



Product Specification



802.11b/g/n Advanced Enterprise Device Server and Access Point Revision: 1.1

May 2013

B&B Confidential

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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 question related to the conventions used or clarification of indicated deviation please contact B&B Sales or Wireless Support.

1.1 Terminology

Airborne Enterprise Device Server and AirborneDirect Enterprise Device Server are 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.

1.4 File Format

These documents are provided as Portable Document Format (PDF) files. To read them, you need Adobe Acrobat Reader 4.0.5 or higher. For your convenience, Adobe Acrobat Reader is provided on the Radio Evaluation Kit CD. Should you not have the CD, go to the Adobe Web site (www.adobe.com) and download the latest version of the free Adobe Acrobat Reader.

2.0 Product Description

The APPN-TT551 module is the latest generation of 802.11 wireless device servers and adapters from B&B. The radio features the following:

- o 802.11 b/g/n Wi-Fi Radio with 32bit ARM9 CPU (128/256Mb SDRAM, 64Mb Flash)
- o Atheros AR6203 802.11 b/g/n radio chipset.
- o Supports Access Point, Infrastructure and AdHoc Client networks (Software selectable)
- o 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
- o Infrastructure device includes:
 - Supports WEP, WPA, WPA2, 802.11i and 802.1x Supplicant, with Certificates.
- o The wireless device server includes integrated:
 - 802.11 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
- o Operating Temperature (-40°C to 85°C)
- o Storage temp (-40°C to 85°C)
- o 52 Pin mini PCIe card connector
- o Hirose U.FL RF connector for the antenna
- o Multiple host interfaces supported:
 - UART (921.6K BAUD)
 - SPI
 - MII/RMII (Bridge/Router modes supported)
- o No host driver required
- o Small form factor module
- o Worldwide Regulatory Support

3.0 Model Numbers

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

Table 1 - Model Numbers

Model Number	Description	Wi-Fi		Interface							Security				RoHS
		802.11 b/g/n Client	802.11 b/g/n Access Point	UART	RS232	RS485	SPI	ML/RMII	GPIO	WEP	WPA	WPA2	802.11i		
APPN-TT551	802.11b/g/n, Access Point/Client	•	•	•	•	•	•	•	•	•	•	•	•	•	
Evaluation Kits															

4.0 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	Signal	Description	PCIe Pin Mapping
1	V _{SS}	Ground	9,15,21,27,29,35,50,40,34,26,18,4
2	Not Used		Not Used
3	DV _{DD}	Power, +3.3 V	2,24,52
4	DV _{DD}	Power, +3.3 V	2,24,52
5	Not Used		Not Used
6	DBG_TXD	Debug serial transmit data	30
7	#RESET	Reset active low input. A transition to high releases the reset condition (see “Reset” in the Data book). There is a weak pull-up on this pin.	22
8	DBG_RXD	Debug serial receive data	32
9	Not Used		Not Used
10	Not Used		Not Used
11	#DEFAULT/LED_LINK	At boot, restore factory default active low input. LAN link or serial connection detected LED output. May be used as digital input or 3.3 V CMOS-compatible digital output ($V_{OL} \leq 0.4$, $2.4 V \leq V_{OH}$).	45
12	UART_CTS1/SPI_SEL	Primary UART clear to send input or SPI select output Signal is LVTTTL-compatible.	36
13	LAN_RX+	LAN receive positive	Not Used
14	LAN_RX-	LAN receive negative	Not Used
15	V _{SS}	Ground	9,15,21,27,29,35,50,40,34,26,18,4
16	V _{SS}	Ground	9,15,21,27,29,35,50,40,34,26,18,4
17	Not Used		Not Used
18	UART_RTS1/SPI_CLK	Primary UART request to send output or SPI clock input Signal is LVTTTL-Compatible.	38
19	Not Used		Not Used
20	Not Used		Not Used
21	Not Used		Not Used
22	SRL_MODE/SPI_INT	Serial transceiver protocol select output or SPI interrupt output (see Error! Reference source not found.). Signal is LVTTTL-Compatible.	47
23	LED_CONNECT	Wireless TCP session established LED output	20
24	UART_RXD1/SPI_MOSI	Primary UART receive data input or SPI slave data input. Signal is LVTTTL-Compatible.	51
25	LED_POST	Power-on self-test LED output	44
26	LED_WLAN_CFG	Wireless IP address assigned LED output	46
27	Not Used		Not Used

