



Morse Micro MM6108-MF08651-US IEEE 802.11ah Sub-1 GHz Wi-Fi HaLow Module User Guide

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Product Overview

Introduction

Morse Micro provides a complete Wi-Fi Halow connectivity solution. The MM6108-MF08651-US is a fully integrated Wi-Fi Halow® module with long-range, low-power consumption and superior RF performance, featuring the MM6108 Wi-Fi Halow soc.

The MM6108-MF08651-US module is designed in compliance with the IEEE 802.11 ah standard, supporting data rates up to 32.5 Mbps with programmable operation between 850 MHz and 950 MHz.

This module includes ultra-long-reach PA, high linearity LNA, T/R switch, 32 MHz crystal oscillator and it has been designed for a simplified Wi-Fi Halow connection to an external host for applications in which a customer wants to merely replace their prior RF technology with a Wi-Fi Halow connection while leveraging the latest WPA3 security protocol.

Battery-operated applications are supported by a combination of features which are inherently supported by the module. The IEEE 802.11 ah standard provides for extended sleep times for battery-operated Stations {STAs or client devices}, with longer durations than other prior IEEE 802.11 a/b/g/ n/ac generations. It also allows longer extended maximum idle times for clients to conserve energy without being removed from the access point's {AP's} list of associated devices.

Features

Ultra-long-range, low-power Wi-Fi Halow module for IoT Applications:

- Module Variants
 - MM6108-MF08651-US: 1/2/4/8 MHz channel bandwidth
- Single-stream max data rate of 32.5 Mbps @8MHz or 15 Mbps @4MHz channel.
- Radio supporting Sub-1 GHz frequency bands
 - Frequency Range: 902-928 MHz
 - Max output power: 21.5 dBm (Average power)
- 802.11 ah OFDM PHY supporting WFA Halow certification
 - BPSK & QPSK, 16-QAM & 64-QAM Modulation
 - Automatic frequency & gain control
 - Packet detect & channel equalization
 - Forward Error Correction (FEC) coding & decoding
 - Support for Modulation and Coding Scheme (MCS) rates MCS 0-7 and MCS 10
 - Support for 1 MHz and 2 MHz duplicate modes
 - Support for Traveling Pilots
- 802.11 ah MAC supporting WFA Ha Low 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
- Support for various interface options
 - SDIO 2.0 compliant host/slave interface
 - 2xUARTs
 - SPI Slave interface
 - I2C Master/Slave interface
 - 4-channel PWM
- 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 voltages, from 3.0V to 3.6V
- Wide spectrum of Security features
 - AES encryption engine
 - Hardware support for SHA 1 and SHA2 hash functions (SHA-256, SHA-384, SHA-512)
 - WPA3 including protected management frames (PMF)
 - Opportunistic Wireless Encryption (OWE)

Applications

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 & 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 Hailo Gateways
- Wi-Fi to Wi-Fi Hailo Bridges
- Wi-Fi Hailo Client Adapters/Dongles
- Smart City Networks

Pin Descriptions

The MM6108-MF08651-US module has 38-pins, which are described in this section. The following illustration shows the top view of the module pin Diagram.

