



HT-HC01 V2

WiFi HaLow Module



Document version

Version	Time	Description	Remark
Rev. 1.0	2024-10-16	P-Development version	Richard
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1 Description

1.1 Overview

[HT-HC01](#) is a Wi-Fi HaLow module with excellent RF performance, which operates in 863-870 and 902-928MHz^①, with maximum data rates of 32.5Mbps and up to 1-2km transmission range.

HT-HC01 uses LLC package, small size and rich pin, can be very convenient to integrate in a variety of PCB. It includes ultra-long range PA, high linear LNA, T/R switching, 32 MHz crystal oscillator, and is designed to simplify Wi-Fi HaLow connectivity to external hosts for applications.

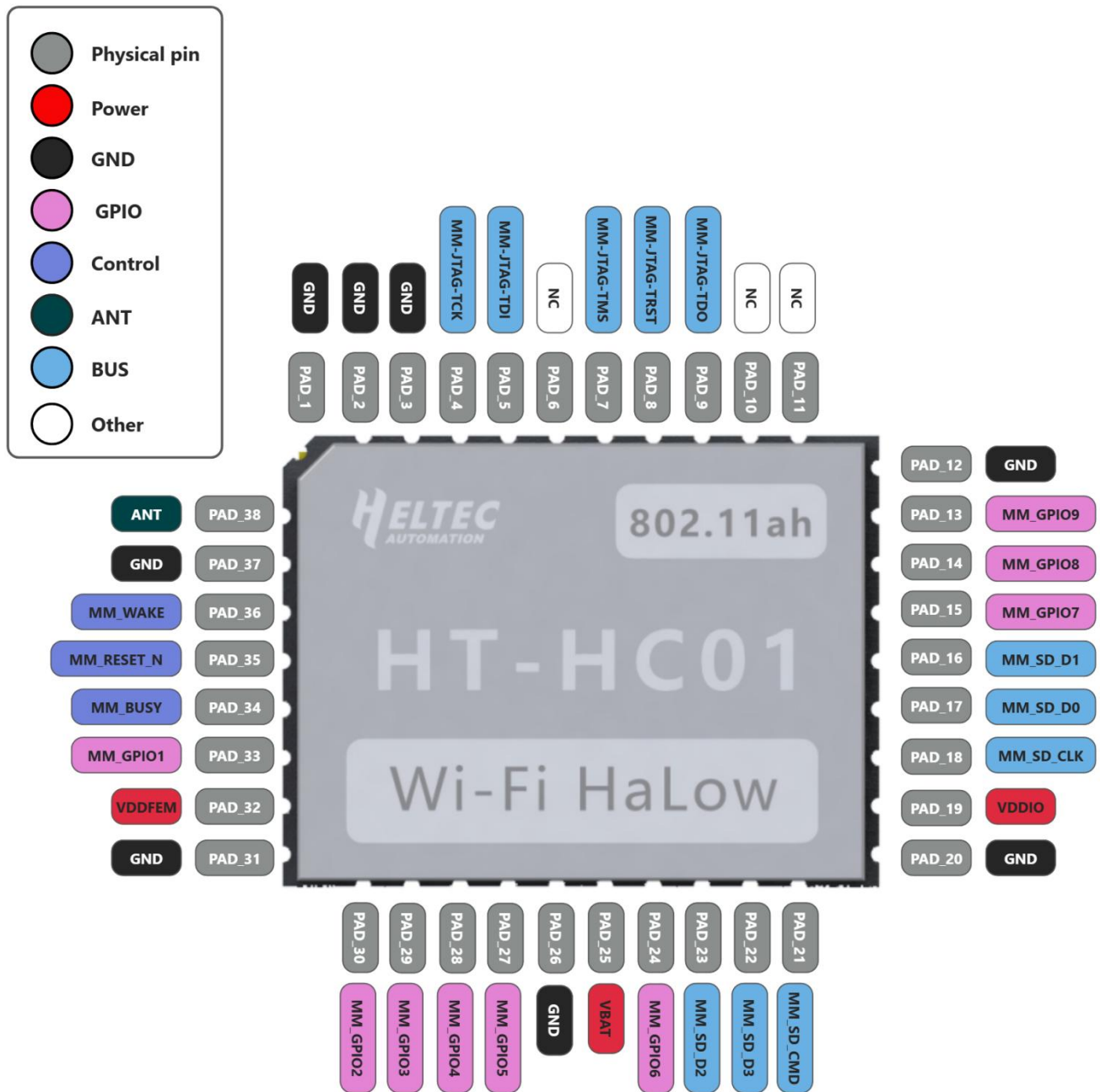
HT-HC01 meets IEEE 802.11ah standard, which is specifically designed for battery-operated devices, allowing them to remain in longer sleep and idle states without frequent wake-ups. This significantly reduces power consumption and extends the device's battery life. As a result, HT-HC01 becomes an ideal choice for Internet of Things (IoT) devices and other battery-powered equipment.