Pin	Signal	Description	PCIe Pin Mapping
28	UART_TXD1/SPI_MISO	Primary UART transmit data output or SPI slave data output. Signal is LVTTTL-Compatible.	49
29	LAN_TX-	LAN transmit negative	Not Used
30	LAN_TX+	LAN transmit positive	Not Used
31	Not Used		Not Used
32	Not Used		Not Used
33	DV _{DD}	Power, +3.3 V	2,24,52
34	DV _{DD}	Power, +3.3 V	2,24,52
35	LED_#RF_ACT	RF activity LED active low output	42
36	V _{SS}	Ground	9,15,21,27,29,35,50,40,34,26,18,4

4.1 Digital UART Ports

The device supports a digital UART port. Use of this port is determined by the device type choice made in firmware. The details of the port can be seen in Table 3.

Table 3 - UART Pin Definition

Device Type	UART 1	All
Pin Definition	UART1 Pin	Debug
Data out (D _{OUT})	28	6
Data In (D _{IN})	24	8
Clear-to-Send (CTS)	12	
Ready-to-Send (RTS)	18	
Serial Mode (SER_MOD)		

The primary UART1 supports a 4-wire interface.

The primary digital UART1 can be used as the primary connection for the Serial device type. Definitions of this interface can be seen in Table 3.

The UART1 interface supports 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.

4.2 Ethernet PHY Port

An MII/RMII 10/100 Ethernet PHY interface is supported. It is enabled by default when the Ethernet device type is selected in firmware.

4.3 Serial Peripheral Interface (SPI)

Please refer to section 6.0 for details on this interface.

4.4 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 Technical Support first. Potential damage to the module may occur.

4.5 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 an 8mA drive current at 3.3VDC.

4.6 Connector Definition

There are a total of three connectors to the radio:

- CN1: 52 pin Mini PCIe form factor
- ANT1: RF connector for 802.11b/g/n antenna.
Hirose U.FL

5.0 Electrical & RF Specification

Table 4- Absolute Maximum Values¹

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 _{DD}	Supply Voltage	3.14	3.30	3.60	V
V _{IL}	Input Low Level Voltage	-0.3		0.8	
V _{IH}	Input High Level Voltage	2.0		V _{DD} + 0.3	
V _{OL}	Output Low Level Voltage			0.4	
V _{OH}	Output High Level Voltage	V _{DD} - 0.4			
I _{IR}	Inrush current <i>400μs duration</i>			1500	mA
I _{CCG}	Operating Current – UART Data (802.11g) <i>Connection Rate @ 54Mb/s</i> <i>UART 100% Duty Cycle @ 920K BAUD</i>		320		mA
I _{CCB}	Operating Current – UART Data (802.11b) <i>Connection rate @ 11Mb/s</i> <i>UART 100% Duty Cycle @ 920K BAUD</i>		430		mA
I _{CCU}	Radio and CPU on. No data traffic (UART)		190		mA

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

Symbol	Parameter	Rate (Mb/s)	Min	Average dBm / mW		Peak dBm / mW		Units
P _{OUTB}	Transmit Power Output 802.11b	11, 5.5, 2, 1		15.0	31.6			dBm
P _{OUTG}	Transmit Power Output 802.11g	6, 9, 12, 18, 24, 36, 48, 54		12.6	18.2			dBm
P _{RSENB}	Receive Sensitivity 802.11b	11		-86				dBm
		1		-92				
P _{RSENG}	Receive Sensitivity 802.11g	54		-72				dBm
		36		-78				
		18		-84				
		6		-89				
F _{RANGEBG}	Frequency Range 802.11b/g		2401			2495		MHz

