

# **B+B** SMARTWORX

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## **Product Specification**

**WLNN series**

**APMN series**

**ABDN series**

**APXN series**

**Modules & Open Boards**

**802.11a/b/g/n Advanced Enterprise  
Device Server and Access Point**

**Revision 5 | September 2017**

# **B+B SmartWorx**

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## 1.0 Conventions

The following section outlines the conventions used within the document. Where convention is deviated from, the deviation takes precedence and should be followed. If you have any questions related to the convention used or clarification of indicated deviation, please contact B+B SmartWorx Sales or Wireless Support.

### 1.1 Terminology

*AirborneM2M Device Server* is used in the opening section to describe the devices detailed in this document. After this section the term **module** will be used to describe the devices.

### 1.2 Notes

A note contains information that requires special attention. The following convention will be used. The area next to the indicator will identify the specific information and make any references necessary.



The area next to the indicator will identify the specific information and make any references necessary.

### 1.3 Caution

A caution contains information that -- if not followed -- may cause damage to the product or injury to the user. The shaded area next to the indicator will identify the specific information and make any references necessary.



The area next to the indicator will identify the specific information and make any references necessary.

## 2.0 Product Description

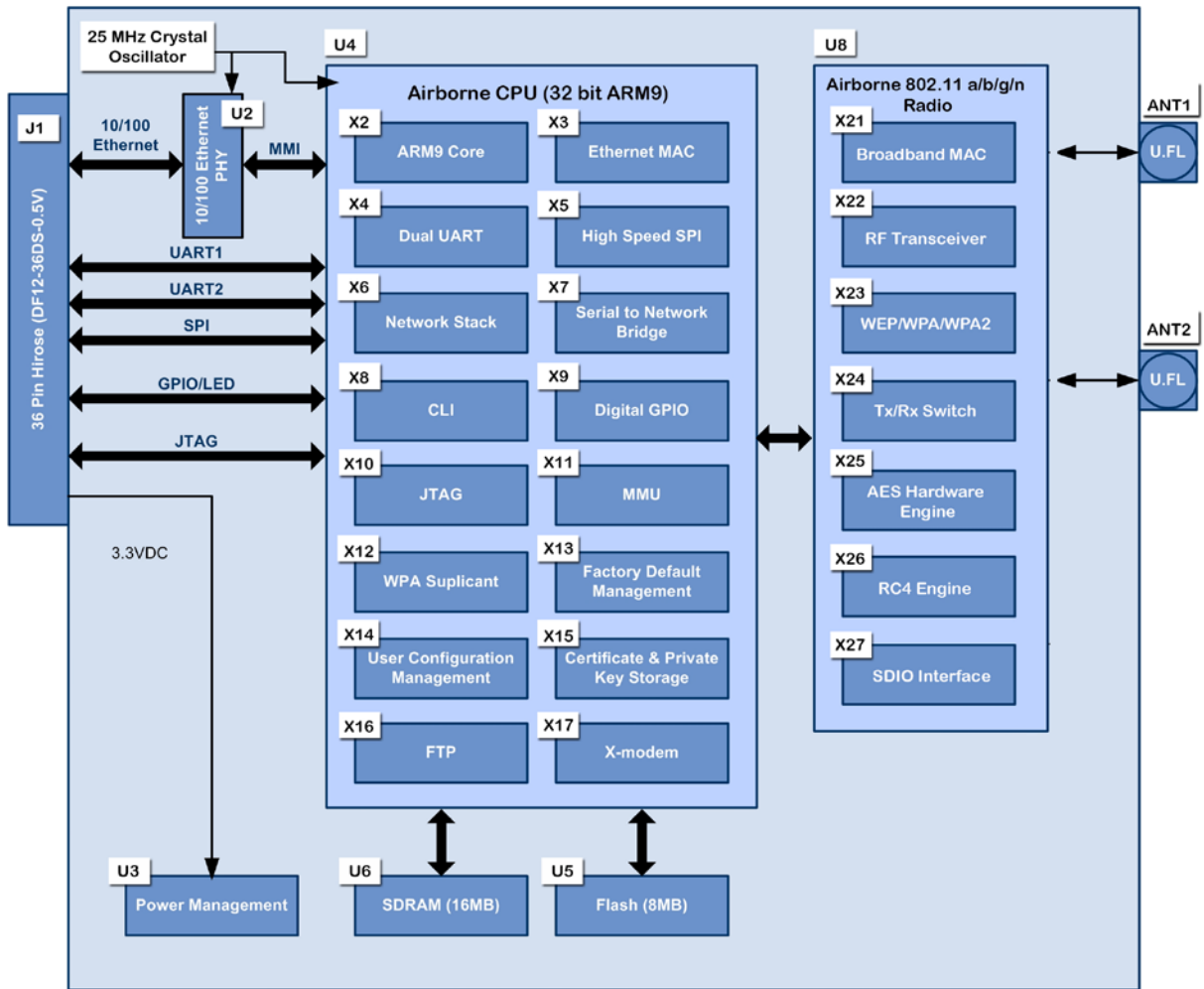
The 9373 and 9768 family of modules are the latest generation of 802.11 wireless device servers and adapters from B+B SmartWorx. The radio features the following:


- 802.11a/b/g/n Wi-Fi Radio with 32-bit ARM9 CPU (128/256Mb SDRAM, 64Mb Flash)
- Atheros AR6203x 802.11a/b/g/n radio chipset.
- Supports Access Point, Infrastructure and AdHoc Client networks (software selectable)
- Access Point device includes:
  - Up to eight (8) simultaneous clients
  - WEP, WPA-PSK and WPA2-PSK security
  - Integrated DHCP server
  - Tx power control
  - MAC address filtering
- Infrastructure device includes:
  - Supports WEP, WPA, WPA2, 802.11i and 802.1x Supplicant, with Certificates.
- The wireless device server includes integrated:
  - 802.11a/b/g/n radio driver
  - TCP/IP stack, UDP, telnet, FTP server
  - Data bridging and buffering
  - Command Line Interface
  - Web interface
  - WPA Supplicant
  - 802.11 radio driver
- Operating Temperature (-40°C to +85°C)
- Storage Temperature (-40°C to +85°C)
- 36-pin high density SMT connector (*Hirose DF12-36*)
- Dual (2) Hirose U.FL RF connector for RF antenna
- Multiple host interfaces supported:
  - Dual UART (921.6K BAUD)
  - Serial (RS-232/422/485)
  - SPI
  - 10/100 Ethernet PHY (Bridge/Router modes supported)
- Advanced low power modes
- Rugged mounting options
- No host driver required
- Small form factor module (Dimensions: 40.6mm x 29.6mm x 7.5mm)

### 3.0 Block Diagram

The following outlines the block diagram of the radio:

Figure 1 – WLNN-xx-xx551, APMN-xxxx | Module 9373 Family Block Diagram



 SDRAM memory size: 32 MB for module 9373.

## 4.0 Model Numbers

The following table identifies the model numbers associated with the device server family. Please contact B+B SmartWorx sales for details, quotes and availability.

