# RS-WC-301 Datasheet

**Redpine Signals, Inc.**
2107 N. First Street, #680
San Jose, CA 95131.
Tel: (408) 748-3385
Fax: (408) 705-3019
Email: info@redpinesignals.com
Website: www.redpinesignals.com

## Overview

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 modules integrate an antenna and a u.FL connector for external antenna with an option to select either one of them.

## Applications:

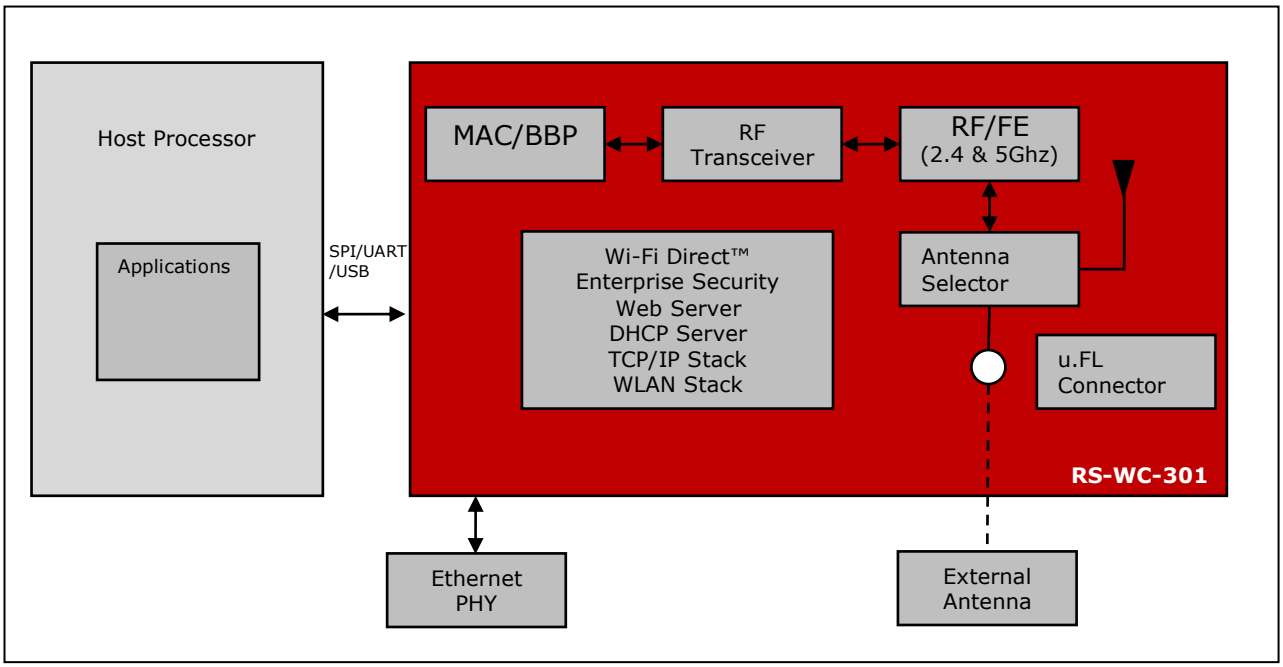
- Seamless Wi-Fi connectivity for Application Processors
- Industrial M2M communications
- Enterprise applications – Wireless Printers, Point of Sale Terminals
- Security Cameras and Surveillance Equipment
- Medical applications – Wireless Medical Instrumentation, Secure Patient Data Logging and Transfer
- 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/n module
- Wi-Fi Direct™
- Integrated TCP, UDP, DHCP, ICMP, IGMP, DNS, DHCP Server
- HTTP Server
- WPA2- Enterprise (EAP-TLS, EAP-FAST, EAP-TTLS, PEAP-MS-CHAP-V2)
- WPA2-PSK, WEP (64 and 128 bit) and TKIP security in infrastructure mode
- WPS (Wi-Fi Protected Setup) for ease of provisioning
- Wireless Firmware Upgrade and Configuration for field deployments.
- QOS-WMM for reliable audio and multi-media streaming
- UART, SPI, USB and Ethernet[1] interfaces supported
- Integrated antenna, frequency reference and low-frequency clock
- Ultra low-power operation with power save modes
- Infrastructure, Ad-hoc and Soft Access Point modes for maximum deployment flexibility
- Single supply – 3.1 to 3.6V operation
- Dimensions – 40mm X 22mm

