

**RS-9110-N-11-28 Self Contained
802.11 a/b/g/n Module with
Networking Stack**

Datasheet

Version 1.9

November 2012

Redpine Signals, Inc.

2107 N. First Street, #680

San Jose, CA 95131.

Tel: (408) 748-3385

Fax: (408) 705-2019

Email: info@redpinesignals.com

Website: www.redpinesignals.com

The RS9110-N-11-28 module from Connect-io-n™ family of products is a complete dual band (2.4/5GHz) IEEE 802.11abgn based wireless device server that directly provides a wireless interface to any equipment with a serial or SPI interface for data transfer. It integrates a MAC, Baseband processor, dual band RF transceiver with power amplifier and diplexer; and all WLAN protocol and configuration functionality, networking stack in embedded firmware to make a dual band 802.11n WLAN solution for a variety of applications. As a wireless serial modem, the RS9110-N-11-28 originates and terminates TCP and UDP connections, enabling a variety of M2M applications at low cost and small footprint.

Applications:

- Seamless Wi-Fi connectivity for any equipment with a serial or SPI interface
- Industrial M2M communications
- Point of Sale Terminals
- Metering
- Security Cameras & Surveillance Equipment
- Warehousing
- Digital Picture Frames
- Logistics and Freight Management

- Several Medical Applications including Patient Monitoring, Remote Diagnostics etc.

Device Features:

- 802.11a/b/g/n (single stream) module
- 2.4/5 GHz, 802.11n RF transceiver with power amplifier
- Supports WPA2-PSK, WEP (64 and 128 bits) and TKIP modes of security in infrastructure mode
- Supports WEP (64 and 128 bits) modes of security in ad-hoc mode
- Host interface through UART and SPI
- Integrated TCP/IP stack with option to bypass the stack in SPI mode
- Ultra low power operation with power save modes
- Ad-hoc and infrastructure modes for maximum deployment flexibility
- Configure module wirelessly and upgrade firmware wirelessly for easy field deployment
- Single supply 3.1 to 3.6 V operation
- Pad for external antenna connection
- Device Dimensions 20 mm x 17.5 mm x 3.5mm

RS9110-N-11-28 System Block Diagram

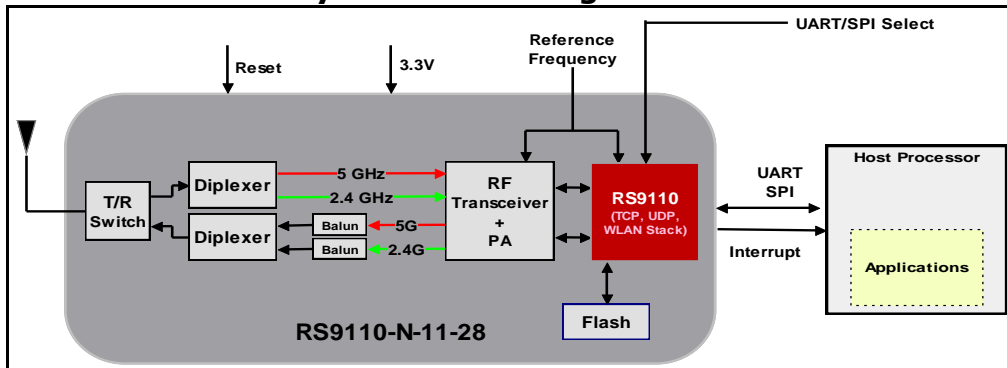


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1: Detailed Feature List

1.1: Host Interfaces

- UART
- The UART forms the physical layer of the TCP/IP stack, transferring frames between a Host processor and the module.
- The UART interface supports variable baud rates from 9600 to 3686400 bps
- AT Command Interface for configuring and operating the module
- SPI
- Standard 4-wire SPI
- Operation up to a maximum clock speed of 25MHz

The module can be configured in UART or SPI mode by configuring the pin MODE_SEL_1 as described in the section for Pin Description.

1.2: WLAN

1.2.1: MAC

- Conforms to IEEE 802.11a/b/g/n standards for MAC
- Dynamic selection of fragment threshold and data rate depending on the channel statistics
- Hardware accelerators for AES
- WPA, WPA2, WEP support
- Infrastructure and Ad-hoc modes

1.2.2: Baseband Processing

- Supports DSSS (1, 2 Mbps) and CCK (5.5, 11 Mbps) modes
- Supports all OFDM data rates (6, 9, 12, 18, 24, 36, 48, and 54 Mbps)
- Supports IEEE 802.11n single-stream modes with data rates up to 65 Mbps
- Supports long, short, and HT preamble modes
- High-performance multipath compensation in OFDM, DSSS, and CCK modes

1.2.3: RF

- Highly integrated 2.4 GHz/5 GHz transceiver with direct conversion architecture

- Receiver with 34 dB RF selectable gain range and 60 dB baseband variable gain range
- Power amplifier with 17 dBm output power for Low Band OFDM and 15 dBm for High Band OFDM.
- Integrated LNA, LPF, Power Amplifier and etc.

1.3: Networking Protocols

- TCP
- UDP
- ARP
- ICMP
- DHCP
- The RS9110-N-11-28 comes with flexible frameworks to enable usage in various application scenarios, viz., high throughput, more network features etc. Please contact Redpine Signals for addition of network features like HTTP server.

