



# Zero Mass Water - Hydropanel

## ZMW World-Class Mesh 915MHz Radio User's Guide

### Preface

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The purpose of this document is to provide a description of the Zero Mass Water “ZMW” Wireless Mesh Radio Network Module, introduce the hardware and software functionality, and explain how the Mesh Network Module is integrated with the master controller.

Document Rev. 2  
FCC ID: 2A029200000700  
IC: 23632-200000700  
Model PN: 200-0007-00  
April 5, 2018

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## Introduction

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The purpose of this document is to provide a detailed description of the Zero Mass Water “ZMW” Wireless Mesh Radio Network Module. It will outline the purpose and provide the concept and features required for system implementation. It will also explain system constraints, interface and interactions with other external hardware and applications. This document is primarily intended to high level summary of the Mesh Radio Network Module and serve as a reference for integrating the radio module into the ZMW Controller.

### Zero Mass High-Level Requirements:

- Zero Mass Water Wireless Mesh Radio Software Statement of Work
- Mesh network with 100+ nodes per network
- Maximum 16 hops from end node to network gateway
- 1 kB every two minutes per node
- 10 km+ range from node to node
- Height for antenna < 10 ft.

At present, communications and network formation functionality is the main purpose of this project. This project is considered highly confidential.

### Definitions, acronyms, and abbreviations

Term	Definition
<i>End Device</i>	A node that communicates primarily with a single Router
<i>Router</i>	A node that forwards packets for network devices
<i>Leader</i>	A Router responsible for managing a set of network Routers
<i>6LoWPAN</i>	Acronym for IPv6 over Low-Power Wireless PAN
<i>802.15.4</i>	Technical Standard to define Low-Rate Wireless PAN
<i>Thread</i>	IPv6-based mesh network protocol
<i>Border Router</i>	A Router that can forward messages between Thread and non-Thread network

### Overview

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This section will provide an overview of the ZMW Controller system, introducing the basic functionality, and explain how the Mesh Network Module is integrated with the master controller.

#### Application Concept

Zero Mass Water is a sustainable water startup with a goal to create an easy, off-grid way for anyone to harvest water with a product call “Source”. Each Source unit looks like a solar panel resting on top of a metal box that essentially uses sunlight to produce electricity and heat, and which allows a set of proprietary materials to passively catch the humidity in the air. The Source units passively absorb water vapor from the air and stores the collected water in tanks underneath the solar panels.

Figure 1 – Source Diagram to illustrate concept

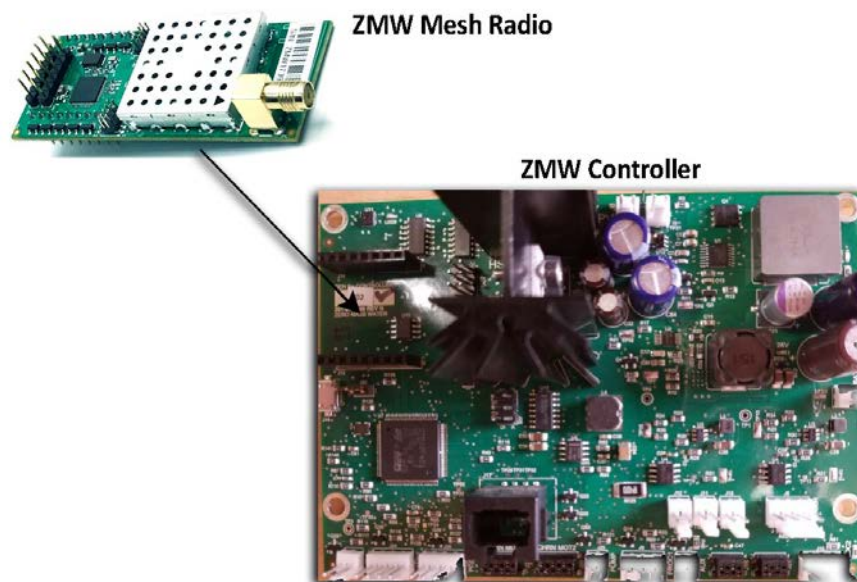
Figure 2 – Network Diagram to illustrate Source Unit Connectivity

### Mesh Radio Network Module Hardware:

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The ZMW Controller interfaces with the Mesh Radio Module through a UART interface via Controller connectors J13 and J14.

