

Wi-Fi HaLow™ Wireless Module

MRF61_FI_MCU

User Guide

Product Model N u m b e r	MFIM0003 MFIM0004
product name	MRF61_FI_MCU_FLS, MRF61_FI_MCU_THS, MRF61_FI_MCU_FLN, MRF61_FI_MCU_THN

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MegaChips Corporation

CAUTION

1. Prohibition on copying and disclosure.

These specifications include intellectual property and know-how belonging to MegaChips Corporation ("MCC") and its partner companies.

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MCC grants no license of patents, copyrights or other intellectual property rights contained in these specifications.

MCC disclaims all liability arising from the use of the specifications with regard to infringement of any patents, copyrights or other intellectual property rights.

3. Safety designs such as redundancy

While MCC has been making continuous effort to enhance the quality and reliability of its devices, the possibility of malfunction cannot be eliminated entirely.

To minimize risk of damage or injury to persons or property arising from a malfunction in a device, customer must incorporate sufficient safety measures in its design, such as redundancy, fire-containment, and anti-failure features.

(If the customer intends to use the devices for applications other than those specified between the customer and MCC, please contact MCC sales representative before such use.)

4. Restriction on use

MCC provides no warranty relating to the use of the devices, where there is risk of serious damage, environmental pollution, loss of life, injury or damage to property, or where reliability or special quality is essential, such as life support, military use, or space exploration.

5. Radiation-proof design

This device has not been designed to be radiation-resistant.

6. Export restriction

The export of this device may be regulated by the government under customs, anti-proliferation rules, or other regulations, and export may be prohibited without governmental license.

7. No prior notice of revision

These specifications are based on materials dated 01/18/2024, and MCC reserves the right to revise these specifications without any prior notice. For mass production planning, please reference the latest version of the specifications.

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1. Product Overview

1.1. Introduction

The MRF61_FI_ MCU wireless module is a product equipped with an IC for Wi-Fi HaLow (IEEE 802.11ah) communications and a microcontroller for IoT .

The radio section of this wireless module is equipped with an SoC (MM6108) developed by MorseMicro , enabling Wi-Fi HaLow communication, which has features such as long-distance communication, wide transmission bandwidth, and low power consumption.

The wireless SoC is modularized in combination with a high-performance microcontroller (SAM51 manufactured by Microchip, hereafter referred to as the on-board microcontroller) that has a wide range of external I /Fs and serves as the host for the wireless SoC . This enables various sensors and external devices to be connected to the on-board microcontroller, and data to be transferred to the cloud, etc. via Wi - Fi HaLow communication.

This wireless module is designed in compliance with the IEEE 802.11ah standard, supporting data rates up to 32.5 Mbps with programmable operation between 902 MHz and 928 MHz.

To make it easy to realize high-performance RF characteristics, this wireless module already has RF peripheral circuits such as RF amplifiers (PA, LNA), TX/RX switches, and 32MHz crystal oscillator built in along with the MM6108. This configuration is also ideal for users who are considering replacing their existing wireless technology with Wi-Fi HaLow while taking advantage of the latest WPA3 security protocol.

This wireless module has external I /F such as GPIO, UART, SPI, I2C, I2S, ADC, DAC, PWM, etc. Sensor equipment and devices can be connected.

For battery-powered applications, several power-saving features of the SoC can be combined and used. The IEEE 802.11ah standard allows battery-powered stations (STAs, client devices) to use the sleep function, which provides a longer sleep time than the existing wireless LAN standard IEEE 802.11a/b/g/n/ac generations. It also allows clients to extend the maximum idle time without being removed from the access point (AP) device list, saving power consumption.

1.2. Features

Ultra-long-range, low-power Wi-Fi HaLow module for IoT Applications:	
Frequency Band	920MHz Band(Sub-1GHz Band)
Channel Band Width	1MHz/2MHz/4MHz/8MHz
Maximum Transmission power	20.67 dBm
Modulation method	OFDM
Sub carrier modulation method (It is depended on communication conditions)	BPSK,QPSK,16-QAM,64-QAM
Theoretical maximum transmission rate	32.5Mbps(In case of 8MHz BW,MCS7)

1.3. Applications

- For applications such as IoT (Internet of Things) and M2M (Machine to Machine)
 - Surveillance cameras and sensors
 - Cloud Connectivity
 - Low power sensor network
 - Building Automation Systems (BAS)
 - Asset Tracking and Management
 - Machine Performance Monitors and Sensors
 - Building access control and security
 - Video and navigation communication with drones
 - Connecting Toys and Games
 - Rural Internet Access
 - Agriculture and Farm Network
 - Smart meters and electricity networks
 - Proximity sensor
 - Industrial Automation
 - Smart Home
 - Electric Vehicle Charging Network
 - electric appliances
 - Network connection to the construction site
 - Smart Signs and Kiosks
 - Retail POS Terminals
 - IP Sensor Network
 - Biometric ID and Keypad
 - Internet connection to the warehouse
 - Smart Lighting Control
 - Wi-Fi and Wi-Fi HaLow Bridge
 - Wi-Fi HaLow Client Adapter Dongle
 - Smart City Network

