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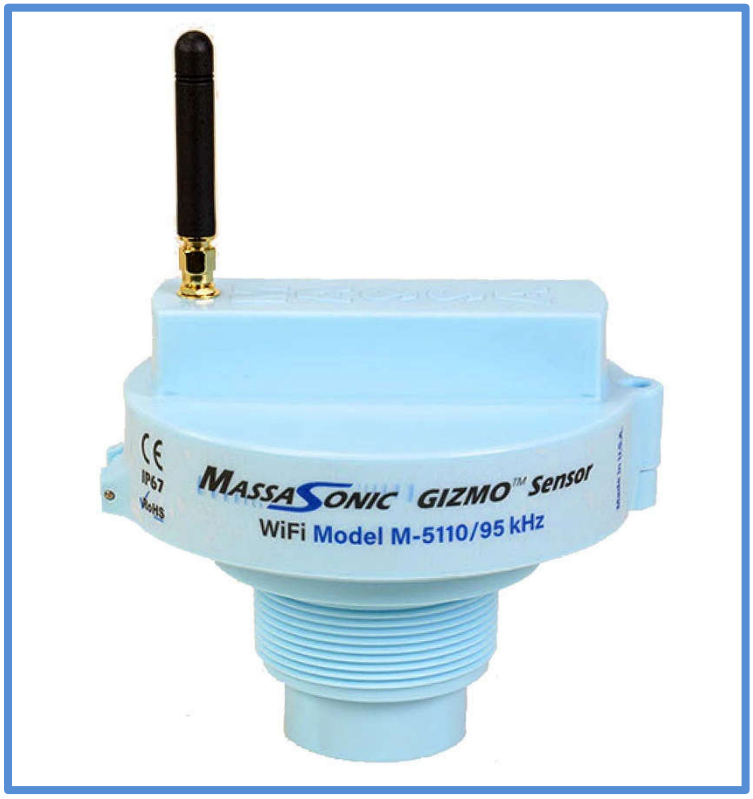
MASSA PRODUCTS CORPORATION
280 LINCOLN STREET, HINGHAM, MA 02043-1796 U.S.A.
781-749-4800 FAX: 781-740-2045 www.massa.com

MassaSonic® Gizmo®

Ultrasonic Level Sensor – WiFi Model

Installation, Specifications & Getting Started Guide using MassaSonic® Application Software



June 6, 2024 Revision 1.0

The Gizmo® Sensor product line listed in the introduction of this manual complies with the European Council EMC Directive 2004/108/EC (EMC) and Low Voltage Directive 2006/95/EC (LVD).

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Table of Contents

1 Introduction

The MassaSonic® Gizmo® Ultrasonic Sensors combine Massa's 70-plus years of experience in electroacoustics with state-of-the-art analog and microprocessor hardware and software design. The result is the most versatile, easiest-to-use ultrasonic sensor on the market. The Gizmo Family of Sensors, listed in the following table, consists of sensors that operate at different frequencies which determine sensing ranges in a typical tank level application.

Family of MassaSonic Gizmo® Ultrasonic Sensors						
Model	**P/N (order number)**	**Description**	**[1]Sensing Range**	**[2]WiFi Range**	**Ultrasonic Freq (nominal)**	**System Beam Angle**
M5110-150-IA	100934-501	Gizmo WiFi 150 w/internal antenna	4″ to 9′	250ft	150 kHz	8°
M5110-150-EA67	100934-502	Gizmo WiFi 150 w/ext IP67 antenna	4″ to 9′	300ft	150 kHz	8°
M5110-95-IA	100933-501	Gizmo WiFi 95 w/internal antenna	8″ to 20′	250ft	95 kHz	8°
M5110-95-EA67	100933-502	Gizmo WiFi 95 w/ext IP67 antenna	8″ to 20′	300ft	95 kHz	8°

In operation, Gizmo® Sensors generate a high-frequency ultrasonic pulse, then measures the time it takes for the reflected echo to return from a target and then calculates the target distance using the speed of sound. The value of the speed of sound, which is a function of temperature, is determined by the sensor using its internal temperature probe. The status data produced is transported via WiFi.

Gizmo's underlying communications support the industry standards JSON (JavaScript Object Notation) data interchange. Gizmo's wireless connectivity using a WiFi module is the first version of the Gizmo platform. Future models will include Cellular and LoRa versions in the Gizmo Sensor package.

The Gizmo® WiFi Sensor is designed to work with the ubiquitous, already installed, In-plant WiFi networks. Once provisioned, the WiFi sensor connects to the facility's network and passes data to either a local host or a cloud-based datacenter. WiFi provisioning and sensor maintenance are made easy with Gizmo's embedded service. Using the Gizmo Smartphone App, users can adjust network settings.

Additional Key Features of Gizmo Sensors include:

- Relatively Easy-to-Use Setup Software
- Built-in Temperature/Sound Speed Compensation
- Real time clock
- Ultrasonic Waveforms Allowing Diagnosis of Measurement Issues
- Fault Detection and Reporting
- Programmable sleep rates for general level measurement
- Programmable wake up time for an option of having a faster reporting rate in cases such as real time tank fill reporting.
- Unscheduled radio wake-up based on alarm level settings to report tank level "too high" or "too low"
- Long battery life, up to 3 years when programmed for 1 hour sleep.

[1] Minimum sensing range increases as temperature increases, however minimum specified range will be reported regardless. See Section 13 for details. Maximum sensing range is target dependent.

[2] WiFi range specification is line of site. Walls and other obstructions can reduce WiFi range down to 30 ft. Also, internal antenna hemispherical beam pattern with near equal sensitivity in horizontal and vertical planes. External antenna is a dipole with a donut shape in the horizontal plane with a null straight overhead. So external antenna is best not to be used if router is overhead.

2 Product Description

This section contains a general overview of the MassaSonic® Gizmo® Ultrasonic Sensors. For additional information including data sheets and application software, please refer to Massa website **www.massa.com/industrial/ultrasonic-sensors/gizmo/**

Specifications

Gizmo Sensors are designed for process control in either indoor or outdoor locations. Below is a list of specifications.

Ultrasonic Sensing Range[1]:
- Sensing Range (model 150): 4″ (100mm) up to 9′ (2.7m)
- Sensing Range (model 95): 8″ (200mm) up to 20′ (6m)

Environmental:
- Temperature: -30°C to +70°C
- Relative Humidity: 0 to 95% non-condensing
- Altitude: 3000 meters (10,000 feet)
- Pollution: Degree 2
- Sound pressure (model 95 only): At 1 meter relative to 20uPa is ~125dB at high power and 115dB for normal power within 10-degree beam (ambient temperature & 50% RH). *Note: This spec pertains to a 10-cycle pulse that only occurs at the sensor's programmed sample rate; there is no sound emitted during any other times.*

Electrical:
- Power: Three 3.6 V AA Lithium (Li-$SOCl_2$) batteries by Saft p/n LS14500. Do not use any other battery technology.
- Operating current: ~30 mAdc with WiFi radio enabled. Sleep current ~1 uAdc
- Temperature Compensation: Internal probe
- Battery Life: With 3 Saft batteries, expected life at 1hr sleep rate is 3 years, 20-year shelf life
- Classification[2]: CE (EN 61326 EMC) Emissions and immunity regarding electromagnetic compatibility

Mechanical:
- Sensor Housing Threads: 2″ NPT
- Sensor Enclosure Rating: NEMA 4X, IP67
- Sensor Dimensions: See sketch in Appendix A
- Housing and Transducer Material: PVDF
- Antenna (external): 2.4 GHz 2dBi, straight, RP-SMA male, IP67
- Wakeup switch: Both internal pushbutton and by magnetic switch
- Weight: 1 lb. (450g) both models, not including batteries

WiFi Radio Module by Silicone Labs (WGM160P series module):
- WiFi: 2.4 GHz, 802.11 b/g/n
- Range: Line of site up to 300ft, in buildings with walls down to 30 ft
- Communications protocol: JSON over MQTT, JSON over TCP/IP tunneling.

WiFi Antenna: Impedance 50 ohms, Gain <= 2.1 dBi, VSWR <= 2, RP-SMA Male, IP67
WiFi Security: AP Login WPA, WPA2, WPA2-PSK, WEP. Encrypted Data over TCP/TLS
WiFi Module Regulatory Approvals: CE and UKCA - EU and UK. FCC – USA. ISED – Canada. MIC – Japan. KC - South Korea

Programming features:
- FOTA programming: Yes (Firmware Over The Air)
- Overfill/underfill Tank Alarm for wakeup radio for immediate push of status: Yes
- Saved Status Events: Store up to 1000 records

- Warning: To avoid potential injury, do not place ears within the 10-degree beam angle for an extended period of time while the product is operating.
- If the sensor is used in a manner not specified, the protection provided by the equipment may be impaired.

[1] Minimum sensing range increases as temperature increases, however minimum specified range will be reported regardless. See Section 13 for details. Maximum range is target dependent.

[2] CE EMC/EMI testing by certified authority

3 Gizmo Overview

Overview

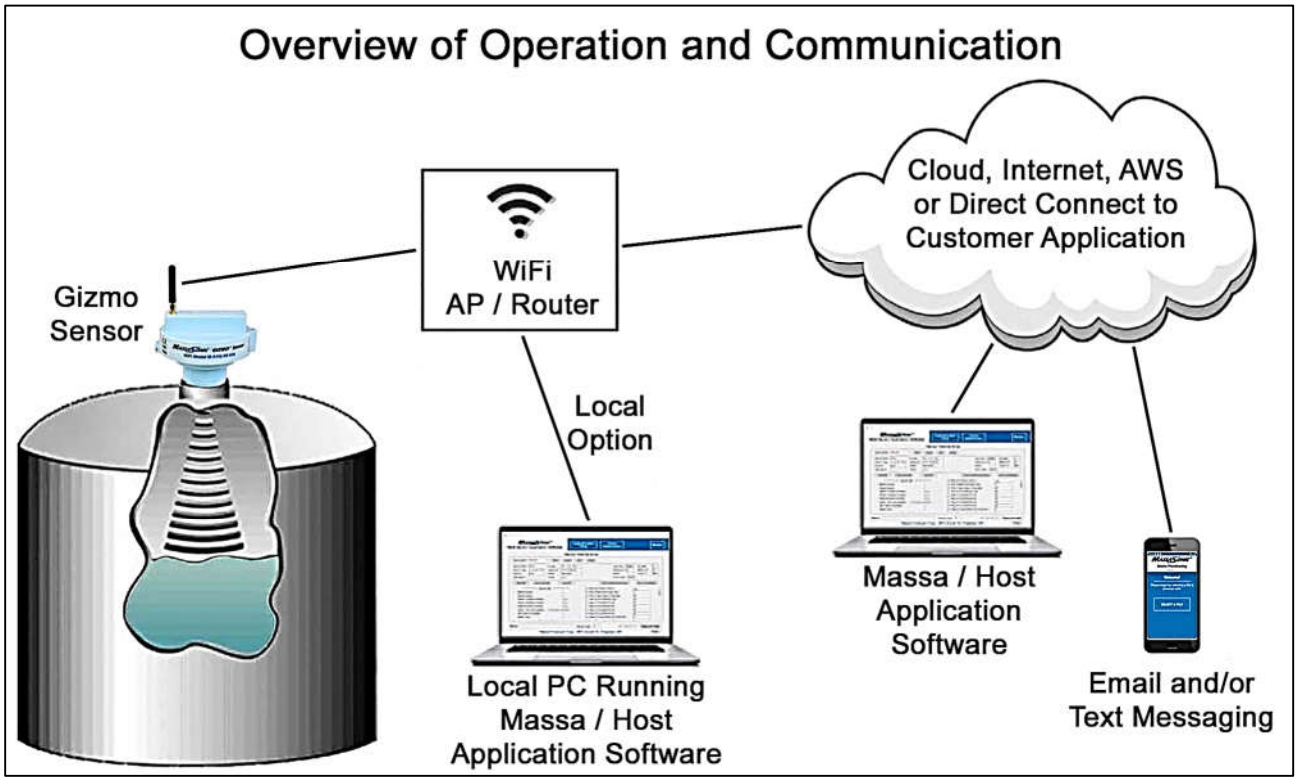
This document provides end-users with information about Gizmo's features and operation. It summarizes sensor operating modes, LED and switch uses, operating features, range measurement operations, communication options, and setup parameters. The goal is for end-users to understand how to operate and apply Gizmo to their specific use case. It is best to set up the sensor before it is installed on the tank.

JSON (JavaScript Object Notation) messages are sent to and from Gizmo using either industry standard Message Queuing Telemetry Transport (MQTT) or Massa's Local Host transport (formerly TCP Direct). See the Communicating with Gizmo section on the next page. Using the MassaSonic® Multi-Sensor Application (MMSA) takes care of all JSON messaging and transport details. For additional information and examples on communicating with Gizmo using JSON messaging, see Gizmo Advanced Users Guides.

Gizmo WiFi Communications

Gizmo features wireless access functionality to connect to preexisting in-plant WiFi network installations.

- Gizmo utilizes the industry standard MQTT transport protocol, for secure JSON (JavaScript Object Notation) data interchange.
- Gizmo WiFi securely connects to a WiFi network and then to an MQTT Broker. The MQTT Broker can be in the cloud or hosted on-site.
- The MQTT Broker is the gateway to all Gizmos. Users may access Gizmo event data, configuration, and waveform diagnostics through the MQTT Broker.
- MassaSonic® Multi-Sensor Application (MMSA) is a software package which provides an easy-to-use GUI interface to Gizmo data via its built in MQTT client.
- Gizmo provisioning sets WiFi details, broker connection, and security settings required for network and broker use. Use either MMSA or Gizmo's Provisioning Smartphone App.
- Gizmo also includes Local Host protocol, a simpler JSON transport connecting directly to MMSA or user proprietary software without the need for the cloud or MQTT broker.