Table 7 - Supported Data Rates by Band

Band	Supported Data Rates (Mb/s)
802.11b	11, 5.5, 2, 1
802.11g	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 ^{1,2}	US/Canada	2.401 - 2.473	11	1 – 11
	Europe	2.401 - 2.483	13	1 – 13
	Japan	2.401 - 2.495	14	1 – 14
802.11g ^{1,2}	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



1. Only channels 1, 6 and 11 are non-overlapping.
2. Channel 14 is non-overlapping (Japan only).

5.1 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 +15dBm $\pm$ 2 dB for all bands (b/g/n) and rates.

5.2 Performance/Range

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

Table 9 - Radio Typical Performance Range

Data Rate	Typical Outdoor Distance
	(2dBi antenna gain on each end for B/G mode)
1.0 Mb/s	350m
11.0 Mb/s	270m
6Mb/s 802.11g	260m
54Mb/s 802.11g	104m

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.

6.0 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.

6.1 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
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

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.

6.2 SPI AC Characteristics

The following specification identifies the required hardware timing to successfully implement a SPI interface with the Airborne 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			μ s

Figure 1 - SPI Read/Write Timing

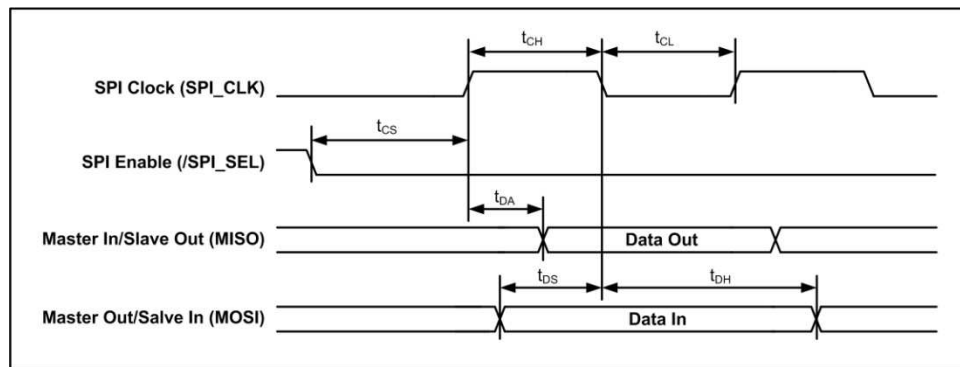
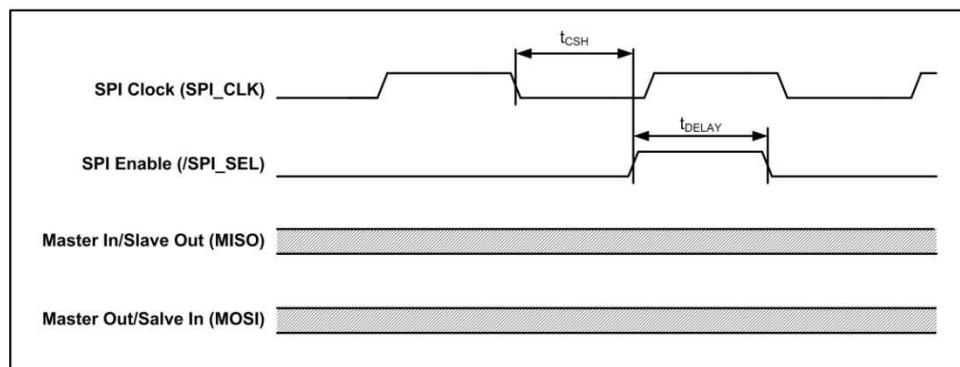


Figure 2 - SPI Clock and Select Timing



6.3 SPI Protocol

A 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 Airborne Device Server module by the host at the same time that the RX message header is sent to the host from the Airborne 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).

