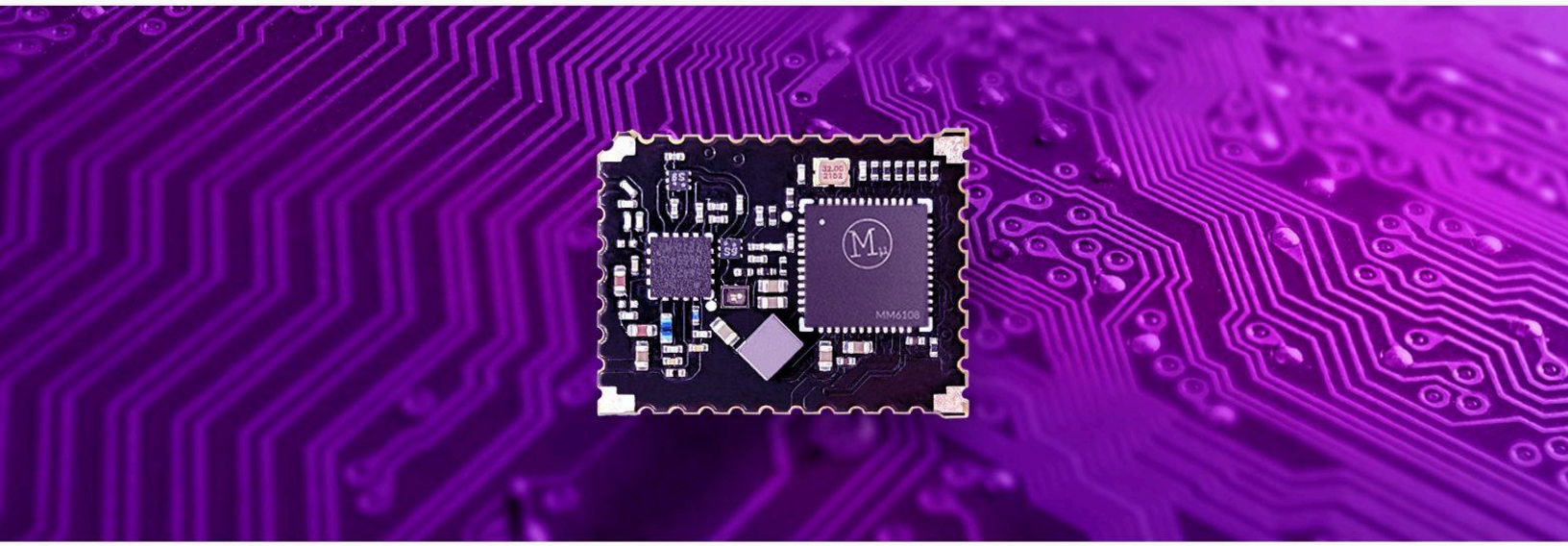
Morse Micro



MM6108-MF08651-US
Data Sheet

IEEE 802.11ah Sub-1 GHz Wi-Fi HaLow Module

Table of Contents

1 Product Overview

1.1 Introduction

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

The MM6108-MF08651-US module is designed in compliance with the IEEE 802.11ah standard. It supports data rates up to 32.5 Mbps and has programmable operation between 902 MHz and 928 MHz.

This module includes an ultra-long-reach PA, a high linearity LNA, a SAW filter, a T/R switch, and a 32 MHz crystal oscillator. It has been designed for a simplified Wi-Fi HaLow connection to an external host for applications where customers want to replace their prior RF technology with a Wi-Fi HaLow connection while using the latest WPA3 security protocol.

Battery-operated applications are supported by a combination of features inherently supported by the module. The IEEE 802.11ah standard provides extended sleep times for battery-operated stations (STAs or client devices), with longer durations than other prior IEEE 802.11a/b/g/n/ac generations. The standard 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.

1.2 Features

Ultra-long-range, low-power Wi-Fi HaLow module for IoT applications:

- Channel bandwidth options of 1/2/4/8 MHz
- Single-stream max. data rate of 32.5 Mbps @ 8 MHz or 15 Mbps @ 4 MHz channel
- Radio supporting Sub-1 GHz frequency bands
    - Frequency range: 902-928 MHz
    - Max output power: 24.5 dBm
- 802.11ah OFDM PHY supporting WFA HaLow certification
    - BPSK & QPSK, 16-QAM & 64-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) rates MCS 0-7 and MCS 10
    - Support for 1 MHz and 2 MHz duplicate modes
    - Support for Traveling Pilots and Short Guard Intervals
- 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
    - Packet aggregation
    - Power-Saving Target Wake Time (TWT) support for long battery life
    - Restricted Access Window (RAW)
    - Automatic and manual MCS rate selection
- Support for various interface options
    - SDIO 2.0 compliant host/slave interface
    - 2 x UARTs
- Power Management Unit (PMU) for various modes of operation
    - Power-down (interrupt driven wake)
    - Hibernate mode (internal / external wake)
    - Active receive / transmit mode
    - Integrated DC-DC converter supporting a voltage supply from 3.0V to 3.6V
- Wide spectrum of security features
    - 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)

1.3 Applications

The MM6108-MF08651-US is 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 or Vehicle-to-Infrastructure 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 MM6108-MF08651-US module has 38 pins, which are described in this section. The following illustration shows the top view of the module pins.

