UW-CM-08
high-performance wireless mesh network module

Product description

The UW-CM-08 is a high-performance wireless module targeted at driving the communication part of high-end mesh networks. The UW-CM-08 has all functionalities integrated in hardware and software to build robust and large wireless mesh networks.

The UW-CM-08 is the compact version of Ubiwave's successful UW-CN-06 and comes in two different versions, the UW-CM-08-CP, with on-board chip antenna, and the UW-CM-08-XT, where an off-module external antenna can be used.

The features of the UW-CM-08 are aimed at performance-critical applications in terms of reliability and the range of the communication. It further includes a variety of input and output functionalities.

The UW-CM-08 is designed to be SMD-mounted onto a host PCB. SMD-mounting provides the best performance at the lowest cost. Additionally the UW-CM-08 was designed to occupy minimal board space. The host PCB would typically include sensor/actuator interfacing circuits as well as the power circuit.

The UW-CM-08 communicates in the 2.4 - 2.4835 GHz unlicensed ISM band, and conforms with EN 300 440 (Europe), FCC CFR47 Part 15 (US) and ARIB STD-T66 (Japan).

Applications

- Security and Safety Systems
- Healthcare Applications
- Asset Management
- Building & Home Automation
- Industrial Automation

Versions

- **UW-CM-08-CP:** version with on-module chip antenna. Ideally suited for all *multi purpose* wireless mesh solutions. Supports ultra-low-power applications, in combination with long transmission range
- **UW-CM-08-XT:** version where RF signal connects to external antenna; ideally suited for all *multi purpose* wireless mesh solutions, requiring a metal enclosure. Supports ultra-low-power applications, in combination with long transmission range.

Radio features

- **Radio:** IEEE 802.15.4 radio component, operating in 2.4GHz ISM band
- **Channels:** 16
- **Data rate:** 250 kbps (PHY layer)
- **Antenna:** chip antenna or external.
- **Long range:** Power amplifier up to 10dBm (ETSI) and up to 17dBm (FCC) 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:

	indoor	outdoor	line-of-sight
range	40-100m	160-400m	1000m

  In the presence of metallic objects, a shorter range can be observed.
- **Ultra-Low-Power:** Nodes can operate for years without replacing batteries.

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 small board space, SMD technology does away with expensive connectors.
- **Robust and compact design:** The surface-mountable module ensures robust, sturdy and compact integration on the motherboard.
- **Antenna flexibility:** available in 2 versions, with choice between compact on-board chip antenna or external antenna on the mother PCB.

Specifications and information herein are subject to change without notice.

UW-CM-08 User Manual

Quick reference

Parameter	min	typ	max	Unit
Maximum output power		17		dBm
2nd harmonic		-37		dBm
3rd harmonic		-51		dBm
Sensitivity		-92		dBm
Supply voltage		2.7-3.6		Volts
Current consumption Rx	26	28	30	mA
Current consumption Tx (for resp. 0dBm/17dBm output power)	24/100	26/140	28/165	mA
Current consumption powerdown		< 1		µA
Operating temperature		-30 to +86		°C

Mesh communication features

All UW-CM-08 modules come pre-configured with the UbiNet™ mesh network communication stack and application of choice. UbiNet™ features include

- **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 .
- **Ultra-Low-Power:** Nodes can operate for years without replacing batteries.
- **Support for mobile nodes:** Nodes can move through the network without requiring network reassociation.
- **Support for low power routing nodes:** Using UbiNet™ S all nodes can be low power and battery operated, even nodes that support mesh routing functionality.
- **Support for network visualization:** Network topology can be visualized using the optional UbiMonitor software component.
- **Robust against interference:** Able to operate in the presence of other wireless devices such as WIFI, Bluetooth and other
- **Scalability:** The network can scale up to 100s of nodes without reconfiguration.

Complementary products

Ubiwave offers a full suite of development tools to assist OEMs in designing systems using the UW-CM-08 and to build software commissioning tools for the installer or end-user:

Check out *www.ubiwave.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 UbiNet™ seamlessly to your embedded application.
- **UbiMonitor:** Graphical tool showing real-time network status. Can be included in any software application.
- **UbiCreator:** Configure and update your mesh network wirelessly.
- **Battery life-time calculator:** Calculate the battery life time considering custom application constraints.