[1] USB interface will be available by May, 3012. Ethernet is planned in future releases

## RS-WC-301 System Architecture



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# 1 Detailed Feature List

## 1.1 Host Interfaces

- UART
  - The UART interface supports variable baud rates from 9600 to 3686400 bps
  - AT Command Interface for configuration and module operation
- SPI
  - Standard 4-wire SPI
  - Operation up to a maximum clock speed of 12.5MHz[2]
- USB 2.0

## 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 WEP 64/128-bit and AES
- Access Point, Client and Ad-hoc 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

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

## 1.3 Security

- WPA2-Enterprise
  - EAP-TLS
  - EAP-TTLS
  - EAP-FAST

[2] This frequency depends on the external delays also.

- PEAP-MS-CHAP-V2

Radius Client is included, Radius Server is not included.

- WPA/WPA2-PSK, WEP, TKIP
- WPS-Push Button Support

## 1.4 Wi-Fi Direct™ Support

The module supports Wi-Fi Direct™. All Wi-Fi Direct modes are supported.

- Wi-Fi Direct in Group Owner mode with 4 clients
- Autonomous Group Owner mode (Access Point)
- Wi-Fi Direct in Client or Peer-to-Peer mode.

Wi-Fi Direct enables two Wi-Fi devices to communicate directly, without an access point in between. RS-WC-301 can act as a group owner, so that Wi-Fi clients (both normal Wi-Fi and Wi-Fi Direct enabled clients) can join to the network created by the RS-WC-301 module and exchange data. The module can also connect, as a client, to another Wi-Fi Direct Group Owner (GO) node.

## 1.5 HTTP Server Support

The module has an embedded HTTP server. The module provides memory space where HTML pages can be loaded. The Host platform's memory may be used for larger pages. The module implements the server back end and will respond to HTTP Get or HTTP Post requests from the remote terminal. The remote terminal can access the web pages through a standard web browser.

## 1.6 Software and Documentation

The following are provided with the Wi-Fi modules

- Sample Host driver source code for SPI/UART interface
- Sample applications and user guide for evaluating functionality of the module.
- Reference schematics for integration with application board.
- Programmers' Reference Manual