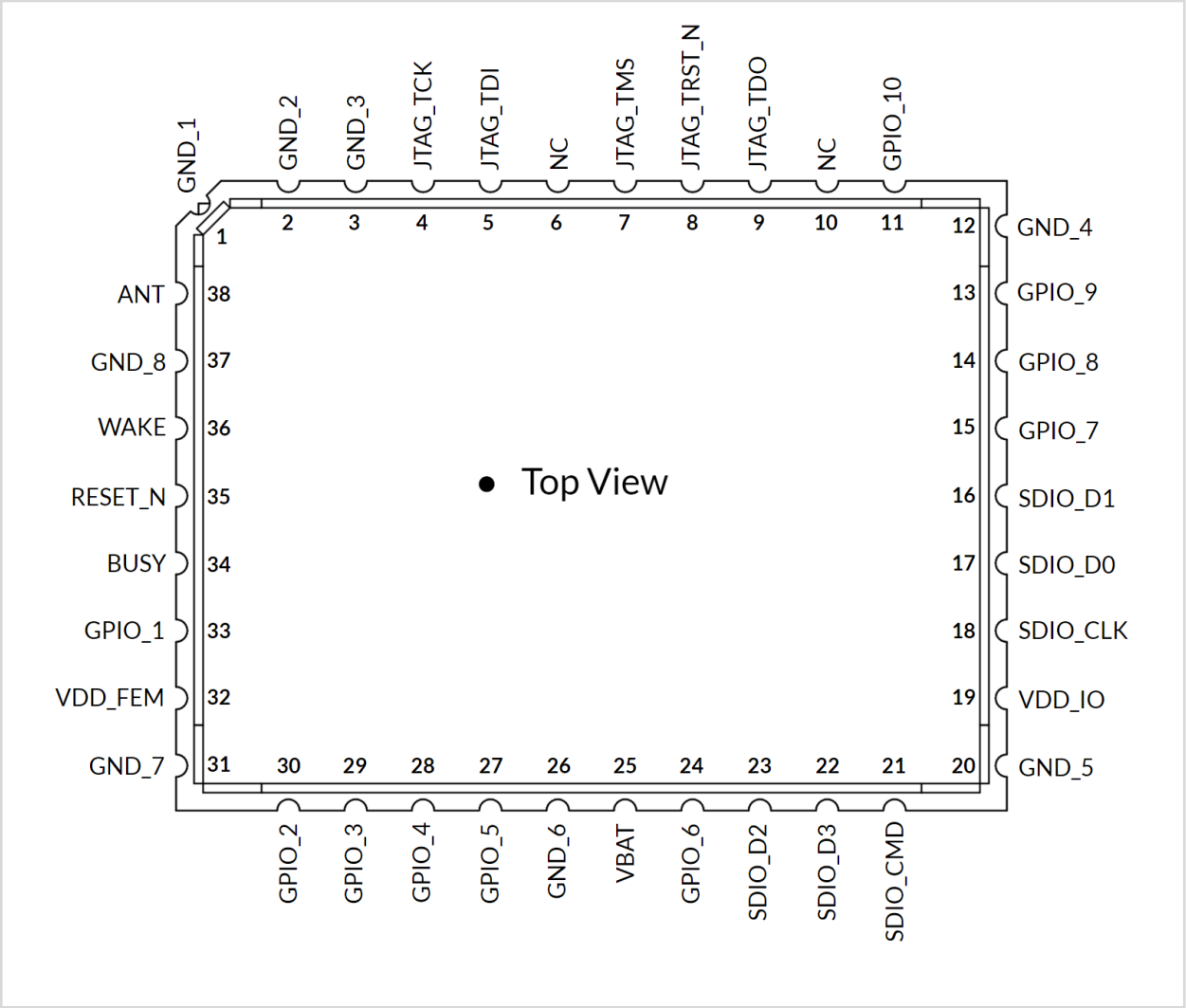


Figure 1: Pin diagram

Pin	Pin Name	Type	Description	Alternate
1	GND	Power	Ground	
2	GND	Power	Ground	
3	GND	Power	Ground	
4	JTAG_TCK	I	JTAG Clock	
5	JTAG_TDI[1]	I	JTAG Data In	
6	NC	NC	Do Not Connect	
7	JTAG_TMS[1]	I	JTAG Mode Select	
8	JTAG_TRST_N	I	JTAG Reset	
9	JTAG_TDO[1]	O	JTAG Data Out	
10	NC	I/O	Do Not Connect	
11	GPIO_10[2]	I/O	General Purpose IO10	
12	GND	Power	Ground	
13	GPIO_9[2]	I/O	General Purpose IO9	
14	GPIO_8[2]	I/O	General Purpose IO8	
15	GPIO_7[2]	I/O	General Purpose IO7	
16	SDIO_D1[3]	I/O	SDIO D1	
17	SDIO_D0[3]	I/O	SDIO D0	
18	SDIO_CLK	I/O	SDIO Clock	
19	VDD_IO	Power	3.3V VDD_IO Supply	
20	GND	Power	Ground	
21	SDIO_CMD[3]	I/O	SDIO Command	SPI_MOSI
22	SDIO_D3[3]	I/O	SDIO D3	SPI_CS
23	SDIO_D2[3]	I/O	SDIO D2	
24	GPIO_6[2]	I/O	General Purpose IO6	
25	VBAT	Power	3.3V VBAT Supply	
26	GND	Power	Ground	
27	GPIO_5[2]	I/O	General Purpose IO5	
28	GPIO_4[2]	I/O	General Purpose IO4	
29	GPIO_3[2]	I/O	General Purpose IO3	
30	GPIO_2[2]	I/O	General Purpose IO2	
31	GND	Power	Ground	
32	VDD_FEM	Power	3.3V Frontend Module Supply	
33	GPIO_1[2]	I/O	General Purpose IO1	
34	BUSY	O	Wi-Fi BUSY	
35	RESET_N[4]	I	System Reset	
36	WAKE[4]	I	Wake	
37	GND	Power	Ground	
38	ANT	Analog	Antenna	

Pin	Pin Name	Type	Description	Alternate
-	GND	Ground	Exposed ground - Connect to PCB 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 SDIO bus pins except SDIO_CLK should be pulled up with a 10k-100k resistor as per the the SDIO standard
[4] Supplied from VBAT domain. Other digital pins are driven by the VDDIO domain.

3 Functional Description

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

3.1 Block diagram

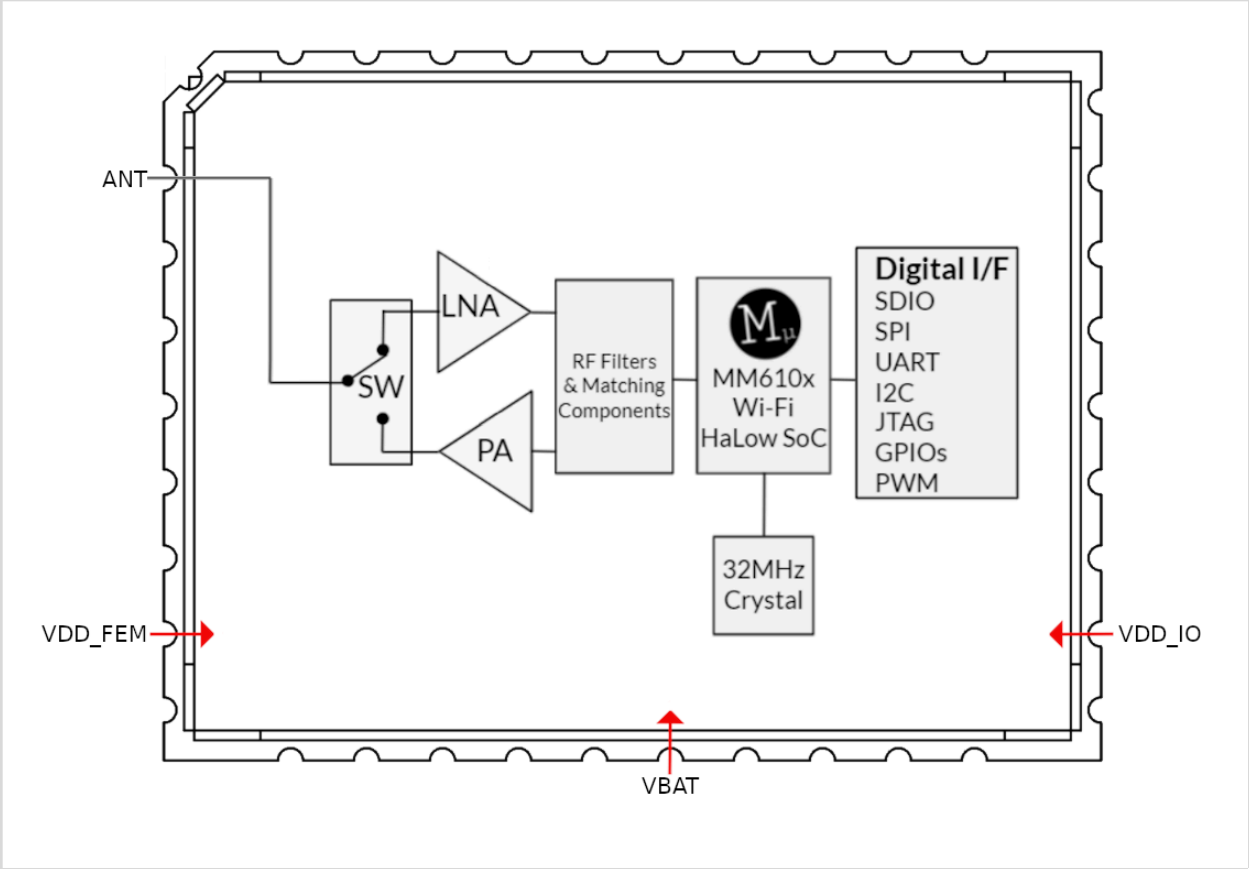


Figure 2: Functional Block Diagram

3.2 Power supply requirements

MM6108-MF08651-US module power is derived from a 3.0 to 3.6V supply on the VBAT pin and a 3.0 to 4.3V supply on the VDD_FEM pin. VBAT powers the module's internal circuitry, while VDD_FEM powers the onboard ultra-long-range power amplifier. The module's transmitter power output can be increased by raising the supply voltage on the VDD_FEM pin to 4.3V, although this will increase overall power consumption.

