User Guide

Wireless Modbus Interface

Applies to: ZMB-30, ZMB-31, ZMB-33

EPI-194-00

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Safety Information

Please read these instructions carefully before trying to install, operate, service or maintain the ZMB. The following special notes may appear throughout the user guide (or on the equipment labels) to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure for users.

Symbol	Description
	The addition of either symbol to a "Danger" or "Warning" safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.
	This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

Electrical Installation

Electrical equipment should be installed, operated, serviced and maintained only by qualified personnel. No responsibility is assumed by EpiSensor for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved.

Installation, wiring, testing and service must be performed in accordance with all local and national electrical codes.

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH
➔ NEVER work alone.
➔ Use appropriate personal protective equipment (PPE) and follow safe electrical work practices.
➔ Only qualified electrical workers should install this equipment. Such work should be performed only after reading the entire set of installation instructions.
➔ If the equipment is not used in a manner specified by EpiSensor, the protection provided by the equipment may be impaired.

➔ Before performing visual inspections, tests, or maintenance on this equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.

➔ Turn off all power supplying the ZMB and the area in which it is installed before working on it.

➔ Always use a properly rated voltage sensing device to confirm that all power is off.

➔ Before closing all covers and doors, inspect the work area for tools and objects that may have been left inside the equipment or panel.

➔ When removing or installing metering or other equipment, do not allow it to extend into an energised bus.

➔ The successful operation of this equipment depends upon proper handling,

➔ Neglecting fundamental installation requirements may lead to personal injury as well as damage to electrical equipment or other property.

➔ Before performing Dielectric (Hi-Pot) or Megger testing on any equipment in which the energy meter is installed, disconnect all input and output wires to the ZMB.

➔ High voltage testing may damage electronic components contained in the ZMB.

➔ Failure to follow these instructions will result in death or serious injury.

Installation & Safety Notes

➔ EpiSensor equipment should be installed, operated, serviced and maintained only by qualified personnel. EpiSensor does not assume any responsibility for any consequences arising out of the use of this equipment.

➔ Fuse for neutral terminal is required if the source neutral connection is not grounded.

➔ Clearly label the device's disconnect circuit mechanism and install it within easy reach of the operator.

➔ The fuses / circuit breakers must be rated for the installation voltage and sized for the available fault current.

➔ The ZMB should be installed in a well ventilated location

Intended Use

Do not use this device for critical control or protection applications where human or equipment safety relies on the operation of the control circuit. Failure to follow these instructions can result in death, serious injury, or equipment damage.

Related Documents

Related installation and configuration documents are listed in the following table:

| Document	Reference No.
EpiSensor ZMB Datasheet	EPI-195-00
Install Sheet for ZMB-3X	EPI-090-00
Application Note - ZMB Device Compatibility	EPI-143-00
Application Note - Modifying Node Profiles for ZMB Product Range	EPI-104-00
Gateway API User Guide	ESE-009-08

Introduction

EpiSensor's ZMB Wireless Modbus Interface is designed to make it easy to collect data from a wide range of heating, cooling and other energy meters using the Modbus RTU (over RS-485) wired communications standard.

The ZMB reports data through the wireless sensor network to the Gateway, which then manages bi-directional communications to various compatible software and IoT platforms.

