ATWILC1000-MR1100A DATASHEET

IEEE 802.11 b/g/n Link Controller SoC

Datasheet

Description

The Atmel® ATWILC1000-MR1100A is a low-power consumption 802.11 b/g/n IoT (Internet of Things) module which is specifically optimized for low power IoT applications. The highly integrated module features small form factor (14.48 x 13.46 x 3.35mm) while fully integrating Power Amplifier, LNA, Switch, and Power Management. With seamless roaming capabilities and advanced security, it could be interoperable with various vendors' 802.11b/g/n Access Points in wireless LAN. The module provides SPI and SDIO to interface to host controller.

Features

- IEEE® 802.11 b/g/n 20MHz (1x1) solution
- Single spatial stream in 2.4GHz ISM band
- Integrated PA and T/R Switch
- 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, 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, UART, and I^2C host interfaces
- 2-/3-wire Bluetooth® coexistence interface
- Operating temperature range of -40 to +85°C
- Power save modes:
  - <1µA Deep Power Down mode typical @3.3V I/O
  - 280µA Doze mode with chip settings preserved (used for beacon monitoring)
  - On-chip low power sleep oscillator
  - Fast host wake-up from Doze mode by a pin or host I/O transaction

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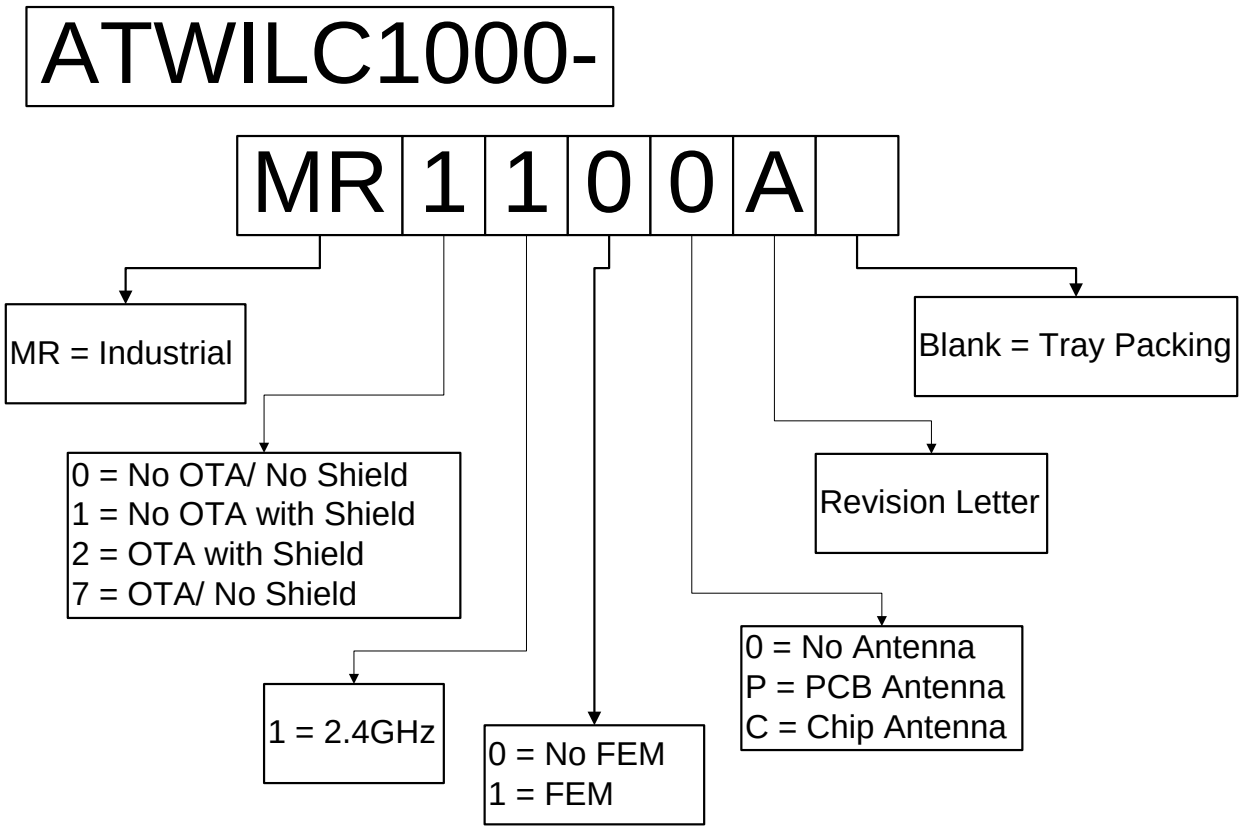
1 Ordering Information and Module Marking

Table 1-1. Ordering Details

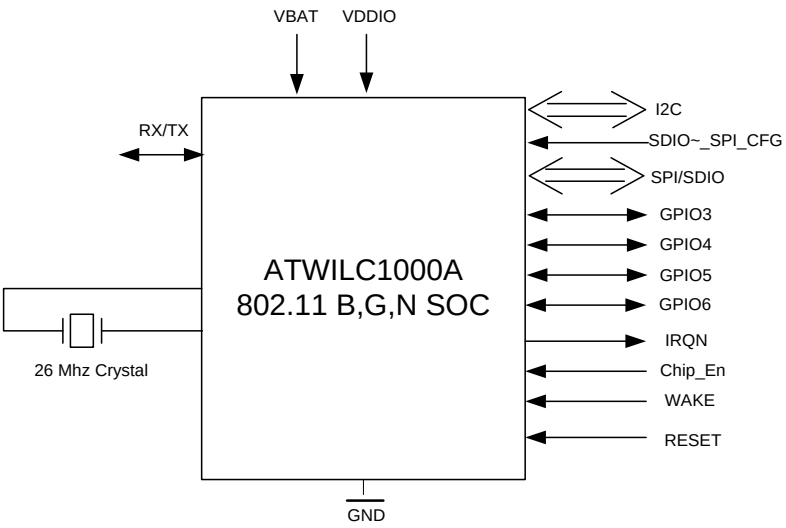
Ordering Code	Package	Description
ATWILC1000-MR1100A	14.48 x 13.46 x 3.35mm	Certified module with ATWILC1000A-Mu chip

