

AW-HM677

IEEE 802.11ah Wireless LAN Module

Datasheet

Rev. B

DF

(For Standard)

Features

General

- Support 850-950MHz frequency band
- Support channel width options of 1/2/4/8 MHz
- Single-stream maximum data rate of 43.3 Mbps at 8 MHz bandwidth
- 802.11ah OFDM PHY supporting Wi-Fi Alliance Wi-Fi HaLow certification with BPSK & QPSK, 16-QAM, 64-QAM and 256-QAM Modulation
- Support Modulation and Coding Scheme (MCS) levels MCS 0-10
- Support for 1 MHz duplicate modes

Host interface

- USB 2.0 High-Speed compliant device interface, it integrated USB 2.0 PHY and device interface supporting High-Speed mode at 480Mbps
- SDIO 2.0 High-Speed at 50MHz max for 200Mbps
- Support for both 1-bit and 4-bit data mode
- Support for SPI mode operation at up to 80MHz for 80Mbps

Standards Supported

- IEEE Std 802.11ah standard

Security Features

- Wi-Fi layer security including WPA3, protected management frames (PMF) and Opportunistic Wireless Encryption (OWE)
- Hardware support for AES and SHA1 and SHA2 hash functions (SHA-256, SHA-384, SHA-512)

Peripheral Interfaces

- SDIO/SPI/USB
- Support for STA and AP roles
- USB 2.0 High-Speed compliant device interface



AzureWave Technologies, Inc.