User Interface

There are two LED's and one button on the front panel of the ZMB product range that are used to show the status of the product and to issue commands. This section describes how to interact with user interface and what each state means.
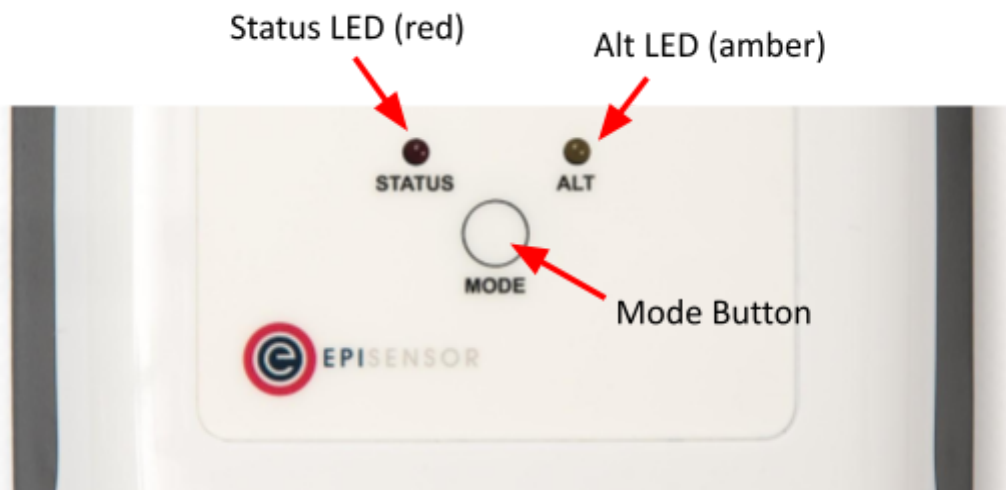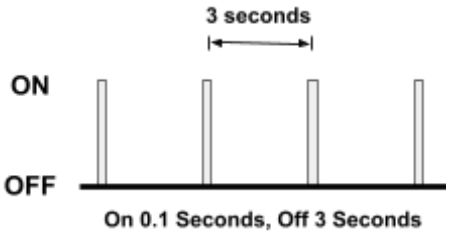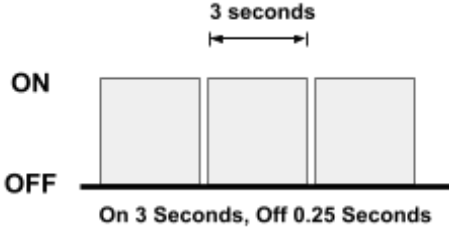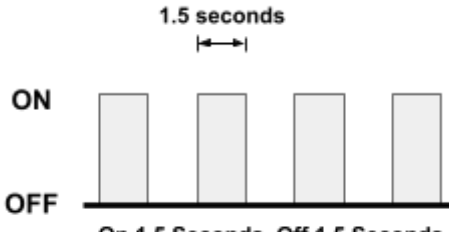
A node must be in "command mode" before users can interact with the product. To put the node in Command Mode, press and hold the "MODE" button for 2 seconds, then release. At this point, a battery powered node will switch the LED On Solid, while a mains powered node will flicker the LED and then switch the LED On Solid.

Status LED

The red status LED will flash in different sequences depending on the current state of the ZMB. This table below lists all possible LED flash sequences and their meaning.

Flash Sequence	Description	Diagram

Heartbeat	The node is operating correctly and has successfully joined a wireless network.	On 0.1 Seconds, Off 3 Seconds
Inverse Heartbeat	The node is has received valid security keys, but is not connected to a Gateway.	On 3 Seconds, Off 0.25 Seconds
Square Wave	The node is operating correctly but has lost contact with the Gateway.	On 1.5 Seconds, Off 1.5 Seconds
On Solid, or Off	If the LED is On Solid, the node is searching for a Gateway to join. If it is Off, the node may not be powered, or there is a problem with the node. Check the power supply, and if the problem persists, contact EpiSensor support.	

Alt LED

The Alt LED will flash when data is transmitted or received on the ZigBee wireless network. For mains powered nodes, it will always be active - but for battery powered nodes, it will only be active when in Command Mode.

Mode Button

The following options are available with Command Mode. The button should be pressed and then released to register a valid button press. If no further button presses are made, the device will terminate "command mode" 4 seconds after the last button press.

Press	Description
0	Send a PING message disable any active Install Mode or Range Test Mode. If the node is not joined, try and join a network.

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1	Send a DATA message to the Gateway for any enabled sensors that are not reporting in 'snap-to-clock' mode.
2	Leave the current network. Mains powered Nodes will automatically try and join a new network once they have left and will periodically retry the join. Battery powered nodes will go to sleep.
4	Start "Install Mode". Node sends a PING message every 15 seconds, with the LED pulse speed indicating the wireless signal strength of the reply. Automatically expires after 5 minutes.
6	Reboot the node. Security keys for the wireless network the node is joined to will not be erased, and all other settings will remain the same.
8	Factory-reset the node and perform a reboot. All settings and security keys will be lost. The node will be returned to its factory default state.
12	Start "Range Test" mode. Node will send a PING message every 5 seconds. The LED pulse speed indicates the wireless signal strength of the reply. Automatically expires after 5 minutes.

