

MASSASONIC® Gizmo® Ultrasonic Level Sensor



MassaSonic® Multi-Sensor Application (MMSA) Software Guide

MASSASONIC
Multi-Sensor Application Software

Monitor Site Setup View History Help Sensor Maintenance

Sensor Override **Site Monitor** Switch to Text Display

Sensor ID	Last Report	Fuel Level (%)	Percent (%)	Range (in)	Voltage (VDC)
T9EC2	04/06 10:42	100.00% Gasoline	100.00 %	0.00 in	0.00 VDC
TA1E6	02/14 12:03	79.76% Gasoline	79.76 %	20.24 in	3.40 VDC
TA146	05/01 02:11	100.00% Gasoline	No Echo	No Echo	No Echo
TA15C	04/30 20:00	50.86% Gasoline	50.86 %	49.14 in	3.55 VDC
T9CAE	08/17 12:44	96.20% Gasoline	96.20 %	3.80 in	3.43 VDC
TA0A6	02/23 09:00	94.64% Gasoline	94.64 %	5.36 in	3.39 VDC
TA1DA		0% Gasoline	0 %	0 in	0 VDC
TA1D2		0% Gasoline	0 %	0 in	0 VDC
TA0BA	04/04 15:01	23.21% Gasoline	23.21 %	76.79 in	3.29 VDC

System Status: **Normal** Tank Count

June 6, 2024 rev 1.0

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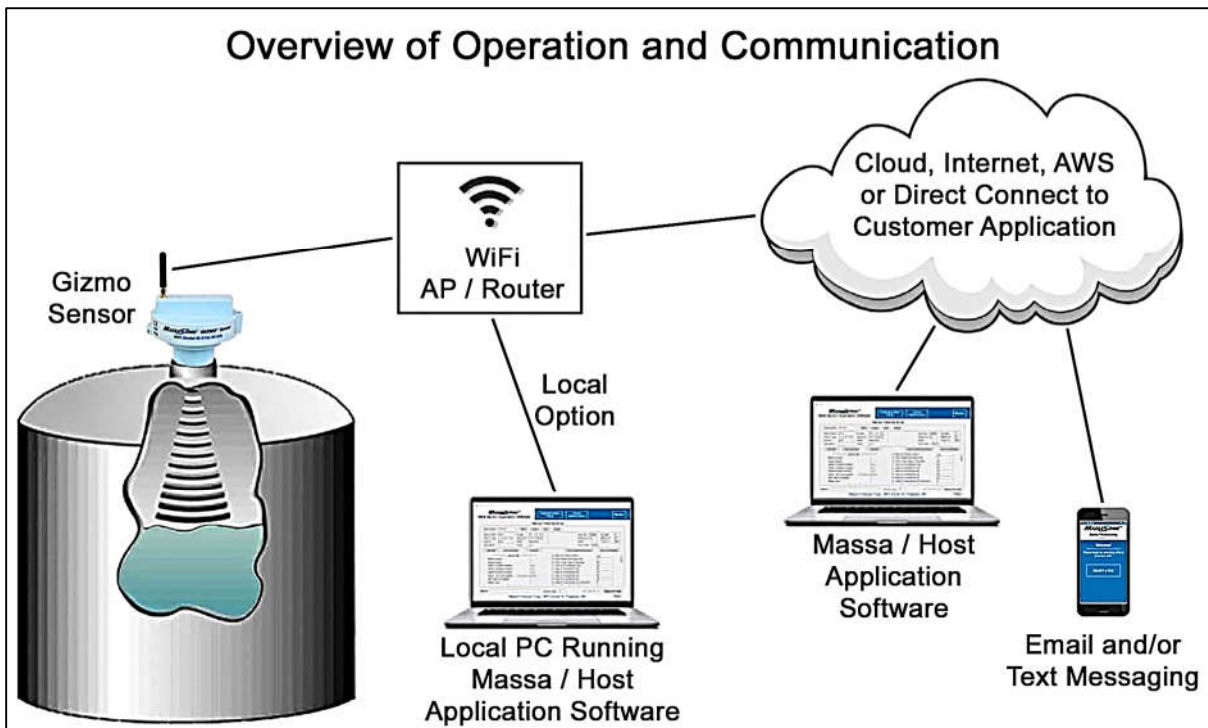
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1 Gizmo Communication Basics

Gizmo features wireless access functionality to connect to preexisting in-plant Wi-Fi network installations or to commercial Cellular carriers.

- Gizmo utilizes both the industry standard MQTT (Message Queuing Telemetry Transport) protocol and the streamlined Local Host (tunneling) transport, for secure JSON (JavaScript Object Notation) data interchange.
- Gizmo Wi-Fi securely connects to a Wi-Fi network and then to an MQTT Broker or Host. 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.
- Gizmo’s Local Host protocol, a simpler JSON transport connecting directly to MMSA or user proprietary software without the need for an MQTT broker and overhead.
- Gizmo is supported by MassaSonic® Multi-Sensor Application (MMSA), a software package, which provides an easy-to-use GUI (Graphic User Interface) for viewing Gizmo data via its built-in MQTT and Local Host drivers.
- Gizmo provisioning sets Wi-Fi details, broker connection, and security settings required for network and broker use. Use either MMSA, cloud based automated Fleet Provisioning, or Gizmo’s Provisioning Smartphone Application
- 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.



Supporting Documents:

1. MassaSonic® Gizmo® Advanced User Guide.
2. Gizmo and MMSA Provisioning Guide for complete provisioning instruction.

2 Overview

MassaSonic® Multi-Sensor Application (MMSA) is Massa's support software for Monitoring, Controlling, and Communicating with Gizmo.

The home page of MMSA includes a user-friendly graphic interface (GUI) presenting a high-level Site Monitor view, Site Setup features for interpreting sensor data, and a history log for sensor level/distance, sensor status, and inventory alarms.

The Sensor Maintenance page is the underlying technical interface to sensors, facilitating the connection and transportation of remote Gizmo data. This toolset takes care of the complexities of multi-channel communications, protocol translation, messaging queues/timing, and sensor maintenance. The toolset is designed to support wired and wireless sensors connected directly to the host platform via a local Wi-Fi router (Local Host), or cloud-based sensors connected via the internet (MQTT).

Using MMSA eliminates the need to write software to implement the Gizmo communication specifications. MMSA takes care of all communication details.

Typical Operation

Battery-powered sensors must spend most of their time asleep—in a minimum-powered state—to preserve battery life. As a result, MMSA spends most of its time waiting for sensors to wake up and connect. In typical operation, the Site Monitor begins by loading the last reported event for each Gizmo sensor and MMSA begins listening for sensor communications from both local and cloud-based Gizmos. Once connected, MMSA processes the incoming sensor data and sends any configuration updates or other commands back to Gizmo. Using the new sensor data, MMSA updates the Monitor, updates event data records, calculates sensor levels, and displays sensor status.

