

Wi-Fi HaLow Module MM610X-001

1. Product overview

MM610X-001 is a Wi-Fi HaLow Sub-GHz wireless module based on Morse Micro[®] MM6108 RF SOC.

HaLow (pronounced halo) is a low-power, long-range version of the IEEE 802.11Wi-Fi standard. HaLow is based on the Wi-Fi Alliance 802.11ah specification and is expected to play an important part in the Internet of Things (IoT).

Wi-Fi CERTIFIED HaLow[™], the designation for products incorporating IEEE 802.11ah technology, augments Wi-Fi by operating in spectrum below 1 gigahertz (GHz) to offer longer range and lower power connectivity.

Excellent RF performance, MM610X-001 module has excellent sensitivity with good selectivity and blocking performance. MM610X-001 module come with U.FL connector for external Sub-GHz antenna.

There are many IO interfaces: UART, SDIO, SPI, I2C and rich GPIOs for PWM and switch functions.

2 KMs LOS distance communication: MM610X-001 module is tested to support up to 2000 meters LOS distance communication, good for both indoor and outdoor IoT applications.

20Mbps UDP Throughput is the best capacity compared with all Wireless IoT long distance throughput. The Phy data rate is 32.5Mbps.

Wi-Fi CERTIFIED HaLow[™] for IoT

Features	Benefits
 Sub-1 GHz spectrum operation	 Long range: approximately 1 km
 Narrow band OFDM channels	 Penetration through walls and other obstacles
 Several device power saving modes	 Supports coin cell battery devices for months or years
 Native IP support	 No need for proprietary hubs or gateways
 Latest Wi-Fi [®] security	

Source: Wi-Fi Alliance[®]

2. Features:

- ✧ Protocol
 - 802.11ah OFDM PHY supporting future WFA HaLow certification
 - BPSK & QPSK, 16-QAM & 64-QAM Modulation
 - Automatic frequency & gain control
 - Packet detect & channel equalization
 - Forward Error Correction (FEC) coding & decoding
 - Supports Modulation and Coding Scheme (MCS) levels MCS 0-7 and MCS 10
 - Supports 1 MHz and 2MHz duplicate mode
 - Supports optional Traveling Pilot
 - 802.11ah MAC supporting WFA HaLow certification
 - Support for STA and AP roles
 - Listen-Before-Talk (LBT) access with energy detect
 - 802.11 power save
 - 802.11 fragmentation and defragmentation
 - Power-Saving Target Wake Time (TWT) support for long battery life
 - Automatic and manual MCS rate selection

- ✧ Radio Operation
 - Single-stream max data rate of 32.5 Mbps (MCS=7, 64-QAM, 8MHz channel, 4 μ Sec GI)
 - Radio supporting worldwide Sub-1 GHz frequency bands
 - Frequency Range: 850-950 MHz
 - Channel width options of 1/2/4/8 MHz

- ✧ Transmitter Performance
 - Tx output power (dBm): +21 dBm (Typical) MCS0

- ✧ RF Interface
 - External antenna connector

- ✧ Power Management Unit (PMU) for various modes of operation
 - Power-down (interrupt driven wake)
 - Hibernate mode (internal / external wake)
 - Target Wake Time mode
 - Active Receive / Transmit mode
 - Integrated DC-DC converter supports a wide supply voltage, from 3.0V to 3.6V

- ✧ Regulatory Certifications coming soon
 - CE/FCC/IC/TELEC/NCC/RCM
 - ESD: HBM 2KV / MM 200V, Latch-up: 150mA
 - Halogen-free / RoHS 2.0 / Reach Annex 14 & 17

- ✧ Operating Range
 - 3.0-3.6V for VBATT and VDDFEM. 1.8-3.6V for VDDIO
 - -40 to +70°C

- ◇ Dimensions
 - 22 mm x 17.0 mm x 2.0 mm (module)

- ◇ 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)

- ◇ MCU Peripherals
 - 12-bit 1 Msps SAR ADC
 - 12 × GPIO
 - 2 × UART, 1 x SPI, 1 x I2C
 - Power Management Unit for power state switching
 - SDIO 2.0 compliant slave interface
 - SDIO 2.0 Default Speed (DS) at 25MHz
 - SDIO 2.0 High Speed (HS) at 50MHz
 - Support for both 1-bit and 4-bit data mode
 - Support for SPI mode operation

- ◇ Surveillance Cameras and Sensors
 - Cloud Connectivity
 - Low-power Sensor Networks
 - Building Automation Systems (BAS)
 - Asset Tracking and Management
 - Machine Performance Monitors & Sensors
 - Building Access Control & Security
 - Drone Video and Navigation Communications
 - Connected Toys and Games
 - Rural Internet Access
 - Agricultural and Farm Networks
 - Utility Smart Meter and Intelligent Grid
 - Proximity Sensors
 - Industrial Automation Controls
 - Smart Home Automation
 - EV Car Chargers
 - Appliances
 - Construction Site Connectivity
 - Smart Signs and Kiosks
 - Retail Point-of-Sale Terminals
 - Vehicle-to-Vehicle Communications
 - IP Sensor Networks
 - Biometric IDs and Keypads
 - Warehouse Connectivity
 - Intelligent Lighting Controls
 - BT/ZigBee(™)/Z-Wave(™) to Wi-Fi HaLow Gateways

