

CMM-9301-V4.4 Bluetooth Low Energy HCI Module



C-MAX

This Module is limited to OEM installation ONLY

1.0 Description

The CMM-9301-V4.4 module is a miniaturised BLE controller module based on EM Microelectronic's low power fully integrated single-chip Bluetooth Low Energy (BLE) Controller EM9301. The module is highly optimized for Bluetooth 4.0 Single Mode (Bluetooth Low Energy) link application and beacon applications requiring ultra low power consumption and short time-to-market. It offers a plug and play solution for any BLE application up to the link layer, without any additional hardware nor RF layout. Built in with a folded-dipole PCB antenna, this small sized, low cost module provides an ideal solution to the new BLE technology.

The EM9301 is designed to act as BLE master or slave according to the Bluetooth 4.0 specification. It can be controlled by any external microcontroller featuring BLE profile and applications, through the standard BT HCI interface.

1.1 Features

- Master and Slave BLE controller compliant to Bluetooth 4.0 specification
- Cost effective solution for beacon applications
- Embedded low-power physical layer, Link Layer with security engine, and a Host Controller Interface (HCI)
- Low average current consumption
- 1Mbps on-air data rate
- Mini-sized (18.5mm x 14mm)
- Integrated Battery Low Detection
- Programmable RF output level (-18 to +3 dBm) for current consumption optimization.
- No Tuning necessary
- SPI interface as HCI transport layer to micro-controller

1.2.1 Module Pin Assignment

Pin Number	Pin Name	Input / Output to module	Pin Description
1	RST	I	Reset (controlled via FET by 100ms HI input pulse) ON (LO) / OFF (HI)
2	GND	GND	Ground Connection
3	CS	I	Chip Select (Active LO)
4	IRQ	O	Interrupt Output for external host Controller
5	SDO	O	SPI Data Output
6	SDI	I	SPI Data Input
7	SCK	I	SPI Clock Input
8	VCC	VCC	Power Supply
9	SEL	N.C	Reserved

CMM-9301-V4.4 Bluetooth Low Energy HCI Module



1.2.2 Module Physical Layout



CMM-9301-V4.4F
(Shielded,
without pin header)

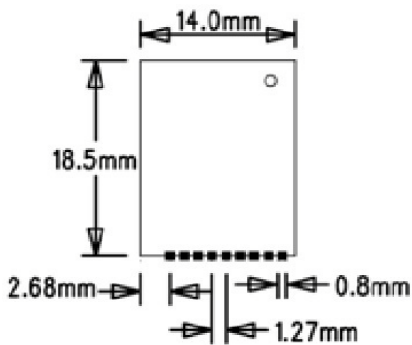


CMM-9301-V4.4X
(Shielded,
with pin header)

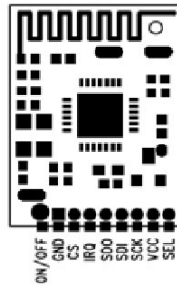
1.2.3 Module Dimensions

Connection pin pitch = 1.27mm

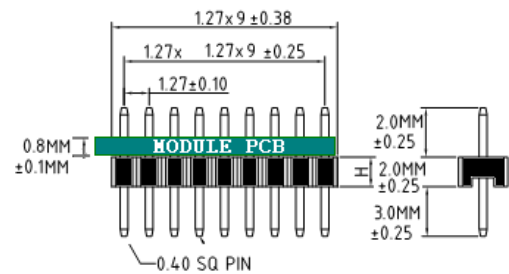
Module Thickness (excluding pin header connectors, including shielding) = 2.5mm max.



Module Dimensions



Pin Definition



Pin Connection Dimension

1.3 SPI Interface with External Controller

The module can be integrated as a part of any Bluetooth LE product and serves as a companion to an external controller with a BLE corestack, acting as an RF front end inclusive of the Physical Layer, Link Layer and Host Controller Interface as defined in the Bluetooth 4.0 specification. The module interfaces with the external controller and BLE corestack via SPI link utilizing HCI command sets from the Bluetooth 4.0 standard.