Install Mode

Issuing a press sequence on the Mode button of a powered node can enable either "Install Mode" or "Site Survey Mode" on that node. In this mode, the LED will flash at a rate that indicates the wireless signal strength (Link Quality Indicator) of that node, based on the following table:

Flash Rate	Flashes per Second	Wireless Signal Strength	LQI
Very Fast	10 flashes / second (Light on 50ms, off 50ms)	Very good Signal	> 200
Fast	2 flashes / second (LED on 250ms, off 250ms)	Good Signal	> 150
Slow	1 flash / 2 seconds (LED on 1 sec, off 1 sec)	OK Signal	> 100
Very Slow	1 flash / 6 seconds (LED on 3 sec, off 3 sec)	Poor Signal	< 100

This mode expires after 15 minutes for Install Mode and 5 minutes for Site Survey Mode.

Electrical Installation

The ZMB is a mains powered device. The mains cable is colour coded to conform to European CENELEC standards. The CENELEC standard insulation colours are as follows:

Live – **Brown**

N – **Blue**

Important Note: The ZMB should be connected via a switched junction box and breaker to protect the cable. Also, please ensure that the live connection is made on the same circuit as the neutral connection where residual-current devices (RCD's) are used.

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Installation should only be carried out only by personnel qualified in the installation of electrical equipment. All parts of the circuit within the enclosure must be considered to be at dangerously high mains voltage when the unit is connected to a mains voltage source.

Mechanical

This section describes how to wall-mount the ZMB enclosure, the enclosure materials and important safety considerations when connecting the ZMB to external systems.

Enclosure & Label Material

The ZMB is housed in an IP67 water and dust proof enclosure to provide maximum safety, flexibility and reliability. The enclosure material is polycarbonate plastic, which is resistant to a variety of chemicals, oils and detergents.

The front label is made from polycarbonate. There will be two or more labels on the back of the enclosure, depending on the model selected. The compliance label is made from PVC and the serial number label is made from polyethylene film.

Mounting Instructions

The ZMB product range will have two (ZMB-31, ZMB-33) or three (ZMB-21) cable glands at the bottom depending on the model.

The ZMB requires 2 screws for mounting. These screws can be preinstalled on a vertical surface spaced 122mm vertically apart. The head of the screw should be less than 8.5mm in diameter and the screw thickness should be less than 4.5mm. The screws should be left unscrewed by more than 5 mm before installing the enclosure.

Important Safety Note
The enclosure of the ZMB must not be drilled, cut or modified in any way for mounting or connecting to external systems.
All parts of the circuit within the enclosure must be considered to be at dangerously high mains voltage when the unit is connected to a mains voltage source. Modifying the enclosure could expose parts of the system to users, or cause an internal fault or short circuit.
There are no user-serviceable parts inside the ZMB enclosure, and it should always be isolated from mains voltages before opening the enclosure lid.

Opening the Enclosure

To make connections to the ZMB, it is necessary to open the lid of the enclosure. This is fastened with four screws that are accessible from the back of the enclosure. This should only be done by qualified personnel, and only when the ZMB has been isolated from any high voltage supplies. Please consult the safety notes at the start of this user guide for more information.

| Important Safety Note |
|---|
| EpiSensor equipment should be installed, operated, serviced and maintained only by qualified personnel.

There are no user-serviceable parts inside the ZMB enclosure, and it should always be isolated from mains voltages before opening the enclosure lid. |

When closing the lid, take care to ensure that no wires or cable ties are obstructing the gasket of the enclosure, as this could interfere with the waterproof seal. When tightening the screws on the lid, apply pressure to the enclosure so the gasket is compressed, and tighten each screw gradually and in sequence.