VDDIO sets the IO voltage of the MM6108, which should be connected to the same power supply as the host MCU. The VDDIO voltage must be between 1.62V and 3.6V and must not exceed the voltage applied to VBAT.

3.3 SDIO host requirements

When selecting a CPU host to interface with the MM8108-MF08651 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:

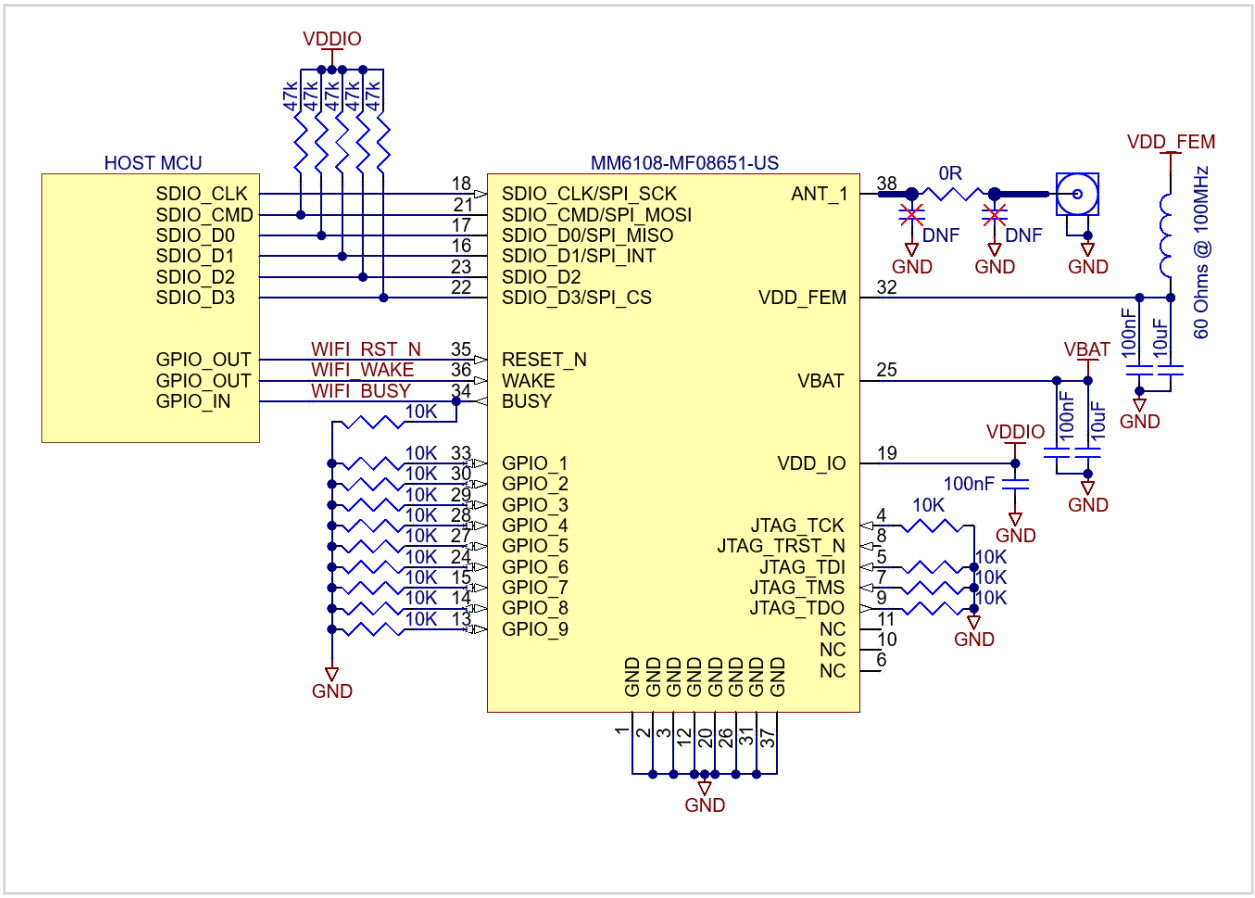


Figure 3: Recommended SDIO host interface circuit using power-saving features

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

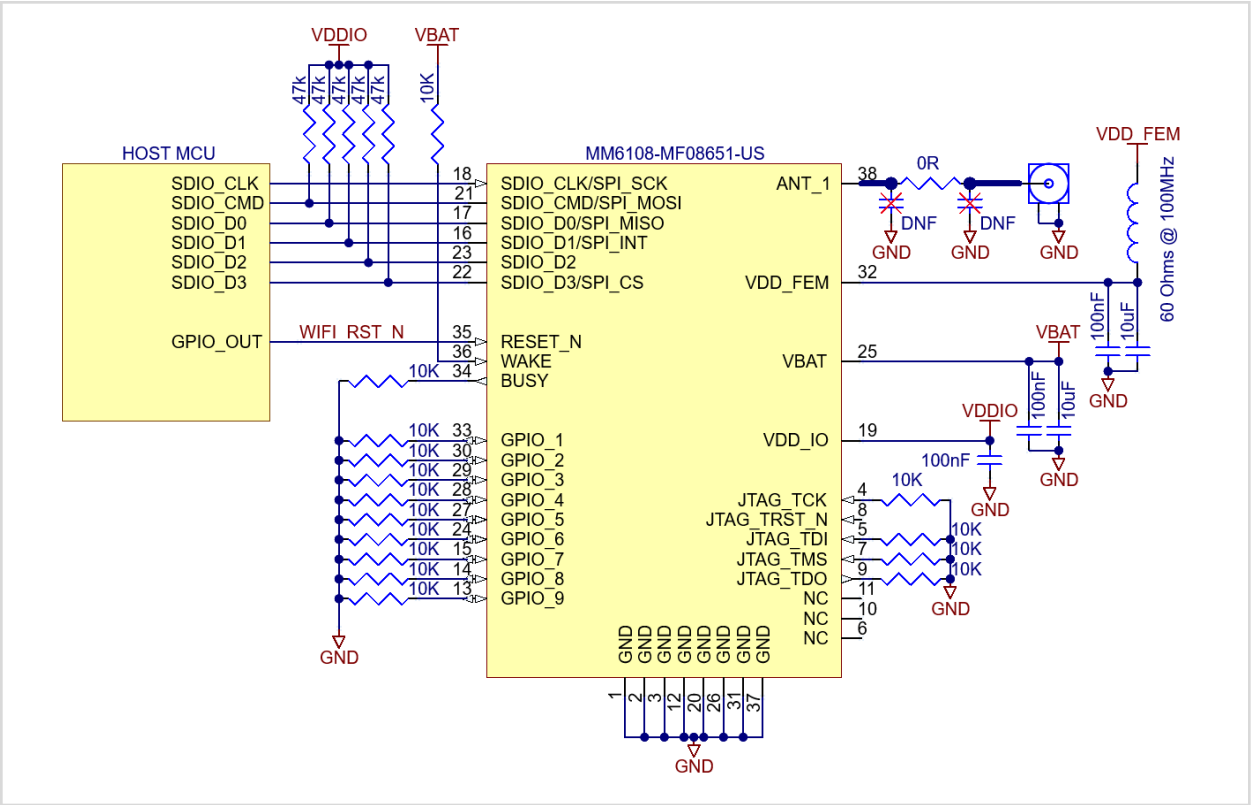


Figure 4: Recommended SDIO host interface circuit for always-on applications

3.4 SPI host requirements

When selecting a CPU host to interface via SPI to the MM6108-MF08651-US module, 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:

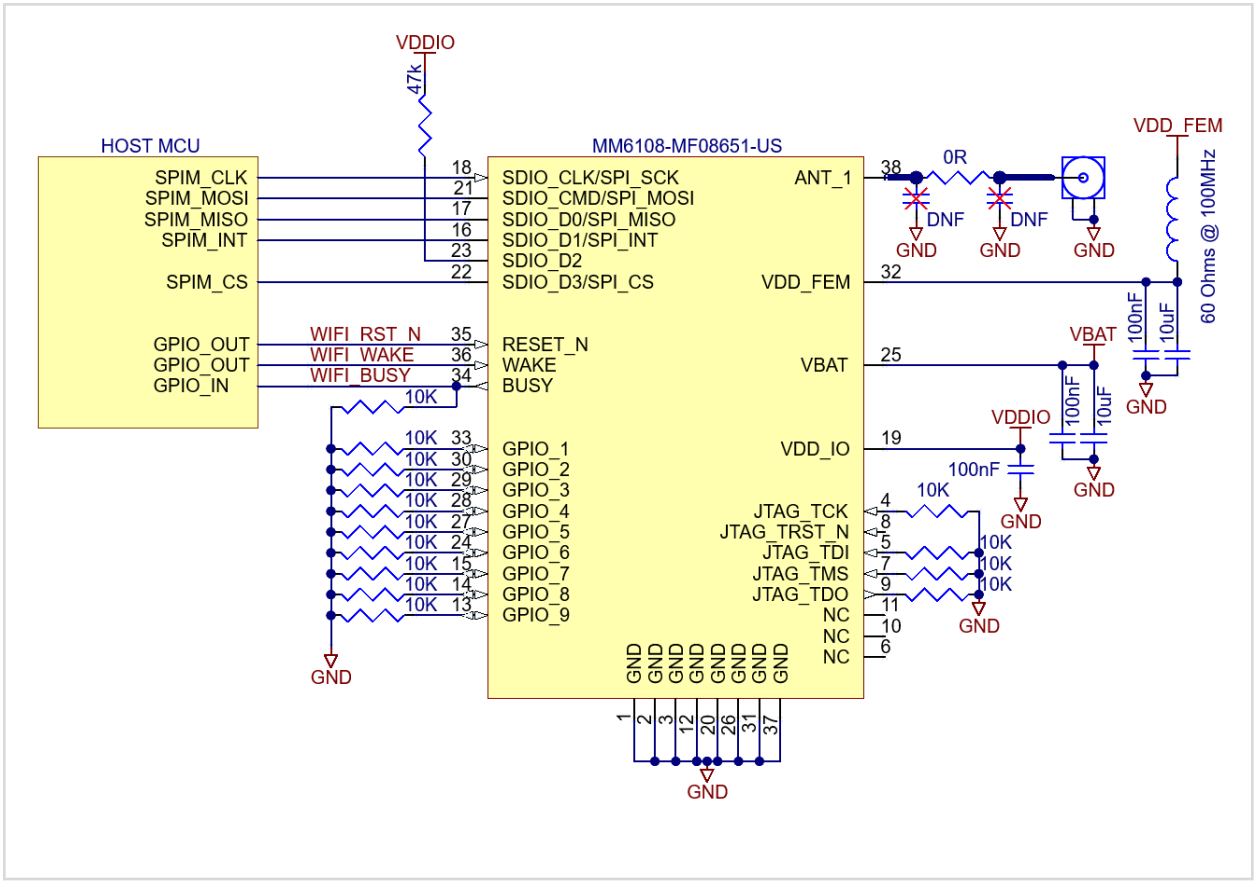


Figure 5: Recommended SPI host interface circuit using power-saving features

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

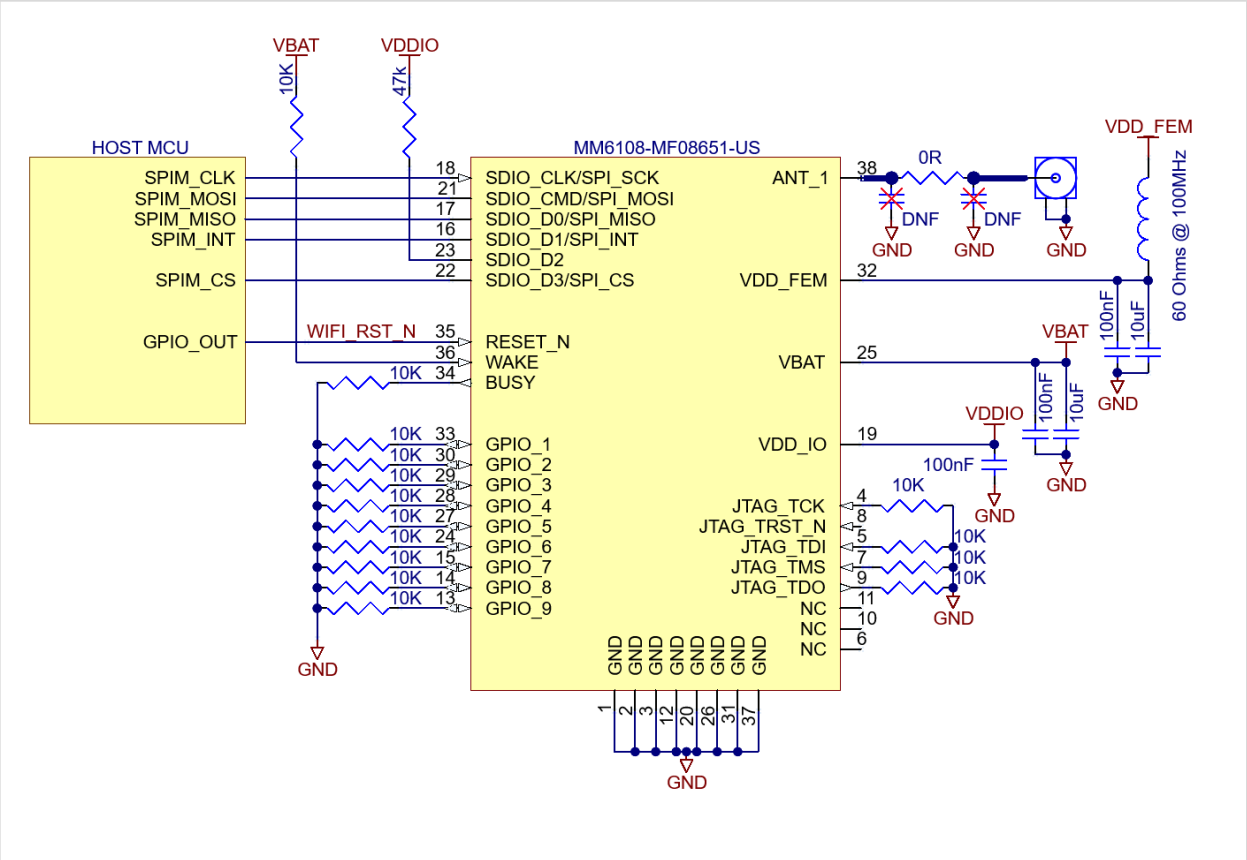


Figure 6: Recommended SPI host interface circuit for always-on applications

3.5 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.