Figure 1-2. Marking Information



2 Block Diagram

Figure 2-1. Block Diagram



3 Pin-out and Package Information

3.1 Pin Description

Figure 3-1. Pin Assignment

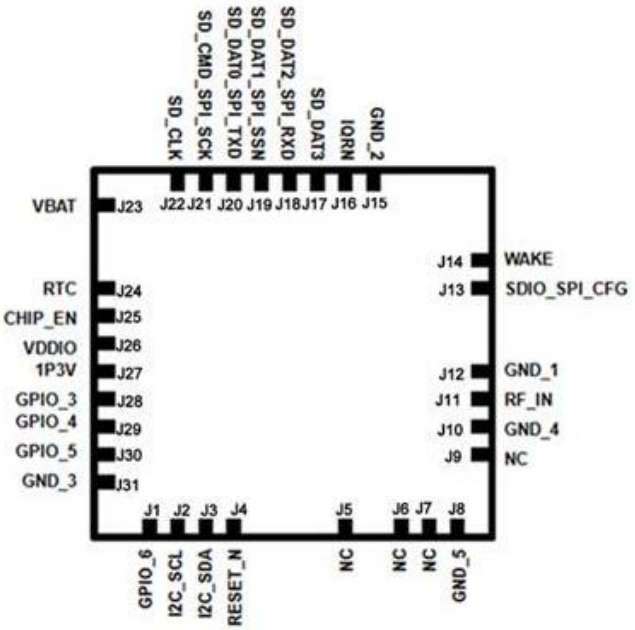


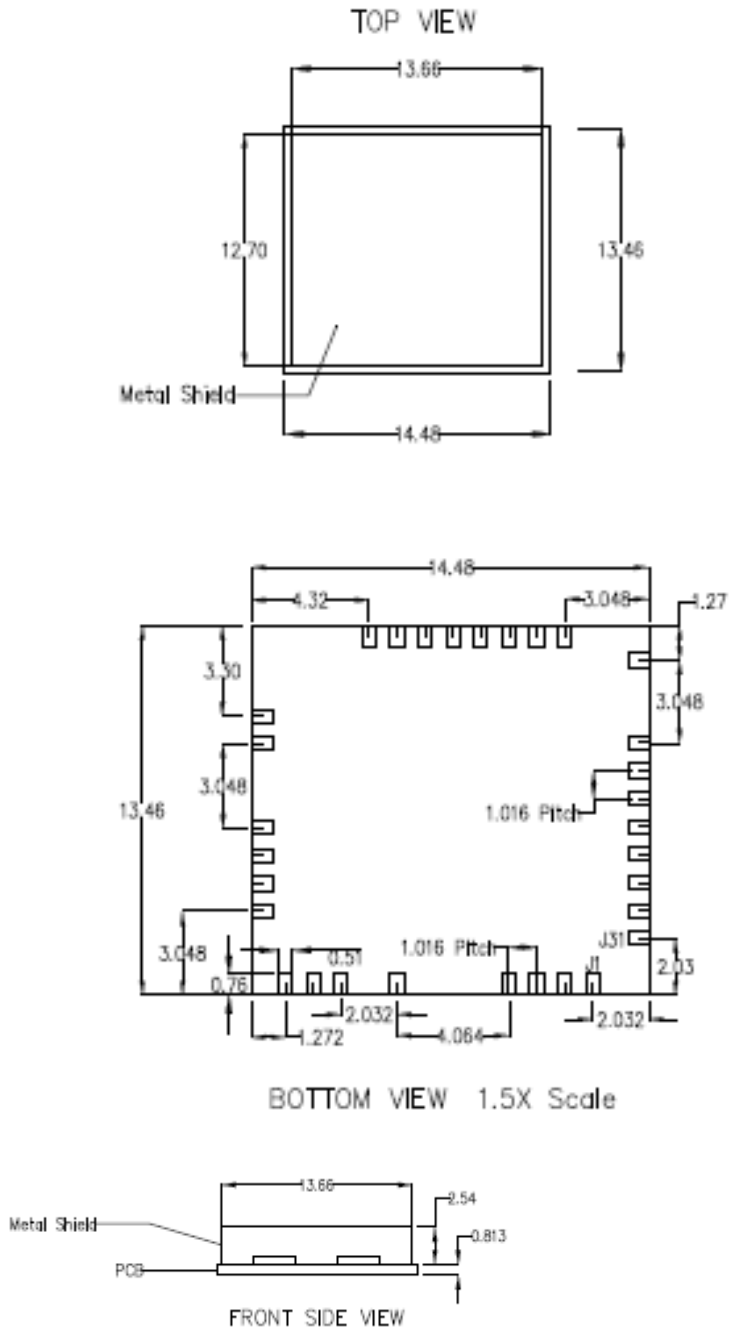
Table 3-1. Pin Description

NO	Name	Type	Description	Programmable Pull-up Resistor
1	GPIO_6	I/O	General purpose I/O.	Yes
2	I2C_SCL	I/O	I^2C Slave Clock. Can be configured as either master or slave. I^2C interface is only used for test purposes. This pin should be brought to a test point only. Do not add a pull-up resistor.	Yes
3	I2C_SDA	I/O	I^2C Slave Data. Can be configured as either master or slave. I^2C interface is only used for test purposes. This pin should be brought to a test point only. Do not add a pull-up resistor.	Yes
4	RESET_N	I	Active-Low Hard Reset. When asserted to a low level, the module will be placed in a reset state. When asserted to a high level, the module will run normally. Connect to a host output that defaults low at power up. If the output floats, add a 1MΩ pull-down resistor if necessary to ensure a low level at power up.	No
5	NC	-	No connect	
6	NC	-	No connect	
7	NC	-	No connect	
8	GND	-	GND	
9	NC	-	No connect	
10	GND	-	GND	
11	RF_IN	I	RF Input	
12	GND	-	GND	
13	SDIO_SPI_CFG	I	Tie to VDDIO through a 1MΩ resistor to enable the SPI interface. Connect to ground to enable SDIO interface.	No
14	WAKE	I	Host Wake control. Can be used to wake up the module from Doze mode. Connect to a host GPIO.	No
15	GND	-	GND	
16	IRQN	O	ATWINC1000 Device Interrupt.	No
17	SD_DAT3/UART_TXD	SDIO=I/O UART=O	SDIO Data Line 3 from ATWILC1000-MR1100A when module is configured for SDIO. UART Transmit Output from ATWILC1000 when module is configured for SPI.	Yes

NO	Name	Type	Description	Programmable Pull-up Resistor
18	SD_DAT2/SPI_RXD	SDIO=I/O SPI=I	SDIO Data Line 2 signal from ATWILC1000-MR1100A when module is configured for SDIO. SPI MOSI (Master Out Slave In) pin when module is configured for SPI.	Yes
19	SD_DAT1/SPI_SSN	SDIO=I/O SPI=I	SDIO Data Line 1 from ATWILC1000-MR1100A when module is configured for SDIO. Active Low SPI Slave Select from ATWILC1000 when module is configured for SPI.	Yes
20	SD_DAT0/SPI_TXD	SDIO=I/O SPI=O	SDIO Data Line 0 from ATWILC1000-MR1100A when module is configured for SDIO. SPI MISO (Master In Slave Out) pin from ATWILC1000 when module is configured for SPI.	Yes
21	SD_CMD/SPI_SCK	SDIO=I/O SPI=I	SDIO CMD Line from ATWILC1000-MR1100A when module is configured for SDIO. SPI Clock from ATWILC1000 when module is configured for SPI.	Yes
22	SD_CLK/UART_RXD	SDIO=I UART=I	SDIO Clock Line from ATWILC1000-MR1100A when module is configured for SDIO. UART Receive input to ATWILC1000 when module is configured for SPI.	Yes
23	VBATT	-	Battery power supply	
24	GPIO_1	I	General Purpose I/O.	Yes
25	CHIP_EN	I	Module enable. High level enables module, low level places module in Power Down mode. Connect to a host Output that defaults low at power up. If the output floats, add a 1MΩ pull-down resistor if necessary to ensure a low level at power up.	No
26	VDDIO	-	I/O Power Supply. Must match host I/O voltage.	
27	1P3V_TP	-	1.3V VDD Core Test Point	
28	GPIO_3	-	General purpose I/O.	Yes
29	GPIO_4	I/O	General purpose I/O.	Yes
30	GPIO_5	I/O	General purpose I/O.	Yes
31	GND	-	GND	

3.2 Module Outline Drawings

Figure 3-2. Module Drawings



4 Electrical Specifications

4.1 Absolute Ratings

Table 4-1. Voltages

Symbol	Description	Min.	Max.	Unit
VBAT	Input supply Voltage	-0.3	5.5	V
VDDIO	SPI, SDIO, GPIO Voltage	-0.3	3.6	V

4.2 Recommended Operating Ratings

Table 4-2. Pin Recommended Operating Ratings

Test Conditions: -40ºC - +85ºC				
Symbol	**Min.**	**Typ.**	**Max.**	**Unit**
VBAT	3.0	3.6	4.2	V
VDDIO	1.8	3.3	3.6	V

Note: The voltage of VDDIO is dependent on system I/O voltage.

5 CPU and Memory Subsystems

5.1 Processor

ATWILC1000A has a Cortus APS3 32-bit processor. This 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.

