6 Bluetooth Radio

8.6.1 Receiver Performance

Radio Performance under nominal conditions: VBAT = 3.3V; VDDIO=3.3V; Temp: 25°C; 50Ω load/source.

Table 8-6. ATWILC3000-MR110 Bluetooth Receiver Performance

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency		2.402		2.480	MHz
Sensitivity Ideal TX	GFSK (0.1% BER) 1Mbps		-93		dBm
	π/4 DQPSK (0.1% BER) 2Mbps		-95.6		
	8DPSK (0.1% BER) 3Mbps		-90		
	BLE (GFSK)		-96		
Maximum Receive Signal Level	GFSK	-10	0		
	π/4 DQPSK	-10	-5		
	8DPSK	-10	-5		

8.6.2 Transmitter Performance

Radio Performance under nominal conditions: VBAT = 3.3V; VDDIO=3.3V; Temp: 25°C; 50Ω load/source.

Table 8-7. ATWILC3000-MR110 Bluetooth Transmitter Performance

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency		2.402		2.480	MHz
Output Power	GFSK	-32	10.0	17(1)	dBm
	π/4 DQPSK	-32	10.0	17(1)	
	8DPSK	-32	10.0	17(1)	
	BLE (GFSK)	-32	10.0	17(1)	

Note: 1. The maximum output power may require board filtering to meet spurious emission limits.

9 External Interfaces

ATWILC3000-MR110 external interfaces include: SPI Slave, SDIO Slave, and UART for 802.11 control and data transfer; UART for Bluetooth control, data transfer, and audio; PCM for Bluetooth audio; I²C Slave for control; SPI Master for external Flash; I²C Master for external EEPROM, and General Purpose Input/Output (GPIO) pins. With the exception of the SPI Slave and SDIO Slave host interfaces, which are selected using the dedicated SDIO_SPI_CFG pin, the other interfaces can be assigned to various pins by programming the corresponding pin muxing control register for each pin to a specific value between 0 and 6.The default values of these registers are 0, which is GPIO mode. Each digital I/O pin also has a programmable pull-up or pull-down. The summary of the available interfaces and their corresponding pin mux settings is shown in Table 9-1. For specific programming instructions, refer to ATWILC3000-MR110 Programming Guide.

Table 9-1. ATWILC3000-MR110 Pin-Mux Matrix of External Interfaces

Pin Name	Pin #	Pull	Mux0	Mux1	Mux2	Mux3	Mux4	Mux5	Mux6
GPIO16	J8	Up	GPIO_16	O_BT_UART1_TXD					
GPIO15	J9	Up	GPIO_15	I_BT_UART1_RXD					
GPIO14	J10	Up	GPIO_14	O_BT_UART1_RTS	IO_I2C_SDA				I_WAKEUP
GPIO13	J11	Up	GPIO_13	I_BT_UART1_CTS	IO_I2C_SCL	O_WIFI_UART_TXD			I_WAKEUP
GPIO3	J23	Up	GPIO_3	O_SPI_SCK_FLASH					O_BT_UART2_TXD
GPIO4	J25	Up	GPIO_4	O_SPI_SSN_FLASH					I_BT_UART2_RXD
GPIO5	J24	Up	GPIO_5	O_SPI_TXD_FLASH		O_WIFI_UART_TXD			I_WAKEUP
GPIO6	J25	Up	GPIO_6	I_SPI_RXD_FLASH		I_WIFI_UART_RXD			I_WAKEUP
RTC_CLK	J20	Up	GPIO_1	I_RTC_CLK		I_WIFI_UART_RXD	O_WIFI_UART_TXD	I_BT_UART1_CTS	
SD_CLK	J22	Up	GPIO_8	I_SD_CLK		I_WIFI_UART_RXD	I_BT_UART1_CTS		
SD_CMD/SPI_SCK	J23	Up		IO_SD_CMD	IO_SPI_SCK				
SD_DAT0/SPI_TXD	J24	Up		IO_SD_DAT0	O_SPI_TXD				
SD_DAT1/SPI_SSN	J25	Up		IO_SD_DAT1	IO_SPI_SSN				
SD_DAT2/SPI_RXD	J26	Up		IO_SD_DAT2	I_SPI_RXD				
SD_DAT3	J27	Up	GPIO_7	IO_SD_DAT3		O_WIFI_UART_TXD	O_BT_UART1_RTS		
GPIO17	J29	Down	GPIO_17	IO_BT_PCM_CLK					I_WAKEUP
GPIO18	J30	Down	GPIO_18	IO_BT_PCM_SYNC					I_WAKEUP
GPIO19	J31	Down	GPIO_19	I_BT_PCM_D_IN					I_WAKEUP
GPIO20	J32	Down	GPIO_20	O_BT_PCM_D_OUT					I_WAKEUP
IRQN	J33	Up	GPIO_2	O_IRQN		I_WIFI_UART_RXD	O_BT_UART1_RTS		
GPIO21	J34	Up	GPIO_21	I_RTC_CLK		I_WIFI_UART_RXD	O_WIFI_UART_TXD	O_BT_UART1_RTS	IO_I2C_MASTER_SCL
HOST_WAKEUP	J35	Up	GPIO_0	I_WAKEUP		O_WIFI_UART_TXD			IO_I2C_MASTER_SDA

9.1 I²C Slave Interface

9.1.1 Description

The I²C Slave interface, used primarily for control by the host processor, is a two-wire serial interface consisting of a serial data line (SDA) on Pin 16 (GPIO14) and a serial clock line (SCL) on Pin 17 (GPIO13). I²C Slave responds to the seven bit address value 0x60. The ATWILC3000-MR110 I²C supports I²C bus Version 2.1 - 2000 and can operate in standard mode (with data rates up to 100kb/s) and fast mode (with data rates up to 400kb/s).