Figure 1: Pin Diagram

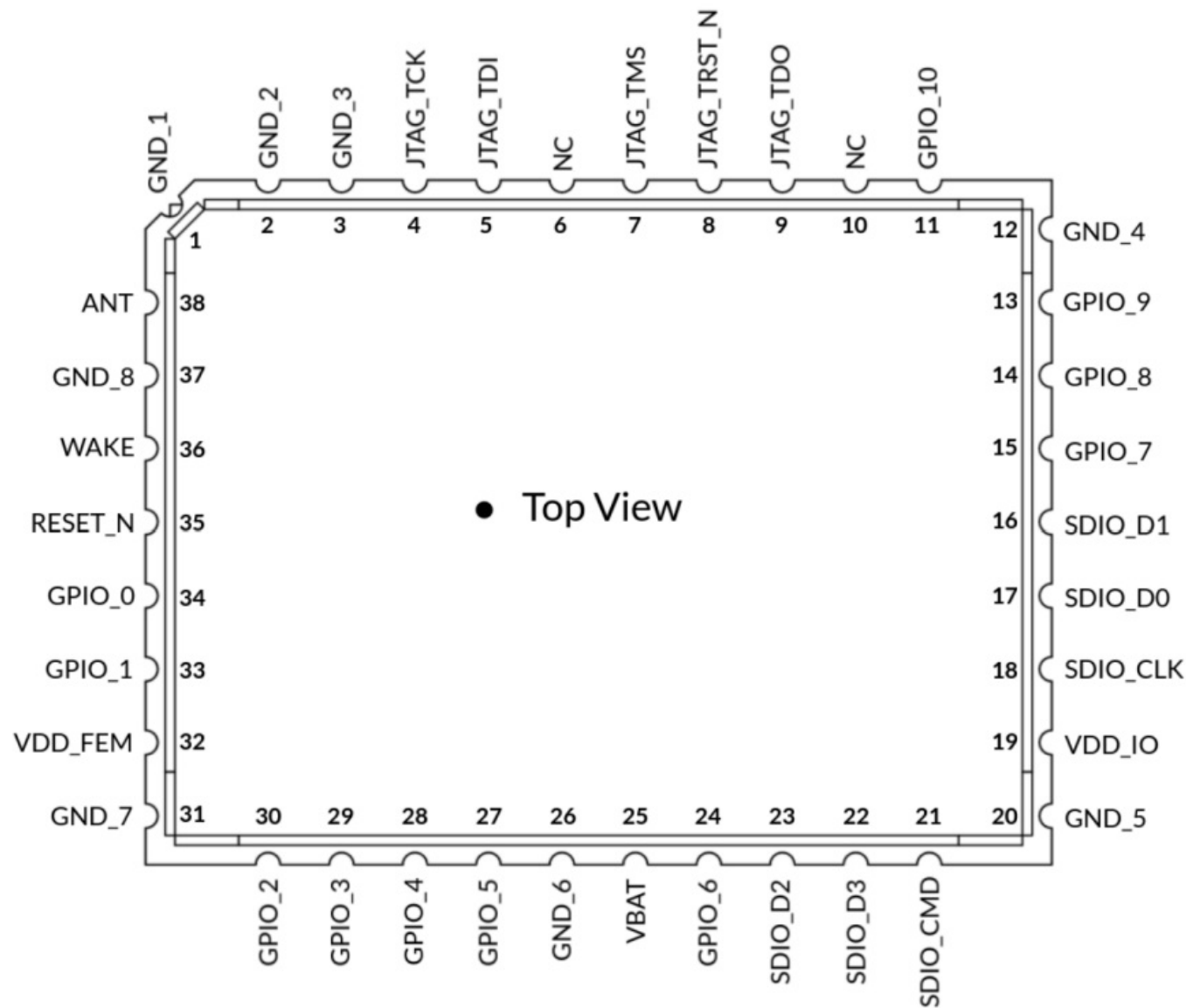


Table 2: Pin Description

Pin)	Name	Type	1Primary Function	Alternate & Other Function(s
1	GND	Power	Ground	
2	GND	Power	Ground	
3	GND	Power	Ground	
4	μ TAG _ TCK 1' I	I	JTAG Clock	
5	IJTAG TD II' I	I	JTAG Data In	
6	Ne	NC	Do Not Connect	
7	IJTAG _ TM S1I1	I	JTAG Mode Select	

8	μTAG TRST	I	JTAG Reset	
9	μTAG_TDO11I	0	JTAG Data Out	
10	NC	1/0	Do Not Connect	
11	GPIO10 12I	1/0	General Purpose 1010	
12	GND	Power	Ground	
13	GPIO912I	1/0	General Purpose 109	
14	GPIO8 12I	1/0	General Purpose 108	
15	GPIO7 12I	1/0	General Purpose 107	UART1 TX
16	SD IO_D1131	1/0	SDIO D1	
17	SDIO_D013I	1/0	SDIO DO	
18	6 D IO CLK	1/0	SDIO Clock	
19	ii/DD 10	Power	3.3V VDD 10 Supply	
20	GND	Power	Ground	
21	\$ D IO CMD J3I	1/0	SDIO Command	
22	\$DIO D3131	1/0	SDIO D3	
23	\$DIO D213I	1/0	SDIO D2	
24	GPIO6 12I	1/0	General Purpose 106	UART1_RX
25	ii/BAT	Power	3.3V VBAT Supply	
26	GND	Power	Ground	
27	GPIO5 12I	1/0	General Purpose 105	I2C_SCL
28	GPIO412I	1/0	General Purpose 104	I2C_SDA
29	GPIO312I	1/0	General Purpose 103	UART0_TX, PWM1- 3
30	GPIO212I	1/0	General Purpose 102	UART0_RX, PWM1_2
31	GND	Power	Ground	
32	r-/DD FEM	Power	3.3V Frontend Module Supply	
33	GPIO112I	1/0	General Purpose 101	PWM1_1
34	(3PIO0	1/0	WiFi BUSY	PWM1 0
35	RESET_N	I	System Reset	
36	WAKE	I	Wake	
37	GND	Power	Ground	
38	I\NT	analog	Antenna	
‘	GND	Ground	Exposed ground pad – Connect to P CB GND	