6.4 SPI Modes

The Airborne 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)

6.5 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. PARM1 and PARM2 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. PARM1 and PARM2 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. PARM1 and PARM2 are unused for this command and should be set to zero.

Command (Hex)	Name	Description
0x10	INTENA	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. The definition of the PARM1 field for this command is a bit-mask and is formatted as follows: Bit 7 Interrupt Sense – 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. Bit 1 TX Interrupt – 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. Bit 0 RX Interrupt – 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. All other bits of PARM1 are unused for this command and should be set to zero. PARM2 is unused for this command and should be set to zero. 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. Important: 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.
0x20	INTDIS	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. The definition of the PARM1 field for this command is a bit-mask and is formatted as follows: Bit 1 TX Interrupt – If this bit is set to a 1, The TX interrupt function will be disabled. Bit 0 RX Interrupt – If this bit is set to a 1, the RX interrupt function will be disabled. All other bits of PARM1 are unused for this command and should be set to zero. PARM2 is unused for this command and should be set to zero. 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.

Command (Hex)	Name	Description
0x40	TXDATA	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. 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. PARM1 is unused for this command and should be set to zero. For example, to send the auth dpac dpac command, use the SPI message 0x40 0x00 0x0F 0x00 0x61 0x75 0x74 0x68 0x20 0x64 0x70 0x61 0x63 0x20 0x64 0x70 0x61 0x63 0x0D. That is, SPI command 0x40, PARM1 is 0x00, PARM2 is 0x000F, followed by the text for auth dpac dpac.
0x80	RXDATA	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. 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. PARM1 is unused for this command and should be set to zero.

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.

7.0 Antenna

The unit supports antenna connections through a Hirose U.FL connector (ANT1). It is located on the top surface of the device next to the RF shielding.

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 operation. They are required to have a VSWR of 2:1 maximum referenced to a 50Ω system impedance.

7.1 Antenna Selection

The Airborne radio supports a number of antenna options, all of which require connection to the U.FL connectors on the radio. The best antenna option will be determined by a number of factors. These include the application, mechanical construction and desired performance. Since the number of possible combinations is enormous, we will review some of the more common solutions in this section. Contact Technical Support for more specific answers if your application is not covered during this discussion.

The available antenna connections include:

Host board mounted antenna

Host chassis mounted antenna

Embedded antenna

Location and performance also need to be considered. The following sections discuss these factors.

7.2 Host Board Mounted Antenna

Host board mounting requires that an antenna connection be physically mounted to the host system board. It also requires that the host board include a U.FL connector to allow a U.FL to U.FL coaxial lead to connect from the radio to the host board. It will then require 50Ω matched PCB traces to be routed from the U.FL connector to the antenna mount.

There are several sources for the U.FL to U.FL coaxial cable. These include Hirose, Sunridge and IPEX. Please contact B&B for further part numbers and supply assistance.

This approach can simplify assembly, but it does require that the host system configuration can accommodate an antenna location that is determined by the host PCB. This approach also makes it harder to seal the enclosure.

Host board mounting also limits your choices of antenna. You must use antennas that screw or press fit to the PCB mount connector. There are many antenna connector types, but if you wish to utilize the FCC/IOC modular approval the connector choice must comply with FCC regulations. These state that a non-standard connector is required. For example, RP-TNC/RP-SMA are allowed, and TNC/SMA are not.

7.3 Host Chassis Mounted Antenna

Host Chassis mounted antennas require no work on the host PCB. They use an antenna type called 'flying lead'. There are two types of flying leads. One

provides a bulkhead mounted antenna connector and the other provides a bulk head mounted antenna. The type you choose will be determined by the application.

A flying lead system connects a U.FL coaxial lead to the radio's U.FL connector. The other end of the coax is attached to either a bulkhead mounted antenna connector or directly to an antenna that has an integrated bulkhead mount.