1.4: Configuration

The RS9110-N-11-28 module can be configured through UART or SPI. The following are some of the commands that can be given to the module:

- Scan
- Connect
- Pre-shared Keys
- SSID of hidden WLAN networks
- DHCP Enable/Disable
- Create/Join an IBSS network
- Open/Close sockets for TCP, UDP, Listening TCP

1.5: Software

- Sample Host driver for SPI
- Configuration and management GUI for Windows XP for UART
- Embedded software for complete WLAN functionality including 802.11n aggregation and Block-ACK, auto rate adaptation, security and also complete network stack and applications including TCP, UDP, ARP, DHCP, HTTP.
- The module can be made to come up as an Access point, to which a standard WLAN device such as a laptop can connect and configure the module or upgrade the firmware

2: Package Description

2.1: Top View



Figure 1: Top View of the Module

2.2: Bottom View



Figure 2: Bottom View of the Module

2.3: Package Dimensions

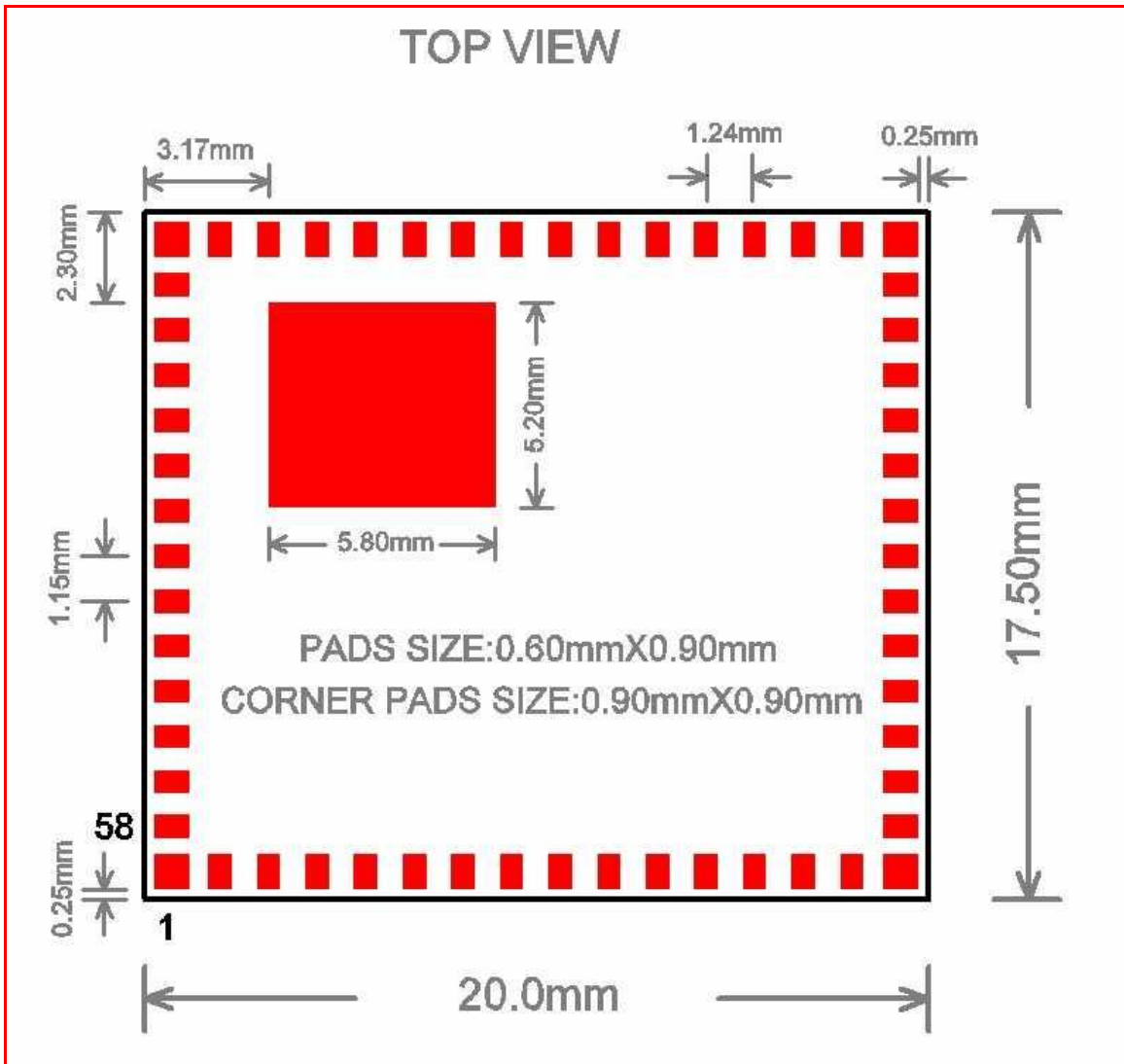


Figure 3: Package Dimensions

Module height = 3.5 mm

2.4: PCB Landing Pattern

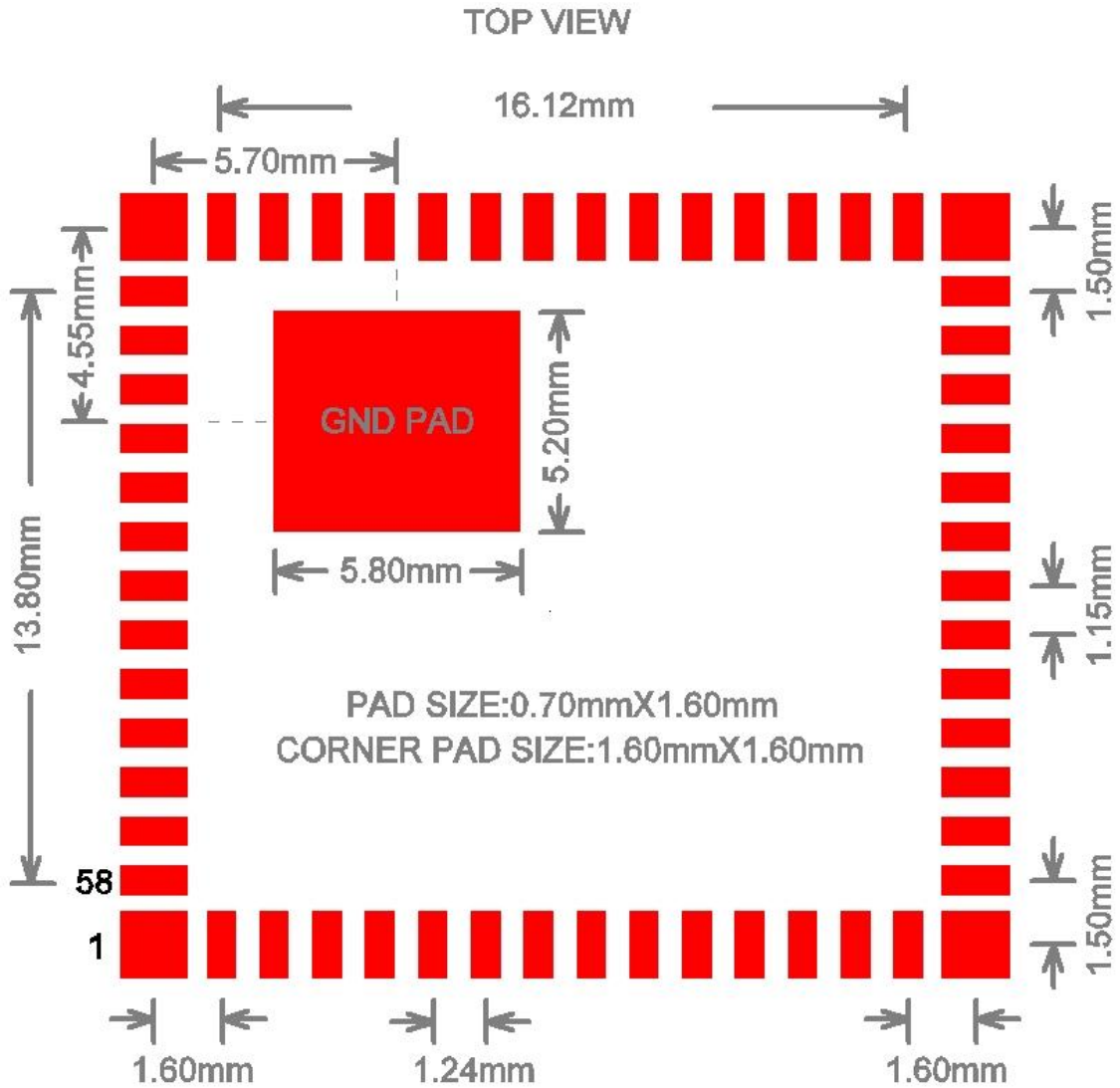


Figure 4: PCB Landing Pattern

2.5: Recommended Reflow Profile

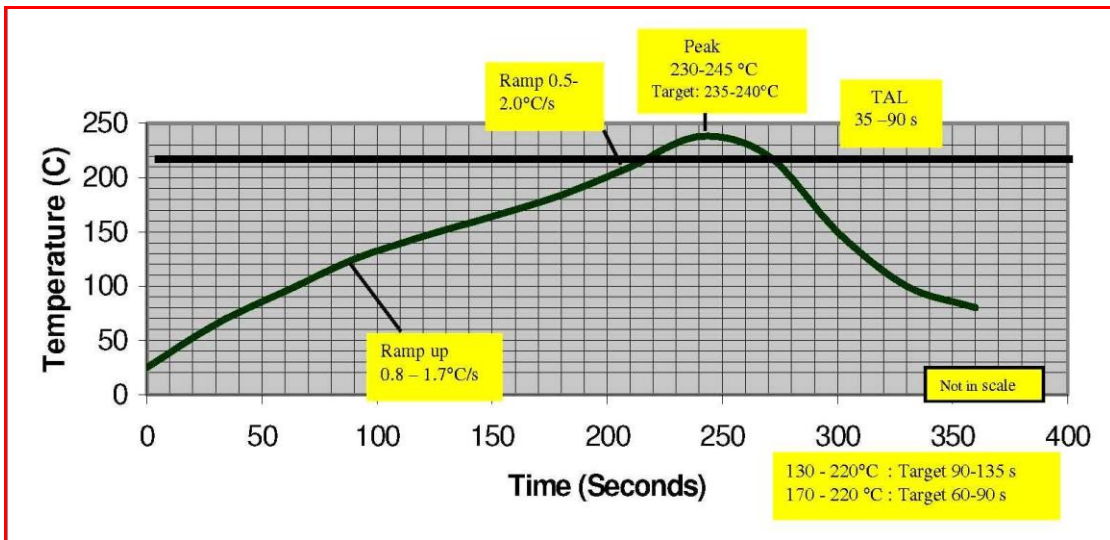


Figure 5: Reflow Profile

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.