# 2 Package Description

## 2.1 Module Dimensions

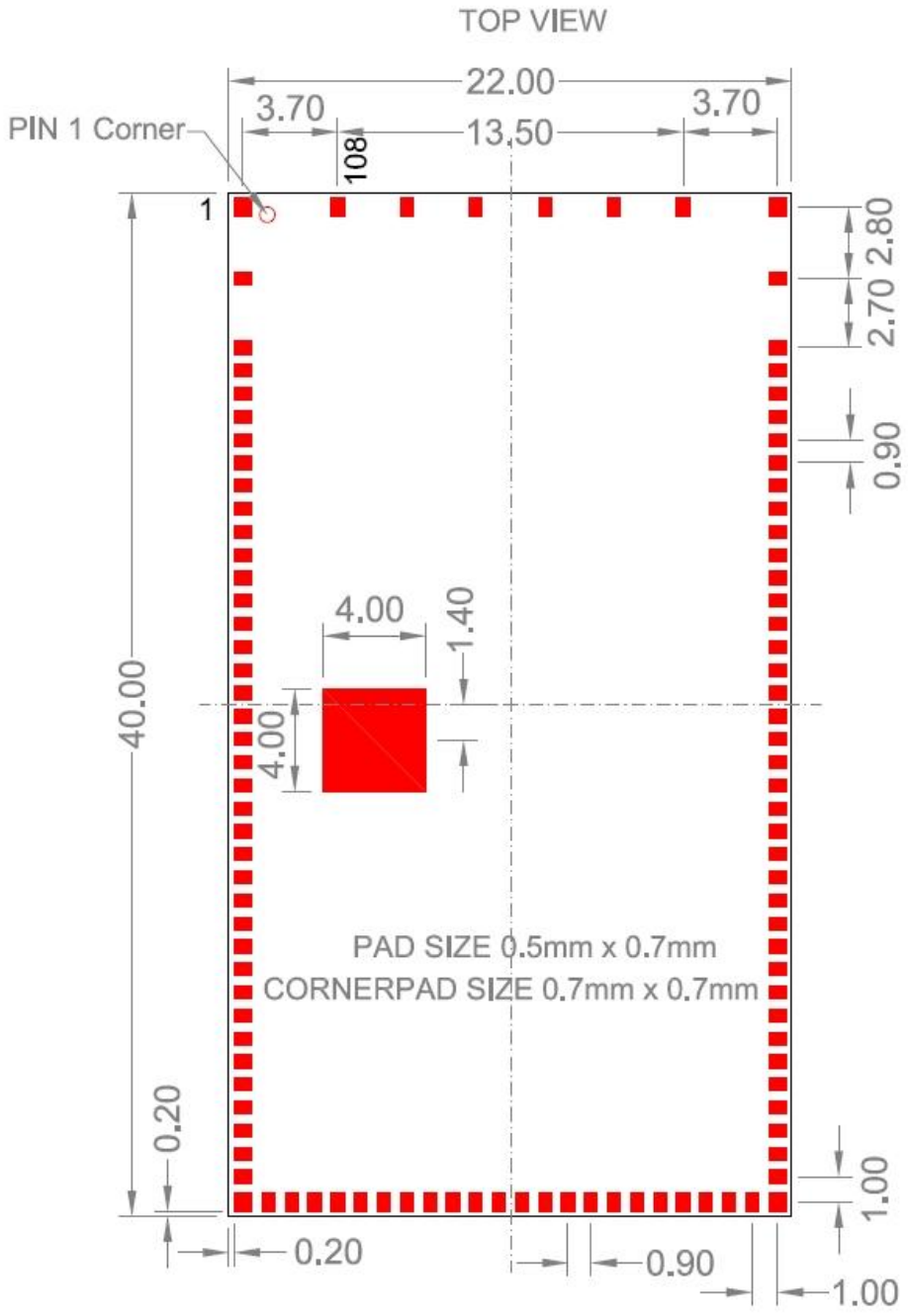


**Figure 1: Module Dimensions**

Package Type: LGA

Module height: 3.75 mm

## 2.2 Pin Description

| Pin No | Pin Name | Direction | 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 | NC | - | No connect |
| 20 | NC | - | No connect |
| 21 | NC | - | No connect |
| 22 | USB-DP | Inout | Data-Plus (USB On-the-Go) |
| 23 | USB-DM | Inout | Data-Plus (USB On-the-Go) |
| 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 | GPIO1-6 | - | GPIO |
| 31 | GPIO1-1 | - | GPIO |
| 32 | TP1 | - | No connect |
| 33 | TP2 | - | No connect |
| 34 | TP3 | - | No connect |
| 35 | TP4 | - | No connect |
| 36 | TP5 | - | No connect |
| 37 | RMII0_RXER | Output | Receive error output |
| 38 | RMII0-RXD0 | Input | Receive Data Input[0] |
| 39 | RMII0-RXD1 | Input | Receive Data Input[1] |