In either case, the use of host chassis mounting significantly reduces the antenna system development effort. It provides for greater flexibility in antenna choice and placement in the host system chassis.

When using the flying lead antenna (integrated bulk head mounting) there are no connector choice restrictions for use with the FCC/IOC modular certification. However if the flying lead connector is used, the same restrictions as identified for the Host Mounted Antenna apply.

There are many suppliers of flying lead antenna and connectors. B&B's Airborne Antenna product line offers a range of antenna solutions.

7.4 Embedded Antenna

Embedded antennas can be the most interesting approach for M2M, industrial and medical applications. Their small form factor and the absence of any external mounting can make them very useful. But they will typically provide lower performance than an external antenna. This does not make them unusable, but it will impact the choice of antenna type and it will require more focus on antenna placement.

The three main embedded antenna types are PCB embedded, chip (PCB mounted) and flying lead. Each has its advantages and disadvantages (See Table 17).

Table 17 - Embedded Antenna Options

Antenna Type	Features			
	Cost	Size	Availability	Performance
PCB Embedded	Lowest	Largest	Custom	Poor
Chip	Low	Small	Standard	Poor
Flying Lead	Low	Small	Standard	Fair

PCB Embedded – This approach embeds an antenna design into the host PCB. It is very common with add-in Wi-Fi cards (CF, PCMCIA, SDIO, etc.), as it requires no external connections and has the lowest production cost. But the lower production costs are offset by significant development costs and diminished performance and flexibility.

Chip – The integration of a chip antenna is simple, and it requires a relatively small footprint on the host system. But, like a PCB embedded antenna, there will be limitations in flexibility and performance.

Many suppliers can provide chip antennas; many configuration and performance options are available.

Flying Lead – Embedded flying lead antennas are similar to external flying lead antennas. The difference is that the embedded antennas have smaller form factors and provide a range of chassis and board mounting options. Embedded

flying lead antennas tend to provide more performance and flexibility than other approaches, since the location of the antenna is not determined by the host PCB design. The assembly of a system using embedded flying lead antennas may be slightly more complex, as the antenna is not necessarily mounted on the host PCBA.

7.5 Antenna Location

The importance of location cannot be over stressed. It can often be the difference between the success and failure of a Wi-Fi implementation.

There are several factors that need to be considered when determining location:

- Distance of Antenna from radio.
- Location of host system.
 - Proximity to RF blocking or absorbing materials.
 - Proximity to potential noise or interference.
 - Position relative to infrastructure (Access Points or Laptops).
- Orientation of host system relative to infrastructure.
 - Is it known?
 - Is it static?

The following things need to be considered during the development process:

1. Minimize the distance between the radio and the location of the antenna. The coaxial cable between the two impacts the Transmit Power and Receive Sensitivity negatively. B&B recommends using 1.32-1.37mm outer diameter U.FL coaxial cables.
2. Minimize the locations where metal surfaces come into contact or are close to the location of the antenna.
3. Avoid locations where RF noise may occur, whether it is close to or overlapping the ISM bands. This would include microwave ovens and wireless telephone systems in the 2.4GHz frequency range.
4. Mount the antenna as high on the equipment as possible.
5. Locate the antenna where there is a minimum of obstruction between the antenna and the location of the Access Points. Access Points are typically located in the ceiling or high on walls.
6. Keep the main antenna's polarization vertical, or in-line with the antenna of the Access Points. 802.11 systems use vertical polarization and aligning both transmit and receive antenna maximizes the link quality.

All of these factors will influence connection quality.

7.6 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:

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

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

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's 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.