The I²C Slave is a synchronous serial interface. The SDA line is a bidirectional signal and changes only while the SCL line is low, except for STOP, START, and RESTART conditions. The output drivers are open-drain to

perform wire-AND functions on the bus. The maximum number of devices on the bus is limited by only the maximum capacitance specification of 400pF. Data is transmitted in byte packages.

For specific information, refer to the Philips Specification entitled “The I²C -Bus Specification, Version 2.1”.

9.1.2 I²C Slave Timing

The I²C Slave timing is provided in Figure 9-1 and Table 9-2.

Figure 9-1. ATWILC3000-MR110 I²C Slave Timing Diagram

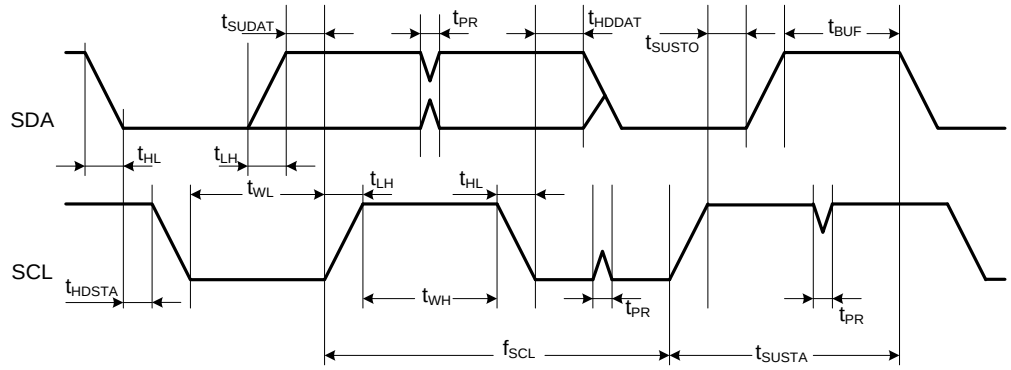


Table 9-2. ATWILC3000-MR110 I²C Slave Timing Parameters

Parameter	Symbol	Min.	Max.	Units	Remarks
SCL Clock Frequency	f_{SCL}	0	400	kHz	
SCL Low Pulse Width	t_{WL}	1.3		µs	
SCL High Pulse Width	t_{WH}	0.6			
SCL, SDA Fall Time	t_{HL}		300	ns	
SCL, SDA Rise Time	t_{LH}		300		This is dictated by external components
START Setup Time	t_{SUSTA}	0.6		µs	
START Hold Time	t_{HDSTA}	0.6			
SDA Setup Time	t_{SUDAT}	100		ns	
SDA Hold Time	t_{HDDAT}	0		ns	Slave and Master Default
		40		µs	Master Programming Option
STOP Setup Time	t_{SUSTO}	0.6		µs	
Bus Free Time Between STOP and START	t_{BUF}	1.3			
Glitch Pulse Reject	t_{PR}	0	50	ns	

9.2 I²C Master Interface

9.2.1 Description

ATWILC3000-MR110 provides an I²C bus master, which is intended primarily for accessing an external EEPROM memory through a software-defined protocol. The I²C Master is a two-wire serial interface consisting of a serial data line (SDA) and a serial clock line (SCL). SDA can be configured on pin 42 (HOST_WAKEUP) and SCL can be configured on pin 41 (GPIO21).

9.2.2 I²C Master Timing

The I²C Master interface supports three speeds:

- Standard mode (100kb/s)
- Fast mode (400kb/s)
- High-speed mode (3.4Mb/s)

The timing diagram of the I²C Master interface is the same as that of the I²C Slave interface (see Figure 9-1). The timing parameters of I²C Master are shown in Table 9-3.

Table 9-3. ATWILC3000-MR110 I²C Master Timing Parameters

Parameter	Symbol	Standard Mode		Fast Mode		High-Speed Mode		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
SCL Clock Frequency	f_{SCL}	0	100	0	400	0	3400	kHz
SCL Low Pulse Width	t_{WL}	4.7		1.3		0.16		µs
SCL High Pulse Width	t_{WH}	4		0.6		0.06		
SCL Fall Time	t_{HLSCL}		300		300	10	40	ns
SDA Fall Time	t_{HLSDA}		300		300	10	80	
SCL Rise Time	t_{LHSCL}		1000		300	10	40	
SDA Rise Time	t_{LHSDA}		1000		300	10	80	
START Setup Time	t_{SUSTA}	4.7		0.6		0.16		µs
START Hold Time	t_{HDSTA}	4		0.6		0.16		
SDA Setup Time	t_{SUDAT}	250		100		10		ns
SDA Hold Time	t_{HDDAT}	5		40		0	70	
STOP Setup time	t_{SUSTO}	4		0.6		0.16		µs
Bus Free Time Between STOP and START	t_{BUF}	4.7		1.3				
Glitch Pulse Reject	t_{PR}			0	50			ns

9.3 SPI Slave Interface

9.3.1 Description

ATWILC3000-MR110 provides a Serial Peripheral Interface (SPI) that operates as a SPI slave. The SPI Slave interface can be used for control and for serial I/O of 802.11 data. The SPI Slave pins are mapped as shown in Table 9-4. The RXD pin is same as Master Output, Slave Input (MOSI), and the TXD pin is same as Master Input, Slave Output (MISO). The SPI Slave is a full-duplex slave-synchronous serial interface that is available immediately following reset when Pin 12 (SDIO_SPI_CFG) is tied to VDDIO.