Table 1 - Model Numbers

Model Number	Description	Wi-Fi		Interface						Security				RoHS
		802.11 a/b/g/n Client	802.11 a/b/g/n Access Point	UART	RS232	RS485	SPI	Ethernet	GPIO	WEP	WPA	WPA2	802.11i	
WLNN-AN-DP551	802.11a/b/g/n, UART Device Server	•		2	•	•			•	•	•	•	•	•
WLNN-ER-DP551	802.11a/b/g/n, 10/100 Ethernet Router Device Adapter	•		2				•	•	•	•	•	•	•
WLNN-SE-DP551	802.11a/b/g/n, UART Device Server with RS232/422/485 driver control	•		2	•	•			•	•	•	•	•	•
WLNN-SP-DP551	802.11a/b/g/n, SPI Device Server	•					•		•	•	•	•	•	•
APMN-Q551	802.11a/b/g/n Access Point, Ethernet Bridge/Router, Dual UART Device Server	•	•	2	•	•	•	•	•	•	•	•		•
Evaluation Kits														
WLNN-EK-DP551	802.11a/b/g/n Enterprise Class Access Point and Serial Device Server Module Evaluation Kit													•

Note: Each model is based on a 9373 module (32 MB Memory).



## 5.0 Pin out and Connectors

Pin definition is dependent upon the device type selected. The specific pin function is defined in Table 2 for each device type. Where multiple options are available for a single device type, these options are software selectable by the device firmware.

Table 2 – Module Pin Definition

Pin	Name	Device Type	Description
1	GND	All	Digital Ground
2	TDI	All	JTAG: Test data in
3	VDD	All	3.3VDC
4	VDD	All	3.3VDC
5	RTCK	All	JTAG: Return Test Clock
6	DTXD	All	D <sub>OUT</sub> Debug
7	/RESET	All	Module RESET
8	DRXD	All	D <sub>IN</sub> Debug
9	RXD2	UART	D <sub>IN</sub> UART2
	RXD2	Serial	D <sub>IN</sub> UART2
	RXD2	SPI	D <sub>IN</sub> UART2
	RXD2	Ethernet	D <sub>IN</sub> UART2
	G6	All	GPIO
10	TDO	All	JTAG: Test data out
11	/FRESET	All	Factory RESET
12	CTS1	UART	Clear-to-Send UART1
	CTS	Serial	Clear-to-Send
	/SPI_SEL	SPI	SPI Select
	CTS1	Ethernet	Clear-to-Send UART1
	F5	All	GPIO
13	NC	UART	No Connect
	NC	Serial	No Connect
	NC	SPI	No Connect
	RX+	Ethernet	Ethernet RX+
14	NC	UART	No Connect
	NC	Serial	No Connect
	NC	SPI	No Connect
	RX-	Ethernet	Ethernet RX-
15	GND	All	Digital Ground
16	GND	All	Digital Ground
17	RTS2	UART	Ready-to-Send UART2
	/TXEN	Serial	Line Driver Tx Enable
	RTS2	SPI	Ready-to-Send UART2
	RTS2	Ethernet	Ready-to-Send UART2
	G2	All	GPIO
18	RTS1	UART	Ready-to-Send UART1
	RTS	Serial	Ready-to-Send
	SPI_CLK	SPI	SPI Clock Input
	RTS1	Ethernet	Ready-to-Send UART1
	F4	All	GPIO
19	CTS2	UART	Clear-to-Send UART2
	RXEN	Serial	Line driver Rx Enable
	CTS2	SPI	Clear-to-Send UART2
	CTS2	Ethernet	Clear-to-Send UART2
	G1	All	GPIO
20	TCK	All	JTAG: Test clock
21	TXD2	UART	D <sub>OUT</sub> UART2
	TXD2	Serial	D <sub>OUT</sub> UART2
	TXD2	SPI	D <sub>OUT</sub> UART2

Pin	Name	Device Type	Description
	TXD2	Ethernet	D <sub>OUT</sub> UART2
	G7	All	GPIO
22	G0	UART	GPIO
	SER_MODE	Serial	Serial interface type selection (RS232/422/485)
	SPI_INT	SPI	SPI Interrupt
	G0	Ethernet	GPIO
23	LED_CON	All	Valid TCP/IP Connection Indicator
	F6		GPIO
24	RXD1	UART	D <sub>IN</sub> UART1
	RXD1	Serial	D <sub>IN</sub> UART1
	MOSI	SPI	D <sub>IN</sub> SPI
	RXD1	Ethernet	D <sub>IN</sub> UART1
	F7	All	GPIO
25	LED_POST	All	POST Status Indicator
	F0		GPIO
26	LED_WLN_CFG	All	Module TCP/IP Configuration Indicator
	F3		GPIO
27	LED_RF_LINK	All	Module RF Link Status Indicator
	F2		GPIO
28	TXD1	UART	D <sub>OUT</sub> UART1
	TXD1	Serial	D <sub>OUT</sub> UART1
	MISO	SPI	D <sub>OUT</sub> SPI
	TXD1	Ethernet	D <sub>OUT</sub> UART1
	F1	All	GPIO
29	NC	UART	No Connect
	NC	Serial	No Connect
	NC	SPI	No Connect
	TX-	Ethernet	Ethernet TX-
30	NC	UART	No Connect
	NC	Serial	No Connect
	NC	SPI	No Connect
	TX+	Ethernet	Ethernet TX+
31	NTRST	All	JTAG: Test RESET signal
32	TMS	All	JTAG: Test mode select
33	VDD	All	3.3VDC
34	VDD	All	3.3VDC
35	LED_RF_ACT	All	Radio Status Indicator, driven by the radio.
36	GND	All	Digital Ground

## 5.1 Digital UART Ports

The device supports two digital UART ports. Use of these ports is determined by the device type choice made in firmware. The details of the ports can be seen in Table 3.

The availability of UART2 is selected in firmware.

Table 3 - UART Pin Definition

Device Type	UART		Serial		All
Pin Definition	UART1 Pin	UART2 Pin	UART1 Pin	UART2 Pin	Debug
Data out (D <sub>OUT</sub> )	28	21	28	21	6
Data In (D <sub>IN</sub> )	24	9	24	9	8
Clear-to-Send (CTS)	12	19	12		
Ready-to-Send (RTS)	18	17	18		
Transmit Enable (/TXEN)			17		
Receive Enable (/RXEN)			19		
Serial Mode (SER_MOD)			22		

The primary UART supports a 4-wire interface. The secondary port supports a 4-wire interface except when being used with the Serial Device type, in which case it is reduced to a 2-wire only.

The primary digital UART can be used as the primary connection for the Serial device type. This type supports a 7-wire interface to allow the definition of the serial interface type (RS232/3422/485) and the data transfer direction. Definitions of this interface can be seen in Table 3.

The UART1 and UART2 interfaces support the following possible configurations:

BAUD: 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200, 230400, 460800, 921600

Flow Control: None, Hardware (CTS/RTS), Software (XON/XOFF)

Default settings: 9600, 8, N, 1, No Flow Control.

## 5.2 Ethernet PHY Port

A 10/100 Ethernet PHY interface is supported on all device types (except SPI). It is enabled by default when the Ethernet device type is selected in firmware. This interface is a 10/100Mbps interface that supports auto negotiation and cross-over cabling. The interface also supports both half and full-duplex for 10Mbps and 100Mbps.