2.6: Baking Instructions

The RS9110-N-11-28 package is moisture sensitive and devices 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 at room conditions, or stored at under 10% relative humidity. If these conditions are not met, the devices must be baked before reflow. The recommended baking time is nine hours at 125° C.

3: Pin Description

3.1: Module Pinout

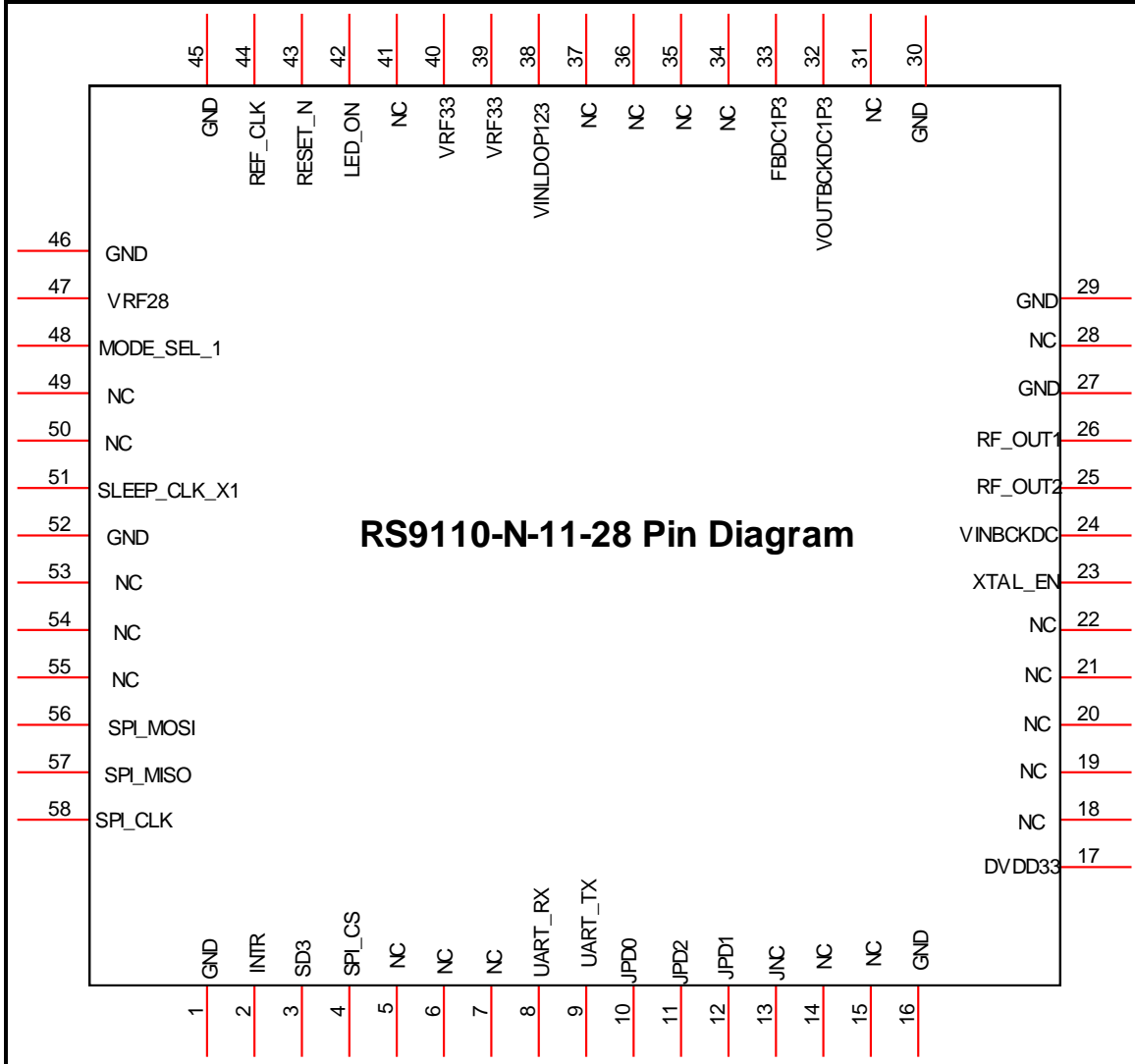


Figure 6: Pinout of the Module

3.2: Pin Description

Pin No.	Pin Name	Direction	Type	Description
1	GND	-		Ground
2	INTR	Output	LVC MOS 8mA	Interrupt to the host. Active high, level triggered. Asserted by the module when:

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Pin No.	Pin Name	Direction	Type	Description
				1.The module has to transmit data to the host through SPI. 2.When the module wakes up from sleep mode
3	SD3	-		No connect in SPI mode. In UART mode, connect pull-down (1K to 10K Ohms)
4	SPI_CS	Input	LVC MOS 8mA	Active low SPI Chip Select. In UART mode, connect pull-down (1K to 10K Ohms)
5	NC	-		No connect
6	NC	-		No connect
7	NC	-		No connect
8	UART_RX	Input	LVC MOS 4mA	UART input. No connect in SPI mode.
9	UART_TX	Output	LVC MOS 8mA	UART output. No connect in SPI mode.
10	JPD0	-		Connect pull down of 1K Ohms
11	JPD2	-		Connect pull down of 1K Ohms
12	JPD1	-		Connect pull down of 1K Ohms
13	JNC	-		No connect
14	NC	-		No connect
15	NC	-		No connect
16	GND	Ground		Ground
17	DVDD33	Power		3.3 Volts Input to the I/O Rail
18	NC	-		No connect
19	NC	-		No connect
20	NC	-		No connect
21	NC	-		No connect
22	NC	-		No connect
23	XTAL_EN	Output	LVC MOS 4mA	This signal controls an external reference clock oscillator for power-save purposes.

