CMM-9304-V2.1
Bluetooth 4.2/5.0 compatible module

C-MAX

This Module is limited to OEM installation ONLY

1.0 Description

The CMM-9304-V2.1 module is a miniaturised Bluetooth® Low Energy module based on EM Microelectronic's low power fully integrated Bluetooth® low energy single-chip EM9304. Built in with a highly efficient PCB antenna, this small sized, low cost module boasts one of the best power consumption characteristics combined with outstanding Bluetooth Low Energy performances.

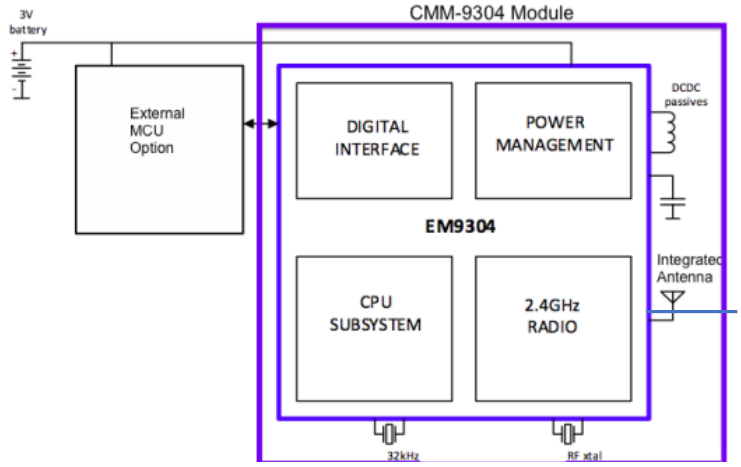
The flexible architecture of the EM9304 allows it to act as a companion IC to any ASIC or MCU-based product, or as a complete System-on-Chip (SoC).

The module offers various possibilities of control via a simple SPI/UART interface: Host Controller Interface (HCI) with the internal Bluetooth® v5.0 link layer; proprietary Application Controller Interface (ACI) with the in-built Bluetooth® v4.2 stack, several profiles, and over-the-air firmware (FOTA) updating routines.

1.1 Features

- Utilize EM Microelectronic's Bluetooth® 5.0 subsystem qualified (QDID 93999) EM9304 chip
- Concurrent Master and Slave roles BLE compliant to Bluetooth® 5.0 specification
- Embedded Bluetooth® 4.2 stack and profiles, low-power Bluetooth® 5.0 physical layer, Link Layer with security engine, and a Host Controller Interface (HCI)
- Low average current consumption
  - 3.0 mA typical peak receiver current (3V powered)
  - 5.2 mA typical peak transmitter current at 0.4 dBm (3V powered)
  - 1.0 uA connect sleep mode current (3V powered)
  - 0.005 uA disable mode current (3V powered)
- High sensitivity : -93dBm Bluetooth low energy receiver sensitivity for 255 bytes PDU
- Small-sized (14.0mm x 17.0mm)
- Integrated Antenna on module, with external antenna connection option
- Wide range programmable RF output (-34 to +6.1 dBm) for current consumption optimization.
- No Tuning necessary
- SPI interface/UART interface to external micro-controller

1.2 Block Diagram



1.2.1 Typical Module Pin Assignment

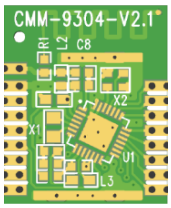
SPI Slave Mode configuration

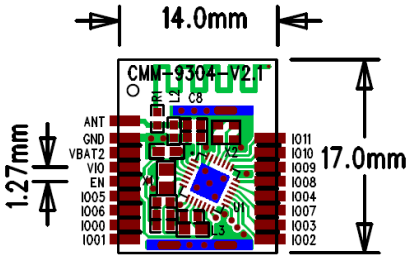
Module Pin Number	Module Pin Name	Input / Output relative to module	Pin Description
1	ANT	I	RF single ended antenna connection pin (50 ohm)
2	GND	GND	Ground Connection
3	VBAT	Supply	VCC Voltage Supply
4	VIO	Supply	GPIO Voltage Level
5	EN	I	Chip Enable (Active HI)
6	TM / GPIO5	I/O	RESET(Active Low)/Logic Input/output
7	URX / GPIO6	O	UART Data in/ Logic Input/output
8	CSN / GPIO0	I	SPI Chip Select (Negated)
9	SCK / GPIO1	I	SPI Clock Input
10	MISO / GPIO2	I/O	SPI Data Out
11	MOSI / GPIO3	I/O	SPI Data In
12	UTX / GPIO7	O	UART Data Out/ Logic Input/output
13	RDY / GPIO4	O	SPI Ready signal
14	TCK / GPIO8	I/O	JTAG/ Logic Input/output
15	TDO / GPIO9	I/O	JTAG/ Logic Input/output
16	TDI / GPIO10	I/O	JTAG/ Logic Input/output
17	TMS / GPIO11	I/O	JTAG/ Logic Input/output