The interface uses a Broadcom BCM5241A Ethernet PHY. Please refer to the manufacturer's datasheet for interface details and appropriate design guidelines.

## 5.3 Serial Peripheral Interface (SPI)

Please refer to section 7.0 for details on this interface.

## 5.4 Debug/Console Port

A debug/console port is supported by a 2-wire serial interface defined in Table 3. This port is a bi-directional serial port intended for debug of the unit only. It does not support data transfer.

It is recommended that a connection to this port be supported via test points or a two pin header. The default settings for the debug port are: 115200, 8, N 1, No Flow Control.



**CAUTION:** Do not use the debug port without contacting B+B SmartWorx Technical Support first. Potential damage to the module may occur.

## 5.5 General Purpose Input/Output (GPIO)

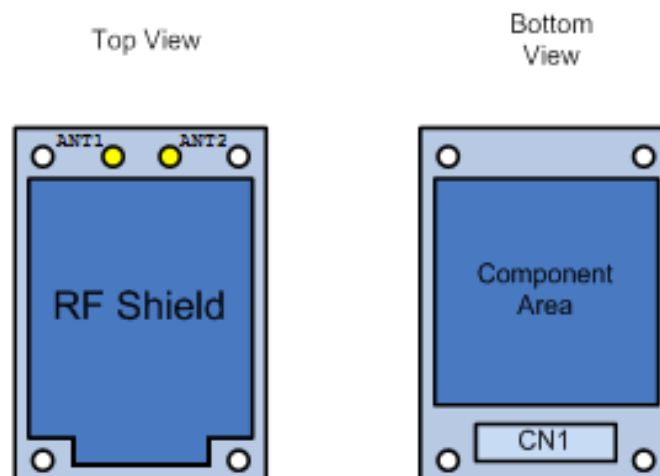
A number of the interface pins support multiple functional definitions. Those alternately defined as GPIO pins can be selected as such via device firmware.

The GPIO pins are digital I/O capable of supporting up to a 16mA drive current at 3.3VDC.

## 5.6 Connector Definition

There are a total of three connectors to the radio:

- CN1: 36-pin Digital Host interface.  
Hirose: **DF12B-36DP-0.5V(XX)** (0.50mm (.020") Pitch Plug, Surface Mount, Dual Row, Vertical, 4.00mm Stack Height, 36 Circuits)
- ANT1: RF connector for 802.11a/b/g/n antenna.  
Hirose U.FL
- ANT2: RF connector for 802.11a/b/g/n antenna (Default).  
Hirose U.FL



## 6.0 Electrical & RF Specification

Table 4- Absolute Maximum Values<sup>1</sup>

Parameter	Min	Max	Unit
Supply Voltage	-0.5	3.6	VDC
Power Dissipation		2.00	W
Operating Temperature Range	-40	85	°C
Storage Temperature	-40	85	°C

Note: 1. Values are absolute ratings, exceeding these values may cause permanent damage to the device.

Table 5 – Operating Conditions & DC Specification

Symbol	Parameter	Min	Typ	Max	Units
V <sub>DD</sub>	Supply Voltage	3.14	3.30	3.60	V
V <sub>IL</sub>	Input Low Level Voltage	-0.3		0.8	
V <sub>IH</sub>	Input High Level Voltage	2.0		V <sub>DD</sub> + 0.3	
V <sub>OL</sub>	Output Low Level Voltage			0.4	
V <sub>OH</sub>	Output High Level Voltage	V <sub>DD</sub> - 0.4			
I <sub>IR</sub>	Inrush current <i>400µs duration, source resistance 150mΩ</i>			1500	mA
I <sub>CCG</sub>	Operating Current – UART Data (802.11g) <i>Connection Rate @ 54Mb/s UART 100% Duty Cycle @ 920K BAUD</i>		320		mA
I <sub>CCB</sub>	Operating Current – UART Data (802.11b) <i>Connection rate @ 11Mb/s UART 100% Duty Cycle @ 920K BAUD</i>		430		mA
I <sub>CCG_ETH</sub>	Operating Current – Ethernet Data (802.11g) <i>Transmitting @ 54Mb/s 10/100 Ethernet 100% Duty Cycle</i>		370		mA
I <sub>CCB_ETH</sub>	Operating Current – Ethernet Data (802.11b) <i>Transmitting @ 11Mb/s 10/100 100% Duty Cycle</i>		480		mA
I <sub>CCU</sub>	Radio and CPU on. No data traffic (UART)		140		mA
I <sub>CCE</sub>	Radio and CPU on. No data traffic (Ethernet)		190		mA
I <sub>SBUO</sub>	Radio off (UART) <i>CPU Idle, radio off (f/w control)</i>		100		mA
I <sub>SBE0</sub>	Radio off (Ethernet) <i>CPU Idle, radio off (f/w control)</i>		150		mA

Symbol	Parameter	Min	Typ	Max	Units
I <sub>SB1U</sub>	Doze Mode (UART/Serial) <i>IEEE PSpoll mode (DTIM = 10), Associated, Idle, Beacon Interval = 100ms CPU Idle, wake on UART traffic</i>		110		mA
I <sub>SB1E</sub>	Doze Mode (Ethernet) <i>IEEE PSpoll mode (DTIM = 10), Associated, Idle, Beacon Interval = 100ms CPU Idle, wake on Network traffic</i>		160		mA
I <sub>SB3U</sub>	Sleep Mode – UART/Serial <i>Radio Off (disassociated) CPU Idle, wake on UART traffic</i>		110		mA
I <sub>SB3E</sub>	Sleep Mode – Ethernet <i>Radio Off (disassociated) CPU Idle</i>	110		150	mA

Table 6 - RF Characteristics – 802.11a/b/g/n

Symbol	Parameter	Rate (Mb/s)	Min	Average		Peak		Units
				dBm / mW	dBm / mW	dBm / mW	dBm / mW	
P <sub>OUTB</sub>	Transmit Power Output 802.11b	11, 5.5, 2, 1		15.0	31.6			dBm
P <sub>OUTG</sub>	Transmit Power Output 802.11g	6, 9, 12, 18, 24, 36, 48, 54		12.6	18.2			dBm
P <sub>OUTA</sub>	Transmit Power Output 802.11a	6, 9, 12, 18, 24, 36, 48, 54		17.0	50.1			dBm
P <sub>RSENB</sub>	Receive Sensitivity 802.11b	11		-86				dBm
		1		-92				
P <sub>RSENG</sub>	Receive Sensitivity 802.11g	54		-72				dBm
		36		-78				
		18		-84				
		6		-89				
P <sub>RSENA</sub>	Receive Sensitivity 802.11a	54		-74				dBm
		36		-80				
		18		-86				
		6		-90				
F <sub>RANGE<sub>BG</sub></sub>	Frequency Range 802.11b/g		2401			2495		MHz
F <sub>RANGE<sub>A</sub></sub>	Frequency Range 802.11a		4910 5150 5470 5725			4990 5350 5725 5825		MHz


Table 7 - Supported Data Rates by Band

Band	Supported Data Rates (Mb/s)
802.11b	11, 5.5, 2, 1
802.11a/g	54, 48, 36, 24, 18, 12, 9, 6
802.11n	65, 58.5, 42, 39, 26, 19.5, 13, 6.5