2. Product Specifications

2.1. Production Spec

Picture 2-1 Production Specifications

Product Specifications		
Power supply	Voltage	VBAT : +3.135~+3.465V VDD_FEM : +3.135~+3.465V VDDIO1/2 : +2.3~+3.465V
Maximum power consumption		T.B.D
Storage temperature		-40°C~+125°C
Operating temperature		-40°C~+85°C
RF Performance	RF terminal impedance	50ohms
	Frequency range	902~928MHz
External Dimensions		40mm x 20mm x 3.6mm
Weidht		4g

2.2. RF characteristics

2.2.1. frequency

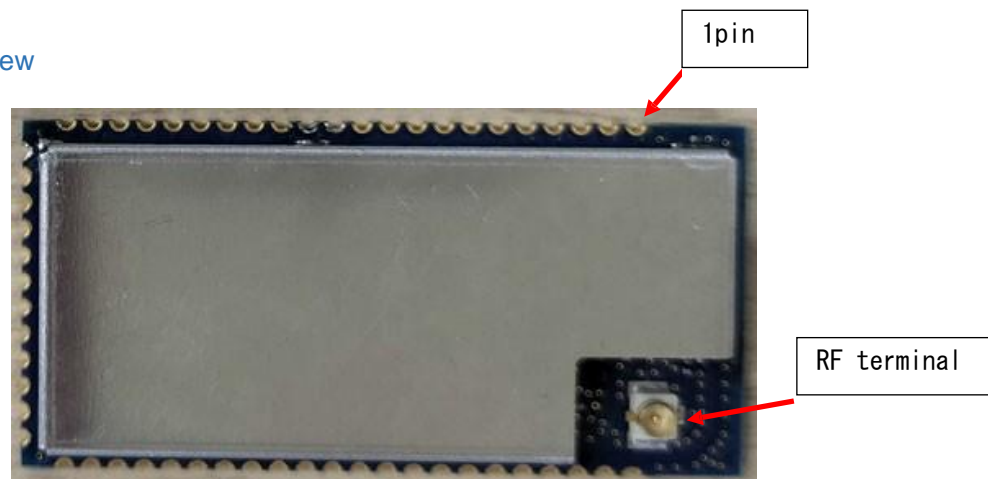
Table 2-1 Frequency Table

Channel spacing (MHz)	Channel Center frequency index	Channel center frequency (MHz)	Channel Center frequency index	Channel center frequency (MHz)
1	3	903.5	27	915.5
	5	904.5	29	916.5
	7	905.5	31	917.5
	9	906.5	33	918.5
	11	907.5	35	919.5
	13	908.5	37	920.5
	15	909.5	39	921.5
	17	910.5	41	922.5
	19	911.5	43	923.5
	21	912.5	45	924.5
	23	913.5	47	925.5
	25	914.5	49	926.5
2	6	905.0	30	917.0
	10	907.0	34	919.0
	14	909.0	38	921.0
	18	911.0	42	923.0
	22	913.0	46	925.0
	26	915.0		

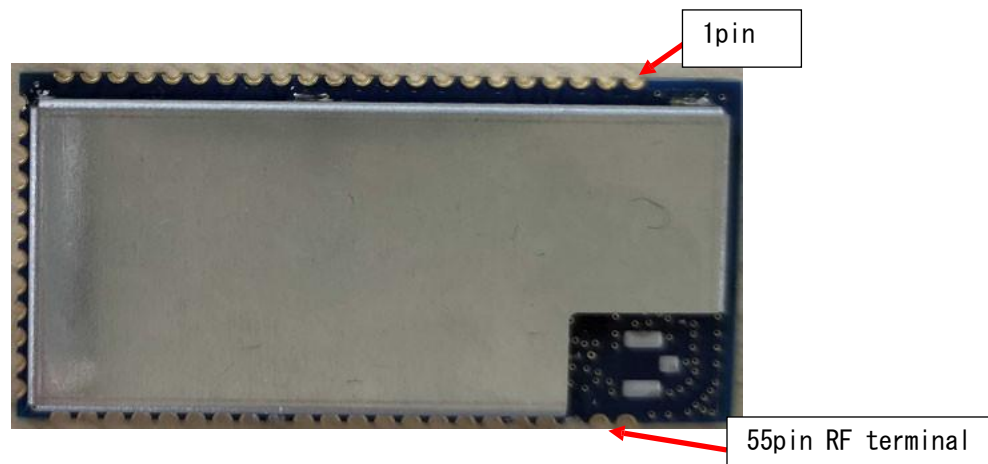
4	8	906.0	32	918.0
	16	910.0	40	922.0
	24	914.0	48	926.0
8	12	908.0		
	28	916.0		
	44	924.0		