Table 9-4. ATWILC3000-MR110 SPI Slave Interface Pin Mapping

Pin #	SPI Function
2	CFG: Must be tied to VDDIO
25	SSN: Active Low Slave Select
23	SCK: Serial Clock

Pin #	SPI Function
26	RXD: Serial Data Receive (MOSI)
24	TXD: Serial Data Transmit (MISO)

When the SPI is not selected, i.e., when SSN is high, the SPI interface will not interfere with data transfers between the serial master and other serial slave devices. When the serial slave is not selected, its transmitted data output is buffered, resulting in a high impedance drive onto the serial master receive line.

The SPI Slave interface responds to a protocol that allows an external host to read or write any register in the chip as well as initiate DMA transfers. For the details of the SPI protocol and more specific instructions refer to ATWILC3000-MR110 Programming Guide.

9.3.2 SPI Slave Modes

The SPI Slave interface supports four standard modes as determined by the Clock Polarity (CPOL) and Clock Phase (CPHA) settings. These modes are illustrated in Table 9-5 and Figure 9-2. The red lines in Figure 9-2 correspond to Clock Phase = 0 and the blue lines correspond to Clock Phase = 1.

Table 9-5. ATWILC3000-MR110 SPI Slave Modes

Mode	CPOL	CPHA
0	0	0
1	0	1
2	1	0
3	1	1

9.3.3 SPI Slave Timing

The SPI Slave timing is provided in Figure 9-2, Figure 9-3, and Table 9-6.

Figure 9-2. ATWILC3000-MR110 SPI Slave Clock Polarity and Clock Phase Timing

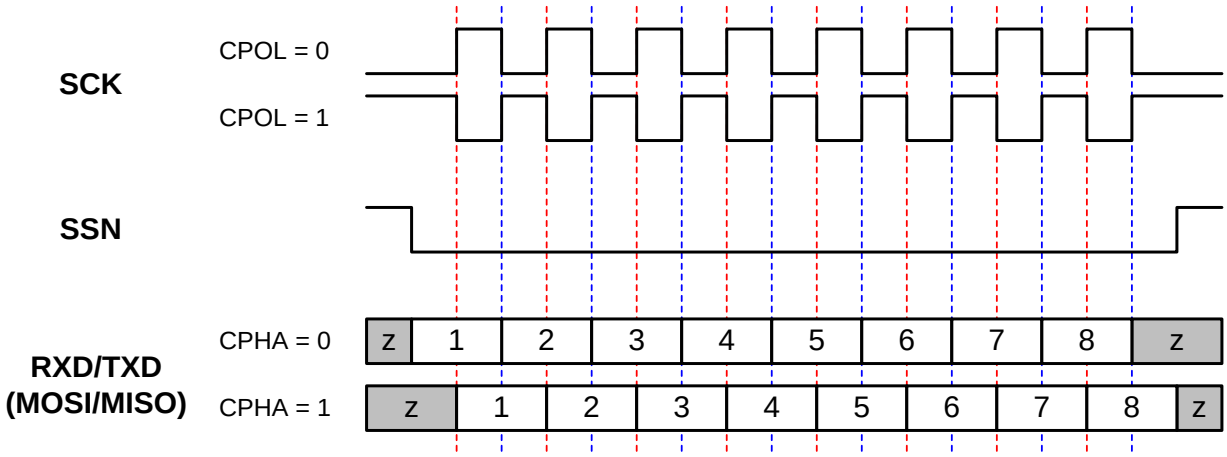


Figure 9-3. ATWILC3000-MR110 SPI Slave Timing Diagram

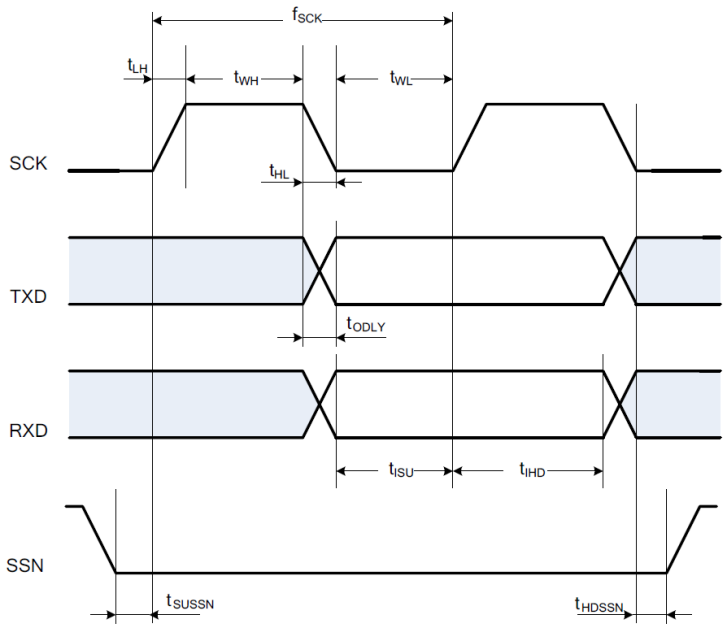


Table 9-6. SPI Slave Timing Parameters (1)

Parameter	Symbol	Min.	Max.	Unit
Clock Input Frequency (2)	f_{SCK}		48	MHz
Clock Low Pulse Width	t_{WL}	6		ns
Clock High Pulse Width	t_{WH}	4		
Clock Rise Time	t_{LH}	0	7	
Clock Fall Time	t_{HL}	0	7	
TXD Output Delay (3)	t_{ODLY}	3	9 from SCK fall 11 from SCK rise	
RXD Input Setup Time	t_{ISU}	3		
RXD Input Hold Time	t_{IHD}	5		
SSN Input Setup Time	t_{SUSSN}	5		
SSN Input Hold Time	t_{HDSSN}	5		