Table 8 - Operating Channels

Band	Region*	Freq Range (GHz)	No. of Channels	Channels
802.11b <sup>1,2</sup>	US/Canada	2.401 - 2.473	11	1 – 11
	Europe	2.401 - 2.483	13	1 – 13
	Japan	2.401 - 2.483	13	1 – 13
802.11g <sup>1,2</sup>	US/Canada	2.401 - 2.473	11	1 – 11
	Europe	2.401 - 2.483	13	1 – 13
	Japan	2.401 - 2.483	13	1 – 13
802.11a <sup>3</sup>	US/Canada	5.15 - 5.35	11	36, 40, 44, 48, 52, 56, 60, 64, 149, 153, 157
		5.470 – 5.725	8	100, 104, 108, 112, 116, 132, 136, 140
		5.725 - 5.825	2	161, 165
	Europe	5.15 - 5.35 5.47 - 5.725	19	36,40,44,48,52,56,60,64,100,104,108,112,116,120,124,128,132,136,140
	Japan	5.150 - 5.250	4	36,40,44,48 (Known as W52)
		5.250 – 5.350	4	52,56,60,64 (Known as W53)
		5.470 - 5.725	11	100,104,108,112,116,120,124,128,132,136,140 (Known as W56)
	China	5.725 - 5.825	5	149,153,157,161,165

\*Contact B+B SmartWorx if specific country or region support is required.



1. Only channels 1, 6 and 11 are non-overlapping.
2. Channel count denotes number of non-overlapping channels. Channels shown represent non-overlapping channel numbers.



### 6.1 AC Electrical Characteristics – Transmitter

Transmit power is automatically managed by the device for minimum power consumption. The MAXIMUM transmit power at the RF connector is typically +20dBm ± 2 dB for all bands (a/b/g/n) and rates.

### 6.2 Performance/Range

The following table illustrates the typical data rates, performance and range that the device is capable of providing use of an omni-directional antenna.

Table 9 - Radio Typical Performance Range

Data Rate	Typical Outdoor Distance (Unity gain antenna)	Typical Outdoor Distance (2dBi antenna gain on each end for B/G mode)
1.0 Mb/s	240m	380m
11.0 Mb/s	135m	215m
6Mb/s 802.11g	135m	215m
54Mb/s 802.11g	12m	19m

Note: These ranges are provided as guidance only. Wireless range is highly dependent on local conditions.

Ranges are based on receiver sensitivity, transmitter power, free-space path loss estimates, antenna gain factors, and link margin estimates. Actual range will vary from those stated. Non line-of-sight applications will result in typical values less than shown above.

The data rate is the supported connection rate for the wireless link. However, the actual data throughput for the link will be less than the stated data rates.

## 7.0 SPI Interface

The following section details the SPI interface specification for both hardware timing and SPI protocol. The device is a SPI slave and requires a compatible SPI master for operation.

### 7.1 Pin-out

When the SPI interface is enabled, through the CLI or web interface, the following pins are assigned for communication.

Table 10 - SPI Pinout Details

Pin Definition	SPI	UART2 Pin	Debug
Master In Slave Out (MISO)	28		
Master Out Slave In (MOSI)	24		
SPI Interrupt (SPI_INT)	22		
SPI Clock (SPI_CLK)	18		
SPI Select (/SPI_SEL)	12		
Data In (RxD2, DTXD)		9	8
Data out (TxD2, DRXD)		21	6
Ready-to-Send (RTS2)		17	
Clear-to-Send (CTS2)		19	

Table 11 - SPI Signal Descriptions

Pin Definition	Description
Master In Slave Out (MISO)	Serial Data OUT; must be connected to the serial data in of the master.
Master Out Slave In (MOSI)	Serial Data IN; Must be connected to the serial data out of the master.
SPI Interrupt (SPI_INT)	Interrupt signal driver by slave see Table 16 for details of operation.
SPI Clock (SPI_CLK)	SPI clock sourced from the master.
SPI Select (/SPI_SEL)	Enable the SPI slave, sourced from the master. Active low signal.



Use of the SPI interface is mutually exclusive with the use of UART1 and the Ethernet ports, as the API interface reuses pins from both of these interfaces.

## 7.2 SPI AC Characteristics

The following specification identifies the required hardware timing to successfully implement a SPI interface with the AirborneM2M Device Server module.

Table 12 - SPI AC Timings

Symbol	Parameter	Min	Typ	Max	Units
$f_{MAX}$	Maximum Clock Frequency			8.00	MHz
$t_{CS}$	SPI Select Low to Clock Rising Edge	100			ns
$t_{CH}$	Clock High	62.5			ns
$t_{CL}$	Clock Low	62.5			ns
$t_{DA}$	Clock High to Data Out			60	ns
$t_{DS}$	Clock Low to Data In Valid Set-up time	14			ns
$t_{DH}$	Clock Low to Data Valid Hold time	2			ns
$t_{CSH}$	Clock Falling Edge to SPI Select High	100			ns
$t_{DELAY}$	SPI Select High to SPI Select Low	40			$\mu$ s

Figure 2 - SPI Read/Write Timing

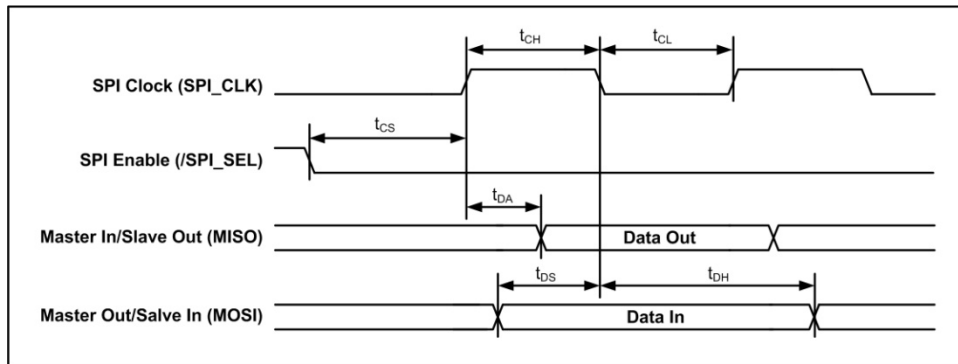
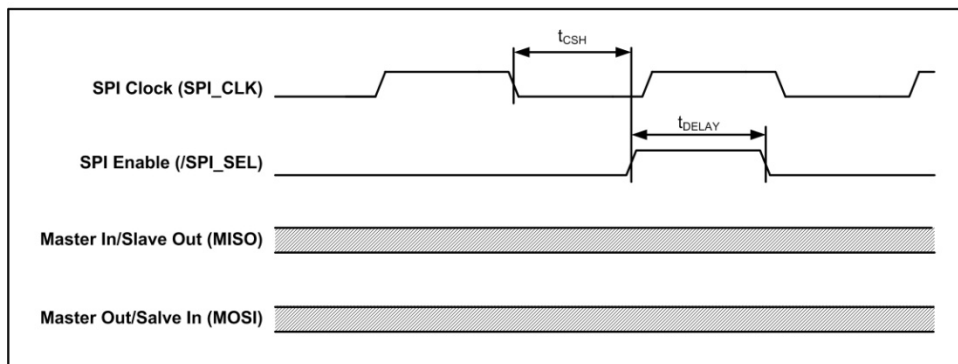


Figure 3 - SPI Clock and Select Timing



### 7.3 SPI Protocol

An SPI message is composed of a 4-byte header followed by 0 or more bytes of data. The header data is full-duplex. That is, the TX message header is sent to the AirborneM2M Device Server module by the host at the same time that the RX message header is sent to the host from the AirborneM2M Device Server.

