

GreenPeak Lime Product Description

The CM09 is a high-performance wireless module developed to provide the entire communications platform of high-end mesh networks. The CM09 has all necessary functions integrated in hardware and software to build large, robust wireless mesh networks.

The CM09 is offered in two different versions, the CM09CP, with on-board chip antenna, and the CM09XT, provided with a provision for attachment of an off-module antenna.

The features of the CM09 are aiming for at performance critical applications requiring reliable and long-range communication links. It also features a wide variety of practical input and output functions.

The CM09 is designed for SMD-mounting onto a host PCB. SMD-mounting provides the best RF performance at the lowest cost. Additionally the CM09 is designed to occupy minimal board space on the host PCB, which typically already includes sensor/actuator interfacing circuits as well as power conditioning circuits.

The CM09 operates in the 2.4 - 2.4835 GHz unlicensed, worldwide ISM band, and is certified to meet EN 300 328 (Europe) and FCC CFR47 Part 15 (US) standards.

Applications

- ▶ Safety and security
- ▶ Healthcare applications
- ▶ Asset management
- ▶ Building & home automation
- ▶ Industrial automation

Versions

The CM09 modules support ultra-low-power applications, in combination with long transmission range.

The **CM09CP** version features an on-module chip antenna. It is ideally suited for all multi purpose wireless mesh solutions.

The **CM09XT** version enables connecting the RF signal to an external antenna. Ideally suited for all multipurpose wireless mesh solutions that require specific, optimized antenna performance, such as increased directivity and/or extended ranges.



Radio Features

- ▶ **Radio:** IEEE 802.15.4 compliant, operating in 2.4GHz worldwide ISM band
- ▶ **Channels:** 16
- ▶ **Data rate:** 250 kbps (PHY layer)
- ▶ **Antenna:** chip antenna or external
- ▶ **Ultra-Low-Power:** nodes can operate for years without replacing batteries or can operate from conditioned outputs of energy harvesting devices
- ▶ **Long range:** extends range up to 100m indoors and 1km outdoors for a single link
- ▶ **Communication range** (in meters, typical and max) measured with on-board ceramic antenna:
In the presence of blocking objects, range may be shorter.

	Indoor	Outdoor	Line-of-sight
Range	40-100m	160-400m	1000m

Additional Hardware Features

- ▶ **Designed for low-power:** on-board power management, including low-frequency clock source, various power-down modes
- ▶ **Large amount of IO:** 32 digital and analogue IOs, including 8 channel 10 bit ADC, 2 UARTS, SPI, JTAG
- ▶ **Cost optimized compact surface-mounted module:** only 35.5 by 16.5 mm, occupies only a small board space, SMD technology eliminates expensive connectors
- ▶ **Robust and compact design:** the surface-mountable module design facilitates robust, sturdy and compact integration onto the mother board
- ▶ **Antenna flexibility:** available in 2 versions, with choice between a compact on-board chip antenna version or the version with optimized RF signal pads for connection to an external antenna
- ▶ **Switchable power amplifier - low power mode:** allows to reduce TX power consumption if there is no need for a power amplifier

Mesh Communication Features

PeakNet™ Embedded Communication Software

All CM09 modules can be configured with a choice of two different mesh network communication stacks: PeakNet™ Z or PeakNet™ LPR.

PeakNet™ Z

The features of this communication stack are:

- ▶ **Mesh network:** messages travel from source node to destination node through intermediate nodes thereby multiplying range as a function of number of hops. The multi-hop feature does not require any application intervention.
- ▶ **Self-forming:** mesh network forms automatically, without any application intervention
- ▶ **Self healing:** when individual links fail the mesh network reestablishes a reliable route autonomously
- ▶ **Security:** data transfer through message encryption (AES 128 bit)
- ▶ **Support for mobile nodes:** Nodes can physically move through the network without requiring network re-association
- ▶ **Support for ultra low power end devices:** Reduced functionality devices can operate for years without replacing batteries
- ▶ **Support for network visualization:** network topology can be visualized using the optional JadeMonitor PC software component
- ▶ **Robust against interference:** able to operate in the presence of other wireless devices such as Wi-Fi, Bluetooth and others
- ▶ **Scalability:** the network can scale up to 100s of nodes without reconfiguration

GreenPeak™ provides embedded API to interface with the PeakNet™Z communication stack

PeakNet™ Low Power Routing (LPR)