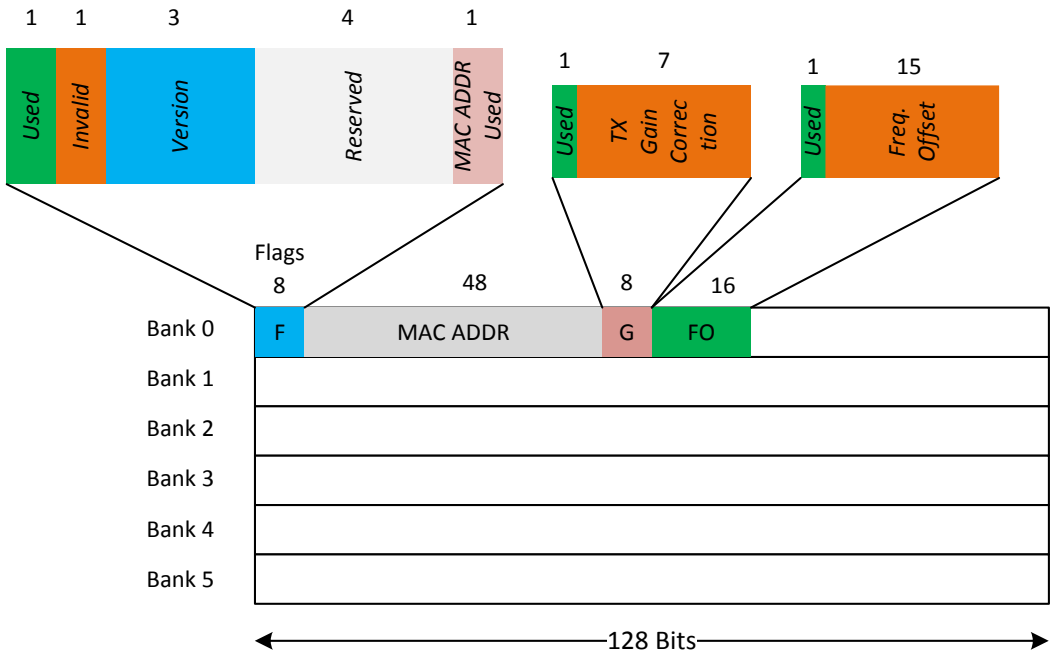
5.2 Memory Subsystem

The APS3 core uses a 128KB instruction/boot ROM along with a 128KB instruction RAM and a 64KB data RAM. In addition, the device uses a 128KB shared RAM, accessible by the processor and MAC, which allows the APS3 core to perform various data management tasks on the TX and RX data packets.

5.3 Non-Volatile Memory (eFuse)

ATWILC1000A has 768 bits of non-volatile eFuse memory that can be read by the CPU after device reset. This non-volatile one-time-programmable (OTP) memory can be used to store customer-specific parameters, such as MAC address; various calibration information, such as TX power, crystal frequency offset, etc.; and other software-specific configuration parameters. The eFuse is partitioned into six 128-bit banks. Each bank has the same bit map, which is shown in Figure 5-1. The purpose of the first 80 bits in each bank is fixed, and the remaining 48 bits are general-purpose software dependent bits, or reserved for future use. Since each bank can be programmed independently, this allows for several updates of the device parameters following the initial programming, e.g. updating MAC address. Refer to ATWILC1000A Programming Guide for the eFuse programming instructions.

Figure 5-1. eFuse Bit Map



6 WLAN Subsystem

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

6.1 MAC

6.1.1 Features

The ATWILC1000A IEEE802.11 MAC supports the following functions:

- IEEE 802.11b/g/n
- IEEE 802.11e WMM QoS EDCA/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)

6.1.2 Description

The ATWILC1000A 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. 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.

6.2 PHY

6.2.1 Features

The ATWILC1000A 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, 11Mbps
- Supports IEEE 802.11g OFDM modulation: 6, 9, 12,18, 24, 36, 48, 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

6.2.2 Description

The ATWILC1000A 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.

6.3 Radio

Table 6-1. Radio Performance under Typical Conditions: VBAT=3.6V; VDDIO=3.3V; Temp.: 25ºC

Feature	Description
Module Part Number	ATWILC1000-MR1100A
WLAN Standard	IEEE 802.11b/g/n, Wi-Fi compliant
Host Interface	SPI, SDIO
Dimension	L x W x H: 14.48 x 13.46 x 3.35 (typical) mm
Frequency Range	2.412GHz ~ 2.4835GHz (2.4GHz ISM Band)
Number of Channels	11 for North America, 13 for Europe, and 14 for Japan
Modulation	802.11b: DQPSK, DBPSK, CCK 802.11g/n: OFDM/64-QAM,16-QAM, QPSK, BPSK
Output Power1	802.11b/11Mbps: 19dBm ±1.5dB @ EVM -9dB
	802.11g/54Mbps: 14.5dBm ±2dB @ EVM -25dB

Feature	Description
	802.11n/65Mbps: 13dBm ±2dB @ EVM -28dB
Receive Sensitivity (11n,20MHz) @10% PER	- MCS=0 PER @ -90 ±1dBm, typical
	- MCS=1 PER @ -86 ±1dBm, typical
	- MCS=2 PER @ -84 ±1dBm, typical
	- MCS=3 PER @ -81.5 ±1dBm, typical
	- MCS=4 PER @ -78 ±1dBm, typical
	- MCS=5 PER @ -74 ±1dBm, typical
	- MCS=6 PER @ -72.5 ±1dBm, typical
	- MCS=7 PER @ -71.5 ±1dBm, typical
Receive Sensitivity (11g) @10% PER	- 6Mbps PER @ -91 ±1dBm, typical
	- 9Mbps PER @ -89 ±1dBm, typical
	- 12Mbps PER @ -88.5 ±1dBm, typical
	- 18Mbps PER @ -86.5 ±1dBm, typical
	- 24Mbps PER @ -84 ±1dBm, typical
	- 36Mbps PER @ -78.5 ±1dBm, typical
	- 48Mbps PER @ -77 ±1dBm, typical
	- 54Mbps PER @ -75 ±1dBm, typical
Receive Sensitivity (11b) @8% PER	- 1Mbps PER @ -98 ±1dBm, typical
	- 2Mbps PER @ -95 ±1dBm, typical
	- 5.5Mbps PER @ -93 ±1dBm, typical
	- 11Mbps PER @ -89 ±1dBm, typical
Data Rate	802.11b: 1, 2, 5.5, 11Mbps
	802.11g: 6, 9, 12, 18, 24, 36, 48, 54Mbps
Data Rate	802.11n: 6.5, 13, 19.5, 26, 39, 52, 58.5, 65Mbps
Data Rate (20MHz ,short GI,400ns)	802.11n: 7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65,72.2Mbps
Maximum Input Level	802.11b: 0dBm typical
	802.11g/n: -5dBm typical
Operating temperature[2]	-40°C to 85°C
Storage temperature	-40°C to 85°C
Humidity	Operating Humidity 10% to 95% Non-Condensing Storage Humidity 5% to 95% Non-Condensing

Notes: 1. Measured at 802.11 spec compliant EVM/Spectral Mask.
2. RF performance guaranteed for temperature range -30 to 85ºC. 1dB derating in performance at -40ºC.

7 External Interfaces

7.1 SPI Interface

7.1.1 Overview

When the module is configured for SPI mode by connecting the SDIO~_SPI_CFG pin to VDDIO, the ATWILC1000-MR1100 has a Serial Peripheral Interface (SPI) that operates as a SPI slave. The SPI interface can be used for control and for serial I/O of 802.11 data. The SPI pins are mapped as shown in Table 7-1. The SPI is a full-duplex slave-synchronous serial interface that is available immediately following reset when pin 10 (SPI_CFG) is tied to VDDIO.

Table 7-1. SPI Interface Pin Mapping

Pin #	SPI Function
10	CFG: Must be tied to VDDIO
16	SSN: Active Low Slave Select
15	MOSI: Serial Data Receive
18	SCK: Serial Clock
17	MISO: Serial Data Transmit

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 MISO line.

The SPI 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.

The SPI SSN, MOSI, MISO and SCK pins of the ATWILC1000-MR1100 have internal programmable pull-up resistors (see Section 8.1). These resistors should be programmed to be disabled. Otherwise, if any of the SPI pins are driven to a low level while the ATWILC1000-MR1100 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.