| | | | |
|---|---|---|---|
| 40 | GND | - | Ground |
| 41 | RMII0-TXEN | Input | Transmit enable input. |
| 42 | RMII0-CRS-DV | Output | Carrier sense/Receive Data Valid output |
| 43 | RMII0-TXD0 | Output | Transmit Data Output[0] |
| 44 | RMII-TXD1 | Output | Transmit Data Output[0] |
| 45 | RMII-MDC | Input | RMII0 Clock Input. This pin is synchronous to the MDIO data interface. |
| 46 | RMII-MDIO | Inout | RMII0 Data I/O. This pin requires an external 4.7KΩ pull-up resistor. |
| 47 | ETH_CLK | Input | Reference Clock Input for 10 Base - T/100 Base -T Physical Layer transceiver |
| 48 | RESET | Input | Reset, active low |
| 49 | GND | - | Ground |
| 50 | MODE-SEL-2 | Input | Interface selection Bit[2] |
| 51 | MODE-SEL-1 | Input | Interface selection Bit[1] |
| 52 | MODE-SEL-0 | Input | Interface selection Bit[0]<br>Module interface Selection:<br>Bit[2],Bit[1],Bit[0] = 000 UART interface<br>Bit[2],Bit[1],Bit[0] = 001 SPI interface<br>Bit[2],Bit[1],Bit[0] = 010 USB interface |
| 53 | WLAN_ACTIVITY | Output | WLAN Activity indicator. This pin is '1' when the module is transmitting data. |
| 54 | CARD_READY | Output | Card ready indicator. Logic '1' indicates successful boot-up of the module. |
| 55 | GPIO0-8 | Inout | GPIO |
| 56 | GPIO0-9 | Inout | GPIO |
| 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 | NC | - | No connect |
| 65 | NC | - | No connect |
| 66 | NC | - | No connect |
| 67 | GND | - | Ground |
| 68 | UART1-CTS | Output | UART – Clear to Send |
| 69 | UART1-RTS | Input | UART – Request to send |
| 70 | UART-RX | Input | UART Receive |
| 71 | UART-TX | Output | UART Transmit |
| 72 | GND | - | Ground |
| 73 | INTR | Output | Interrupt, Active High |
| 74 | SPI_MOSI | Input | SPI Data input |
| 75 | SPI_MISO | Output | SPI Data output |
| 76 | SPI_CLK | Input | SPI Clock |

| | | | |
|---|---|---|---|
| 77 | SPI_CS | Input | 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 | External RF power amplifier output |
| 89 | GPIO0-4 | Inout | GPIO |
| 90 | GPIO0-3 | Inout | GPIO |
| 91 | GPIO0-5 | Inout | GPIO |
| 92 | GPIO0-1 | Inout | GPIO |
| 93 | NC | - | No connect |
| 94 | GPIO0-7 | Inout | GPIO |
| 95 | NC | - | No connect |
| 96 | GPIO0-6 | Inout | GPIO |
| 97 | BT_PRIORITY | Input | Indicates through logic high that BT is transmitting high priority traffic. When BT coexistence is not used, this pin should be connected to ground. |
| 98 | WLAN_ACTIVE | Output | This indicates that WLAN activity is in progress. When low, BT device has the opportunity to transmit. |
| 99 | BT_ACTIVE | Input | This signal may be used by an external Bluetooth device to indicate its activity or impending activity. |
| 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 |

**Table 1: Pin Description**

Notes:

Some pins are not used in the default configuration or mode of operation. These may be used in custom applications with appropriate firmware.

## 2.3 Recommended Reflow Profile

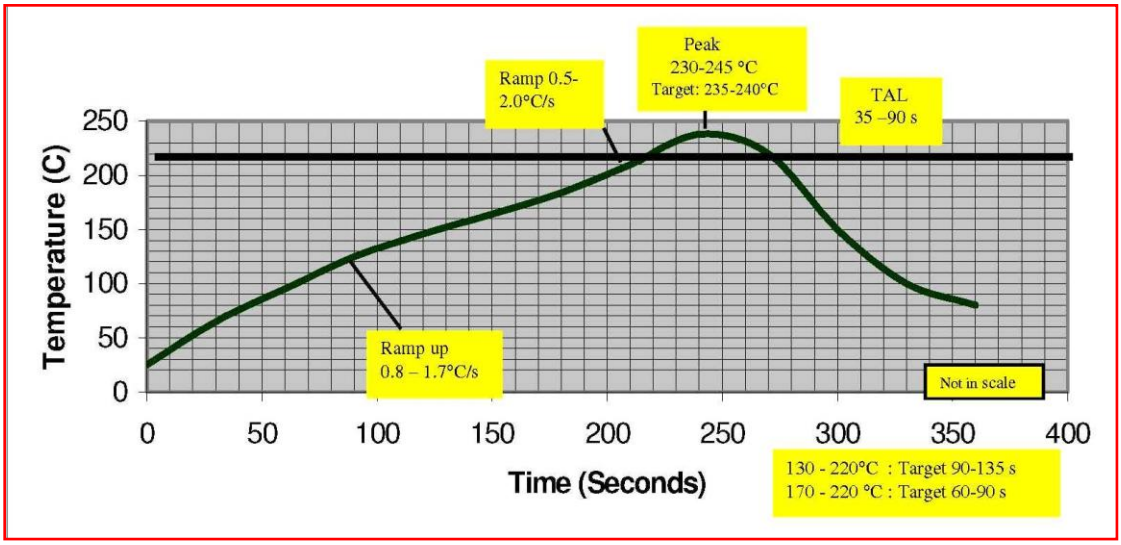


**Figure 2:Reflow Profile**

NOTE: The profile shown is based on SAC 305 solder (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.