Instead of PeakNet™Z, the CM09 can be programmed with the PeakNet™ Low Power Routing communication stack as an option. PeakNet™ LPR is the industry's first and most advanced (patented) communications stack that supports mesh routing functionality with battery-operated, or even battery-less, devices. Differentiating features of this communication stack include:

- ▶ Mesh network: all devices are low power routers
- ▶ No distinction between RFDs and FFDs
- ▶ Low power: no line-powered devices are required
- ▶ All nodes can operate from batteries or energy harvesters
- ▶ Patented and smart power-up/power-down and synchronization techniques enable all mesh nodes to operate in a low-power mode

Complementary Products

In addition to industry leading modules, GreenPeak also offers a full suite of development tools to assist OEMs in designing systems using the CM09 and to build software commissioning tools for the installer or end-user.

Please take a look at www.greenpeak.com for additional information regarding:

- ▶ **Control Panel Builder:** easy to use software API exposing all network events (node association, change of inputs,...) to a control panel
- ▶ **Embedded Interface Builder:** use Standard Interface Objects or build your own to interface PeakNet™ seamlessly to your embedded application
- ▶ **JadeMonitor:** graphical tool showing real-time network status; can be included in any software application
- ▶ **JadeConfigurator:** configure your mesh network via a serial interface with a PC
- ▶ **JadeCreator:** configure and update your mesh network wirelessly
- ▶ **Energy Budget Calculator:** powerful tool that calculates the battery autonomy in applications based on the PeakNet™ low power solution

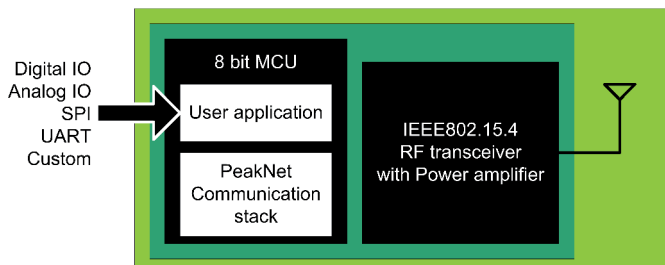
System Diagram

The module's hardware consists of an IEEE802.15.4 compliant radio with power amplifier & antenna and an 8-bit micro controller unit (MCU). The processor handles the embedded software.

When the pre-programmed PeakNet™Z firmware with the serial command set is on-board, the user application will typically run on an external processor, configuring the module.

In case the embedded API is used, both the communication stack and the customer's application firmware are inside the module. The user application interfaces with the outside world through the IO ports on the module, analog or digital IOs, UARTs, SPI.

Software can be updated through JTAG, ISP, UART or RF interface.



Absolute Maximum Ratings

Parameter	Min	Max	Unit
Supply voltage	-0.3	3.6	V
Voltage on any pin	-0.3	VCC+0.5	V
Input RF level		10	dBm
Storage temperature	-50	150	°C
Operating temperature	-30	85	°C



Caution !

ESD sensitive device.

Precaution should be used when handling the device in order to prevent permanent damage.