The SPI used is a 5-wire, 8-bit, MSB-first, Motorola-compatible with CPOL=0 and CPHA=0 interface. Only half-duplex transport is supported.

The SPI interface is defined through the following pins:

CSN: Chip select signal. This signal is active low and it is mandatory, even when only one slave device is connected to the host.

SPI_SCK: SPI clock signal. When CSN is active, the host shall send to the controller a multiple of 8 clock cycles (and bits) during each SPI transaction. When CSN is not active, CMM-9301 module ignores any signal sent to this pin. This allows the host to set a clock signal to serve other devices.

SPI_MOSI: host-to-controller transfer data line. The host shall generate data on the negative edge and sample data on the positive edge of SPI_SCK signal. SPI data shall be sent in byte format, with most significant bit (MSB) first.

SPI_MISO: controller-to-host transfer data line. When CSN is active, the controller generates data on the negative edge and sample data on the positive edge of SPI_SCK signal. When CSN is inactive, the controller sets this output in tri-state mode. SPI data is sent in byte format, with most significant bit (MSB) first.

IRQ: interrupt request. This signal is set by the controller when an event needs to be sent to the host. This signal is active high.

The CMM-9301-V4.4 module follows a proprietary flow control over SPI, both from host to controller and from controller to host. Each SPI transaction shall be done for 8 bits of data.

Host-to-controller flow

When the host needs to communicate with the controller, the following flow shall be followed:

- 1) The host sets MOSI signal to '1'
- 2) The host shall activate CSN after 100ns
- 3) The host shall poll MISO line. The first polling shall be done at least 100 ns after CSN is activated.
- 4) If MISO = '0' then the controller reception buffer is full and the host is not allowed to start the transaction.
- 5) If MISO = '1' then the controller reception buffer is not full and the host can start the transaction. After each set of 8 rising edge of SPI_SCK, the host shall poll MISO line to check whether the controller reception buffer is not full. The first polling can be done on the first SPI_SCK falling edge.

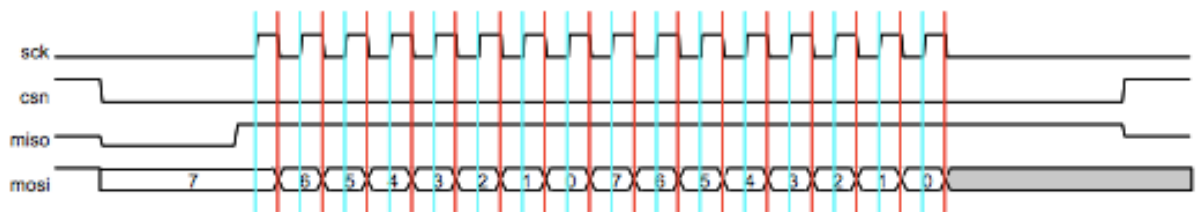


Figure 7.1 SPI writing transaction, with a wait state at start of the transaction

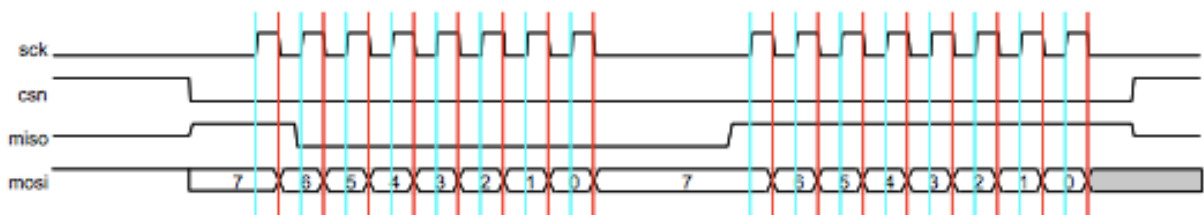


Figure 7.2 SPI writing transaction with a wait state after the first byte received

Controller-to-host flow

When the controller needs to communicate with the host, the following flow is followed:

- 1) The controller sets IRQ line to '1'. This means that the controller has at least 1 byte of data to transmit.
- 2) The host shall pull down MOSI signal.
- 3) The host shall activate CSN and after 100 ns
- 4) The host starts a SPI transaction by sending a data byte equal to 0x00
- 5) The host reads data sent by the controller on MISO line.
- 6) If IRQ is set to '0' during an SPI transaction then the controller has no other data to transmit. Once all bit of the transaction are read, the host can stop sending a clock
- 7) If EM9301 is in the Xtreme Power Mode, multi-transactions cannot be used and the host can read only one byte. If there are more bits to read, CSN has to be deactivated and activated again after reading one byte.