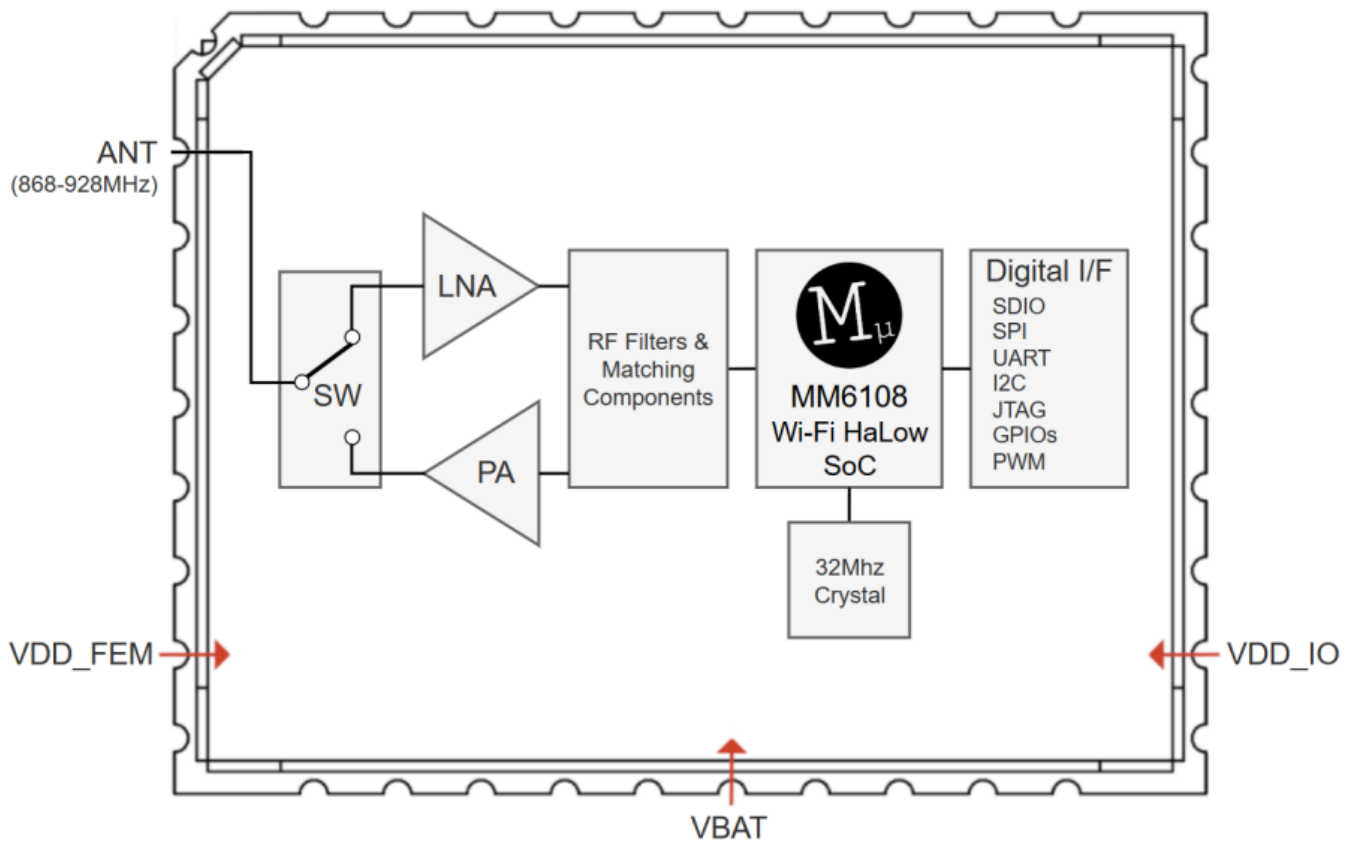
1. JTAG pins should be tied to GND via a 10k pull down resistor
2. All unused GPIO should be tied to GND via a 10k pull down resistor
3. All SOIO bus pins should be pull up with a 10 ... 100k resistor as per the SDIO standard