Revision History

Document NO: R2-2677-DST-01

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1. Introduction

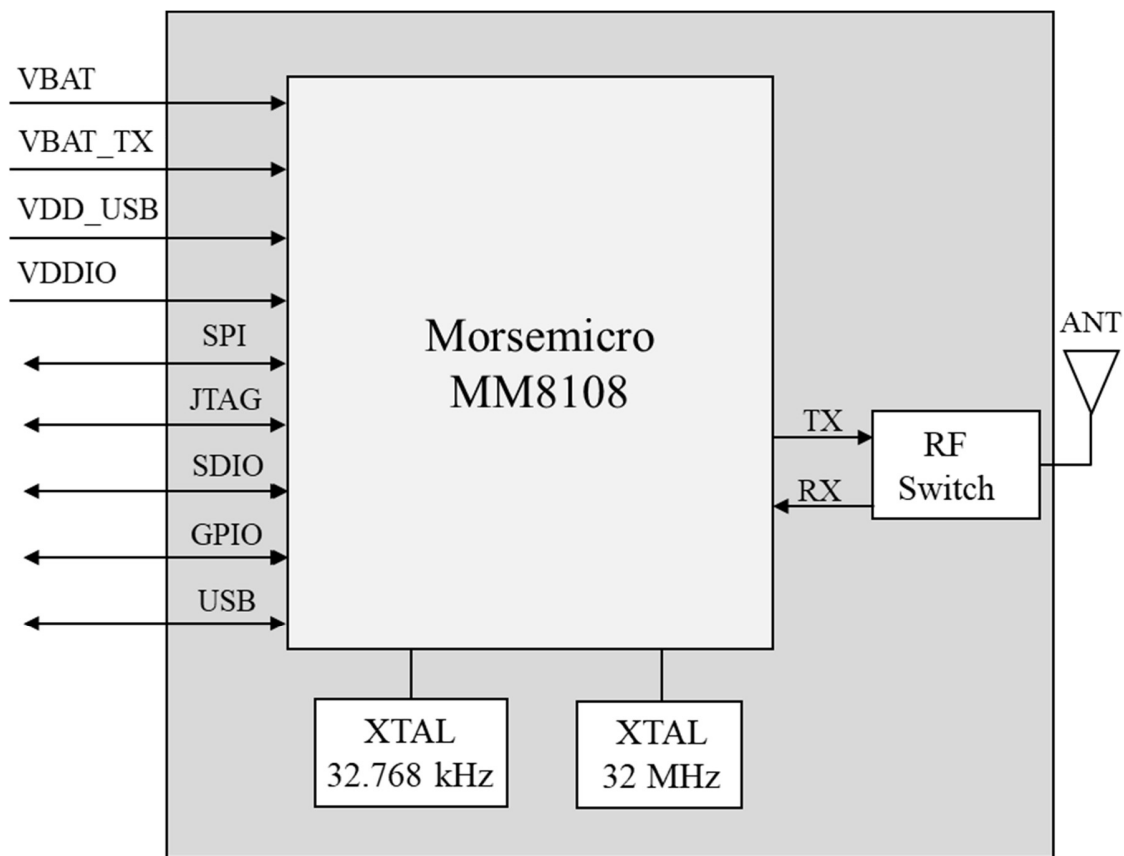
1.1 Product Overview

AzureWave Technologies, Inc. introduces the pioneer of the IEEE 802.11ah WIFI LGA module --- **AW-HM677**, including radio, PHY and MAC functions that are compliant with the IEEE 802.11ah standard. It's an open standard wireless network technology operating in the sub-1 GHz license-exempt RF bands (850-950 MHz range), so it doesn't incur ongoing monthly costs like cellular/mobile network connections. By operating in the sub-GHz range, this ultra-low-power wireless protocol can connect more IoT devices at much longer distances and much lower power than traditional Wi-Fi. With a footprint of only 11x10mm, the **AW-HM677** module has been designed to optimize performance and power consumption for power-sensitive battery-operated and high-speed agricultural, mining, industrial, home, and city applications.

The **AW-HM677** is a fully integrated Wi-Fi HaLow® module with long range, low power consumption, and superior RF performance. It is compliant with IEEE 802.11ah, supporting data rates up to 43.3 Mbps using world-first 256-QAM modulation at an 8 MHz bandwidth, and provides for operation in the sub-1 GHz license-exempt RF bands. The radio in the MM8108 supports programmable operation in these bands worldwide, between 850MHz and 950MHz.

AW-HM677 supports WPA3 and all standard security features required for Wi-Fi HaLow product certifications.

1.2 Block Diagram



AW-HM677 Block Diagram

1.3 Specifications Table

1.3.1 General

Features	Description
Product Description	IEEE 802.11ah Wireless LAN Module
Major Chipset	Morse Micro MM8108 (79-pin BGA)
Host Interface	SDIO/SPI/USB
Dimension	10mm x 11mm x 2mm (Tolerance remarked in mechanical drawing)
Form Factor	LGA module, 38 pins
Antenna	ANT Main : TX/RX
Weight	TBD

1.3.2 WLAN

Features	Description				
WLAN Standard	IEEE 802.11ah				
Frequency Rage	Sub-1GHz (850 – 950 MHz)				
Modulation	OFDM, BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM				
Channel Bandwidth	1/2/4/8 MHz				
Output Power (Board Level Limit)*					
		Min	Typ	Max	Unit
	MCS0 (1/2 MHz) @EVM≤-8dB	23	25	27	dBm
	MCS0 (4 MHz) @EVM≤-8dB	20	22	24	dBm
	MCS0 (8 MHz) @EVM≤-8dB	18	20.5	23	dBm
	MCS8 (2 MHz) @EVM≤-32dB	16	18	20	dBm
	MCS9 (1 MHz) @EVM≤-33dB	14	16	18	dBm

	MCS9 (4 MHz) @EVM≤-33dB	15	17	19	dBm
	MCS9 (8 MHz) @EVM≤-33dB	14	16	18	dBm
Receiver Sensitivity					
		Min	Typ	Max	Unit
	MCS0 (1 MHz)		-103	-102	dBm
	MCS0 (2 MHz)		-79	-78	dBm
	MCS0 (4 MHz)		-98	-97	dBm
	MCS0 (8 MHz)		-94	-93	dBm
	MCS8 (2 MHz)		-78	-77	dBm
	MCS9 (1 MHz)		-79	-78	dBm
	MCS9 (4 MHz)		-74	-73	dBm
	MCS9 (8 MHz)		-70	-69	dBm
Data Rate	■ 1 MHz Bandwidth: up to 4.444Mbps ■ 2 MHz Bandwidth: up to 8.667Mbps ■ 4 MHz Bandwidth: up to 20Mbps ■ 8 MHz Bandwidth: up to 43.333Mbps				
Security	■ AES encryption engine ■ Hardware support for SHA1 and SHA2 hash functions (SHA-256, SHA-384,SHA-512) ■ WPA3 including protected management frames (PMF) ■ Opportunistic Wireless Encryption (OWE)				

* The Output Power is only guaranteed at room temperature.