Tamper Evident Seals

Some applications (particularly applications where data is used for billing purposes) will require tamper evident seals to be attached to the ZMB enclosure. These seals can be attached to two or more of the corners of the ZMB enclosure, as shown on the diagram below.
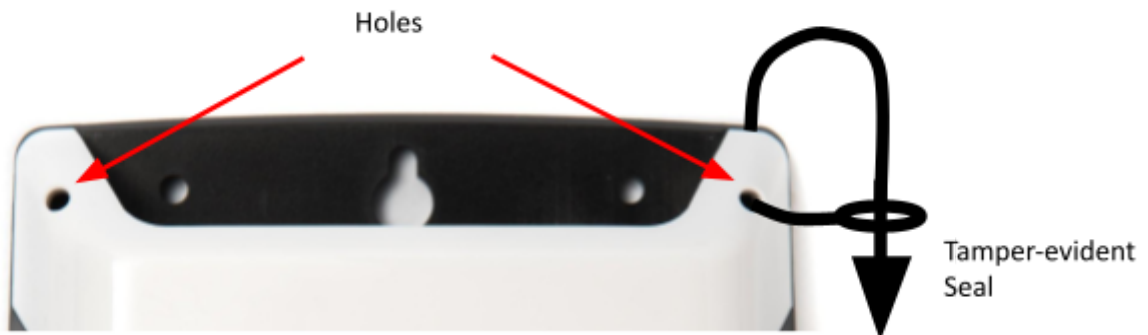
Compliance

There is a compliance label on the back of the ZMB enclosure that has important regulatory and node identification information.

The label material is gloss white PVC foil with permanent adhesive and gloss overlaminate. The following table lists the certification and safety symbols that appear on the certification labels of EpiSensor products. Please refer to it for a definition of each symbol.

| Symbol	Name	Description
CE	CE Mark	This marking certifies that a product has met EU consumer safety, health or environmental requirements.
	WEEE Symbol	The directive imposes the responsibility for the disposal of waste electrical and electronic equipment on the manufacturers of such equipment.
	Class II IEC Protection	This certifies that this product has been designed in such a way that it does not require a safety connection to electrical earth/ground.
IP67 Waterproof	IP / NEMA Rating	Water and dust ingress protection standard. IP67 / NEMA 4 means complete protection against contact with dust, and protected from ingress of water when immersed in up to 1 metre depth for up to 30 minutes. For more information, see IEC 60529.
RoHS	RoHS Directive	Restriction of Hazardous Substances Directive restricts (with exceptions) the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment.
	Safety Alert	This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.
	Danger / Warning	The addition of either symbol to a "Danger" or "Warning" safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

EpiSensor products are not suitable or specifically designed, manufactured or licensed for use in military, aviation, powerplant, medical or in other inherently dangerous or safety critical applications.

Communications

There are a variety of communication options on the ZMB that are used to configure settings, stream live sensor data and poll 3rd party systems for data. This section describes the communications capability of the ZMB, with information on wiring, configuration and safety considerations.

Modbus communications are possible from the ZMB using an RS485 multidrop network or an RS232 point to point cable running at TTL levels (3.3Volts).

Only one standard can be used at a time. Internal circuitry switches between the TTL connection and the RS485 connection. Do not connect both at the same time.
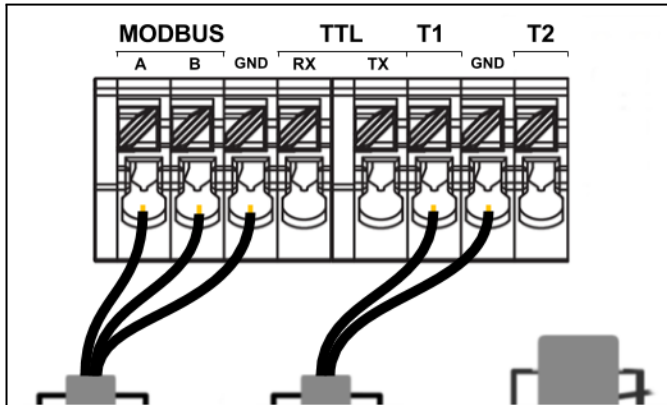
RS-485 Wiring

The ZMB includes a connector for both temperature probes and the Modbus/RS485 cable.