Note:
1. Timing is applicable to all SPI modes
2. Maximum clock frequency specified is limited by the SPI Slave interface internal design; actual maximum clock frequency can be lower and depends on the specific PCB layout
3. Timing based on 15pF output loading

9.4 SPI Master Interface

9.4.1 Description

ATWILC3000-MR110 provides a SPI Master interface for accessing external flash memory. The SPI Master pins are mapped as shown in Table 9-7. The TXD pin is same as Master Output, Slave Input (MOSI), and the RXD pin is same as Master Input, Slave Output (MISO). The SPI Master interface supports all four standard modes of clock polarity and clock phase shown in Table 9-5. External SPI flash memory is accessed by a processor

programming commands to the SPI Master interface, which in turn initiates a SPI master access to the flash. For more specific instructions refer to ATWILC3000-MR110 Programming Guide.

Table 9-7. ATWILC3000-MR110 SPI Master Interface Pin Mapping

Pin #	Pin Name	SPI Function
23	SPI_SCK	Serial Clock Output
25	SPI_SSN	Active Low Slave Select Output
26	SPI_RXD	RXD: Serial Data Transmit Output (MISO)
24	SPI_TXD	TXD: Serial Data Receive Input (MOSI)

9.4.2 SPI Master Timing

The SPI Master timing is provided in Figure 9-4 and Table 9-8.

Figure 9-4. ATWILC3000-MR110 SPI Master Timing Diagram

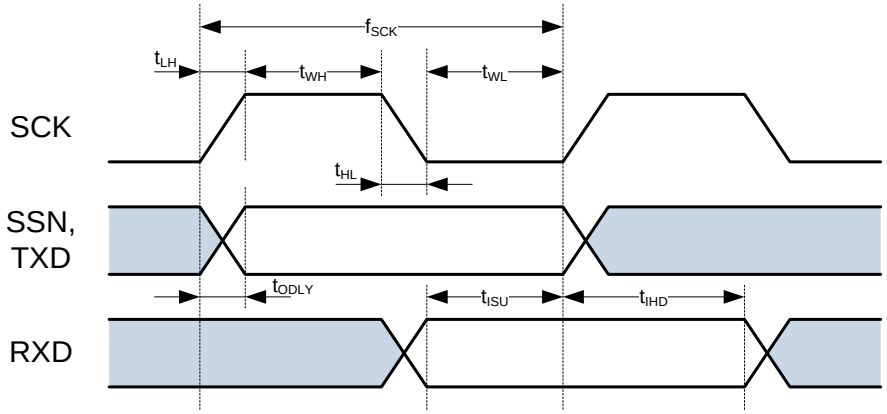


Table 9-8. SPI Master Timing Parameters (1)

Parameter	Symbol	Min.	Max.	Unit
Clock Output Frequency (2)	f_{SCK}		20	MHz
Clock Low Pulse Width	t_{WL}	19		ns
Clock High Pulse Width	t_{WH}	21		
Clock Rise Time (3)	t_{LH}		11	
Clock Fall Time (3)	t_{HL}		10	
RXD Input Setup Time	t_{ISU}	24		
RXD Input Hold Time	t_{IHD}	0		
SSN/TXD Output Delay (3)	t_{ODLY}	-5	3	

Note:
1. Timing is applicable to all SPI modes
2. Maximum clock frequency specified is limited by the SPI Master interface internal design; actual maximum clock frequency can be lower and depends on the specific PCB layout
3. Timing based on 15pF output loading

9.5 SDIO Slave Interface

9.5.1 Features

- Meets SDIO card specification version 2.0
- Host clock rate variable between 0 and 50MHz
- 1 bit/4-bit SD bus modes supported
- Allows card to interrupt host
- Responds to Direct read/write (IO52) and Extended read/write (IO53) transactions
- Supports Suspend/Resume operation

9.5.2 Description

The ATWILC3000-MR110 SDIO Slave is a full speed interface. The interface supports the 1-bit/4-bit SD transfer mode at the clock range of 0-50MHz. The Host can use this interface to read and write from any register within the chip as well as configure the ATWILC3000-MR110 for data DMA. To use this interface, pin 12 (SDIO_SPI_CFG) must be grounded. The SDIO Slave pins are mapped as shown in Table 9-9.

Table 9-9. ATWILC3000-MR110 SDIO Interface Pin Mapping

Pin #	SPI Function
2	CFG: Must be tied to ground
27	DAT3: Data 3
26	DAT2: Data 2
25	DAT1: Data 1
24	DAT0: Data 0
23	CMD: Command
22	CLK: Clock

When the SDIO card is inserted into an SDIO aware host, the detection of the card will be via the means described in SDIO specification. During the normal initialization and interrogation of the card by the host, the card will identify itself as an SDIO device. The host software will obtain the card information in a tuple (linked list) format and determine if that card's I/O function(s) are acceptable to activate. If the card is acceptable, it will be allowed to power up fully and start the I/O function(s) built into it.

The SD memory card communication is based on an advanced 9-pin interface (Clock, Command, 4 Data, and 3 Power lines) designed to operate at maximum operating frequency of 50MHz.

9.5.3 SDIO Timing

The SDIO Slave interface timing is provided in Figure 9-5 and Table 9-10.