8.0 RESET Function

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

Figure 3 - Power on RESET Timing

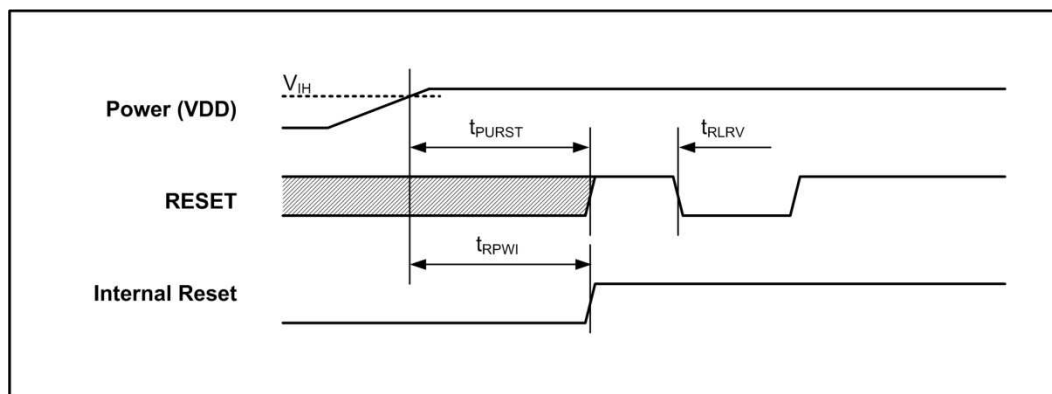


Figure 4 - RESET Timing

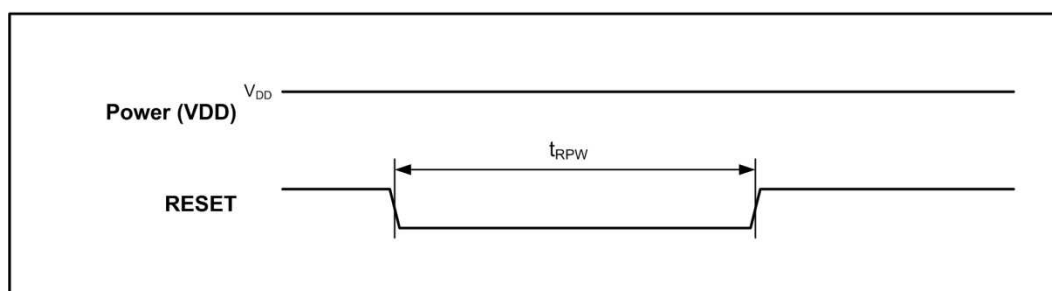
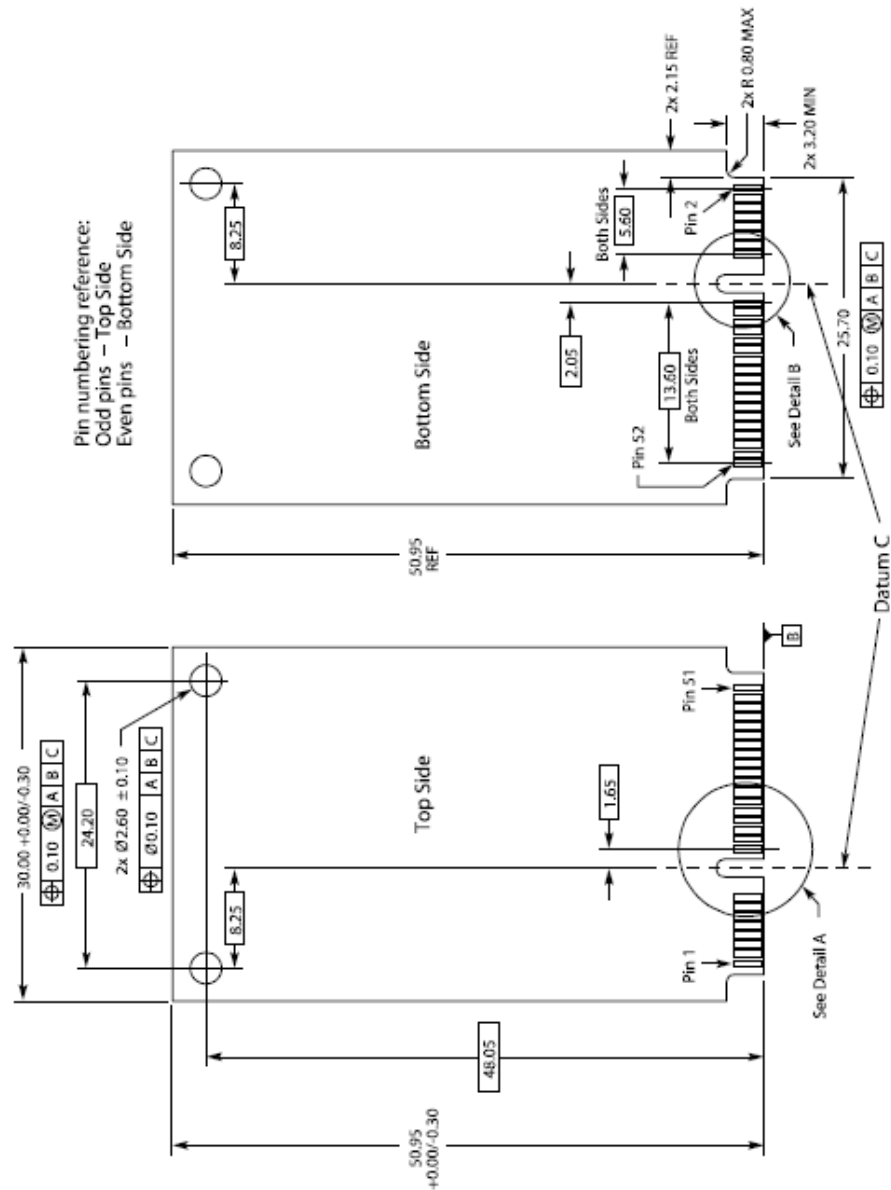