7.1.2 SPI Timing

The SPI timing is provided in Figure 7-1 and Table 7-2.

Figure 7-1. SPI Timing Diagram (SPI Mode CPOL=0, CPHA=0)

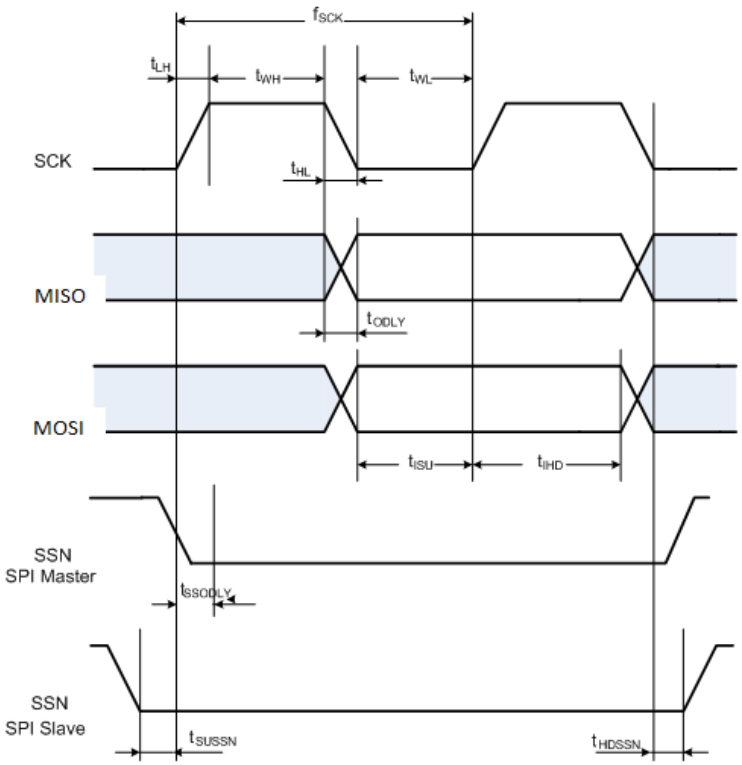


Table 7-2. SPI Slave Timing Parameters

Parameter	Symbol	Min.	Max.	Unit	Remarks
Clock Input Frequency	f_{SCK}		48	MHz	
Clock Low Pulse Width	t_{WL}	15		ns	
Clock High Pulse Width	t_{WH}	15			
Clock Rise Time	t_{LH}		10		
Clock Fall Time	t_{HL}		10		
Input Setup Time	t_{ISU}	5			
Input Hold Time	t_{IHD}	5			
Output Delay	t_{ODLY}	0	20		
Slave Select Setup Time	t_{SUSSN}	5			
Slave Select Hold Time	t_{HDSSN}	5			

7.2 UART Interface

When the module is configured for SPI mode by connecting the SDIO~_SPI_CFG pin to VDDIO, the ATWILC1000-MR1100 has a Universal Asynchronous Receiver/Transmitter (UART) interface available on pins J14 and J19. It can be used for control or data transfer if the baud rate is sufficient for a given application. The UART is compatible with the RS-232 standard, where NMC1000 operates as Data Terminal Equipment (DTE). It has a two-pin RXD/TXD interface.

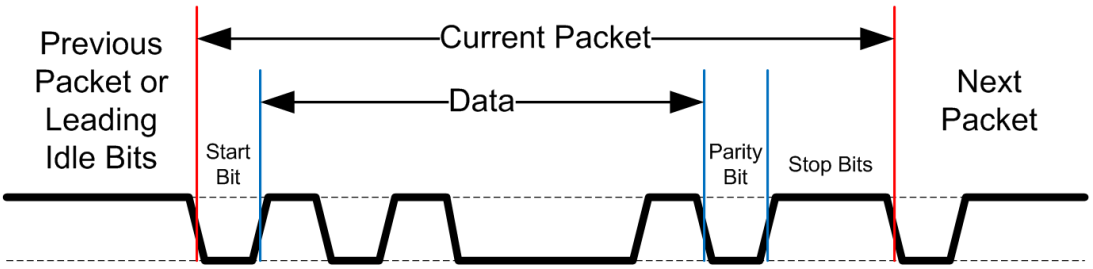
The UART features programmable baud rate generation with fractional clock division, which allows transmission and reception at a wide variety of standard and non-standard baud rates. The UART input clock is selectable between 10MHz, 5MHz, 2.5MHz, and 1.25MHz. The clock divider value is programmable as 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 4x8 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 7-2. This example shows 7-bit data (0x45), odd parity, and two stop bits.

See the ATWILC1000-MR1100 Programming Guide for information on configuring the UART.

Figure 7-2. Example of UART RX or TX Packet



7.3 SDIO Interface

7.3.1 Overview

When the module is configured for SDIO mode by connecting the SDIO~_SPI_CFG pin to Ground, the ATWILC1000-MR1100 has a SDIO interface. The SDIO interface can be used for control and for serial I/O of 802.11 data. The SDIO pins are mapped as shown in 0. The SDIO interface is available immediately following reset when pin 10 (SPI_CFG) is tied to ground.

The ATWILC1000-MR1100 SDIO 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 ATWILC1000-MR1100 for data DMA.

Table 7-3. ATWILC1000 SDIO Interface Pin Mapping

Pin #	SDIO Function
10	CFG: Must be tied to ground
14	DAT3: Data 3
15	DAT2: Data 2
16	DAT1: Data 1
17	DAT0: Data 0
18	CMD: Command
19	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, four data and three power lines) designed to operate at maximum operating frequency of 50MHz.

7.3.2 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

7.3.3 SDIO Timing

Figure 7-3. SDIO Timing Diagram

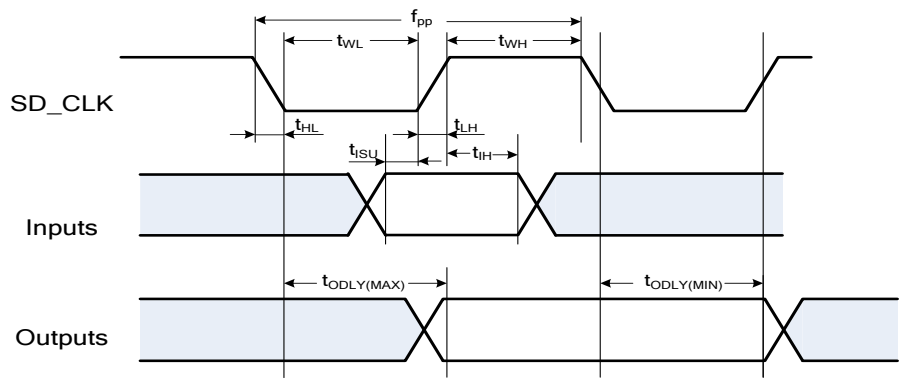


Table 7-4. SDIO Timing Parameters

Parameter	Symbol	Min.	Max.	Unit
Clock Input Frequency	f_{PP}	0	50	MHz
Clock Low Pulse Width	t_{WL}	10		ns
Clock High Pulse Width	t_{WH}	10		
Clock Rise Time	t_{LH}		10	
Clock Fall Time	t_{HL}		10	
Input Setup Time	t_{ISU}	5		
Input Hold Time	t_{IH}	5		
Output Delay	t_{ODLY}	0	14	

7.4 I²C Interface

7.4.1 Overview

ATWILC1000-MR1100 provides an I²C bus slave that allows the host processor to read or write any register in the chip. ATWILC1000-MR1100 supports I²C bus Version 2.1 – 2000.

The I²C interface, used primarily for debug, is a two-wire serial interface consisting of a serial data line (SDA, Pin 17) and a serial clock (SCL, Pin 18). It responds to the seven bit address value 0x60. The ATWILC1000-MR1100 I²C interface can operate in standard mode (with data rates up to 100Kb/s) and fast mode (with data rates up to 400Kb/s).

The I²C 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”.