3. External view

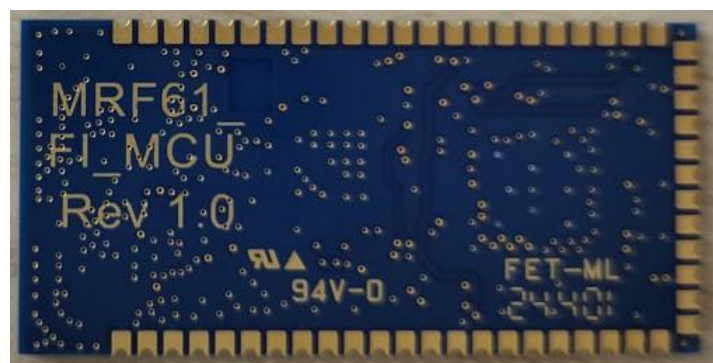
3.1. External view



Picture 3-1 MRF61 FI MCU S/N (U.FL) the Top with shield



Picture 3-2 MRF61 FI MCU S/N the Top with shield



Picture 3-3 MRF61 FI MCU S/N the Bottom side

3.2. Label position



Picture 3-4 Label position

3.3. Pin Table

Table 3-1 terminal table

serial number	Terminal name	Category	function	Remarks
1	VDD_FEM	Power	+3.3V power supply	
2	VDD_FEM	Power	+3.3V power supply	
3	N C	N C	Unused	
4	VBAT	Power	+3.3V power supply	
5	VBAT	Power	+3.3V power supply	
6	N C	N C	Unused	
7	G N	Power	GND	
8	I2C_SDA	I/O	Microcomputer I2C Host I/F	Internal Pull -up 2.7kΩ
9	I2C_SCL	O	Microcomputer I2C Host I/F	Internal Pull -up 2.7kΩ
Ten	G PIO6	I/O	Microcontroller GPIO	
11	G PIO5	I/O	Microcontroller GPIO	
12	GND	Power	ground	
13	TCC_1	I/O	Microcomputer TCC (Timer, counter control) I/F	
14	TCC_0	I/O	Microcomputer TCC (Timer, counter control) I/F	
15	GND	Power	ground	
16	S PI_MISO	I	Microcomputer SPI I/F	
17	S PI_MOSI	O	Microcomputer SPI I/F	
18	S PI_SS	I	Microcomputer SPI I/F	
19	S PI_SCK	O	Microcomputer SPI I/F	
20	GND	Power	ground	
21	VDDIO 2	Power	+ 3.3V power supply digital power supply	
22	VDDIO 2	Power	+ 3.3V power supply digital power supply	
23	GND	Power	ground	
24	GND	Power	ground	
25	G PIO4	I/O	Microcontroller GPIO	
26	R ESETn	I	H /W RESET Low active	
27	S -WDIO	I/O	Microcomputer SWD I/F	Internal Pull -up 1kΩ
28	S- WCLK	I	Microcomputer SWD I/F	
29	S YS_RSTB	I	S /W RESET Low active	

30	A DC_IN0	I/O	Microcontroller ADC/DAC I/F	
31	A DC_IN1	I	Microcontroller ADC/DAC I/F	
32	G PIO3	I/O	Microcontroller GPIO	
33	G PIO2	I/O	Microcontroller GPIO	
34	GND	Power	ground	
35	VDDIO 1	Power	+ 3.3V power supply digital power supply	
36	VDDIO 1	Power	+ 3.3V power supply digital power supply	
37	A DC_IN2	I	Microcontroller ADC/DAC I/F	
38	A DC_IN3	I	Microcontroller ADC/DAC I/F	
39	G PIO1	I/O	Microcontroller GPIO	
40	G PIO0	I/O	Microcontroller GPIO	
41	U ART_TX	O	Microcomputer UART I/F	
42	U ART_RX	I	Microcomputer UART I/F	
43	GND	Power	ground	
44	S D_CMD	I/O	Microcomputer SDIO I/F	(*2)
45	S D_D 0	I/O	Microcomputer SDIO I/F	(*2)
46	S D_D1	I/O	Microcomputer SDIO I/F	(*2)
47	S D_D 2	I/O	Microcomputer SDIO I/F	(*2)
48	S D_D3	I/O	Microcomputer SDIO I/F	(*2)
49	GND	Power	ground	
50	S D_CLK	O	Microcomputer SDIO I/F	(*2)
51	S D_CD	I	Microcomputer SDIO I/F SD detected = Low	(*2)
52	S D_WP	I	Microcomputer SDIO I/F	(*2)
53	GND	Power	ground	
54	GND	Power	ground	
55	RFout_EdgeTH	I/O (*1)	HaLow RF signal	Impedance: 50 Ω
56	GND	Power	ground	

*1 When using the SDIO I/F, an external pull-up resistor of 10kΩ is required.