3 Gizmo Overview

Real Time Clock

Gizmo includes a Real Time Clock (RTC) to maintain accurate time to timestamp events. The RTC updates on each Gizmo wakeup using an internet time server. Gizmo uses NTP to query the time server and converts the returned time to J2000 epoch time. This timestamp is recorded with each Measurement Event.

LED indicators and Blink Patterns

Gizmo has two multi-color LEDs, the sensor LED and the radio LED. These LEDs indicate sensor and radio status. Gizmo's green LED has two blink styles, a very short pulse and a longer, more intense blink. Short pulses are used to indicate Gizmo operation and status. After startup, the longer, more intense blink indicates Gizmo is going to sleep.

On Powerup (insert batteries)

Gizmo LEDs blink the following test and status pattern on normal startups:

1. One second sensor green LED blink — Bootloader normal startup
2. Two sets of sensor red/green LED blinks: — Sensor LED test
3. One radio green LED blink: — Radio power up test
4. Two sets of radio red/green LED blinks: — Radio LED test
5. One long sensor green LED blink: — Gizmo goes to sleep

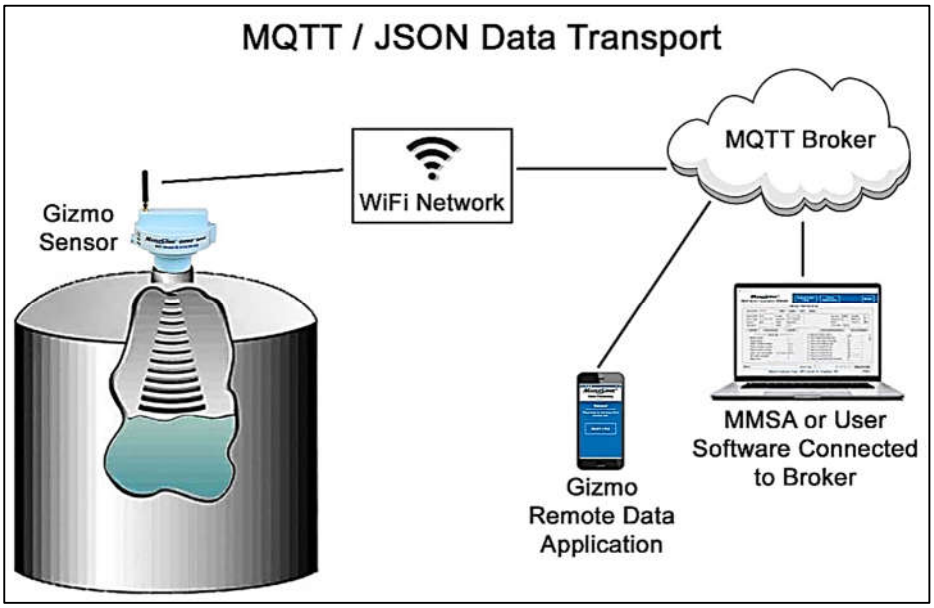
Communicating with Gizmo

Gizmo offers two data transport methods for end-user communications. The transport method is selected during Gizmo provisioning.

Gizmo with MQTT / JSON Messages

Gizmo WiFi Sensors support MQTT / JSON data transport. MQTT with JSON data interchange is a lightweight protocol design for limited resource embedded systems. This implementation of Gizmo communications is aimed at customers using (or soon to be using) the popular, industry standard MQTT broker with JSON data payload. See MassaSonic Gizmo MQTT / JSON Specification for details.
MQTT/JSON communication is selected by default during Gizmo provisioning.

Note: With an MQTT broker, multiple clients, including MMSA, can communicate with Gizmo, subscribing to Gizmo topics, monitor Gizmo events, and publishing new settings to the same Gizmo.



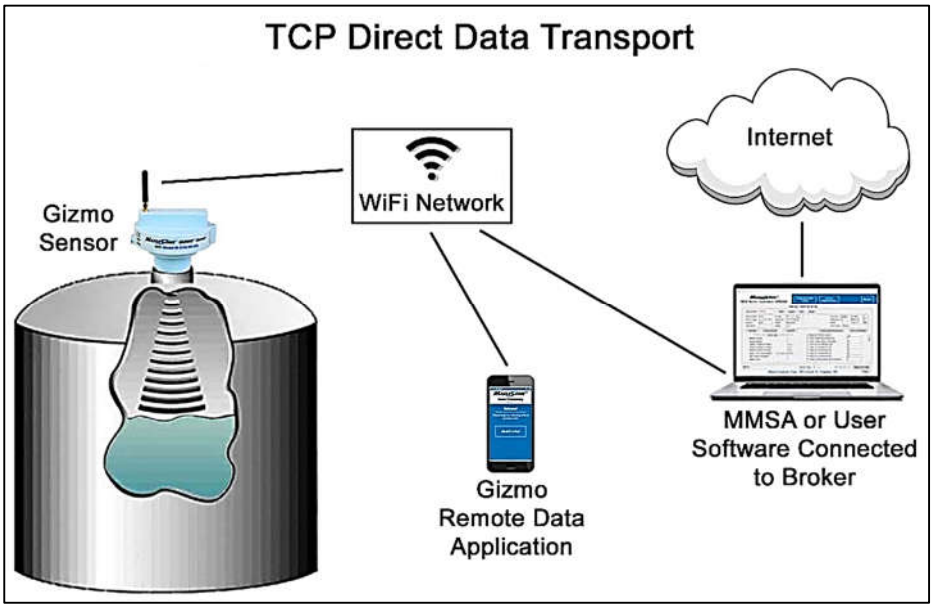
3 Gizmo Overview

Gizmo with Local Host

Gizmo WiFi Sensors also support Local Host data transport. Local Host is an alternative to MQTT. Local Host transports the same JSON data payload directly via the underlying TCP/IP protocol. This eliminates the MQTT protocol layer, MQTT topic overhead, and the required MQTT broker, simplifying messaging and required support services.

This Local Host implementation is aimed at more streamlined systems with a local network and a computer running a single instance of MMSA.

Local Host is selected during Gizmo provisioning.



Gizmo WiFi Communication Profiles

Gizmo stores network login and security information in two profiles; the Primary profile, and the Fallback profile. Each profile includes a complete set of WiFi and Broker/Host information necessary to connect and transport data.

On wakeup, Gizmo first makes 3 attempts to connect using the Primary profile. If unsuccessful, Gizmo then makes 3 attempts using the Fallback profile. If still unsuccessful, Gizmo goes back to sleep until its next wakeup time.

3 Gizmo Overview

On Wakeup When Sleep Time Has Expired or Button Press

When Gizmo wakes after sleep time, or the user momentarily pushes the Wake Button, the sensor's green LED will pulse once indicating the start of range measurement. After range measurement, Gizmo will power the radio. The radio's green LED will blink once when powered on, once when the radio connects to the WiFi network, and once on each data transmission to the broker.

If the Wake Button was used, the sensor's green LED will also pulse every 3 seconds until Gizmo goes back to sleep.

When Gizmo goes back to sleep, the green LED will show a longer blink (more intense).

Note: Upon Wake Button push, if the Sensor LED does not blink immediately then Gizmo is already awake and busy. To force Gizmo to sleep, press and hold the Wake button for 4 seconds.

Wake Button and Wake Magnetic Switch Control

The Wake Button and Wake Magnetic Switch perform identical functions. The Wake Button is used when Gizmo's cover is open (initial install or battery change). The Wake Magnetic Switch is used for the same functions when Gizmo's cover is closed. All details described below for the Wake Button also applies to the Wake Magnetic Switch.

The following operations can be initiated with the Wake Button:

- Force wakeup, range measurement, and report.
  Push and hold the Wake Button for 1 green Sensor LED pulse. Gizmo wakes in currently programmed operating mode.
- Initiate radio provisioning.
  Push and hold the Wake Button for 3 green Sensor LED pulses. This should take approximately 6 seconds. Gizmo will start the provisioning mode.
- Force radio provisioning Access Point reset.
  Push and hold the Wake Button for 11 green Sensor LED pulses. Gizmo wakes, powers the radio, resets the radio's provisioning AP and password to default values, and goes back to sleep.

Note: Upon Wake Button push, if the Sensor LED does not blink immediately Gizmo is already awake and busy. To force Gizmo to sleep, press and hold the Wake button for 4 seconds.

Sensor Power and Battery Life

Gizmo's power source requires three 3.6 V Lithium (Li-$SOCl_2$) batteries manufactured by Saft p/n LS 14500. The LS 14500 is a Primary type (not rechargeable) battery. Do not use any other type of battery technology.

Gizmo employs radio power management to maximize battery life. If sleep time is greater than 90 minutes, radio power is shut off during Gizmo sleep. If sleep time is less than 90 minutes, the radio power is not shut off but set to a very low power mode while still maintaining WiFi connection parameters.

Battery life is calculated to be more than 18,000 measurement/report cycles on a single set of batteries which translates to a battery life of:

One range measurement and report per day	> 20 years
One range measurement and report per hour	> 3 years
Delayed report mode of one range measurement per hour with one report of all measured data per day	> 20 years

For Configuration Data Registers, see table in Section 9.

4 Gizmo Guide on Getting Started with MMSA Application Software

4.1 Overview

This section details Gizmo setup for MQTT/JSON services. The following example uses the AWS (Amazon Web Services) IoT MQTT Broker, the MassaSonic® Multi-Sensor Application (MMSA) software, and your local WiFi network with internet access. This example walks through Gizmo provisioning and briefly describes the use of MMSA software to monitor and configure Gizmo.

Note that both Gizmo and MMSA have been factory provisioned and configured for temporary operation with Massa's AWS demonstration account.

4.2 MassaSonic® Multi-Sensor Application (MMSA) Software

The MMSA Application is Massa's software for communicating with Gizmo. MMSA includes an easy-to-use user interface and built-in MQTT client and Local Host server drivers. MMSA works with both communication methods described above.

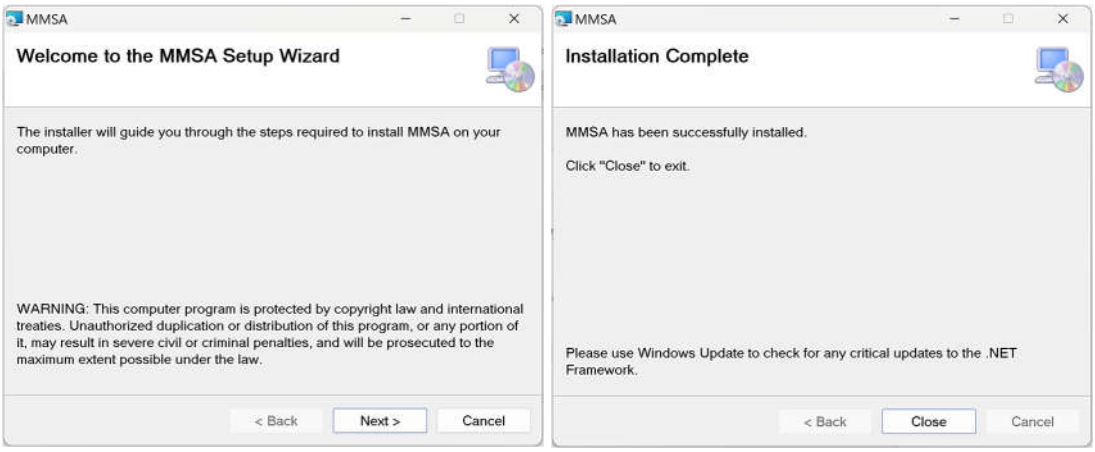
With MMSA's user-friendly GUI, user requests and new parameter settings are translated into JSON messages and queued for transmission when Gizmo is awake.

If Gizmo is provisioned for MQTT, when Gizmo wakes, queued messages are published to a broker for transfer to Gizmo.

If Gizmo is provisioned for Local Host, when Gizmo wakes, queued messages are sent directly to Gizmo. See next section for setting up the MMSA Software.

4.3 Install MMSA

MMSA's installation package includes two files, MMSA_V0_1_xx.msi and setup.exe. See Massa's website for the most up to date version. To install, run setup.exe and follow through the process until the installation is complete.

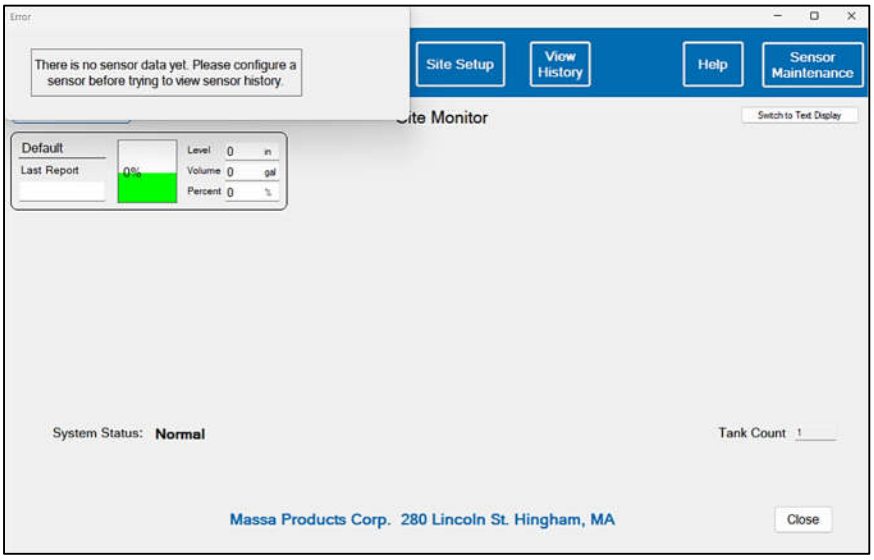


A desktop icon will be included in the installation. Click on it to start.