Label	Also Called	Also Called
A	RS485+	D1
B	RS485-	D0
GND	Earth	Ground

On long cable runs, a 120R terminating resistor is required at both ends across the A and B wires. Individual drops do not need terminating resistors.

The cable should be a shielded twisted pair with the shield at one end connected to Earth / Ground. If the system is earthed away from the ZMB, then the Shield/GND wire should not be connected to the ZMB.

The RS485 multidrop network is limited to 32 devices per network.

RS485 is popular for inexpensive local networks, multidrop communication links and long haul data transfer over distances of up to 4,000 feet. However, the achievable distance is a function of the cable. The longer the cable,

the greater the attenuation. Because attenuation increases with frequency, cables also exhibit a lowpass filter behavior so that achievable distance diminishes with data rate.

The communications parameters are configured using the Gateway UI or the API. Because Modbus is the only protocol implemented on the RS485 network, and Modbus always uses 8 data bits, the number of databits are not configurable. The Baud Rate, Stop Bits and Parity are all configurable through the Gateway. All Slaves connected to the ZMB must use the same communications parameters, and all slaves must use a unique Slave Address on the Network.

TTL Wiring

The ZMB includes 3 terminals to achieve RS232 communications on the TTL connection. This is a point to point connection and the Modbus network would be required to include just one Modbus Slave.

Label	Also Called
TX	RS232 Transmit
RX	RS232 Receive
GND	Ground

Modbus

For a full description of the Modbus specification please see https://modbus.org. Some specific details that pertain to the ZMB devices are included here.

The ZMB implements Modbus RTU on the RS485 network. Modbus RTU allows up to 255 Slave addresses but because of the RS485 limitation, there should be a max of 32 nodes on the multi-drop network. However, the address range of 0-255 can still be implemented, provided there are a maximum of 32 physical nodes.

Furthermore, the ZMB has a maximum of 30 Modbus Sensors, which would mean if the maximum number of physical nodes were connected to the Modbus cable, then two of them would be unreachable by the ZMB.

The ZMB implements Modbus Master. There should only be one Modbus Master (Modbus Client) on the Modbus RTU network. Therefore all other nodes on the network are Modbus Slaves (or Modbus Servers).

The simplest method to configure a Modbus Slave that is connected to the ZMB is to use a "Node Profile". Once a specific set of slave addresses, register addresses, register types, lengths etc have all been configured and are reporting correctly, the configuration from that node can be saved as a Node Profile. This Node Profile can then be uploaded to any Gateway and applied to other ZMB nodes.

Configuration

The ZMB-3x must be configured as the only Modbus Master on the RS485 network. All other devices on the network must be Modbus Slave devices. All Modbus devices on the network must communicate with the same

communications parameters - those being the Baud Rate, Parity and Stop Bits. All Modbus devices must use 8 databits (if it is configurable).

Property ID	Setting	Description	Unit	Resolution	Reporting	Default	Read/Write
6410	**Modbus Baud Rate**	RS485 Communication Parameter for Modbus Network	-	-	-	-	Read/Write
6411	**Modbus Parity**	RS485 Communication Parameter for Modbus Network	-	-	-	-	Read/Write
6412	**Modbus Stop Bits**	RS485 Communication Parameter for Modbus Network	-	-	-	-	Read/Write

The ZMB supports a number of Modbus functions;

- Read Coil 0x01
- Read Discrete Input 0x02
- Read Holding Register 0x03
- Read Input Register 0x04
- Write Coil 0x05
- Write Single Register 0x06
- Write Multiple Coils 0x0F
- Write Multiple Registers 0x10

