

# **RS-WC-301**

## **Datasheet**

### **Version 2.02**

**June 2013**

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The RS-WC-301 module is a complete IEEE 802.11 a/b/g/n wireless device server that provides a wireless interface to any equipment with a UART, SPI or USB interface. The module integrates a MAC, baseband processor, RF transceiver with power amplifier; and all WLAN protocol and networking stack functionality in embedded firmware to make a fully self-contained 802.11n WLAN solution for a variety of applications. The module integrates an antenna and a U.FL connector for external antenna with an option to select either one of them.

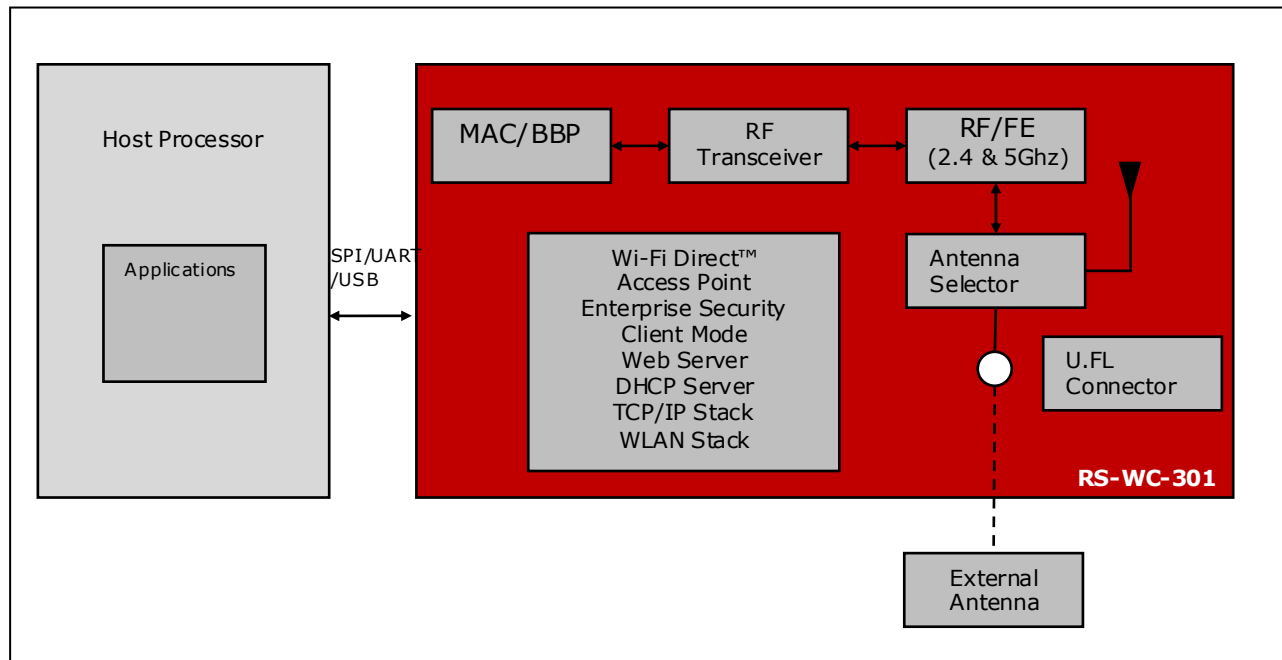
**Applications:**

- Seamless Wi-Fi connectivity for Application Processors
- Industrial M2M communications
- Enterprise applications – Wireless Printers, Point of Sale Terminals
- Security Cameras and Surveillance Equipment
- Medical applications – Wireless Medical Instrumentation, Secure Patient Data Logging and Transfer
- Consumer applications– Wi-Fi connectivity to smart-phones and Tablet PCs using Wi-Fi Direct™ in devices such as Refrigerators, Washing Machines, Audio/Video Equipment, Digital Picture Frames etc.

**Device Features:**

- 802.11 a/b/g and single-stream 802.11n module
- Wi-Fi Direct™
- Access Point with WPA2-PSK Security
- Client Mode with WPA/WPA2-PSK and Enterprise Security
  - WPA/WPA2-Enterprise (EAP-TLS, EAP-FAST, EAP-TTLS, PEAP-MS-CHAP-V2)
- Integrated TCP, UDP, DNS client, ICMP, IGMP, DHCP Server
- HTTP Server and Client
- DNS Client
- 802.11d and 802.11h
- WPS (Wi-Fi Protected Setup) for ease of provisioning
- UART, SPI, USB interfaces supported
- Upgrade firmware wirelessly
- Integrated antenna, frequency reference and low-frequency clock
- Ultra low-power operation with power save modes
- Single supply – 3.1 to 3.6V operation
- Dimensions – 40mm X 22mm X 3.5mm

## RS-WC-301 System Architecture



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## **1 Detailed Feature List**

### **1.1 Host Interfaces**

- UART
  - AT Command Interface supported for configuration and module operation
  - Baud-rate of 115200 bps supported currently. Support for higher baud rates are planned in future firmware releases
- SPI
  - Standard 4-wire SPI
  - Operation up to a maximum clock speed of 12.5MHz<sup>1</sup>
- USB 2.0
  - The USB interface in the module corresponds to the CDC-ACM class and presents itself as a USB Device to the Host USB.