^① The hardware versions are different for 868MHz and 915MHz.

1.2 Features

- Long-range transmission, up to 1km or and further within the visual distance.
- Channel bandwidth options of 1/2/4/8 MHz.
- High data rate, single-stream max rate of 32.5 Mbps @ 8 MHz.
- Support Sub-1 GHz frequency bands, frequency range: US 902~928 MHz.
- Max output power:29dBm.
- 802. 11ah OFDM PHY supporting WFA HaLow certification.
- 802. 11ah MAC supporting WFA HaLow certification.
- Support for various interface options, include SDIO 2.0, 2* UART..
- Hibernate mode (internal / external wake).
- Integrated DC-DC converter supporting VDD supply from 3.0V to 3.6V, and VFEM supply from 5V.
- 1.27mm stamp hole design, easy to integrate.
- Wide spectrum of security features.

2 Pin Description



PAD_1	Name	Type	Function	Alternate & Other Function(s)
PAD_1	GND	POWER	Ground	
PAD_2	GND	POWER	Ground	
PAD_3	GND	POWER	Ground	
PAD_4	MM_JTAG_TCK	I	JTAG Clock	

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PAD_5	MM_JTAG_TDI	I	JTAG Data In	
PAD_6	NC	NC		
PAD_7	MM_JTAG_TMS	I	JTAG Mode Select	
PAD_8	MM_JTAG_TRST_N	I	JTAG Reset	
PAD_9	MM_JTAG_TDO	O	JTAG Data Out	
PAD_10	NC	I/O		
PAD_11	NC	I/O		
PAD_12	GND	POWER	Ground	
PAD_13	MM_GPIO_9	I/O	General Purpose IO9	
PAD_14	MM_GPIO_8	I/O	General Purpose IO8	
PAD_15	MM_GPIO_7	I/O	General Purpose IO7	UART1_TX[4]
PAD_16	MM_SDIO_D1	I/O	SDIO D1	SPI_INT
PAD_17	MM_SDIO_DO	I/O	SDIO D0	SPI_MISO
PAD_18	MM_SDIO_CLK	I/O	SDIO Clock	SPI_SCK
PAD_19	MM_VDD_IO	POWER	3.3V VDD_IO Supply	
PAD_20	GND	POWER	Ground	
PAD_21	MM_SDIO_CMD	I/O	SDIO Command	SPI_MOSI
PAD_22	MM_SDIO_D3	I/O	SDIO D3	SPI_CS
PAD_23	MM_SDIO_D2	I/O	SDIO D2	
PAD_24	MM_GPIO_6	I/O	General Purpose IO6	UART1_RX[4]
PAD_25	VBAT	POWER	3.3V VBAT Supply	
PAD_26	GND	POWER	Ground	
PAD_27	MM_GPIO_5	I/O	General Purpose IO5	I2C_SCL[4]