For each of these functions, the corresponding Properties must be configured allowing the ZMB to interpret and report the data in a meaningful format. The complete list of Modbus Properties are;

| Property ID	Setting	Description	Unit	Resolution	Reporting	Default	Read/Write
6400	**Modbus Address**	The Slave Address of the unit on the RS485 Network	-	-	-	0	Read/Write
6401	**Register Address**	The Register Address on the Slave. This is zero based so may be 1 less than the Register address listed in any Slave device documentation	-	-	-	0000	Read/Write
6408	**Read Function**	The Modbus Read Fucntion for this Sensor ID. There may be none!	-	-	-	0x00	Read/Write
6409	**Write Function**	The Modbus Write Function for this Sensor ID. There may be none!	-	-	-	0x00	Read/Write
6404	**Register Count**	1 or 2. 1 Register is 16bits, 2 Registers are 32 bits	-	-	-	1	Read/Write
6407	**Register Signed Type**	Is the value returned a signed or unsigned value	-	-	-	False	Read/Write
6403	**Register Float Type**	Is the value returned a 32 bit Floating point number as defined by IEEE 754	-	-	-	False	Read/Write
6402	**Bit Position**	The position in the returned register for "Coil" type reads/writes	-	-	-	0	Read/Write
6405	**Register Byte Swap**	Swap the Byte order in a 16 or 32 bit	-	-	-	False	Read/Write

| 6406 | Register Word Swap | Swap the Word order in a 32 bit value | - | - | - | False | Read/Write |

Note: Error codes from Modbus are detected by the ZMB but are currently not reported to the Gateway.

Wireless Communications

All EpiSensor products use IEEE 802.15.4 ZigBee Pro for wireless communications operating at 2.4GHz. This is a secure, scalable mesh networking communications protocol designed for transmitting small amounts of data reliably, and at low power levels.

There are two types of nodes in the EpiSensor wireless mesh network: powered nodes and battery nodes. Powered nodes on the wireless sensor network are capable of routing data from any other type of wireless nodes.
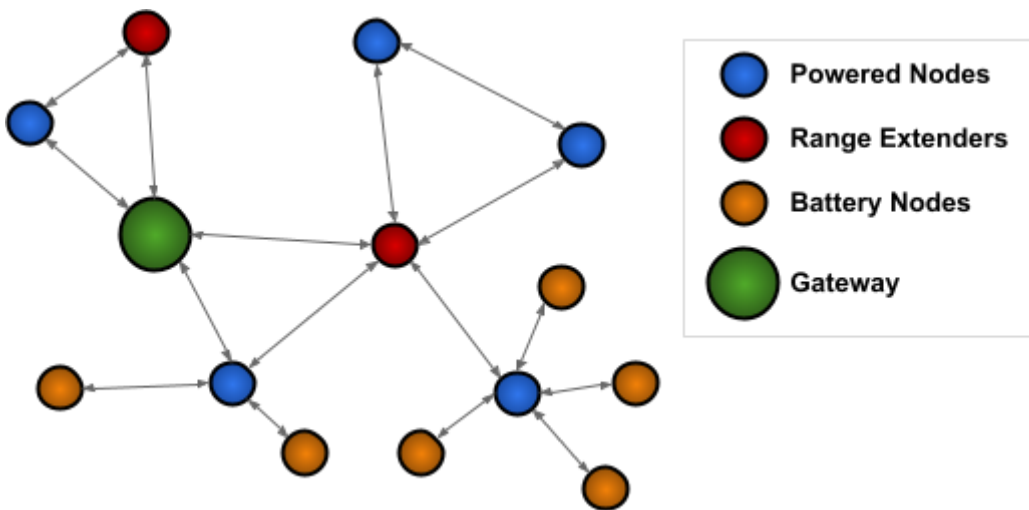
Range extenders are powered nodes where the main function is to route data. Any node with a mains power supply will act as a routing node in the network. Battery nodes do not route data – they spend most of the time in a low power mode.

Each powered node can have up to 32 'neighbours' which are nodes with a mains power supply and can Route data back to the Gateway. They can also have up to 32 'children' which are nodes that are battery powered and cannot participate in any routing in the network.

The range that can be achieved with ZigBee will depend mainly on two factors: the power level of the ZigBee radio module and the environment that the device is installed in. There are two types of ZigBee radio module used across the EpiSensor product range, a power amplified version, and non-power amplified version.

The power output of nodes with a power-amplified module can be configured with an output power level of +20 dBm depending on the region they are deployed in. Non-power amplified nodes have a maximum output power of +8 dBm.