This module can also be configured into other configuration modes and the pins will be converted to different definitions as the following table

Peripheral	Function	GPIO0	GPIO1	GPIO2	GPIO3	GPIO4	GPIO5	GPIO6	GPIO7	GPIO8	GPIO9	GPIO10	GPIO11
SPI Slave	CSN_S	IN	0	0	0	IN	0	0	0	0	IN	0	IN
SPI Slave	SCK_S	0	IN	0	0	0	0	0	IN	0	0	0	0
SPI Slave	MISO_S	0	0	OUT	OUT	0	0	0	0	0	OUT	OUT	0
SPI Slave	MOSI_S	0	0	IN	IN	0	0	0	0	0	IN	IN	0
SPI Slave	RDY	0	OUT	0	0	OUT	0	OUT	OUT	0	0	0	0
UART	Rx	IN	IN	IN	IN	IN	0	IN	0	0	0	0	0
UART	Tx	OUT	OUT	OUT	OUT	0	0	0	OUT	OUT	0	0	0
UART	nCTS	0	IN	IN	IN	IN	0	0	0	IN	IN	IN	0
UART	nRTS	OUT	OUT	OUT	OUT	0	0	0	OUT	0	0	OUT	0
SPI Master	SCK_M	0	OUT	0	0	OUT	0	0	OUT	0	OUT	OUT	0
SPI Master	MISO_M	0	0	IN	IN	0	0	0	0	0	IN	IN	0
SPI Master	MOSI_M	0	0	OUT	OUT	0	0	0	0	OUT	0	OUT	OUT
I2C Master	SCL	INOUT	0	0	0	INOUT	0	INOUT	0	0	INOUT	0	0
I2C Master	SDA	0	INOUT	0	0	0	INOUT	INOUT	INOUT	INOUT	0	0	0
SW	RF_Activity	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT
RF	PA_Enable	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT
GPIO	GPIO	INOUT	INOUT	INOUT	INOUT	INOUT	INOUT_PD	INOUT	INOUT	INOUT	INOUT	INOUT	INOUT
Timer2	Start/Stop	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN
Timer3	Start/Stop	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN
Timer2	Capture	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN
Timer3	Capture	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN
Timer2	Clock	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN
Timer3	Clock	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN
Timer2	Output	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT
Timer3	Output	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT
PML	Mode	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT	OUT
JTAG	TMS	0	0	0	0	0	0	0	0	0	0	0	IN
JTAG	TDI	0	0	0	0	0	0	0	0	0	0	IN	0
JTAG	TDO	0	0	0	0	0	0	0	0	0	OUT	0	0
JTAG	TCK	0	0	0	0	0	0	0	0	IN	0	0	0

1.2.2 Module Dimensions and Pinnings





Module Thickness (excluding pin header connectors, including shielding) = 2.8 mm max.

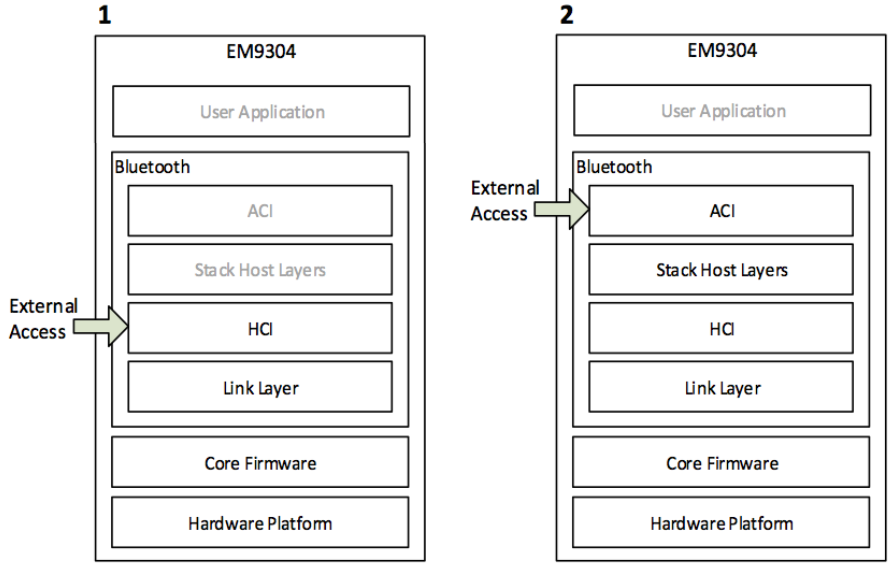
1.3 Controller and Companion Modes of Operation