7.4.2 I²C Timing

The I²C timing is provided in Figure 7-4 and Table 7-5.

Figure 7-4. I²C Timing Diagram

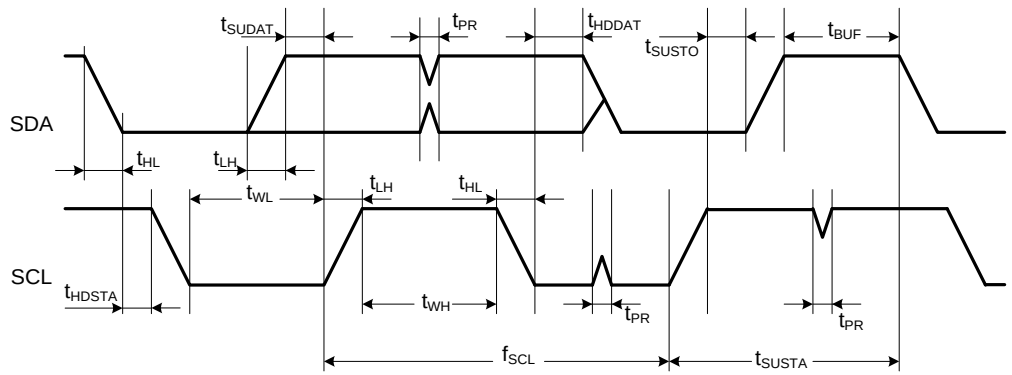


Table 7-5. I²C Timing Parameters

Parameter	Symbol	Min.	Max.	Unit	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 40			Slave and Master Default 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	

7.5 Wi-Fi/Bluetooth Coexistence

ATWILC1000A supports 2- and 3-wire Wi-Fi/Bluetooth Coexistence signaling conforming to the IEEE 802.15.2-2003 standard, Part 15.2. The type of coexistence interface used (2- or 3-wire) is chosen to be compatible with the specific Bluetooth device used in a given application. Table 7-6 shows a usage example of the 2-wire interface using the GPIO3 and GPIO4 pins; 3-wire interface using the GPIO3, GPIO4, and GPIO5 pins; for more specific instructions on configuring Coexistence refer to ATWILC1000A Programming Guide.

Table 7-6. Coexistence Pin Assignment Example

Pin Name	Function	Target	Pin #	2-wire	3-wire
GPIO3	BT_Req	BT is requesting to access the medium to transmit or receive. Goes high on TX or RX slot.	28	Used	Used
GPIO4	BT_Pri	Priority of the BT packets in the requested slot. High to indicate high priority and low for normal.	29	Not Used	Used
GPIO5	WL_Act	Device response to the BT request. High - BT_req is denied and BT slot blocked.	30	Used	Used
GPIO6	Ant_SW	Direct control on Antenna (coex bypass).	31	Not Used	Optional

8 Power Consumption

8.1 Description of Device States

ATWILC1000A has several Devices States:

- ON_Transmit – Device is actively transmitting an 802.11 signal
- ON_Receive – Device is actively receiving an 802.11 signal
- ON_Doze – Device is on but is neither transmitting nor receiving
- Power_Down – Device core supply off (Leakage)

8.2 Controlling the Device States

Table 8-1 shows how to switch between the device states using the following:

- CHIP_EN – Device pin (pin #23) used to enable DC/DC Converter
- VDDIO – I/O supply voltage from external supply

Table 8-1. Device States

Device State	CHIP_EN	VDDIO	Power Consumption[1]	
			I_{VBATT}	I_{VDDIO}
ON_Transmit	VDDIO	On	230mA @ 18dBm	29mA
ON_Receive	VDDIO	On	68mA	29mA
ON_Doze	VDDIO	On	280µA	<10µA
Power_Down	GND	On	<0.5µA	<0.2µA

Note: 1. Conditions: VBAT @ 3.6V, I/O @ 1.8V.

8.3 Restrictions for Power States

When no power supplied to the device, i.e., the DC/DC Converter output and VDDIO are both off (at ground potential). In this case, a voltage cannot be applied to the device pins because each pin contains an ESD diode from the pin to supply. This diode will turn on when 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 SLEEP or 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.

8.4 Power-Up/Down Sequence

The power-up/down sequence for ATWILC1000A is shown in Figure 8-1. The timing parameters are provided in Table 8-2.

Figure 8-1. Power Up/Down Sequence

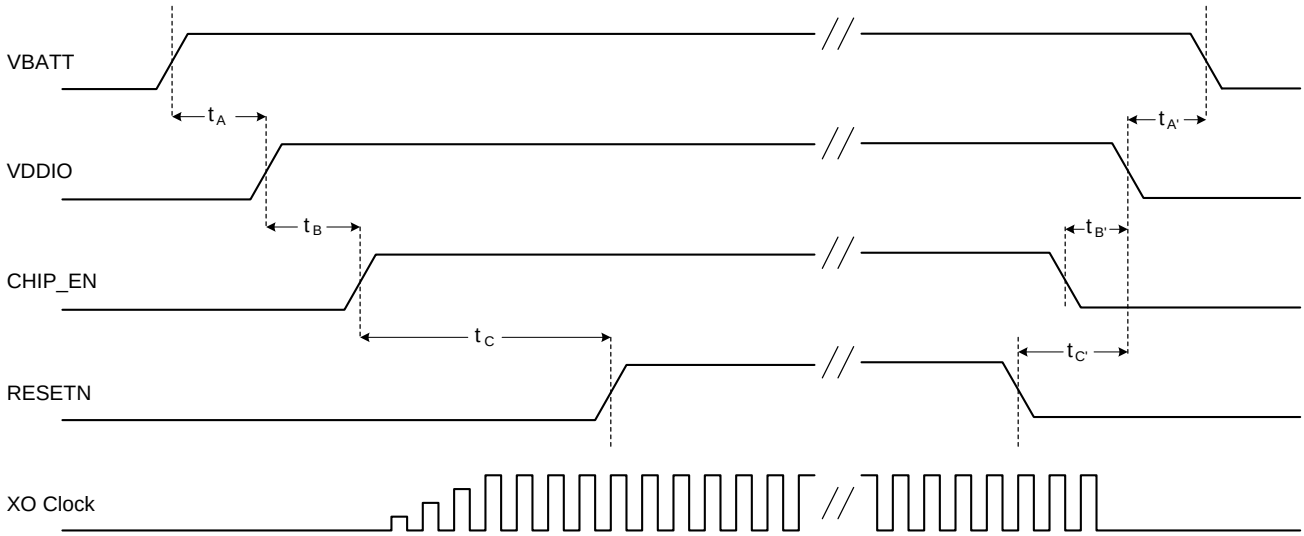


Table 8-2. Power-Up/Down Sequence Timing

Parameter	Min.	Max.	Unit	Description	Notes
t_A	0		ms	VBATT rise to VDDIO rise	VBATT and VDDIO can rise simultaneously or can be tied together. VDDIO must not rise before VBATT.
t_B	0			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			CHIP_EN rise to RESETN 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			VDDIO fall to VBATT fall	VBATT and VDDIO can fall simultaneously or can be tied together. VBATT must not fall before VDDIO.
$t_{B'}$	0			CHIP_EN fall to VDDIO fall	VDDIO must not fall before CHIP_EN. CHIP_EN and RESETN can fall simultaneously.
$t_{C'}$	0			RESETN fall to VDDIO fall	VDDIO must not fall before RESETN. RESETN and CHIP_EN can fall simultaneously.

8.5 Digital I/O Pin Behavior during Power-up Sequences

Table 8-3 represents digital IO Pin states corresponding to device power modes.