Electrical specifications ⁽¹⁾

Parameter	Min	Typ	Max	Unit	Condition
Operating frequency	2405		2480	MHz	
Number of channels ⁽²⁾		16			
Channel spacing		5		MHz	
RF pin input/output impedance		50		Ohm	
Bit rate		250		Kbit/s	
DSSS chip rate		2		Mc/s	
Frequency stability			+/- 40	ppm	
Transmit power					
FCC		17		dBm	
ETSI ⁽³⁾		10			
Low-power mode		-7			
Harmonics					
2nd Harmonic			-42	dBm	
3rd Harmonic			-42	EIRP	
Spurious emission, Tx:					
30-100 MHz			-36	dBm	Complies with EN 300 328, FCC CRF47 Part 15 and ARIB STD-66
1-12.75 GHz			-30		
1.8-1.9 GHz			-47		
5.15-5.3 GHz			-47		
Sensitivity		-92		dBm	PER = 1%
Adjacent channel rejection +/- 5MHz		45/30		dB	
Alternate channel rejection +/- 10MHz		54/53		dB	
Blocking / desensitization					
+/- 5 MHz from band edge		-28		dBm	Wanted signal 3dB above sensitivity level, CW interferer, PER = 1%
+/- 10 MHz from band edge		-28			
+/- 20 MHz from band edge		-27			
+/- 50 MHz from band edge		-28			
Saturation (max. Input level)	0	10		dBm	PER = 1%
Spurious emission, Rx:					
30-100 MHz			-57	dBm	Complies with EN 300 328, FCC CRF47 Part 15 and ARIB STD-66
1-12.75 GHz			-47		
Supply voltage	2.7		3.6	V	
Supply voltage rise time			150	µs	If appropriate rise time cannot be guaranteed, the RESET pin should be activated after supply voltage is stable
Current consumption, Rx		30		mA	
Current consumption					
High power mode nPAEN=0 @ 13 dBm		100		mA	
Low power mode nPAEN=1		45			
Current consumption, Powerdown		1		µA	
MCU flash memory		128		kByte	
MCU RAM		8		kByte	
MCU EEPROM		4		kByte	
MCU clock frequency		8		MHz	
MCU low frequency crystal		32.768		kHz	
Digital IO					
Input logic level, low	0.5		0.3 VCC	V	
Input logic level, high	0.6 VCC		VCC+0.5		
Output logic level, low (10 mA)	0		0.5		
Output logic level, high (-10 mA)	2.4		3.0		
Reset pin					
Input logic level, low	-0.5		0.1VCC	V	
Input logic level, high	0.9VCC		VCC+0.5		
nPAEN ⁽⁴⁾					Power amplifier is disabled at logic high
Input logic level, low			0.4V		
Input logic level, high	1.7V				
Internal pull down, input current at 3.3V		90uA			
Internal RESET pull-up resistor	30		60	kOhm	
1.8V regulated voltage at pin 29	1.7	1.8	1.9	V	

(1) RF performance is measured in conducted mode unless stated otherwise. All electrical performance data is measured at 25 degrees Celsius and 3.3V Supply Voltage.

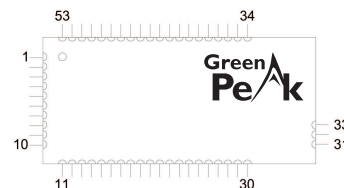
(2) IEEE 802.15.8 channel 26 is disabled on the FCC version of the CM09 module.

(3) Power is measured in conducted mode. The gain of the embedded antenna of the CM09CP module is 3dBi peak. In case of the CM09CP for the ETSI domain the TX power is adjusted to stay within regulatory limits (10dBm EIRP).

(4) To achieve the lowest leakage current in powerdown mode while using active TX power control, it is advised to switch nPAEN to GND before entering the powerdown mode. If the PA should be always disabled, this can be achieved by connecting the nPAEN pin to the VREF1.8V pin. The Leakage current in powerdown mode through nPAEN will be zero because the VREF1.8V is 0V in powerdown mode. In active mode VREF1.8V will be available again, so the PA will be disabled.

Pin Description

The pin list and its description is given in table below. Pins are numbered from 1 to 53, pin 1 is indicated by an opening in the shield can in upper left corner.