### **1.2 WLAN**

#### MAC

- IEEE 802.11 a/b/g/n standard
- Dynamic selection of data rate depending on the channel conditions
- Hardware accelerated implementation of AES
- Wi-Fi Direct, Access Point and Client modes

#### Baseband Processing

- Supports DSSS (1, 2 Mbps) and CCK (5.5, 11 Mbps) modes
- Supports all OFDM data rates (6 Mbps to 54 Mbps in 802.11g and MCS0 to MCS7 in 802.11n mode)
- Supports long, short, and HT preamble modes
- High-performance multipath compensation in OFDM, DSSS, and CCK modes

#### RF

- 2.4/5 GHz transceiver and Power Amplifier with direct conversion architecture
- Integrated frequency reference and antenna

### **1.3 Security**

- WPA/WPA2-Enterprise (supported when the module is configured in Client mode)
  - EAP-TLS

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<sup>1</sup> This frequency depends on the external delays also.

- 
- EAP-TTLS
  - EAP-FAST
  - PEAP-MS-CHAP-V2
  - WPA/WPA2-PSK
  - WPS-Push Button Support

## **1.4 Wi-Fi Direct™**

The module supports Wi-Fi Direct™. Wi-Fi Direct enables two Wi-Fi devices to communicate directly, without an access point in between. RS-WC-301 can act as a Wi-Fi Direct Group Owner, so that Wi-Fi Direct Peer-to-Peer nodes can join and exchange data. The module can also connect as a Peer-to-Peer client to another Wi-Fi Direct Group Owner (GO) node. Legacy Wi-Fi (non Wi-Fi Direct) nodes can also connect to the module

## **1.5 Access Point**

The module has an embedded Access Point. It supports four clients when in Access Point mode, and also acts as a DHCP server. WPA2-PSK security is supported. All standard Wi-Fi devices like Laptops, Smart-phones and Tablet PCs can connect to the Access Point. The connected clients can go to power save during this mode.

## **1.6 HTTP Server**

The module hosts an HTTP server. It provides memory space where HTML pages can be loaded. The module implements the server back end and responds to HTTP Get or HTTP Post requests from the remote terminal. The remote terminal can access the web pages through a standard web browser.

## **1.7 HTTP Client**

The module can act as a HTTP client and can be configured to send HTTP GET and HTTP POST requests to a remote HTTP server, and also receive the responses and forward to the Host.

## **1.8 Software and Documentation**

The following are provided with the Wi-Fi modules

- Programming Reference Manual that contains descriptions of all commands to control and operate the module
- Reference schematics for module's integration with application board.
- Sample Host driver source code for SPI interface
- Sample applications and Evaluation Board User Guide for evaluating functionality of the module



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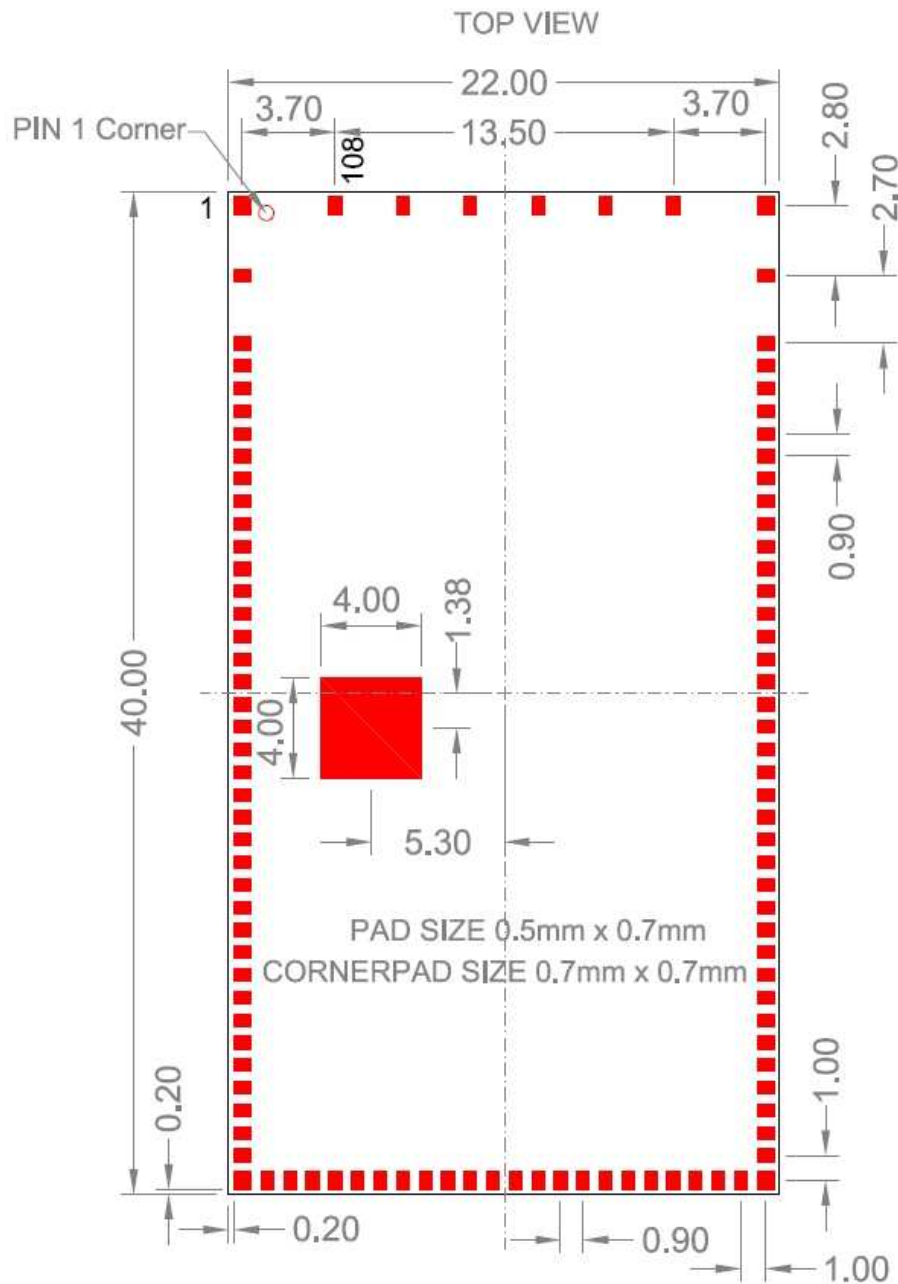
## 2 Package Description