4. Antenna list

Ant.	Port	Brand	Model Name	Antenna Type	Connector	Gain(dBi)
1	1	Linx Technologies	ANT-916-HETH	Helical	-	+6.4dBi
2	1	molex	1052620002	Monopole Antenna with Cable	U.FL Type SMT coaxial connector	+1.5dBi
3	1	molex	2111400100	Monopole Antenna with Cable	U.FL Type SMT coaxial connector	+1.0dBi
4	1	molex	1052620001	Monopole Antenna with Cable	U.FL Type SMT coaxial connector	+1.6dBi
5	1	Linx Technologies	ANT-916-CW-RCS	Monopole	RP-SMA plug	+4.8dBi
6	1	Kyocera	P822603	Chip	-	+0.7dBi
7	1	Johanson Technology	0915AT43A0026001E	Chip	-	-1.0dBi
8	1	PulseLarsen Antennas	W1063	Dipole	RP-SMA Male	+1.0dBi

4.1. FCC

The host manufacturer should reference KDB Publication 996369 D04 Module Integration Guide.

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

IMPORTANT NOTE:

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 & your body.

IMPORTANT NOTE:

This module is intended for OEM integrators. This module is only FCC authorized for the specific rule parts 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.

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

USERS MANUAL OF THE END PRODUCT:

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

The end user must 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.

LABEL OF THE END PRODUCT:

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

“Contains FCC ID: 2AGYI-WM0151”.

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.

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.

Antennas

This radio transmitter has been approved by the FCCD to operate with the antenna types listed on the page 12 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.

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.

Note 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 permissive changes, if the module will be used differently than granted conditions, please contact us to ensure modifications will not affect compliance.

4.2. ISSED

This device contains license-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.

This device contains license - exempt transmitters / receivers that are RSS compliant (s) license

exempt of Innovation, Sciences and Development Economic Canada. The operation East subject to the following two conditions :

- (1) This device must not cause interference.
- (2) This device must accept any interference, including interference likely to cause operation unwanted device .

This device and its antenna(s) must not be co-located with any other transmitters except in accordance with IC multi-transmitter product procedures.

This device and its antenna (s) must not be co -located or functioning in association with another antenna or transmitter.

The radio transmitter (IC: 29836-WM0151) has been approved by Innovation, Sciences and Development economical Canada to work with antenna types listed below and having a maximum allowable antenna gain. Antenna types not included in this list which have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

L'émetteur radio (IC : 29836-WM0151) a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antennes énumérés ci-dessous et ayant un gain d'antenne maximal autorisé. Les types d'antennes non inclus dans cette liste qui ont un gain supérieur au gain maximal indiqué pour tout type répertorié sont strictement interdits pour une utilisation avec cet appareil.

Ant.	Port	Brand	Model Name	Antenna Type	Connector	Gain(dBi)
1	1	Linx Technologies	ANT-916-HETH	Helical	-	+6.4dBi
2	1	molex	1052620002	Monopole Antenna with Cable	U.FL Type SMT coaxial connector	+1.5dBi
3	1	molex	2111400100	Monopole Antenna with Cable	U.FL Type SMT coaxial connector	+1.0dBi
4	1	molex	1052620001	Monopole Antenna with Cable	U.FL Type SMT coaxial connector	+1.6dBi
5	1	Linx Technologies	ANT-916-CW-RCS	Monopole	RP-SMA plug	+4.8dBi
6	1	Kyocera	P822603	Chip	-	+0.7dBi
7	1	Johanson Technology	0915AT43A0026001E	Chip	-	-1.0dBi
8	1	PulseLarsen Antennas	W1063	Dipole	RP-SMA Male	+1.0dBi

IMPORTANT NOTE:**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 minimum distance 20cm between the radiator & your body.

This equipment is compliant with limits IC radiation exposure guidelines established for an uncontrolled environment. This equipment must be installed and used with a minimum distance of 20 cm between the radiation source and your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements ISÉ 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.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

USERS MANUAL OF THE END PRODUCT:

In the user's manual of the end product, the end user has to be informed to keep at least 20cm 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 must 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.

LABEL OF THE END PRODUCT:

The final end product must be labeled in a visible area with the following
" Contains IC: 29836-WM0151".

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 Electronic labelling.

Date:2024/10/01	Version 1.0	Create New				Hamada kazuharu
Data 2025/2/10	Version 2.0	Update				Hamada kazuharu
Data 2025/3/5	Version 3.0	Update				Hamada kazuharu

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