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PAD_28	MM_GPIO_4	I/O	General Purpose IO4	I2C_SDA[4]
PAD_29	MM_GPIO_3	I/O	General Purpose IO3	UART0_TX, PWM1_3[4]
PAD_30	MM_GPIO_2	I/O	General Purpose IO2	UART0_RX, PWM1_2[4]
PAD_31	GND	POWER	Ground	
PAD_32	VDD_FEM	POWER	5V Frontend Supply	
PAD_33	MM_GPIO_1	I/O	General Purpose IO1	PWM1_1[4]
PAD_34	MM_GPIO_0	O	Wi-Fi BUSY	
PAD_35	RESET_N	I	System Reset	
PAD_36	WAKE	I	Wake	
PAD_37	GND	POWER	Ground	
PAD_38	ANT_1	ANALOG	Antenna	

NOTE:

- JTAG pins should be tied to GND via a 10k pull down resistor
- All unused GPIO should be tied to GND via a 10k pull down resistor
- All SDIO bus pins should be pull up with a 10k-100k resistor as per the the SDIO standard
- Pending software support
- Supplied from VBAT domain. Other digital pins are driven by VDDIO domain.

3 Specifications

3.1 General Specifications

Table 3.1 General specifications

Parameters	Description
Main Chip	MM6108IQ
Power Supply	VBAT/VDD_IO : 3.0~3.6V
	VDD_FEM : 3.0~5.25V
HaLow Standard	IEEE 802.11ah
Band Width	1/2/4/8MHz
Interface	38 Header Pins
Power consumption	See table 3.2.4
Operating temperature	-40 ~ 85°C
Operating humidity	10% ~ 90%, no-condensing
Dimensions	18.5*14*2.6mm
Data Rate	Maximum physical air interface rate: 32 Mbps

3.2 Electrical characteristics

3.2.1 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 the recommended conditions may result in a reduced lifetime and/or reliability problems (even if the absolute maximum ratings are not exceeded).

Table3.2.1 Absolute max ratings

Parameter	Min	Max	Unit
VBAT voltage	-0.3	4.3	V
VDD_FEM voltage	-0.3	5.5	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

3.2.2 Immunity

Table3.2.2 Immunity

Parameter			Min	Max	Unit
Electrostatic discharge(ESD) performance	Human body model (H3M).perANSI/ESDA/JED EC JS001	RF Input	-1000	1000	V
	Charged device model (CDM).perJESD22-C101	All pins except RF Input	-2000	2000	V
		All pins	-500	500	V

3.2.3 Recommended operating conditions

Table3.2.3 Recommended operating conditions

Parameter	Min	Type	Max	Unit
Ambient temperature	-40	25	85	°C
VBAT	3.0	3.3	3.6	V
VDD_FEM	3.0	5.0	5.25	V
VDD_IO	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

3.2.4 Power consumption

3.2.4.1 Sleep Power

Table3.2.4.3 Sleep power

Mode	Condition VBAT/VDD_IO =3.3V VDD_FEM =5V	VBAT			VFEM			Unit
		Min	TYP	Max	Min	TYP	Max	
Snooze	RC Oscillator on, Memory retained, configurable wake up timer	9.5	27	370		1.2		μA
Deep sleep	RC Oscillator on, configurable wake up timer	0.8	1	1.8		1.2		μA
Hibernate	Power off, wait for external interrupt	0.03	0.05	1		1.2		μA

3.3 RF characteristics

3.3.1 Receiver sensitivities

Table3.3.1 Receiver sensitivities

MCS index	Modulation scheme	Coding rate	Phy rate (kbps) per BW				Minimum Receive sensitivity (dBm) per BW			
			1MHz	2MHz	4MHz	8MHz	1MHz	2MHz	4MHz	8MHz
0	BPSK	1/2	333	722	1500	3250	-105	-103	-101	-97
1	QPSK	1/2	667	1444	3000	6500	-102	-100	-97	-93
2	QPSK	3/4	1000	2167	4500	9750	-99	-97	-95	-91
3	16-QAM	1/2	1333	2889	6000	13000	-96	-94	-91	-88
4	16-QAM	3/4	2000	4333	9000	19500	-93	-90	-88	-85
5	64-QAM	2/3	2667	5778	12000	26000	-89	-87	-84	-80
6	64-QAM	3/4	3000	6500	13500	29250	-88	-85	-83	-79
7	64-QAM	5/6	3333	7222	15000	32500	-87	-84	-81	-77
10	BPSK	1/2 x 2	167	N/A			-107	N/A		