System diagram
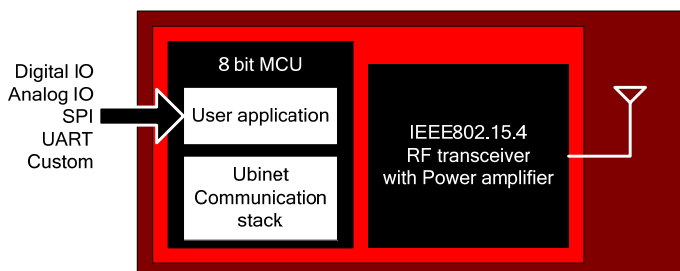
The module consists mainly of 3 parts : an IEEE802.15.4 compliant radio with power amplifier and antenna, an 8 bit micro controller unit (MCU), and the embedded software.
The software consists of a communication stack and a user application. The user application interfaces with the outside world through the IO ports on the module, analog or digital IOs, UARTs, SPI.
Depending on the application, a specific configuration for the communication stack can be selected, according to the stack selector on next page.
The module comes pre-programmed with the software of choice. Software can be updated through JTAG, ISP, UART or RF interface.

Mesh Communication Stack Selector
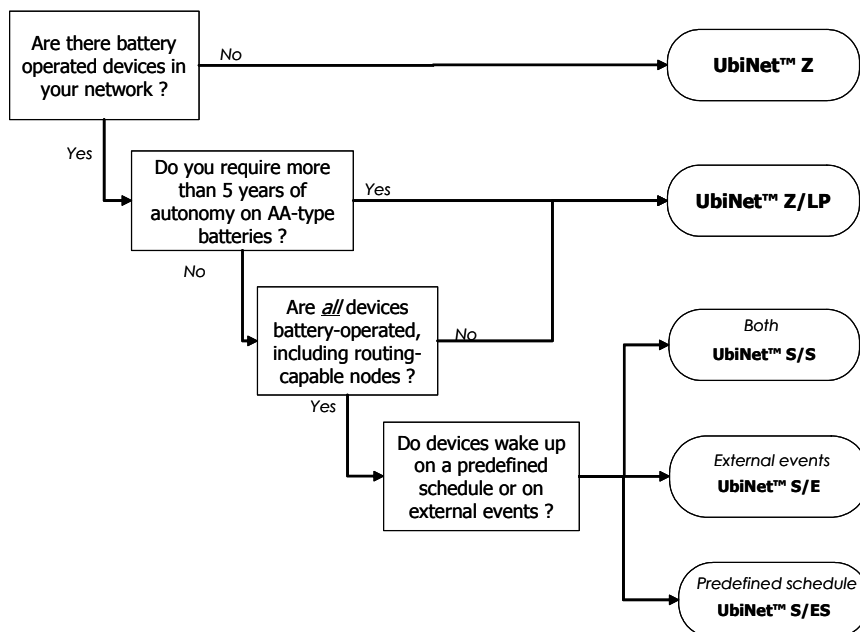
Absolute Maximum Ratings

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
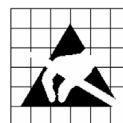
Caution ! ESD sensitive device. Precaution should be used when handling the device in order to prevent permanent damage

Stress exceeding any of the limiting values may cause permanent damage to the device.

Electrical specifications

Parameter	Min	Typ	Max	Unit	Condition
Operating frequency	2405		2480	MHz	
Number of channels		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	-10		+17	dBm	

Harmonics
    2nd Harmonic
    3rd Harmonic
		-37
		-51
				dBm	

Spurious emission, Tx:
    30-100   MHz
    1-12.75 GHz
    1.8-1.9   GHz
    5.15-5.3 GHz
			-36
			-30
			-47
			-47
				dBm	Complies with EN300 328,
					EN 300 440, FCC CRF47
					Part 15 and ARIB STD-66

Specifications and information herein are subject to change without notice.