## 2.4 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 | Vin | 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 | $T_{store}$ | -65 to 150 | °C |
| Electrostatic discharge tolerance (HBM) | $ESD_{HBM}$ | 2000 | V |
| Electrostatic discharge tolerance (MM) | $ESD_{MM}$ | 200 | V |
| Electrostatic discharge tolerance (CDM) | $ESD_{CDM}$ | 500 | V |

**Table 2: Absolute Maximum Ratings**

## 3.2 Recommended Operating Conditions

| Parameter | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Input Supply voltage | $V_{DD}$ | 3.1 | 3.3 | 3.6 | V |
| Ambient temperature | $T_a$ | -40 | 25 | 85 | °C |

**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 | 3.0 | - | - | V |
| Input leakage current (at 3.3V or 0V) | - | - | 1 | µA |
| Tristate output leakage current (at 3.3V or 0V) | - | - | 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 | (Tspi[3]/2)-2 | (Tspi/2)+2 | 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_CLK to SPI_MISO valid | DS11 | - | 10 | Ns |

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

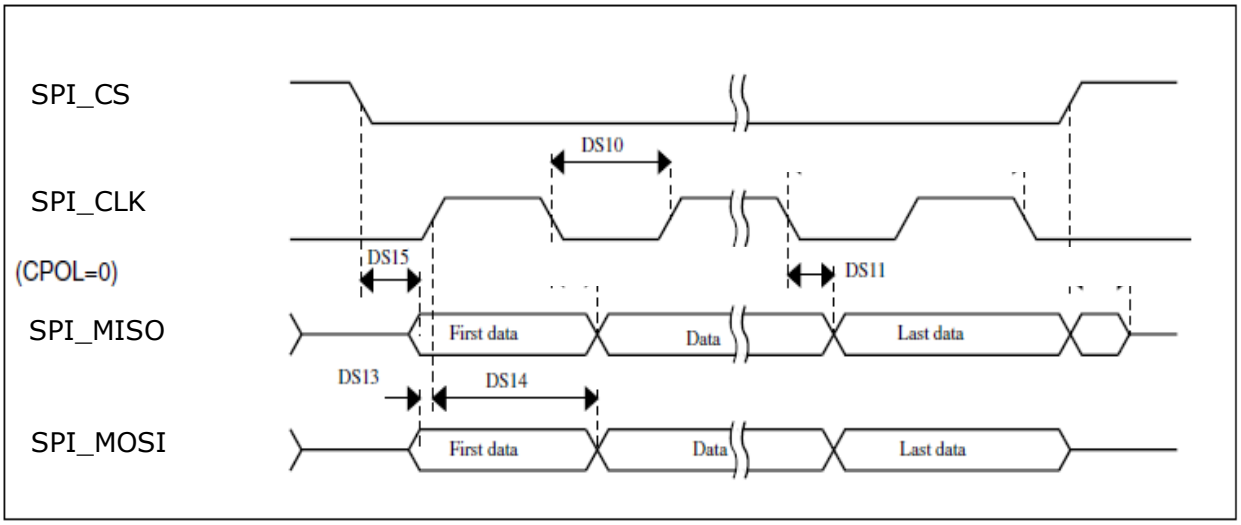


**Figure 3:Interface Timings – SPI**

[3] Time period corresponding to Frequency Fspi

# 4 Performance Specifications

## 4.1 Wireless Specifications

| Feature | Description |
|---|---|
| Frequency Band | 2.400 – 2.500 GHz (2.4 GHz ISM band)<br>4.900 – 5.850 GHz (High Band) |
| Modulation | OFDM with BPSK, QPSK, 16-QAM, and 64-QAM<br>802.11b with CCK and DSSS |
| Supported Data Rates | 802.11n: 6.5, 13, 19.5, 26, 39, 52, 58.5,65 Mbps<br>802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54 Mbps<br>802.11b: 1, 2, 5.5, 11 Mbps |
| 802.11n Features | MCS 0-7, STBC, RIFS, Greenfield Protection<br>A-MPDU, A-MSDU Aggregation with Block-ack |
| Typical Transmit Power (+/- 2 dBm) | 17 dBm for 802.11b DSSS<br>17 dBm for 802.11b CCK<br>15 dBm for 802.11g/n OFDM<br>12 dBm in 'a' mode |