Table 8-3. Digital I/O Pin Behavior in Different Device States

Device State	VDDIO	CHIP_EN	RESETN	Output Driver	Input Driver	Pull Up/Down Resistor (96Ω)
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)	Disabled	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

9 Notes on Interfacing to the ATWILC1000-MR1100

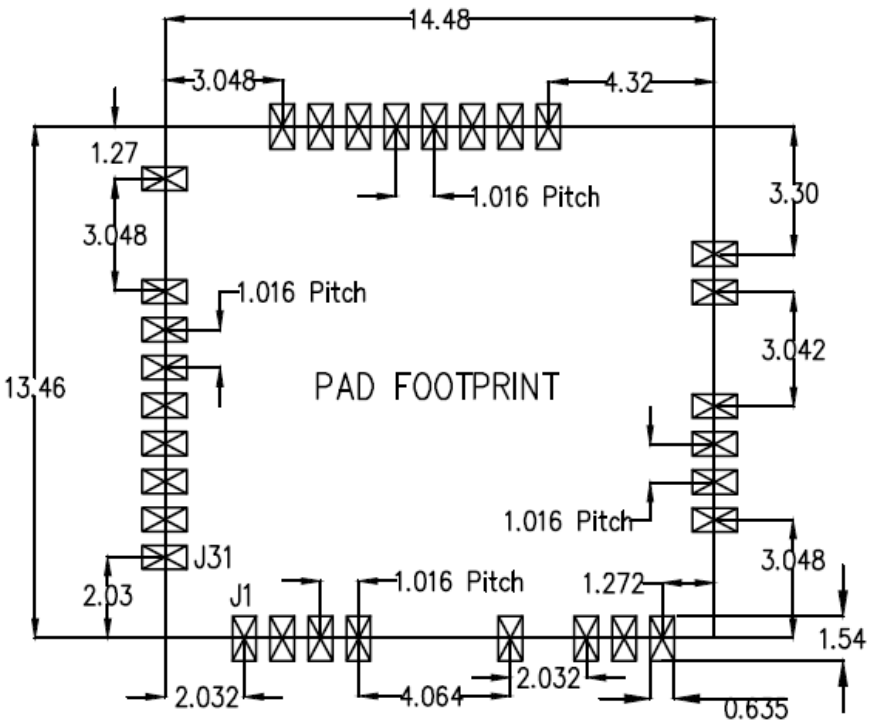
9.1 Programmable Pull-up Resistors

The ATWILC1000-MR1100 provides programmable pull-up resistors on various pins. 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 module pin on the ATWILC1000-MR1100 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 ATWILC1000-MR1100 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 through each pull-up resistor that is driven low would be approximately 3.3V/100K = 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.

See the ATWILC1000-MR1100 Programming Guide for information on enabling/disabling the programmable pull up resistors.

10 Recommended Footprint

Figure 10-1. Footprint Drawing (unit = mm)



11 RF Performance Placement Guidelines

It is critical to follow the recommendations listed below to achieve the best RF performance:

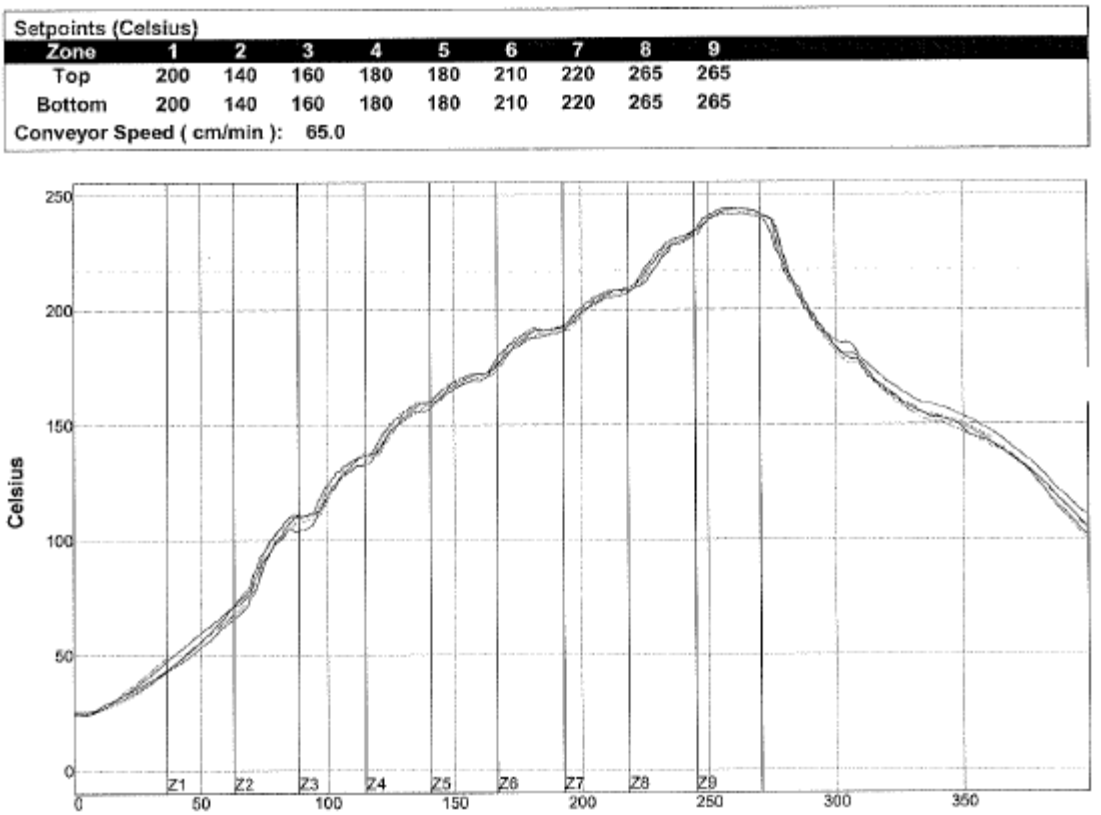
- Module must be placed on main board - printed antenna area must overlap with the carrier board. The portion of the module containing the antenna should not stick out over the edge of the main board. The antenna is designed to work properly when it is sitting directly on top of a 1.5mm thick printed circuit board.
- If the module is placed at the edge of the main board, a minimum 22mm by 5mm area directly under the antenna must be clear of all metal on all layers of the board. “In-land” placement is acceptable; however deepness of keep-out area must grove to: module edge to main board edge plus 5mm. DO NOT PLACE MODULE IN THE MIDDLE OF THE MAIN BOARD OR FAR AWAY FROM THE MAIN BOARD EDGE.
- Keep away from antenna, as far as possible, large metal objects to avoid electromagnetic field blocking
- Do not enclose the antenna within a metal shield
- Keep any components which may radiate noise or signals within the 2.4GHz – 2.5GHz frequency band far away from the antenna or better yet, shield those components. Any noise radiated from the main board in this frequency band will degrade the sensitivity of the module.
- Contact Atmel for assistance if any other placement is required.

12 Recommended Reflow Profile

Refer to IPC/JEDEC standard. Peak temperature: <250°C.

Number of Times: Two times maximum.

Figure 12-1. Typical Reflow Profile



PWI= 64%	Max Rising Slope		Max Falling Slope		Soak Time 150-200C		Reflow Time /217C		Peak Temp	
<TC2>	1.17	-41%	-3.92	-30%	74.60	-51%	54.87	-56%	242.73	-23%
<TC3>	1.19	-40%	-2.68	13%	75.03	-50%	54.99	-56%	241.73	-31%
<TC4>	1.18	-41%	-4.09	-35%	74.83	-51%	54.90	-56%	244.28	-12%
<TC5>	1.19	-40%	-3.63	-20%	73.47	-55%	53.11	-64%	244.22	-13%
<TC6>	1.17	-41%	-4.04	-34%	73.63	-55%	55.09	-55%	243.92	-15%
Delta	0.02		1.41		1.56		1.98		2.55	