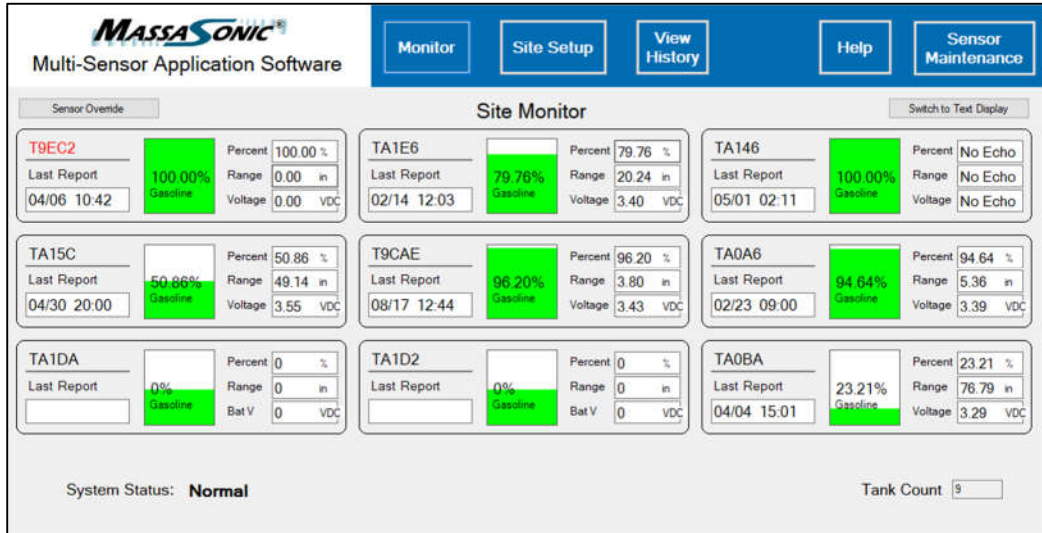
Installing MMSA Software

MMSA installation package includes two files, MMSA_Setup.msi and setup.exe. To install MMSA run setup.exe. This software installs all the required files including a desktop icon.

3 Site Monitor

The primary screen is the Site Monitor, which displays sensor parameters of interest. The Site Monitor has 3 selectable columns of sensor data. The user may select from tank Level, Range, Volume, Percentage Full, Temperature, and Battery Voltage. The Site Monitor includes the last Gizmo time stamp for each sensor and support for high/low level alarms and warning indications. This data can be displayed both graphically and textually.

Graphic Display



Text Display

Name	Content	Last Time	Percent	Range	Bat V	Name	Content	Last Time	Percent	Range	Bat V
T9EC2	Gasoline	04/06 10:42	100.00 %	0.00 in	0.00 VDC	TA0A6	Gasoline	02/23 09:00	94.64 %	5.36 in	3.39 VDC
TA1E6	Gasoline	02/14 12:03	79.76 %	20.24 in	3.40 VDC	TA1DA	Gasoline				
TA146	Gasoline	05/01 02:11	No Echo	No Echo	No Echo VDC	TA1D2	Gasoline				
TA15C	Gasoline	04/30 20:00	50.86 %	49.14 in	3.55 VDC	TA0BA	Gasoline	04/04 15:01	23.21 %	76.79 in	3.29 VDC
T9CAE	Gasoline	08/17 12:44	96.20 %	3.80 in	3.43 VDC						

Monitor Units

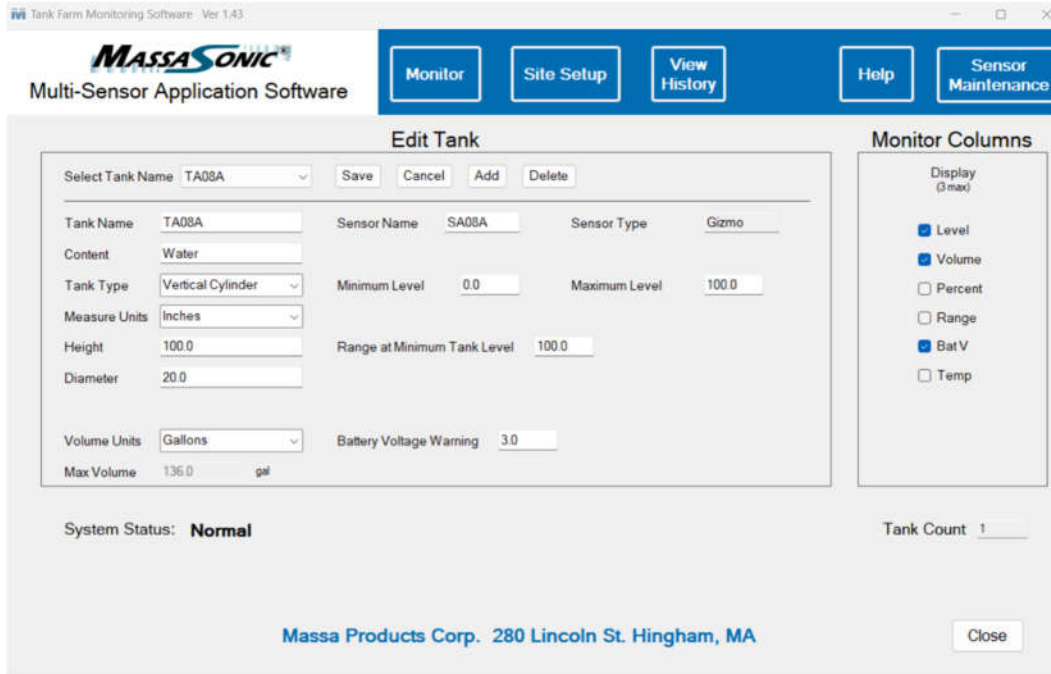
MMSA base measurement units are in Gizmo units of inches. When selected, units of Feet or Meters are scaled from Inches and displayed accordingly.

Volume units are Gallons, Liters, and Cubic Feet. Volume is also scaled from Cubic Inches and displayed accordingly.

MMSA software is capable of handling hundreds of sensors. This demonstration installation is limited to 50 sensors.

4 Site Setup

Clicking the Site Setup button in the top banner brings up the Site Setup screen. In this screen, the user can add, delete, edit, and save parameters. The user can also select which columns to display on the Site Monitor screen. For demonstration purposes, MMSA is set up as a tank farm in the images below.



Edit Tank

1. To edit an existing tank, first select the tank in the Select Tank Name dropdown list.
2. See the **Editing Tank Details** section below for more information about editing each field.
3. When finished, click the Save button.

Add Tank

1. Click the Add button.
2. Enter a new unique tank name.
3. See the **Editing Tank Details** Section below for more information about editing each field.
Note: Most tank values on-screen are default values from the previously displayed tank. This simplifies adding a new tank when the tank on-screen has similar values to the new tank.
4. When finished, click the Save button.

Delete Tank

1. Select the tank to be deleted in the Select Tank Name dropdown list.
2. Click the Delete button.
3. To confirm the deletion, select Yes in the popup window.