Table 18 - RESET Timing

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			μ s

9.0 Mechanical Outline

Figure 5 – APPN-TT551 Mechanical Outline



Module Connector: **52 Pin Mini PCIe form factor**

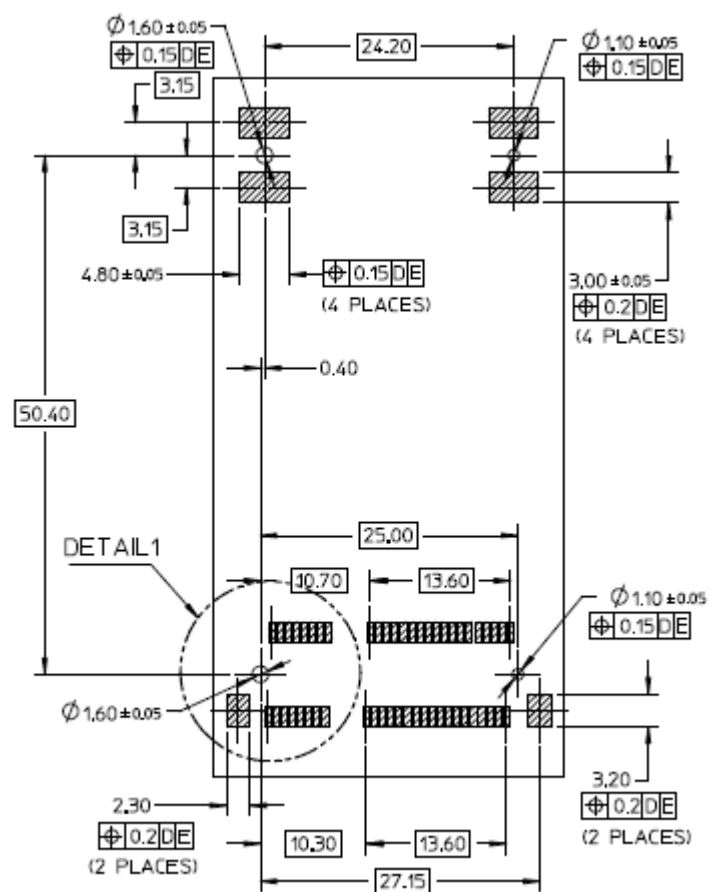
Board Connector: **0679105700 (Molex Inc)**