**If you have any certification questions about output power please contact FAE directly.

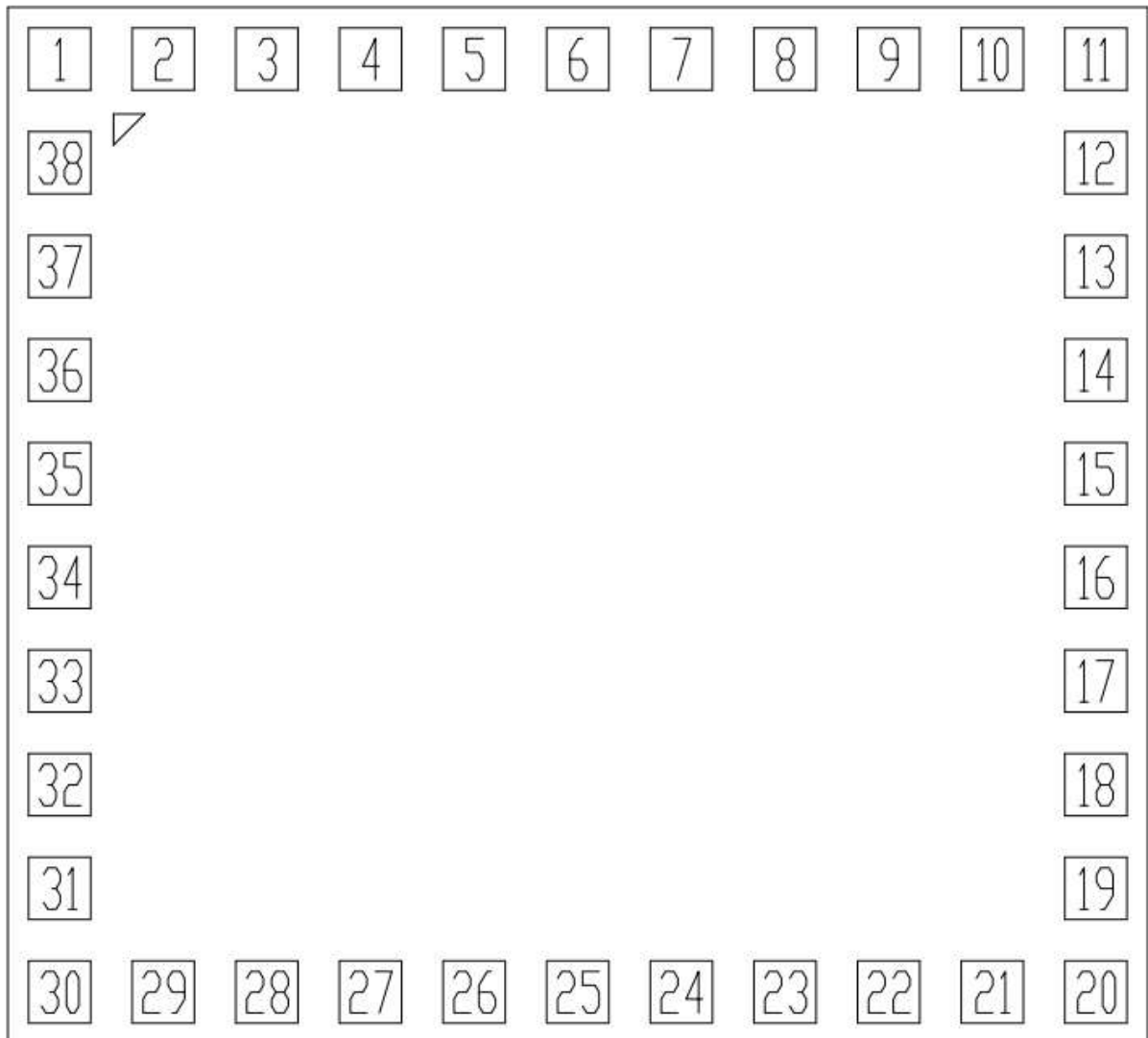
1.3.3 Operating Conditions

Features	Description
Operating Conditions	
Voltage	VBAT: 3.3V VDDIO: 3.3V
Operating Temperature	-40°C ~ 85 °C
Storage Temperature	-40°C ~ 125 °C

* The voltage on VDDIO must not exceed VBAT.