3.3.2 Transmission power

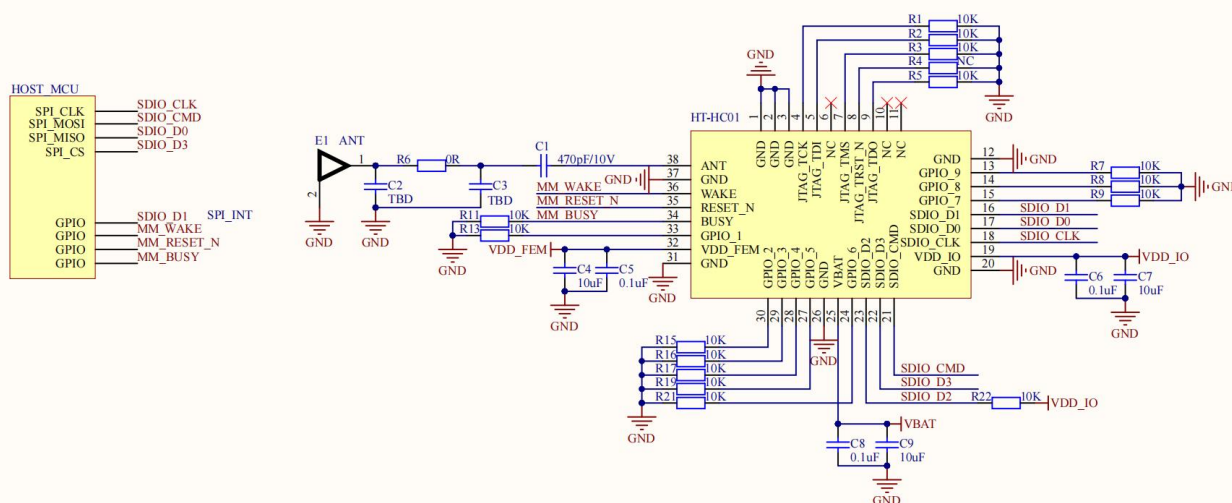
Table3.3.2 Transmission power

Tx output power (1/2/4/8 MHz BW)	Min (dBm)	Typical (dBm)	Max (dBm)
MCS 0	26	29	26
MCS 7	22	23	24