Cancel Adding/Editing Tanks

- a. If adding a tank, the cancel button returns to the previously selected tank and displays its values.
- b. If editing a tank, the cancel button overwrites edit values with previous tank values.

4 Site Setup (continued from previous page)

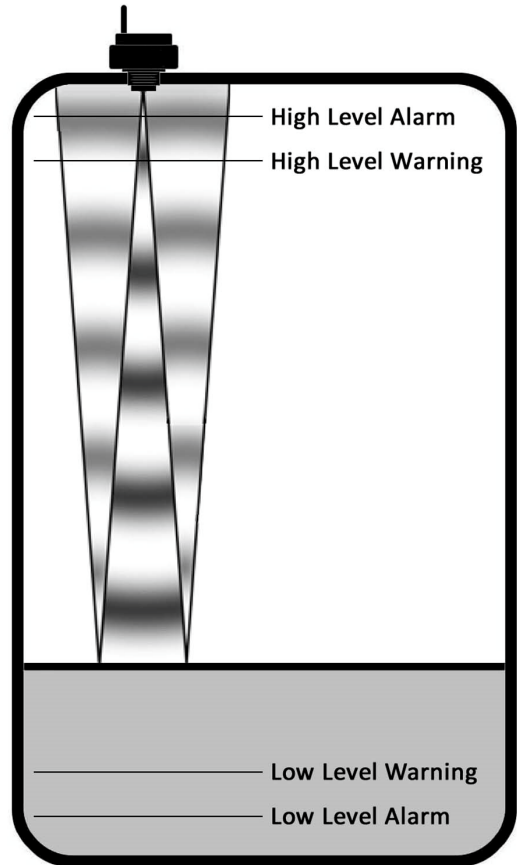
Editing Tank Details

Editing a tank setup includes the following steps:

1. Start by entering a unique Tank Name. Only the first 10 characters are displayed in the Monitor.
2. A Tank Content field is available, which defines what is stored in the tank.
3. Select Measure Units of Inches, Feet, or Meters.
Note: *If you change units after entering values, all values will be adjusted to the new units. Base units of Gizmo are inches. Foot and meter measurements are scaled from inches.*
4. Select Tank Type of Vertical Cylinder, Horizontal Cylinder, or Rectangular for volume calculation.
5. Enter the Tank Dimensions.
6. Select Volume Units of Gallons, Liters, or Cubic Feet.
Note: *Volume units of gallons, liters, and cubic feet are scaled from cubic inches.*
Note: *The Max Volume field is for reference use when setting Alarm On volume levels. It is calculated from tank size and tank type and displayed in selected volume units.*
7. Enter the Sensor Name. This links the tank to the sensor installed in the tank. The sensor is typically set up first, so the sensor name is available for this step. If the sensor has not been set up it can be added later.
8. Enter the Tank Minimum Level and Maximum Level for tank span calculation.
9. Enter the Gizmo reported range when the tank level is at its minimum. Since Gizmo measures range from the top of the tank, the tank level will be calculated as:

$$\text{Level} = \text{Range at Minimum Level} - \text{reported range}$$

10. When edits are complete click Save.



Site Monitor Column Selection

The Site Monitor screen can display up to three sensor readings. Possible selections are Level, Range, Percent, Volume, Temperature, and Battery Voltage. The user may select a maximum of three available items.

Note: *The selection of sensor readings applies to all sensors.*

5 Event History Log

MMSA includes an Event History Log of all reported events. The history log file format is .csv, compatible with Excel and can be viewed by clicking the View History button in the top banner.

As of MMSA V1.42, the Event History Log file is named MMSA_Events.csv and can be found in the MMSA application folder (C:\Multi_Sensor_App\).

MASSASONIC®
Multi-Sensor Application Software

Monitor Site Setup View History Help Sensor Maintenance

View History

Selected Time: 3/24/2024 - 4/24/2024
 Previous Month
 Interval: None
 Tank Name Filter: None
 Print Data Graph History

	Date	Time	Tank	Lev	Volume	% Full	Units	Sensor	Bat Volt	Temp	RSSI	TStatus
▶	4/18/2024	13:07:00	TA1CE	9...	130.83	96.2	in / gal	SA1CE	3.35	22.5	-48	0
	4/18/2024	13:07:00	TA076	9...	130.83	96.2	in / gal	SA076	3.35	22.5	-53	0
	4/18/2024	13:06:00	TA15C	9...	130.83	96.2	in / gal	SA15C	3.35	22.5	-48	0
	4/18/2024	13:05:00	TA1CE	9...	130.83	96.2	in / gal	SA1CE	3.35	22.5	-48	0
	4/18/2024	13:05:00	TA076	9...	130.83	96.2	in / gal	SA076	3.35	22.5	-48	0
	4/18/2024	13:05:00	TA15C	9...	130.83	96.2	in / gal	SA15C	3.35	22.5	-48	0
	4/18/2024	13:04:00	TA1CE	9...	130.83	96.2	in / gal	SA1CE	3.35	22.5	-48	0
	4/18/2024	13:04:00	TA076	9...	130.83	96.2	in / gal	SA076	3.55	22.5	-53	0
	4/18/2024	13:04:00	TA15C	9...	130.83	96.2	in / gal	SA15C	3.35	22.5	-48	0
	4/18/2024	13:03:00	TA1CE	9...	130.83	96.2	in / gal	SA1CE	3.35	22.5	-53	0
	4/18/2024	13:03:00	TA076	9...	130.83	96.2	in / gal	SA076	3.35	22.5	-48	0

System Status: **Normal** Tank Count: 10

6 Sensor Override Modes

Gizmo includes Fill/Empty and Fast Sample Override Modes that force the sensor into faster Wake/Report cycles to better track level changes during fill or empty operations. The Fill/Empty mode only reports when the target level is hit, or mode timeout has occurred. The Fast Sample Mode reports every measurement.

On the Site Monitor screen, click the Sensor Override button in the top left corner to open the Override Status panel below.

Tank Name	Override Start Time	Mode	Status
TA1DA	4/22/2024 3:14:24 ...	Empty	IN PROGRESS

Buttons: Add, Delete Selected, Cancel

To add an override for a sensor, simply press the add button and select the sensor to be overridden. Then, configure the parameters as discussed below.

Select Tank

Confirm
Cancel

- **Start Time:** The date and time of the override start.
- **Fill or Empty Mode:** Select either Fill, Empty, or Fast Sample.
- **Target Level:** For Fill or Empty, enter the desired target level in inches. Not needed for Fast Sample
- **Sample Rate:** Enter the desired Sample Rate (measurement rate) in seconds for this override operation. The minimum time is 10 seconds.
- **Mode Timeout:** Enter the maximum override operating time in seconds.

TA0BA Override Settings

Start Time	04/22/2024 14:50 <input type="button" value="📅"/>
Fill/Empty Mode	Fill <input type="button" value="▼"/>
Fill/Empty Target Level (inch)	<input type="text" value="95"/>
Sample Rate (sec)	<input type="text" value="30"/>
Mode Timeout (sec)	<input type="text" value="300"/>

Note: Override modes drain Gizmo batteries much faster than normal operating modes. This battery drain can be limited by selecting longer Sample Rates and shorter Mode Timeouts.