Parameter	Min	Typ	Max	Unit	Condition
Sensitivity		-92		dBm	PER = 1%
Adjacent channel rejection +/- 5MHz		46/39		dB	
Alternate channel rejection +/- 10MHz		58/55		dB	

Blocking / interferer rejection
    +/- 5 MHz
    +/- 10 MHz
    +/- 20 MHz
    +/- 50 MHz
	
	-50
	-45
	-40
	-30
		
		-24
		-24
		-24
		-23
				dBm	Wanted signal 3dB above sensitivity level, CW interferer, PER = 1%

Saturation	0	10		dBm	

Spurious emission, Tx:
    30-100   MHz
    1-12.75 GHz
			
			-57
			-47
				dBm	Complies with EN300 328, EN 300 440, FCC CRF47 Part 15 and ARIB STD-66

Supply voltage	2.7		3.6	V	
Supply voltage rise time			150	µs	If appropriate rise time cannot be guaranteeed, the RESET pin should be activated after supply voltage is stable
Current consumption, Rx		30		mA	
Current consumption, Tx	24/100	26/140	28/165	mA	At resp 0/ 17 dBm ouptut power
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
    Input logic level, high
    Output logic level, low (10 mA)
    Output logic level, high (-10 mA)
	
	0.5
	0.6 VCC
	0
	2.4
			
			0.3 VCC
			VCC+0.5
			0.5
			3.0
				V	

Reset pin
    Input logic level, low
    Input logic level, high
	
	-0.5
	0.9VCC
			
			0.1VCC
			VCC+0.5
				V	

Internal RESET pull-up resistor	30		60	kOhm	
1.8V regulated voltage at pin 29	1.7	1.8	1.9	V	

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.

Specifications and information herein are subject to change without notice.
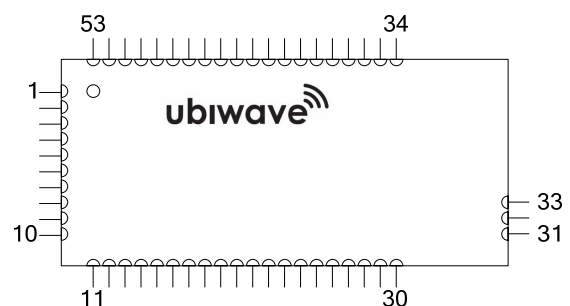
Pin no	Pin name	Description and internal MCU connection
1	GND	System ground
2	VCC	Supply voltage input
3	PG0	Digital I/O, PG0
4	GND	System ground
5	PD7(CTS1)	Digital I/O, PD7 / CTS1
6	PD5(RTS1)	Digital I/O, PD5 / RTS1
7	PG2	Digital I/O, PG2
8	PD3(TXD1)	Digital I/O, PD3 / TXD1 / INT3
9	PD2(RXD1)	Digital 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	PD0 / 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

Specifications and information herein are subject to change without notice.

Antenna and Range Considerations

The UW-CM-08-CP 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. However, when used indoors, reflections of the radio waves in metallic structures tend to spread the polarisation, so even if same orientation is not possible, communication will still take place, but the range is somewhat shorter, typically by 20%.

The antenna should be kept away (> 10mm) from metallic or other conductive and dielectric materials, and should never be used inside a metallic enclosure.

In applications where the module must be placed in a metallic enclosure, an external antenna must be used. In these applications, the UW-CM-08-XT is be delivered without the ceramic antenna. The RF output must be connected to an antenna through the RF pin. The RF input/output is matched to 50 Ohm.

Layout recommendations

The recommended layout pads for the module are shown in the figure below. Dimensions are given in millimeter and inches.
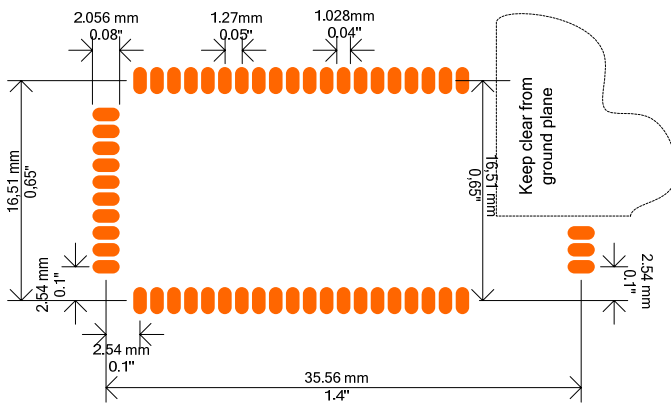
The area underneath the module should be covered with solder resist in order to prevent short circuiting the test pads on the back side of the module. A solid ground plane is preferred, except for the area underneath the ceramic antenna (when used), which should be kept open, and if possible extended in east and north direction as far as possible. Best possible placement of the module on a mother PCB is in the nort-east corner, as shown in figure on page 7.