4 Reference Design

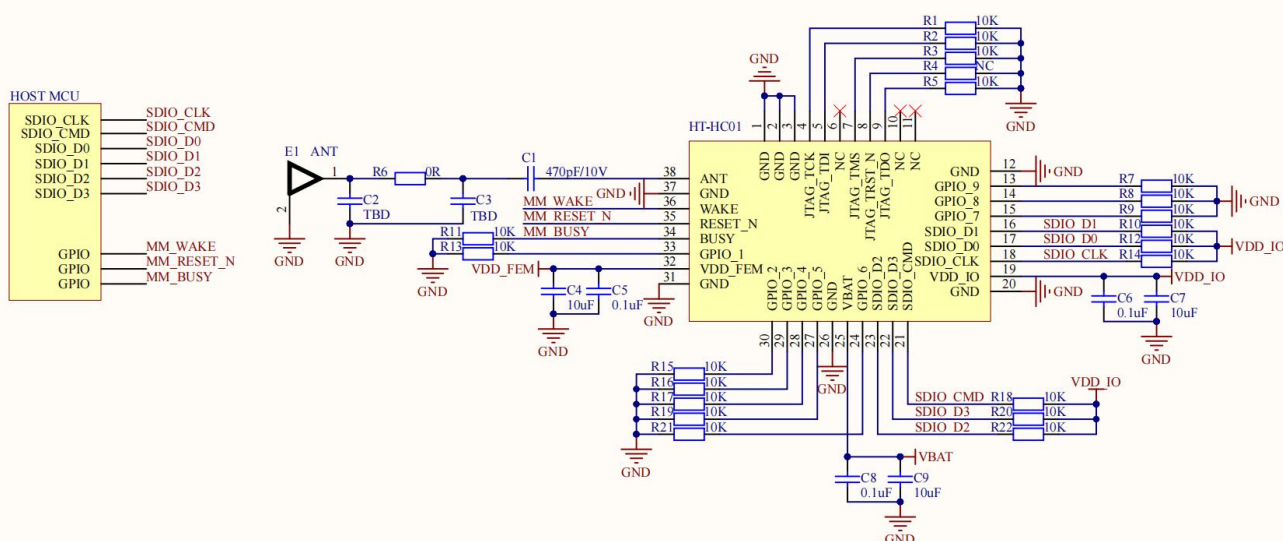
4.1 SPI

[https://resource.heltec.cn/download/HT-HC01/Reference design/SPI.PDF](https://resource.heltec.cn/download/HT-HC01/Reference_design/SPI.PDF)



4.2 SDIO

https://resource.heltec.cn/download/HT-HC01/Reference_design/SDIO.PDF



4.3 Requirements and considerations

4.3.1 SDIO host requirements

- The host should support SDIO v2.0 with SDIO clock speeds of up to 50 MHz. Slower clock

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speeds will impact the maximum achievable throughput.

- At a minimum, 2 x GPIOs are required as a CMOS output to drive the RESET and WAKE signals. If power save is used, a third GPIO is needed, set as a CMOS input to receive the BUSY signal from the module.
- The SDIO data and command lines should be pulled up with 10k-100k resistors as per the SDIO 2.0 specification.

4.3.2 SPI host requirements

When selecting a CPU host to interface via SPI to the MM6108-MF08551 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 reduce significantly if there is no DMA support. For example, an SPI interface with an 8-byte buffer per transaction might only achieve 2Mbps throughput on the SPI bus.

4.3.3 Power management

MM6108-MF08551 module power is derived from a 3.0 to 3.6V supply provided on pins VBAT and VDD_FEM. VBAT powers the internal circuitry of the MM6108 and VDD_FEM powers the on-board ultra-long-range power amplifier.

VDDIO sets the IO voltage of the MM6108 and 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

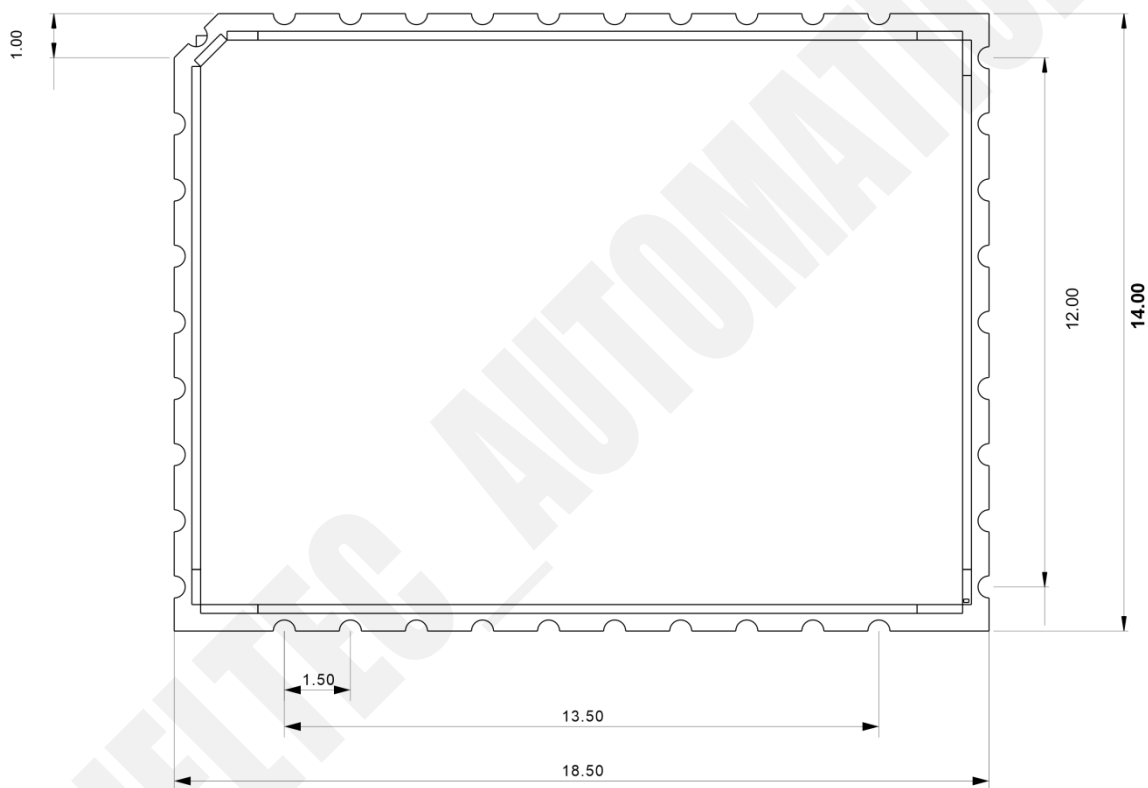
not exceed VBAT.

