

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.

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.

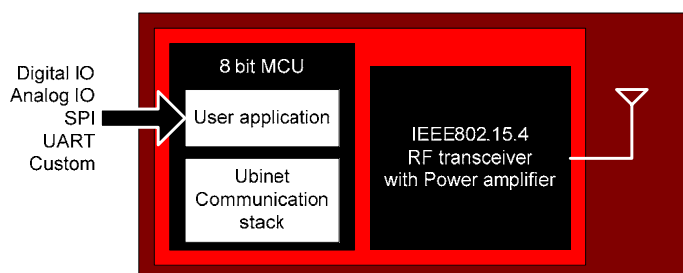
Complementary products

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:

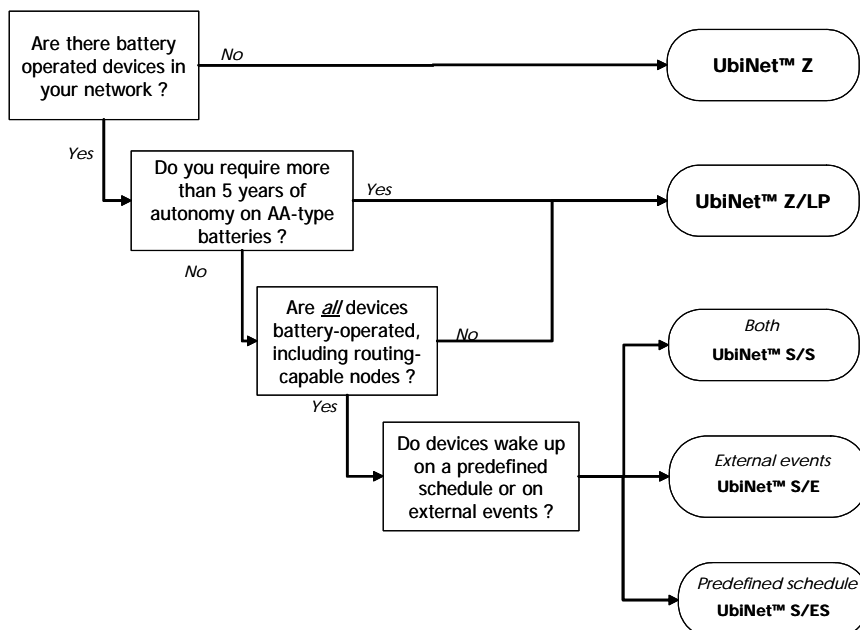
- **Control Panel Builder:** Easy to use software API exposing all network events (node association, change of inputs, ...) to a control panel.
- **Embedded Interface Builder:** Use Standard Interface Objects or build your own to interface UbiNet™ seamlessly to your embedded application.
- **UbiMonitor:** 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



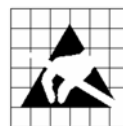
The module consists mainly of 3 parts : an IEEE802.15.4 compliant radio with power amplifier and antenna, an 8 bit micro controller unit (MCU), and the embedded software. The software consists of a communication stack and a user application. The user application interfaces with the outside world through 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

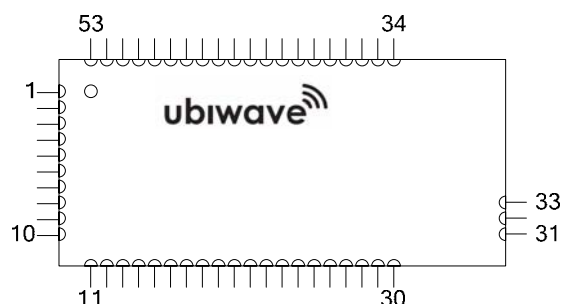
| Parameter | Min | Typ | Max | Unit | Condition |
|-------------------------------|------|-----|--------|--------|--|
| Operating frequency | 2405 | | 2480 | MHz | |
| Number of channels | | 16 | | | |
| Channel spacing | | 5 | | MHz | |
| RF pin input/output impedance | | 50 | | Ohm | |
| Bit rate | | 250 | | Kbit/s | |
| DSSS chip rate | | 2 | | Mc/s | |
| Frequency stability | | | +/- 40 | ppm | |
| Transmit power | -10 | | +17 | dBm | |
| Harmonics | | | | | |
| 2nd Harmonic | | -37 | | dBm | |
| 3rd Harmonic | | -51 | | | |
| Spurious emission, Tx: | | | | | Complies with EN300 328, EN 300 440, FCC CRF47 Part 15 and ARIB STD-66 |
| 30-100 MHz | | | -36 | dBm | |
| 1-12.75 GHz | | | -30 | | |
| 1.8-1.9 GHz | | | -47 | | |
| 5.15-5.3 GHz | | | -47 | | |