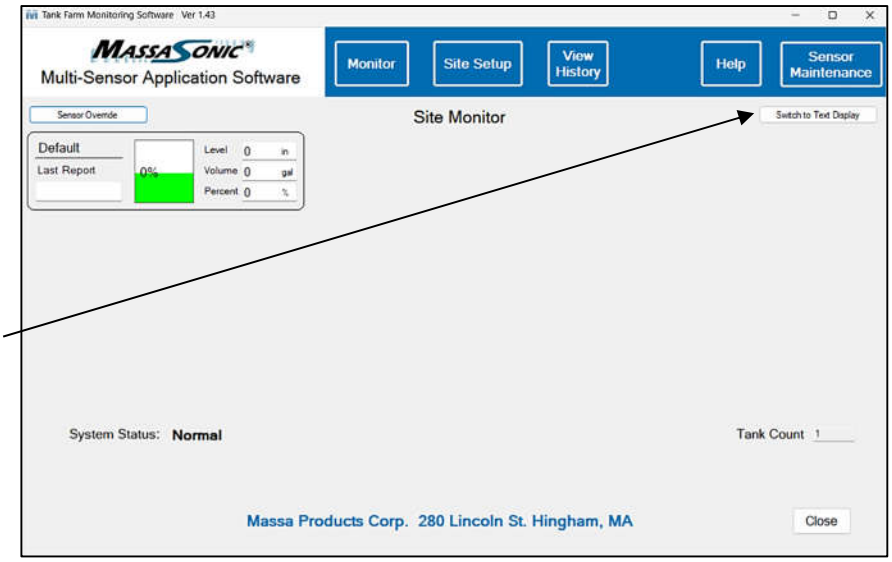
4 Gizmo Guide on Getting Started with MMSA Application Software

4.4 Initial MMSA Setup

The first time the software starts after an installation, it will indicate that a Gizmo sensor has not yet been configured.



The Site Monitor page has the choice of viewing the Gizmo status graphically as shown here or it can be selected to view it in Text mode.



Note: After MMSA installation, Windows Defender Firewall may display a blocked warning. Please Allow Access. If the blocked warning message does not appear and you later have trouble provisioning the sensor, close MMSA and proceed with the steps in section 4.5. Otherwise proceed to section 4.6.

4 Gizmo Guide on Getting Started with MMSA Application Software

4.5 MMSA Software Access Around Firewall

This step is required for the MMSA Software to get around a laptop's firewall. This document will specifically show how to create a rule in Windows 11 for the "MultiTankApp.exe" and "GizmoProvision.exe" programs. For other firewalls, similar setups may follow this procedure for allowing access to the MMSA software.

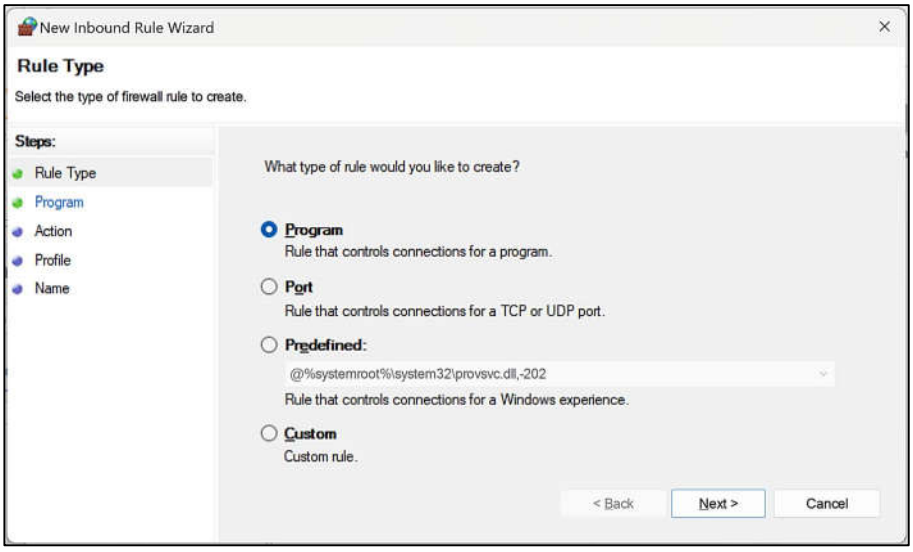
Gain access to the Windows Defender Firewall Control Panel.

Click on Advanced Settings

Click on Inbound Rules

Click on New Rule

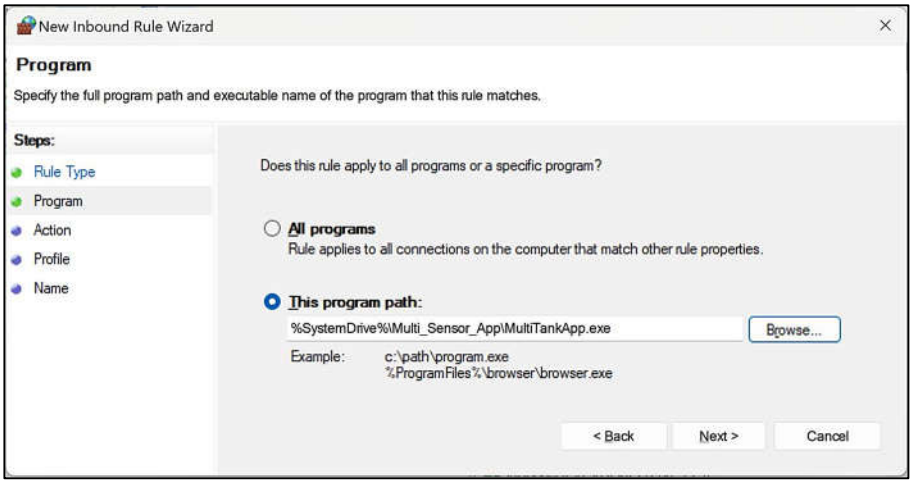
Click on Program then Next



Select "This program path:" and click Browse to find the MultiTankApp.exe.
The program was loaded with the default directory, the location is:

C:\Multi_Sensor_App

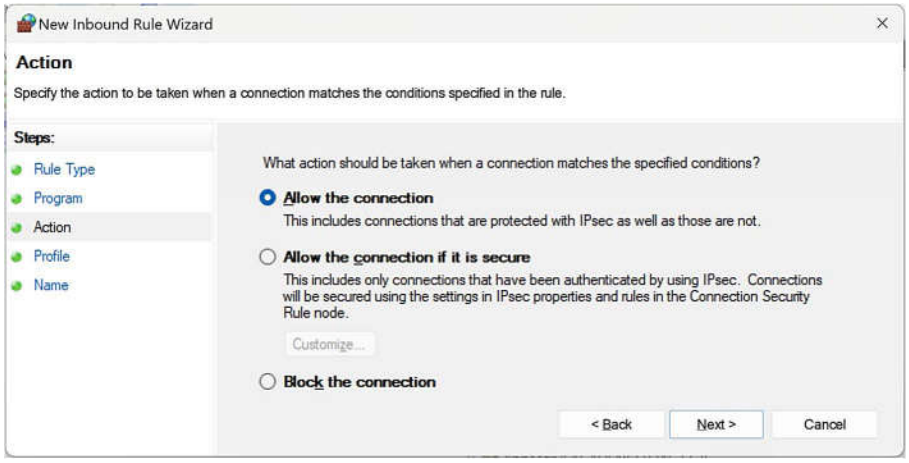
Then click Next



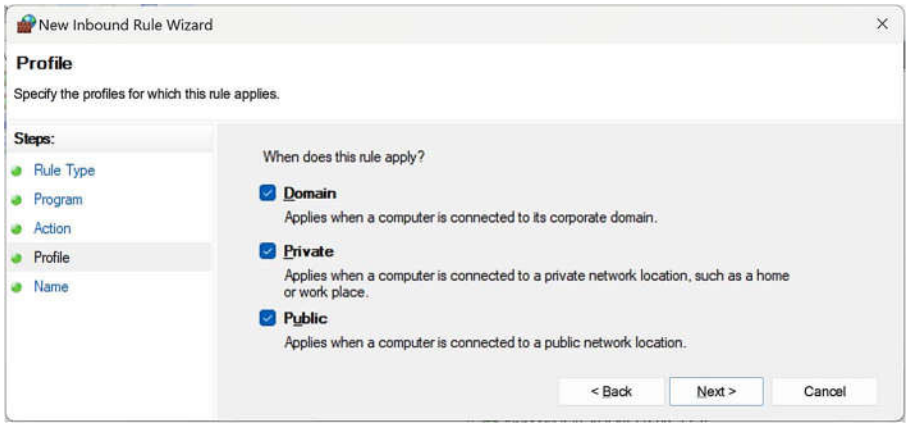
4 Gizmo Guide on Getting Started with MMSA Application Software

4.5 MMSA Software Access Around Firewall (continued from previous page)

Click on "Allow the connection" then click Next.

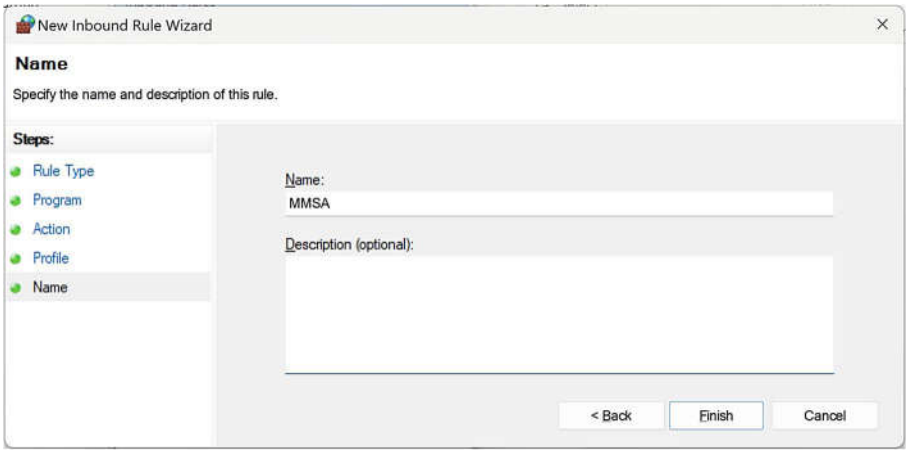


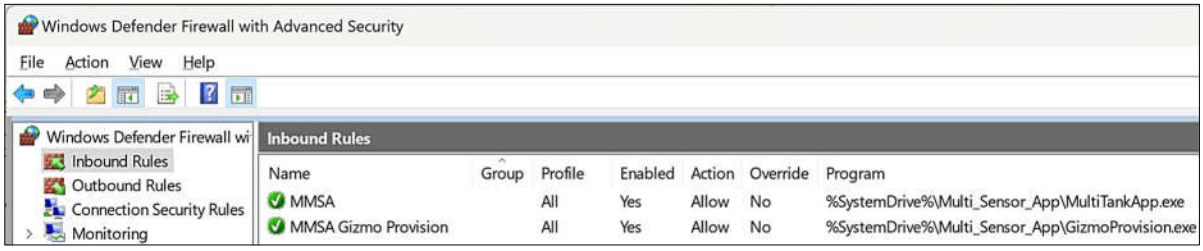
Apply rule to all the defaulted checkboxes. Then click Next.



This page allows the creation of the rule name. For MMSA, simply use this name.

Repeat this procedure for the second executable file named "GizmoProvision.exe". After both rules have been created, they will be seen in the Inbound Rules list as shown below. The name of the GizmoProvision.exe rule was saved as MMSA Gizmo Provision.





4 Gizmo Guide on Getting Started with MMSA Application Software

4.6 Overview of Sensor Out of the Box

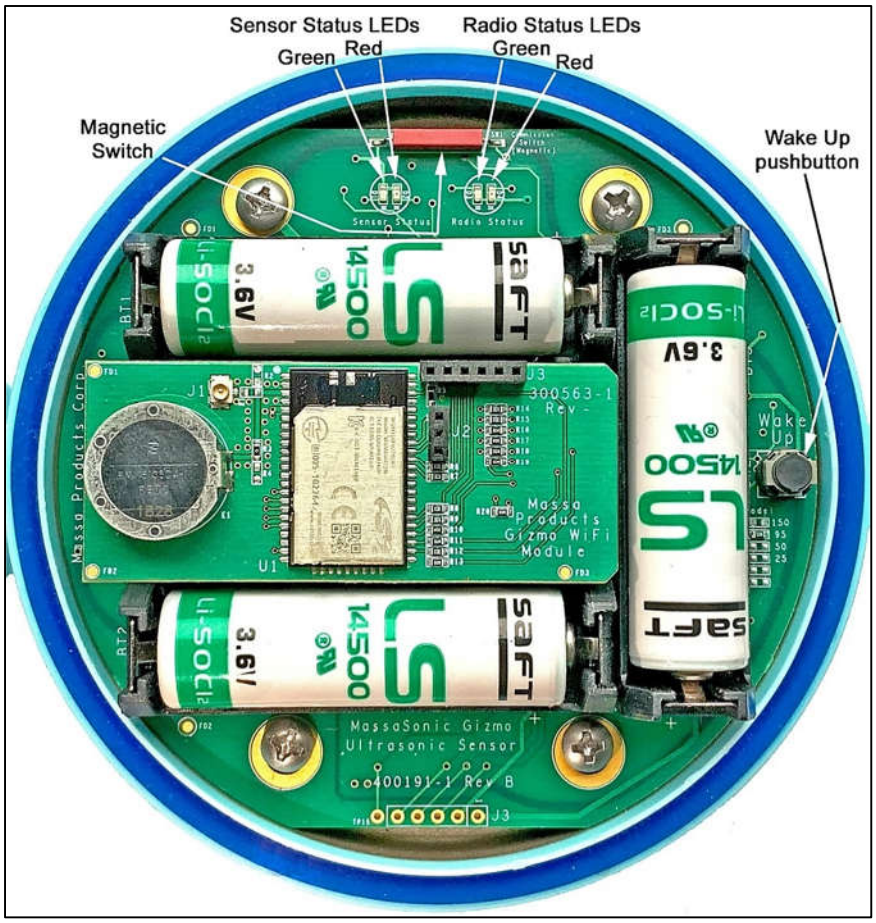
To have the MMSA Software communicate with a Gizmo Sensor requires it to be provisioned with your WiFi network. When batteries are installed, the sensor performs an LED power up sequence then wakes up the radio looking for a network. **Note:** Gizmo batteries are wired in parallel. To remove power from Gizmo be sure to remove all 3 batteries.