4.3.4 Digital interfaces

All unused digital IO 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.

5 Hardware Dimensions

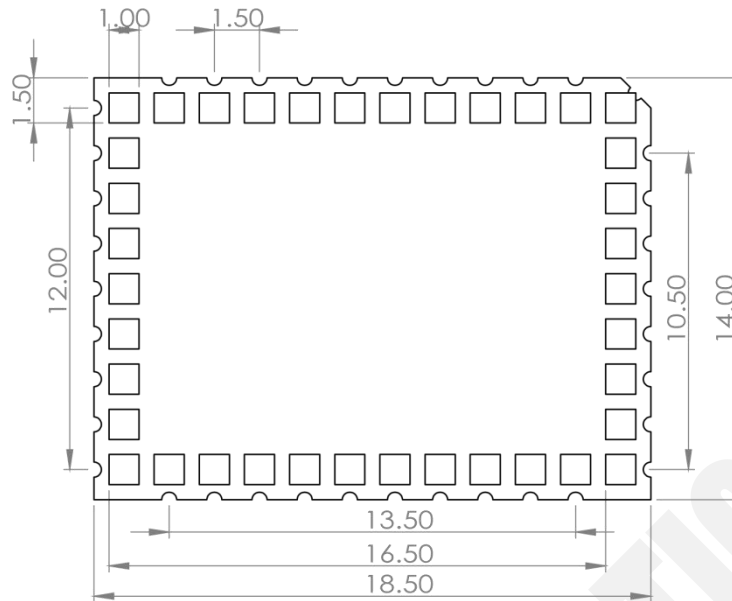
5.1 Dimensions



5.2 PCB footprint

For a detailed PCB Footprint, please refer to the following link:

https://resource.heltec.cn/download/Heltec_Module_Footprint/HT-HC01



6 Resource

6.1 Relevant resources

- Documents Page: [Heltec Products Operation Documentation](#)
- Reference Design: https://resource.heltec.cn/download/HT-HC01/Reference_design

6.2 Heltec Contact Information

Heltec Automation Technology Co., Ltd

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FCC Statement

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help

Important Note: 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 minimum distance 20cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. Country Code selection feature to be disabled for products marketed to the US/Canada.

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

1. The antenna must be installed such that 20 cm is maintained between the antenna and users;
2. The transmitter module may not be co-located with any other transmitter or antenna;
3. For all products marketed in US, OEM has to limit the operation channels in CH1 to CH11 for 2.4G band by supplied firmware programming tool. OEM shall not supply any tool or info to the end-user regarding to Regulatory Domain change. (If modular, only test Channel 1-11)

As long as the three conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Important Note:

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

End Product Labeling

The final end product must be labeled in a visible area with the following: Contains FCC ID: 2A2GJ-HT-HC01

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user' s manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Integration instructions for host product manufacturers according to KDB 996369 D03
OEM Manual v01r01

2.2 List of applicable FCC rules

CFR 47 FCC PART 15 SUBPART C and CFR 47 FCC PART 15 SUBPART E has been investigated. It is applicable to the modular transmitter.