Figure 3 - ZMW Controller:



## ZMW World-Class Mesh 915MHz Radio – User’s Manual

### ZMW Controller Interface Connector:

	J13	P1
Pin Number	Controller Description	Mesh Radio Description
1	UART_STAT	Not Used
2	RST_RADIO_N	RST_RADIO_N
3	UART_RTS	UART_CTS
4	SCK	Not Used
5	MISO	Not Used
6	MOSI	Not Used
7	+3.3V	+3.3V
8	GND	GND

	J14	P2
Pin Number	Controller Description	Mesh Radio Description
1	UART_RI	UART_STAT
2	UART_CTS	UART_RTS
3	UART_RX	UART_TX
4	USRT_TX	UART_RX
5	I2C1_SCL	Not Used
6	I2C1_SDA	Not Used
7	+5V	Not Used
8	GND	GND

### Hardware Description:

The Network Radio Module is designed using dedicated application and Radio microcontrollers (MCU). The application MCU will provide all network management responsibilities associated with network management and data communications between the ZMW Controller and other ZMW Controller's on the network. The Radio MCU will provide the Mesh Network Stack and the Dual-Band 2.4GHz / 802.15.4 Radio physical layer.

### *ZMW Controller to Network Application MCU Communications*

	J14	P2
Pin Number	Controller Description	Mesh Radio Description
1	UART_RI	UART_STAT
2	UART_CTS	UART_RTS
3	UART_RX	UART_TX
4	USRT_TX	UART_RX
5	I2C1_SCL	Not Used
6	I2C1_SDA	Not Used
7	+5V	Not Used
8	GND	GND

### Mesh Network Controller Software Overview:

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The Mesh Network Controller software is broken into 4 main components as follows:

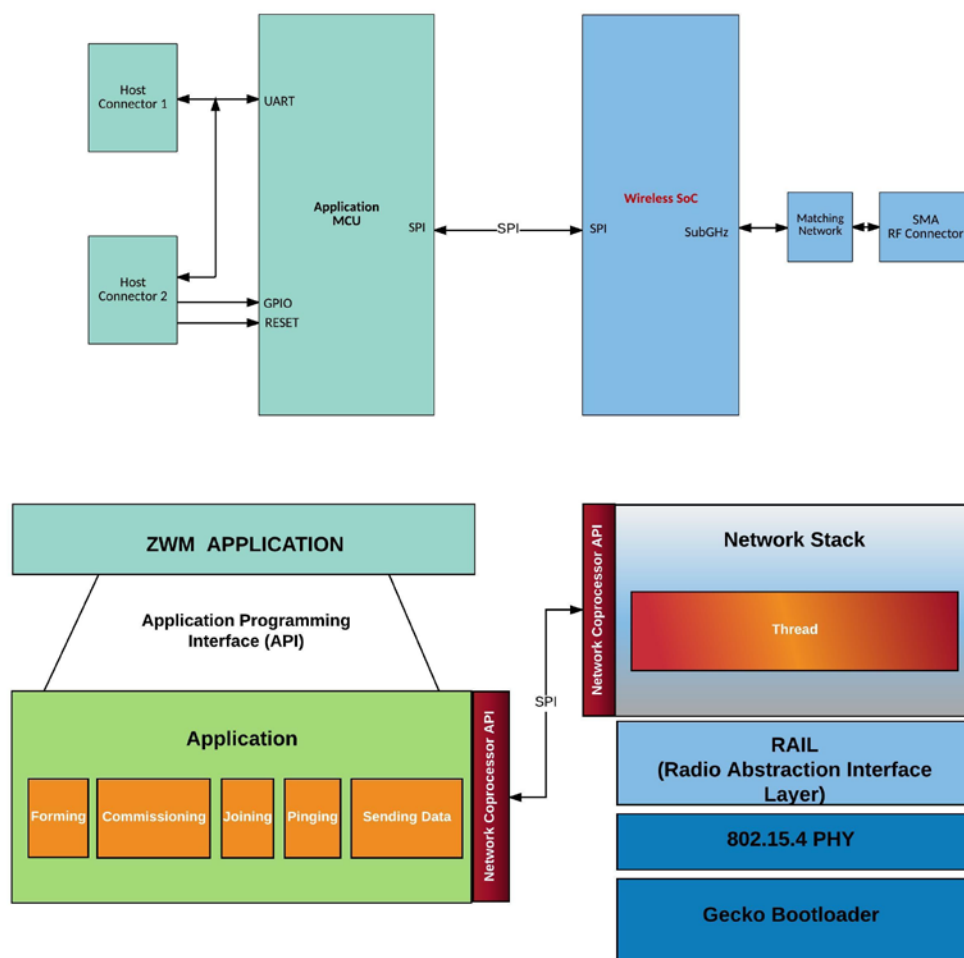
*Thread Mesh Network Stack* – Wireless mesh networking protocol that supports IPv6 addressing and simple IP bridging. Runs on existing 802.15.4 wireless SoCs.

