



Morse Micro
reaching farther™



MM8108-MF15457

Multi-region Wi-Fi HaLow / IEEE 802.11ah Module
with USB host interface and Integrated Amplifiers

User Guide

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1. Product Overview

1.1. Introduction

Wi-Fi HaLow (pronounced HEYlow) is the first global Wi-Fi standard (IEEE 802.11ah) tailored to meet the Internet of Things (IoT) needs. 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.

Morse Micro, the world's leading Wi-Fi HaLow (802.11ah) solutions provider, offers several Wi-Fi HaLow connectivity solutions. The **MM8108-MF15457** is a fully integrated Wi-Fi HaLow® module with long range, low power consumption, and superior RF performance, featuring our second generation MM8108 Wi-Fi HaLow SoC. It is compliant with IEEE 802.11ah, supporting data rates up to 43.3 Mbps, 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.

Its integrated power amplifier (PA) offers class-leading transmit performance and energy efficiency with on-chip amplification of up to 26dBm, which is ideal for low-cost devices. The ultra-high linearity integrated low-noise amplifier (LNA) offers exceptional receive sensitivity. These innovations, combined with digital transmit filtering and pre-distortion circuits, result in an advanced transceiver design that ensures out-of-the-box compatibility with most global Wi-Fi HaLow regulatory environments.

MM8108-MF1547 supports a USB 2.0 High-Speed host interface and an SDIO/SPI host interface, offering solution architects more flexibility when integrating Wi-Fi HaLow connectivity into their existing solution.

With a footprint of only 11x10mm, the MM8108-MF1547 module has been designed to optimize performance and power consumption, showcasing the benefits of our second-generation SoC. It is ideal for power-sensitive battery-operated and high-speed agricultural, mining, industrial, home, and city applications.

MM8108-MF15457 supports WPA3 and all standard security features required for Wi-Fi HaLow product certifications.

1.2. Features

- Single-stream maximum data rate of 43.3 Mbps at 8 MHz bandwidth
- Radio supporting worldwide Sub-1 GHz frequency bands
 - Frequency range: 850-950 MHz
 - Channel bandwidth options of 1/2/4/8 MHz
 - High power and extremely high efficiency integrated PA with maximum 26dBm (400mW) output power at 45% PA efficiency and 37% whole SoC efficiency
 - Novel PA architecture maintains efficiency at power backoff
 - Ultra-low power receiver with integrated LNA, NF < 4dB
- 802.11ah OFDM PHY supporting Wi-Fi Alliance Wi-Fi HaLow certification
 - BPSK & QPSK, 16-QAM, 64-QAM and 256-QAM Modulation
 - Automatic frequency and gain control
 - Packet detect and channel equalization
 - Forward Error Correction (FEC) coding and decoding
 - Support for Modulation and Coding Scheme (MCS) levels MCS 0-10
 - Support for 1 MHz duplicate modes
 - Support optional Traveling Pilots
- 802.11ah MAC supporting Wi-Fi Alliance Wi-Fi 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 extended battery life
 - Automatic and manual MCS rate selection
- On-chip software stack assisting with host offload of Wi-Fi connection management
- USB 2.0 High-Speed compliant device interface
 - Integrated USB 2.0 PHY and device interface supporting High-Speed mode at 480Mbps
- SDIO 2.0 compliant device interface
 - SDIO 2.0 High-Speed at 50MHz max for 200Mbps
 - Support for 1-bit and 4-bit data mode
 - Support for SPI mode operation at up to 80MHz for 80Mbps
- Power Management Unit (PMU) supporting various modes of operation
 - Single supply 3.0-3.6V for integrated DC-DCs and LDOs
 - Multiple low-power modes (hibernate, deep sleep, snooze) support extreme power environments.
- Wide spectrum of 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)