### 2.1 Top View



**Figure 1: RS-WC-301 Module**

## 2.2 Module Dimensions



**Figure 2: Module Dimensions**

Package Type: LGA

Module height: 3.5 +/- 0.05 mm

## 2.3 Pin Description

Pin No	Pin Name	Direction	Type	Description
1	GND	-	-	Ground
2	GND	-	-	Ground
3	GND	-	-	Ground
4	GND	-	-	Ground
5	GND	-	-	Ground
6	GND	-	-	Ground
7	GND	-	-	Ground
8	GND	-	-	Ground
9	GND	-	-	Ground
10	GND	-	-	Ground
11	GND	-	-	Ground
12	GND	-	-	Ground
13	GND	-	-	Ground
14	GND	-	-	Ground
15	NC	-	-	No connect
16	NC	-	-	No connect
17	PD	-	-	Pull down with 4.7k ohms
18	GND	-	-	Ground
19	USB_ID	Input	3.3V I/O	Device/Host mode sense (OTG Mode). No connect if OTG is not used
20	USB_LDO_FLAG	Input	3.3V I/O	Power distribution IC Health Monitor (OTG Mode). No connect if USB is not used
21	USB_LDO_EN	Output	3.3V I/O, 2mA	Power Distribution IC Enable (OTG Mode). No connect if USB is not used
22	USB_DP	Input	3.3V I/O	USB differential pin (Positive). No connect if USB is not used
23	USB_DM	Input	3.3V I/O	USB differential pin (Negative). No connect if USB is not used
24	NC	-	-	No connect
25	NC	-	-	No connect
26	NC	-	-	No connect
27	NC	-	-	No connect
28	NC	-	-	No connect
29	NC	-	-	No connect
30	PT_GPIO1	Output	3.3V I/O, 2mA	Pass through output pin controllable by Host software.
31	PT_GPIO2	Output	3.3V I/O,	Pass through output pin controllable by Host

			2mA	software
32	TP1	-	-	Test point
33	TP2	-	-	Test point
34	TP3	-	-	Test point
35	TP4	-	-	Test point
36	TP5	-	-	Test point
37	NC	-	-	No connect
38	NC	-	-	No connect
39	NC	-	-	No connect
40	GND	-	-	Ground
41	NC	-	-	No connect
42	NC	-	-	No connect
43	NC	-	-	No connect
44	NC	-	-	No connect
45	NC	-	-	No connect
46	NC	-	-	No connect
47	NC	-	-	No connect
48	RESET_N	Input	3.3V I/O	Active low reset for the module
49	GND	-	-	Ground
50	MODE_SEL_2	Input	3.3V I/O	Interface selection Bit[2]
51	MODE_SEL_1	Input	3.3V I/O	Interface selection Bit[1]
52	MODE_SEL_0	Input	3.3V I/O	Interface selection Bit[0] Module interface Selection: Bit[2], Bit[1], Bit[0] = '000' for selecting UART interface Bit[2], Bit[1], Bit[0] = '001' for selecting SPI interface Bit[2], Bit[1], Bit[0] = '010' for selecting USB interface
53	CARD_READY	Output	3.3V I/O, 2mA	Card ready indicator. Logic '0' indicates successful boot-up of the module
54	WIFI_ACTIVITY	Output	3.3V I/O, 2mA	Wi-Fi Activity indicator. This pin is '0' when the module is transferring data
55	ADC2	Input	3.3V I/O	Analog input to internal ADC. Not used in current firmware, should be left open
56	ADC1	Input	3.3V I/O	Analog input to internal ADC. Not used in current firmware, should be left open
57	GND	-	-	Ground
58	GND	-	-	Ground
59	VCC3.3	Power	-	3.3V Power Supply
60	VCC3.3	Power	-	3.3V Power Supply