*Network Coprocessor API* – Network coprocessor API provides communications interface between the network stack and application

*Network Application* – Provides all network management functions and data communications between ZMW host and Network Module.

*ZME Application API* – Provides the communication framework for sending commands between the ZMW Controller and Network Module application processor.

Figure 5 - ZMW Network Controller Software Configuration:

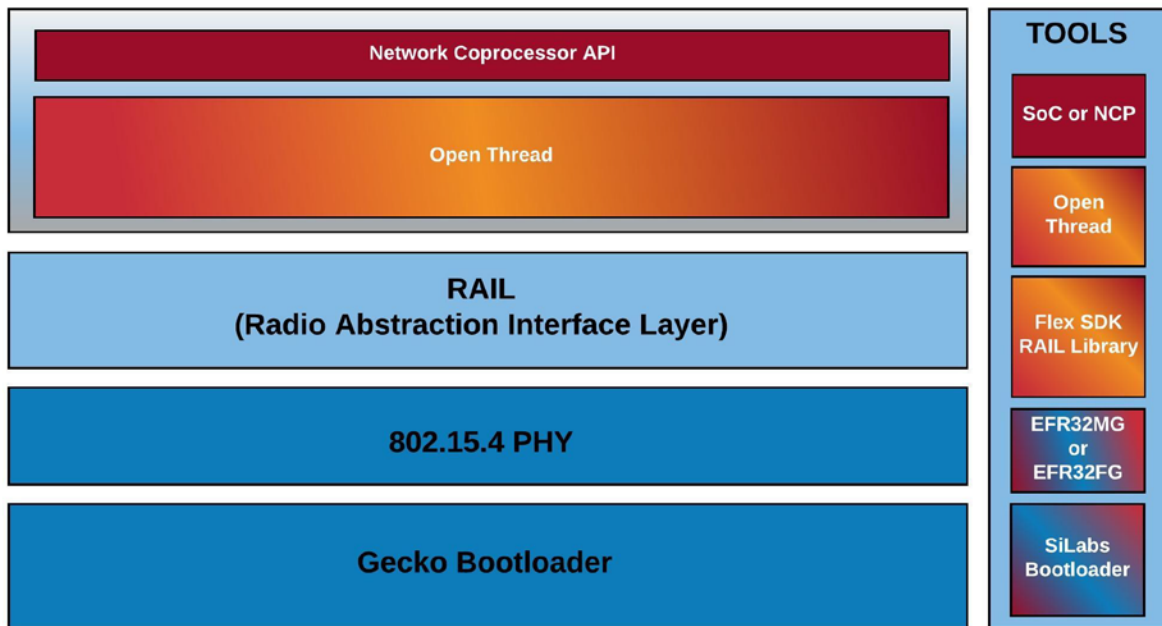


## Network Stack Overview and Implementation

The ZMW Mesh Network stack will be based on a port of Open Thread reconfigured at the radio layer to support 802.15.4 SubGHz radio. To accomplish this task Open Thread must be customized to interface with the SiLabs “Radio Abstraction Interface Layer” (RAIL). The stack configuration is outlined below.