Pin no	Pin name	Description and Internal MCU Connection
1	GND	System ground
2	VCC	Supply voltage input
3	PG0	Digital I/O, PG0
4	nPAEN	Power amplifier enable: nPAEN = 0: High power mode / nPAEN = 1: Low power mode
5	PD7(CTS1)	Digital I/O, PD7 / CTS1
6	PD5(RTS1)	Digital I/O, PD5 / RTS1
7	PG2	Digital I/O, PG2
8	PD3(TXD1)	Digital I/O, PD3 / TXD1 / INT3
9	PD2(RXD1)	Digital I/O, PD2 / RXD1 / INT2
10	GND	System ground
11	GND	System ground
12	PF7/ADC7	Digital or analogue I/O, PF7, JTAG TDI
13	PF6/ADC6	Digital or analogue I/O, PF6, JTAG TDO
14	PF5/ADC5	Digital or analogue I/O, PF5, JTAG TMS
15	PF4/ADC4	Digital or analogue I/O, PF4, JTAG TCK
16	PF3/ADC3	Digital or analogue I/O, PF3
17	PF2/ADC2	Digital or analogue I/O, PF2
18	PF1/ADC1	Digital or analogue I/O, PF1
19	PF0/ADC0	Digital or analogue I/O, PF0
20	AREF	Analogue reference voltage pin for the internal A/D Converter. Internally decoupled with 22nF.
21	PE0	Digital I/O, PE0
22	PE1	Digital I/O, PE1
23	PE2	Digital I/O, PE2
24	PE3	Digital I/O, PE3
25	PE4	Digital I/O, PE4 / INT4
26	PE5	Digital I/O, PE5 / INT5
27	PE6	Digital I/O, PE6 / INT6
28	PE7	Digital I/O, PE7 / INT7
29	1.8V	Internally regulated voltage. Normally not connect. May be used for AREF
30	GND	System ground
31	GND	System ground
32	RF	RF I/O connection to antenna, 50 Ohm. Do not connect for integrated antenna or connector variant.
33	GND	System ground
34	GND	System ground
35	PB0	Do not connect, internally used for CSn
36	PB1/SCLK	SPI interface must be shared with MAC, ISP SCK
37	PB2/MOSI	SPI interface must be shared with MAC, ISP MOSI
38	PB3/MISO	SPI interface must be shared with MAC, ISP MISO
39	PB4	Digital I/O, PB4
40	PB5	Do not connect, internally used for VREG_EN
41	PB6	Do not connect, internally used for RESETn
42	PB7	Digital I/O, PB7
43	TOSC2	Internal 32.768 kHz oscillator
44	RESET	Internal MCU reset. Active low with internal pull-up.
45	PDO / INT0	Do not connect, internally used for DCLK / FIFOP
46	PD1 / INT1	Do not connect, internally used for DIO / FIFO
47	PD2/RXD1	Same as pin 9
48	PD3/TXD1	Same as pin 8
49	PD4	Do not connect, internally used for SFD
50	PD5(RTS1)	Same as pin 6
51	PD6	Do not connect, internally used for CCA
52	PD7(CTS1)	Same as pin 5
53	GND	System ground

Application Circuit

An application example circuit is shown in figure 3.