Figure 9-5. ATWILC3000-MR110 SDIO Slave Timing Diagram

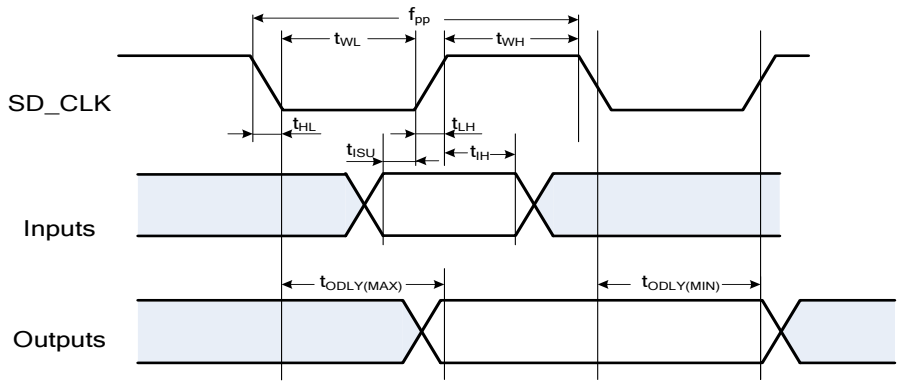


Table 9-10. ATWILC3000-MR110 SDIO Slave Timing Parameters

Parameter	Symbol	Min.	Max.	Units
Clock Input Frequency (1)	f_{PP}		50	MHz
Clock Low Pulse Width	t_{WL}	6		ns
Clock High Pulse Width	t_{WH}	7		
Clock Rise Time	t_{LH}	0	5	
Clock Fall Time	t_{HL}	0	5	
Input Setup Time	t_{ISU}	6		
Input Hold Time	t_{IH}	8		
Output Delay (2)	t_{ODLY}	3	11	

Note: 1. Maximum clock frequency specified is limited by the SDIO Slave interface internal design, actual maximum clock frequency can be lower and depends on the specific PCB layout
2. Timing based on 15pF output loading

9.6 UART Interface

ATWILC3000-MR110 provides Universal Asynchronous Receiver/Transmitter (UART) interfaces for serial communication in both the 802.11 and Bluetooth subsystems.

- The Bluetooth subsystem has two UART interfaces: a 4-pin interface for control, data transfer, and audio (BT UART1), and a 2-pin interface for debugging (BT UART2).
- The 802.11 subsystem has one 2-pin UART interface (Wi-Fi UART), which can be used for control, data transfer, or debugging.

The UART interfaces are compatible with the RS-232 standard, and the ATWILC3000-MR110 operates as a Data Terminal Equipment (DTE) type device. The 2-pin UART uses receive and transmit pins (RXD and TXD). The 4-pin UART uses two pins for data (TXD and RXD) and two pins for flow control/handshaking: Request To Send (RTS) and Clear To Send (CTS).

IMPORTANT

The RTS and CTS are used for hardware flow control; they MUST be connected to the host MCU UART and enabled for the UART interface to be functional.

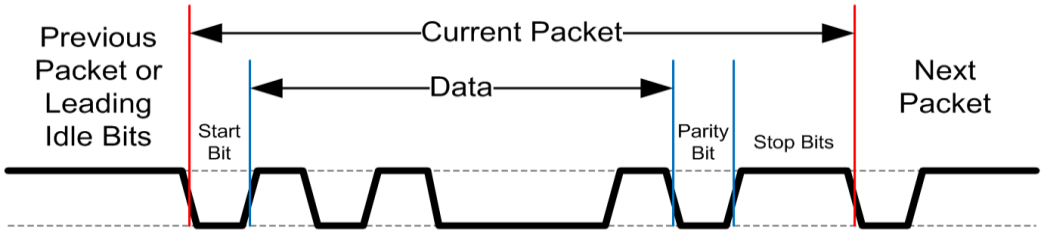
The pins associated with each UART interfaces can be enabled on several alternative pins by programming their corresponding pin mux control registers (see Table 9-1 for available options).
The UART features programmable baud rate generation with fractional clock division, which allows transmission

and reception at a wide variety of standard and non-standard baud rates. The Bluetooth UART input clock is selectable between 104MHz, 52MHz, 26MHz, and 13MHz. The clock divider value is programmable as 13 integer bits and three fractional bits (with 8.0 being the smallest recommended value for normal operation). This results in the maximum supported baud rate of 10MHz/8.0 = 13MBd. The 802.11 UART input clock is selectable between 10MHz, 5MHz, 2.5MHz, and 1.25MHz. The clock divider value is programmable as 13 integer bits and three fractional bits (with 8.0 being the smallest recommended value for normal operation). This results in the maximum supported baud rate of 10MHz/8.0 = 1.25MBd.

The UART can be configured for seven or eight bit operation, with or without parity, with four different parity types (odd, even, mark, or space), and with one or two stop bits. It also has Rx and Tx FIFOs, which ensure reliable high speed reception and low software overhead transmission. FIFO size is 4 x 8 for both Rx and Tx direction. The UART also has status registers showing the number of received characters available in the FIFO and various error conditions, as well the ability to generate interrupts based on these status bits.

An example of UART receiving or transmitting a single packet is shown in Figure 9-6. This example shows 7-bit data (0x45), odd parity, and two stop bits. For more specific instructions refer to ATWILC3000-MR110 Programming Guide.

Figure 9-6. Example of UART Rx or Tx Packet



9.7 PCM Interface

ATWILC3000-MR110 provides a PCM/IOM interface for Bluetooth audio. This interface is compatible with industry standard PCM and IOM2 compliant devices, such as audio codecs, line interfaces, TDM switches, and others. The PCM audio interface supports both master and slave modes, full duplex operation, mono and stereo. The interface operates at 8kHz frame rate and supports bit rates up to 512 bits/frame (4.096Mbps). The PCM interface pins are mapped as shown in Table 9-11.