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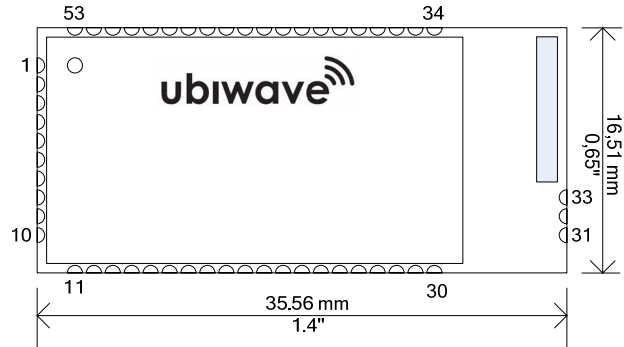
The module size is 0.65" x 1.4" x 0.14" (16.5 x 35.6 x 3.5 mm).

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

Unconnected pins should be soldered to the pads, and the pads should be left floating. For the module version

with integrated antenna, the RF pad (pin 31) can be soldered, but the pad should be left unconnected.

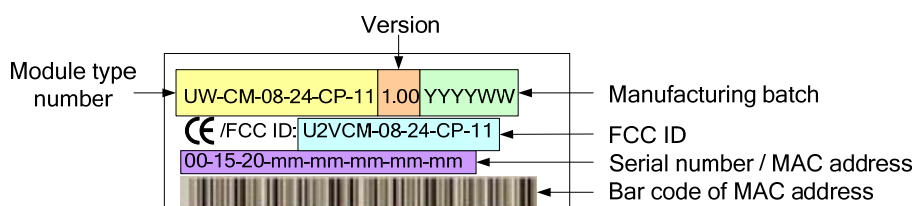The two ground pads (pin 30 and 32 on the right side) should be grounded for all variants.

If the antenna or antenna connector is placed away from the module at the motherboard, the track between the RF pin and the connector should be a 50 Ohm transmission line.

On a two layer board made of FR4 the width of a microstrip transmission line should be 1.8 times the thickness of the board, assuming a dielectric constant of 4.8. The line should be run at the top of the board, and the bottom side should be a ground plane.
Example: For a 1.6 mm thick FR4 board, the width of the trace on the top side should be 1.8 x 1.6 mm = 2.88 mm.

Recommended placement on host PCB

▨	Ground plane of host PCB
▢	Empty area on host PCB

The module is best placed such that the antenna is positioned in a corner of the host PCB. The area underneath the antenna should be left empty.

Typical application diagram

More details on IO application can be found in the pinning information on page 5

Identification and label information

All modules are clearly labeled as in figure below.

FCC information

The UW-CM-08 comes in 2 versions. The FCC IDs for both of them are given below :

Type number	FCC ID	Remark
UW-CM-08-24-CP-11	U2VCM-08-24-CP-11	Certified with FCC Full modular approval
UW-CM-08-24-XT-11	U2VCM-08-24-XT-11	Only a quarter wave monopole whip antenna with gain ≤ 4.1 dB can be used If an antenna connector is used in the final application, it must be a non-standard connector like U.FL (Hirose), AMC (Amphenol), reversed polarity SMA or similar.

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.

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.

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Labeling requirements

⚠ WARNING:	The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Ubiwave FCC identifier for this product as well as the FCC Notice above. The FCC identifiers are listed above in the Agency Identifier Numbers section.

Disclaimer

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Life Support Policy

This Ubiwave product is not designed for use in life support appliances, devices, or other systems where malfunction can reasonably be expected to result in significant personal injury to the user, or as a critical component in any life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness. UbiwaveNV customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify UbiwaveNV for any damages resulting from any improper use or sale.

Revision history

Date	Version	Author	Description
April 26 2006	1.1	Niek Van Dierdonck	Preliminary draft
January 8 2007	1.2	Wim De Kimpe	Pre release
January 9 2007	1.3	Wim De Kimpe	Release
February 21 2007	1.4	Wim De Kimpe	Updated FCC and label info
April 4 2007	1.5	Wim De Kimpe	Updated FCC information section and added application information
April 19 2007	1.6	Wim De Kimpe	Updated FCC information section

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