Molex Inc: PCIe Mini card edgecard 52 pos

RF Connector: **U.FL**Hirose: *Ultra Small Surface Mount Coaxial Connector*

10.0 Recommended Footprint

Figure 6 - Recommended PCB Footprint



11.0 Regulatory Certification and Agency Approvals

IMPORTANT!

It is required that the following section be read and understood before use of the B&B Airborne™ 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 19 - Regulatory Approvals

Country	Standard	Status
North America (US & Canada)	FCC Part 15 Sec. 15.107, 15.109, 15.207, 15.209, 15.247 Modular Approval	Pending
Europe	CISPR 16-1 :1993 ETSI EN 300 328 Part 1 V1.2.2 (2000-07) ETSI EN 300 328 Part 2 V1.1.1 (2000-07)	Pending
Japan	ARIB STD-T71 v1.0, 14 (Dec 2000) ARIB RCR STD-T33 (June 19, 1997) ARIB STD-T66 v2.0 (March 28, 2002)	Pending

11.1 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.

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

11.2 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.

11.3 Information for Canadian Users (IC Notice)

This device has been designed to operate with an antenna having a maximum gain of 3.8dBi 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.

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 (3913A-APPN551) 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. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Cet émetteur radio (3913A-APPN551) 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. Types d'antennes ne figurent pas dans cette liste, ayant un

gain supérieur au gain maximum indiqué pour ce type, sont strictement interdites pour une utilisation avec cet appareil.

The following is a list of the Antenna's approved to work with this transmitter, please contact your B&B representative if you have any questions.

MFG	P/N	Max. Gain 2.4G (dBi)	Impedance (Ω)
Taoglas	GW.71.5153	3.8	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.

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.

11.4 FCC/IC Modular Approval

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

The APPN-TT551 is covered by the following modular grants:

Table 20 - 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	F4AAPN551
Canada	RSS 210 Modular Approval	3913A-APPN551

By providing FCC modular approval on the Airborne module, 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.

B&B supports a group of pre-approved antenna; use of one of these antennas eliminates the need to do any further subpart C testing or certification. If an antenna is not on the list, it is a simple process to add it to the pre-approved list without having to complete a full set of emissions testing. Please contact B&B Technical support for details of our qualification processes.

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.

The following documents are associated with this applications note:

FCC Part 15 – Radio Frequency Devices

FCC Public Notice – DA 00-1407 (June 26th, 2000)

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

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

11.5 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 Airborne™ device, whenever physically possible:

Figure 7 - Full FCC/IC Label

Contains Transmitter Module FCC ID: F4AAPPN551
Contains Canadian Certification Number IC: 3913A-APPN551
The radio component is an integral part of the equipment and cannot be removed.

This device complies 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.

Figure 8 - Minimum FCC/IC Label

Contains
FCC ID: F4AAPPN551
IC: 3913A-APPN551

When the device is so small or for such use that it is not practicable to place the label shown in Figure 7, the label shown in Figure 8 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 7 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.

11.6 Regulatory Test Mode Support

The Airborne Device Server includes support for all FCC, IC and ETSI test modes required to perform regulatory compliance testing on the module, please contact B&B Technical Support for details on enabling and using these modes.

12.0 Physical & Environmental Approvals

The device has passed the following primary physical and environmental tests. The test methods referenced are defined in SAE J1455 Aug1994.

Table 21 - 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
Altitude	Sect 4.8	Operational: 0-12,000ft (62 KPa absolute pressure) Non-operational: 0-40,000ft (18.6 KPa absolute pressure)

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