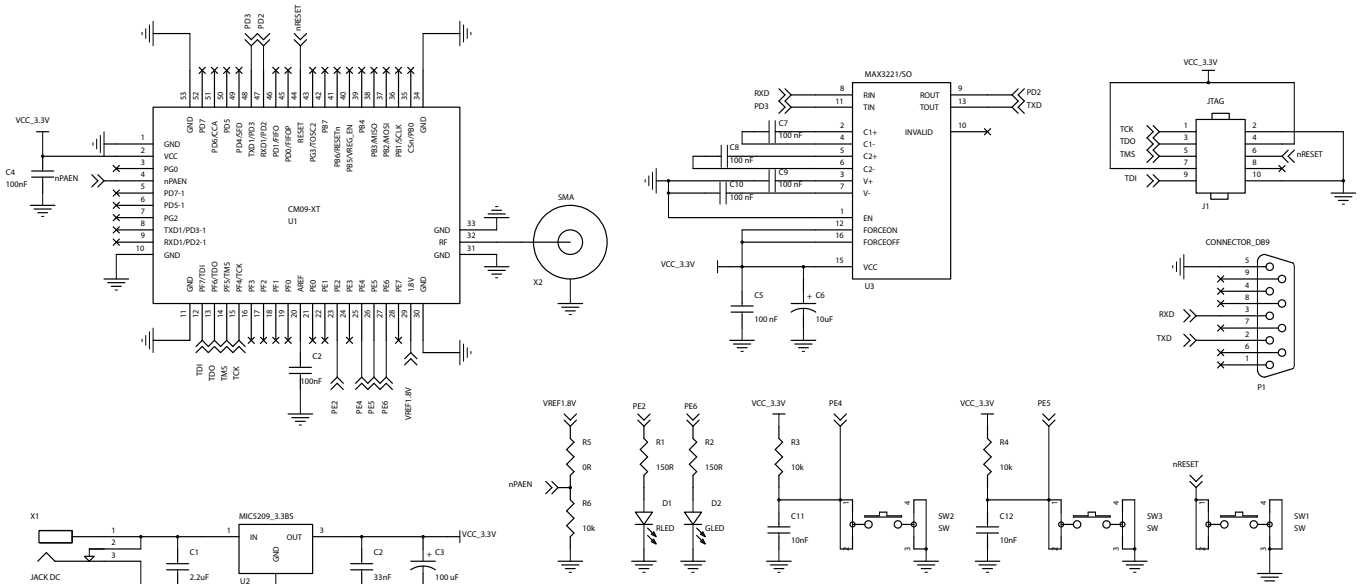


Figure 3

R5	R6	Function
Do not place	10k	PA is enabled
0 Ohm	Do not place	PA is disabled

Component Reference	Value	Manufacturer	Manufacturer Reference
C1	2.2uF	Kemet	C0402C225M9PAC
C4,C2	100nF	Kemet	C0402C104K4RAC
C2	33nF	Kemet	C0402C333K4RAC
C3	100 uF	Kemet	T495C107K006ATE150
C5,C7,C8,C9,C10	100 nF	Kemet	C0402C104K4RAC
C6	10uF	Kemet	B45025B1069K757
C12,C11	10nF	Kemet	T495C106K020ATE400
D1	RLED	Avago	HSMC-C150
D2	GLEED	Osram	LGN971
J1	JTAG	Samtec	TSM-106-02-S-DV
P1	DCON	Multicomp	5504F1-09S-01-03-F1
R2,R1	150R	Multicomp	0402WGF1500TCE
R3, R4, R6	10k	Multicomp	0402WGF1002TCE
R5	0R	Multicomp	0402WGF0000TCE
SW1,SW2,SW3	SWITCH	Omron	B3FS-1052
U1	CM09	GreenPeak	GPCM09XT
U2	LDO	Micrel	MIC5209_3.3BS
U3	RS232	Maxim	MAX3221
X1	DC-JACK	Cliff	DC8 power socket
X2	SMA	Jyebao	SMA8402-0000

Antenna and Range Considerations

The CM09CP module is delivered with an integrated antenna. This is highly recommended for most applications, as this gives a very compact solution containing all the critical RF parts within the module.

The radiation pattern from the antenna is similar to the donut-shaped radiation from a quarter wave antenna. That is, the maximum radiation is in the plane perpendicular to the length axis of the antenna. For best possible omni-directional radiation the module should be oriented so that the antenna is vertical.

The antenna should be kept away ($> 10\text{mm}$) from metallic or other conductive and dielectric materials. Metallic enclosures shield the antenna and reduce the communication range drastically. In applications where the module must be placed in a metallic enclosure, an external antenna gives best results. The signal for the external antenna is available on the RF pin of the CM09XT module. The RF input/output is matched to 50 Ohm.

Layout Recommendations

The recommended layout pads for the module are shown in the figure 4. Dimensions are given in millimeter and inches.

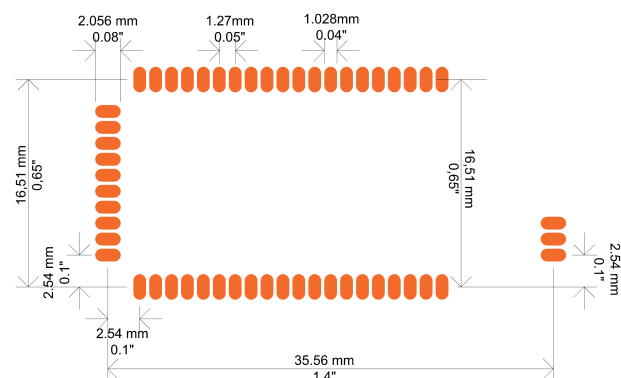


Figure 4

The area underneath the module should be covered with solder resist in order to prevent short circuiting the test pads on the backside of the module. A solid ground plane under the module is preferred.

Each ground pin should be connected directly to the ground plane. In case the ground plane is on an inner layer of the pcb, via's should be placed as close as possible to every ground pad of the module to create low impedance grounding. Unconnected pins should be soldered to the pads, and the pads should be left floating.

Chip Antenna Layout Recommendations

When using the module with on-board ceramic chip antenna the area underneath the antenna should be kept open, and if possible extended in east and north direction as far as possible. Best possible placement of the module on a mother PCB is in the north-east corner, as shown in figure 4. Also with this module it is obligatory not to solder pads 31,32 and 33. Figure 5 shows an example the top layer the recommended layout.

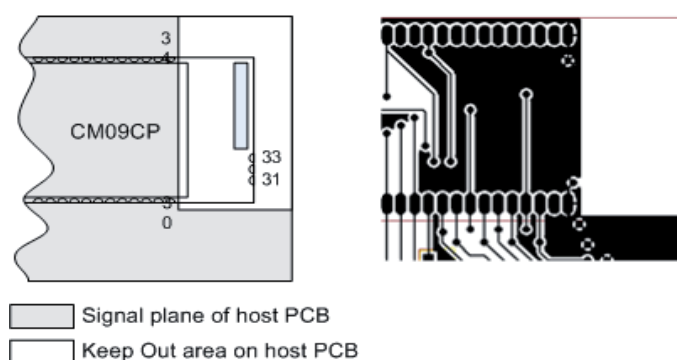


Figure 5

External Antenna Layout Recommendations

In case of connecting an external antenna, the track between the RF pin and the connector should be a 50 Ohm transmission line. The impedance of a transmission line depends on the dielectric constant of the pcb material, the trace width and the distance trace to ground plane. GreenPeak recommends to calculate the track width using a simulation tool. Such as AppCad which is a free tool which can be downloaded from <http://hp.woodshot.com>.