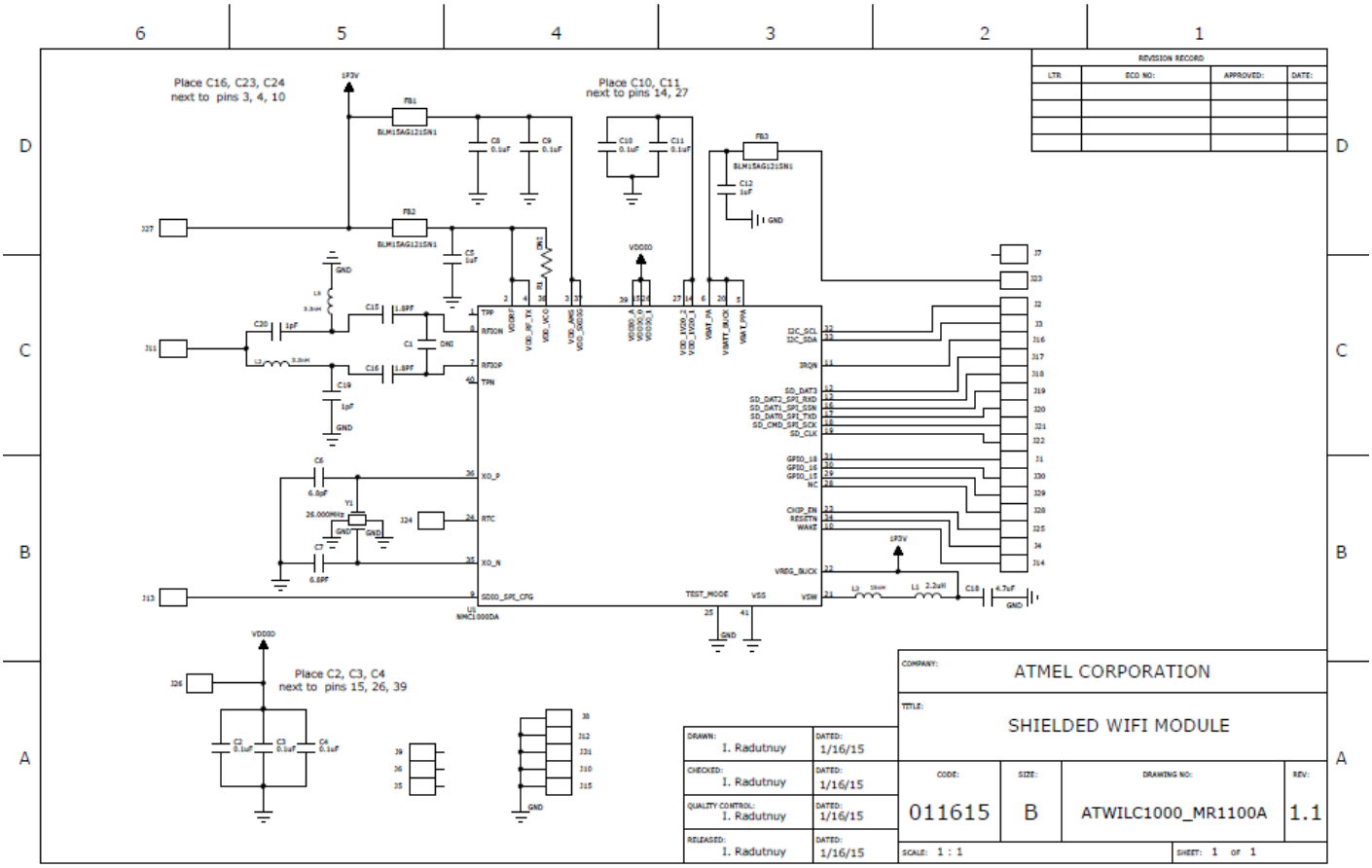
Process Window:

Solder Paste: RoHS

Statistic Name	Low Limit	High Limit	Units
Max Rising Slope (Target=2.0) (Calculate Slope over 90 Seconds)	0	3	Degrees/Second
Max Falling Slope (Calculate Slope over 6 Seconds)	-6	-0.1	Degrees/Second
Soak Time 150-200C	60	120	Seconds
Time Above Reflow - 217C	45	90	Seconds
Peak Temperature	232	260	Degrees Celsius

13 Module Schematics

Figure 13-1. ATWILC1000-MR1100A Schematic



14 Module Bill of Materials (BOM)

Table 14-1. ATWILC1000-MR1100 BOM

WiFi shielded module with internal PMU and discrete balun, Revised: Friday, January 9, 2015

WILC1000-MR1100A Revision: 1.1 Rev.1.1 reflects C15, C16 values change to 1.8pF

Item	Qty	Reference	Value	Description	Manufacturer	Part Number	Footprint
1	2	C5,C12	1.0uF	CAP,CER,1.0uF,20%,X5R,0402,6.3V	Panasonic	ECJ-0EB0J105M	CS0402
2	7	C2,C3,C4,C8,C9,C10, C11	0.1uF	CAP,CER,0.1uF,10%,X5R,0402,10V	AVX	0402ZD104KAT2A	CS0402
3	1	C18	4.7uF	CAP CER 4.7UF 4V 20% X5R 0402	Murata	GRM155R60G475ME15D	CS0402
4	2	C19,C20	1pF	CAP CER 1PF 50V NP0 0201	Murata	GRM0335C1H1R0CA01D	CS0201
5	2	C6,C7	6.8PF	CAP,CER,6.8pF,5%,NPO,0402,50V	Murata	GRM1555C1H6R8JZ02	CS0402
6	2	C15,C16	1.8PF	CAP CER 1.8PF 50V NP0 0201	Murata	GRM0335C1H1R8CA01D	CS0201
7		C1	DNI				
8	3	FB1,FB2,FB3	BLM15AG121SN1	FERRITE,120 OHM @100MHz,0402	Murata	BLM15AG121SN1	FBS0402
9	1	L1	2.2uH	POWER INDUCTOR,2.2uH,20%,1250mA,0.22ohms,0603	Murata	LQM18PN2R2MFRL	LPS0603
10	2	L2,L5	3.3nH	INDUCTOR 3.3+/-0.2NH 750MA 0201	Murata	LQP03TN3N3C02D	LS0201
11		R1	DNI	RESISTOR,Thick Film,0 ohm,0402	Panasonic	ERJ-2GE0R00X	R0402
12	1	L3	15nH	INDUCTOR 15NH 300MA 0402	Murata	LQG15HS15NJ02D	LS0402
13	1	U1	ATWILC1000A-MU-T	IC, WiFi, 40QFN	Atmel	ATWILC1000A-MU-T	40QFN
14	1	Y1	26.000MHz	CRYSTAL,26MHz,CL=8pF,20ppm,-30-85C,ESR=50,2.5x2.0mm	River	FCX-05	FCX-05

15 Application Reference Design

The ATWILC1000-MR1100A reference design schematic is shown in Figure 15-1.