2. Pin Definition

2.1 Pin Map



AW-HM677 Pin Map (Top View)

2.2 Pin Table

Pin No.	Definition	Basic Description	Voltage	Type
1	GND1	GROUND		Ground
2	ANTENNA	RF IN/OUT		I/O

3	GND2	GROUND		Ground
4	MM_RESET_N	Asynchronous chip reset (active low)		Analog
5	MM_WAKE	External input wake from Deep Sleep and Snooze modes		Analog
6	MM_JTAG_TMS	JTAG mode select		Digital I/O
7	MM_JTAG_TCK	JTAG clock		Digital I/O
8	MM_JTAG_TDO	JTAG data out		Digital I/O
9	MM_JTAG_TDI	JTAG data in		Digital I/O
10	VBAT	3.3V VBAT supply for the buck regulator	3.3V	Supply
11	GND3	GROUND		Ground
12	MM_SD_D0	SDIO/SPI data line		Digital I/O
13	MM_SD_D3	SDIO/SPI data line		Digital I/O
14	MM_SD_D1	SDIO/SPI data line		Digital I/O
15	MM_SD_D2	SDIO/SPI data line		Digital I/O
16	MM_SD_CMD	SDIO/SPI command/data line		Digital I/O
17	MM_SD_CLK	SDIO/SPI clock input		Digital I/O
18	MM_GPIO5	Programmable digital I/O		Digital I/O
19	MM_GPIO4	Programmable digital I/O		Digital I/O
20	GND4	GROUND		Ground
21	MM_GPIO3	Programmable digital I/O		Digital I/O
22	VDDIO	VDD supply for digital I/O	3.3V	Supply
23	GND5	GROUND		Ground
24	VBAT_TX	3.3V VBAT supply to the BUCK_TX regulator	3.3V	Supply
25	VDD_USB	USB 3.3V supply	3.3V	Supply
26	GND6	GROUND		Ground

27	USB_D_N	USB DM line		USB I/O
28	USB_D_P	USB DP line		USB I/O
29	MM_GPIO2	Programmable digital I/O		Digital I/O
30	GND7	GROUND		Ground
31	MM_GPIO1	Programmable digital I/O		Digital I/O
32	MM_GPIO0	Programmable digital I/O		Digital I/O
33	MM_GPIO6	Programmable digital I/O		Digital I/O
34	MM_GPIO7	Programmable digital I/O		Digital I/O
35	MM_GPIO8	Programmable digital I/O		Digital I/O
36	MM_GPIO9	Programmable digital I/O		Digital I/O
37	MM_GPIO10	Programmable digital I/O		Digital I/O
38	GND8	GROUND		Ground

3. Electrical Characteristics

3.1 Absolute Maximum Ratings

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V _{BAT}	3.3V power supply	-0.3	-	3.6	V
MM_RESET_N/ MM_WAKE_UP	RESET_N/ WAKE_UP	-0.3	-	3.6	V
Digital I/O pin	Digital I/O	-0.3	-	V _{DDIO} +0.3	V
Analog/RF pin	Analog/RF	-0.3	-	1.2	V
T _{stg}	Storage temperature	-40	-	125	°C

3.2 Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V _{BAT}	3.3V power supply	3.0	3.3	3.6	V
V _{DDIO}	3.3V I/O supply Input	2.25	3.3	3.6	V
T _{AMBIENT}	Ambient temperature	-40		85	°C
T _{stg}	Storage temperature	-40		125	°C

*Performance specifications are achieved under typical operating conditions, unless otherwise specified.

4. Digital Interfaces

4.1 SDIO Device

A host interface via SDIO 2.0 capable of High-Speed mode, operating at 3.3V, is available. When selecting a CPU host to interface with the AW-HM677 module via the SDIO interface, ensure the host supports SDIO 2.0 with SDIO clock speeds of up to 50MHz. Slower clock speeds will impact the maximum achievable throughput.