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 | -50 | -24 | | dBm | Wanted signal 3dB above sensitivity level, CW interferer, PER = 1% |
| +/- 10 MHz | -45 | -24 | | | |
| +/- 20 MHz | -40 | -24 | | | |
| +/- 50 MHz | -30 | -23 | | | |
| Saturation | 0 | 10 | | dBm | |
| Spurious emission, Tx: | | | | | Complies with EN300 328, EN 300 440, FCC CRF47 Part 15 and ARIB STD-66 |
| 30-100 MHz | | | -57 | dBm | |
| 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, Tx | 24/100 | 26/140 | 28/165 | mA | At resp 0/ 17 dBm output 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 | 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 | | |
| 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.



| 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 |

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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.

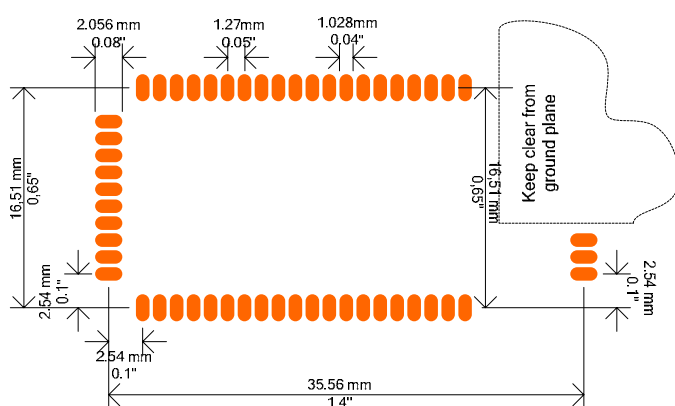
The radiation pattern from the antenna is similar to the donut-shaped radiation from a quarter wave antenna. That is, the maximum radiation is in the plane perpendicular to the length axis of the antenna. For best possible omni-directional radiation the module should be oriented so that the antenna is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

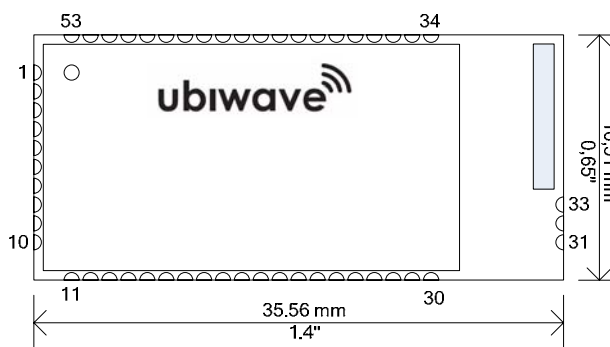
Layout recommendations

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 (e.g. By placing the module in the corner of the PCB).

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.

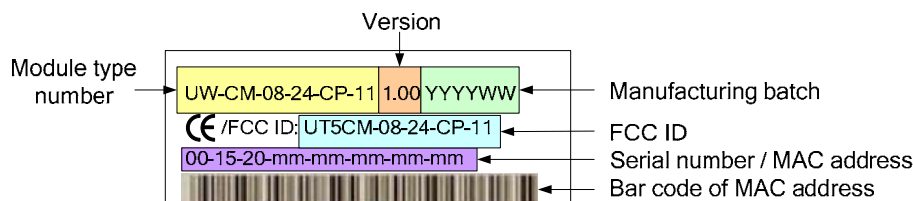
If the antenna or antenna connector is placed away from the module at the motherboard, the track between the RF pin and the connector should be a 50 Ohm transmission line.

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 $1.8 \times 1.6 \text{ mm} = 2.88 \text{ mm}$.

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 | UT5CM-08-24-CP-11 | Certified with FCC Full modular approval |
| UW-CM-08-24-XT-11 | UT5CM-08-24-XT-11 | Certified with FCC limited modular approval only; a final FCC approval must be obtained for the end product with external antenna. |

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.

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 |
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