Functional Description

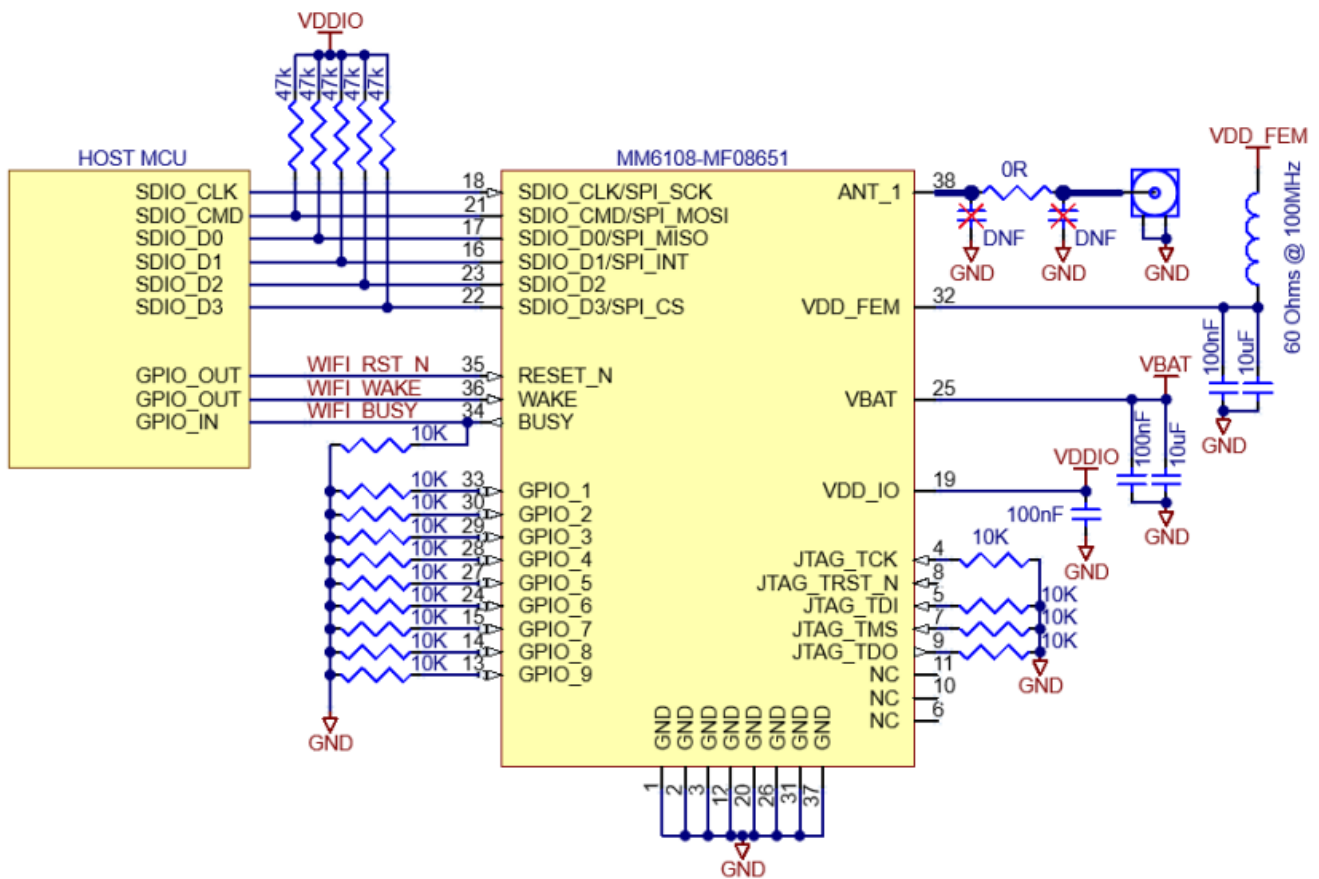
The following sections describe the functions of the MM6108-MF08651-US device.