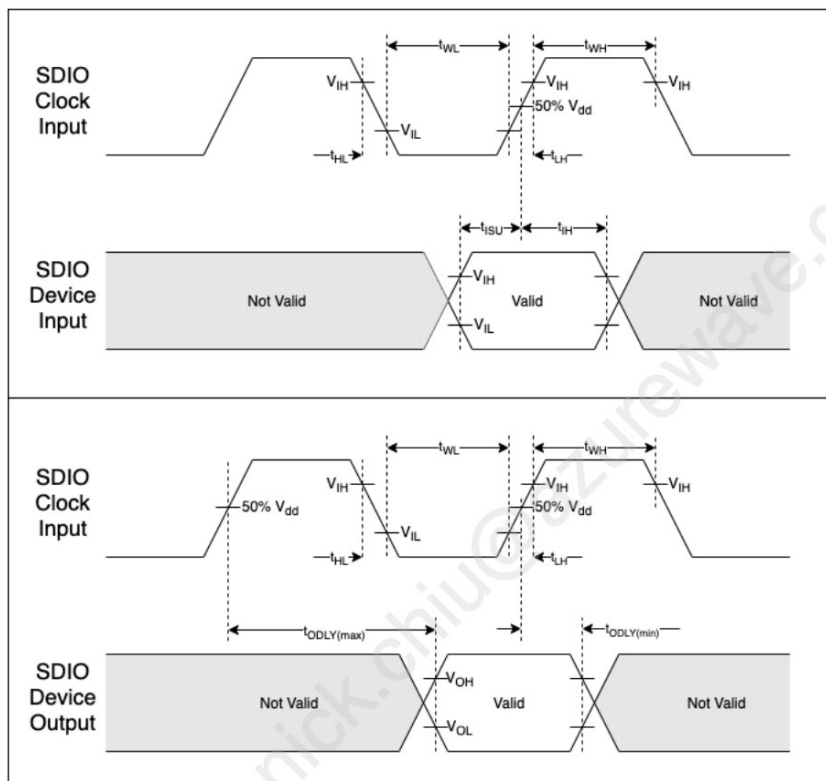
4.1.1 Pins

Name	SDIO 4-bit Mode	SDIO 1-bit Mode
MM_SD_CLK	Clock pin (input)	
MM_SD_CMD	Command pin	
MM_SD_D0	Data pin 0	
MM_SD_D1	Data pin 1	IRQ
MM_SD_D2	Data pin 2	Unused
MM_SD_D3	Data pin 3	Unused

Note: Unused pins should be pulled high.

4.1.2 Bus Timing

The SDIO clock rate supports up to 50MHz. The device always operates in SD high speed mode.



Parameter	Min	Max	Units
Clock frequency	0	50	MHz
Clock low time (t_{WL})	7		ns
Clock high time(t_{WH})	7		ns
Clock rise time (t_{LH})		3	ns
Clock fall time (t_{HL})		3	ns
Input setup time (t_{ISU})	6		ns
Input hold time (t_{IH})	2		ns
Output delay ($t_{ODLY(max)}$)		14	ns
Output hold time ($t_{ODLY(max)}$)	2.5		ns
Total system capacitance for each line		40	pF

4.2 SPI Device

The SPI master interface uses the physical unidirectional pin layout as defined below, over which the modified SDIO protocol is used for communication.

4.2.1 Pins

Name	SPI mode function
MM_SD_CLK	Clock pin (input)
MM_SD_D3	Chip select (active low)
MM_SD_CMD	Master data out/slave data in
MM_SD_D0	Master data in/slave data out
MM_SD_D1	SPI interrupt
MM_SD_D2	Not connected/unused

4.2.2 Initialization in SPI Mode

After power-on, this host interface can be brought up as either SDIO or SPI. As per the SDIO specification, to switch the interface to SPI mode, the host must send a CMD0 while holding CS low (its asserted state).

For further details on the protocol, see the SD Specification Part E1 “SDIO Simplified Specification” version 2.00.

4.2.3 SPI Bus Timing

The SPI clock rate supports up to 80MHz. The SPI bus timing is identical to the SDIO bus timing, where MOSI and MISO are considered input and output timing, respectively, in the SDIO bus timing specification.

The SPI bus defaults to clock idling at logical 0 (CPOL=0), and data is launched and captured on the positive edges of the clock, as per SDIO high-speed mode. It may be configured to behave like CPHA=0 (drive output on negative edge, sample on positive edge) after being initialized.

4.3 GPIO

4.3.1 Features

The GPIO hardware consists of a register to set each pin's drive enable, drive value and read the value present on the pin (whether driving or not).

Each pin can also be configured to generate an interrupt based on level, or edge (rising or falling). Each pin can be an individual interrupt source via the platform interrupt controller. Inputs are synchronized to the main digital clock and so any pulses must be at least 3 x 96MHz clock cycles in length.

There are internal pull-up and pull-down facilities in the pads, as well as drive-strength selection.

4.3.2 Reset State

At cold boot the pins which are GPIOs will be undriven and in a high-impedance state.