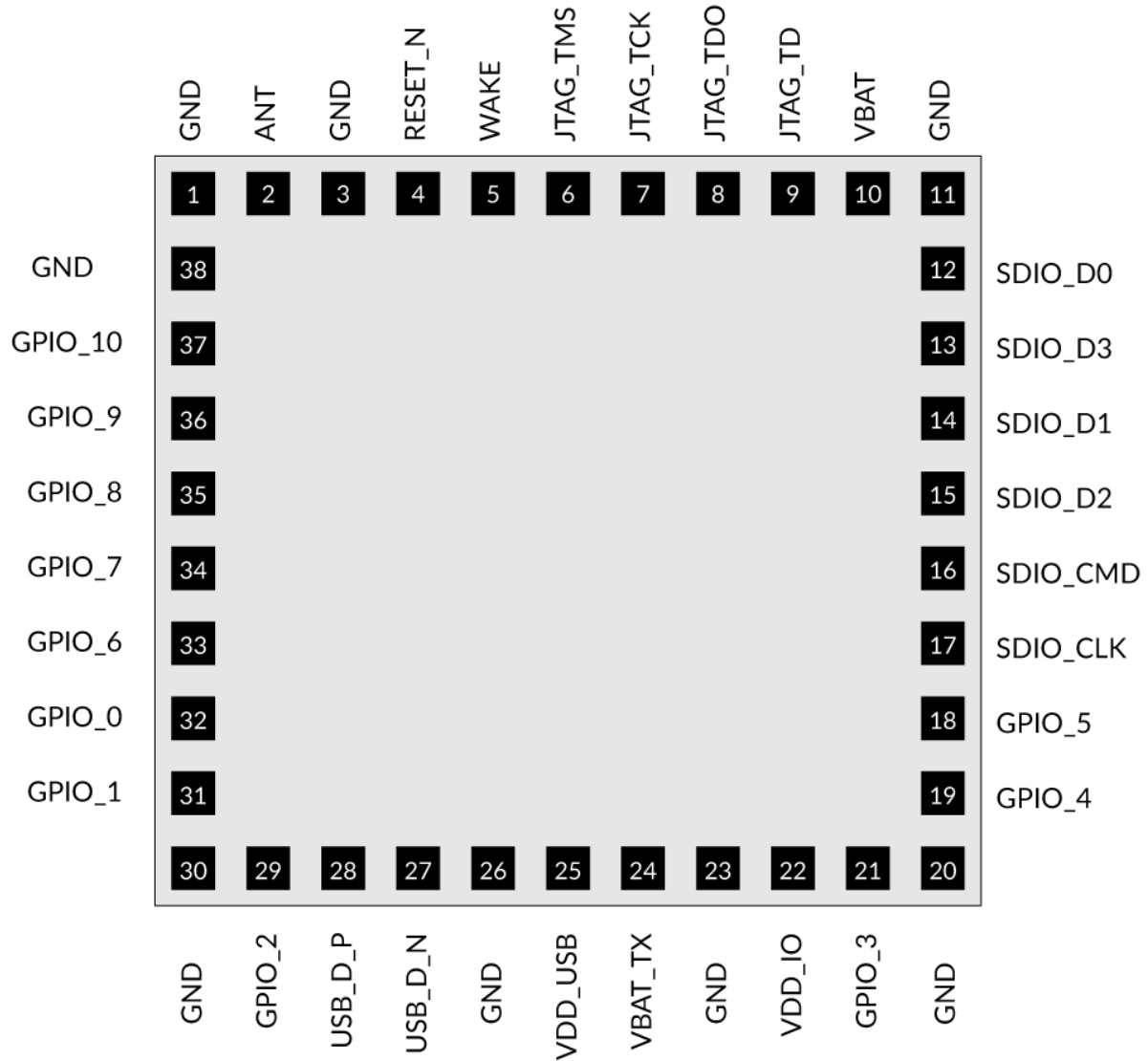
1.3. Applications

Ideally suited for Internet of Things (IoT) and Machine-to-Machine (M2M) applications such as:

- Surveillance cameras and sensors
- Cloud connectivity
- Low-power sensor networks
- Building Automation Systems (BAS)
- Asset tracking and management
- Machine performance monitors and sensors
- Building access control and 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

2. Pin Descriptions

The MM8108-MF15457 module has 38 pins, which are described in this section. The following illustration shows the top view of the module pins.



Pin	Pin Name	Type	Description	Alternate
1	GND	Ground	Ground	
2	ANT	Analog	Antenna	
3	GND	Ground	Ground	
4	RESET_N ^[4]	Analog	Asynchronous chip reset (active low)	
5	WAKE ^[4]	Analog	External wake from Deep Sleep and Snooze	
6	JTAG_TMS ^[1]	Digital I/O	JTAG Mode Select	GPIO15 ^[2]
7	JTAG_TCK ^[1]	Digital I/O	JTAG Clock	GPIO13 ^[2]
8	JTAG_TDO ^[1]	Digital I/O	JTAG Data Out	GPIO16 ^[2]
9	JTAG_TDI ^[1]	Digital I/O	JTAG Data In	GPIO14 ^[2]
10	VBAT	Supply	3.3V VBAT Supply	
11	GND	Ground	Ground	
12	SDIO_D0 ^[3]	Digital I/O	SDIO Data line	SPI_MISO
13	SDIO_D3 ^[3]	Digital I/O	SDIO Data line	SPI_CS
14	SDIO_D1 ^[3]	Digital I/O	SDIO Data line	SPI_INT
15	SDIO_D2 ^[3]	Digital I/O	SDIO Data line	
16	SDIO_CMD ^[3]	Digital I/O	SDIO Command line	SPI_MOSI
17	SDIO_CLK	Digital I/O	SDIO Clock input	SPI_SCK
18	GPIO5 ^[2]	Digital I/O	Programmable digital I/O	
19	GPIO4 ^[2]	Digital I/O	Programmable digital I/O	
20	GND	Ground	Ground	
21	GPIO3 ^[2]	Digital I/O	Programmable digital I/O	
22	VDDIO	Supply	Host supply for digital I/O	
23	GND	Ground	Ground	
24	VBAT_TX	Supply	3.3V VBAT-TX Supply	
25	VDD_USB	Supply	USB Supply	
26	GND	Ground	Ground	
27	USB_D_N	I/O	USB DM line	
28	USB_D_P	I/O	USB DP line	
29	GPIO2 ^[2]	Digital I/O	Programmable digital I/O	
30	GND	Ground	Ground	
31	GPIO1 ^[2]	Digital I/O	Programmable digital I/O	
32	GPIO0 ^[2]	Digital I/O	Programmable digital I/O	
33	GPIO6 ^[2]	Digital I/O	Programmable digital I/O	
34	GPIO7 ^[2]	Digital I/O	Programmable digital I/O	
35	GPIO8 ^[2]	Digital I/O	Programmable digital I/O	
36	GPIO9 ^[2]	Digital I/O	Programmable digital I/O	
37	GPIO10 ^[2]	Digital I/O	Programmable digital I/O	
38	GND	Ground	Ground	