Figure 6 – EFR32MG Network MCU Software Configuration



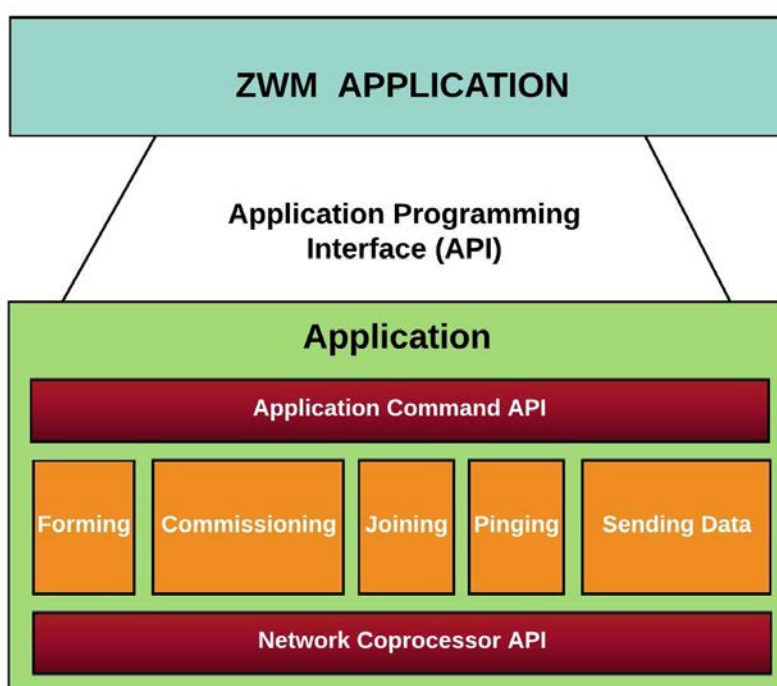
In addition to the porting at the radio layer, Open Thread will require integration of the Network Coprocessor API to allow the stack (Radio MCU) to interface with the Mesh Network Controller application MCU

### Network Module Application Overview and Implementation

The ZMW Network Module application is responsible for managing all network communications and provides the following services:

- Network Management (Forming, Commissioning, Joining, etc.)
- Data communications between ZMW Host and Network

Figure 7 – Application MCU Software Configuration



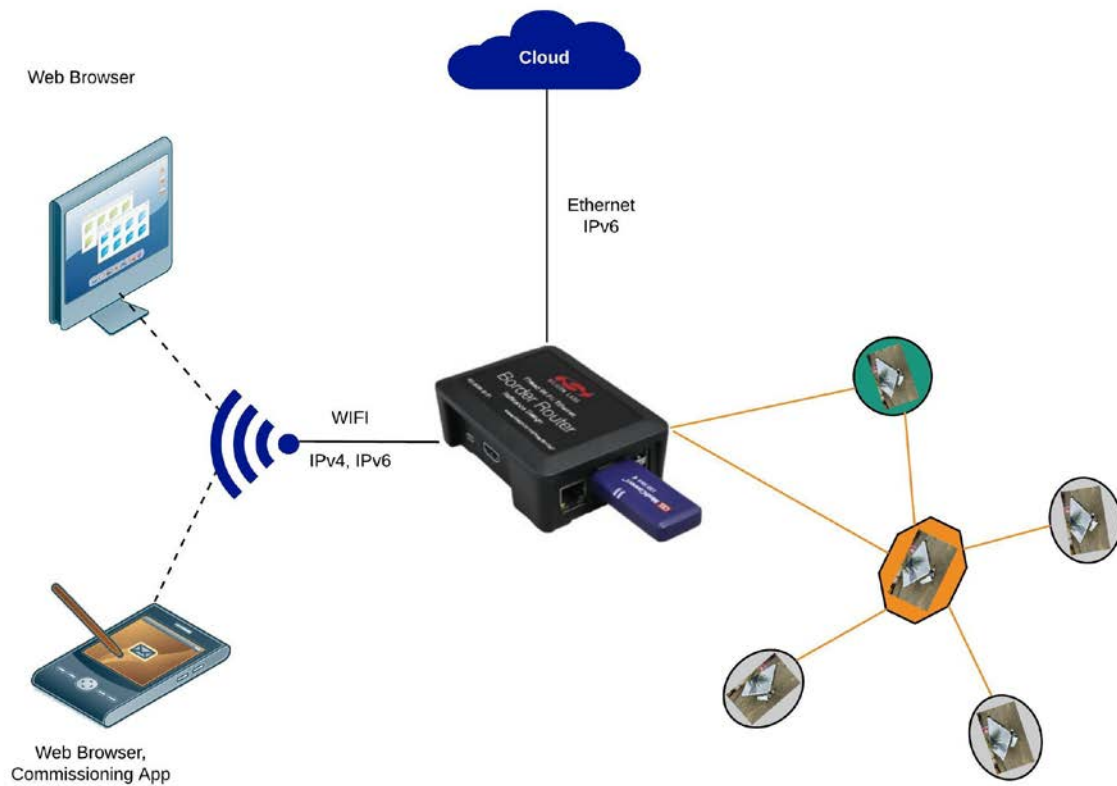
In addition to providing basic network management and data communication services, the application must provide a programming API that allows the ZMW Host MCU to communicate with the network via a simple command interface.