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Pin No.	Pin Name	Direction	Type	Description
				1 – Enable 0 – Disable
24	VINBCKDC	Power		3.3 Volts input to the Lite-Fi's PMU
25	RF_OUT2	RFIn/RFOut		Antenna-2 port. 50 ohms impedance.
26	RF_OUT1	Rfin/Rfout		Antenna-1 Port. 50 ohms impedance
27	GND	Ground		Ground
28	NC	No-connect		No connect
29	GND	Ground		Ground
30	GND	Ground		Ground
31	NC	No-connect		No connect
32	VOUSBCKDC1P3	Power		Internal DC-DC convertor output. A Schottky diode is to be placed on this line for protection.
33	FBDC1P3	Power		Feedback for the DC-DC Converter
34	NC	-		No connect
35	NC	-		No connect
36	NC	-		No connect
37	NC	-		No connect
38	VINLDO123	Power		Input to the LDO's. This has to be connected to FBDC1P3.
39	VRF33	Power		3.3 Volts input to the RF transceiver
40	VRF33	Power		3.3 Volts input to the RF transceiver
41	NC	-		No connect
42	LED_ON	Inout	LVC MOS 4mA	LED Control signal. Indicates activity on WLAN – the device pulls this line low when the module is activated. To be connected to the Cathode of an LED with a recommended series resistor of 820 ohms to VDD. This pin may also be used as a GPIO.
43	RESET_n	Input	LVC MOS	Active low power on reset. Required to be low for at least 10 ms after

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Pin No.	Pin Name	Direction	Type	Description
				power on.
44	REF_CLK	Input		Reference Clock source: 40 MHz.
45	GND	Ground		Ground
46	GND	Ground		Ground
47	VRF28	Power		2.8 Volts LDO OUTPUT
48	MODE_SEL_1	Input	LVC MOS 2mA	SPI Mode: Connect pull down (3.9K Ohms to 4.7K Ohms) UART Mode: No connect
49	NC	-		No connect
50	NC	-		No connect
51	SLEEP_CLK_X1	Input		Ground
52	GND	Ground		Ground
53	NC	-		No connect
54	NC	-		No connect
55	NC	-		No connect
56	SPI_MOSI	Input	LVC MOS 8mA	SPI Data Input. Connect pull down (1K to 10K Ohm)
57	SPI_MISO	Output	LVC MOS 8mA	SPI Data Output. No connect in UART mode.
58	SPI_CLK	Input	LVC MOS 8mA	SPI interface clock input. Connect pull down (1K to 10K Ohm)

Notes:

- Please contact Redpine Signals for application notes or for customization of a solution.

4: Electrical Characteristics

4.1: Absolute Maximum Ratings

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

Parameter	Symbol	Value	Units
Input Supply voltage	V _{in}	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
PA Output Load Mismatch		10:1	
Electrostatic discharge tolerance (MM)	ESD _{MM}	200	V
Electrostatic discharge tolerance (CDM)	ESD _{CDM}	500	V
Electrostatic discharge tolerance (HBM)	ESD _{HBM}	2000	V

Table 1: Absolute Maximum Ratings

4.2: Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Units
Input supply voltage	V _{IN}	3.1	3.3	3.6	V
Supply voltage for I/O Rail	DVDD33	3.1	3.3	3.6	V
Supply voltage for the RF	VRF33	3.1	3.3	3.6	V
Ambient temperature	T _a	-40	25	85	°C

Table 2: Recommended Operating Conditions

4.3: DC Characteristics – Digital I/O Signals

Parameter	Min.	Typ.	Max.	Units
Input high voltage	2	-	5.5	V
Input low voltage	-0.3	-	0.8	V
Output low voltage	-	-	0.4	V
Output high voltage	2.4	-	-	V

Parameter	Min.	Typ.	Max.	Units
Input leakage current (at 3.3V or 0V)	-	-	±10	μA
Tristate output leakage current (at 3.3V or 0V)	-	-	±10	μA

Table 3: Input/Output DC Characteristics

4.4: AC Characteristics

4.4.1: SPI Interface

Parameter	Symbol	Min.	Typ.	Max.	Units
SPI_CLK Frequency	Fspi	0		25	MHz
SPI_CS to output valid	Tcs	3.5	-	7.5	ns
SPI CS, setup time	Tcst	2	-		
SPI_DATAIN (MOSI), setup time	Tsd	1	-		ns
SPI_DATAIN (MOSI), hold time	Thd	1.5	-		ns
SPI_DATAOUT (MISO), clock to output delay	Tod	4	-	9.25	ns