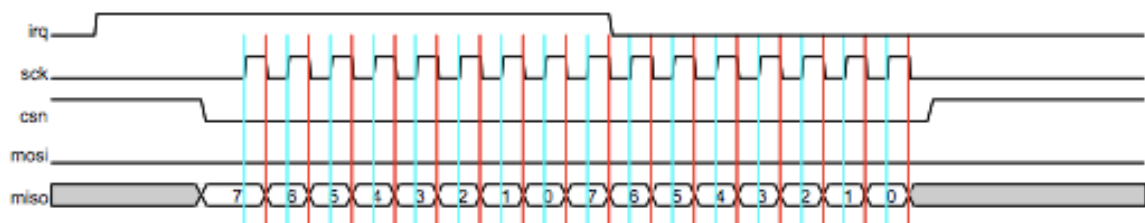


Figure 7.3 SPI read transaction with an empty buffer after the second byte

CMM-9301-V4.4

Bluetooth Low Energy HCI Module



1.4 HCI commands

The HCI commands provide access and control to various capabilities of the Link Layer of the EM9301 controller on the module as defined in Volume 2 of the Bluetooth Specification 4.0. The list of supported HCI commands are as follows:

HCI command name	OGF	OCF	OpCode	Notes
Set Event Mask	0x03	0x001	0x0C01	
Reset	0x03	0x003	0x0C03	
Read Local Version Information	0x04	0x001	0x1001	
Read Local Supported Commands	0x04	0x002	0x1002	
Read Local Supported Features	0x04	0x003	0x1003	
Read BD_ADDR	0x04	0x009	0x1009	
LE Set Event Mask	0x08	0x001	0x2001	
LE Read Buffer Size	0x08	0x002	0x2002	
LE Read Local Supported Features	0x08	0x003	0x2003	
LE Set Random Address	0x08	0x005	0x2005	
LE Read Supported States	0x08	0x01C	0x201C	
LE Read White List Size	0x08	0x00F	0x200F	
LE Clear White List	0x08	0x010	0x2010	
LE Add Device To White List	0x08	0x011	0x2011	
LE Remove Device From White List	0x08	0x012	0x2012	
LE Set Advertising Parameters	0x08	0x006	0x2006	
LE Set Advertising Data	0x08	0x008	0x2008	
LE Set Scan Response Data	0x08	0x009	0x2009	
LE Set Advertise Enable	0x08	0x00A	0x200A	c
LE Read Advertising Channel TX Power	0x08	0x007	0x2007	
LE Set Scan Parameters	0x08	0x00B	0x200B	
LE Set Scan Enable	0x08	0x00C	0x200C	c
LE Create Connection	0x08	0x00D	0x200D	c
LE Create Connection Cancel	0x08	0x00E	0x200E	
Disconnect	0x01	0x006	0x0406	
LE Connection Update	0x08	0x003	0x2013	
LE Set Host Channel Classification	0x08	0x014	0x2014	
LE Read Channel Map	0x08	0x015	0x2015	
LE Read Remote Used Features	0x08	0x016	0x2016	
Read Transmit Power Level	0x03	0x02D	0x0C2D	
Read Remote Version Information	0x01	0x01D	0x041D	
Read RSSI	0x05	0x0005	0x1405	a
LE Encrypt	0x08	0x017	0x2017	
LE Rand	0x08	0x018	0x2018	
LE Start Encryption	0x08	0x019	0x2019	
LE Long Term Key Request Reply	0x08	0x01A	0x201A	
LE Long Term Key Request Negative Reply	0x08	0x01B	0x201B	
LE Receiver Test	0x08	0x01D	0x201D	c
LE Transmitter Test	0x08	0x01E	0x201E	c
LE Test End	0x08	0x01F	0x201F	

For details of the HCI commands, please refer to the Bluetooth Specification Version 4.0.