The LED sequence at power up validates the Gizmo sensor and the WiFi radio are functioning.

The turn on sequence is as follows:

Sensor Status green LED is turned on for 1 second followed by
Sensor Status LED red-green-red-green followed by
Radio Status LED green pause green-red-green-red

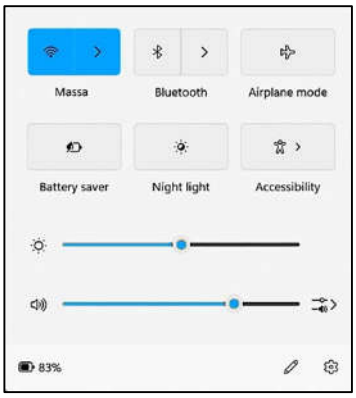
The sensor searches for a WiFi network for about a minute and if not able to join, the Status LED will have a long green blink and go to sleep. Next step is to provision the Gizmo by having it create a hot spot and have your computer join to continue the provisioning process with the MMSA Software.



4 Gizmo Guide on Getting Started with MMSA Application Software

Massa recommends getting started with MQTT and our AWS IoT demonstration account. This is the quickest way to get Gizmo up and running. This demonstration account is for limited use to evaluate Gizmo and MMSA for your installation and requirements. See Gizmo's Advanced User Provisioning Guide for permanent accounts.

4.7 Provisioning, Setting up Gizmo as a WiFi Access Point (Hot Spot)



The first step for the Gizmo Sensor is to create a WiFi access point (hotspot) for your computer to join. This provisioning step requires that the sensor be asleep. After powering up sensor, wait a minute for it to fall asleep (no blinking LEDs). Once asleep, push and hold the *Wake Up* button until the Sensor Status green LED blinks exactly 3 times, then release the button.

Open your computer's WiFi dialog box. In this Windows 11 view to the right, click on the right arrow on the WiFi network to see the access points. In this example, the WiFi access point for the computer is currently "Massa".

Note: Verify the MMSA Software is closed as you continue this process.

Preliminary access will be achieved by seeing the sensor on the WiFi network list indicated with the Gizmo name followed by its MAC address. The first figure to the left shows a Gizmo Sensor named "Gizmo_5c027209a08a". If a sensor does not appear on the list, refresh this page by going back to the WiFi dialog box by clicking on the top left arrow then click back to the WiFi network dialog.

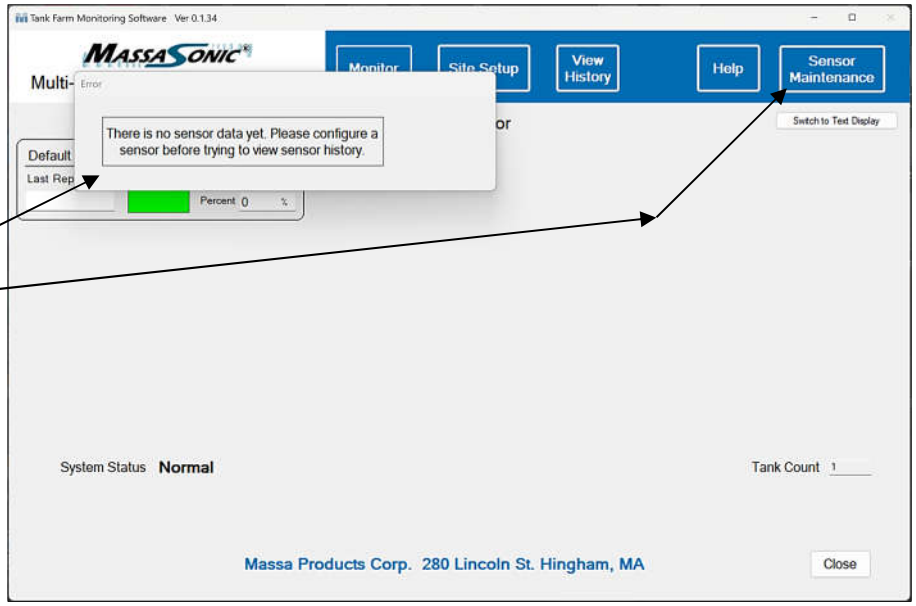
Next, click on *Gizmo_5c027209a08a* to have the Connect button to appear (2nd figure). Then, click on the *Connect* button and enter the sensor's security key, which is the sensor's MAC address as seen in the 3rd figure. Click *Next* button and then after a few moments, the sensor's security key will be verified and the network connection will be establish directly from sensor to the computer as seen in 4th figure to the right.

Failure to join will be indicated as "Can't connect to this network" requiring restarting this procedure. Make sure that sensor is still awake and blinking to connect. Note that this is a time sensitive procedure as the sensor only stays awake for just 6-minutes.

4 Gizmo Guide on Getting Started with MMSA Application Software

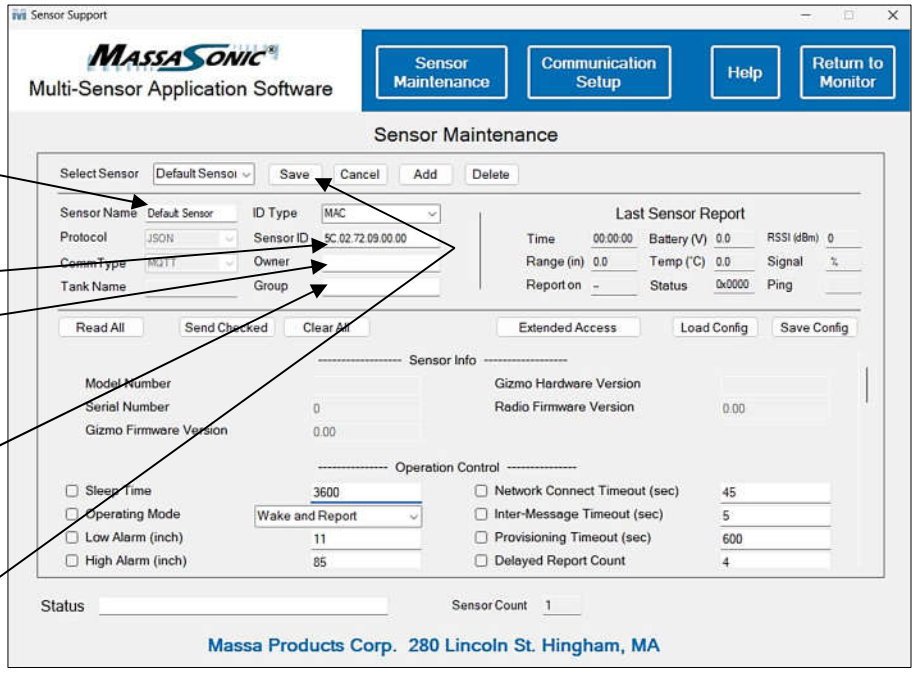
4.8 Provisioning the Sensor for use with the MMSA Software

Now that the sensor is a WiFi access point with the computer, it is time to set up the MMSA Application Software with the sensor.
Start the MMSA program (ignore this error message) and then press the Sensor Maintenance button.

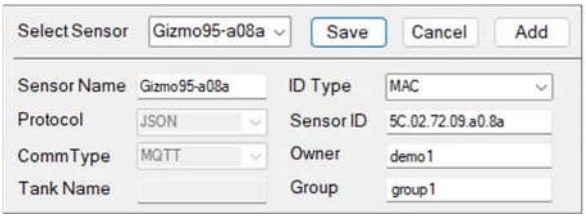


To add a sensor to the MMSA application, enter these items to the form:

1) Create and enter a unique Sensor Name
2) Enter sensor's MAC address for Sensor ID
3) Enter a unique Owner identifier value here. This could be your name or initials
4) Enter a unique Group identifier value here. This is another identifier for a sensor.
5) Click the Save button when all these 4 items are entered.



Here is an example of sensor information that was saved containing part of the sensor's MAC in the Sensor Name. This naming convention will help identify the sensor when additional ones are added later (using the Add button).

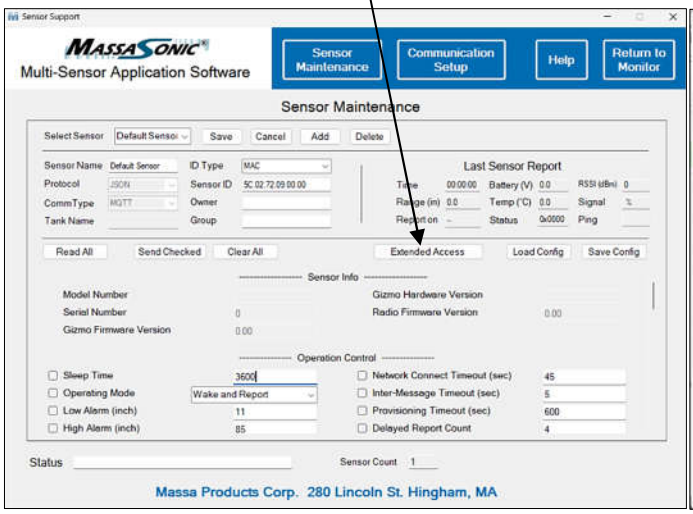


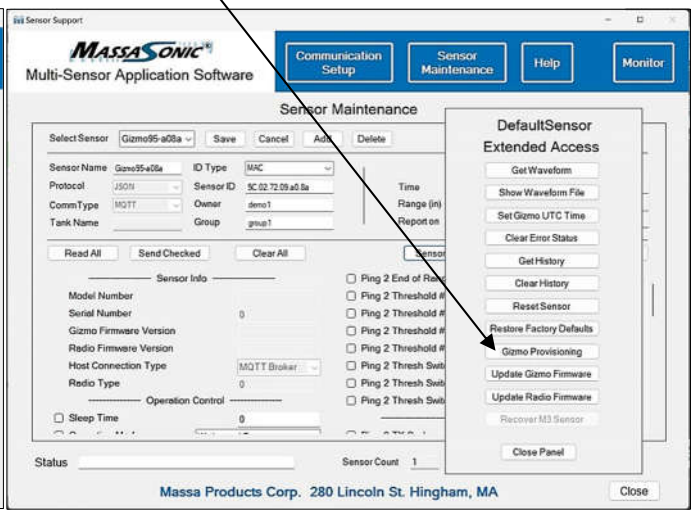
Close the MMSA software, then restart it and click on the Sensor Maintenance button.

4 Gizmo Guide on Getting Started with MMSA Application Software

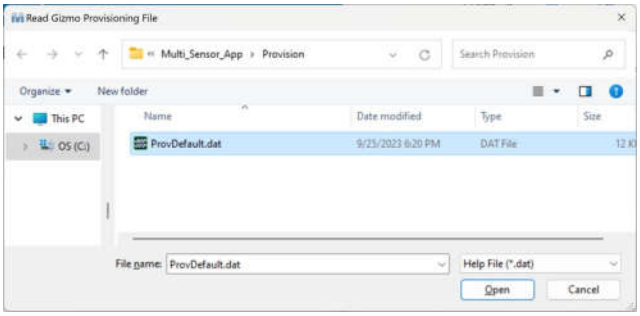
4.8 Provisioning the Sensor for use with the MMSA Software

Next, click on the *Sensor Extended Access* button. Then click *Gizmo Provisioning*.

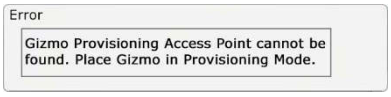




A provisioning file is requested to be read. Use the MMSA software default file this first time (ProvDefault.dat). Click Open to load the file.

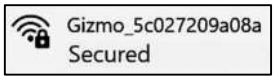


If this error message is seen below, it most likely means that the sensor was not saved as seen on the previous page, or the host computer has not yet connected to the Gizmo access point.