6 Sensor Override Modes (continued from previous page)

Sequence of Operation

- After the override Set button is clicked, MMSA gives the sensor a “PENDING” status in the Override Status panel.
- The next time that Gizmo connects to MMSA, MMSA sends Gizmo the override parameters selected above.
- When Gizmo wakes at the override Start Time, it changes the normal Sleep Time to the override mode Sample Rate. MMSA sets the sensor’s override status to “IN PROGRESS”.
- Gizmo will continue to wake up and measure at the override Sample Rate.
- If the measured level has not reached the override Target Level, an alarm condition, or override mode Timeout, Gizmo goes back to sleep.
- If the measured level reaches the override Target Level, Gizmo reports the measurement event with Type = 5 (fill/empty target reached). This terminates the override mode, restores the previous sleep time, and Gizmo goes back to sleep. MMSA sets the sensor’s override status to “COMPLETED”.
- If the elapsed time of the override mode reaches the timeout, Gizmo reports the measurement event with Type = 6 (override timeout reached). This terminates the override mode, restores the previous sleep time, and Gizmo goes back to sleep. MMSA sets the sensor’s override status to “TIMEOUT”.
- If another status is returned by the next message from Gizmo, the override status panel displays “UNKNOWN” for the sensor.

After the override mode is complete, select the completed override and click the delete button in the Sensor Override Status window.

7 Sensor Maintenance

Sensor Maintenance provides tools for sensor setup, maintenance, installation troubleshooting, and communication. With these tools, users can request data, send commands, and view results.

The Sensor Maintenance window can be opened by pressing the Sensor Maintenance button in the top banner of MMSA.

All Sensor Maintenance functions are applied to a single sensor, selected by the Select Sensor dropdown list. Whether reading sensor settings, retrieving a waveform, restoring factory defaults, or deleting a sensor, you must **first select the sensor** from the Select Sensor dropdown list.

Viewing the Last Sensor Reported Event

The right top third of the screen shows reported information about the last event received from a Gizmo sensor. Reported fields are:

1. Last Time: The time of day the last Gizmo report was received (24-hour time).
2. Range: Last reported measured range in inches.
3. Status: See Table 1 for Event Status values.
4. RSSI: Radio signal quality in dBm.
5. Battery: Last reported Gizmo battery voltage.
6. Temp: Last reported Gizmo temperature.
7. Signal: Acoustic signal strength in % of full scale
8. Report On: The reason for this report.
9. Ping: Which ping (1, 2, 3, or 4) returned a target echo. If Range is "No Echo", then no valid target was found

7 Sensor Maintenance (continued from previous page)

Read Sensor Configuration from Gizmo

To read a Gizmo sensor's Configuration, first select the sensor from the Select Sensor dropdown list, then click the Read All button. This will queue up a query to read from Gizmo, denoted by the "... " symbol shown next to the Read All button. The next time the Gizmo wakes and connects, MMSA will send the Read All command. When Gizmo receives the command and sends the Sensor Configuration back to MMSA, the "... " symbol will change to a check mark. This indicates that the screen has been updated with the configuration stored in Gizmo.

Note: *Switching to another sensor's configuration or closing the window will hide the status indicator for the Read All command.*

Add a Sensor

1. Click the Add button.
2. Select Sensor Protocol from the Sensor Comm Type popup panel. As of MMSA V1.42, only JSON is available. Once selected, press Accept.

Note: *MQTT and Local Host transport protocols are selected with Gizmo provisioning.*

3. Enter a new unique sensor name.
4. Enter the Gizmo's Sensor ID (see Editing the Identification Settings for more information)
5. If the Gizmo will use MQTT, enter an Owner and Group
6. When finished, click the Save button.

Delete a Sensor

1. To delete a sensor, first select the sensor by name from the Select Sensor dropdown list.
2. Click Delete.
3. A dialog will pop up to confirm the deletion of the sensor.
4. Press yes to delete and no to retain the sensor.

Cancel Adding/Editing a Sensor

- a. If adding a sensor, the cancel button returns to the previously selected sensor and displays its values.
- b. If editing a sensor, the cancel button overwrites edit values with previous sensor values.

7 Sensor Maintenance (continued from previous page)

Editing a Sensor

There are two types of edits to a sensor’s information: editing the Identification Settings (located in the left side top third of the screen) and editing the Sensor Configuration (located in the bottom two-thirds of the screen).

Editing the Identification Settings

To change the Identification Settings, select the sensor’s name in the Select Sensor dropdown, edit the fields below, and press the save button.

- **Sensor Name** Enter Sensor name (Max 32-characters).
- **Protocol** Selected when creating a sensor.
- **CommType** Automatically fills from Gizmo Provisioning.
- **Tank Name** Automatically fills if this sensor is linked to a tank in the Site Setup.
- **ID Type** Gizmo Wi-Fi and Cellular sensors are identified by Gizmo’s permanently assigned MAC or IMEI.
- **Sensor ID** Enter the WiFi MAC address or the cellular IMEI in the following format:
MAC: Enter 6 two-character pairs of hexadecimal values (ex: F8.30.02.37.C9.4F).

Note: hexadecimal numbers are characters 0-9 and A-F

IMEI: Enter a 15-character numeric value (ex: 352465103302176)

- **Owner** (MQTT Only) Allows filtering by sensor Owner through MQTT. This must match the value provided in provisioning to access sensor data.
- **Group** (MQTT Only) Allows filtering by sensor Group through MQTT. This must match the value provided in provisioning to access sensor data.

Note: Be sure that the combination of ID Type and Protocol defined above match the combination of one of the communication channels. See Communication Setup.

Editing the Sensor Configuration

First, select the sensor’s name in the Select Sensor dropdown. Then, enabled fields may be edited, saved for future use to a configuration file, and/or sent to the sensor to modify operation. Field details are described in Table 1 and Table 2.

- a. To save the settings as a configuration template file, simply press the Save Config button and select the file to save the configuration.
- b. To load settings from a configuration template file, simply press the Load Config button and select the file to load the configuration from.
- c. To update the sensor’s configuration, press the checkbox adjacent to the fields that you would like to update and press the Send Checked button.

Note, disabled or fields in light gray are read only fields from the sensor. MMSA cannot change disabled fields.