Block Diagram

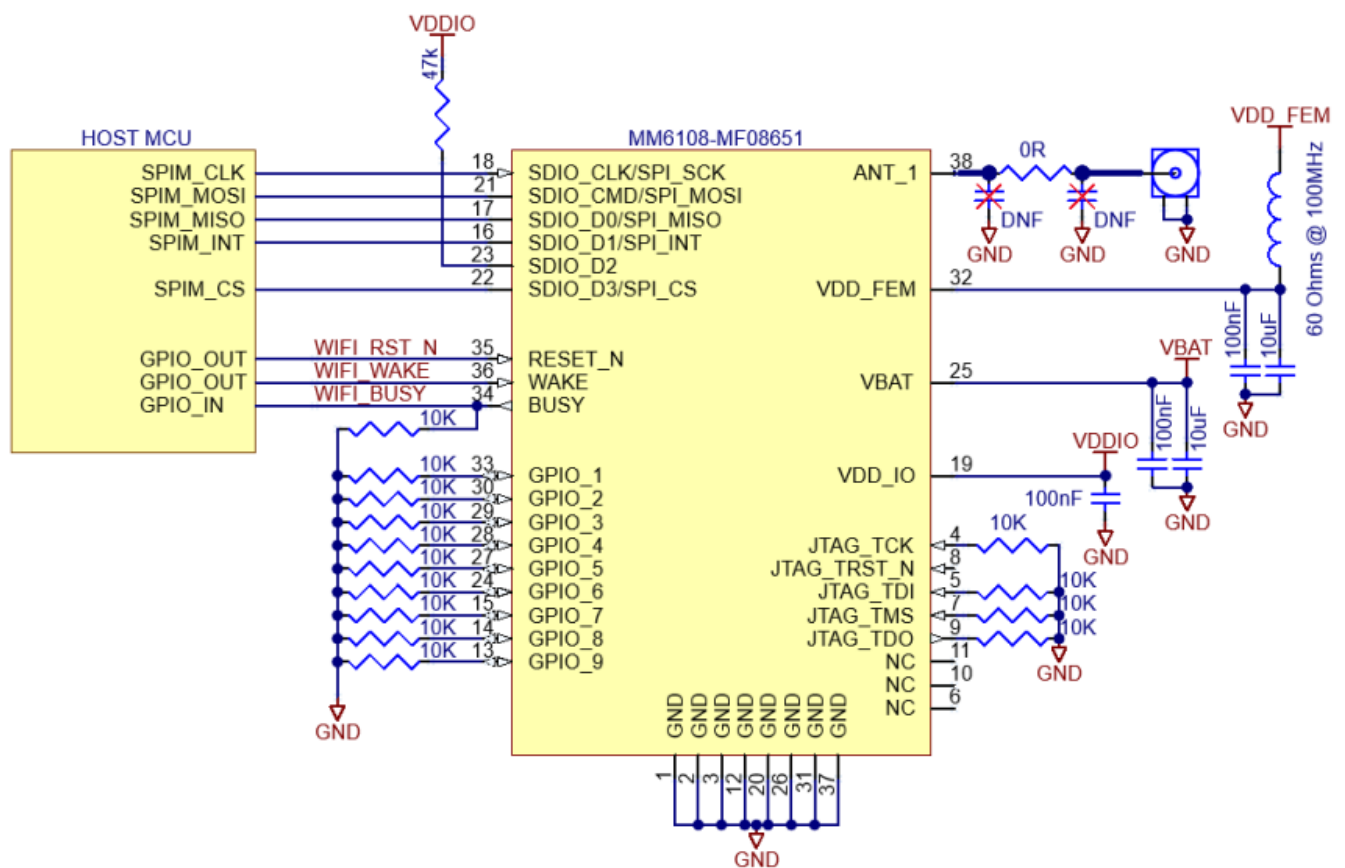
Figure 1: Block Diagram



Recommended Usage Schematics



SDIO Configuration



SPI Configuration

In order to achieve optimal RF performance, the following steps should be followed:

1. Use a 500 impedance controlled trace from the antenna pin (38) and the antenna connection.
2. Use a solid ground plane under the RF trace and the module.
3. Ensure the ground fill is heavily stitched with vias around the RF traces.
4. Keep all power supply and digital signals away from the RF traces.
5. If an impedance matching circuit is needed, ensure that no RF stubs are created.
6. Keep the RF path short, smooth and near. Use large radius bends, never 90 degree bends.
7. Choose a pc stickup so the RF trace width is close to the width of the matching component pads. This will minimize any impedance mismatch.
8. Do not use thermals on RF traces because of their high loss.

Power Management

Module power is derived from a 3.0 to 3.6V supply provided on pin VBAT. A 3.3V supply is provided on pin VDD_FEM to power the on-board ultra-long-range PA.

VDDIO sets the I/O voltage of the MM61 OB and should be connected to the same power supply as the host MCU.

Digital Interfaces

All unused digital I/O pins must be pulled up or down to ensure they do not float. Failure to do so, will result in a higher leakage current on the VDDIO supply.

Please refer to the MM6108 chip datasheets for a description of the supported peripheral interfaces.

Electrical Characteristics

Absolute Max ratings

Stress beyond absolute maximum ratings may cause permanent damage to the module.

Functional operation is guaranteed for recommended operation conditions only. Operation of the device outside of recommended conditions may result in reduced lifetime and/or reliability problems even if the absolute maximum ratings are not exceeded.