Table 9-11. ATWILC3000-MR110 PSM Interface Pin Mapping

Pin #	PCM Function
29	CLK: Bi-directional clock input/output
30	SYNC: Bi-directional Frame sync (mono) or Left-Right Channel identifier (stereo)
31	D_IN: Serial data input
32	D_OUT: Serial data output

9.8 GPIOs

18 General Purpose Input/Output (GPIO) pins, labeled GPIO 0-8 and 13-21, are available to allow for application specific functions. Each GPIO pin can be programmed as an input (the value of the pin can be read by the host or internal processor) or as an output (the output values can be programmed by the host or internal processor), where the default mode after power-up is input. GPIOs 7 and 8 are only available when the host does not use the SDIO interface, which shares two of its pins with these GPIOs. Therefore, for SDIO-based applications, 16 GPIOs (0-6 and 13-21) are available.

9.9 Internal Pull-Up Resistors

ATWILC3000-MR110 provides programmable pull-up resistors on various pins (see Table 3-1). The purpose of these resistors is to keep any unused input pins from floating which can cause excess current to flow through the input buffer from the VDDIO supply. Any unused pin on the device should leave these pull-up resistors enabled so the pin will not float.

The default state at power up is for the pull-up resistor to be enabled. However, any pin, which is used, should have the pull-up resistor disabled. The reason for this is that if any pins are driven to a low level while the device is in the low power sleep state, current will flow from the VDDIO supply through the pull-up resistors, increasing the current consumption of the module.

Since the value of the pull-up resistor is approximately 100KΩ, the current through any pull-up resistor that is being driven low will be VDDIO/100K. For VDDIO = 3.3V, the current would be approximately 33µA. Pins which are used and have had the programmable pull-up resistor disabled should always be actively driven to either a high or low level and not be allowed to float. Refer to ATWILC3000-MR110 Programming Guide for information on enabling/disabling the programmable pull-up resistors.

10 Reference Design

The ATWILC3000-MR110 module application schematics are shown in Figure 10-1 and Figure 10-2.