The TX message header consists of a Command (CMD) byte, followed by three Parameter (PARM) bytes. They are described in the SPI Commands section 0 below.

The RX message header is shifted out as the first four bytes of an SPI message regardless of the contents of the TX message header. The RX message header consists of a RX Data Available field and a TX Buffer Available field. The RX Data Available field indicates the number of data bytes the Device Server has available for the host. The data can be received by the RXDATA command. The TX Buffer Available field indicates how many data bytes the Device Server is able to accept from the host. This data is to be shifted in by the host using the TXDATA (Table 16) command. Both fields are 16 bit values and are stored in little-endian format (Least significant byte first).



 The /SPI\_SEL signal must be de-asserted between successive SPI messages. The messages will not be processed correctly if /SPI\_SEL is held asserted across multiple messages.

Table 13 - TX Message Header

0	1	2	3
CMD	PARM1	PARM2	

Table 14 - RX Message Header

0	1	2	3
RX Data Available		TX Buffer Available	

 SPI data is transferred most significant bit first (msb).

## 7.4 SPI Modes


The AirborneM2M device supports the following four SPI modes. These are selectable through the command line or web interfaces. The default mode is zero (0).

Table 15 - SPI Modes

SPI Mode	Clock Idle	Clocking Edge
0	Low	High-Low (trailing edge)
1	Low	Low-High (leading edge)
2	High	Low-High (trailing edge)
3	High	High-Low (leading edge)

## 7.5 SPI Commands

The following commands are available for use in the CMD message header.



Unused parameters should be set to zero.

Table 16 - SPI Command Description

Command (Hex)	Name	Description
0x00	NOP	The NOP command does nothing. It is intended to be used when the host wants to simply retrieve the RX Message Header without any other operation. PARAM1 and PARAM2 are unused for this command and should be set to zero.
0x04	BREAK	The BREAK command will issue a break sequence to the module. It is analogous to the BREAK signal on a common UART. Use this command to issue a BREAK if the <i>esc-mode-serial brk</i> setting is configured in the module. PARAM1 and PARAM2 are unused for this command and should be set to zero.
0x08	TXINTCLR	The TXINTCLR command will clear the TX interrupt. Use this command when the module is issuing a TX interrupt but the host has no more data to send. This is analogous to the reset TX interrupt command on a common UART. The result of this command is that the TX interrupt is cleared even though the host is not writing more data to the module. PARAM1 and PARAM2 are unused for this command and should be set to zero.

Command (Hex)	Name	Description
0x10	INTENA	<p>The INTENA command will configure the specific interrupts to be enabled from the module. For this command, the PARM1 field will define the interrupts to be enabled.</p> <p>The definition of the PARM1 field for this command is a bit-mask and is formatted as follows:</p> <p><b>Bit 7    Interrupt Sense</b> – Determines the asserted state of the interrupt pin. If this bit is set to a 1, the interrupt pin will be active high; otherwise the interrupt pin will be active low. The module will use the setting of this bit from the most recently issued INTENA command to determine the Interrupt Sense.</p> <p><b>Bit 1    TX Interrupt</b> – If this bit is set to a 1, the interrupt pin will be asserted when there is space available in the TX buffer. The interrupt will be cleared when the module has TX data to process from the host. Alternately, the host can clear this interrupt by using the TXINTCLR command if the host has no more data to send.</p> <p><b>Bit 0    RX Interrupt</b> – If this bit is set to a 1, the interrupt pin will be asserted when there is RX data available. The interrupt will be cleared when the host has received all the RX data available from the module.</p> <p>All other bits of PARM1 are unused for this command and should be set to zero.</p> <p>PARM2 is unused for this command and should be set to zero.</p> <p>For example, to enable TX interrupts with the interrupt pin active high, use the SPI message 0x10 0x82 0x00 0x00. That is, SPI command 0x10, PARM1 is 0x82, PARM2 is 0x0000.</p> <p><b>Important:</b> The INTENA command can only be used to enable the specified interrupts. This command cannot be used to disable specified interrupts by setting the corresponding interrupt enable bits to zero in PARM1. The INTDIS command must be used to disable the specified interrupts.</p>
0x20	INTDIS	<p>The INTDIS command will configure the specific interrupts to be disabled from the module. For this command, the PARM1 field will define the interrupts to be disabled.</p> <p>The definition of the PARM1 field for this command is a bit-mask and is formatted as follows:</p> <p><b>Bit 1    TX Interrupt</b> – If this bit is set to a 1, The TX interrupt function will be disabled.</p> <p><b>Bit 0    RX Interrupt</b> – If this bit is set to a 1, the RX interrupt function will be disabled.</p> <p>All other bits of PARM1 are unused for this command and should be set to zero.</p> <p>PARM2 is unused for this command and should be set to zero.</p> <p>For example, to disable TX interrupts, use the SPI message 0x20 0x02 0x00 0x00. That is, SPI command 0x20, PARM1 is 0x02, PARM2 is 0x0000.</p>

Command (Hex)	Name	Description
0x40	TXDATA	<p>The TXDATA command is used to send data to the module to be interpreted as commands if the module is in CLI mode, or to be transmitted on the wireless link if the module has an active data connection established.</p> <p>The host may send at most the number of bytes indicated by the TX Buffer Available field in the RX Message Header. The actual number of bytes sent by the host is determined by the 16 bit value in PARM2. The value in PARM2 is little-endian (least significant byte first) and must be less than or equal to the number in the TX Buffer Available field. Any bytes sent in excess of this number will be ignored.</p> <p>PARM1 is unused for this command and should be set to zero.</p> <p>For example, to send the <code>auth dpac dpac</code> command, use the SPI message <code>0x40 0x00 0x0F 0x00 0x61 0x75 0x74 0x68 0x20 0x64 0x70 0x61 0x63 0x20 0x64 0x70 0x61 0x63 0x0D</code>. That is, SPI command <code>0x40</code>, PARM1 is <code>0x00</code>, PARM2 is <code>0x000F</code>, followed by the text for <code>auth dpac dpac</code>.</p>
0x80	RXDATA	<p>The RXDATA command is used to receive data from the module. In CLI mode, this data will be the local echoing of the commands issued to the module, as well as the command responses generated by the module. If the module has an active data connection established, this data will be the data received on the wireless link.</p> <p>The host may receive at most the number of bytes indicated by the RX Data Available field in the RX Message Header. The actual number of bytes received by the host is determined by the 16 bit value in PARM2. The value in PARM2 is little-endian (least significant byte first) and must be less than or equal to the number in the RX Data Available field. If additional clock cycles are sent to the module beyond this number, meaningless data will be returned.</p> <p>PARM1 is unused for this command and should be set to zero.</p>

The TXDATA and RXDATA commands can be combined for full-duplex operation. For example, a command byte of **0xC0** would be a TXDATA and RXDATA command combined. The result of this command would be that the module would accept data being shifted in as TX data, while at the same time, RX data would be shifted out. In this case, the number of bytes transferred for TXDATA must be equal to the number of bytes transferred for RXDATA. The PARM2 parameter will indicate the number of bytes to be transferred for both the TXDATA and RXDATA commands.