Edit the sensor’s configuration or operating parameters are as follows:

Operation Control

- **Sleep Time:** Enter Gizmo’s sleep time in seconds
- **Operating Mode:** Select Gizmo’s operating mode
- **Low Alarm:** Enter the range at which Gizmo’s Low Alarm will be reported
- **High Alarm:** Enter the range at which Gizmo’s High Alarm will be reported

7 Sensor Maintenance (continued from previous page)

Operation Control (continued from previous page)

- Unit Description Enter Gizmo’s description, 32 characters max
- Network Connect Timeout The time allowed, after wakeup, for the Gizmo to connect to the WiFi or Cellular network. If connection fails Gizmo will go back to sleep and try again on the next wakeup
- Inter-Message Timeout The time allowed between host messages before Gizmo going back to sleep
- Provisioning Timeout The time allowed to complete provisioning
- Delayed Report Count In the Report on Delayed Count Mode, the number of Sleep Cycles before Gizmo reports

Measurement Control

- Max Pings: The maximum number of Pings Gizmo will use to measure range
- Preset Temp: Select On to use a preset temperature for range calculation. Select Off to use Gizmo’s internal temperature sensor for range calculation
- Preset Temp Value: When Preset Temp is On, enter the temperature to use for range calculation

Ping 1, Ping 2, Ping 3, and Ping 4

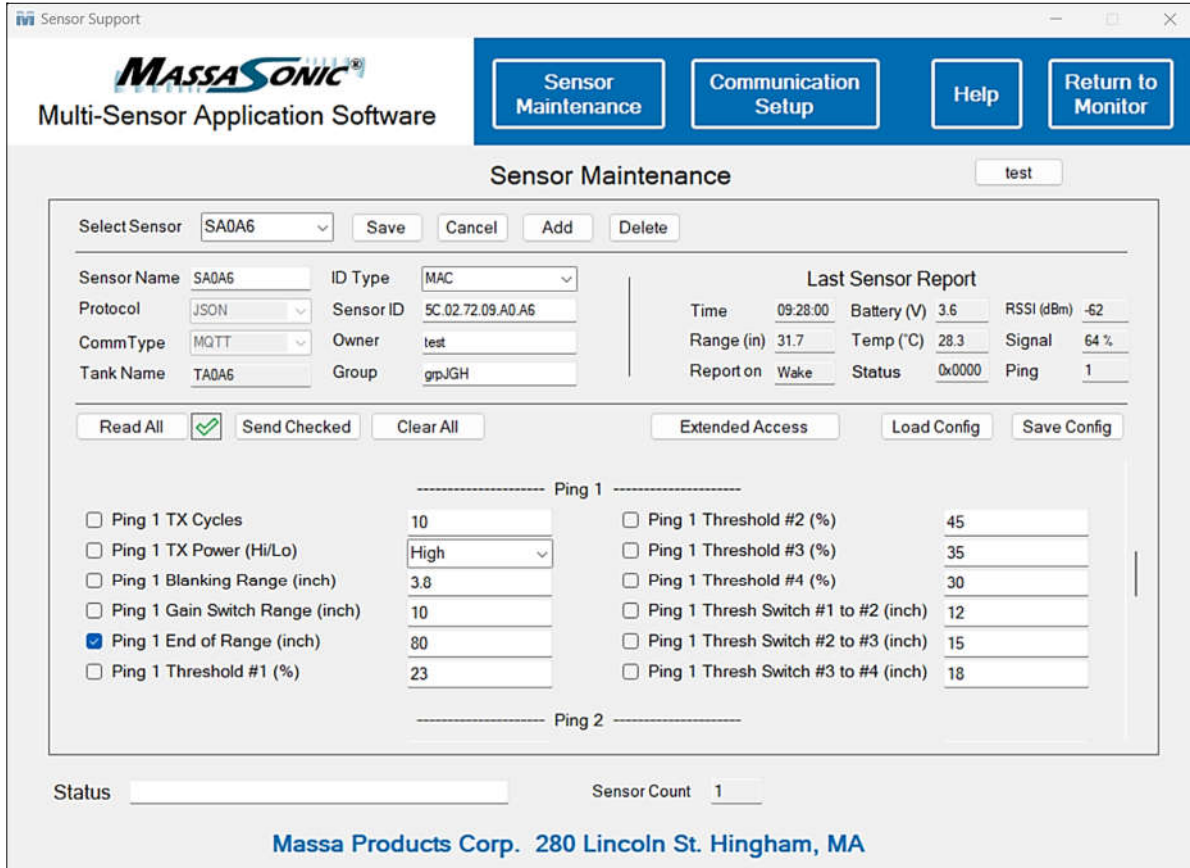
- TX Cycle: Enter number of acoustic transmit cycles to use in this ping
- TX Power: Select transmit power, High or Low, for this ping
- Blank Range: Enter this ping’s blank range in inches, where Gizmo does not look for an echo
- Gain Switch Range: Enter this ping’s Low to High gain switch range where Gizmo will switch to High Gain to better detect weak echoes
- End of Range: Enter this ping’s maximum range. If an echo has not been Detected within this range, the echo process will be terminated and the next ping will be initiated
- Ping (n) Threshold #1: Enter this ping’s first echo detection threshold
- Ping (n) Threshold #2: Enter this ping’s second echo detection threshold
- Ping (n) Threshold #3: Enter this ping’s third echo detection threshold
- Ping (n) Threshold #4: Enter this ping’s forth echo detection threshold
- Ping (n) Thresh Switch #1 to #2: Enter this ping’s range to switch from #1 to #2 first echo detection threshold
- Ping (n) Thresh Switch #2 to #3: Enter this ping’s range to switch from #2 to #3 first echo detection threshold
- Ping (n) Thresh Switch #3 to #4: Enter this ping’s range to switch from #3 to #4 first echo detection threshold

See the MassaSonic Gizmo Advanced Users Guide for settings details.

7 Sensor Maintenance (continued from previous page)

Writing Sensor Configuration to Gizmo

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.



8 Sensor Commands

To send a command, first select the sensor from the Select Sensor dropdown list, then click the Extended Access button. This brings up the Extended Access panel shown to the right.

Note: All Extended Access commands are queued and will wait for Gizmo to wake up to send.