Parameter	Min	Max	Unit
VBAT voltage	-0.3	4.3	V
VDD_FEM voltage	-0.3	4.3	V
Voltage on digital I/O pin	-0.3	4.3	V
Voltage on analog/RF pin	-0.3	1.2	V
Storage Temperature	-40	125	°C
RF Input Power (CW)	—	6	dBm

Immunity

Parameter			Min	Max	Unit
Electrostatic discharge (ESD) performance	Human body model (HBM), per ANSI / ESD A / JEDEC JSOOI	All pins	TBD	TBD	V
	Charged device model (COM), per JESD22-C101	All pins	TBD	TBD	V

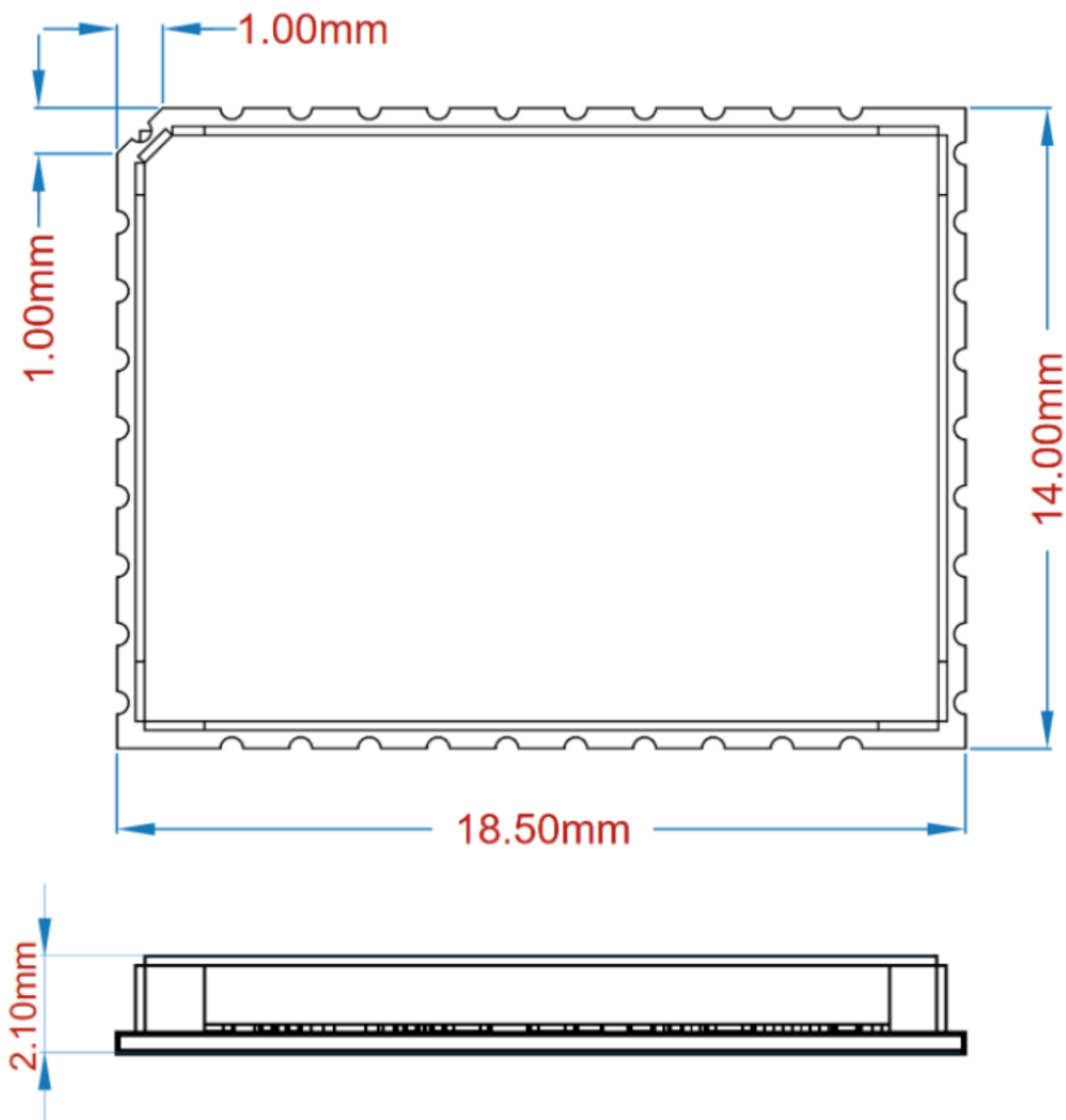
Recommended Operating Conditions

Parameter	Min	Typ	Max	Unit
Ambient Temperature	-40	27	85	°C
VBAT	3.0	3.3	3.6	V
VDD_FEM	3.0	3.3	3.6	V
VDD,o3	1.8	3.3	3.6	V
Digital 1/ 0 voltage	0	3.3	VDD,o	V