Module as Controller (1 in figure below)

The CMM-9304 module can be used with an external host where the user application and the host layers of the stack reside in the external processor or host controller. Interaction with the module occurs through the standard HCI commands (defined in the Bluetooth Core Specifications, volume 2, part E) and vendor specific HCI commands via the SPI/UART interface detailed in section 3 below.

Module as Companion (2 in figure below)

The CMM-9304 module can be used with an external host where the user application resides in the external host, and the stack resides in the EM9304. Interaction with the module occurs through proprietary ACI commands via the SPI/UART interface.



2. SPI Slave Interface

The CMM-9304 module has a Slave SPI to be used for the HCI (or ACI) transport layer.

2.1 SPI Slave Features

The SPI slave block supports following features:

- 4 wire SPI interface (SCK, CSN, MISO, MOSI) with flow control (RDY output signal).
- Half duplex communication. Direction (write/read) is determined by a control byte
- Supported SPI clock speed up to 16MHz.
- Motorola compliant, clock polarity CPOL = 0 (clock is inactive low), clock phase CPHA = 0 (data is valid on clock rising edge).
- All 4 SPI clock polarity/phase configurations.
- 64 bytes long RX FIFO for reception and 64 bytes long TX FIFO for transmission.
- Multi byte transactions (without de-asserting CSN between bytes)

2.2 SPI Slave RDY signal

RDY signal has following meaning depending on SPI transaction phase:

1. Data ready (when CSN = '1')

- RDY at '1' ➔ SPI Slave has some data to send.
- RDY at '0' ➔ SPI Slave has no data to send.

2. SPI ready (between CSN falling edge and end of 1st header byte)

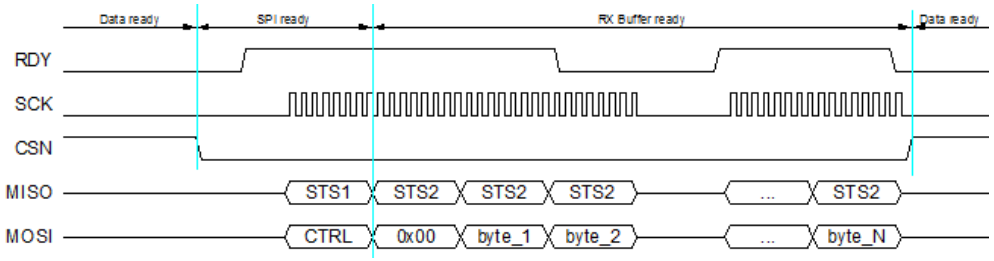
- RDY at '1' ➔ SPI Slave is ready and SPI transaction can start, SPI Master can transmit another byte.
- RDY at '0' ➔ SPI Slave is not ready and SPI transaction cannot start. SPI master has to wait until RDY is at '1'.

3. Buffer ready (between end of 1st header byte and CSN rising edge)

- RDY at '1' ➔buffer is ready and byte can be written/read

- RDY at '0' ➔buffer is not ready and byte cannot be written/read. SPI master has to wait until RDY is at '1'. After asserting CSN and before sending first byte SPI Master checks if RDY is at '1'. This check shall be done at least T_RDY (100ns) after asserting CSN. If RDY is at '1' SPI transaction can start, if RDY is at '0' SPI master has to wait until RDY is at '1'.

An example of write transaction using RDY as a flow control during transaction is shows in Figure 1.