61	VCC3.3	Power	-	3.3V Power Supply
62	GND	-	-	Ground
63	GND	-	-	Ground
64	WAKEUP	Input	3.3V I/O	The module wakes up from sleep if a logic high is driven into this pin. Used only in SPI mode, should be left open in UART mode
65	SPI_READY	Output	3.3V I/O, 2mA	Handshake signal to be used in SPI mode. It should be connected to a GPIO of the Host MCU. In other modes, this pin can be left open
66	USB_VREGIN	Input	-	5V power supply for USB transceiver. No connect when USB is not used
67	GND	-	-	Ground
68	UART_CTS	Input	3.3V I/O	UART clear to send. Not used in current firmware, should be left open
69	UART_RTS	Output	3.3V I/O, 2mA	UART request to Send. Not used in current firmware, should be left open
70	UART_RX	Input	3.3V I/O	UART Receive
71	UART_TX	Output	3.3V I/O, 2mA	UART Transmit
72	GND	-	-	Ground
73	INTR	Output	3.3V I/O, 2mA	Active high, level triggered interrupt. Used in SPI mode. The interrupt is raised by the module to indicate there is data to be read by the Host, or to indicate the module has woken up from sleep. In UART mode, it can be left open
74	SPI_MOSI	Input	3.3V I/O	SPI Data input
75	SPI_MISO	Output	3.3V I/O, 2mA	SPI Data output
76	SPI_CLK	Input	3.3V I/O	SPI Clock
77	SPI_CS	Input	3.3V I/O	SPI Slave Select
78	NC	-	-	No connect
79	NC	-	-	No connect
80	NC	-	-	No connect
81	NC	-	-	No connect
82	JPD2	-	-	Connect pull down of 1

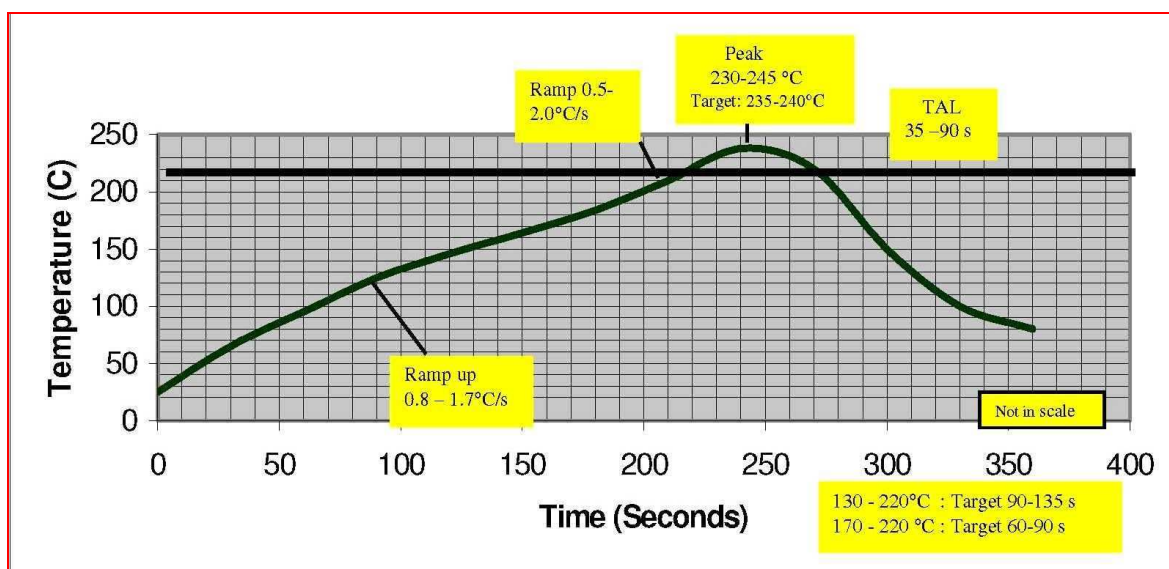
				kOhms
83	JNC	-	-	No connect
84	JPD1		-	Connect pull down of 1 kohms
85	JPD0	-	-	Connect pull down of 1 kohms
86	GND	-	-	Ground
87	GND	-	-	Ground
88	PA_EN	Output	LVC MOS, 4mA	External PA enable. If an external Power Amplifier is used, this should be connected to the enable of the external PA. Not used in current firmware, should be left open
89	NC	-	-	No connect
90	WF_HNDSHKE2	Output	3.3V I/O, 9mA	Handshake signal for wireless firmware upgrade. Should be connected to a GPIO pin of the Host MCU
91	NC	-	-	No connect
92	WF_HNDSHKE1	Input	3.3V I/O 9mA	Handshake signal for wireless firmware upgrade. Should be connected to a GPIO pin of the Host MCU
93	NC	-	-	No connect
94	NC	-	-	No connect
95	NC	-	-	No connect
96	NC	-	-	No connect
97	BT_PRIORITY	Input	LVC MOS, 2mA	Used to indicate through logic high that BT is transmitting high priority traffic. Not used in current firmware, this pin should be grounded
98	WLAN_ACTIVE	Output	LVC MOS, 2mA	Used for BT Coexistence. It indicates with logic high that WLAN activity is in progress. When low, BT device has the opportunity to transmit. Not used in current firmware, should be left open
99	NC	-		No connect
100	GND	-		Ground
101	NC	-		No connect
102	NC	-		No connect
103	NC	-		No connect
104	NC	-		No connect