3.6 Sleep/Wake Sequencing

3.6.1 Host initiates wake sequence

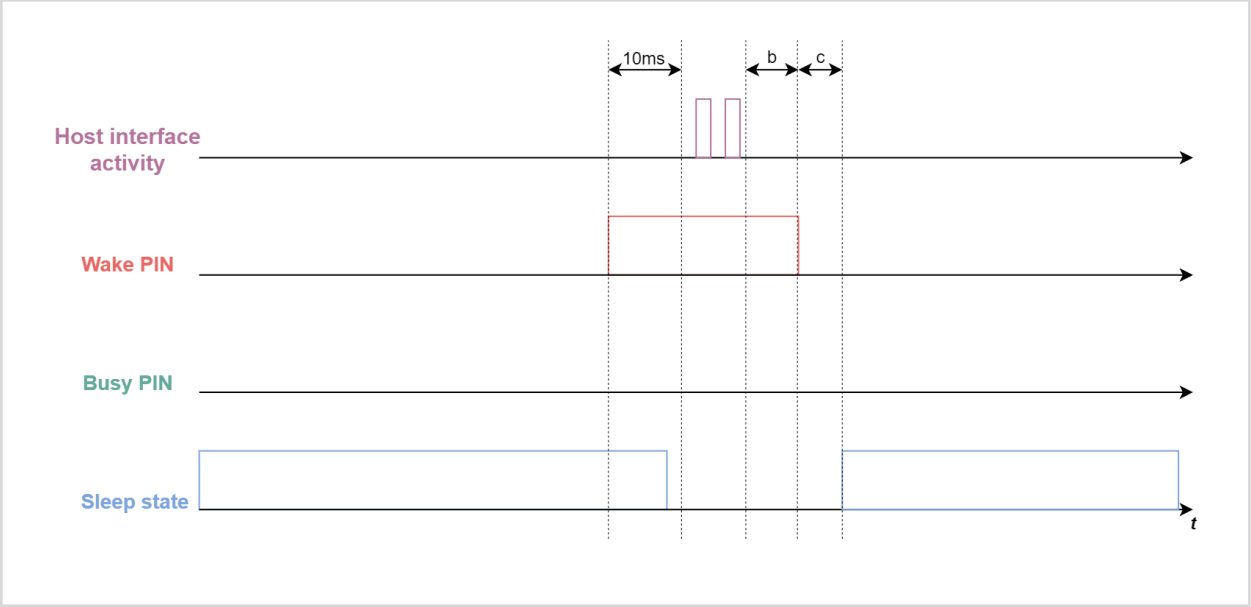


Figure 7: Host-initiated wake sequence diagram

1. The driver raises the wake pin and waits for a static period of 10 ms before initializing the shared communication bus and initiating host interface activity. On MM6108, this period is typically 10 ms.
2. After completing communication, the driver will wait a static period, b, before lowering the wake pin (assuming no further communication has occurred). Depending on the nature of the communication (802.11 data vs. commands), this period can range from 5 to 90ms.
3. After the wake pin has fallen, the MM6108 will wait for a period, c, before initiating hardware sleep. This dynamic period will differ depending on the power-saving protocol and other chip-specific factors.

3.6.2 MM6108-MF08651 initiates wake sequence with host interface disabled

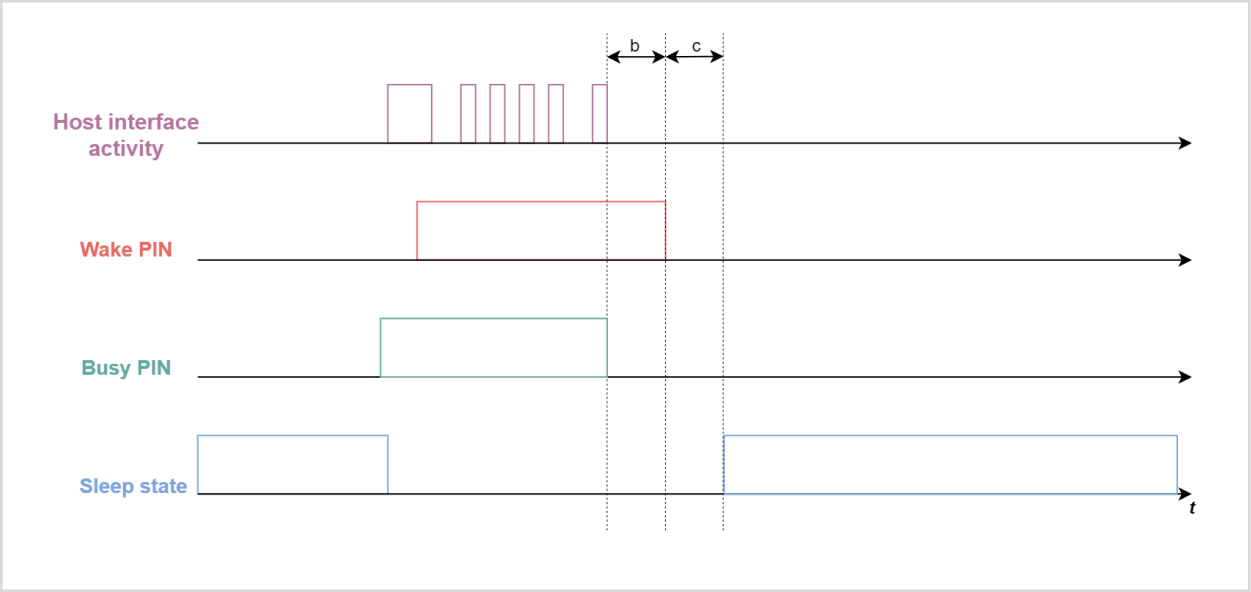


Figure 8: Module-initiated wake sequence with host interface disabled diagram

1. The MM6108 wakes from sleep and realizes it needs to pass traffic or an event to the host. It begins by asserting the busy pin.
2. The busy pin will fire an interrupt on the host, after which the host will immediately:
    a. Raise the Wake PIN.
    b. Wait a static period, 10ms
    c. Initializes / enables the shared host interface.
3. After asserting the busy pin, the MM6108 will initiate host interface communication immediately. It does not wait until the host 'enables' the shared host interface. This is okay, as the bus transaction will be waiting for the host, and an interrupt should fire as soon as the host enables bus interrupts.
4. The busy pin will drop immediately once the MM6108 no longer needs to converse with the host. The host will wait a static period, b, before dropping the wake pin.
5. After the wake pin has fallen, the MM6108 will wait for a period, c, before initiating hardware sleep.

3.6.3 MM6108-MF08651 initiates communication with host interface enabled

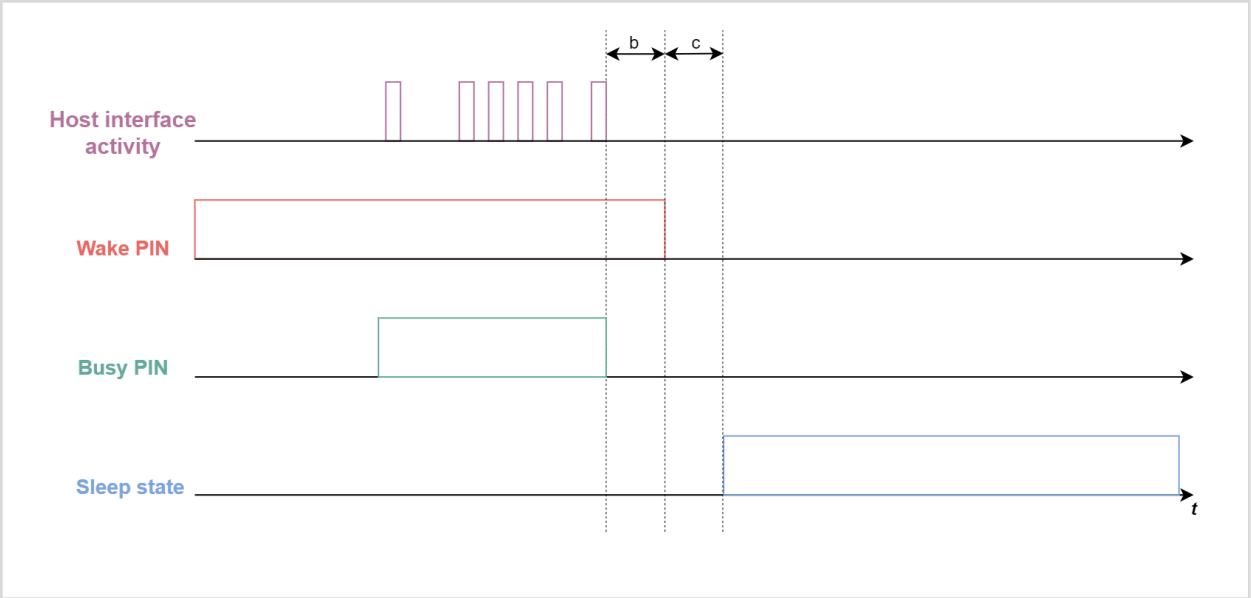


Figure 9: Module-initiated wake sequence with host interface enabled diagram

1. The MM6108 was previously woken by the host for communication.
2. Sometime after wake and host->MM6108 communication, the MM6108 realizes it needs to send data back to the host (MM6108->host). It will assert the busy pin.
3. The busy pin will fire an interrupt on the host, after which it will immediately:
    a. Process the interrupt but take no further action, as the wake pin has already been asserted and the shared host interface is currently enabled/initialized.
4. After MM6108->host communication completion, hardware sleep will be initiated as described above.