- *Figure 1: SPI Slave write transaction with active flow control by means of RDY.*

2.3 Flow Control using Byte count in Status Byte STS2

A Master with DMA, using the status byte STS2, can run an SPI transaction without interruptions. In this case SPI Master can ignore RDY during the SPI transaction and use instead the status byte STS2 to determine the maximum length of the SPI transaction. Once maximum length of SPI transaction is known (from STS2), the SPI Master can configure the DMA to realize the rest of the SPI transaction. After transmitting the given number of bytes (less than or equal to maximum length determined from STS2) SPI transaction shall be finished by de-asserting CSN. A new SPI transaction shall start by asserting CSN and reading status bytes to determine maximum length of this new transaction. Examples of transactions ignoring RDY are shown in Figure 2 and in Figure 3.

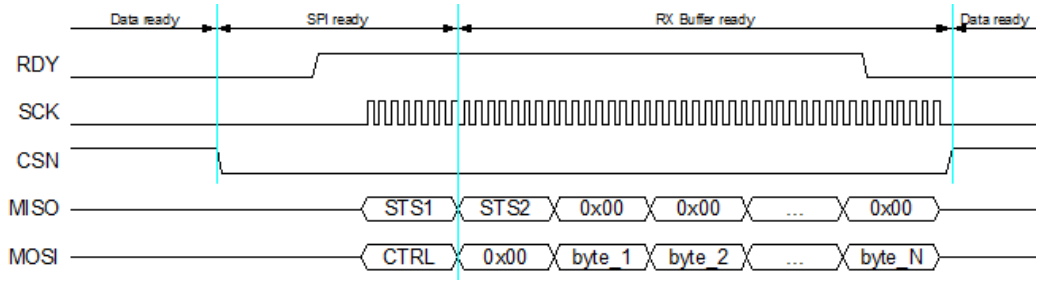


Figure 2: SPI Slave Write Transaction.

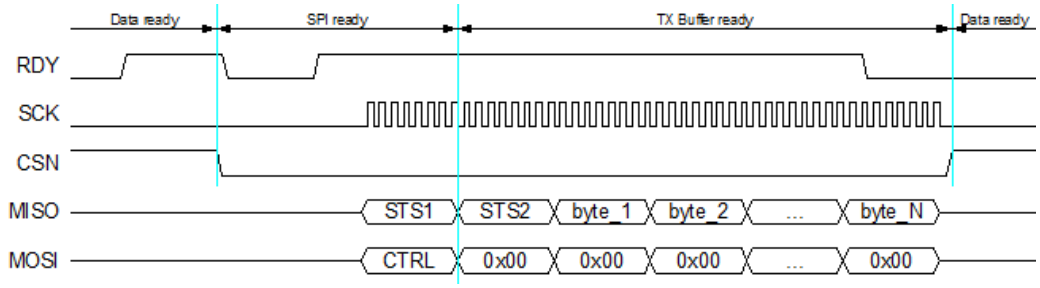


Figure 3: SPI Slave Read Transaction.

2.4 SPI Slave Operation

Start of the SPI transaction is as follows:

1. The SPI Master asserts CSN to '0',
2. Waits until RDY is at '1'
3. Sends 2 header bytes
4. Reads the status bytes STS1 and STS2.

The status byte STS1 on MISO indicates general status of device. The status byte STS2 on MISO indicates buffer capacity and it depends on read or write transaction. In case of write transaction STS2 contains the number of bytes which can be written into Slave RX buffer. In case of read transaction STS2 contains the number of bytes which can be read from Slave TX buffer.

After receiving header bytes (STS1 and STS2), the SPI Master knows how many bytes can be transferred via SPI in the current transaction (read or write) and the rest of SPI transaction is standard.

The control byte (CTRL) sent on MOSI defines type of transaction (read or write). The second byte on MOSI is dummy to align with read status data from the Slave and reads 0x00.

The type of transaction (read or write) in half duplex mode is defined by CTRL, the 1st byte sent by the Master:

- CTRL = 0x81 for a read transaction.
- CTRL = 0x42 for a write transaction.

The STS1 byte contains the status of the SPI slave.

- STS1 = 0xC0 when slave is ready.

The STS2 byte contains the maximum number of bytes which can be written into RX FIFO without RX FIFO overflow during a write transaction, or the maximum number of bytes which can be read from TX FIFO without TX FIFO underflow during a read transaction.

An SPI transaction can be terminated by the SPI Master at any time. The SPI Master can send only a header in order to get the status of the RX/TX buffer and then stop the SPI transaction.