Table 4: AC Characteristics – SPI Interface

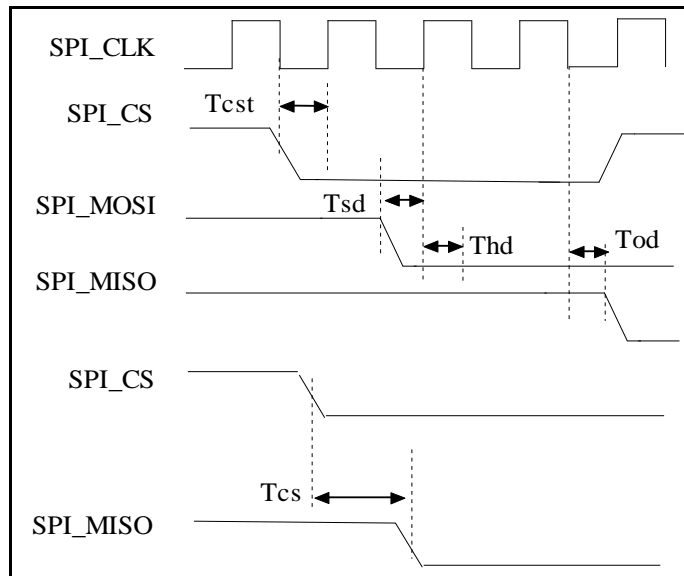


Figure 7: Interface Timings – SPI Interface

4.4.2: Reset Sequence and Timing

Following diagram shows the timing requirement for Reset_n input in two scenarios. This timing is valid for both UART and SPI based modules. The crystal oscillator output should be stable before releasing reset.

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

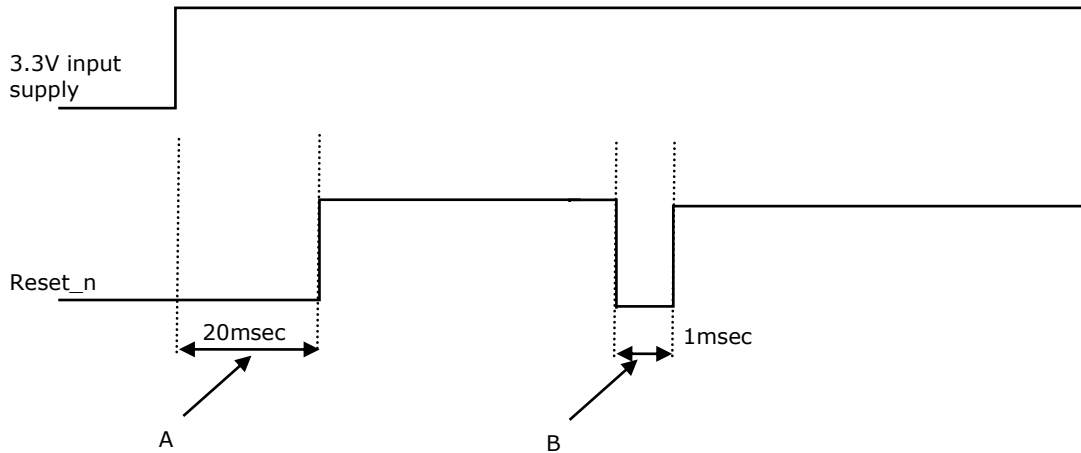


Figure 8: Reset Pin Timing Diagram

5: Performance Specifications

5.1: Wireless Specifications

Feature	Description
Frequency Band	2.400 – 2.500 GHz (Low band) 4.900 – 5.850 GHz (High Band)
Frequency Reference	40 MHz
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, 65 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, Greenfield Protection A-MPDU, A-MSDU Aggregation with Block-ack
Typical Transmit Power (+/- 2 dBm) `bg` Mode	17 dBm for 802.11b DSSS 17 dBm for 802.11b CCK 15 dBm for 802.11g/n OFDM
Typical Transmit Power (+/- 2 dBm) `a` Mode	12 dBm

Table 5: Wireless Specification

5.2: Receive Characteristics

5.2.1: Sensitivity

Data Rate (bg Mode)	Typical Sensitivity (+/- 1.5 dBm)
1 Mbps	-94.0 dBm (< 8% PER)
2 Mbps	-89.0 dBm (< 8% PER)
11 Mbps	-86.0 dBm (< 8% PER)
6 Mbps	-89.0 dBm (<10% PER)
54 Mbps	-74.0 dBm (< 10% PER)
65 Mbps	-71.0 dBm (< 10% PER)
Data Rate (a 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 6: Receive Sensitivity

5.3: Throughput

Interface	(TCP) Throughput
UART (measured at 115200 bauds per sec)	Tx - 75 kbps Rx - 72 kbps
SPI	Tx - 8 Mbps (TCP), 9 Mbps (UDP) Rx - 5 Mbps (TCP), 6 Mbps (UDP)

The numbers are the actual application throughputs. For physical data rates, please refer to the table [Wireless Specification](#).

5.4: Standards Compliance

RS9110-N-11-28 is compliant with the requirements of IEEE 802.11b, 802.11g, 802.11a, 802.11j, and 802.11n that include the following:

- Transmit Spectral Mask
- Transmit Center Frequency Leakage
- Transmit Center Frequency Tolerance
- Symbol Clock Frequency Tolerance
- Transmit Constellation error
- Receiver Adjacent Channel Interference Rejection
- Receiver Non-adjacent Channel Rejection
- Receiver Minimum Input Level
- Receiver Maximum Input Level

6: Software Architecture

The following figure depicts the software architecture of the RS9110-N-11-28 module.