[1] JTAG pins should be tied to GND via a 10k pull-down resistor

[2] All unused GPIO should be tied to GND via a 10k pull-down resistor

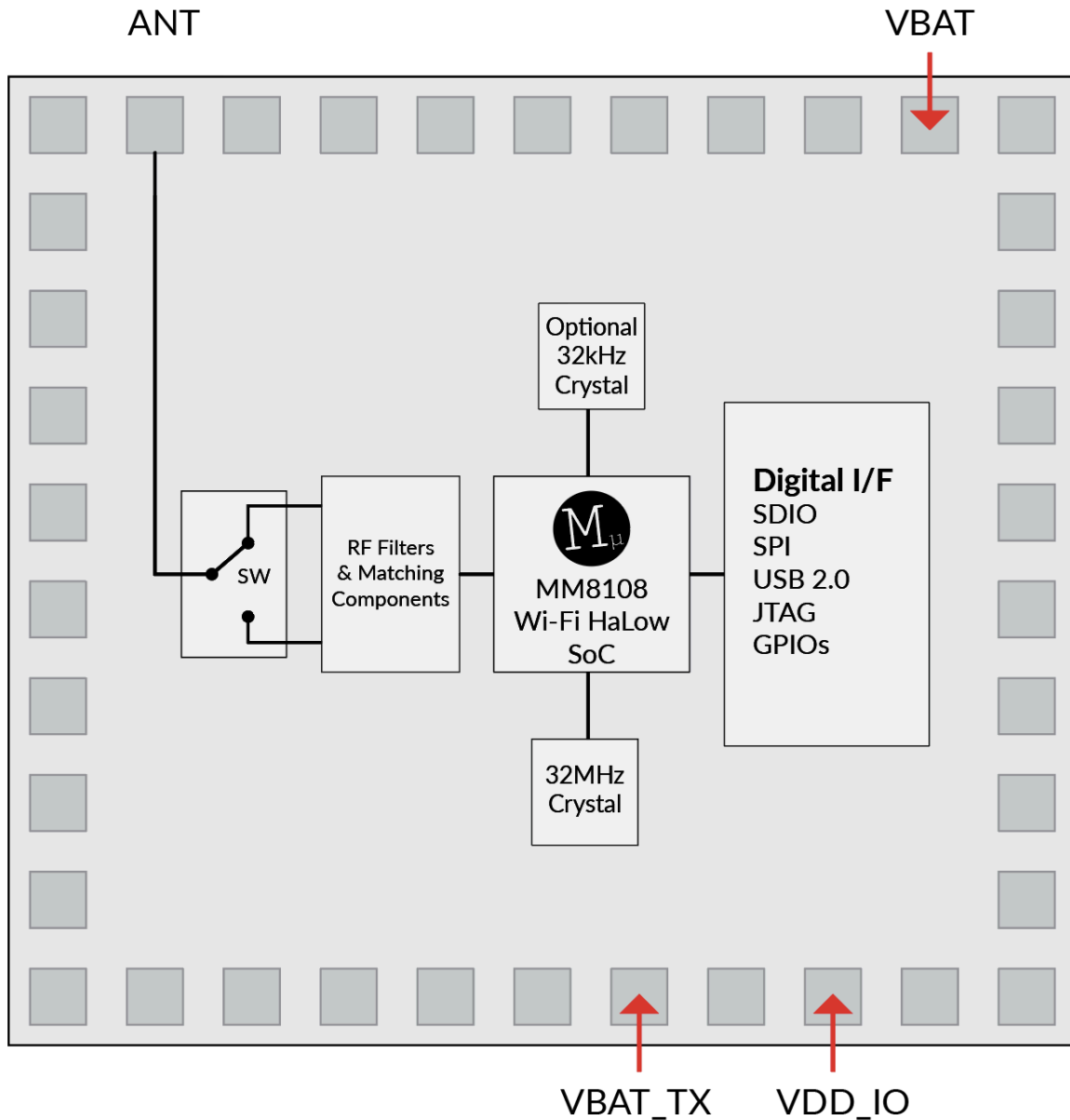
[3] All SDIO bus pins except SDIO_CLK should be pulled up with a 10k-100k resistor as per the SDIO standard

[4] Supplied from VBAT domain. The VDDIO domain drives other digital pins.

3. Functional Description

The following sections describe the functions of the MM8108-MF15457 module.

3.1. Block diagram



3.2. Power supply requirements

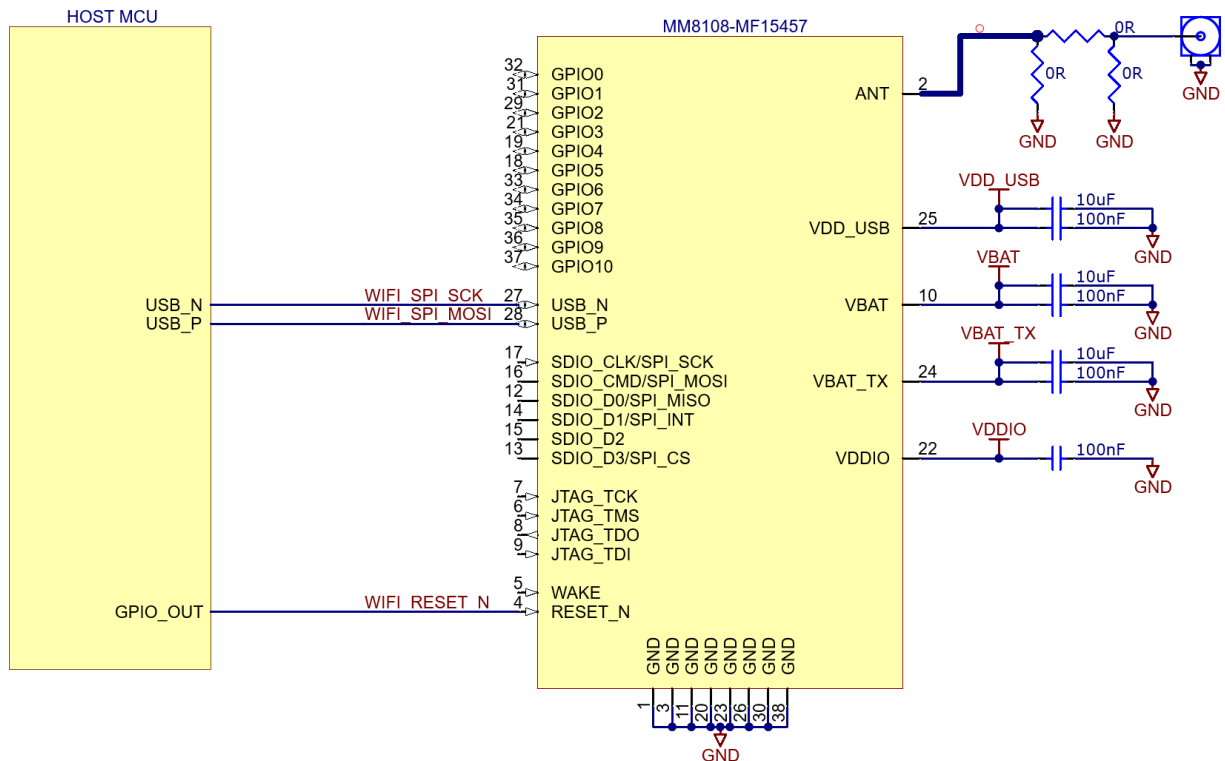
MM8108-MF15457 module power is derived from a 3.0 to 3.6V supply on pins VBAT and VBAT_TX.