105	NC	-		No connect
106	NC	-		No connect
107	NC	-		No connect
108	NC	-		No connect
109	GND PAD	-		Thermal Ground Pad

**Table 1: Pin Description**

Notes: The reference schematics showing pin connections for the module are present in the Module Integration Guide document. The document can be requested from Redpine Signals. Some pins are not used in the default configuration or mode of operation. These may be used in custom applications with appropriate firmware.

## 2.4 Recommended Reflow Profile



**Figure 3:Reflow Profile**

NOTE: The profile shown is based on SAC 305 solder (96.5% Tin, 3% silver, 0.5% copper). We recommend the ALPHA OM-338 lead-free solder paste. This profile is provided mainly for guidance. The total dwell time depends on the thermal mass of the assembled board and the sensitivity of the components on it.

## 2.5 Baking Instructions

The RS-WC-301 package is compliant to MSL-3. It is a moisture sensitive device and must be handled appropriately. After the devices are removed from their vacuum sealed packs, they should be taken through reflow for board assembly within 168 hours during which time, they are expected to be stored at MSL-3 environmental conditions (less than 60% relative humidity and 30° C). If these conditions are not met, the devices must be baked before reflow. The recommended baking time is nine hours at 125° C.

## 3 Electrical Characteristics

### 3.1 Absolute Maximum Ratings

Absolute maximum ratings in the table given below are the values beyond which the device could be damaged. Functional operation at or beyond these conditions is not guaranteed.

Parameter	Symbol	Value	Units
Input Supply voltage	V <sub>in</sub>	3.6	V
Supply voltage for I/O Rail	DVDD33	3.6	V
Supply Voltage for the RF	VRF33	3.6	V
RF Input Level	RFIN	10	dBm
Storage temperature	T <sub>store</sub>	-65 to 150	°C
Electrostatic discharge tolerance (HBM)	ESD <sub>HBM</sub>	2000	V
Electrostatic discharge tolerance (MM)	ESD <sub>MM</sub>	200	V
Electrostatic discharge tolerance (CDM)	ESD <sub>CDM</sub>	500	V

**Table 2: Absolute Maximum Ratings**

### 3.2 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Units
Input Supply voltage	V <sub>DD</sub>	3.1	3.3	3.6	V
Ambient temperature	T <sub>a</sub>	-40	25	85	°C
Peak source current for Power Supply design <sup>2</sup>		-	-	500	mA

**Table 3: Recommended Operating Conditions**

### 3.3 DC Characteristics – Digital I/O Signals

Parameter	Min.	Typ.	Max.	Units
Input high voltage	2.2	-	3.6	V
Input low voltage	-0.3	-	0.8	V
Output low voltage	-	-	0.5	V
Output high voltage	2.6	-	-	V
Input leakage current (at 3.3V or 0V)	-	-	1	μA

<sup>2</sup> For information on power consumption in functional modes, please contact Redpine Signals.



Parameter	Min.	Typ.	Max.	Units
Hi-Z (off-state ) leakage current (per pin)	-	-	1	μA

**Table 4: Input/Output DC Characteristics**

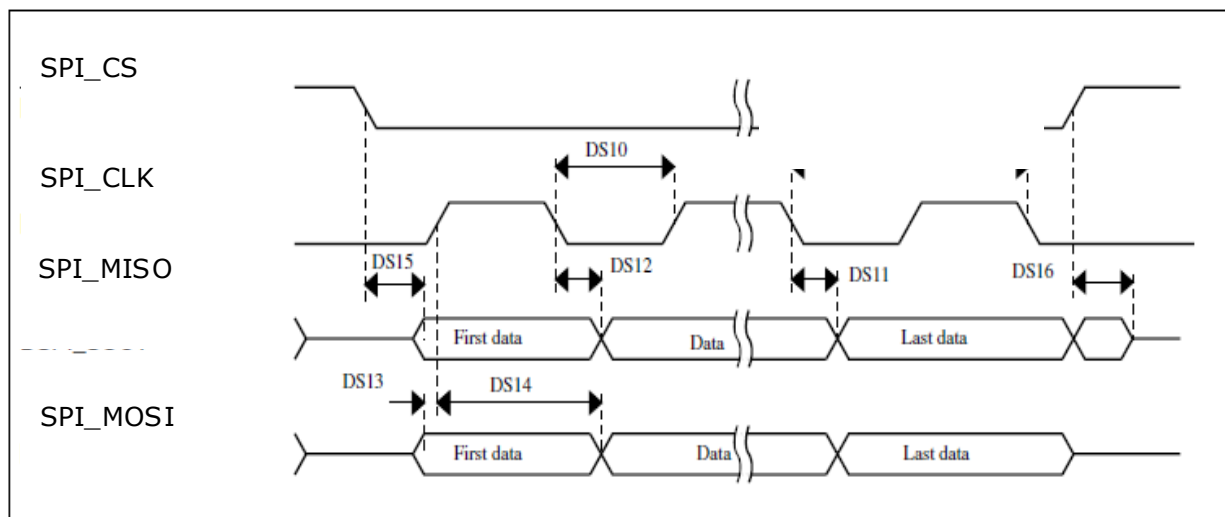
### 3.4 AC Characteristics – Digital I/O Signals