2.3 Specific operational use conditions

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

This radio transmitter 2A2GJ-HT-HC01 has been approved by Federal Communications Commission 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. The concrete contents to check are the following three points.

- 1) Must use an antenna such as Dipole Antenna with a gain not exceeding 5.5 dBi;
- 2) Should be installed so that the end user cannot modify the antenna;

3) Feed line should be designed in 50ohm.

Fine-tuning of return loss etc. can be performed using a matching network. The antenna shall not be accessible for modification or change by the end user. A modification to the antenna requires FCC/ISED Class II permissive change.

This device has been approved as mobile device in accordance with FCC and ISED Canada RF exposure requirements. This means that a restricted minimum separation distance of 20cm between the antenna and any person is mandatory.

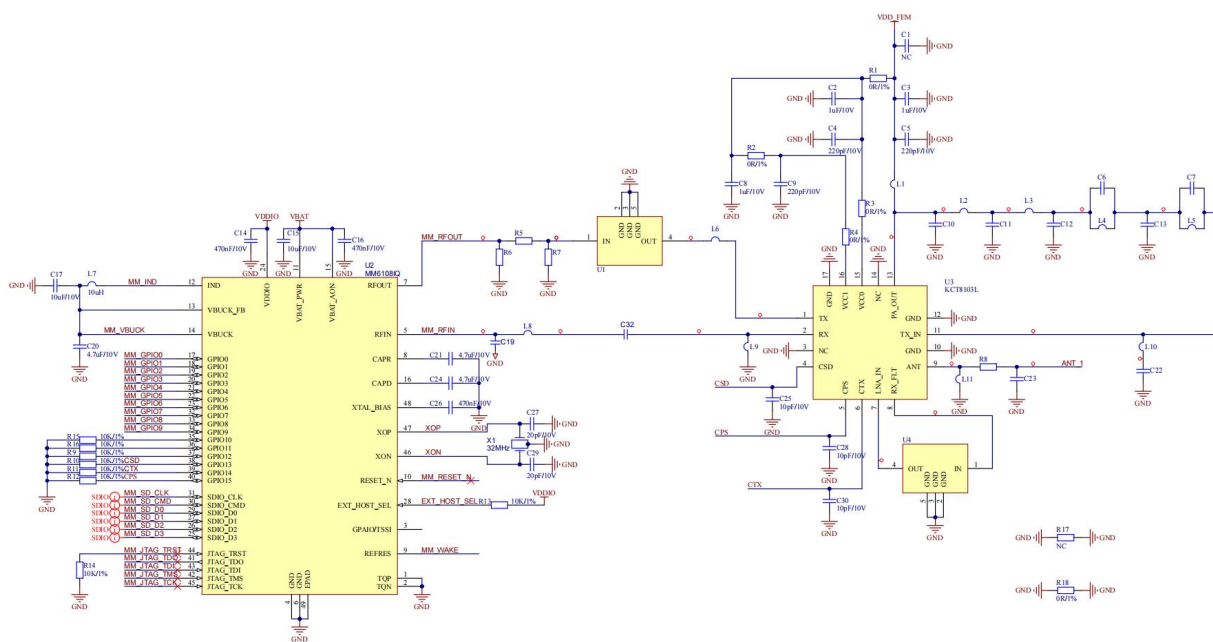
A change in use that involves a separation distance $\leq 20\text{cm}$ (Portable usage) between the Module' s antenna and any persons is a change in the RF exposure of the module and, hence, is subject to a FCC Class 2 Permissive Change and a ISED Canada Class 4 Permissive Change policy in accordance with FCC KDB 996396 D01 and ISED Canada RSP-100.