VDDIO sets the IO voltage of the MM8108, which should be connected to the same power supply as the host MCU.

There are no strict power-up sequencing requirements; however, the voltage on VDDIO must not exceed VBAT.

3.3. USB host requirements

A schematic diagram detailing the recommended USB host interface circuit is shown below:



Recommended USB host interface circuit

3.4. SDIO host requirements

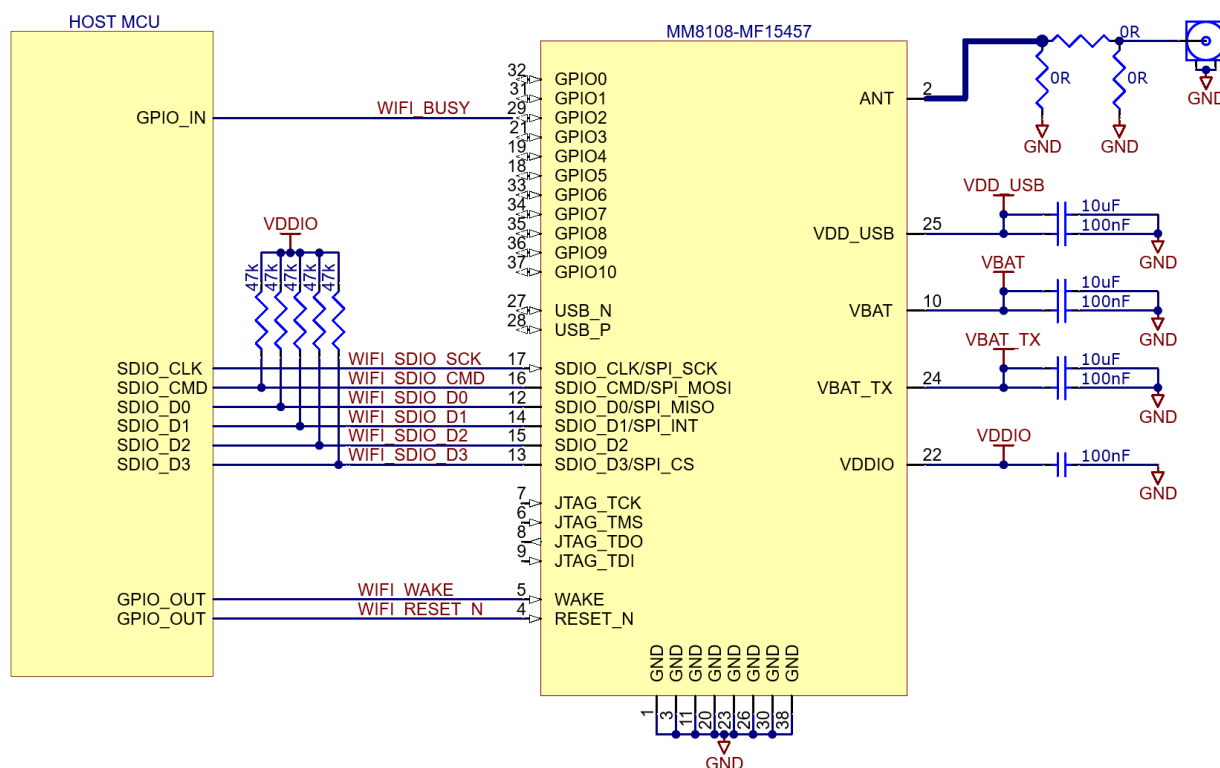
When selecting a CPU host to interface with the MM8108-MF15457 module via the SDIO interface, ensure the host supports SDIO 2.0 with SDIO clock speeds of up to 50 MHz. Slower clock speeds will impact the maximum achievable throughput.

The SDIO data and command lines should be pulled up with 10k-100k resistors per the SDIO 2.0 specification.

Most applications will benefit from the module's power-saving features. Two GPIOs, set as CMOS outputs, are required to drive the RESET and WAKE signals. A third GPIO, set as a CMOS input, is needed to receive the BUSY signal from the module.