4 Electrical Characteristics

4.1 Absolute max ratings

Stress beyond absolute maximum ratings may cause permanent damage to the MM6108-MF08651-US module. Functional operation is only guaranteed for recommended operating 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	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

Table 1: Absolute max ratings

4.2. Immunity

Parameter			Min	Max	Unit
Electrostatic discharge (ESD) performance	Human body model (HBM), per ANSI / ESDA / JEDEC JS001	RF Input	-1000	1000	V
		All pins except RF Input	-2000	2000	V
	Charged device model (CDM), per JESD22-C101	All pins	-500	500	V

Table 2: Immunity

4.3 Recommended operating conditions

Parameter	Min	Typ	Max	Unit
Ambient temperature	-40	25	85	°C
VBAT	3.0	3.3	3.6	V
VDD_FEM	3.0	3.3	4.3	V
VDDIO[1]	1.62	3.3	3.6	V
Digital I/O voltage	0	3.3	VDDIO	V
RESET / WAKE I/O Voltage	0	3.3	VBAT	V

Table 3: Recommended operating conditions

[1] VDDIO should not exceed VBAT

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

4.4 Power consumption

4.4.1 Transmit power consumption

Modulation Coding Scheme	Condition: T_A=25°C, V_{BAT}/V_{DDIO} = 3.3V	V_{DD_FEM} = 3.3V		V_{DD_FEM} = 4.3V		Unit
		V_{BAT} Current	V_{DD_FEM} Current	V_{BAT} Current	V_{DD_FEM} Current	
MCS 0	1 MHz channel	57	152	58	168	mA
	2 MHz channel	60	152	61	168	mA
	4 MHz channel	66	151	66	160	mA
	8 MHz channel	78	147	77	154	mA
MCS 7	1 MHz channel	51	104	53	122	mA
	2 MHz channel	55	104	57	123	mA
	4 MHz channel	62	102	64	119	mA
	8 MHz channel	72	99	76	117	mA

Table 4: Transmit power consumption

4.4.2 Receive power consumption

Mode	Condition: T_A=25°C, V_{BAT}/V_{DDIO} = 3.3V, V_{DD_FEM} = 3.3V or 4.3V	V_{BAT} Current			V_{DD_FEM} Current			Unit
		Min	Typ	Max	Min	Typ	Max	
Listen	1 MHz channel	25	26	35	4	4.5	4.7	mA
	2 MHz channel	26	28	35	4	4.5	4.7	mA
	4 MHz channel	30	32	40	4	4.5	4.7	mA
	8 MHz channel	35	37	46	4	4.5	4.7	mA
Active receive MCS7	1 MHz channel	26	27	36	4	4.5	4.7	mA
	2 MHz channel	30	30	40	4	4.5	4.7	mA
	4 MHz channel	38	40	49	4	4.5	4.7	mA
	8 MHz channel	53	54	67	4	4.5	4.7	mA
Active receive MCS0	1 MHz channel	26	28	37	4	4.5	4.7	mA
	2 MHz channel	29	30	39	4	4.5	4.7	mA
	4 MHz channel	36	36	47	4	4.5	4.7	mA
	8 MHz channel	48	50	63	4	4.5	4.7	mA

Table 5: Receive power consumption

4.4.3 Sleep power consumption

Mode	Condition: T_A=25°C, V_{BAT}/V_{DDIO} = 3.3 V, V_{DD_FEM} =3.3V or 4.3V	V_{BAT} Current			V_{DD_FEM} Current			Unit
		Min	Typ	Max	Min	Typ	Max	
Snooze	RC Oscillator on, Memory retained, wake on timer	9.5	42	370	0.001	0.05	0.55	uA
Deep sleep	RC Oscillator on, wake on timer	0.8	1	1.8	0.001	0.05	0.55	uA
Hibernate	Power off, wait for external interrupt	0.03	0.05	1	0.001	0.05	0.55	uA

Table 6: Sleep power consumption

4.4.4 DTIM3 power consumption

Mode	Condition: T_A=25°C, V_{BAT}/V_{DDIO} = 3.3 V	V_{DD_FEM} = 3.3V		V_{DD_FEM} = 4.3V		Unit
		V_{BAT}	V_{FEM}	V_{BAT}	V_{FEM}	
S1G beacons	1 MHz channel	395	47	393	48	uA
	2 MHz channel	395	47	393	48	uA
	4 MHz channel	280	25	271	26	uA
	8 MHz channel	280	25	268	26	uA
S1G beacons with proprietary DTIM signaling[1]	1 MHz channel	190	13	187	14	uA
	2 MHz channel	190	13	187	14	uA
	4 MHz channel	190	9	168	11	uA
	8 MHz channel	190	9	168	11	uA

Table 7: DTIM3 power consumption

4.4.5 DTIM10 power consumption

Mode	Condition: T_A=25°C, V_{BAT}/V_{DDIO} = 3.3 V	V_{DD_FEM} = 3.3V		V_{DD_FEM} = 4.3V		Unit
		V_{BAT}	V_{FEM}	V_{BAT}	V_{FEM}	
S1G beacons	1 MHz channel	155	15	145	16	uA
	2 MHz channel	155	15	144	16	uA
	4 MHz channel	115	8	109	9	uA
	8 MHz channel	115	8	109	9	uA
S1G beacons with proprietary DTIM signaling[1]	1 MHz channel	95	5	88	6	uA
	2 MHz channel	95	5	88	6	uA
	4 MHz channel	90	5	80	5	uA
	8 MHz channel	90	5	80	5	uA

Table 8: DTIM10 power consumption

[1] Signaling that indicates whether a power-saving STA should receive and process an entire beacon

4.5 RF Specifications

4.5.1 Receiver Sensitivity

Sensitivities for 10% packet error rate, 1000 byte packets.

MCS index	Modulation scheme	Coding rate	Phy rate (Mbps) per BW				Minimum receive sensitivity (dBm)			
			1 MHz	2 MHz	4 MHz	8 MHz	1 MHz	2 MHz	4 MHz	8 MHz
10	BPSK	1/2 x 2	0.17	N/A			-107	N/A		
0	BPSK	1/2	0.33	0.72	1.5	3.3	-105	-103	-101	-97
1	QPSK	1/2	0.67	1.4	3.0	6.5	-102	-100	-97	-93
2	QPSK	3/4	1.0	2.2	4.5	9.8	-99	-97	-95	-91
3	16-QAM	1/2	1.3	2.9	6.0	13	-96	-94	-91	-88
4	16-QAM	3/4	2.0	4.3	9.0	20	-93	-90	-88	-85
5	64-QAM	2/3	2.7	5.8	12	26	-89	-87	-84	-80
6	64-QAM	3/4	3.0	6.5	14	29	-88	-85	-83	-79
7	64-QAM	5/6	3.3	7.2	15	33	-87	-84	-81	-77

Table 9: Receiver sensitivity

4.5.2 Transmitter Output Power

Note: The following transmit power levels are for IEEE compliance for 802.11ah. They do not consider any backoffs needed for regional spectrum compliance (eg, FCC, IC, TELEC).