3. HCI commands

The HCI commands provide access and control to various capabilities of the Link Layer of the EM9304 controller on the module as defined in the Bluetooth Core Specifications, volume 2, part E. For details of the standard Bluetooth HCI commands, please refer to the Bluetooth Specification Version 5.0.

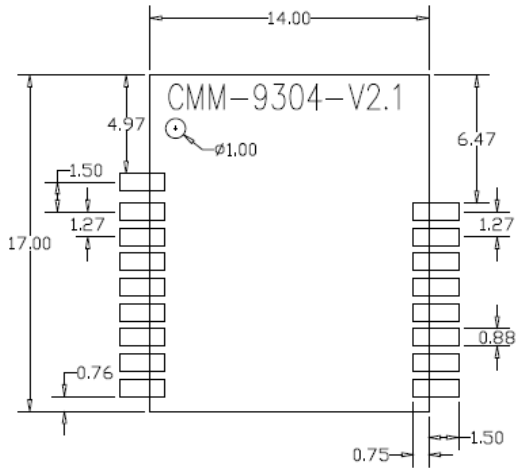
In addition, vendor specific HCI commands are also usable for the control and monitor of EM9304 chip specific features

HCI Command	OGF	OCF	Opcode	PTM Support
EM_SetPublicAddress	0x3F	0x002	0xFC02	No
EM_SetUartBaudRate	0x3F	0x007	0xFC07	No
EM_TransmitterTest	0x3F	0x011	0xFC11	No
EM_TransmitterTestEnd	0x3F	0x012	0xFC12	No
EM_ReadAtAddress	0x3F	0x020	0xFC20	Yes
EM_ReadContinue	0x3F	0x021	0xFC21	Yes
EM_WriteAtAddress	0x3F	0x022	0xFC22	Yes
EM_WriteContinue	0x3F	0x023	0xFC23	Yes
EM_SetPowerModeEx	0x3F	0x024	0xFC24	Yes
EM_SetRfActivitySignalEx	0x3F	0x025	0XFC25	Yes
EM_SetRfPowerLevelEx	0x3F	0x026	0xFC26	No
EM_WritePatchStart	0x3F	0x027	0xFC27	Yes
EM_WritePatchContinue	0x3F	0x028	0xFC28	Yes
EM_WritePatchAbort	0x3F	0x029	0xFC29	Yes
EM_SetClockSource	0x3F	0x02A	0xFC2A	Yes
EM_SetMemoryMode	0x3F	0x02B	0xFC2B	Yes
EM_GetMemoryUsage	0x3F	0x02C	0xFC2C	Yes
EM_SetSleepOptions	0x3F	0x02C	0xFC2D	Yes
EM_SvldMeasurement	0x3F	0x02C	0xFC2E	Yes
EM_SetEventMask	0x3F	0x0A7	0xFC2F	Yes
EM_CalculateCrc32Ex	0x3F	0x0A1	0xFCA1	Yes

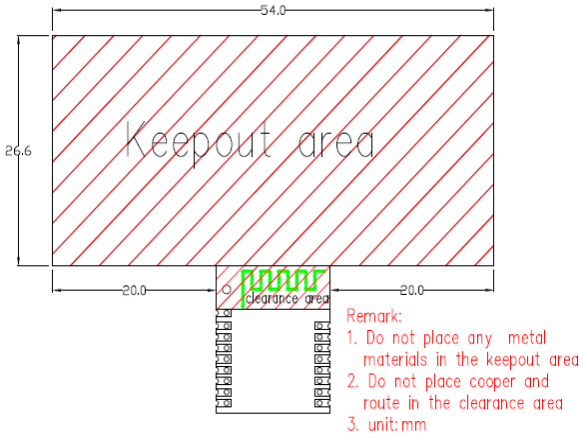
For details of description of EM Vendor specific commands, please refer to EM9304 datasheet.