Figure 15-1. WILC1000-MR1100A SDIO

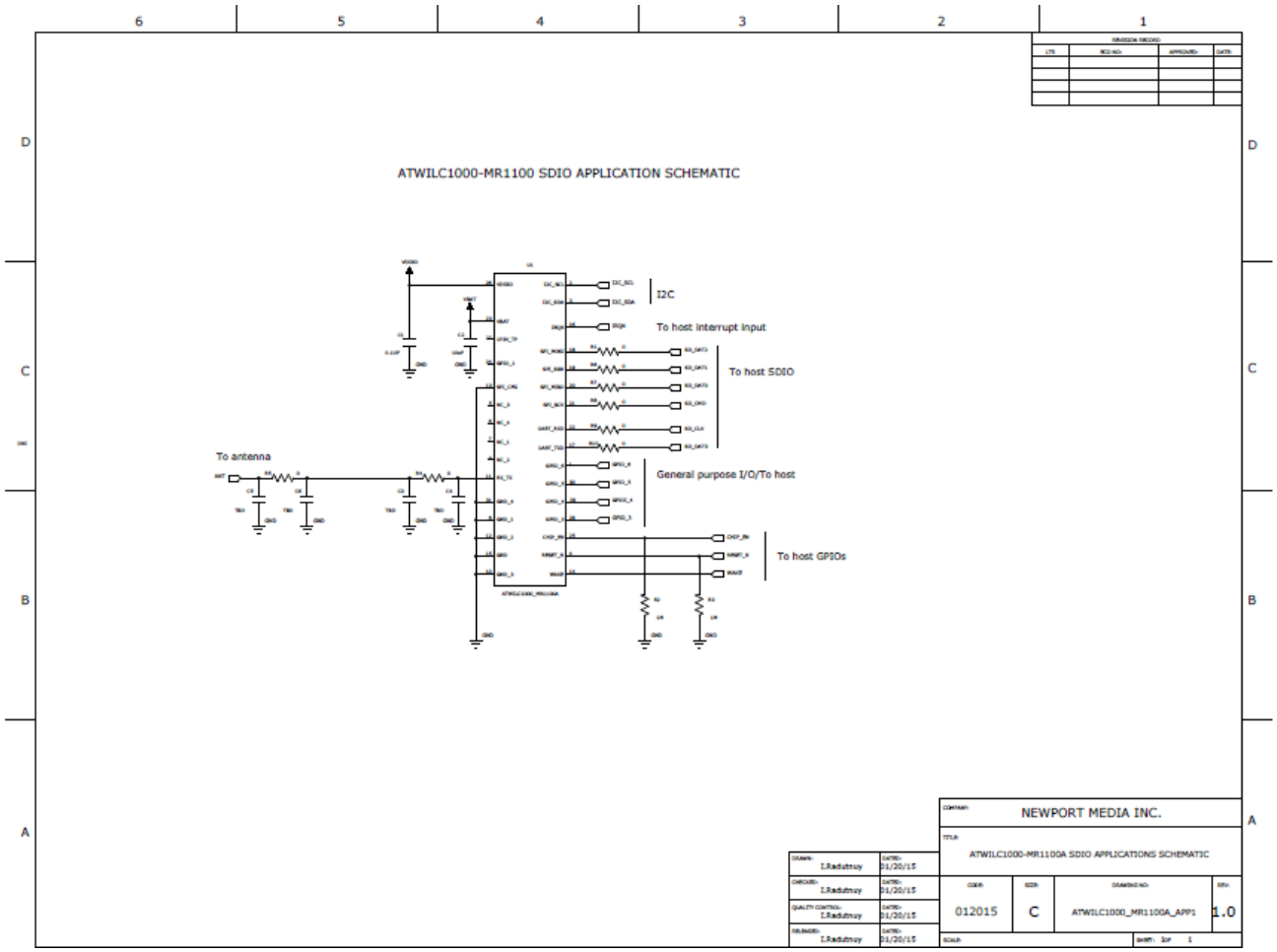
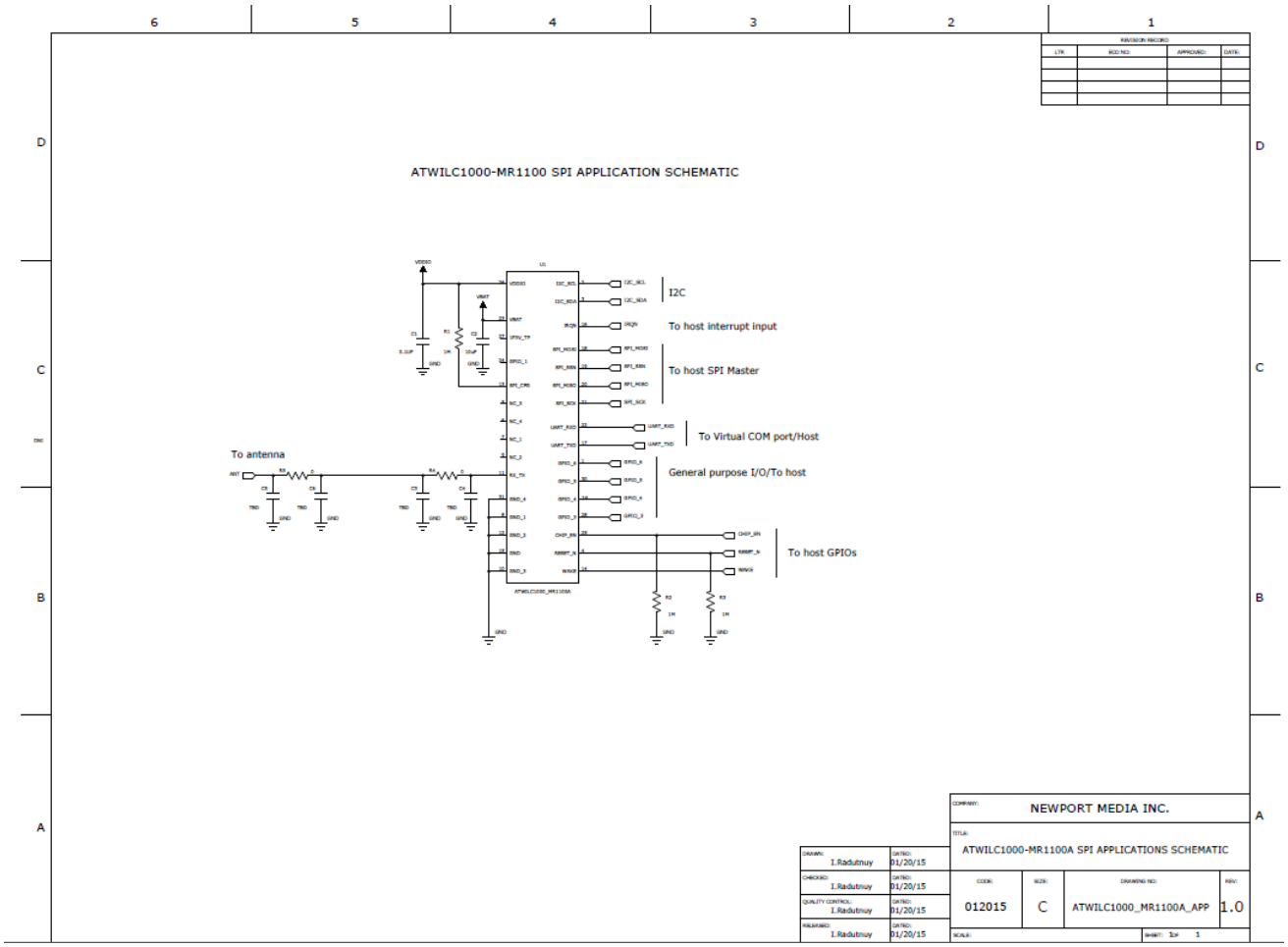


Figure 15-2. WILC1000-MR1100A SPI



16 Reference Documentation and Support

16.1 Reference Documents

Atmel offers a set of collateral documentation to ease integration and device ramp.

The following list of documents available on Atmel web or integrated into development tools.

To enable fast development contact your local FAE or visit the http://www.atmel.com/.

Title	Content
Datasheet	This Document
Design Files Package	User Guide, Schematic, PCB layout, Gerber, BOM, and System notes on: RF/Radio Full Test Report, radiation pattern, design guidelines, temperature performance, ESD.
Platform Getting Started Guide	How to use package: Out of the Box starting guide, HW limitations and notes, SW Quick start guidelines.
HW Design Guide	Best practices and recommendations to design a board with the product. Including: Antenna Design for Wi-Fi (layout recommendations, types of antennas, impedance matching, using a power amplifier etc.), SPI/UART protocol between Wi-Fi SoC and the Host MCU.
SW Design Guide	Integration guide with clear description of: High level Arch, overview on how to write a networking application, list all API, parameters and structures. Features of the device, SPI/handshake protocol between device and host MCU, with flow/sequence/state diagram, timing.
SW Programmer Guide	Explain in details the flow chart and how to use each API to implement all generic use cases (e.g. start AP, start STA, provisioning, UDP, TCP, http, TLS, p2p, errors management, connection/transfer recovery mechanism/state diagram) - usage and sample App note

For a complete listing of development-support tools and documentation, visit http://www.atmel.com/, or contact the nearest Atmel field representative.

17 Revision History

Doc Rev.	Date	Comments
42432A	03/2015	Initial document release.

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