## 8.0 Antenna

The unit supports antenna connections through two Hirose U.FL connectors (ANT1 and ANT2). They are located on the top surface of the device next to the RF shielding. Antenna selection options are selectable through both the web and command line interfaces.

Any antenna used with the system must be designed for operation within: the 2.4GHz ISM band and must specifically support 2.412GHz to 2.482GHz for 802.11b/g, the 5GHz ISM band and must specifically support 5.1GHz to 5.9GHz for 802.11a operation. They are required to have a VSWR of 2:1 maximum referenced to a 50 $\Omega$  system impedance.

### 8.1 Performance

Performance is difficult to define. The appropriate metric changes with each application, and may be a combination of parameters and application requirements. The most important characteristic will normally be link quality. This can be defined as the available bandwidth between the two devices. The lower the link quality, the less likely it will be that the devices can communicate.

Measurement of link quality can be made in several ways; Bit Error Rate (BER), Signal to Noise (SNR) ratio, Signal Strength and distortion. The link quality is used by the radio to determine the link rate. In general, when the link quality for a given link rate drops below a predefined limit the radio will drop to the next lowest link rate and try to communicate at that rate.

The reverse is also true. If the radio observes good link quality at one rate it will try to move up to the next rate to see if communication can still be sustained. Note that for a given position the link quality improves as the link rate is reduced. As the link rate drops, the radios' Transmit power and Receive sensitivity improve.

Looking at the link rate is an indirect way of assessing the quality of the link between the device and an Access Point. You should strive to make the communication quality as good as possible in order to support the best link rate. But be careful not to *over specify* the link rate. Consider your application's bandwidth requirements and tailor your link rate to optimize the link quality. For example, if the link quality for a location at 6Mb/s is better than it would be for 54Mb/s, and the application only needs 2Mb/s of data throughput, the 6Mb/s rate would provide better link quality.

Radio performance is only one of the things that contribute to the link quality. Other factors include the items discussed earlier and choices made regarding overall antenna gain. The antenna gain contributes to the Equivalent Isotropically Radiated Power (EIRP) of the system. This is called link margin, and it is part of the overall measurement of the link quality.

Link Margin provides a measure of all the parts of the RF path that impact the communications between two systems. The basic equation looks like this:



$$\mathbf{EIRP\ (dB) = TxP + TxA - TxC}$$

$$\mathbf{Link\ Margin\ (dB) = EIRP - FPL + (RxS + RxA - RxC)}$$

Where:

- TxP = Transmitter output power (dBm)
- TxA = Transmitter antenna gain (dBi)
- TxC = Transmitter to Antenna coax cable loss (dB)
- FPL = Free Path Loss (dB)
- RxS = Receiver receive sensitivity (dBm)
- RxA = Receiver antenna gain (dBi)
- RxC = Receiver to Antenna coax cable loss (dB)

This is a complex subject and we won't try to cover it here. B+B SmartWorx technical experts can help you if you need to explore it in more detail. But you should understand that optimizing link quality involves a combination of hardware selection, design choices and radio configuration.

## 9.0 RESET Function

For correct operation of the on-board Power-on RESET (POR) and internal RESET controllers, the RESET pin on the WLNN-XX-DP550 family must obey the following timing and signal conditions.

Figure 4 - Power on RESET Timing

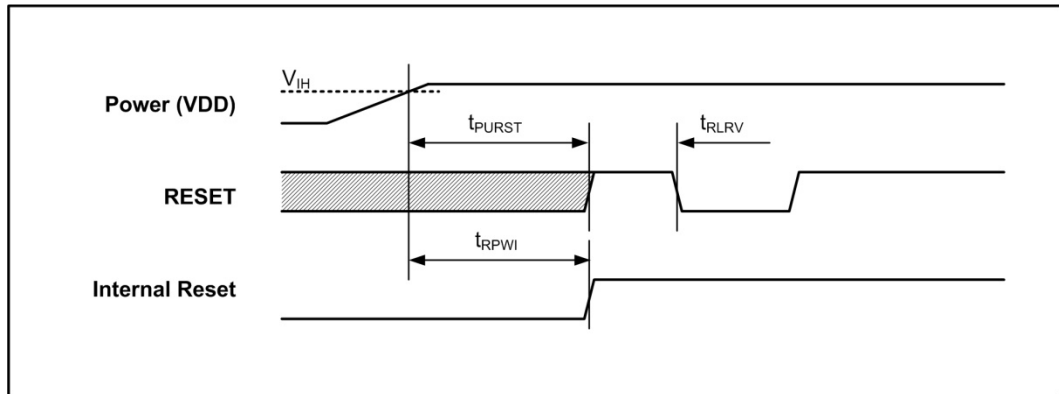


Figure 5 - RESET Timing

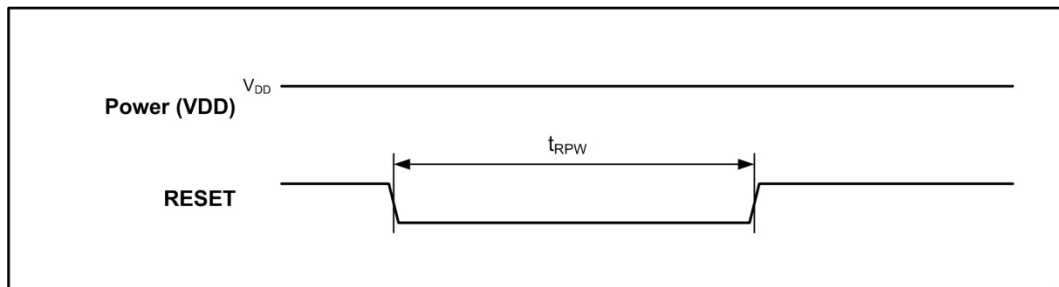
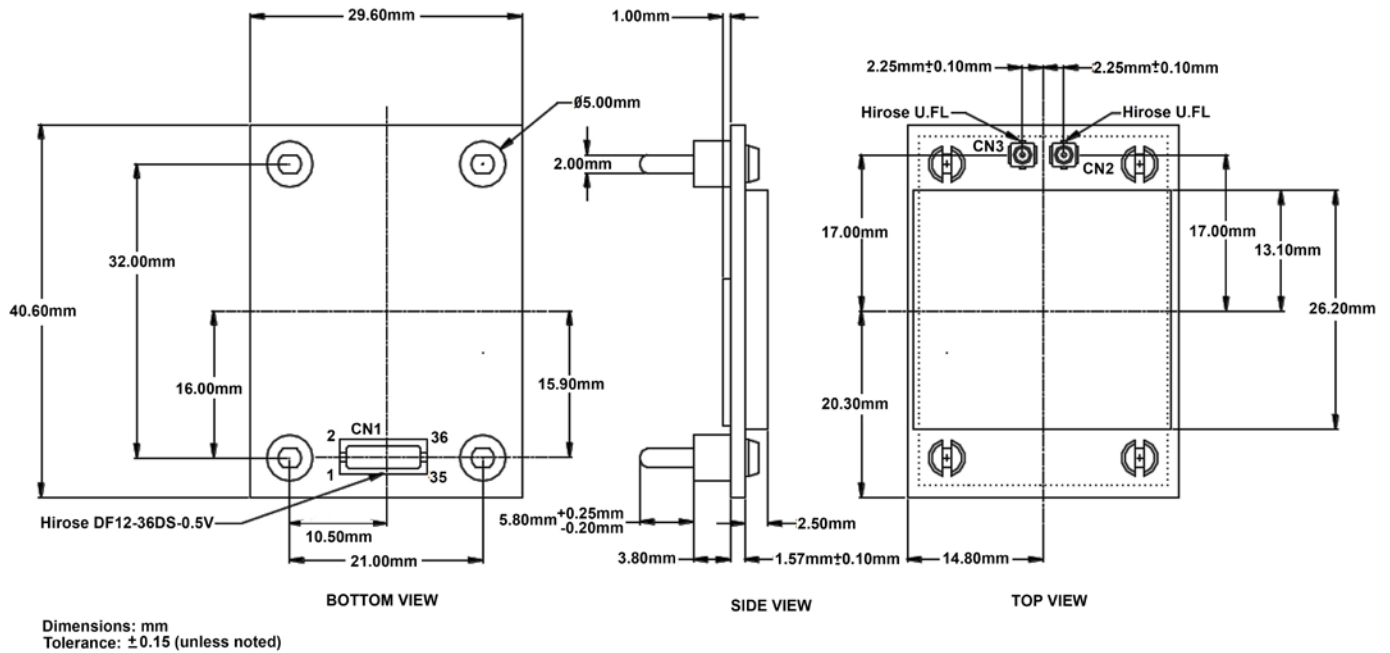