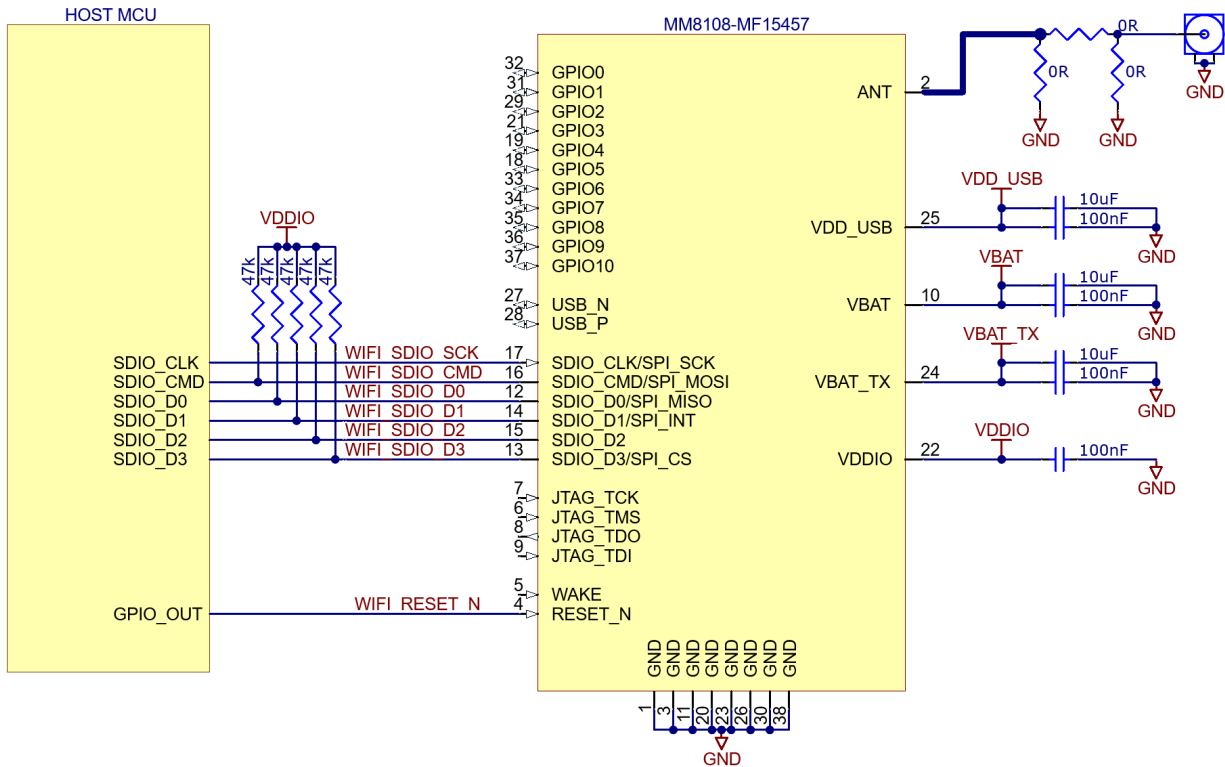
In applications where the module must always be on, and the power-saving features can not be used, such as access points, the WAKE pin can be fixed to VBAT, reducing the need for GPIOs on the host processor to only one.

A schematic diagram detailing the recommended SDIO host interface circuit using the module's power-saving features is shown below:



Recommended SDIO host interface circuit using power-saving features

A schematic diagram detailing the recommended SDIO host interface circuit for always-on applications is shown below:



Recommended SDIO host interface circuit for always-on applications

3.5. SPI host requirements

When selecting a CPU host to interface with the MM8108-MF15457 module via the SPI interface, consider the following recommendations to achieve the best throughput:

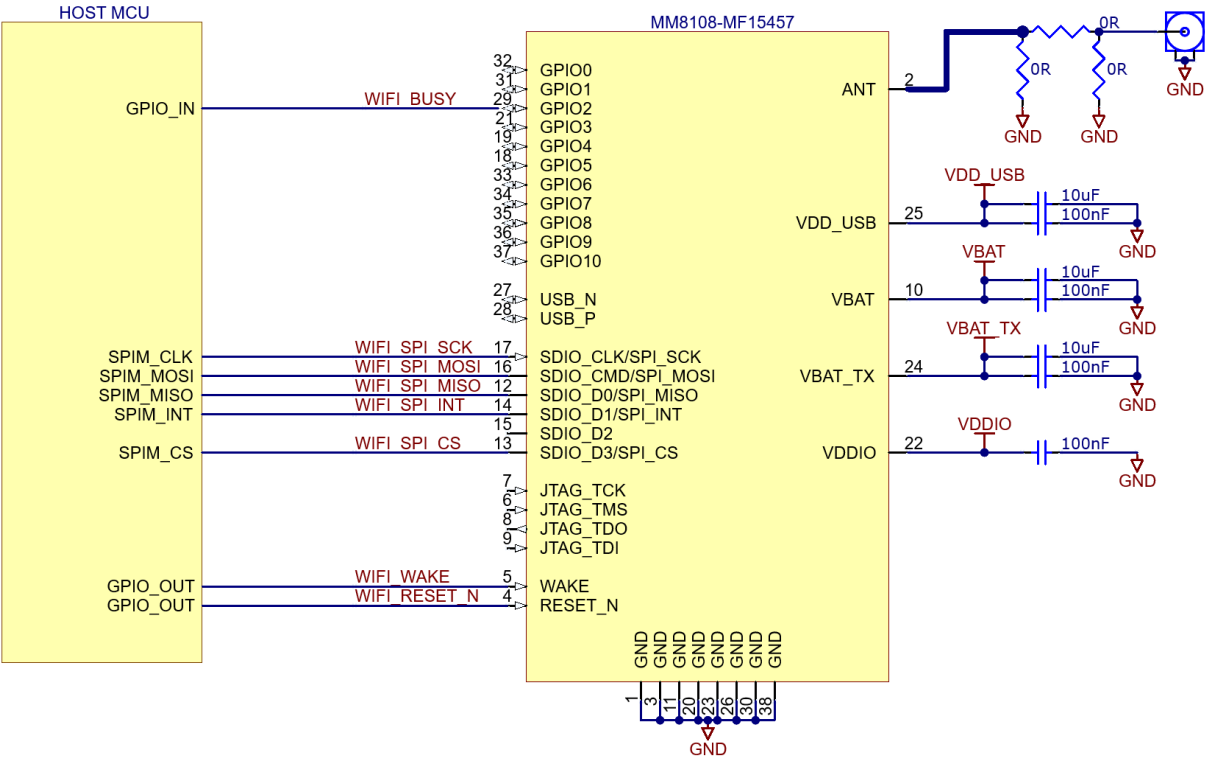
- The host should support level-triggered interrupts.
- The host should support full-duplex SPI mode.
- The host should support DMA-backed transactions on the SPI bus.