2.4 Limited module procedures

Not applicable

2.5 Trace antenna designs

The antenna circuit adopts standard 50Ω impedance matching design, with complete trace layout and supporting electronic components between the module RF output terminal and antenna terminal. The detailed antenna circuit trace information and supporting component parameters are listed in the table below:



Comment	Description	Designator	Footprint	Quantity	Tolerance	Value
NC	MLCC	C1	C0402	1	20%	NC
1uF/10V	MLCC	C2, C3, C8	C0201	3	10%	1uF/10V
220pF/10V	MLCC	C4, C5, C9	C0201	3	1%	220pF/10V
2.4pF/10V	MLCC	C6	C0201	1	0.1pF	2.4pF/10V
0.9pF/10V	MLCC	C7	C0201	1	0.1pF	0.9pF/10V
3.6pF/10V	MLCC	C10	C0201	1	0.1pF	3.6pF/10V
9.1pF/10V	MLCC	C11	C0201	1	0.1pF	9.1pF/10V
NC	MLCC	C12, C22, C23	C0201	3	0.1pF	NC
2pF/10V	MLCC	C13	C0201	1	0.1pF	2pF/10V
470nF/10V	MLCC	C14, C16, C26	C0201	3	10%	470nF/10V
10uF/10V	MLCC	C15, C17	C0402	2	20%	10uF/10V
0.5pF/10V		C19	C0201	1	0.1pF	0.5pF/10V
4.7uF/10V	MLCC	C20, C21, C24	C0402	3	20%	4.7uF/10V
10pF/10V	MLCC	C25, C28, C30	C0201	3	1%	10pF/10V
20pF/10V	MLCC	C27, C29	C0201	2	1%	20pF/10V
100pF/10V		C32	C0201	1	1%	100pF/10V
8.2nH		L1	L0402	1	2%	8.2nH
0.8nH		L2	L0201	1	0.1nH	0.8nH
0R/1%		L3	L0201	1	1%	0R/1%
3.3nH		L4	L0201	1	0.1nH	3.3nH
3.0nH		L5	L0201	1	0.1nH	3.0nH
8.2nH		L6	L0201	1	3%	8.2nH
10uH		L7	1008	1	20%	10uH
13nH		L8	L0201	1	3%	13nH
68nH		L9, L11	L0201	2	3%	68nH
NC		L10	L0201	1	0.1nH	NC
0R/1%		R1, R2, R3, R4, R	R0201	6	1%	0R/1%
51R/1%		R5	R0201	1	1%	51R/1%
120R/1%		R6, R7	R0201	2	1%	120R/1%
10K/1%		R9, R10, R11, R1	R0201	8	1%	10K/1%
NC		R17	R0201	1	1%	NC
NC		SHIELD1	MF04_MF06_SH	1		
YFSAS915MV01U	filter	U1, U4	SMD1411-5P	2		YFSAS915MV01UC1
MM61081Q	IC WiFi HaLow E	U2	QFN48P600X600	1		MM61081Q
KCT8103L	KCT8103L	U3	LGA-16L(3X3)	1		KCT8103L
32MHz	Crystal, 32MHZ	X1	CRYSTAL_1612	1	10ppm/10pp	32MHz

2.6 RF exposure considerations

This equipment complies with FCC 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.

2.7 Antennas

This radio transmitter FCC ID: 2A2GJ-HT-HC01 has been approved by Federal Communications Commission 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.

Max. Antenna Gain & Antenna Type: 2.5dBi Dipole Antenna

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following: Contains FCC ID: 2A2GJ-HT-HC01

2.9 Information on test modes and additional testing requirements

Host manufacturer which installs this modular with single modular approval shall perform the test of radiated emission and spurious emission according to FCC part 15C:15.247 and FCC Part 15 and 15.209 requirements. Only if the test results comply with the above standards can the host product be sold legally.

2.10 Additional testing, Part 15 Subpart B disclaimer

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Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B.

2.11 Note EMI Considerations

Host manufacture is recommended to use 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.

2.12 How to make changes

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system. According to the KDB 996369 D02 Q&A Q12, a host manufacture only needs to do an evaluation (i.e., no C2PC required when no emission exceeds the limit of any individual device (including unintentional radiators) as a composite). The host manufacturer must fix any failure.