Table 17 - RESET Timing

Symbol	Parameter	Min	Typ	Max	Units
$t_{PURST}$	Valid $V_{DD}$ to RESET valid			200	ms
$t_{RLRV}$	RESET Valid to RESET Low	0			ms
$t_{RPWI}$	Valid $V_{DD}$ to Internal RESET completed			200	ms
$t_{RPW}$	RESET Pulse Width	100			$\mu$ s

## 10.0 Mechanical Outline

Figure 6 – 9373 and 9768 Modules - Mechanical Outline



Module Connector: **DF12B-36DS-0.5V(XX)** (Hirose)

Hirose: 0.50mm (.020") Pitch Plug, Surface Mount, Dual Row, Vertical, 4.00mm Stack Height, 36 Circuits

Board Connector: **DF12(4.0)-36DP-0.5V(XX)** (Hirose)

Hirose: 0.50mm (.020") Pitch Plug, Surface Mount, Dual Row, Vertical, 4.00mm Stack Height, 36 Circuits

RF Connector: **U.FL**

Hirose: Ultra Small Surface Mount Coaxial Connector

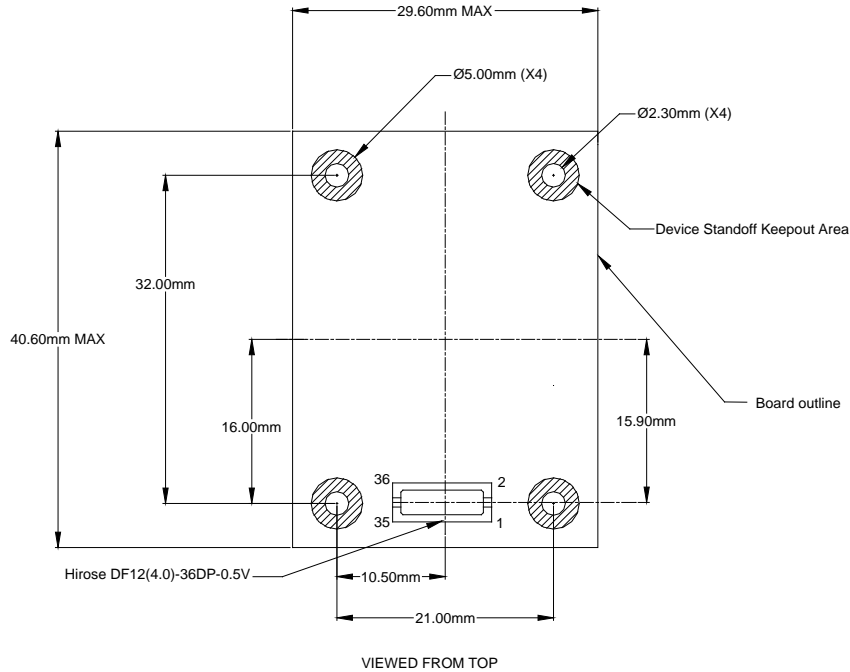


The standard mounting hardware for the device uses a friction fit for retention of the thru-hole pins to the host board.

To support this configuration, the maximum diameter of the thru-hole pin is 2.8mm. Although this exceeds the recommended mounting hole size (see section 11.1), the pin diameter is compliant and will compress to fit the recommended hole diameter.

## 11.0 Recommended Footprint

Figure 7 - Recommended PCB Footprint




### 11.1 Mounting Hole Specification

The mounting hole specification is important. It allows for a tight and reliable friction-based interference between the host PCB and the DP50 stand-off hardware.

<b>Nominal Diameter:</b>	2.2 mm
<b>Tolerance:</b>	+0.15 mm/-0.00 mm
<b>Host Board Thickness:</b>	0.8 mm to 1.6 mm

## 12.0 Regulatory Certification and Agency Approvals



IMPORTANT!

It is required that the following section be read and understood before use of the B+B SmartWorx AirborneM2M™ device is permitted.

Use of approved antenna is required for compliance to FCC and IC regulations.

The unit complies with the following agency approvals:

Table 18 - Regulatory Approvals

Country	Standard
North America (US & Canada)	FCC Part 15 Sec. 15.107, 15.109, 15.207, 15.209, 15.247 Modular Approval
Europe	ETSI EN 300 328 v2.1.1 (2016) ETSI EN 301 893 v1.8.5 (2017) EN55032 : 2012+AC :2013 (Class A) ETSI 301-489-1 : v2.1.1 ETSI 301-489-17 : v.3.1.1 EN 61000-3-2 : 2014 EN 61000-3-3 : 2013

### 12.1 FCC Statement

This equipment has been tested and found to comply with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for assistance.

Operations in the 5.15-5.25GHz and channel 5260MHz are restricted to indoor usage only.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

## 12.2 FCC RF Exposure Statement

To comply with FCC/IC RF exposure compliance requirements, the antenna used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operate in conjunction with any other antenna or transmitter.

As such, the radio component of this device is intended only for OEM integrators under the following two conditions:

- The antenna must be installed such that 20 cm is maintained between the antenna and users.
- The transmitter module may not be co-located with any other transmitter or antenna.

As long as the two conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end product for any additional compliance requirements required with this module installed (e.g., digital device emissions, PC peripheral requirements).