4.3.3 Power-Save State

During power-save the digital GPIOs can be programmed to retain their output state.

4.4 USB

A USB 2.0 High Speed interface is available, supporting device mode only at up to 480Mbps, providing a high throughput host interface.

4.4.1 Pin

Name	USB 2.0 Interface
USB_D_P	High speed differential pin, DP
USB_D_N	High speed differential pin, DM
VDD_USB	3.3V analog supply voltage for USB 2.0

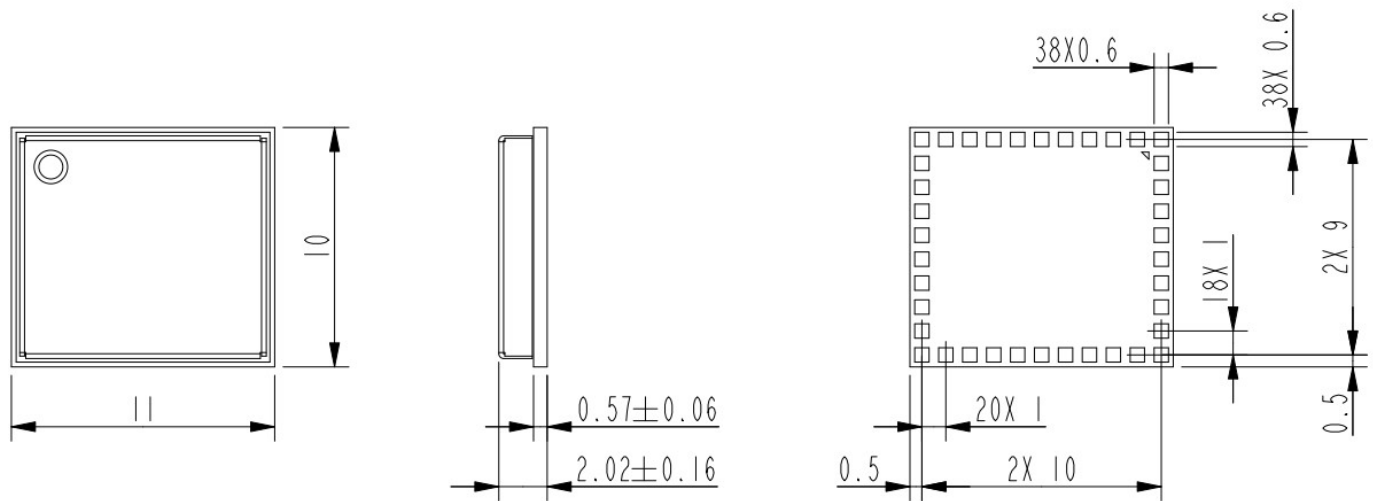
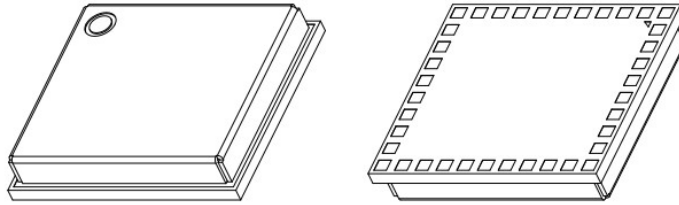
4.4.2 Features

- An integrated USB 2.0 PHY and MAC capable of up to High Speed mode at 480Mbps.
- Device endpoints implementing bulk data, isochronous transfers and interrupts sufficient for host driver to operate chip as network AP or STA.
- Suspend and resume power management functions.
- USB snooze mode with in-band wake.
 - ♦ Snooze mode is a low power mode the chip may enter and return from with full state retention. Even while USB is in use as a host interface, the chip can still enter and exit snooze mode, and this is referred to as USB snooze.
 - ♦ To enter USB snooze, the USB link must be in suspend state.
 - ♦ USB host issuing resume signaling over the USB bus (ie. in-band) will initiate chip wake from USB snooze and return to continuation of operation

Parameter	Min	Typ	Max	Unit
VDD_USB	3.0	3.3	3.6	V
V _{noise_VDD_USB} (Allowable power noise on supply, 1Hz-1kHz)	-	-	150	mV
I _{VDD_USB} in High Speed mode (480Mbps)	-	8.1	8.4	mA