Standard SPI can achieve up to 25 Mbps at 50 MHz, but this will be significantly reduced without DMA support. For example, an SPI interface with an 8-byte buffer per transaction might only achieve 2 Mbps throughput on the SPI bus.

Most applications will benefit from the module's power-saving features. Two GPIOs, set as CMOS outputs, are required to drive the RESET and WAKE signals. A third GPIO, set as a CMOS input, is needed to receive the BUSY signal from the module.

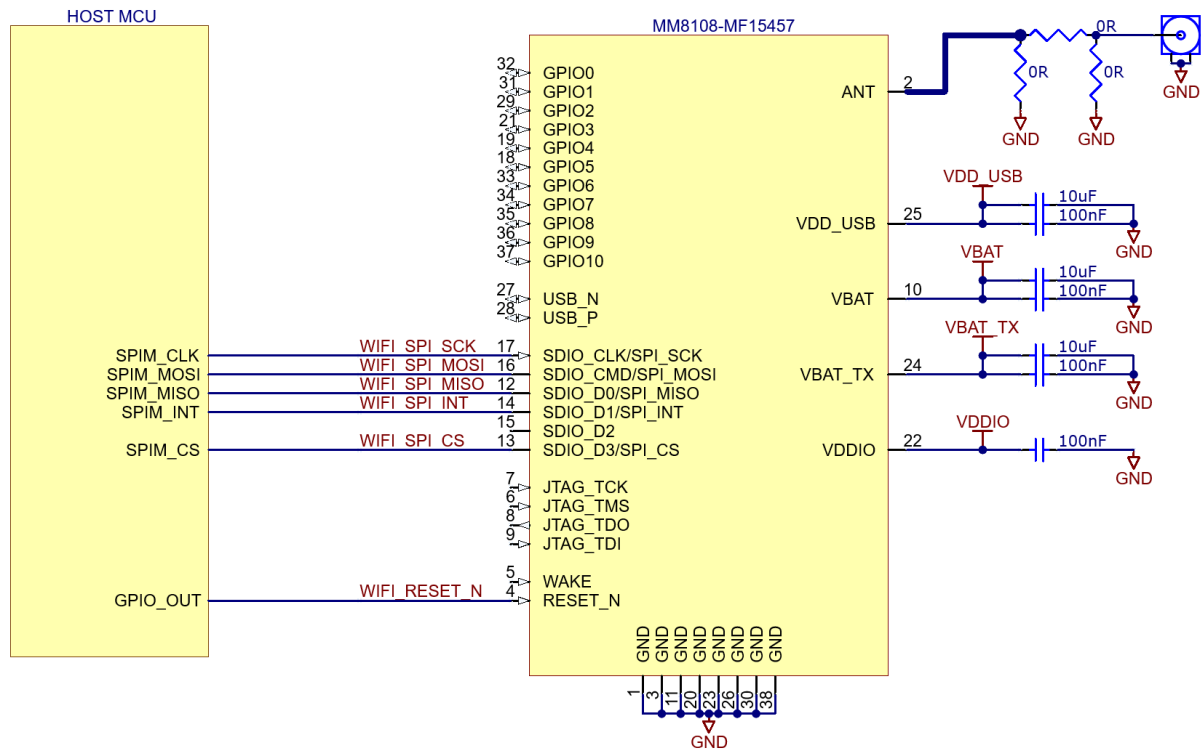
In applications where the module must always be on, and the power-saving features can not be used, such as access points, the WAKE pin can be fixed to VBAT, reducing the need for GPIOs on the host processor to only one.

A schematic diagram detailing the recommended SPI host interface circuit using the module's power-saving features is shown below:



Recommended SPI host interface circuit using power-saving features

A schematic diagram detailing the recommended SPI host interface circuit for always-on applications is shown below:



Recommended SPI host interface circuit for always-on applications

3.6. Digital Interfaces

All unused digital IO pins must be pulled up or down to prevent floating pins. Failure to do so will result in a higher leakage current on the VDDIO supply.

4. Electrical Characteristics

4.1. Absolute max ratings

Stress beyond absolute maximum ratings may cause permanent damage to the MM8108-MF15457 module. Functional operation is only guaranteed for recommended operation conditions. Operation of the device outside the recommended conditions may result in a reduced lifetime and reliability problems even if the absolute maximum ratings are not exceeded.