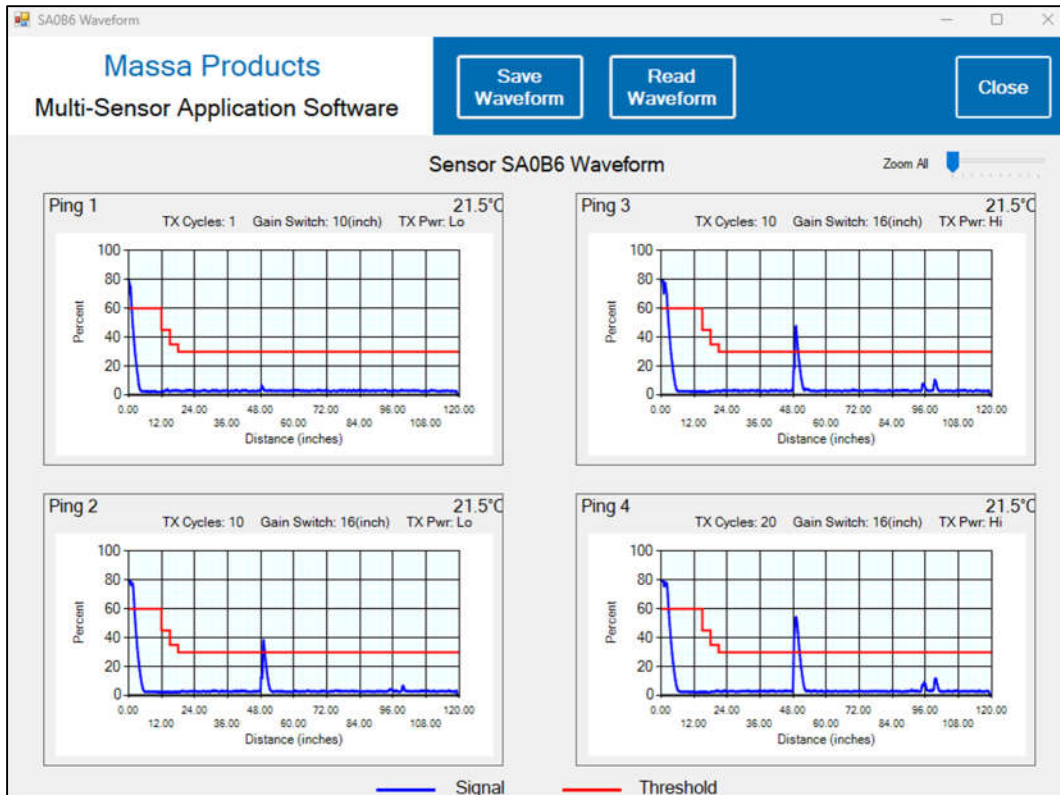
The Gizmo toolset provides the following commands:

Get Waveform

To get diagnostic waveforms, click the Get Waveform button, select one or all ping waveforms to retrieve, then click the Accept button. MMSA adds the waveform request to the message queue. When the corresponding Gizmo sensor connects, MMSA will request the waveform data. Once the waveforms have been received, they are displayed as follows.

The waveform screen below shows the acoustic waveform with target echo and echo detection thresholds for all 4 pings. The cursor and left mouse button can be used to highlight and magnify portions of each plot. Additionally, the Zoom All bar can be used to scale all plots simultaneously.

The waveform data and related sensor settings can be saved for future reference or for sharing via email. Click the Save Waveform button. This will bring up a file dialog. Enter a file name and click Save.



8 Sensor Commands (continued from previous page)

Show Waveform File

To display a previously saved waveform, click the Show Waveform File button. This brings up a dialog that lets you select the file name of interest. Select the file and click Open.

Set Gizmo UTC Time

Click the Set Gizmo UTC Time button to set Gizmo's Real Time Clock to UTC time (time zone of 0) in J2000 epoch time form. This is completed after the Gizmo sensor completes its next report.

Clear Error Status

Upon clicking the Clear Error Status button, the Gizmo sensor will clear the associated error status. See Table 1 for more information about how to read the error status.

Get History

A Gizmo sensor will store up to 1000 measurement events at one time. The index of the last recorded event is included in each reported event. To retrieve history data click Get History. Enter the number of records to retrieve and the starting index to retrieve from, then press Accept. MMSA will then create a query to retrieve the specified history data and add them to the outgoing message queue. The retrieved history is then stored in an Excel-compatible .csv file for easy accessibility.

Clear History

Upon clicking the Clear History button, the Gizmo sensor will delete its event history after sending the next report.

Reset Sensor

Upon clicking the Reset Sensor button, the Gizmo will reset and reboot after sending the next report.

Restore Factory Defaults

Upon clicking the Restore Factory Defaults button, the Gizmo sensor will restore the sensor's configuration to the factory defaults after sending the next report.

Note: *This does not change Sensor identification settings.*

Gizmo Provisioning

Clicking the Gizmo Provisioning button will start the Gizmo Provisioning software. See the Gizmo and MMSA Provisioning Guide for instructions on how to provision Gizmo.

Update Sensor Firmware

Clicking the Sensor Firmware button will update the Gizmo sensor's microprocessor firmware. When Gizmo receives this command, it will look for an updated version of the sensor's firmware in Gizmo's GitHub repository. If there is an updated version of the firmware, Gizmo will download and install it.

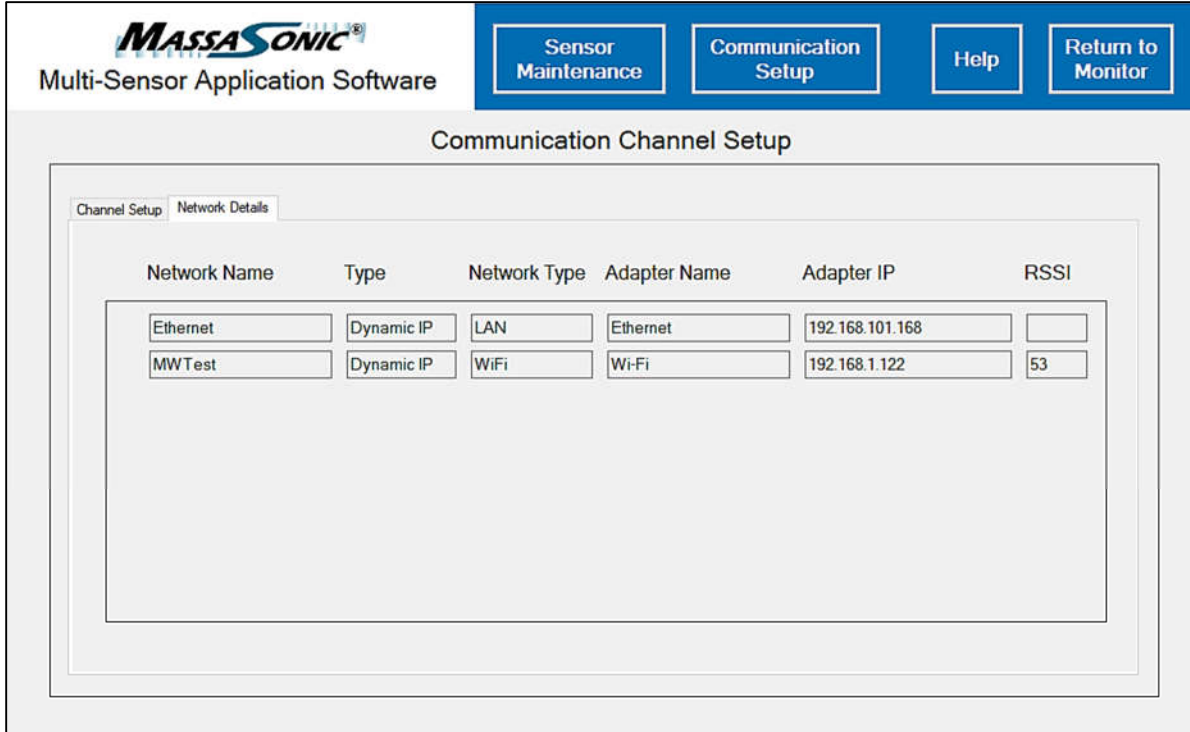
Update Radio Firmware

Clicking the Radio Firmware button will update the Gizmo radio's microprocessor firmware. When Gizmo receives this command, it will look for an updated version of the radio's firmware in Gizmo's GitHub repository. If there is an updated version of the firmware, Gizmo will download and install it.