4.8.1 Gizmo Provisioning – Provision AP & Topics Qualifiers Tab

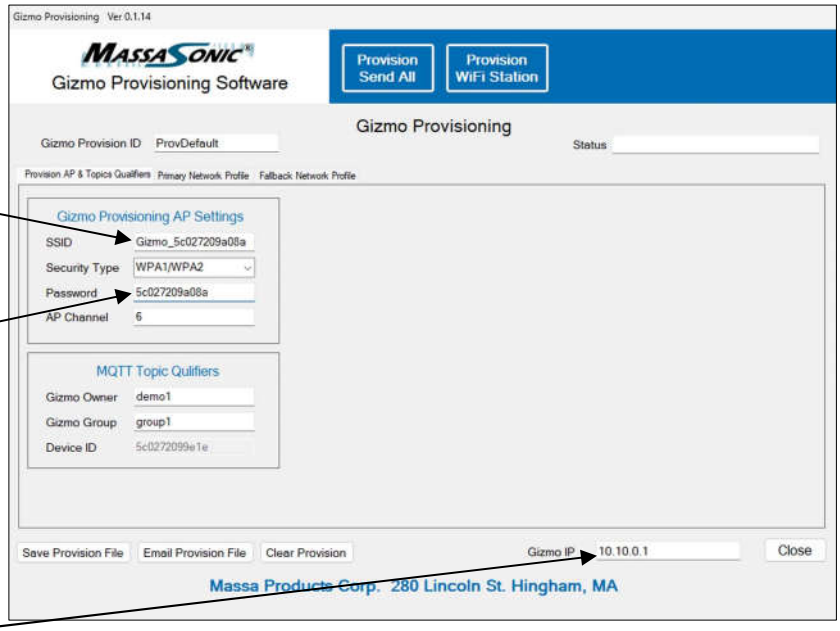
After loading the default provisioning file from above, enter the sensor's network name as you see it in the WiFi list at SSID



Then add the Password. For Gizmo Sensors, it is the MAC address.

Note: do not press the Save Provision File or Provision Send All buttons just yet. Go to the next steps to load the Primary and Fallback Network profiles.

Note, if sensor is connected to computer as access point, Gizmo IP will be indicated 10.10.0.1 here.



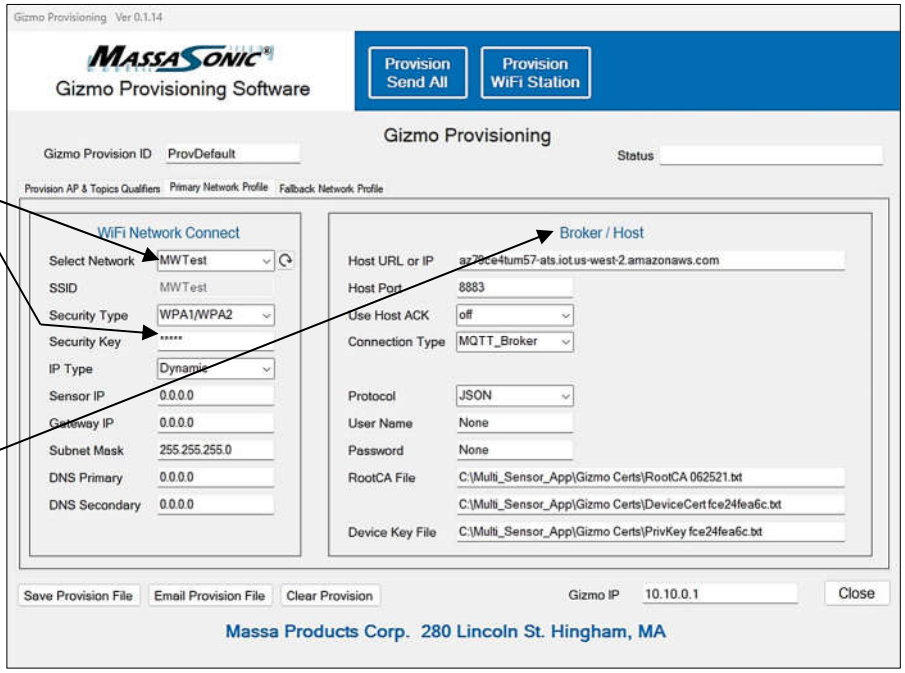
4 Gizmo Guide on Getting Started with MMSA Application Software

4.8 Provisioning the Sensor for use with the MMSA Software (continued from previous page)

4.8.2 Gizmo Provisioning – Primary Network Profile Tab

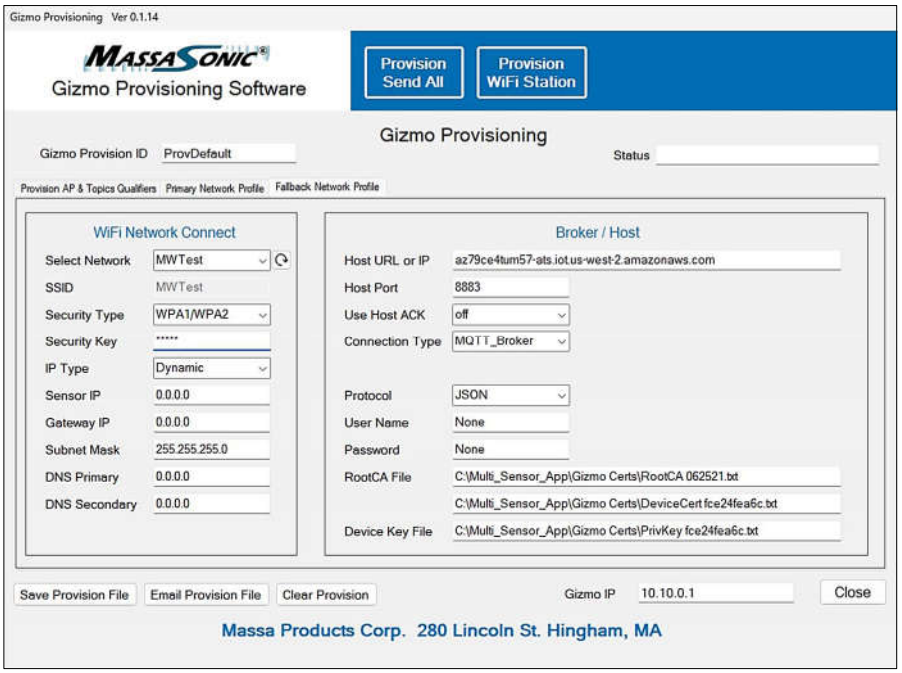
Click the Primary Network Profile tab. This tab is where the WiFi Network information is saved which is the bridge between the computer and sensor. Select your network SSID and enter the network password. Here is an example for this document.

Gizmo's default provisioning, shown here, is for the AWS IoT Broker, MQTT transport, and Massa's AWS demonstration account.



4.8.3 Gizmo Provisioning – Fallback Network Profile Tab

Click the Fallback Network Profile tab. This tab is where the WiFi Network credentials are saved as a second network profile option if the Primary Network has failed for any reason. The same Primary network credentials can be applied here if only one WiFi network is available. In this case this Fallback Network Profile will act as a retry of finding and joining the Primary network.



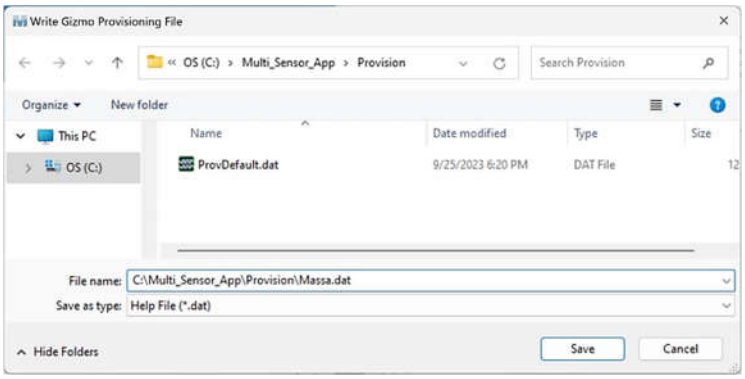
4 Gizmo Guide on Getting Started with MMSA Application Software

4.8 Provisioning the Sensor for use with the MMSA Software (continued from previous page)

4.8.4 Saving Provisioned Sensor and Network Profiles

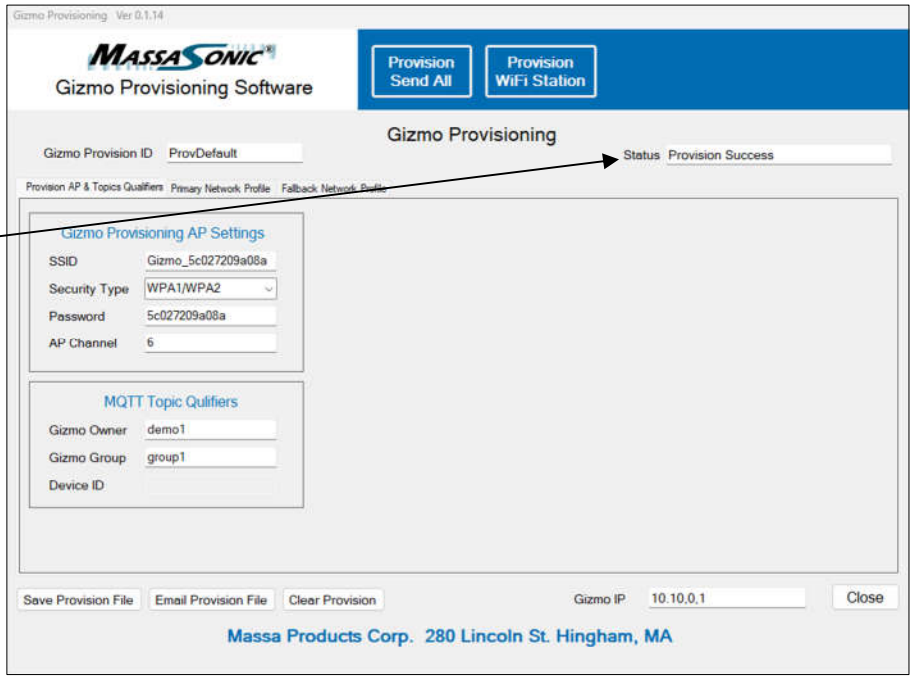
After all credentials for sensor and WiFi network have been entered, click the Provision Send All button to configure the sensor with the MMSA Application Software.

Then MMSA application requests to save the provisioned sensor data to file. It may be saved to the default file or create its own file as shown here.



A successfully provisioned sensor will be indicated in the Status box shown here.

Close MMSA software and close Gizmo Provisioning software. In the WiFi Dialog box close Gizmo WiFi connection. Re-connect your computer to your network with internet service.



4 Gizmo Guide on Getting Started with MMSA Application Software

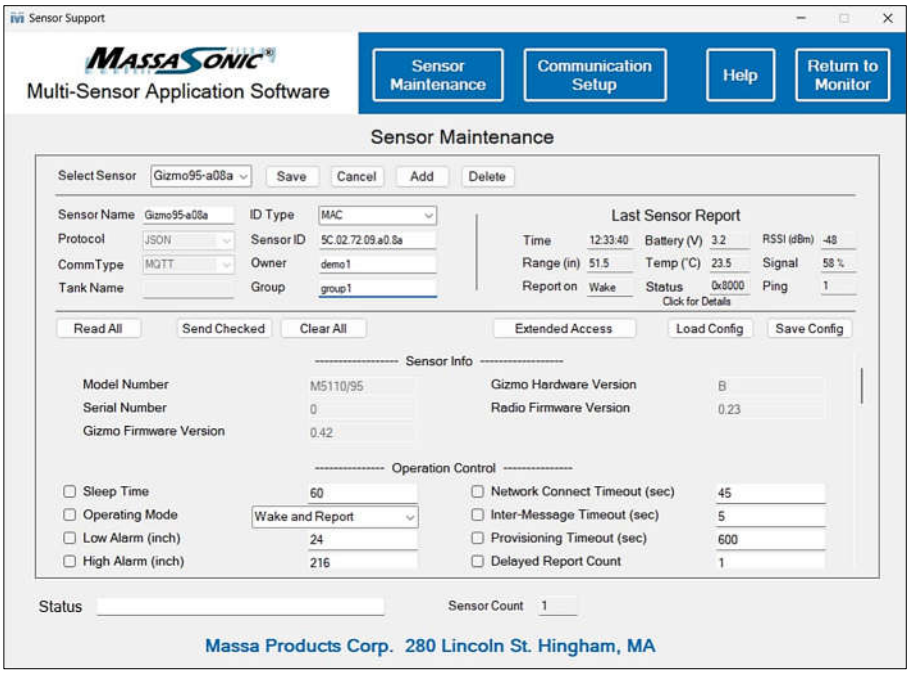
4.9 Viewing Gizmo Status using MMSA Software

At this point, Gizmo is provisioned to use local WiFi network and the AWS MQTT Broker. Note that Massa's AWS broker operates as a simple pass thru for Gizmo's status data. This will require the MMSA Software to be running. Here are the steps to observe the data. It starts with reconnecting the MMSA to your WiFi as follows:

1) Close MMSA Provisioning and Sensor Maintenance screens
2) Connect the PC to a network (either Ethernet or WiFi) that has internet access
3) Restart MMSA Software. On startup MMSA will automatically establish communications with the AWS broker.
4) As the Gizmo sends its status data to the AWS broker, MMSA will retrieve the status data. MMSA will also pass commands, read or write Gizmo configuration and request diagnostic waveforms through the broker.

After the Gizmo Sensor has been provisioned, MMSA will display the Gizmo range event data in the upper right corner of the Sensor Maintenance screen. The event data in this screen includes measurement range, time it was recorded, RF signal strength, temperature, battery voltage, event type, and Gizmo status.