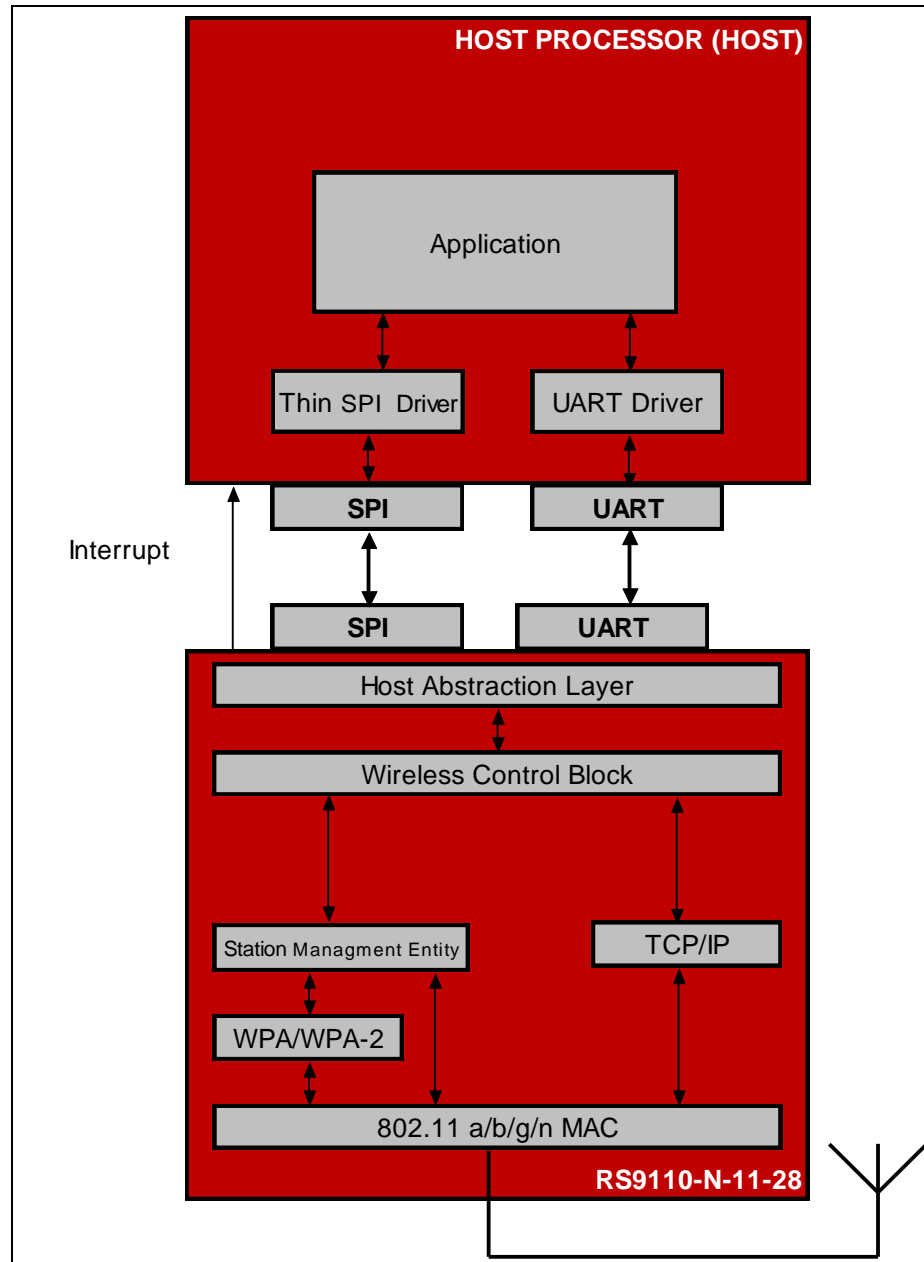


Figure 9: RS9110-N-11-28 Software Architecture Block Diagram

As shown in the figure above, the RS9110-N-11-28 module is integrated with the Host using either UART or SPI interfaces. The transmission and reception of the data to/from the Host depends on the interface used to connect the module as briefed below.

UART mode:

The Host transmits/receives raw data using UART interface when the RS9110-N-11-28 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.

SPI mode:

Host transmits/receives raw data using SPI interface when the RS9110-N-11-28 module is configured for SPI mode. A thin driver on the Host takes care of interacting with the Wi-Fi module through the SPI Host interface.

6.1: Host

The Host is any system that has applications being executed and either a UART or SPI interface. The Host configures the RS9110-N-11-28 module through AT commands.

6.1.1: UART

The UART on the Host side provides an interface for the host to access the Wi-Fi module. UART is used to configure various parameters of the RS9110-N-11-28 module and also to send and receive data over the network by accessing the TCP/IP stack in the RS9110-N-11-28 module.

6.1.2: 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.

6.1.3: Thin SPI Driver

The SPI driver on the Host is a thin driver through which the applications interact with the Wi-Fi module. The SPI driver uses the SPI host controller driver on the Host to send/receive the data to/from the RS9110-N-11-28 module and also to configure the same over the SPI interface.