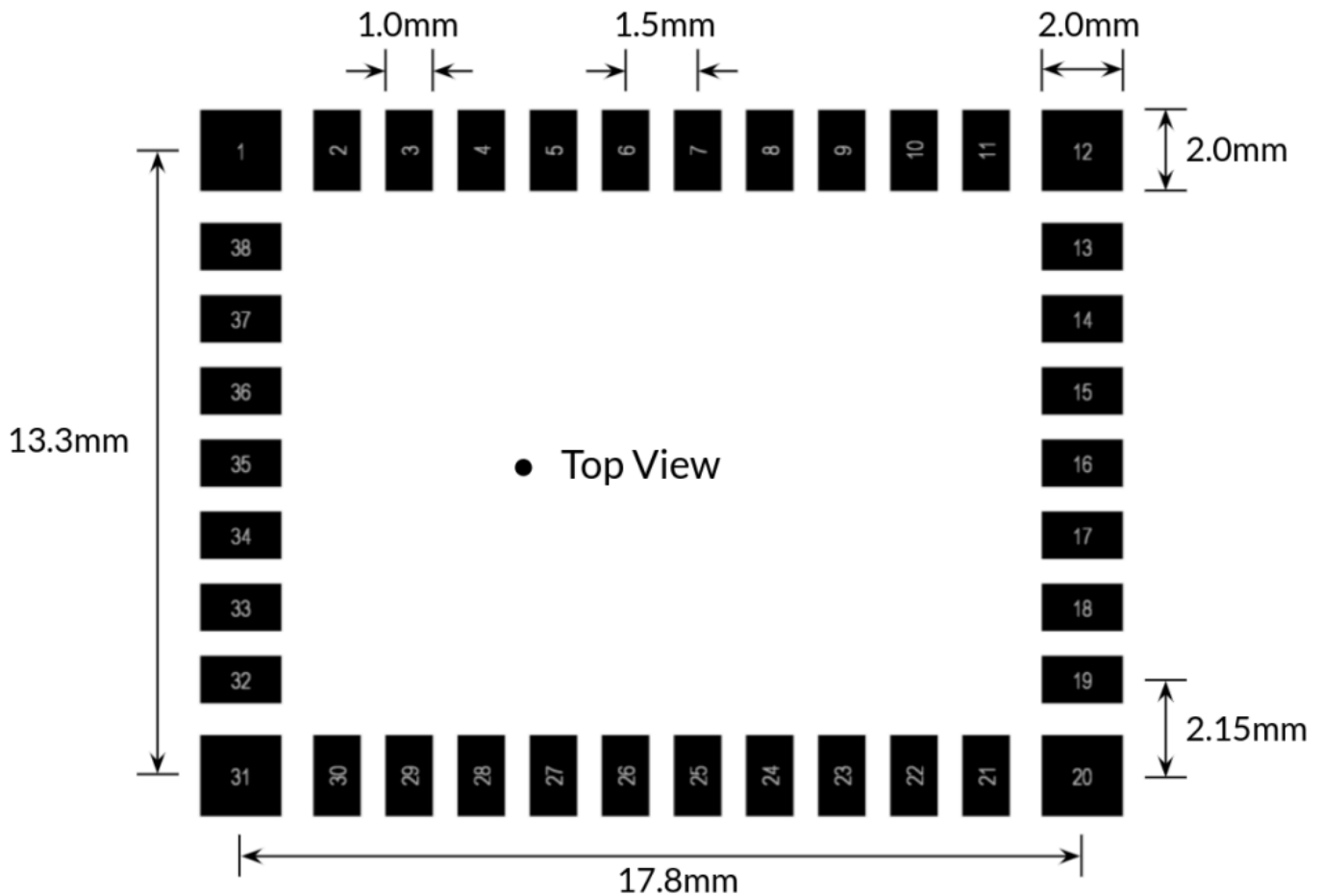
a. VDD10 should not exceed VBAT

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

Physical Specification



Recommended PCB Footprint



Certification

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 operation in conjunction with any other antenna or transmitter except in accordance with multi-transmitter product procedures. User 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.

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: 2A740-628C73"

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 manufacture 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.