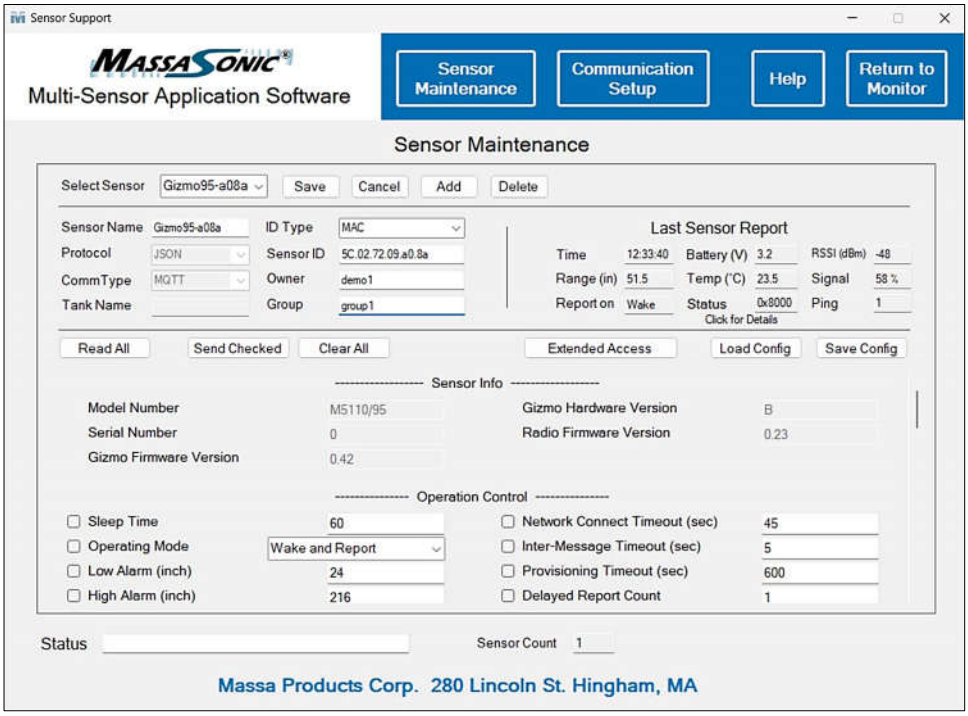
To update, press the Gizmo's Wake Up button to obtain a new reading in a few seconds as the sensor sends status to MQTT broker and MMSA software reads status from MQTT broker.



4 Gizmo Guide on Getting Started with MMSA Application Software

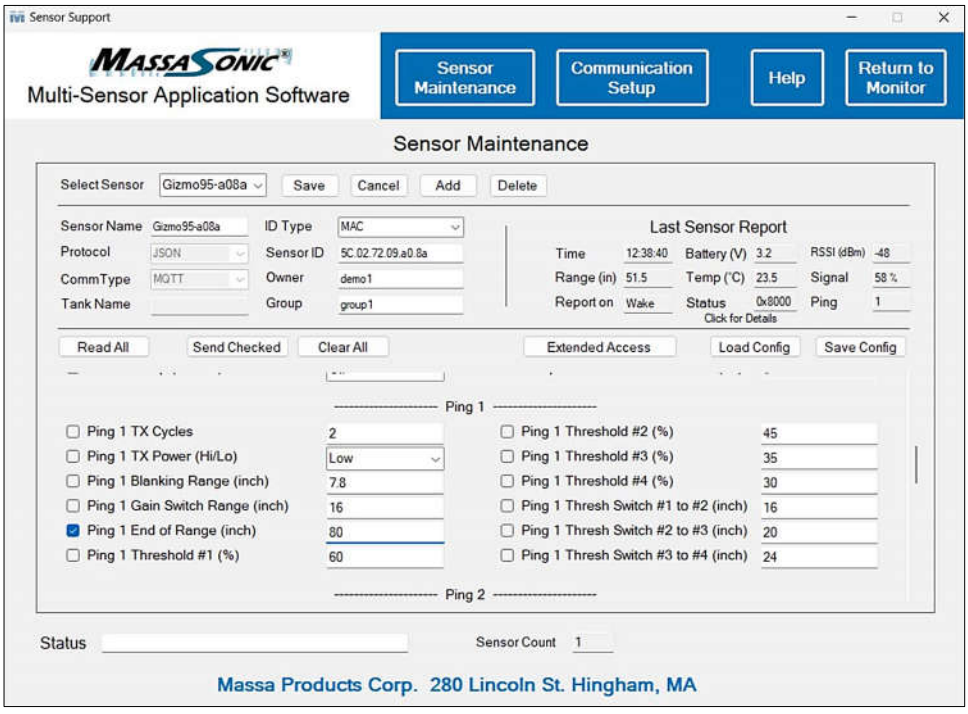
4.9.1 Reading and Editing Gizmo Settings using MMSA Software

To read back all Gizmo settings, click on the *Read All* button. If sensor is sleeping, this read request message will remain in an MMSA queue until the sensor wakes up. When Gizmo wakes up it will report all settings.



To write a setting to the Gizmo, select which parameter to change, enter a valid value, and click on the check box beside the desired value. When all changes have been entered, click *Send Checked*. When Gizmo wakes up, the selected settings will be sent to Gizmo. In this example, Ping 1 End of Range is set to 80 (inches). Clicking *Send Checked* will program the sensor with this value next time the sensor wakes up.

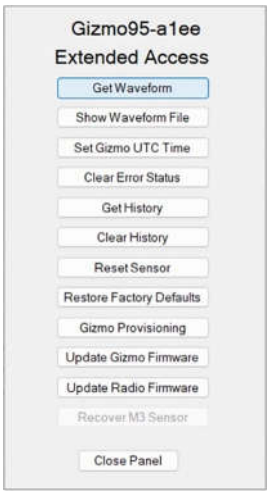
Notice, on the next page that waveform for Ping 1 now displays out to 80".

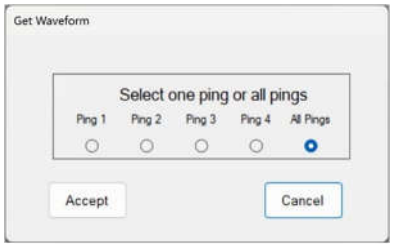


4 Gizmo Guide on Getting Started with MMSA Application Software

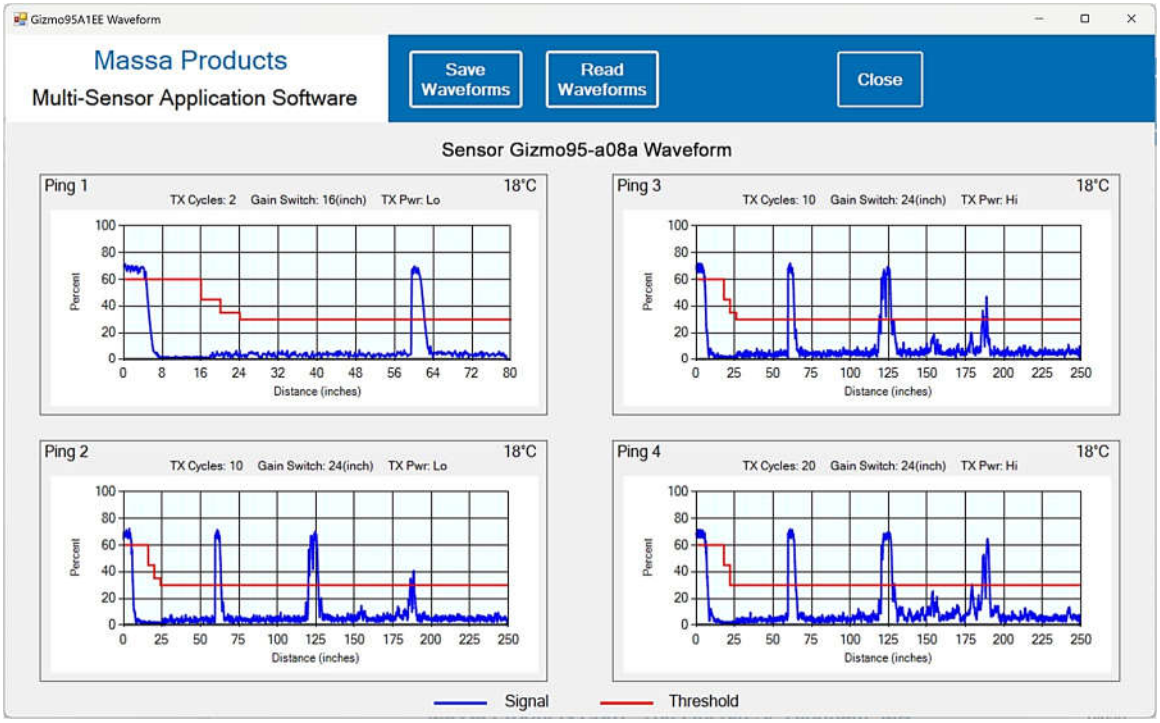
4.9.2 Obtaining Gizmo Diagnostic Waveforms using MMSA Software

One of the key features of the Gizmo Sensor is its ability to obtain ultrasonic diagnostic waveforms and have them saved to file for analysis if any application issues arise. If there happens to be an issue with incorrect reporting of range, these diagnostic waveforms can provide the reason for such issues like an obstruction in the path of the real level. In such cases, sensor sensitivity settings can be adjusted to provide the proper measurement reporting. To obtain waveforms, select the sensor in the Sensor Maintenance form, then select Sensor Extended Access as seen on the figure to the left. This will bring up the Get Waveform dialog box. Select All Pings followed by the Accept button. When the sensor wakes up on its expired sleep period, it will report status then obtain the waveforms that can be saved to file for later viewing.





Here is a representation of what the Waveform Playback Software will look like. It is a good idea to save a set of waveforms when the tank is empty to validate no obstructions are present. Click "Save Waveforms", then "Close" this form.



5 Gizmo Operating Modes

Gizmo Operating Modes

Gizmo includes seven operating modes tailoring operation to application requirements and battery life. Six modes support battery power with the seventh mode requiring line power.

Here is a list and brief description of operating modes.

- **Report On Wake** is the default operation and sends status (tank level) upon waking up based on the programmed Sleep Time setting.
- **Report On Delayed Event Count** is a mode that sends status reports as a block minimizing radio traffic and saving battery power. This mode features unscheduled reporting if over and under Alarms are enabled.
- **Wake & Catch Up** occurs automatically when WiFi or broker connections failed upon previous attempts upon waking up. When Gizmo wakes up and finally connects to the WiFi network, it will automatically send a block of records that were not previously sent.
- **Tank Fill / Empty Override** provides a fast-sampling rate during tank fill or empty. This temporary override of the set Sleep Rate occurs at a programmed scheduled time and includes an end time to halt this operation. See below for additional information about this mode.
- **Fast Sampling Override** is a mode that provides a temporary burst of fast sampling for fast changing tank levels upon next scheduled awake for a fixed length of time. See below for additional information about this mode.
- **Report On Request From Host (Future Operation)** is a mode where sensor performs its level measurement upon expiration of Sleep Time but provides the status report only upon request by the host. Gizmo will timeout if host does not request for data or other commands like changing settings.
- **Always Powered (Future Operation)** is a mode that keeps the sensor on the WiFi network. Gizmo will continue to report tank level at programmed sleep rate, report tank level upon request, change sensor settings, update Gizmo clock, provide historical records of past tank levels, provide diagnostic waveforms, or perform over the air firmware updates.

6 Ultrasonic Operation Details

Ultrasonic Range Measurement

Range to target (tank level) is measured by driving the transducer with a tone burst, referred to as a ping, and waiting for the arrival of a returned echo for the target. The returning echo is captured when the received signal level goes higher than the programmed threshold. This echo capture event is recorded with the precise elapsed time from the start of ping until echo capture. Using the medium's speed of sound, the range to the target can be calculated from the echo's arrival time.

The acoustic environment will vary with installation. Factors such as range, medium, temperature, and obstacles in the acoustic path will affect sound propagation. Gizmo implements the following set of features to accurately determine the distance to targets in diverse and varying environments.

The following ping parameters are programmable to adjust for acoustic environment with optimized battery life.

Time Varying Threshold

The expected signal level of the returning echo decreases as distance to the target surface increases. To compensate for this, Gizmo implements a programmable 4 step time varying threshold. The value for each threshold step and the time of each threshold step change may be programmed based on the specific acoustic environment.

Threshold Values are programmed as a percentage of the maximum echo level. Threshold Switch Times are programmed in inches from the start of ping.

Ping Transmit Cycles

To boost weak echoes, the user may program the number of cycles in the ping tone burst. More ping cycles means more acoustic energy transmitted, which translates to higher-level echo signals from distant targets. The number of transmit cycles is programmable for each ping.

Ping Transmit Power

Gizmo employs two power levels to drive the transmit ping. For close targets, Gizmo would use low power, which is adequate for close target capture and conserve battery power. For more distant targets, Gizmo will use high power, which uses more battery power but gets the weaker target. Transmit power level, set as Low or High, and is programmable with each ping.

Time Switched Gain

To further boost weak signals, Gizmo implements a Time Switched Gain increase which amplifies a weak acoustic signal. Initially, all pings start with low gain until the gain switch time is reached. At gain switch time, high gain is enabled. The switch time is programmed in inches for each ping.

Blanking Range

When Gizmo pings, the transmitted acoustic energy takes some time die out. To guard against this energy being detected as a false target, ping Blank Range prevents target capture for the specified blank range time. Blank Range is programmed in inches for each ping.

End of Range

End of Range, programmed in inches, terminates the ping process at the specified time. In the case of up-close targets, terminating the ping process after expected target capture will conserve battery life. End of Range is programmed for each ping.

6 Ultrasonic Operation Details

Ping Sequence Strategy

Gizmo uses a set of pings with varying tone bursts and transmit power to capture the echo. Gizmo's default ping settings are selected to conserve battery and assumes the target is at close range. The ping sequence starts with a 1 cycle ping (minimum transmit energy) and low power. When an echo is captured, the ping sequence terminates, and range is reported. If no echo is captured, Gizmo continues with the ping sequence listed below until an echo is captured or the ping sequence is complete.

1. 1 cycle short ping with low power
2. 10 cycle long ping with low power
3. 1 cycle short ping with high power
4. 10 cycle long ping with high power

If after all pings are complete and no echo is captured, the No Echo state is reported.