- Wi-Fi to Wi-Fi HaLow Bridges
- Wi-Fi HaLow Client Adapters/Dongles
- Smart City Networks

3. Specification:

Item	Specification
RF Transmit Power	Tx output power (dBm): +21 dBm (Typical)@MCS0 (+/- 2dBm) +18 dBm (Typical)@MCS7 (+/- 2dBm)
Antenna	1 x UFL (IPEX) connector
PHY Rate	Up to 32.5Mbps
Physical Connectors	43 holes PCB board edge stamp holes
Operation Voltage	3.0V to 3.6V
Operation Temperature	-40 to 70 °C
Security	WPA3
Host Interface	SDIO, SPI

RF Receiver Sensitivity

MCS Index	Modulation Scheme	Coding Rate	Phy Rate (kbps) per BW				Spec Sensitivity (dBm) per BW			
			1MHz	2MHz	4MHz	8MHz	1MHz	2MHz	4MHz	8MHz
0	BPSK	1/2	333	722	1500	3250	-105	-103	-101	-97
1	QPSK	1/2	667	1444	3000	6500	-102	-100	-97	-93
2	QPSK	3/4	1000	2167	4500	9750	-99	-97	-95	-92
3	16-QAM	1/2	1333	2889	6000	13000	-96	-94	-91	-88
4	16-QAM	3/4	2000	4333	9000	19500	-93	-90	-88	-85
5	64-QAM	2/3	2667	5778	12000	26000	-89	-87	-84	-81
6	64-QAM	3/4	3000	6500	13500	29250	-88	-85	-83	-80
7	64-QAM	5/6	3333	7222	15000	325500	-87	-84	-81	-78
10	BPSK	1/2 x 2	167	N/A			-107	N/A		

Transmit Power consumption

Mode	Condition $T_A=25^{\circ}\text{C}$, $V_{BAT}=V_{DDIO}=3.3\text{V}$	V_{BAT} Current (Typ)	V_{FEM} (Typ)	Unit
Transmit Current (MCS7, 16dBm, 100% D.C.)	1MHz channel	51	104	mA
	2MHz channel	55	104	mA
	4MHz channel	62	102	mA
	8MHz channel	72	99	mA
Transmit Current (MCS0, 21dBm, 100% D.C.)	1MHz channel	57	151	mA
	2MHz channel	60	151	mA
	4MHz channel	66	151	mA
	8MHz channel	78	147	mA

FCC Compliance Statement:

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.

This device must accept any interference received, including interference that may cause undesired operation. Product that is a radio transmitter is labeled with FCC ID.

FCC Caution:

- (1) Exposure to Radio Frequency Radiation. This equipment must be installed and operated in accordance with provided instructions and the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter. End-users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.
- (2) Any changes or modifications not expressly approved by the grantee of this device could void the user's authority to operate the equipment.
- (3) This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
- (4) Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user authority to operate the equipment.

IMPORTANT NOTE: In the event that these conditions cannot be met (for example certain laptop configurations or 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.

The modular transmitter is only FCC authorized for the specific rule parts listed on the grant, and that the 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 module has been tested for compliance to FCC Part 15 (15.247)

If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

OEM integration instructions:

This device is intended only for OEM integrators under the following conditions,
The module is only limited to installation in mobile applications. The antenna must be installed such that 20 cm is maintained between the antenna and users, and the transmitter module may not be co-located with any other transmit or antenna. The module shall be only used with the integral antenna(s) that has been originally tested and certified with this module.
As long as 3 conditions above are met, further transmitter test will not be required.
However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirement with this module installed (for example, digital device emission, PC peripheral requirements, etc.)

OEM integration instructions:

In the event that these conditions cannot be met (for example certain laptop configuration or co-location with another transmitter), then the FCC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID of the module cannot be used on the final product. In these and circumstance, the OEM integrator will be responsible for re-evaluating. The end product (including the transmitter) and obtaining a separate FCC authorization

End product labeling:

This transmitter module is authorization only for use in device 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 following,

"Contains Transmitter Module FCC ID: TKZMM610X-001 or Contains FCC ID: TKZMM610X-001"

The end product shall bear the following 15.19 statement: 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.

Information that must be placed in the end user manual:

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

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 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 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.

This module has been approved to operate with the antenna types listed below, with the maximum permissible gain indicated.

Frequency Band	Antenna Type	Model Number	Gain(dBi)
863-930MHz	Dipole Antenna	ANTSM90003004001	2.5

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

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;
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance **20cm** between the radiator & your body.

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20cm de distance entre la source de rayonnement et votre corps

This radio transmitter [IC: 9968A-MM610X001] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antenna Type	Model Number	Antenna Gain(dBi)	Remark
Dipole Antenna	ANTSM90003004001	2.5	For 863-930MHz

Le présent émetteur radio [IC: 9968A-MM610X001] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

End Product Labeling

This transmitter module is authorized only for use in device 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 following: "Contains transmitter module IC: IC: 9968A-MM610X001".

Contient le module d'émission IC: IC: 9968A-MM610X001

The Host Model Number (HMN) must be indicated at any location on the exterior of the end product or product packaging or product literature which shall be available with the end product or online.

This device is intended only for OEM integrators under the following conditions:

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

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

- 1) L'antenne doit être installée de telle sorte qu'une distance de 20cm est respectée entre l'antenne et les utilisateurs, et
- 2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

NCC

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