**Table 6: Wireless Specifications**

## 4.2 Receive Sensitivity

| Data Rate | Typical Sensitivity (+/- 1.5 dBm) | Sweep – PER Floor |
|---|---|---|
| 1 Mbps | -97.0 dBm | < 0.1% |
| 2 Mbps | -93.0 dBm | < 0.1% |
| 11 Mbps | -88.0 dBm | < 0.1% |
| 6 Mbps | -91.0 dBm | < 0.1% |
| 54 Mbps | -75.0 dBm | < 0.1% |
| 65 Mbps | -71.0 dBm | < 0.1% |
| **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**

Range varies with the conditions under with wireless communication is sought. For large office environments, in the presence of obstacles, a range of over 40

meters can be achieved, while in open, line-of-sight environments, over 300 meters can be achieved.

## 4.3 Throughput

| Interface | Application Throughput |
|---|---|
| UART (measured at 115200 bauds per sec) | Tx/Rx – 100 kbps |
| SPI (measured at 12.5 Mhz SPI clock) | Tx – 9 Mbps<br>Rx – 8 Mbps |

## 4.4 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 Non-adjacent Channel Rejection
- Receiver Minimum Input Level
- Receiver Maximum Input Level

# 5 Software Architecture Overview

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

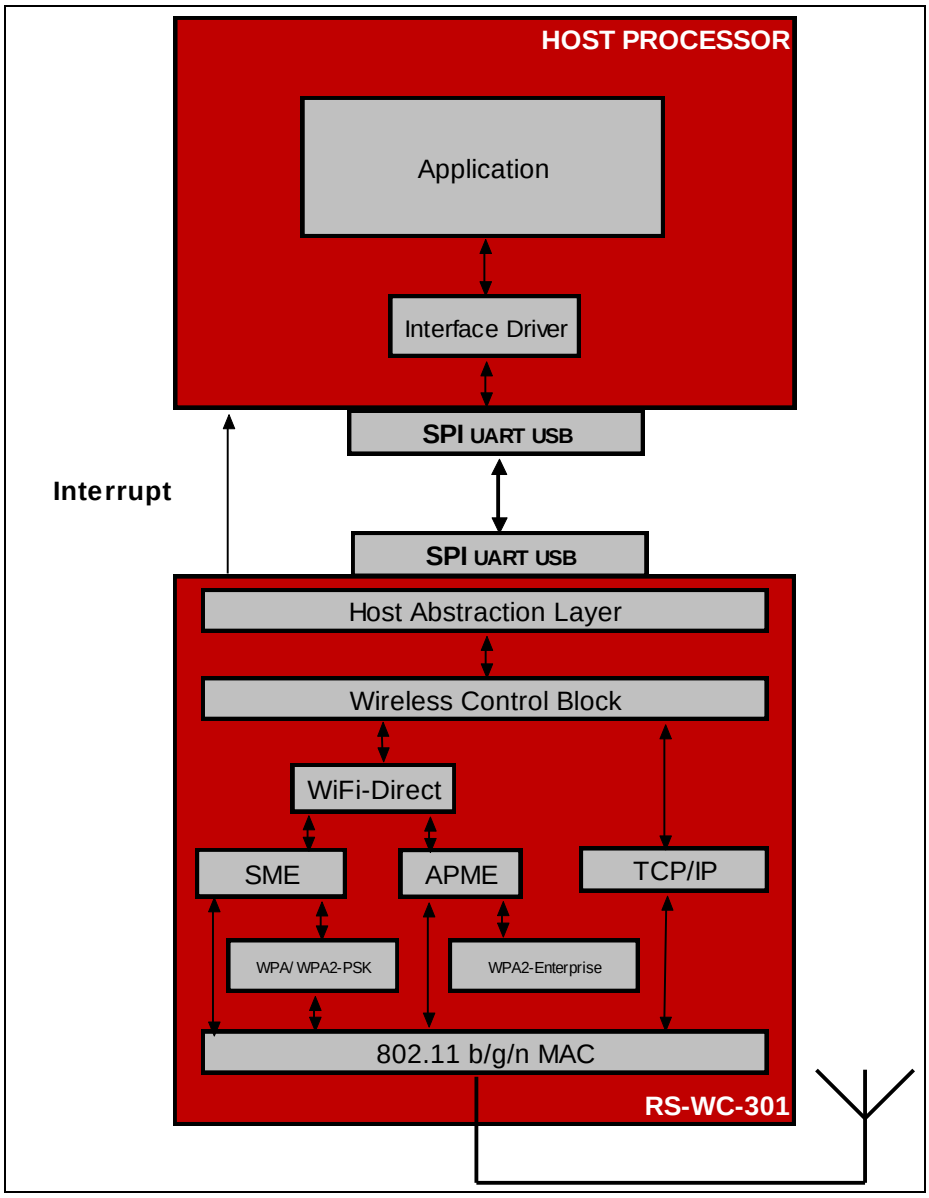


**Figure 4: RS-WC-301 Software Architecture Block Diagram**

As shown in the figure above, the RS-WC-301 module is integrated with the Host using either UART, SPI or the 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 and either a UART or SPI interface.

### 5.1.1 UART

The UART on the Host side provides an interface for the Host to access the Wi-Fi module.

The Host transmits and receives data using UART interface when the RS-WC-301 module is configured for UART mode. The access to the TCP/IP stack in the Wi-Fi module through the UART is provided through AT commands.

### 5.1.2 SPI

The SPI on the Host side provides an interface for the Host to access the Wi-Fi module. SPI on the Host acts as the master.

The Host transmits and receives data using the SPI interface when the RS-WC-301 module is configured for SPI mode. The access to the TCP/IP stack in the Wi-Fi module through the SPI is provided through SPI frames.

### 5.1.3 USB

The USB 2.0 interface on the Host side provides an interface for the Host to access the Wi-Fi module. USB on the Host acts as the master.

The Host transmits/receives data using the USB 2.0 interface when the RS-WC-301 module is configured for USB mode. The access to the TCP/IP stack in the Wi-Fi module through the USB is provided through USB based commands.