Figure 10-1. ATWILC3000-MR110 Application Schematic for SPI Operation

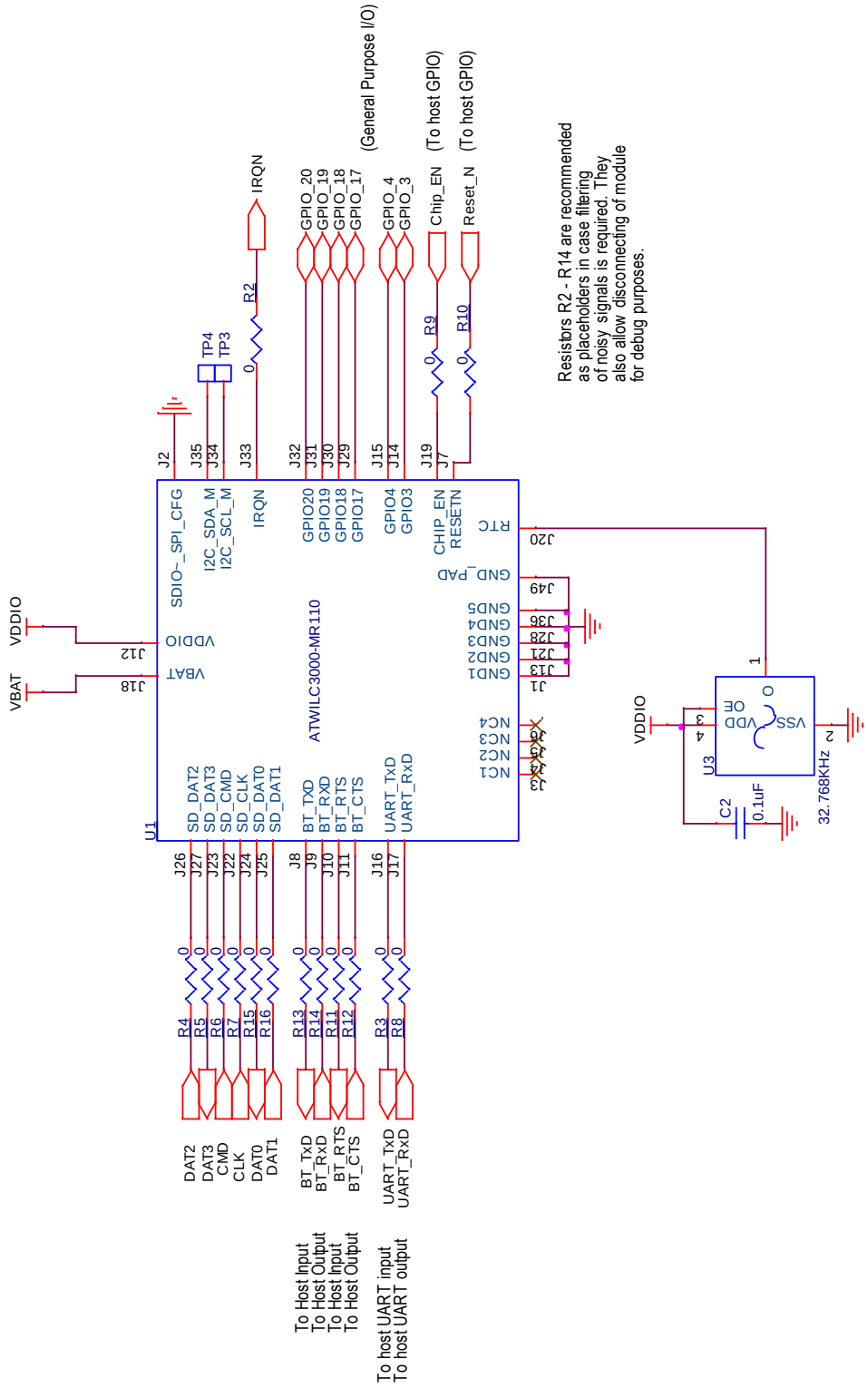
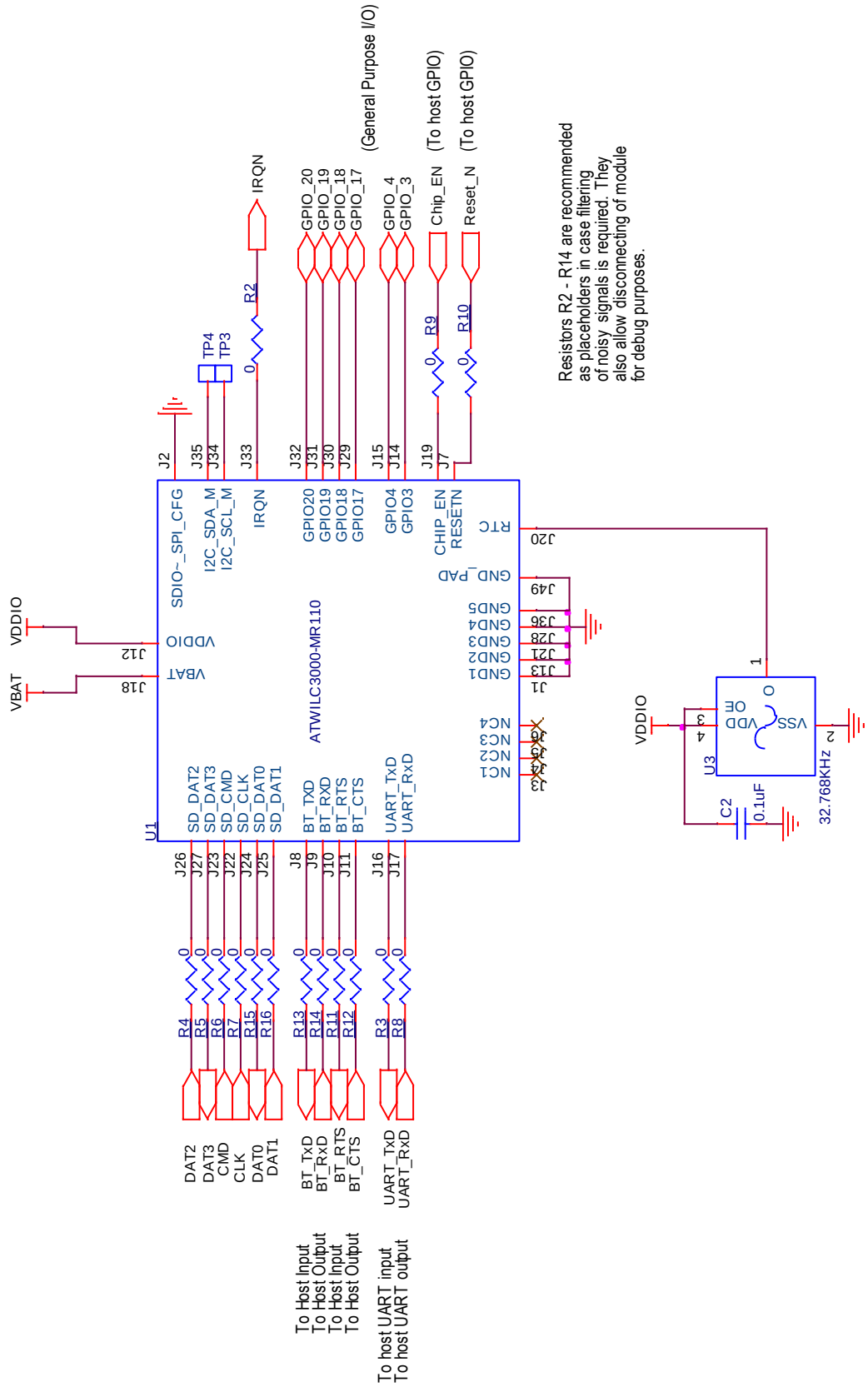


Figure 10-2. ATWILC3000-MR110 Application Schematic for SDIO Operation



10.2 SPI Application Bill of Material

WILC3000-MR110CA Module Application (SPI)							
Bill Of Materials							
Item	Qty	Reference	Value	Description	Manufacturer	Part Number	Footprint
1	1	U1	ATWILC3000-MR110CA	WiFi/BT/BLE Combo Module	Atmel	ATWILC3000-MR110CA	Custom
2	1	U2	ASH7KW-32.768KHZ-L-T	Oscillator, 32.768KHz, +0/-175ppm,1.2V-5.5V, -40 - +85C, 3.2x1.5mm	Abracon	ASH7KW-32.768KHZ-L-T	OSCCC320X150X100-4N
3	1	R1	1M	RESISTOR,Thick Film,1 Mohm,0201	Panasonic	ERJ-1GEJ105C	RS0201
4	13	R2-R14	0	RESISTOR,Thick Film,0 ohm,0201	Panasonic	ERJ-1GN0R00C	RS0201