CMM-9301-V4.4

Bluetooth Low Energy HCI Module



In addition, vendor specific HCI commands are also usable for the control and monitor of EM9301 chip specific features:

HCI command	OGF	OCF	OpCode	Notes
EM_WRITE_DATA	0x3F	0x000	0XFC00	
EM_Go to page 40	0x3F	0x001	0XFC01	
EM_SET_PUBLIC_ADDRESS	0x3F	0x002	0XFC02	
EM_SET_OPERATING_STATE	0x3F	0x003	0XFC03	
EM_SVLD	0x3F	0x004	0XFC04	
EM_SET_RF_POWER_LEVEL	0x3F	0x005	0XFC05	
EM_POWER_MODE_CONFIGURATION	0x3F	0x006	0XFC06	
EM_SET_UART_BAUD_RATE	0x3F	0x007	0XFC07	
EM_SET_DCDC_VOLTAGE	0x3F	0x008	0XFC08	
EM_BLE_IDLE_LEAVE	0x3F	0x009	0XFC09	b
EM_SET_RF_ACTIVITY	0x3F	0x00A	0XFC0A	b
EM_SET_XTAL_STARTUP_TIME	0x3F	0x00B	0XFC0B	b
EM_SET_RF_AUTOCAL_CONFIG	0x3F	0x00C	0XFC0C	b
EM_SET_RF_INITIALIZATION_CONFIG	0x3F	0x00D	0XFC0D	b,c
EM_READ_RF_CALIBRATION_VALUES	0x3F	0x00E	0XFC0E	b
EM_WRITE_RF_CALIBRATION_VALUES	0x3F	0x00F	0XFC0F	b
EM_SET_BLE_IDLE_PARAMETERS	0x3F	0x010	0XFC10	b
EM_TRANSMITTER_TEST	0x3F	0x011	0XFC11	b,c
EM_TRANSMITTER_TEST_END	0x3F	0x012	0XFC12	b

Table 7.4 Vendor specific HCI commands

Notes :

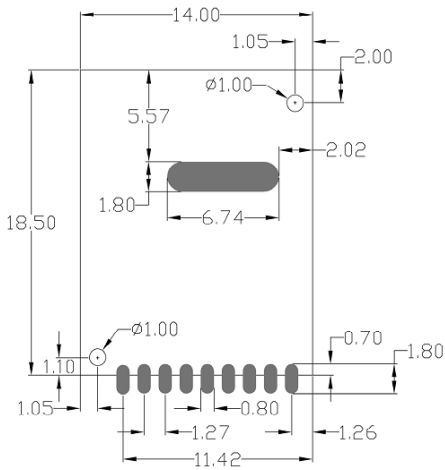
- a) Typical RSSI accuracy is ± 8 dB
- b) Only supported by EM9301 noDCDC version 022
- c) During starting BLE activity or RF calibration HCI commands should not be queued. In other words next HCI command can be sent only if previous was completely proceeded (Command Complete/Status event was received for previously sent HCI command). This is only valid for EM9301 noDCDC version 022.