If an echo is captured, range is calculated from the captured time of flight (time from ping start to echo capture) and the medium's speed of sound (determined by sensor's temperature probe). See Gizmos Advanced Users Guide for JSON messaging examples.

Ultrasonic Waveform Diagnostics

To aid installation in complex acoustic environments, Gizmo includes a diagnostic tool that returns the received ultrasonic signal waveform data for the requested single ping or for all four pings. This signal will not only show the target and signal strength relative to thresholds but also other possible interfering objects in the acoustic path. Using this analysis, appropriate thresholds, ping sequencing, gain, and blanking range can be programmed to optimize target capture and range accuracy. See Gizmos Advanced Users Guide for JSON messaging examples.

7 Gizmo Status Records and Firmware Updating

Event Reports

When Gizmo wakes in either the Report on Wake or Wake and Catch Up modes, Gizmo reports JSON formatted measurement events. Details of the event report are shown in Table 1. See Gizmos Advanced Users Guide for complete JSON details.

Event History

Gizmo records up to 1000 Measurement Events, as described in Table 1, in its internal Event Log. When 1000 events have been recorded, the next event overwrites the oldest recorded event. The Event Log is available to read back by user software. The event log is read by specifying the start event index (1 thru 1000) and the number of Events to read. The index of the most recent or last recorded Event is reported in each Event report. See Gizmos Advanced Users Guide for additional information.

FOTA (Firmware Over-the-Air) Update

Gizmo includes a FOTA capability that provides remote updates of both sensor and radio firmware. Under user control, sensor or radio firmware is downloaded and installed from Massa's GitHub repository. New firmware version notification will be posted on Massa's website. When Gizmo receives the command to update radio or sensor firmware, it will check the repository revision. If newer than Gizmo's current revision, Gizmo will proceed to download and install the new version. See Gizmos Advanced Users Guide for additional information.

7 Gizmo Status Records and Firmware Updating

Table 1
Measurement Event Report

Data Item	Data Type	Description
Type	Int	Event reason 0 = none 1=Report on every wakeup 2=Report after delayed count events 3 = Report catchup 4=Report on alarm 5=Report on fill or empty target reached 6=Report on override timeout 7 = Report on override sample ready 8=Test report after provisioning 9=Report on request
Time	uint32	Event time stamp, seconds in J2000 epoch time
Range	Float	Measurement range in inches
Temp	Float	Temperature in degrees C
Volts	Float	Gizmo battery voltage
RSSI	Int	Radio signal
PingUsed	Int	Value from 1 to 4 indication which ping successfully returned the range measurement
Status	Int	Bit 0: Sensor Detection Fault. Bit 1: Temperature Probe Fault. Bit 2: Battery Low. Replace. Bit 4-6: Communication type 0 = MQTT 1 = MQTT with Fleet Provision 2 = Local Host 3 = Local Host with TLS Bit 7: Gizmo needs RTC time set Bit 13: Config validate error Bit 14: Config set to Factory Defaults Bit 15: Config set to Embedded defaults.
SignalStrength	Int	Ultrasonic signal strength in percent of Full scale
LastEventIndex	Int	Start index of current block of history data

8 Provisioning and Messaging Details

Gizmo Provisioning to WiFi Network

Provisioning data is the set of connection and security information that enables Gizmo to connect to a network, connect to a remote host or broker, and transfer data securely over that connection. Gizmo provides two provisioning profiles, Primary and Fallback. Both provisioning profiles are stored in Gizmo's internal non-volatile memory.

Provisioning Details

Gizmo uses a two-layer provisioning strategy:

- The Network Connect Layer provides details of network connection and login, as well as host connection. At a minimum Gizmo requires Network Connect provisioning. In the case of Gizmo WiFi, Network Connect details include the WiFi network SSID and Password as well as the host (broker) IP / URL and Port.
- The Security Layer provides the x.509 Device Certificate, Private Key, and the root Certificate Authority. Gizmo uses the credentials in this layer to mutually authenticate connection to sites like AWS IoT Core.

Provisioning Methods

The following are methods to program Gizmo's provisioning data:

- Direct Provisioning over Local WiFi Network using Gizmo Direct Provisioning (GP) software.
  1. In this method the user would first define Gizmo as a Thing in their AWS console, create a unique X.509 certificate, and attach Gizmo's access policy.
  2. Download the root CA, new Device Certificate and new Private key credentials. The downloaded files will be referenced by file name in Gizmo Provisioning (GP) software.
  3. Define the Network Connect details using the GP software GUI.
  4. Save this Gizmo's provisioning data for later use.
  5. When Gizmo is delivered to the end user and first powered, Gizmo Provisioning software is used to program both Network Connect and Security layer details. Place Gizmo in its provisioning mode. See Gizmo's Getting Started guide. Gizmo will establish a local WiFi network using its built-in provisioning AP.
  6. Connect your PC to Gizmo's provisioning AP, start the GP software, load the provisioning data file saved above and provision Gizmo.

- Provisioning using AWS services
  Gizmo supports the AWS Fleet Provisioning method.
  1. In this method Gizmo would be factory pre-provisioned with default or bootstrap Claim security credentials and network details.

     If network details were not provided at production time, then the GP software can be used to complete the pre-provisioning process, supplying missing security and network parameters.

     Note: Since AWS Fleet provisioning is an automated process, Gizmo's final operating parameters for the desired installation site must be entered into an AWS Dymo database. Massa provided Lambda functions and procedures are available to assist with uploading a .csv format data file to the database.

     The above will leave Gizmo in a default or bootstrap mode ready to connect and be automatically provisioned by AWS.

8 Provisioning and Messaging Details

Provisioning Methods (continued from previous page)

2. When Gizmo is powered on site, it connects to the local WiFi network as defined in steps 1 above. Once a WiFi network connection is established, Gizmo will connect to AWS and trigger the automated final site provisioning process.
3. From there AWS IoT will download the new credentials and network details to Gizmo. Gizmo will overwrite the Claim credentials and network data, saving the new details in a non-volatile memory profile for use on the next and subsequent connections.

- Gizmo Provisioning by MQTT

  Once Gizmo is initially provisioned and communicating via MQTT, provisioning details can be modified by sending all or part of the JSON Provisioning object. See details in the Gizmo Advanced Users Guide.

9 Gizmos Sensor Info, Operating Status, & Control Parameters Table

Data Item	Data Type	Limits	Default	Description
Sensor Info				**Sensor Info Section**
Model	String	Read Only	-	Gizmo model number
SN	Uint32	Read Only	-	Gizmo serial number
SensorFmwrVer	Float	Read Only	-	Sensor firmware revision
RadioFmwrVer	Float	Read Only	-	Radio firmware revision
SensorPCBVer	Float	Read Only	-	Sensor PCB revision
SensorTime	Uint32	J2000 epoch time	2451545.0	Gizmo time, seconds in J2000 epoch GMT time
EventCount	Uint16	Read Only	-	Available history events
RadioType	Uint8	Read Only	1	Bits 1-3: WiFi = 1 Cellular = 2 Bits 4-7: 0 = MQTT 1 = MQTT with Fleet Provision 2 = Local Host 3 = Local Host with TLS
Sensor Status	Uint16		-	Bit 0: Sensor Detection Fault. Bit 1: Temperature Probe Fault. Bit 2: Battery Low. Replace. Bit 4-6: Communication type 0 = MQTT 1 = MQTT with Fleet Provision 2 = TCP Direct 3 = TCP Direct with TLS Bit 7: Gizmo needs RTC time set Bit 13: Config validate error Bit 14: Config set to Factory Defaults Bit 15: Config set to Embedded defaults Bit 16: Radio Provision File Error Bit 17: Sensor FOTA Error Bit 18: Radio FOTA Error

9 Gizmos Sensor Info, Operating Status, & Control Parameters Table

Data Item	Data Type	Limits	Default	Description
OpsControl				**Operation Control Section**
SleepInterval	Uint32	60 sec. to 7 days	60	Sleep interval
OpMode	Uint8	0 to 5	1	Mode 1=Report on every wakeup 2=Report after history count measurements. 3=Report all events since last report
TimeZone	Uint8		0	Gizmo time zone (not used)
AlarmLow	Float	0 - 120 in (150) 0 - 250 in (95)	98″ (150) 216″ (95)	Distance below which, measure is in alarm
AlarmHigh	Float	0 - 120 in (150) 0 - 250 in (95)	11″ (150) 24″ (95)	Distance above which, measure is in alarm
Description	String	32 – 126 (ASCII character limit)	All 32 (space)	32 user description
RadioConnectTO	Uint16	5 to 300 seconds	45	Max radio attempt to connect wait time before sleep
InterMessageTO	Uint16	2 to 60 sec	5	Max inter-message time before sleep
ProvisioningTO	Uint16	60 to 600 sec	600	Max provisioning time
ReportCount	Uint8	1 to 255	1	Number of wake-up, measurement, and sleep cycles before report
Measurement Control				
Preset Temperature Off / On	Boolean	0 or 1	0	0=Off, 1=On
Preset Temperature Value	Float	-30 to +70	23	Degree C
TempCal	Float	-50 to +50	Read only	Temperature calibration offset by factory

9 Gizmos Sensor Info, Operating Status, & Control Parameters Table

Data Item	Data Type	Limits	Default	Description
Ping1 (see Note below)				**Config: Ping 1 Section**
TxCycles	Uint8	1 - 4 cycles	1 (150) 2 (95)	Number cycles in transmit tone burst
TxHiPwrEnable	Boolean	0 or 1	0	0= low power, 1= high power
BlankRange	Float	0 - 120 in (150) 0 - 250 in (95)	3.8 (150) 7.8 (95)	Measurement blanking range in inches
GainSwitch	Float	0 - 120 in (150) 0 - 250 in (95)	10.0 (150) 16.0 (95)	Distance for low to high gain switch in inches
EndOfRange	Float	0 - 120 in (150) 0 - 250 in (95)	120 (150) 250 (95)	End of range in inches
Threshold	Uint8[4]	0 - 100 %	60,45, 35,30	Array of 4 thresholds, percentage of maximum echo amplitude values
ThreshDistance	Float[3]	0 - 120 in (150) 0 - 250 in (95)	12,15,18 (150) 16,20,24 (95)	Array of 3 threshold switch distances in milliseconds. First element is time of switch between threshold 1 and threshold 2
Ping2				**Config: Ping 2 Section**
TxCycles	Uint8	0 - 32 cycles	10 (150) 10 (95)	Number cycles in transmit tone burst (to disable ping, set to 0)
TxHiPwrEnable	Boolean	0 or 1	0	0= low power, 1= high power
BlankRange	Float	0 - 120 in (150) 0 - 250 in (95)	6.0 (150) 12.0 (95)	Measurement blanking range in inches
GainSwitch	Float	0 - 120 in (150) 0 - 250 in (95)	16.0 (150) 24.0 (95)	Distance for low to high gain switch in inches
EndOfRange	Float	0 - 120 in (150) 0 - 250 in (95)	120 (150) 250 (95)	End of range in inches
Threshold	Uint8[4]	0 - 100 %	60,45, 35,30	Array of 4 thresholds, percentage of maximum echo amplitude values
ThreshDistance	Float[3]	0 - 120 in (150) 0 - 250 in (95)	12,15,18 (150) 16,20,24 (95)	Array of 3 threshold switch distances in milliseconds. First element is time of switch between threshold 1 and threshold 2

NOTE: Ping 1 performs signal processing for overfill condition when targets are within the sensor's specified minimum sensing range. Due to this operation, the number of ping cycles is limited. As noted in the specifications section of this document, the minimum sensing range increases as temperature increases (see Section 13) with the minimum specified range will be reported regardless.

9 Gizmos Sensor Info, Operating Status, & Control Parameters Table

Data Item	Data Type	Limits	Default	Description
Ping3				**Config: Ping 3 Section**
TxCycles	Uint8	0 - 32 cycles	10 (150) 10 (95)	Number cycles in transmit tone burst (to disable ping, set to 0)
TxHiPwrEnable	Boolean	0 or 1	1	0= low power, 1= high power
BlankRange	Float	0 - 120 in (150) 0 - 250 in (95)	8.0 (150) 15.0 (95)	Measurement blanking range in inches
GainSwitch	Float	0 - 120 in (150) 0 - 250 in (95)	16.0 (150) 24.0 (95)	Distance for low to high gain switch in inches
EndOfRange	Float	0 - 120 in (150) 0 - 250 in (95)	120 (150) 250 (95)	End of range in inches
Threshold	Uint8[4]	0 - 100 %	60,45, 35,30	Array of 4 thresholds, percentage of maximum echo amplitude values
ThreshDistance	Float[3]	0 - 120 in (150) 0 - 250 in (95)	15,18,21 (150) 18,22,26 (95)	Array of 3 threshold switch distances in milliseconds. First element is time of switch between threshold 1 and threshold 2
Ping4				**Config: Ping 4 Section**
TxCycles	Uint8	0 - 32 cycles	20 (150) 20 (95)	Number cycles in transmit tone burst (to disable ping, set to 0)
TxHiPwrEnable	Boolean	0 or 1	1	0= low power, 1= high power
BlankRange	Float	0 - 120 in (150) 0 - 250 in (95)	8.0 (150) 15.0 (95)	Measurement blanking range in inches
GainSwitch	Float	0 - 120 in (150) 0 - 250 in (95)	16.0 (150) 24.0 (95)	Distance for low to high gain switch in inches
EndOfRange	Float	0 - 120 in (150) 0 - 250 in (95)	120 (150) 250 (95)	End of range in inches
Threshold	Uint8[4]	0 - 100 %	60,45, 35,30	Array of 4 thresholds, percentage of maximum echo amplitude values
ThreshDistance	Float[3]	0 - 120 in (150) 0 - 250 in (95)	15,18,21 (150) 18,22,26 (95)	Array of 3 threshold switch distances in inches. First element is time of switch between threshold 1 and threshold 2