Channel Bandwidth	Modulation Coding Scheme	V_{DD_FEM} = 3.3V			V_{DD_FEM} = 4.3V			Unit
		Min	Typical	Max	Min	Typical	Max	
1, 2 MHz	MCS 0	20	21	22	22	23.5	24.5	dBm
	MCS 7	16	17	18.5	18.5	20	21	dBm
4 Mhz	MCS 0	20.5	21	22	22	23.5	24.5	dBm
	MCS 7	16	17	18	18.5	20	20.5	dBm
8 Mhz	MCS 0	20.5	21	21.5	21.5	23	24.5	dBm
	MCS 7	15.5	17	17.5	18	19.5	20.5	dBm

Table 10: Transmitter output

4.6 Digital specifications

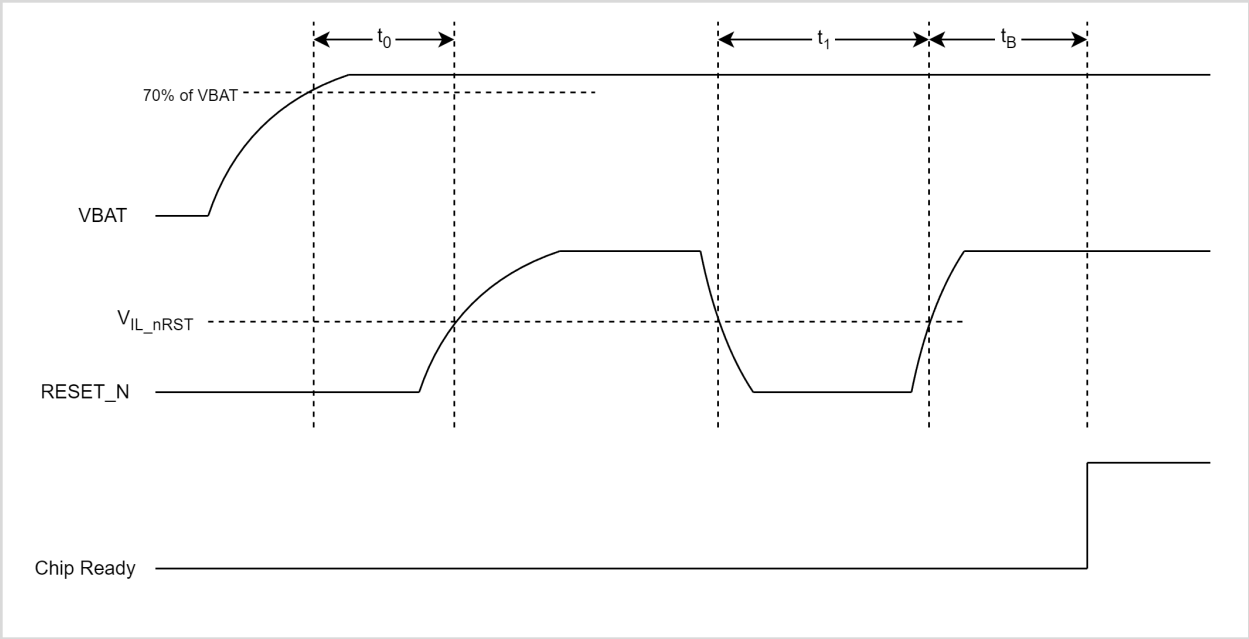


Figure 10: Powering on and reset timing diagram

Parameters	Description	Min	Max	Unit
V_{IL_nRST}	Reset threshold	450		mV
t_0	Time between VBAT brought up (3.3V) and RESET_N being activated	50		µs
t_1	Duration of RESET_N signal level < VIL_nRST to reset the chip	1000		µs
t_B	Boot Time		6	ms

Table 11: Digital specifications

Parameters	Description	VDDIO	Min	Max	Unit
V_{IL_GPIO}	Low input threshold for all GPIO and SDIO pins	1.8	-0.3	0.63	V
		2.5	-0.3	0.7	V
		3.3	-0.3	0.8	V
V_{IH_GPIO}	High input threshold for all GPIO and SDIO pins	1.8	1.17	3.6	V
		2.5	1.7	3.6	V
		3.3	2.0	3.6	V
V_{OL_GPIO}	Low output voltage for all GPIO and SDIO pins assuming a 8mA load	1.8	0.13	0.38	V
		2.5	0.10	0.27	V
		3.3	0.08	0.18	V
V_{OH_GPIO}	High output voltage for all GPIO and SDIO pins assuming a 8mA load	1.8	1.34	1.70	V
		2.5	2.20	2.41	V
		3.3	3.07	3.23	V
V_{OL_SDIO}	Low output voltage for all SDIO pins assuming a 8mA load	1.8	0.17	0.52	V
		2.5	0.14	0.36	V
		3.3	0.11	0.24	V
V_{OH_SDIO}	High output voltage for all SDIO pins assuming a 8mA load	1.8	1.19	1.67	V
		2.5	2.10	2.39	V
		3.3	2.99	3.21	V