#### 3.4.1 SPI Interface

Parameter	Symbol	Min.	Max.	Units
SPI_CLK Frequency	Fspi	0	12.5	MHz
SPI_CLK high/low time	DS10	$(T_{spi}^3/2)-2$	$(T_{spi}/2)+2$	Ns
SPI_CLK to SPI_MISO valid	DS11	-	10	ns
SPI_CLK to SPI_MISO invalid	DS12	0	-	ns
SPI_MOSI to SPI_CLK setup	DS13	2	-	ns
SPI_CLK to SPI_MOSI hold	DS14	7	-	ns
SPI_CS active to SPI_MISO driven	DS15	-	14	ns
SPI_CS inactive to SPI_MISO not driven	DS16	-	14	Ns

**Table 5: AC Characteristics – SPI Interface**

<sup>3</sup> Time period corresponding to Frequency Fspi

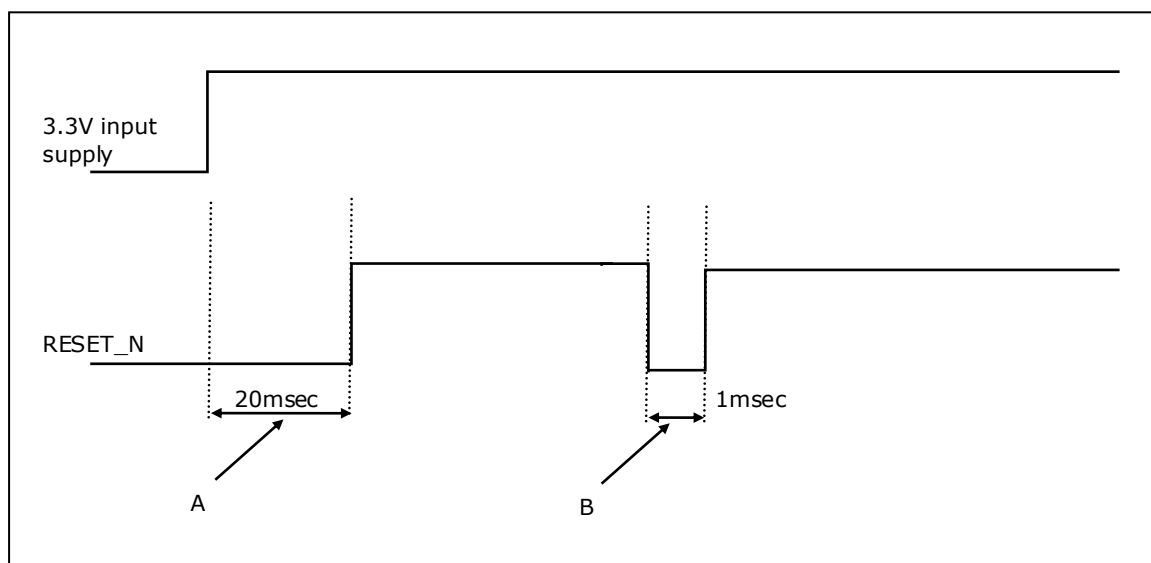


**Figure 4: Interface Timings – SPI**

### 3.5 Reset Timing

Following diagram shows the timing requirement for Reset input in two scenarios.

- A. Power up
- B. Giving reset during module operation



**Figure 5: Reset Pin Timing Diagram**

## 4 Performance Specifications

### 4.1 Wireless Specifications

Feature	Description
Frequency Band	2.400 – 2.500 GHz (2.4 GHz ISM band) 4.900 – 5.850 GHz (High Band)
Modulation	OFDM with BPSK, QPSK, 16-QAM, and 64-QAM 802.11b with CCK and DSSS
Supported Data Rates	802.11n: 6.5, 13, 19.5, 26, 39, 52, 58.5 Mbps 802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54 Mbps 802.11b: 1, 2, 5.5, 11 Mbps
802.11n Features	MCS 0-7, STBC, RIFS, A-MPDU, A-MSDU Aggregation with Block-ack
Typical Transmit Power (+/- 2 dBm)	17 dBm for 802.11b DSSS 17 dBm for 802.11b CCK 15 dBm for 802.11g/n OFDM 12 dBm in 802.11a mode