Module Type	Tx Power	Rx Sensitivity	LoS Range	Region(s)
Normal	+8 dBm	-101dBm	up to 300m (985ft)	Worldwide
Power-amplified	+20 dBm	-106dBm	up to 1600m (5250ft)	North America (FCC / IC)

All communications over the ZigBee wireless network is AES 128-bit encrypted. For more detailed information on ZigBee security features, contact EpiSensor support.

Sensors

Reading Data

The ZMB reads data by polling each of the Modbus Sensors that have become due to report. The ZMB builds a "Read Data" Modbus packet using the Sensor Settings parameters for Slave Address, Register Address, Read Function and Register Count.

When the Modbus Slave replies, that reply is parsed using the Sensor Settings parameters for Signed Type, Float Type, Bit Position (for Read Coil only), Byte Swap and Word Swap.

Depending on the model of ZMB, a number of generic Modbus sensors are available. They default to being disabled and are not reporting data as none of the Register settings are available until configured.

Sensor ID	Data Feed	Description	Unit	Resolution	Reporting	Default	Read/Write
1100	**Modbus Register 0**	Generic Modbus Register that can be used to interface with any connected Modbus Slave	-	-	Off	-	Read/Write
….							
1129	**Modbus Register 29**	Generic Modbus Register that can be used to interface with any connected Modbus Slave	-	-	Off	-	Read/Write
4097	**Link Quality**	Link Quality % - measure of Zigbee signal			Off	60	Yes
4099	**RSSI**	Channel noise in dbm			Off	60	Yes
4101	**Neighbour Count**	The number of mains powered devices this device can route messages through			Delta and Interval	360	Yes
4102	**Child Count**	The number of battery power "child" devices that use this device to route messages through			Delta and Interval	360	Yes

Additionally, the following sensor is available on ZMB's that are supplied with a temperature probe:

Sensor ID	Data Feed	Description	Unit	Resolution	Reporting	Default	Read/Write
380	**Temperature**	Temperature Sensor	C	0.01C	15min	-	Read/Write

Ordering Information

EpiSensor products are available to order directly or via EpiSensor's distribution partners. The following table lists the available ZMB options.

SKU	Description
ZMB-30	Mains powered, single 2.5m waterproof temperature probe, max 4 Modbus registers, live stream mode
ZMB-31	Mains powered, no temperature probes, max 30 Modbus registers
ZMB-33	Mains powered, no temperature probes, max 4 Modbus registers, live stream mode

Troubleshooting & Support

If you are experiencing problems with your ZMB or any other part of your EpiSensor system, or you notice something unusual - please contact EpiSensor support at the following email address, phone number or via live chat on our website.

- Email: support@episensor.com
- Tel: +353 61 512 500
- Website: http://episensor.com

For customers and partners who are deploying systems in business-critical environments, there are a number of support packages available that offer a higher level of service and response time. For more information on EpiSensor Premium Support, visit: http://episensor.com/premium-support/

Warranty

All EpiSensor products and provided with a 365 day limited warranty effective from the shipping/invoice date of an order. During the warranty period, under the conditions of normal use, EpiSensor will repair or replace any product that has a manufacturing defect.

Warranty can be extended by up to 4 years within 30 days of a purchase. For more information on warranty, visit: http://episensor.com/warranty/

Glossary

Definitions for terms and abbreviations used in this document are listed in the following table:

Term	Description
Sensor	Describes a feed of data within the EpiSensor system

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Node	Used to describe a physical EpiSensor product
Gateway	The central computer that managed the EpiSensor system
ZigBee	IEEE 802.15.4 Wireless communications standard that EpiSensor nodes use
WSN	Wireless Sensor Network
Reporting Mode	Defines how an EpiSensor node should report data to the Gateway
Reporting Interval	The length of time between each data point produced by a node
Snap to Clock	Reporting mode where data is 'snapped' to the nearest 1 minute / 5 minute / 15 minute interval etc.
Interval and Delta	Reporting mode where data is produced when the reporting interval has elapsed, unless a change is detected
Allow join mode	A mode that can be enabled on the Gateway that allows new wireless nodes to join