6.2: RS9110-N-11-28

The RS9110-N-11-28 module incorporates Wi-Fi, TCP/IP, HTTP, DHCP, ARP, etc., and OS functionality to act as a wireless device server. It handles all the network connectivity functions. The following sections describe the software components of the RS9110-N-11-28 module in brief.

6.2.1: SPI

The SPI on the RS9110-N-11-28 acts the SPI slave. It is a standard 4-wire SPI and can support a maximum frequency of 25MHz.

6.2.2: UART

The UART on the RS9110-N-11-28 module is the physical interface which transmits/receives the data from the Host. It supports variable baud rates from 9600 to 3686400 bps. AT commands are used to configure and operate the module through UART interface.

6.2.3: Host Abstraction Layer (HAL)

The HAL abstracts the lower layers in the host interface with which the RS9110-N-11-28 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.

6.2.4: 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 (in case of TCP/IP) as described below.

6.2.4.1: TCP/IP Control frames

If the frames from the host are interpreted as TCP/IP specific frames then the WCB interacts with the TCP/IP stack.

6.2.5: 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 user 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.

6.2.6: WPA Supplicant

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

6.2.7: Power Save Modes

The RS9110-N-11-2X module supports three power modes. The Host can switch among the power modes depending on the Wi-Fi connection status as defined in this section.

6.2.7.1: Power mode 0

In this mode, power save is disabled in the RS9110-N-11-2X module. The module will be in Power Mode 0 by default.

6.2.7.2: Power mode 1

The RS9110-N-11-2X module powers off the Baseband, RF and also the Core Control block in this mode. To power off the Core Control block, the RS9110-N-11-2X module sends request to Host for permission to sleep.

Once the permission is received the Core Control block is powered off. The Host has to wait for the module to wakeup based on the timer that is configured by the Host, before it can transmit any packets.

The functioning of the module in this mode depends on the connection status as explained below

1. Before Wi-Fi connection

In this state, the module is configured with a sleep timer. Once the timer expires, the module powers on the Core Control block and

sends the request for sleep permission to the Host again. On getting permission the Host, the module will power off the Core Control block for another interval of the sleep period.

If the host wants to perform any Wi-Fi related activity like scanning or joining networks, it has to switch to Power Mode 0. After a connection is established, it can switch back to Power Mode 1 or 2.

2. After Wi-Fi Connection

In this state, the RS9110-N-11-2X module periodically wakes up to receive beacons from the Access Point (AP). If there is no data to be transmitted or received to/from the Access Point, it powers off the Baseband and RF components and requests the Host permission to turn off the Core Control block. On receiving permission from the Host, the module goes to sleep and wakes up before the next beacon comes.

6.2.7.3: Power mode 2

The RS9110-N-11-2X module powers off the Baseband and RF components in this mode. The Core Control block interacting with the Host is always functional in this mode. Hence, the module can receive commands from the host at any time.

NOTE: The average current consumption in Power Mode 2 is higher than Power Mode 1.

The functioning of the module in this mode depends on the connection status as explained below

1. Before Wi-Fi connection

If this power mode is enabled before the Wi-Fi connection is established, the module powers off the Baseband and RF components until the Host reconfigures the module to Power Mode 0.

If the host wants to perform any Wi-Fi related activity like scanning and joining networks, it has to switch to Power Mode 0. This can be done at any time during the operation. The Host can switch back to Power Modes 1 or 2 after the Wi-Fi connection is established.

2. After Wi-Fi Connection

In this state, the RS9110-N-11-2X module gets information from the Access Point to which it is connected for any buffered data at every beacon. If there is no data to be transmitted or received to/from the Access Point, it powers off the Baseband and RF components.

7: Ordering Information

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/>

Device Ordering Information:

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

Device Number	Description	Packaging	Qualification
RS9110-N-11-28-04	Part with UART/SPI as Host Interface. UART or SPI mode can be selected using the pin MODE_SEL_1.	Tray	-40 C to +85 C
RS9110-N-11-28-04-EVB	Evaluation board with UART/SPI as Host Interface. UART or SPI mode can be selected using the pin MODE_SEL_1.	Board	

Table 7: Device Ordering Information

Collateral:

The following documentation and software are available along with the RS9110-N-11-28 module.

- Embedded firmware for WLAN and TCP/IP stack
- AT Command Interface and SPI driver software
- Reference schematics and layout guidelines – Describes hardware schematics to operate the module in UART and SPI modes.
- Programming Reference Manual – Describes how to operate the module in UART and SPI modes.
- Evaluation Board (EVB) and related user guides

8: Command Reference (AT commands and SPI commands)

AT Command Set (for UART interface) and SPI command set (for SPI interface) supports the following in RS9110-N-11-XX module. This is an indicative list and not a full list. Full list of commands available in Programming Reference Manual.

- i. Configure the band to 2.4GHz or 5 Ghz
- ii. Initialize MAC and Baseband
- iii. Scan for available networks
- iv. Join an available network in infrastructure or ad-hoc modes
- v. Configure IP addresses
- vi. Open and close TCP and UDP sockets
- vii. Send and receive data
- viii. Soft reset
- ix. Query by host for network parameters like RSSI, IP addresses, security type etc.



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Наши контакты:

Телефон: +7 812 627 14 35

Электронная почта: sales@st-electron.ru

Адрес: 198099, Санкт-Петербург,
Промышленная ул, дом № 19, литера Н,
помещение 100-Н Офис 331