Parameter	Min	Max	Unit
VBAT voltage	-0.3	3.6	V
RESET_N/WAKE	-0.3	3.6	V
Digital I/O pin	-0.3	VDDIO + 0.3	V
Analog/RF pin	-0.3	1.2	V
Storage temperature	-40	125	°C
RF input power (CW)	-	6	dBm

4.2. Immunity

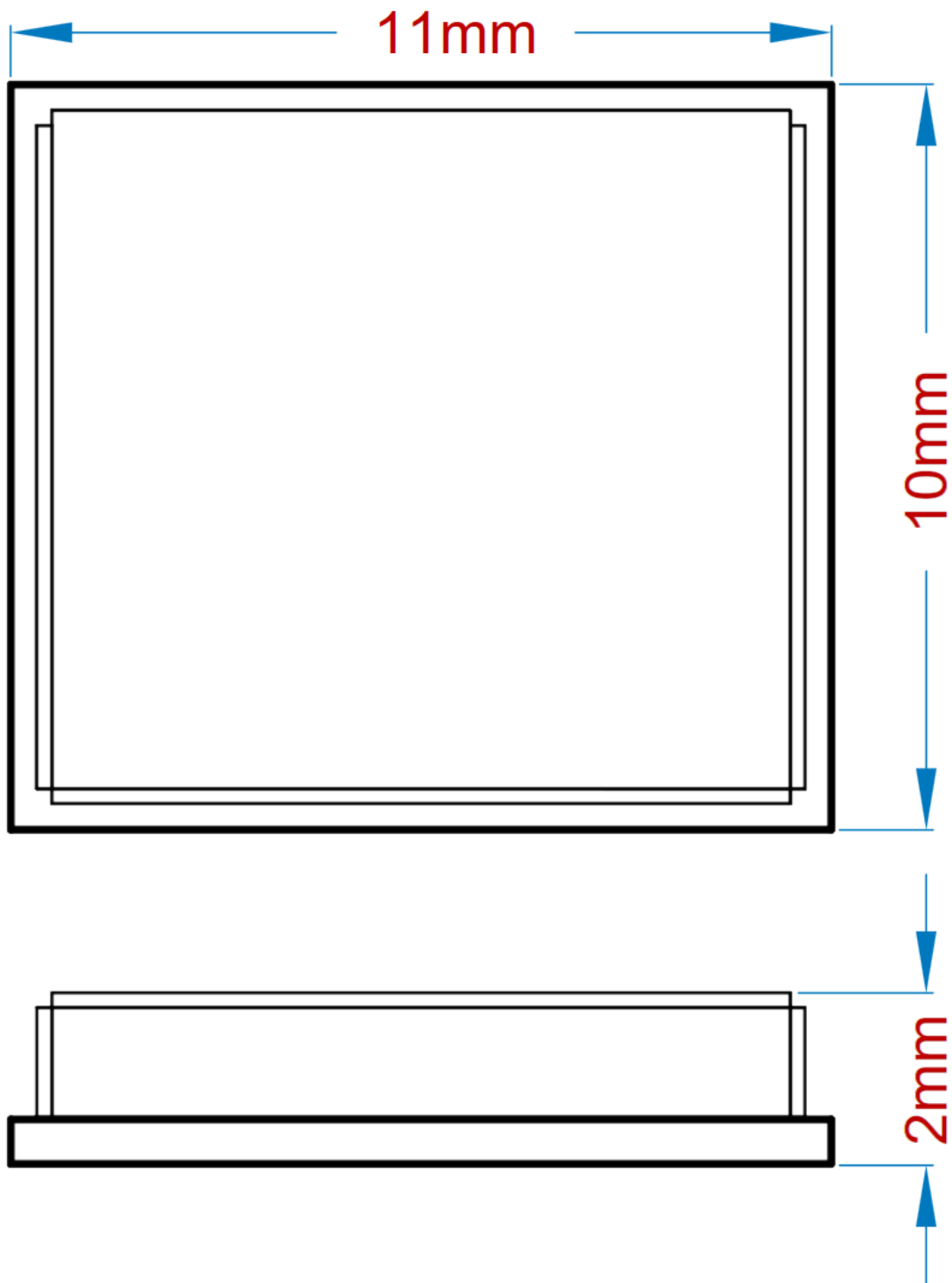
Parameter			Min	Max	Unit
Electrostatic discharge (ESD) performance	Human body model (HBM), per ANSI / ESDA / JEDEC JS001	RF Input	-500	500	V
		All pins except RF Input	-2000	2000	V
	Charged device model (CDM), per JESD22-C101	All pins	-500	500	V