5. Mechanical Information

5.1 Mechanical Drawing



6. Package information

1. One reel can pack TBD pcs
2. One production label is pasted on the reel, one desiccant and one humidity indicator card are put on the reel



One desiccant

One production label

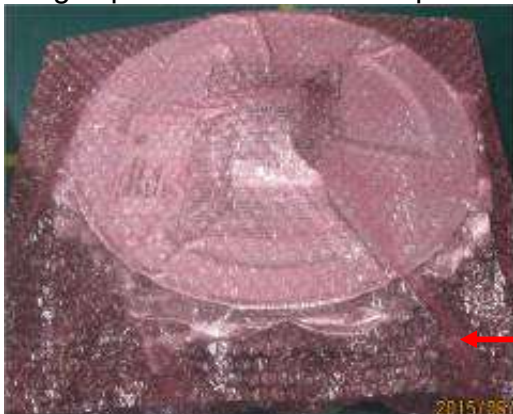
One humidity indicator card

3. One reel is put into the anti-static moisture barrier bag, and then one label is pasted on the bag



One production label

4. A bag is put into the anti-static pink bubble wrap



One anti-static pink bubble wrap

5. A bubble wrap is put into the inner box and then one label is pasted on the inner box



One production label

6. **5 inner boxes** could be put into one carton



Production

7. Sealing the carton by AzureWave tape



8. One carton label and one box label are pasted on the carton. If one carton is not full, one balance label pasted on the carton



Example of carton label	
Example of box label	

Example of production label	
Example of balance label	

7. Regulatory

7.1 FCC

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. 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 use is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

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.

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance 20cm between the radiator and your body.

IMPORTANT NOTE:

This module has been tested and found to comply with the following requirements for Modular Approval.

- Part 15.247 - Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

RF exposure considerations:

In the end product, the antenna(s) used with this transmitter must be installed to provide a separation distance of at least 20cm from all persons and must not be co-located or operated in conjunction with any other antenna or transmitter except in accordance with multi-transmitter product procedures. Users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying the RF exposure compliance.

Antennas:

This radio transmitter has been approved by the FCC and ISED to operate with the antenna types listed below with the maximum permissible gain 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.

Antennes:

Cet émetteur radio a été approuvé par la FCC et ISED pour fonctionner avec les types d'antennes répertoriés ci-dessous avec le gain maximal autorisé indiqué. Les types d'antennes non inclus dans cette liste, ayant un gain supérieur au gain maximum indiqué pour ce type, sont strictement interdits pour une utilisation avec cet appareil.

Antenna Type	Frequency (MHz)	MF	Model PN	Peak Antenna Gain (dBi)
Dipole	902-928	Cortec	AN0915-5005BSM	2.34
Dipole	868-928	Pulse Larson	W1063	1.0

Required End Product Labeling Any device incorporating this module must include an external, visible, permanent marking or label which states: “Contains FCC ID: 2A74O-737B5B”

Test Modes:

This device uses various test mode programs for test set up which operate separate from production firmware. Host integrators should contact the grantee for assistance with test modes needed for module/host compliance test requirements.

Additional Testing, Part 15 Subpart B Disclaimer

The modular transmitter is only FCC authorized for the specific rule parts (i.e. FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

EMI Considerations:

Note that a host manufacturer is recommended to use KDB996369 D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

For standalone mode, reference the guidance in KDB996369 D04 Module Integration Guide and for simultaneous mode; see KDB996369 D02 Module Q&A Question 12, which permits the host manufacturer to confirm compliance.

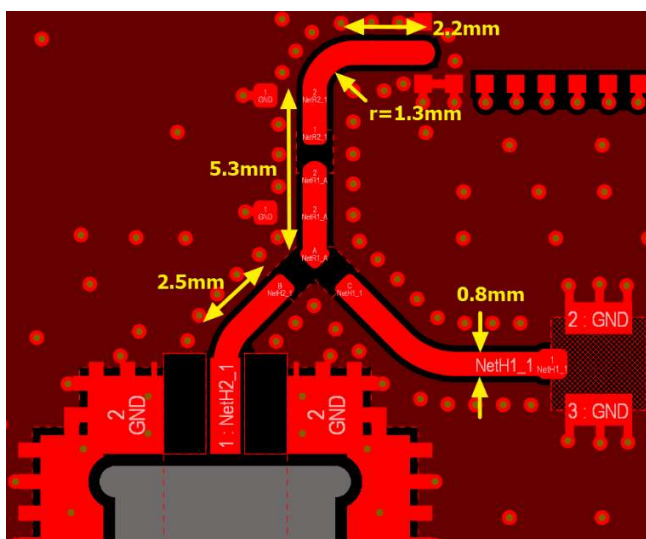
How to make changes:

Only Grantees are permitted to make permissive changes, if the module will be used differently than granted conditions, please contact us to ensure modifications will not affect compliance.