## Network Management

ZMW Networks will be managed by an external Border Router, or a ZMW Controller providing Border Router services. Border Router's provide the following:

- Communications with devices on the local network
- Remote communications to Cloud Services
- Local management communications via Mobile or PC Web Browser
- Device to Cloud data communications

Figure 8 – Network Management Configuration



## Agency certifications - United States

### United States (FCC) – 15.21 Information to User:

900 MHz Mesh Radio Modules comply with Part 15 of the FCC rules and regulations. Compliance with the labeling requirements, FCC notices and antenna usage guidelines is required.

To fulfill FCC certification requirements, the OEM must comply with the following regulations:

- n The system integrator must ensure that the text on the external label provided with this device is placed on the outside of the final product.
- n 900 MHz Mesh Radio modules may only be used with antennas that have been tested and approved for use with this module.

### OEM labeling requirements

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**WARNING!** As an Original Equipment Manufacturer (OEM) you must ensure that FCC labeling requirements are met. You must include a clearly visible label on the outside of the final product enclosure that displays the following content:

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Contains FCC ID: 2AO29200000700

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (i) this device may not cause harmful interference and (ii) this device must accept any interference received, including interference that may cause undesired operation.

### FCC Notices

**IMPORTANT:** The 900 MHz Mesh Radio Module has been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Modifications not expressly approved by Zero Mass Water could void the user's authority to operate the equipment.

**IMPORTANT:** OEMs must test final product to comply with unintentional radiators (FCC section 15.107 and 15.109) before declaring compliance of their final product to Part 15 of the FCC rules.

**IMPORTANT:** The RF module has been certified for remote and base radio applications.

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:

- n Re-orient or relocate the receiving antenna.
- n Increase the separation between the equipment and receiver.
- n Connect equipment and receiver to outlets on different circuits.
- n Consult the dealer or an experienced radio/TV technician for help.

## RF Exposure Statement

If you are integrating the 900 MHz Mesh Radio into another product, you must include the following Caution statement in product manuals to alert users of FCC RF exposure compliance:



**CAUTION!** To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended. The antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

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## FCC-approved antennas (900 MHz)

You can install 900 MHz Mesh Radio using antennas and cables constructed with standard connectors (Type-N, SMA, TNC, and so forth) if you perform the installation professionally and according to FCC guidelines. If a non-professional performs the installation, you must use non-standard connectors (RPSMA, RPTNC, and so forth).

The modules are FCC-approved for fixed base station and mobile applications on channels 1-12 (900 MHz Mesh Radio). If you mount the antenna at least 20 cm (8 in) from nearby persons, the FCC considers the application to be a mobile application. You must test antennas that are not in the table to comply with FCC Section 15.203 (Unique Antenna Connectors) and Section 15.247 (Emissions).

### ***High Gain Antenna Summary***

The following antenna types have been tested and approved for use with the 900 MHz Mesh Radio module:

**Antenna type: Omni-directional** The 900 MHz Mesh Radio RF Module was tested and approved with 6 dBi antenna gain. You can use any omni-directional antenna with 6 dBi gain or less with no cable loss.

## Agency certifications - Industry Canada (IC)

### Labeling Requirements

IC requires you to place a clearly visible label on the outside of the final product enclosure, displaying the following text:

Contains Model 900 MHz Mesh Radio IC: 23632-200000700

The integrator is responsible for its product to comply with IC ICES-003 & FCC Part 15, Sub. B - Unintentional Radiators. ICES-003 is the same as FCC Part 15 Sub. B and Industry Canada accepts FCC test report or CISPR 22 test report for compliance with ICES-003.

### IC RSS-102 Compliance Statement

This system has been evaluated for RF Exposure per RSS-102 and is in compliance with the limits specified by Health Canada Safety Code 6. Limits on Human Exposure to Radio Frequency Fields in the range from 3 kHz to 300 GHz. The system must be installed at a minimum separation distance from the antenna to a general bystander of 7.9 inches (20 cm) to maintain compliance with the General Population limits.

L'exposition aux radiofréquences de ce système a été évaluée selon la norme RSS-102 et est jugée conforme aux limites établies par le Code de sécurité 6 de Santé Canada. Le système doit être installé à une distance minimale de 7.9 pouces (20 cm) séparant l'antenne d'une personne présente en conformité avec les limites permises d'exposition du grand public.

### IC RSS-Gen 8.4 Compliance Statement

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any Interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.