Table 12: Digital Specifications

5 Physical Dimensions

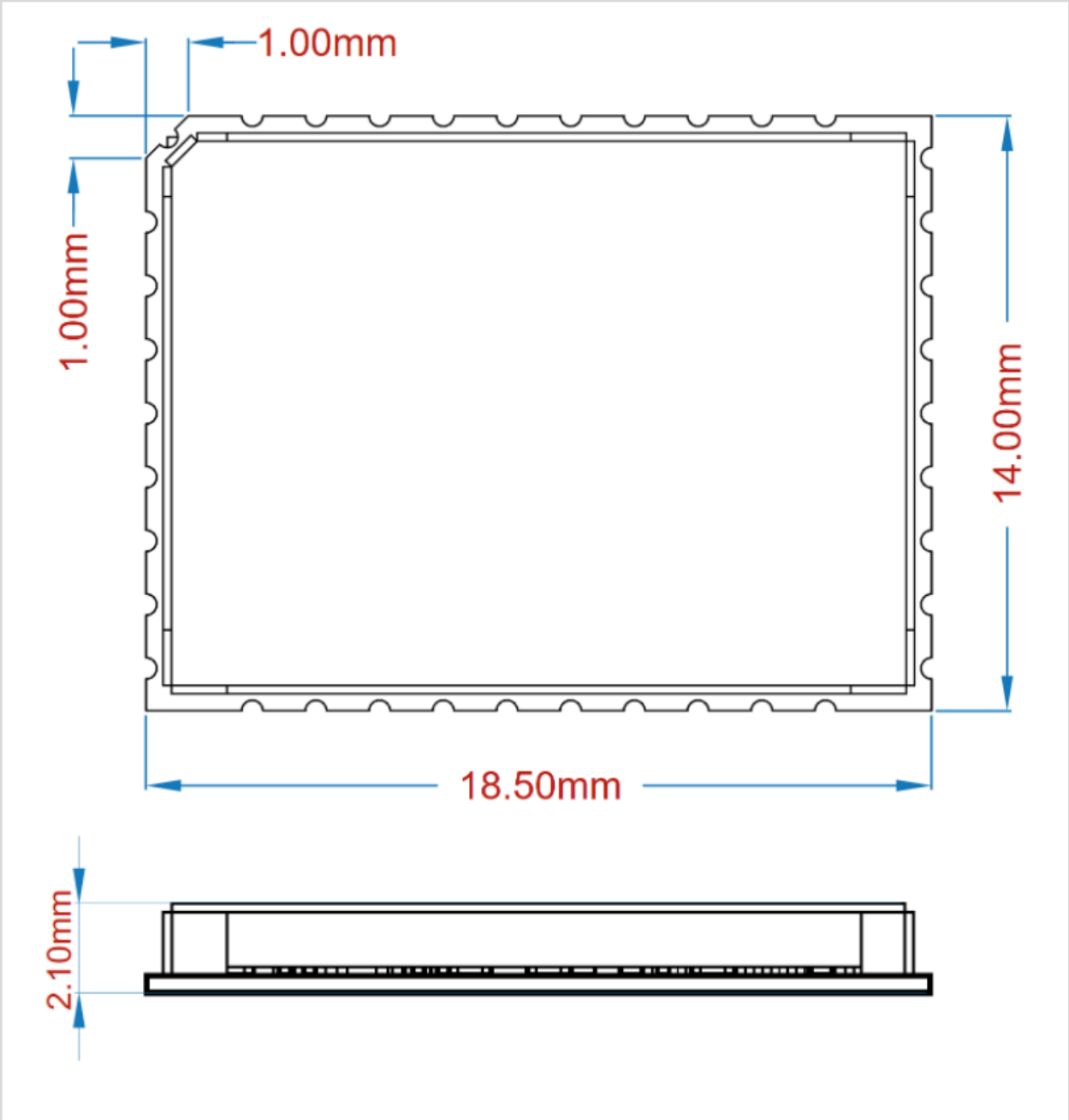


Figure 11: Package dimensions

6 Recommended PCB Footprint

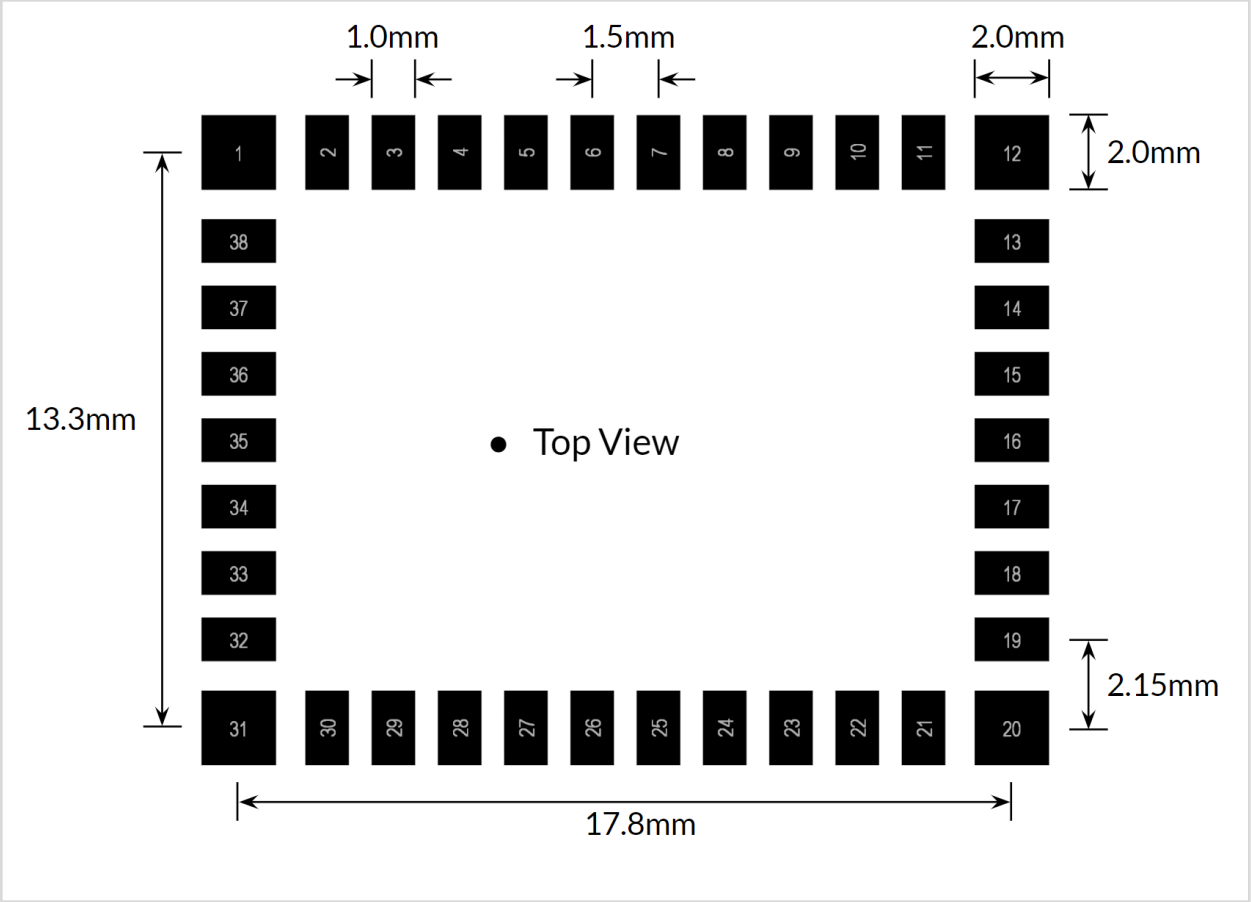


Figure 12: PCB Footprint diagram

7 Certification

7.1 FCC

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.

7.1.1 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.

7.1.2 Important Note To Integrators

This module is intended for OEM integrators. It is only FCC authorized for the specific rule parts listed on the grant, and the host product manufacturer is responsible for compliance with 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.

Additional testing and certification may be necessary when multiple modules are used.

7.1.3 End Product User Manual Requirement

In the user manual of the end product, the end user has to be informed to keep at least 20cm of separation with the antenna while this end product is installed and operated. The end user has to be informed that the FCC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied.

The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

This device complies with Part 15 of 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.

7.1.4 End Product Label Requirement

The end product must be labeled in a visible area with the following:

Contains FCC ID: 2A74O-DB3F2B

This device complies with Part 15 of 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 13: End Product Label Requirement

7.2. IC

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.

Cet appareil contient des émetteurs / récepteurs exempts de licence qui sont conformes au (x)

RSS (s) exemptés de licence d'Innovation, Sciences et Développement économique Canada. L'opération est soumise aux deux conditions suivantes:

(1) Cet appareil ne doit pas provoquer d'interférences.

(2) Cet appareil doit accepter toute interférence, y compris les interférences susceptibles de provoquer un fonctionnement indésirable de l'appareil.

This radio transmitter 29791-628C73 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.

Le présent émetteur radio 29791-628C73 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 d'antenne. Les types d'antennes non inclus dans cette liste qui ont un gain supérieur au gain maximal indiqué pour tout type listé sont strictement interdits pour une utilisation avec cet appareil.

7.2.1 IC Radiation Exposure Statement:

This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 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 20 cm de distance entre la source de rayonnement et votre corps.

7.2.2 Important Note To Integrators

This module is intended for OEM integrators. The OEM integrator is responsible for complying with all the rules that apply to the product into which this certified RF module is integrated. Additional testing and certification may be necessary when multiple modules are used. Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

7.2.3 End Product User Manual Requirement

In the users manual of the end product, the end user has to be informed to keep at least 20 cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the IC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied.

The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference

(2) this device must accept any interference received, including interference that may cause undesired operation.

7.2.4 End Product Label Requirement

The end product must be labeled in a visible area with the following:

Contains IC: 29791-628C73

Figure 14: End Product Label Requirement

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

8 Part Numbers and 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

Table 13: Part number and ordering information

9 Handling and Storage

The MM6108-MF08651-US module 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 (≤30°C and <60% 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

Release Number	Release Date	Release Notes
DS102	17 Jun 2025	Updated formatting
DS101	28 Feb 2025	General updates to layout and formatting Higher voltage VFEM impacts added
DS100	16 Dec 2023	Initial release

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