4.3. Recommended operating conditions

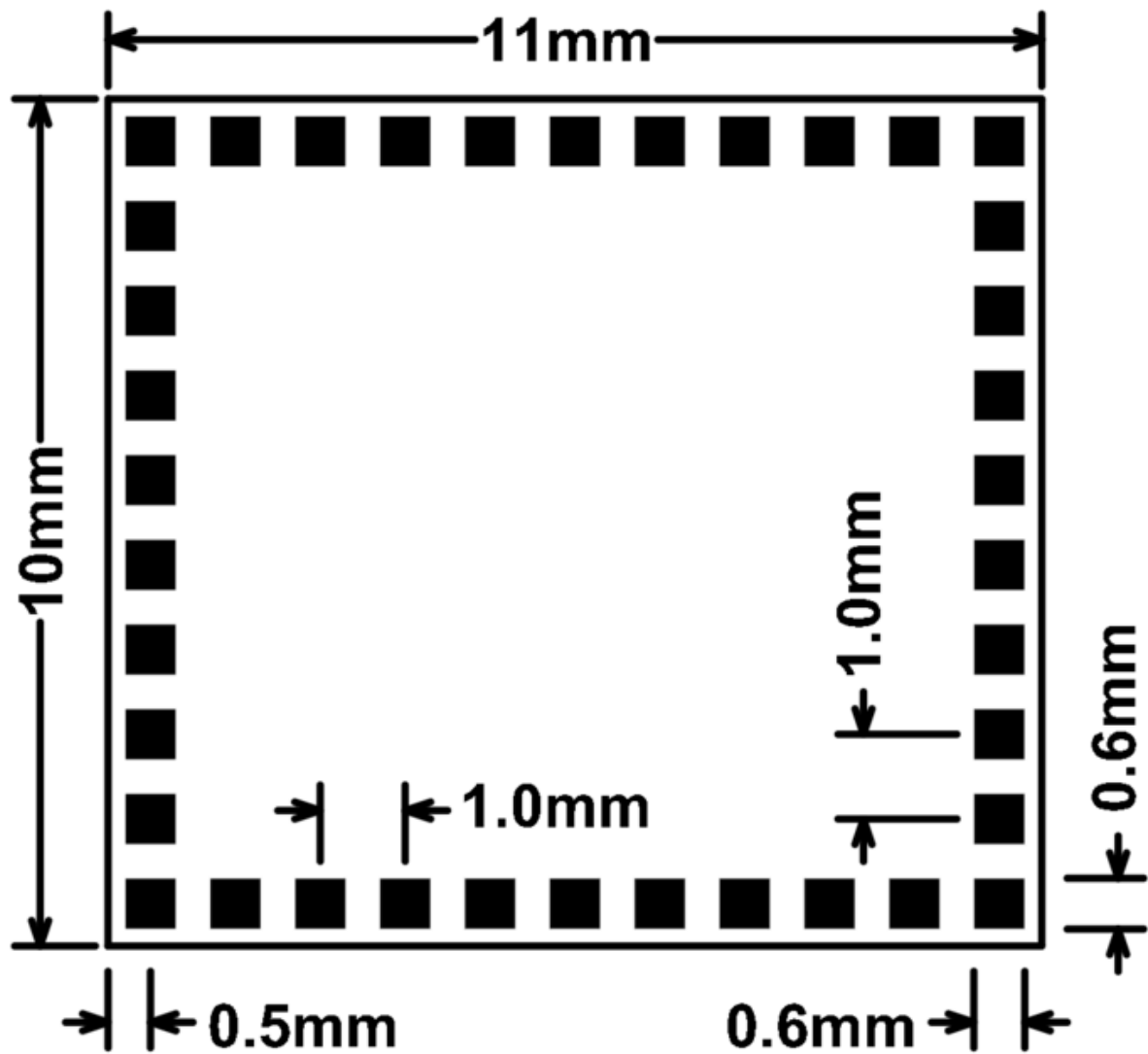
Parameter	Min	Typ	Max	Unit
Ambient temperature	-40		85	°C
Storage temperature	-40		125	°C
VBAT	3.0	3.3	3.6	V
VDDIO	2.25	3.3	3.6	V

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

5. Physical Specifications



6. Recommended PCB Footprint



7. Certification

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 user 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.

Radio	Antenna Type	Freq. (MHz)	Peak Antenna Gain (dBi)
802.11 ah	Dipole Antenna	902-928	1.00

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.

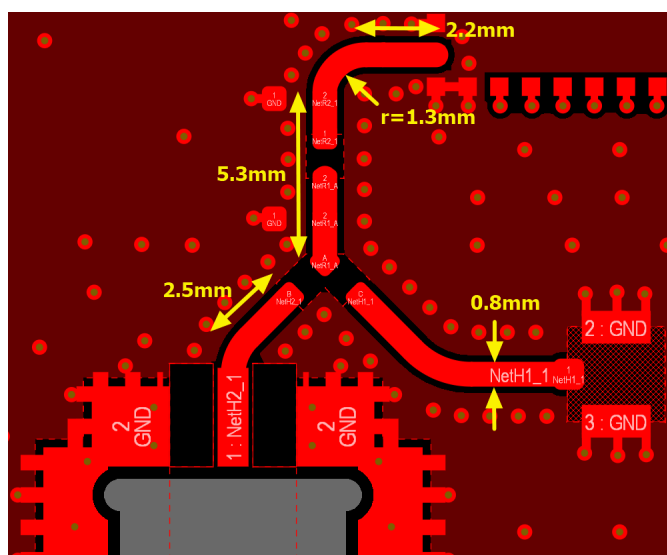
How to make changes:

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.

Radio	Antenna Type	Freq. (MHz)	Peak Antenna Gain (dBi)
802.11 ah	Dipole Antenna	902-928	1.00

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.

8. Part Numbers and Ordering Information

Part Number	Packing Type	Pins	Size (mm)	Description
MM8108-MF15457	Tray	38	14.0 x 18.5 x 2.1	IEEE 802.11ah Sub-1 GHz 1/2/4/8 MHz Wi-Fi HaLow Module

9. Handling and Storage

The MM8108-MF15457 class of modules is a moisture-sensitive device rated at Moisture Sensitive Level 3 (**MSL3**) per IPC/JEDEC J-STD-20.

After opening the moisture-sealed storage bag, modules that will be subjected to reflow solder or other high-temperature processes must be:

1. Mounted to a circuit board within 168 hours at factory conditions ($\leq 30^{\circ}\text{C}$ and $< 60\% \text{ RH}$)

OR

2. Continuously stored per IPC/JEDEC J-STD-033

Modules exposed to moisture and environmental conditions exceeding packaging and storage conditions **MUST** be baked before mounting, according to IPC/JEDEC J-STD-033. Failure to meet packaging and storage conditions will result in irreparable damage to modules during solder reflow.

10. Revision History

MM8108-MF15457 ADS101; February 28th, 2025

- Add power on and reset timing details
- Updated standby power consumption

MM8108-MF15457 ADS100; January 8th, 2025

- Initial release

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