The top layer of a layout following the design rules is show in figure 6.

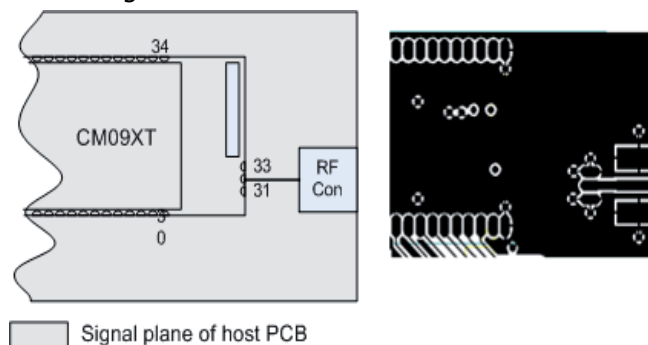
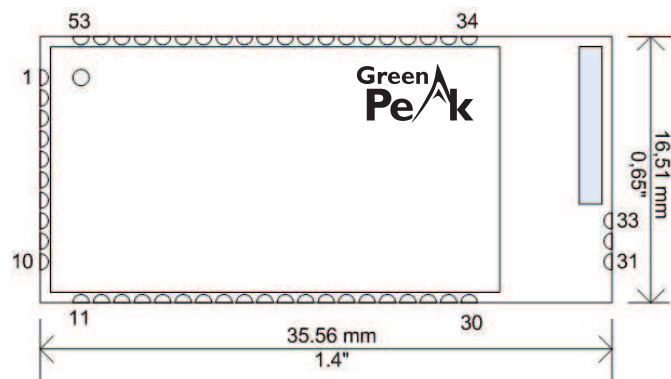


Figure 6

Mechanical Drawing and Dimensions



The module size is 0.65" x 1.4" x 0.14" (16.5 x 35.6 x 3.5 mm).

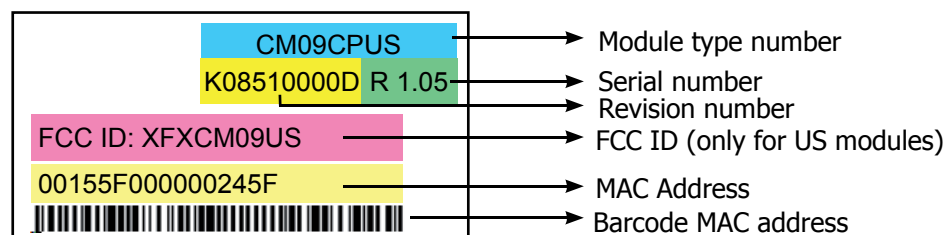
Carrier Tape and Reel Specification

Carrier tape and reel is in accordance with EIA Specification 481.

Tape width	56 mm
Component pitch	20 mm
Hole pitch	4 mm
Reel diameter	13"
Units per reel	Max 800

Identification and label information

All modules are clearly labeled as in figure below.



RoHS Compliance

CM09 modules meet the requirements for RoHS compliance.

Order/Regulatory Information

Type number	FCC ID	Remark
CM09CPUS	XFBCM09US	Certified with FCC Full modular approval
CM09XTUS	XFBCM09US	Certified with FCC Full modular approval. The CM09XTUS module is certified as a FCC Transmitter Module with 3dBi maximum gain for the external antenna.
CM09CPEU	n.a.	Certified with EN 300 328, complies with ARIB STD-66
CM09XTEU	n.a.	Certified with EN 300 328, complies with ARIB STD-66

FCC Notice



WARNING

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.



WARNING

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



WARNING

This device complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. The antenna used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.



WARNING

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.



WARNING

If the FCC ID of the CM09 modules is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module.

This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: XFXXCM09US."



GreenPeak Lime CM09

High-performance wireless mesh network module

Disclaimer

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