Antenna Trace Design The modular transmitter is configured for monostatic operation, which requires only a single RF I/O pin for full duplex communication. The output must be routed to the antenna via 50 ohm microstrip or stripline on the OEM PCB. No coupling capacitor is required given that the RF pin is AC-coupled internally.

Antenna Trace Design:

The modular transmitter is configured for monostatic operation, which requires only a single RF I/O pin for full duplex communication. The output must be routed to the antenna via 50 ohm microstrip or stripline on the OEM PCB. No coupling capacitor is required given that the RF pin is AC-coupled internally.



Length: 10mm
 Width: 0.8mm
 Thickness: 1.6mm
 Type of trace: 1/2oz
 Dielectric constant: 4.3
 Antenna connector: SMA

The trace from Pin No. 2 to the antenna connector on the OEM PCB must be maintained identical to the above specification with SMA connector. Only trace designs approved with an original grant or through permissive change can be used by an OEM, any changes are deemed as antenna type change and should be reviewed to ensure compliance with the FCC and ISSED requirements.

Verification must be conducted and the results shall not exceed below ranges to ensure identical antenna design is applied to subsequent integration and end product production.

Impedance 50 ohm +/- 10%

Input power is 26dBm (Average power)

VSWR absolute max $\leq 10:1$ (limit to avoid permanent damage)

VSWR recommended $\leq 1.92:1$ (limit to fulfill all regulatory requirements)

Test procedure of verification

1. Set module device in support transmission mode
2. Verify RF power through conducted measurement at balanced impedance of 50ohms, the KDB 971168 D01 Power Meas License Digital System shall be used as the supplemental test methodology to adjust the proper setting obtaining the measurement results
3. Verify the Tx power in the datasheet, and compliance test reports

7.2 IC

Industry Canada Statement:

This device contains license-exempt transmitter(s) / receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(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.

This device contains license-exempt transmitter(s) / receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s).

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique 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.

Caution: Exposure to Radio Frequency Radiation

1. To comply with the Canadian RF exposure compliance requirements, this device and its antenna must not be co-located or operating in conjunction with any other antenna or transmitter
2. To comply with RSS 102 RF exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna of this device and all persons

Attention: exposition au rayonnement radiofréquence:

1. Pour se conformer aux exigences de conformité RF canadienne l'exposition, cet appareil et son antenne ne doivent pas être co-localisés ou fonctionnant en conjonction avec une autre antenne ou transmetteur.
2. Pour se conformer aux exigences de conformité CNR 102 RF exposition, une distance de

séparation d'au moins 20 cm doit être maintenue entre l'antenne de cet appareil et toutes les personnes

Antennas:

This radio transmitter has been approved by the ISED to operate with the antenna types listed below with the maximum permissible gain 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.

Antennes:

Cet émetteur radio a été approuvé par la ISED pour fonctionner avec les types d'antennes répertoriés ci-dessous avec le gain maximal autorisé indiqué. Les types d'antennes non inclus dans cette liste, ayant un gain supérieur au gain maximum indiqué pour ce type, sont strictement interdits pour une utilisation avec cet appareil.

Antenna Type	Frequency (MHz)	MF	Model PN	Peak Antenna Gain (dBi)
Dipole	902-928	Cortec	AN0915-5005BSM	2.34
Dipole	868-928	Pulse Larson	W1063	1.0

Required End Product Labeling

Any device incorporating this module must include an external, visible, permanent marking or label which states: "Contains IC : 29791-737B5B"

Obligation d'étiquetage du produit final:

Tout dispositif intégrant ce module doit comporter un externe, visible, marquage permanent ou une étiquette qui dit: "Contient IC : 29791-737B5B"

RF exposure considerations:

In the end product, the antenna(s) used with this transmitter must be installed to provide a separation distance of at least 20cm from all persons and must not be co-located or operated in conjunction with any other antenna or transmitter except in accordance with multi-transmitter product procedures. Users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying the RF exposure compliance.