CMM-9301-V4.4 Bluetooth Low Energy HCI Module

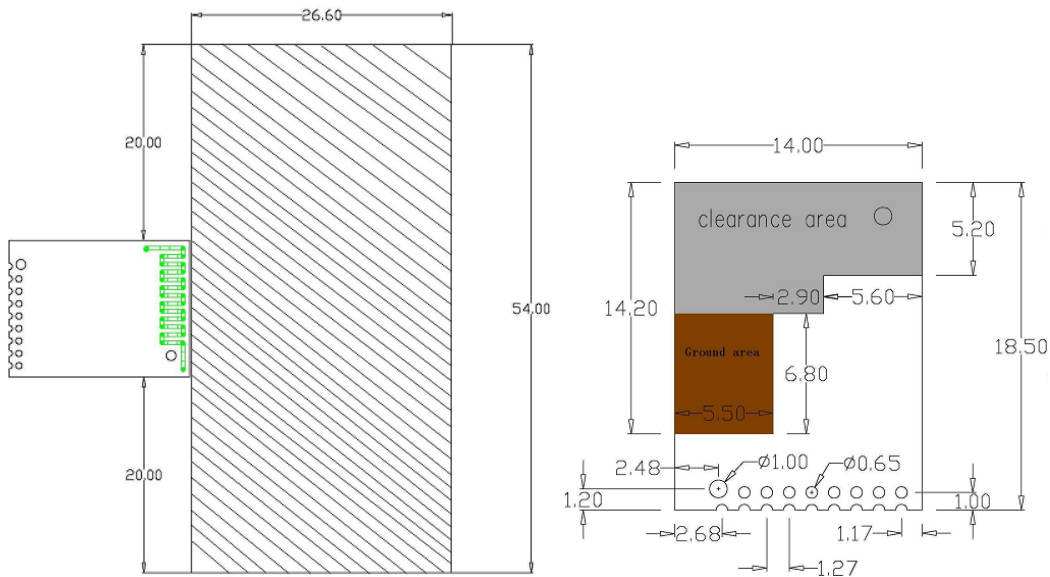


1.5 Recommended PCB layout and foot print

Footprint on main PCB for module connection



Recommended PCB layout



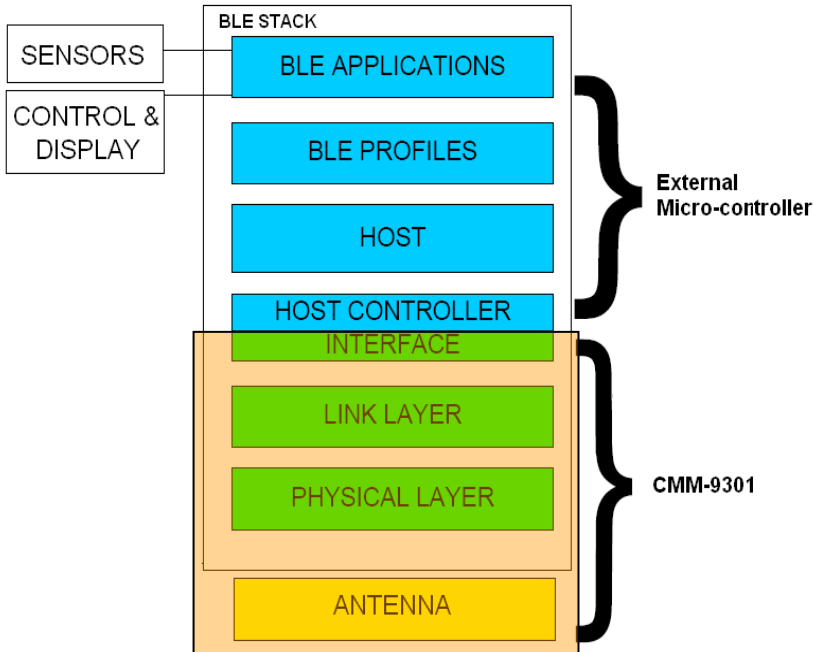
- Keep metal away from the shaded area
- Units are in mm.
- Ground plane recommended under module in Ground Area
- Keep metal away from the clearance area
- Units are in mm

CMM-9301-V4.4 Bluetooth Low Energy HCI Module



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1.6 BLE Application Reference Block Diagram



2. Module Electrical Specifications

Specifications	CMM-9301-V4.4
Bluetooth Version	Bluetooth 4.0
Input Voltage Range	2.3V to 3.6V
Frequency Range	2.400 to 2.484 GHz
Modulation	GFSK
On-air data rate	1Mbps
RF channels	40
Current Consumption (Vcc = 2.5V)	
- Off mode (RESET = HI)	1 uA typ.
- Active mode (RX)	12.9 mA typ.
- Active mode (TX at 0 dBm)	12.1 mA typ.
Operating Temperature Range	- 20 to + 60 degrees C
Operating Humidity	30% ~ 90%
Storage Temperature Range	- 40 to + 85 degrees C
Storage Humidity	30% ~ 90%

Note : For more detailed timing and electrical characteristics, please contact C-MAX Asia Ltd for EM9301 updated datasheet.