## 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 software components of the RS-WC-301 module in brief.

### 5.2.1 SPI

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 the physical interface which transmits/receives the data from the Host. It supports variable baud rates from 9600 to 3686400 bps. There is support for AT commands to configure and operate the module through UART interface.

### 5.2.3 USB

The USB 2.0 interface on the module provides an interface for the host to access the Wi-Fi module. USB on the module acts as a slave.

### 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 negotiation 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[4]

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 RS-WC-301 module invokes the IEEE 802.11n power save protocol and powers off the Baseband, RF and also the Core Control Block during the sleep intervals. The functioning of the module in power save mode depends on the connection status as explained below

1. Before Wi-Fi connection

   In this state, the module can be configured to periodically attempt to connect to a given Access Point. This activity is interspersed with phases of deep sleep.

2. After Wi-Fi Connection

   In this state, the RS-WC-301 module periodically wakes up to receive beacons from the Access Point (AP). If there is no data to be transmitted to or received from the Access Point, it goes back to sleep.

[4] Contact Redpine Signals, Inc. for detailed information on power consumption

# 6 Ordering Information

## 6.1 Contact Information

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

Redpine Signals, Inc.

2107 North First Street, Suite 680,

San Jose, CA 95131 USA

Phone: +1 408 748 3385

E-mail: sales@redpinesignals.com

Website: http://www.redpinesignals.com/

## 6.2 Device Ordering Information

The following table lists the part numbers to be used for ordering modules or evaluation boards (EVB). Redpine can create and 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 8: 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
- API interface and driver source code for UART, SPI and USB interfaces
- Software Programmers' Reference Manual – Describes how to operate the module in different supported modes.
- Reference schematics and layout guidelines – Describes hardware schematics to integrate the module in the user's board.
- Evaluation Board (EVB), related user guides and demo applications to evaluate functionalities for Wi-Fi Direct , Enterprise Security, Soft Access Point and normal client modes.

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