4. Recommended PCB layout and foot print

Footprint on main PCB for module connection



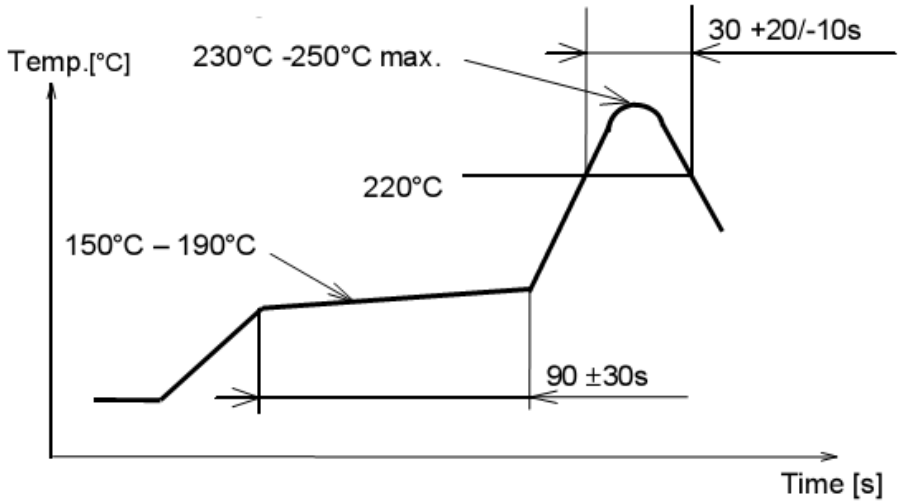
Recommended PCB layout



5. Key Module Electrical Specifications

Specifications	CMM-9304-V2.1
Bluetooth Version	Bluetooth® 5.0 (HCI, LL, PHY), 4.2 (stack)
Input Voltage Range	1.9 V to 3.6V
Frequency Range	2.400 to 2.484 GHz
Modulation	GFSK
On-air data rate	1Mbps
RF channels	40
RF Output Power	- 34 ~ + 6.1 dBm
RF Input Impedance	50 ohms
RF Sensitivity (for 255 byte extended PDU)	-93dBm
Current Consumption (Vcc = 3.0V)	
- Off mode (Chip Disable)	0.005 uA typ.
- Connected Sleep mode (LC Xtal)	1 uA typ.
- Active mode (RX)	3.0 mA typ.
- Active mode (TX at 0.4 dBm)	5.2 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%

6. Temperature Profile for Lead-free Reflow Soldering



7. Ordering Information

Part Number	Shielding	Dimensions (in mm)	DC-DC	Power supply range (in V)	With pin connectors?
CMM-9304-V2.1S	Shielded	14.0 x 17.0	Step-down configuration	1.9 ~ 3.6	No
CMM-9304-V2.1SP	Shielded	14.0 x 17.0	Step-down configuration	1.9 ~ 3.6	Yes

8. Packaging Information

In trays of 100 pcs per tray

9. FCC Warning Statement

FEDERAL COMMUNICATIONS 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 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.

9.1 Caution

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

9.2 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 minimum distance 20cm between the radiator & your body
This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter.

9.3. Important Note

The module is limited to OEM installation ONLY
1. 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.
2. The host manufacturer is responsible for additional testing to verify compliance as a composite system. When testing the host device for compliance with the Part 15 Subpart B requirements, the host manufacturer is required to show compliance with the Part 15 Subpart B while the transmitter module(s) are installed and operating. The modules should be transmitting and the evaluation should confirm that the module's intentional emissions are compliant (i.e. fundamental and out of band emissions) with the Radio essential requirements. The host manufacturer must verify that there are no additional unintentional emissions other than what is permitted in the Part 15 Subpart B or emissions are complaint with the Radio aspects.

This module is intended for OEM integrator. The OEM integrator is still responsible for
1. ensuring that the end-user has no manual instructions to remove or install module
2. the FCC compliance requirement of the end product, which integrates this module.
3. Appropriate measurements(e.g. 15 B compliance) and if applicable additional equipment authorizations (e.g. Verification, Doc) of the host device to be addressed by the integrator/manufacturer.
4. The separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations
5. 20cm minimum distance has to be able to be maintained between the antenna and the users for the host this module is integrated into. Under such configuration, the FCC radiation exposure limits set forth for an population/uncontrolled environment can be satisfied.
6. Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.
7. That module is limited to installation in mobile or fixed applications, according to Part 2.1091(b)
8. The maximum antenna gain required for authorized antennas per Part15. 204 (including ant. spec.)

The user manual of the end product should include
In the users 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 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. If the size of the end product is smaller than the palm of the hand, then additional FCC part 15.19 statement is required to be available in the users manual: 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.

10. RED Statement

This device is pending for compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU

Disclaimer of Warranty

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Note

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C-MAX reserves the right to make changes on this specification without notice at any time.

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