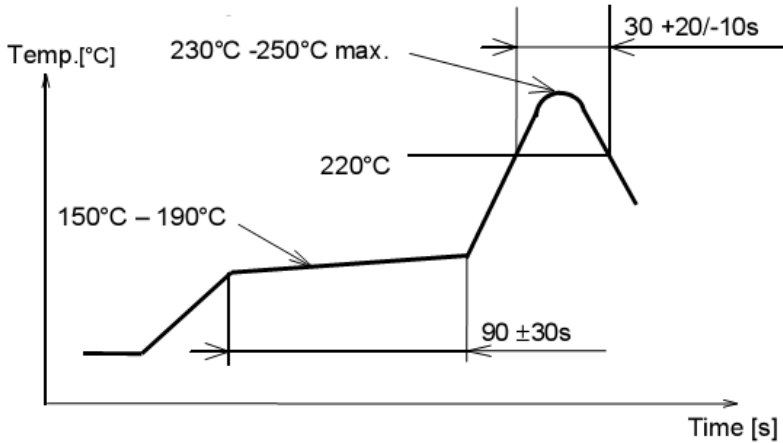
SPEC No.	Revision	State	C-MAX printed	Version	Page
CMM-9301-V4.4 BLE HCI module	3.4	2017-06-30	2017-07-03	English	8 of 16

CMM-9301-V4.4 Bluetooth Low Energy HCI Module



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3. Temperature Profile for Lead-free Reflow Soldering

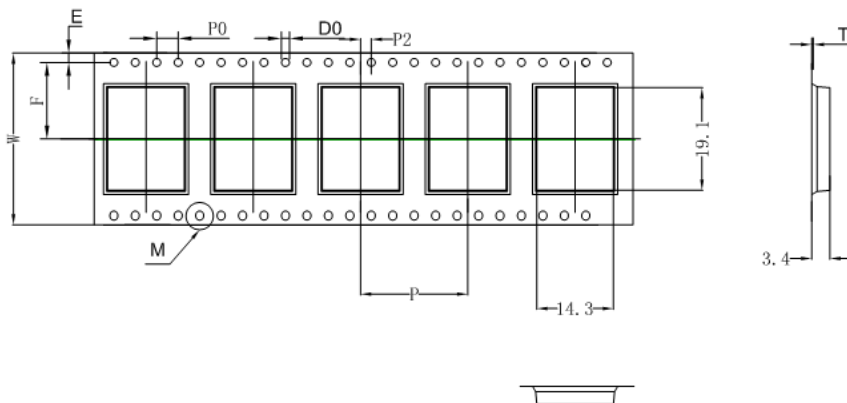


4. Ordering Information

CMM-9301-V4.4F	Shielded, no pin connectors	18.5 x 14	2.3 ~ 3.6
CMM-9301-V4.4X	Shielded, with pin connectors	18.5 x 14	2.3 ~ 3.6

5. Packaging Information

CMM-9301-V4.4F - Tape and Reel



Item	D ₀	D ₁	P ₀	P ₂	E	W	A ₀	A ₁
Dimension	1.50 +0.10-0.00	0.00 +0.00-0.00	4.00 +0.10-0.10	2.00 +0.10-0.10	1.75 +0.10-0.10	32.0 +0.30-0.30	14.3 +0.10-0.10	0.00 +0.10-0.10

Item	B ₀	B ₁	K ₀	K ₁	P	F	T
Dimension	19.1 +0.10-0.10	0.00 +0.00-0.00	3.40 +0.10-0.10	0.00 +0.10-0.10	20.0 +0.10-0.10	14.2 +0.10-0.10	0.30 +0.05-0.05



6. FCC Statement

The module is limited to OEM installation ONLY.

The module is limited to installation in mobile or fixed application.