**Table 6: Wireless Specifications**

### 4.2 Receive Sensitivity

Data Rate	Typical Sensitivity (+/- 1.5 dBm)	Condition
1 Mbps	-97.0 dBm	< 8% PER
2 Mbps	-93.0 dBm	< 8% PER
11 Mbps	-88.0 dBm	< 8% PER
6 Mbps	-91.0 dBm	< 10% PER
54 Mbps	-75.0 dBm	< 10% PER
65 Mbps	-71.0 dBm	< 10% PER
Data Rate (11a Mode)	Typical Sensitivity (+/- 1.5 dBm)	
6 Mbps	-88.0 dBm (<10% PER)	
54 Mbps	-72.0 dBm (< 10% PER)	
65 Mbps	-69.0 dBm (< 10% PER)	

**Table 7: Receive Characteristics – Sensitivity**

### 4.3 Standards Compliance

RS-WC-301 is compliant with the requirements of IEEE 802.11b, 802.11g, 802.11a and 802.11n that include the following:

- Transmit Spectral Mask
- Transmit Center Frequency Leakage
- Transmit Center Frequency Accuracy
- Receiver Adjacent Channel Interference Rejection
- Receiver Minimum Input Level
- Receiver Maximum Input Level

### 4.4 Throughput

Interface	Throughput
SPI (12.5 Mhz SPI clock)	Tx – 4 Mbps (TCP) – 5.5 Mbps (UDP) Rx – 3.5 Mbps (TCP) – 5 Mbps (UDP)
UART (at 115200 bps)	Tx – 90 kbps (TCP, UDP) Rx – 75 kbps (TCP, UDP) <sup>4</sup>

**Table 8: Throughput**

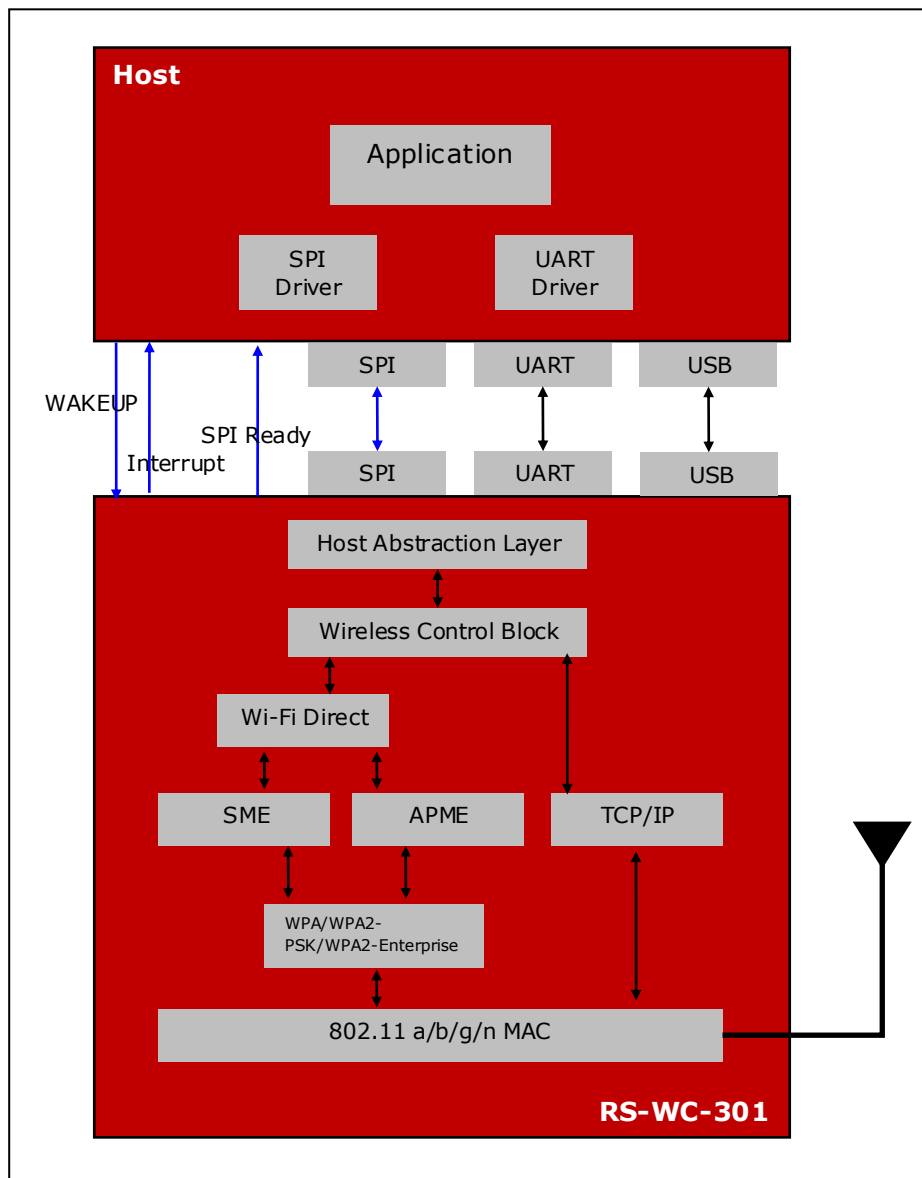
Throughputs vary with the speed of the Host, the environment (that determines packet retransmissions) etc.