9 Communication Details and Setup

MMSA connects to the outside world through several network communication channels. Depending on the Gizmo installation and environment, MMSA may require only one channel connecting to an MQTT broker, and others may require additional Local Host or Smartphone connection.

On startup, MMSA scans all available PC network connections, recording the list of available LAN and Wi-Fi networks. The network list can be viewed on the Communication Setup → Network Details tab as shown below. The list is used to select specific networks in channel setup.



Setup Page Usage

The Communication Setup screens below include channel Edit, Add, Save, and Delete capabilities:

Add Channel

1. Click the Add button and a new set of channel settings will appear.
2. Edit the fields as described below.
3. Click the Save button when done and restart MMSA.

Edit Channel

1. Edit the Channel Name, which allows you to tell apart channels.
2. Edit the Channel Type, which sets up for different types of connections. As of MMSA V1.42, the supported channel types are MQTT Broker, Local Host (TCP Direct), Smartphone Remote Monitoring (SP Remote Data), and Local Host with TLS security (TCP Direct with TLS). See the sections below for configuring each type of connection.
3. Select the Network Connection to associate with the Channel. If your desired network does not appear in the dropdown menu, restart MMSA.
4. Click the Save button to finish and restart MMSA.

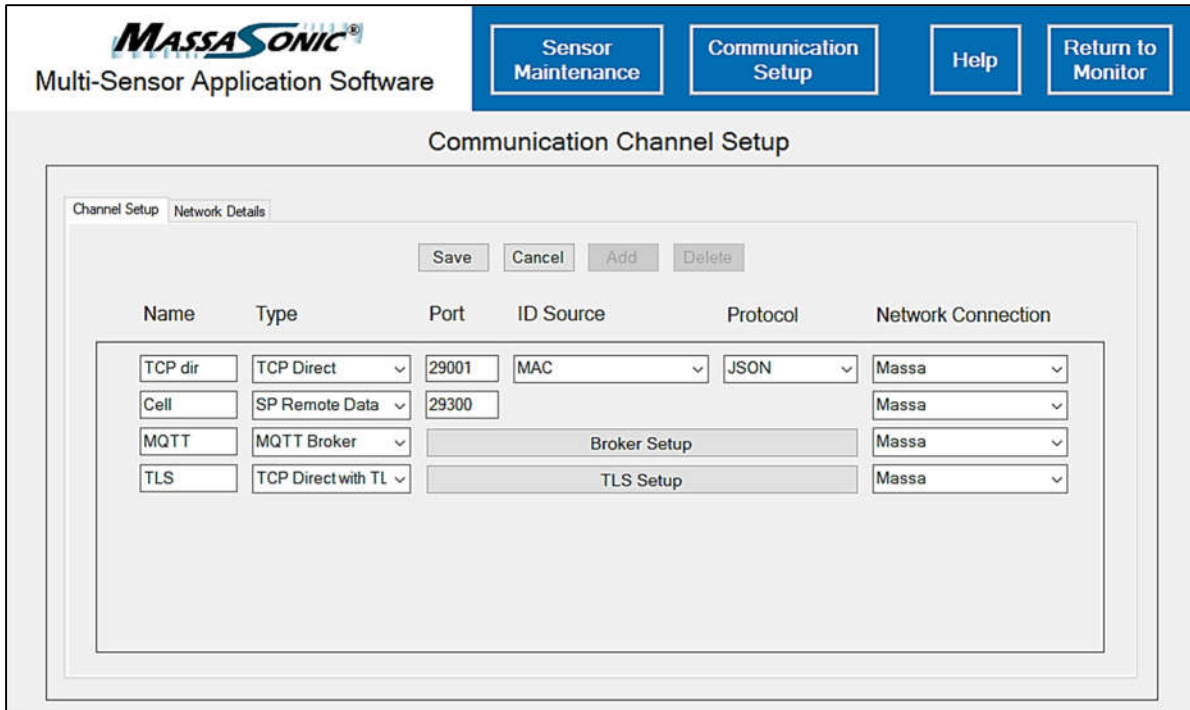
9 Communication Details and Setup (continued from previous page)

Delete Channel

1. Click the Delete button and select the channel that you wish to delete.
2. Click Accept, then click Yes to delete the channel. Pressing Cancel or No will abort the deletion.
3. Restart MMSA to apply your change.

Cancel Adding/Editing a Channel

- a. While adding a channel, the cancel button will remove the new channel entries.
- b. While editing a channel, the cancel button restores the channel to its original values.



Channel setup defines how MMSA connects to an MQTT broker, listens for Gizmo’s Local Host connections, and provides Smartphone Remote Data app monitoring. The following describes channel operation and channel setup fields.

Notes:

1. Channels operate independently. You can have the same or different Wi-Fi networks on all channels.
2. MMSA supports multiple MQTT Broker channels as of MMSA V1.42.
3. MMSA supports multiple Local Host channels, but they must use different ports.
4. MMSA logs all sensor communication to the CommLog, MQTTCommLog, TCPDirectLog, and SPAppCommLog text files in the MMSA application folder (C:\Multi_Sensor_App\).

9 Communication Details and Setup (continued from previous page)

Smartphone Remote Data Monitoring

By default, MMSA collects, saves, and locally displays measured data. MMSA can also distribute this measured data to registered Smartphones via Wi-Fi. Field technicians with smartphones and the Gizmo Remote Monitoring App can register their phones to view tank data while away from their computers.

Once a smartphone is registered, tank data will be sent to the smartphone as soon as the Site Monitor updates with new data. See Gizmo Sensors Remote Monitoring App Users Guide for smartphone use.

To configure Smartphone Remote Data Monitoring, enter or select the following:

- **Channel Name** Can be any name for the channel.
- **Channel Type** Must be SP Remote Data.
- **Channel Port** Must be 28000.
- **Network Connection** Must be the same Wi-Fi network as the MMSA client is hosted on.
- Click Save on the Channel Setup tab to save the new channel.
- Restart MMSA to apply the new channel settings.

Local Host Communications

With Local Host (also called TCP Direct), Gizmo and MMSA transport packets directly between each other. JSON data payloads are wrapped in packets for transport over a TCP/IP network. The network configuration can be quite flexible. Packets may be routed simply using the local Wi-Fi network or may be transported by Wi-Fi routers and cellular carriers via the internet, ending up in MMSA on your desktop computer.

Upon waking up, Gizmo generates a JSON formatted measurement event. The Wi-Fi or Cellular module wraps the event data in a TCP/IP packet, and based on provisioning, assigns the packet a destination address. The network then routes that packet over the required Wi-Fi, cell carrier, and/or internet service to its final destination, MMSA.