We hereby acknowledge our responsibility to provide guidance to the host manufacturer in the event that they require assistance for ensuring compliance with the Part 15 Subpart B requirements

NOTICE: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications made to this equipment not expressly approved by CMA Industrial Development Foundation Limited may void the FCC authorization to operate this equipment.

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

Radio frequency radiation exposure information:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. Please see the RF Exposure information. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

This device should be installed and operated with a minimum distance of 20cm between the antenna and all persons.

Label requirements:

Contains: FCC ID: 2ABBXCM9301V442017

CMM-9301-V4.4 Bluetooth Low Energy HCI Module



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FCC RF Exposure Requirement:

- At least 20cm separation distance between the antenna and the user's body must be maintained at all times. And must not transmit simultaneously with any other antenna or transmitter, except in accordance with FCC multi transmitter product procedures.
- To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, the maximum antenna gain including cable loss in a mobile-only exposure condition must not exceed 0dBi in the 2.4GHz band.
- A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

Note: If this module is intended for use in a portable device, you are responsible for separate approval to satisfy the SAR requirements of FCC Part 2.1093.

Please be noted that the following information and instructions should be placed in the end-user's operating manual.

The CMM-9301-V4.4 Module must be installed in the designated host as specified in this manual.

- Separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.
- The CMM-9301-V4.4 Module and its antenna must not be co-located or operating in conjunction with any other transmitter or antenna within a host device. This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment.
- A label must be affixed to the outside of the end product into which the CMM-9301-V4.4 Module is incorporated, with a statement similar to the following: For CMM-9301-V4.4: This device contains FCC ID: 2ABBXCM9301V442017.
- The module shall be in non-detachable construction protection into the finished products, so that the end-user has to destroy the module while remove or install it.
- This module is to be installed only in mobile or fixed applications. According to FCC part 2.1091(b) definition of mobile and fixed devices is:

Mobile Device:

A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. In this context, the term "fixed location" means that the device is physically secured at one location and is not able to be easily moved to another location.

SPEC No.	Revision	State	C-MAX printed	Version	Page
CMM-9301-V4.4 BLE HCI module	3.4	2017-06-30	2017-07-03	English	11 of 16



Portable Device:

For purposes of this section, a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.

- Separate approval is required for all other operating configurations, including portable configurations with respect to FCC Part 2.1093 and different antenna configurations.
- A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID: 2ABBXCM9301V442017. The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required.
- For a host using this FCC certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: "Contains: FCC ID : 2ABBXCM9301V442017" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.
- Host product is required to comply with all applicable FCC equipment authorizations regulations, requirements and equipment functions not associated with the transmitter module portion, compliance must be demonstrated to regulations for other transmitter components within the host product; to requirements for unintentional radiators (Part 15B). To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. If a host was previously authorized as an unintentional radiator under the Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements. Since this may depend on the details of how the module is integrated with the host, we suggest the host device to recertify part 15B to ensure complete compliance with FCC requirement: Part 2, Subpart J, Equipment Authorization Procedures, KDB784748 D01 v07, and KDB 997198 about importation of radio frequency devices into the United States.

OEM RESPONSIBILITIES TO COMPLY WITH FCC REGULATIONS

The CMM-9301-V4.4 Module has been certified for integration into products only by OEM integrators under the following conditions: This device is granted for use in Mobile only configurations in which the antennas used for this transmitter must be installed to provide a separation distance of at least 20 centimeters from all persons and not be co-located with any other transmitters except in accordance with FCC and Industry Canada multi-transmitter product procedures.

As long as the two 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 (for example, digital device emissions, PC peripheral requirements, etc.).

SPEC No.	Revision	State	C-MAX printed	Version	Page
CMM-9301-V4.4 BLE HCI module	3.4	2017-06-30	2017-07-03	English	12 of 16

CMM-9301-V4.4 Bluetooth Low Energy HCI Module



IMPORTANT NOTE:

In the event that these conditions cannot be met (for certain configurations or co-location with another transmitter), then the FCC and Industry Canada authorizations are no longer considered valid and the FCC ID and IC Certification Number 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 and Industry Canada authorization.