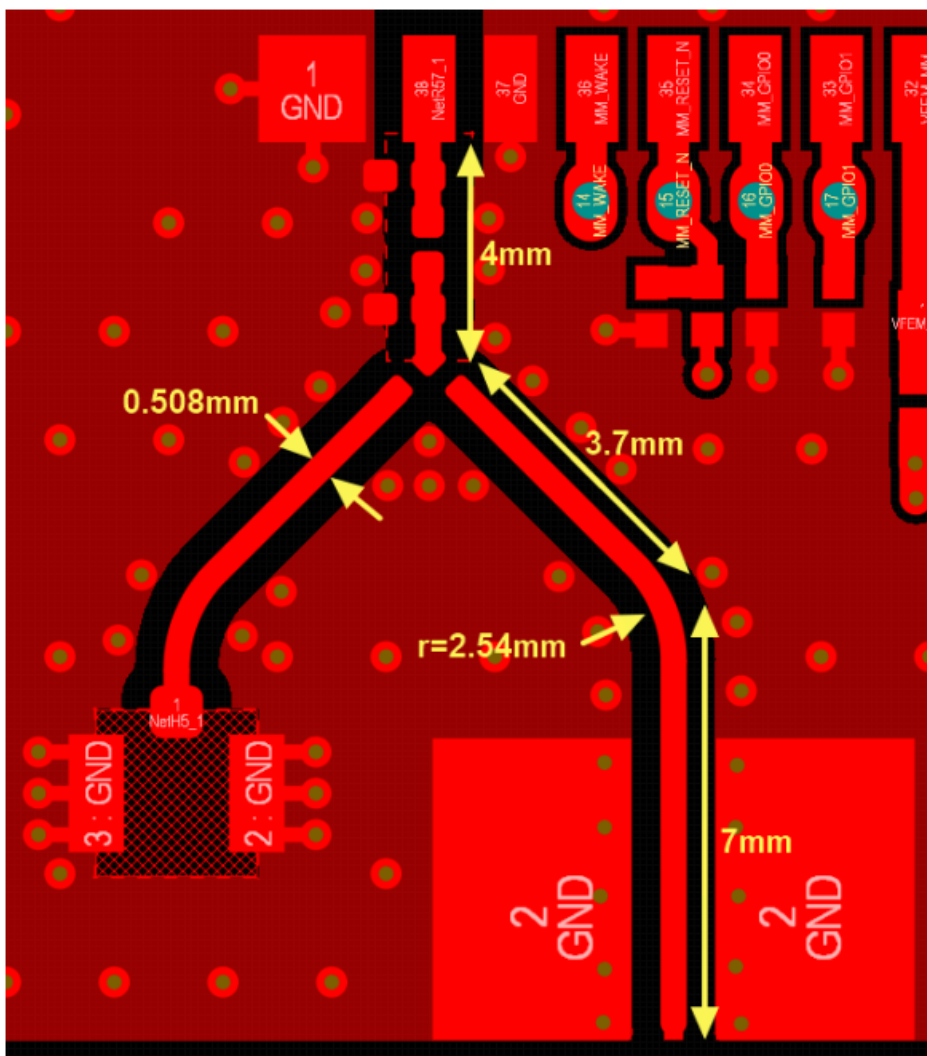
How to make changes

Only Grantees are permitted to make permanent 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 strip line on the OEM PCB. No coupling capacitor is required given that the RF pin is AC-coupled internally.

- **Length:** 15mm
- **Width:** 0.508mm
- **Thickness:** 1.6mm
- **Type of trace:** 1/2oz
- **Dielectric constant:** 4.3
- **Antenna connector:** RP-SMA



The trace from Pin No. 38 to antenna connector on the OEM PCB must be maintained identical as the above specification with RP-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 ISED 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%

Max power is 21.5dBm (Average power)

VSWR absolute max ≤ 10:1 (limit to avoid permanent damage)

VSWR recommended ≤ 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 971 168 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.

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).

deux conditions suivantes:

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.

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.

Required End Product Labeling

Any device incorporating this module must include an external, visible, permanent marking or label which states: "Contains IC : 29791-628C73"

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 operation in conjunction with any other antenna or transmitter except in accordance with multi-transmitter product procedures. User and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying the RF exposure compliance.

Part Number and Ordering Information

Part Ordering Information

Part Number	Packing Type	Pins	Size (mm)	Description
MM6108-MF08651 -us	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

Handling and Storage

The MM6108-MF08651-US class of modules are 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 (s30°C and <60% RH) OR
2. Continuously stored per IPC/JEDEC J-STD-033

Modules that have been 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.

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Revision History

MM6108-MF08651-US UG100; 2nd November, 2023

- Initial release

CUSTOMER SUPPORT

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About Morse Micro

Morse Micro is producing IEEE 802.11 ah / Wi-Fi HaLow solutions for Internet of Things (IOT) – based on a newly certified Wi-Fi standard called HaLow. Morse Micro is a VC-backed Startup headquartered in Sydney, Australia. Learn more at www.morsemicro.com



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Documents / Resources

	<p>Morse Micro MM6108-MF08651-US IEEE 802.11ah Sub-1 GHz Wi-Fi HaLow Module [pdf] User Guide</p> <p>628C73, 2A74O, MM6108-MF08651-US IEEE 802.11ah Sub-1 GHz Wi-Fi HaLow Module, MM6108-MF08651-US, IEEE 802.11ah Sub-1 GHz Wi-Fi HaLow Module, IEEE 802.11ah Sub-1 GHz HaLow Module, Wi-Fi HaLow Module, HaLow Module, Module</p>
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References

- [User Manual](#)

[Manuals+](#), [Privacy Policy](#)

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