9 Gizmos Sensor Info, Operating Status, & Control Parameters Table

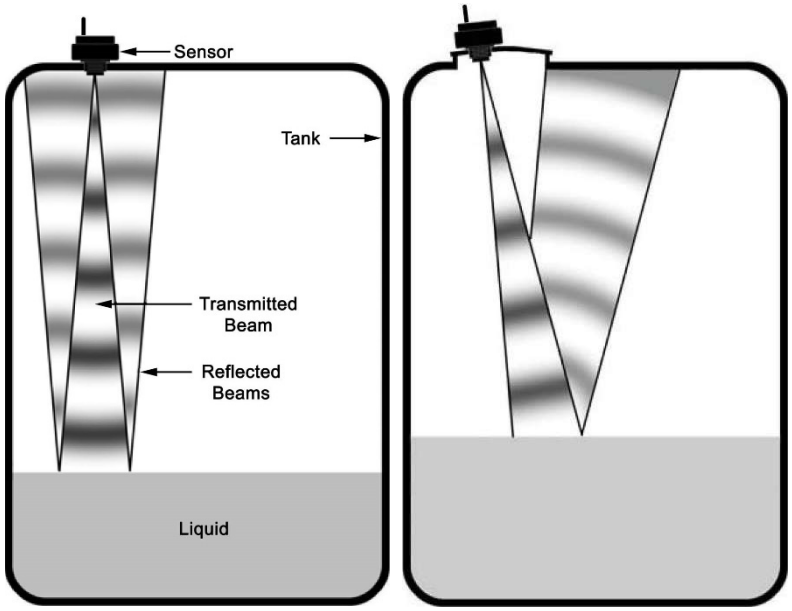
Data Item	Data Type	Limits	Default	Description
Fill Empty Override				**Config: Fill Empty Section**
StartTime	Uint32	J2000 epoch time	2459946.0000000	Override start time, seconds in J2000 epoch time (1-1-2023)
OverrideMode	Uint8	0 - 3	0	0= No Override, 1= Fill, 2= Empty, 3=Fast Sample
OverrideTarget	Float	0 - 120 in (150) 0 - 250 in (95)	0	Target, when reached Gizmo will send a report and terminate mode.
OverrideRate	Uint16	0 - 600 seconds	0	Override mode sample rate (override sleep time)
OverrideTimeout	Uint16	0 - 36000 seconds	600	Maximum override mode time. Reverts to normal sleep time after this time expires.

10 Installation Examples and Pitfalls to Avoid

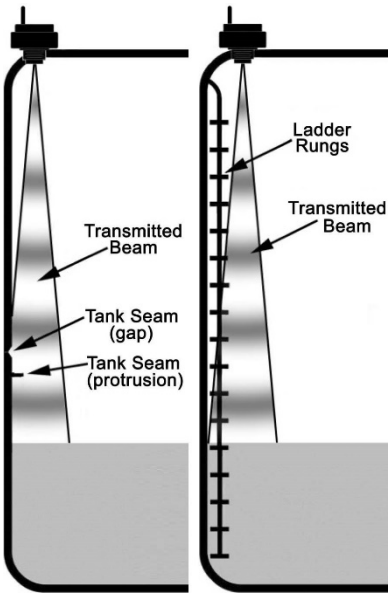
Once the Gizmo sensor has been provisioned to your network and is collecting status data, it is time to mount it on the tank. Many tanks have 2″ NPT or NPS threaded fittings that will allow the sensor to be mounted directly into it. Other installations may require adapters such as 4″ to 2″ reducers. Placement is relatively critical as to avoid obstructions or near water fill intakes. It is best to show some graphic examples for these concepts.

The tank on the left has the sensor placed away from the tank wall and without any obstruction to provide a clear path to the liquid level and good status reporting.

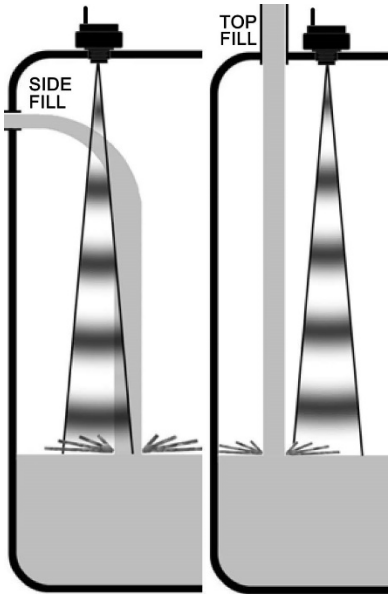
The tank on the right has the sensor placed on the tank off angle that will not provide the strongest reflected signal back to the sensor. As the tank empties, the sensor may not get a signal back and thus would report a No Echo response.



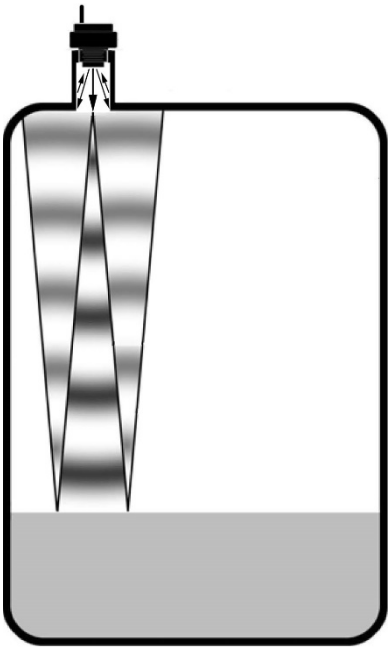
Sensor placed near a tank wall could have issues such as detecting tank weld seams or gaps, protrusions or ladders. Although sensor settings could be adjusted, it is best to move the sensor away from sidewall to improve reliable level reporting.



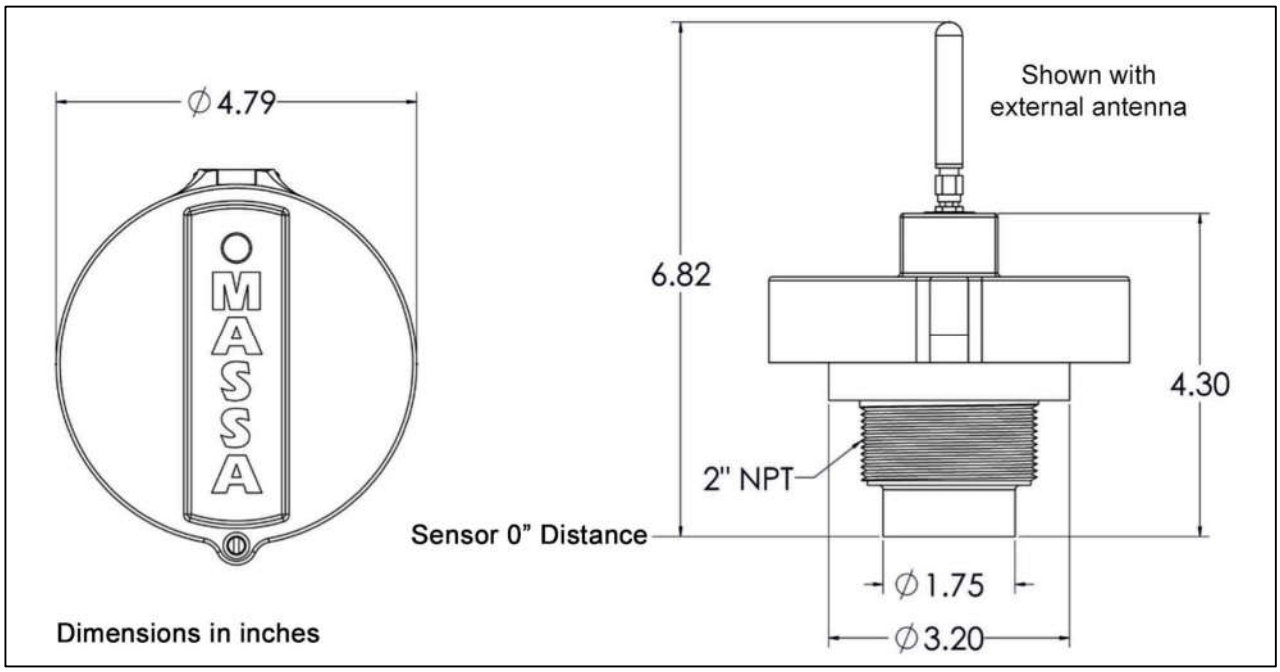
Sensor placed near tank fill and drain ports may report incorrect tank reading or a No Echo report during filling or draining of the tank. Sensor should be relocated away from these ports for reliable reporting during these times.



Sensors placed in standpipes pose their own challenges. Custom sensor sensitivity adjustments may be required. Massa tech support will require sensor waveforms to help customize sensor settings for the installation.



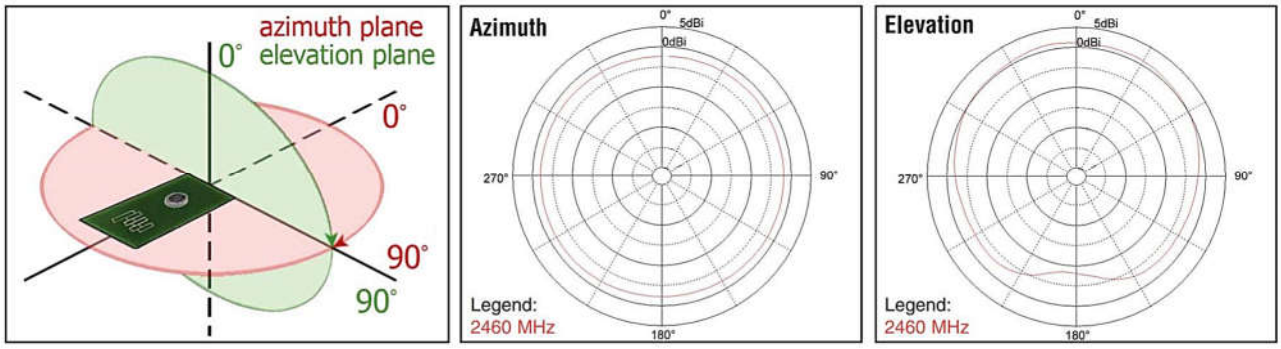
11 Product Dimensions and Zero Distance Reference Point



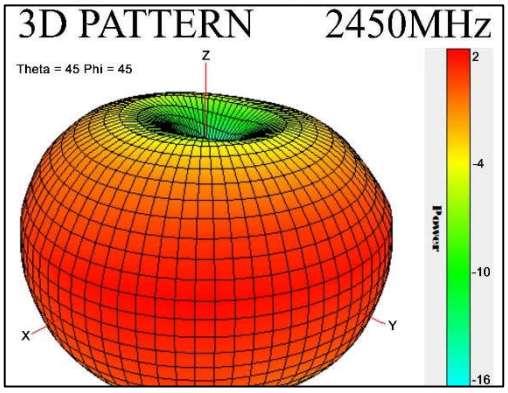
12 WiFi Antennas

WiFi range is affected by several factors. Walls will reduce range. External dipole antenna will have greater range over the internal on-board puck antenna. However, the external antenna is more donut shaped radiation pattern which will have reduced range when sensor or access point (AP) is over each other. The puck with its hemispherical radiation pattern is best for slightly shorter ranges regardless of AP elevation. Shown below is the radiation pattern for the puck antenna.

Radiation pattern of the puck antenna on Sensor's WiFi Module



Although a radiation pattern has not been performed on the Gizmo Sensor with external antenna, here is the radio pattern for an external antenna supplied with the Gizmo. As you can see, placing the sensor above or below the access point will not provide good results.



13 Sensing Range over Temperature

Temperature that exceeds value indicated below will pose a slight variance in reporting a linear measurement when a target approaches the indicated minimum distances. NOTE: The sensor's reported range will be the minimum specified distance when the target is at this distance. This table will aid in determining how to set up the application.

Temperature	Gizmo Model 150	Gizmo Model 95
< 36°C	3.9"	7.8"
36°C to 55°C	4.4"	10.1"
> 55°C	4.7"	12.5"

14 Customer Support

Note that Gizmo Sensor will provide many years of use. It is not intended to be serviced except by Massa Products Corporation. Any questions, please contact:

Massa Products Corporation
280 Lincoln Street
Hingham, MA 02043 USA

Tel: (781) 749-4800 Toll-Free in the USA: 800-962-7543
Hours: 8:00am to 4:30pm (Eastern Standard Time)
Website: www.massa.com Email: sales@massa.com

15 Warranty

MASSA PRODUCTS CORPORATION, hereinafter called MASSA, warrants each of its products to be free from defects in material and workmanship for a period of one year commencing on the date of delivery to the original Purchaser. The obligation under this warranty is limited to the repair or replacement at MASSA'S sole discretion of any MASSA product returned to MASSA or to an authorized field service station. OTHER THAN AS SET FORTH ABOVE, MASSA MAKES NO WARRANTY REGARDING ITS PRODUCTS (INCLUDING, WITHOUT LIMITATION, WARRANTIES AS TO MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE) EITHER EXPRESS OR IMPLIED. MASSA SPECIFICALLY MAKES NO WARRANTIES AS TO THE SUITABILITY OF THE PRODUCTS FOR ANY PARTICULAR APPLICATION, WHETHER FOR PURCHASER OR PURCHASER'S CUSTOMERS.

Massa Products Corporation reserves the right to change system and performance specifications without notice.

Revision History

Revision	Date	Notes
01	June 6, 2024	First release