In the event that these conditions cannot be met (for example, co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

## 12.3 Information for Canadian Users (IC Notice)

This device has been designed to operate with an antenna having a maximum gain of 5.5dBi in the 5GHz band and 4.1 in the 2.4GHz band. An antenna having a higher gain is strictly prohibited per regulations of Industry Canada. The required antenna impedance is 50Ω. Only approved antenna may be used with this equipment.

Antennas – Maximum Gain	
<b>Dual-band Monopole (“rubber duck”)</b>	<ul style="list-style-type: none"> <li>• Maximum gain of 3.8dBi at 2.4 GHz</li> <li>• Maximum gain of 5.5dBi at 5 GHz</li> </ul>
<b>Dual-band Dipole</b>	<ul style="list-style-type: none"> <li>• Maximum gain of 3.0dBi at 2.4 GHz</li> <li>• Maximum gain of 5.1dBi at 5 GHz</li> </ul>

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the Equivalent Isotropically Radiated Power (EIRP) is not more than required for successful communication.

*Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut*

*choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.*

This radio transmitter (9373 and 9768 variants 3913A-WLNN551) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antennas not included in this list are permitted as long as the maximum gain indicated for that type (monopole or dipole) is not exceeded. However, antennas that are not of the monopole or dipole type, and/or exceed the maximum gain for that type, are strictly prohibited for use with this device. Operations in the 5.15-5.25GHz and channel 5260MHz are restricted to indoor usage only.

*Cet émetteur radio (9373 et 9768 variantes 3913-WLNN551) a été approuvé par Industrie Canada pour fonctionner avec les types d'antennes énumérés ci-dessous avec le gain maximal admissible et l'impédance d'antenne requise pour chaque type d'antenne indiqué. Les antennes non comprises dans cette liste sont autorisées tant que le gain maximal indiqué pour ce type (monopôle ou dipôle) n'est pas dépassé. Cependant, les antennes qui ne sont pas du type monopôle ou dipôle et / ou dépassent le gain maximal pour ce type sont strictement interdites pour être utilisées avec cet appareil. Les opérations dans l'5,15 à 5,25 GHz et 5260MHz canaux sont limités à une utilisation en intérieur uniquement.*

The following is a list of suggested antennas to use with this transmitter. Please contact your B+B SmartWorx representative if you have any questions.

Monopole Antennas (“rubber duck”)				
MFG	P/N	Max. Gain 2.4G (dBi)	Max. Gain 5G (dBi)	Impedance (Ω)
Nearson	T131AH-2.4/4.9/5.X-S	2.0	2.0	50
Taoglas	GW.71.5153	3.8	5.5	50

Dipole Antennas				
MFG	P/N	Max. Gain 2.4G (dBi)	Max. Gain 5G (dBi)	Impedance (Ω)
Laird	CAF 94505	2.0	4.0	50
Taoglas	PC.11.07.0100A	3.0	4.5	50
Taoglas	FXP.810.07.0100C	2.4	5.1	50
Taoglas	FXP.830.07.0100C	2.6	5.0	50

The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada’s website [www.hc-sc.gc.ca](http://www.hc-sc.gc.ca).

This Device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

*Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.*

## 12.4 FCC/IC Modular Approval

This document describes the AirborneM2M WLN FCC modular approval and the guidelines for use as outlined in FCC Public Notice (DA 00-1407).

The 9373 and 9768 modules are covered by the following modular grants:

Table 19 - Modular Grant Numbers

Country	Standard	Grant
North America (US)	FCC Part 15 Sec. 15.107, 15.109, 15.207, 15.209, 15.247 Modular Approval	F4AWLNN551
Canada	RSS 210 Modular Approval	3913A-WLNN551

By providing FCC modular approval on the AirborneM2M WLN modules, the customers are relieved of any need to perform FCC part15 subpart C Intentional Radiator testing and certification, except where they wish to use an antenna that is not already certified.

Please note that as part of the FCC requirements for the use of the modular approval, the installation of any antenna must require a professional installer. This is to prevent any non-authorized antenna being used with the radio. There are ways to support this requirement but the most popular is to utilize a non-standard antenna connector, this designation includes the reverse polarity versions of the most popular RF antenna types (SMA, TNC, etc.). For more details please contact B+B SmartWorx.

The following documents are associated with this applications note:

FCC Part 15 – Radio Frequency Devices

FCC Public Notice – DA 00-1407 (June 26<sup>th</sup>, 2000)

B+B SmartWorx recommends that during the integration of the radio, into the customers system, that any design guidelines be followed. Please contact B+B SmartWorx Technical Support if you have any concerns regarding the hardware integration.

Contact B+B SmartWorx Technical support for a copy of the FCC and IOC grant certificates, the test reports and updated approved antenna list.

## 12.5 End Product Labeling

This transmitter module is authorized only for use in devices where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the FCC and Industry of Canada Grant numbers as shown in Table 20.

The following label or similar must be placed on the outside of the product, utilizing the AirborneM2M™ device, whenever physically possible:



Figure 8 - Full FCC/IC Label

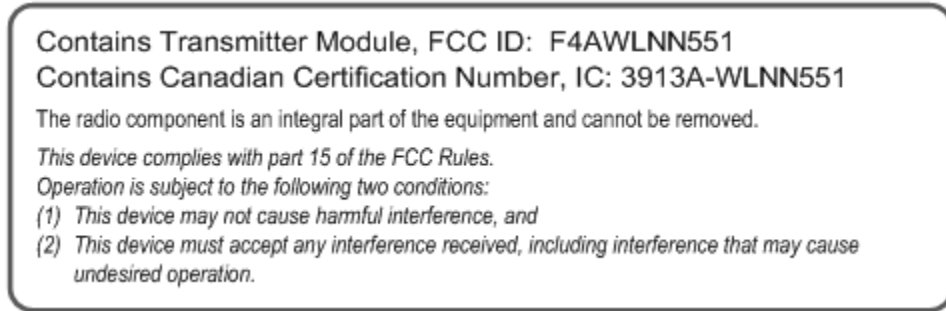
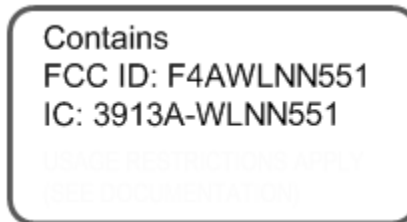


Figure 9 - Minimum FCC/IC Label



When the device is so small or for such use that it is not practicable to place the label shown in Figure 8, the label shown in Figure 9 may be used, however the information required shall also be placed in a prominent location in the instruction manual or pamphlet supplied to the user. Alternatively, the required information shown in Figure 8 shall be placed on the container in which the device is marketed.

In all cases the FCC and IC identifiers must be displayed on the device in which the module is installed.

## 13.0 Physical & Environmental Approvals

The device has passed the following primary physical and environmental tests.

Table 20 - Mechanical Approvals

Test	Reference	Conditions
Temperature Range (Operational)	Table 1B, Type 2b	-40°C to +85°C
Temperature Range (Non-Operational)		-40°C to +85°C
Humidity	Sect 4.2.3	0-95%RH @ 38°C condensing Fig 4a – 8 hours active humidity cycle

Test reports are available from B+B SmartWorx Technical Support. Please contact directly for the latest documentation.