OEM LABELING REQUIREMENTS FOR END-PRODUCT

The CMM-9301-V4.4 module is labeled with its own FCC ID Certification Number. The FCC ID certification numbers are not visible when the module is installed inside another device, as such the end device into which the module is installed must display a label referring to the enclosed module. The final end product must be labeled in a visible area with the following: "Contains: FCC ID: 2ABBXCM9301V442017".

The OEM of the CMM-9301-V4.4 Module must only use the approved antenna(s) listed above, which have been certified with this module. The device carries FCC authorization and is marked with the FCC ID Number. Whilst any device into which this authorized module is installed will not normally be required to obtain FCC authorization, this does not preclude the possibility that some other form of authorization or testing may be required for the finished device.

OEM END PRODUCT USER MANUAL STATEMENTS

The OEM integrator should not provide information to the end user regarding how to install or remove this RF module or change RF related parameters in the user manual of the end product.

If this module is intended for use in a portable device, you are responsible for separate approval to satisfy the SAR requirements of FCC Part 2.1093.

The user manual for the end product must include the following information in a prominent location:

This device is granted for use in mobile only configurations in which the antennas used for this transmitter must be installed to provide a separation distance of at least 20 centimeters from all persons and not be co-located with any other transmitters except in accordance with FCC and Industry Canada multi-transmitter product procedures.

The end product with an embedded FCC ID: 2ABBXCM9301V442017 Module may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

SPEC No.	Revision	State	C-MAX printed	Version	Page
CMM-9301-V4.4 BLE HCI module	3.4	2017-06-30	2017-07-03	English	13 of 16

The labeling instructions of finished products refer to following requirements:

A certified module has the option to use a permanently affixed label, or an electronic label (see Electronic Labeling below). For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see Certification labeling requirements above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).

For a host using a certified module with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straight forward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: "Contains FCC ID: 2ABBXCM9301V442014" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

Other user manual statements may apply.

7. RED Statement

Hereby, C-MAX Asia Limited declares that this CMM-9301-V4.4 is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU.

DECLARATION OF CONFORMITY

Bluetooth Module Model No. CMM-9301-V4.4

Rating : 1 x 3V button cell

Is in compliance with the following standard(s) or specification(s) according to

RE Directive 2014/53/EU

EN300 328 (V2.1.1 2016-11)

EN301 489-1 (V2.2.0 2017-03)

EN301 489-17 (V3.2.0 2017-03)

EN62479:2010

8. Japan MIC wireless certification

Certificate

No: 16-210647

of
Technical Regulations Conformity
for
Specified Radio Equipment in Japan

PHOENIX TESTLAB GmbH, operating as a Registered Certification Body (RCB ID: 204) with respect to Japan, declares that the listed product complies with the Technical Regulations Conformity Certification of Specified Radio Equipment (ordinance of MPT N°. 37, 1981), Article 2, Paragraph 1, Item 19.

Product description: **Bluetooth Low Energy HCI Module**
Trademark / Model name: **C-MAX /CMM-9301-V4.4**
Family name: --
Serial No: --
Software Release No: --
Type of emissions: **F1D**
Frequency and power: **BT (LE): 2402 - 2480 MHz; 40 ch; 2.0 mW**

Manufacturer: **C-MAX Asia Limited**
Address: **Room 117, 1/F
Liven House
61-63 KingYip Street
Kwun Tong**
City: **Hongkong**
Country: **China**

This certificate is granted to:

Certificate holder: **C-MAX Asia Limited**
Address: **Room 117, 1/F
Liven House
61-63 KingYip Street
Kwun Tong**
City: **Hongkong**
Country: **China**

- The validity of this certificate is limited to products, which are equal to the one examined in the type-examination.
- When the holder of this certificate is placing the product on the Japanese market, the product must be affixed with the following Specified Radio Equipment marking:



204-640002

CMM-9301-V4.4 Bluetooth Low Energy HCI Module



C-MAX

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SPEC No.	Revision	State	C-MAX printed	Version	Page
CMM-9301-V4.4 BLE HCI module	3.4	2017-06-30	2017-07-03	English	16 of 16