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<sup>4</sup> Throughput for USB interface are being characterized, will be available in next revision

## 5 Software Architecture Overview

The following figure depicts the software architecture of the RS-WC-301 module.



**Figure 6: RS-WC-301 Software Architecture Block Diagram**

As shown in the figure above, the RS-WC-301 module is integrated with the Host using the UART, SPI or USB interface. The module receives all configuration commands from the Host and transfers data to or receives data from the Host through this interface.

## **5.1 Host**

The Host is any system that has applications being executed through a UART, SPI or USB interface.

## **5.2 RS-WC-301**

The RS-WC-301 module incorporates TCP/IP, DHCP, ARP, etc., to act as a wireless device server. It handles all the network connectivity functions. The following sections describe the components of the RS-WC-301 module.

### **5.2.1 SPI**

The SPI on the RS-WC-301 module is one of the physical interfaces which transmits/receives the data to/from the Host. The SPI on the RS-WC-301 acts the SPI slave. It is a standard 4-wire SPI and can support a maximum frequency of 12.5 MHz.

### **5.2.2 UART**

The UART on the RS-WC-301 module is one of the physical interfaces which transmits/receives the data to/from the Host. There is support for AT commands to configure and operate the module through UART interface.

### **5.2.3 USB**

The USB2.0 on the RS-WC-301 module is the third physical interface which transmits/receives the data to/from the Host. The USB in the module acts as a USB device and corresponds to the CDC-ACM class. The USB interface of the module supports the full speed USB mode (12 Mbps physical data rate).

### **5.2.4 Host Abstraction Layer (HAL)**

The HAL abstracts the lower layers in the host interface with which the RS-WC-301 module is connected. The HAL interacts with the Wireless Control Block layer for the processing of the frames obtained from or destined to the Host.

### **5.2.5 Wireless Control Block (WCB)**

The data from/to the Host is classified as Wi-Fi specific frames and TCP/IP specific frames. The WCB layer processes the frame obtained and acts accordingly. The functionality of the WCB module depends on the type of the frame and the direction of the frame.

### **5.2.6 Station Management Entity (SME)**

The SME is the core layer which manages the Wi-Fi connectivity. The SME maintains the state machine to detect the activity on the Wi-Fi network and indicates to the Host accordingly. It also performs re-association to the configured access point in Infrastructure mode. It interacts with the WPA supplicant if Security is enabled in the Wi-Fi network.

### **5.2.7 Access Point Management Entity (APME)**

The APME is the core layer which manages the connectivity in Access Point mode. This mode is invoked in Wi-Fi Direct Group Owner mode or in Access Point mode. The APME maintains the state machine to handle multiple clients connected to the module.

### 5.2.8 WPA Supplicant

The WPA supplicant is used to initiate the 802.1x/EAP authentication. It also plays a major part in performing the 4-way handshake to derive the PTK in WPA/WPA2-PSK modes.

## 5.3 Power Save

The RS-WC-301 module is an ultra low power Wi-Fi module. The Host can select either an always-on mode or power save mode for the module. In power save mode, the module powers off the Baseband, RF and also the Core Control Block during the sleep intervals. There are three power save modes supported in the module:

**Power Mode 1:** This mode is based on a configurable internal timer. The module can be made to wake-up at periodic intervals, based on the timer configured by the Host.

**Power Mode 2:** In this mode, the module can be woken up from sleep by the Host at any time.

**Power Mode 3:** In this mode, the module can be set to shut down mode by the Host using a software command. When woken up by the Host, it initiates a boot-up sequence as if a fresh power up has happened. Power consumption is lowest in this mode. More detailed description of the power save modes is available in the Programming Reference Manual.

Some representative numbers for power consumption in specific scenarios are described below.

Power Save State	Value (mA)	Description
Deep Sleep	2.3 mA	This is the state of the module when it is in sleep state in Power Mode 1 and 2.
Continuous Tx	447 mA	Module transmitting data continuously at 54 Mbps physical data rate and 17dBm RF power
Continuous Rx	300 mA	Module receiving data continuously
Shut down	110 $\mu$ A	This is the state of the module when it is set to shut down mode in Power Mode 3

**Table 9: Power Consumption**

## 6 Ordering Information

### 6.1 Contact Information

For additional information, please contact Sales at Redpine Signals, Inc.

Redpine Signals, Inc.

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### 6.2 Device Ordering Information

The following table lists the part numbers to be used for ordering modules or evaluation boards (EVB). Redpine can also provide customized firmware based on user requirements.

Device Number	Description	Packaging	Qualification
RS-WC-301	Module	Tray	-40 C to +85 C
RS-WC-301-EVB	Evaluation board	Board	

**Table 10: Device Ordering Information**

### 6.3 Software and Documentation

The following software and documentation are available along with the RS-WC-301.

- Embedded firmware for WLAN and TCP/IP stack
- APIs for all the supported interfaces
- Programming Reference Manual – Describes the commands to control and operate the module
- Module Integration Guide - Reference schematics and layout guidelines to integrate the module in the user's board
- Evaluation Board (EVB), EVB User Guide and demo applications to evaluate module functionalities

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