10.3 SDIO Application Bill of Material

WILC3000-MR110CA Module Application (SDIO)							
Bill Of Materials							
Item	Qty	Reference	Value	Description	Manufacturer	Part Number	Footprint
1	1	U1	ATWILC3000-MR110CA	WiFi/BT/BLE Combo Module	Atmel	ATWILC3000-MR110CA	Custom
2	1	U2	ASH7KW-32.768KHZ-L-T	Oscillator, 32.768KHz, +0/-175ppm,1.2V-5.5V, -40 - +85C, 3.2x1.5mm	Abracon	ASH7KW-32.768KHZ-L-T	OSCCC320X150X100-4N
3	13	R2-R14	0	RESISTOR,Thick Film,0 ohm,0201	Panasonic	ERJ-1GN0R00C	RS0201

11 Reflow Profile Information

This section provides guidelines for reflow processes in getting the Atmel module soldered to the customer's design.

11.1 Storage Condition

11.1.1 Moisture Barrier Bag Before Opened

A moisture barrier bag must be stored in a temperature of less than 30°C with humidity under 85% RH.

The calculated shelf life for the dry-packed product shall be 12 months from the date the bag is sealed.

11.1.2 Moisture Barrier Bag Open

Humidity indicator cards must be blue, < 30%.

11.2 Stencil Design

The recommended stencil is laser-cut, stainless-steel type with thickness of 100µm to 130µm and approximately a 1:1 ratio of stencil opening to pad dimension. To improve paste release, a positive taper with bottom opening 25µm larger than the top can be utilized. Local manufacturing experience may find other combinations of stencil thickness and aperture size to get good results.

11.3 Baking Conditions

This module is rated at MSL level 3. After sealed bag is opened, no baking is required within 168 hours so long as the devices are held at <= 30 ºC/60% RH or stored at <10% RH.

The module will require baking before mounting if:

The sealed bag has been open for > 168 hours.
Humidity Indicator Card reads >10%.
SIPs need to be baked for 8 hours at 125 ºC.

11.4 Soldering and Reflow Condition

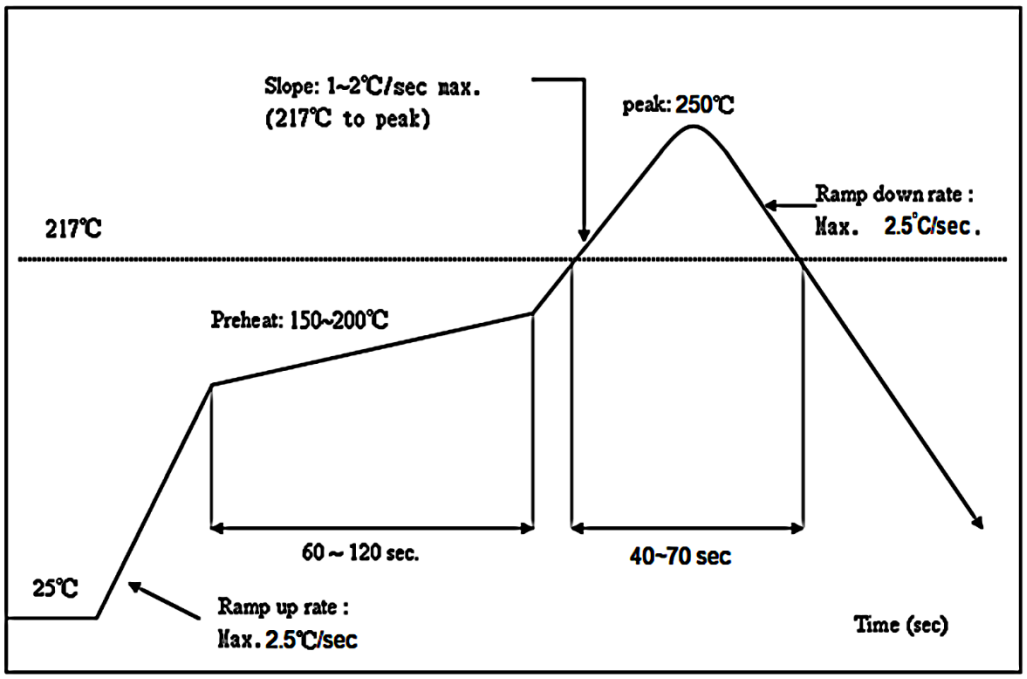
11.4.1 Reflow Oven

It is strongly recommended that a reflow oven equipped with more heating zones and Nitrogen atmosphere be used for lead-free assembly. Nitrogen atmosphere has shown to improve the wet-ability and reduce temperature gradient across the board. It can also enhance the appearance of the solder joints by reducing the effects of oxidation.

The following bullet items should also be observed in the reflow process:

- Some recommended pastes include NC-SMQ® 230 flux and Indalloy® 241 solder paste made up of 95.5 Sn/3.8 Ag/0.7 Cu or SENJU N705-GRN3360-K2-V Type 3, no clean paste.
- Allowable reflow soldering times: Three times based on the following reflow soldering profile (see Figure 11-1).
- Temperature profile: Reflow soldering shall be done according to the following temperature profile (see Figure 11-1).
- Peak temp: 250°C.

Figure 11-1. Solder Reflow Profile



12 Agency Certifications

This section provides information related to compliance with various agencies requiring certification for this module.

- FCC – ID reference document (2ADHKWILC3000)
- Wi-Fi Alliance®
- Bluetooth 4.0
  - QD ID Controller (pending)
  - QD ID Client (pending)
- ESTI
- CE
- IC
- TELEC

13 Revision History

Doc Rev.	Date	Comments
42569A	03/2016	Initial document release.

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