To configure Local Host, enter or select the following:

- **Channel Name** Can be any name for the channel.
- **Channel Type** Must be Local Host.
- **Channel Port** Must match Gizmo’s provisioned Local Host port (default 29001)
- **ID Source** Should be either “MAC” for Wi-Fi Gizmos or “IMEI” for Cellular Gizmos.
- **Channel Protocol** Should be set to JSON.
- **Network Connection** The network that MMSA will use to listen for Gizmo.

Possible network topologies:

1. If Gizmo and MMSA connect to the same Wi-Fi network, then set the Network Connection to that network.
 2. If Gizmo is on a remote network and will use the internet to connect to MMSA, then set the Network Connection to any LAN or Wi-Fi network with an internet connection. Note, in this case the internet router’s Port Forwarding will have to be set to forward Gizmo packets to the computer running MMSA.
- Click Save on the Channel Setup tab to save the new channel.
 - Restart MMSA to apply the new channel settings.

9 Communication Details and Setup (continued from previous page)

Local Host with TLS Communications

Local Host with TLS is very similar to Local Host, with the added layer of protection from the widely used Transport Layer Security (TLS). By using public and private keys stored within MMSA and the Gizmo sensor, MMSA establishes an encrypted connection to Gizmo, making the connection unreadable by those who do not have access to the secret private keys stored on MMSA and Gizmo.

Gizmo and MMSA provide support for X.509 certificates from Trusted Certificate Authority and self-signed certificates alike.

To configure Local Host with TLS, enter or select the following:

- **Channel Name** Can be any name for the channel.
- **Channel Type** Must be Local Host with TLS.
- Click the TLS Setup button to open additional settings (shown below).
 - **Server Port** Must match Gizmo’s provisioned Local Host port (default 29001).
 - **ID Source** Should be either “MAC” for Wi-Fi Gizmos or “IMEI” for Cellular Gizmos.
 - **Protocol** Should be set to JSON.
 - **Server Cert** The server certificate file path for MMSA that the Gizmo must trust.
 - **Server Cert Password** The password for the provided server certificate
 - Click the Save Settings button to confirm the changes.
- **Network Connection** The network that MMSA will use to listen for Gizmo. Possible network topologies:
 1. If Gizmo and MMSA connect to the same Wi-Fi network, then set the Network Connection to that network.
 2. If Gizmo is on a remote network and will use the internet to connect to MMSA, then set the Network Connection to any LAN or Wi-Fi network with an internet connection. Note, in this case the internet router’s Port Forwarding will have to be set to forward Gizmo packets to the computer running MMSA.
- Click Save on the Channel Setup tab to save the new channel.
- Restart MMSA to apply the new channel settings.

Note: A **Local Host channel** cannot share the same port with any other Local Host channel nor any Local Host with TLS channel.

The image shows a dialog box titled "TLS Settings". It contains the following fields and controls:

- Server Port:** A text input field containing the number "29".
- ID Source:** A dropdown menu with "MAC" selected.
- Protocol:** A dropdown menu with "JSON" selected.
- Server Cert:** An empty text input field.
- Server Cert Password:** An empty text input field.
- Buttons:** "Save Settings" and "Cancel" buttons at the bottom.

9 Communication Details and Setup (continued from previous page)

MQTT Broker Communications

Through MQTT communications, Gizmo and MMSA communicate using JSON messages published to and distributed by an MQTT Broker. Data transactions happen through publishing and subscribing to topics. Both Gizmo and MMSA send data by publishing JSON packets to specific topics (ex: event data is published to the `.../report/event` topic). Both Gizmo and MMSA receive packets by subscribing to topics. When the broker receives a message on a topic, the broker forwards the message to all connections that are subscribed to that specific topic.

When MMSA starts up, it connects to a specified MQTT broker. On connection, MMSA subscribes to topics of interest (`.../request/config` or `.../report/event`). Note, a wildcard `#` may be used to subscribe to all broker transactions. MMSA stays connected to the broker waiting for Gizmo to wake up and publish. When Gizmo wakes up it connects to the MQTT broker, subscribes to topics, and publishes a measurement event with the topic `.../report/event`. Since MMSA subscribed to the event topic, the broker will send MMSA a copy of the measurement event. The reported measurement signals to MMSA that Gizmo is awake. In response, MMSA will publish all queued messages destined for that Gizmo.

MMSA authenticates the broker using TLS through validation of a X.509 certificate chain.

To configure the MQTT Broker, enter or select the following:

- **Channel Name** Can be any name for the channel.
- **Channel Type** Must be MQTT Broker.
- Click the Broker Setup button to open additional settings (shown on the following page):
 - **Broker URL** The URL/IP of the MQTT Broker to use.
 - **Broker Port** The port to use on the MQTT Broker.
 - **Broker Cert** The local path to the MQTT Broker’s Root Certificate Authority file.
 - **MMSA Cert** The local path to a .pfx (PKCS#12 format) file type that includes the client certificate and private key.
 - **MMSA Cert Password** The password used when creating the MMSA certificate .pfx file
 - **MMSA ID** A unique identification string for MMSA to connect to the MQTT broker.
 - **User Name** (Optional) Enter “None” if not required by the broker.
 - **Password** (Optional) Enter “None” if not required by the broker.
 - **MMSA Subscription Topics** Enter MMSA subscription topics. These are generally the top two qualifiers of Owner and Group followed by the wild card symbol `#` (ex: `Owner1/Group1/#`). You can subscribe up to five topics.
 - Click the Save Settings button to confirm the Broker Settings changes.
- **Network Connection** The Wi-Fi or LAN network that has a connection to the internet or the computer that the broker is hosted on.
- Click Save on the Channel Setup tab to save the new channel.
- Restart MMSA to apply the new channel settings.

9 Communication Details and Setup (continued from previous page)

Broker Settings - Login

Broker URL

Broker Port

Broker Cert

MMSA Cert

MMSA Cert Password

MMSA ID

User Name

Password

Subscriptions Topics

Topic 1

Topic 2

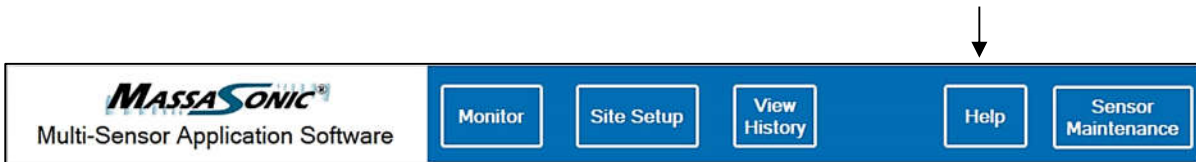
Topic 3

Topic 4

Topic 5

10 Help

To reference Gizmo supporting documents, click the Help button in the top banner. Select a file and it will open automatically.



11 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 Bit 16: Radio Provision File Error Bit 17: Sensor FOTA Error Bit 18: Radio FOTA Error
SignalStrength	Int	Ultrasonic signal strength in percent of Full scale
LastEventIndex	Int	Start index of current block of history data

12 Table 2 – Sensor Info, Operating Status, & Control Parameters

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

12 Table 2 – Sensor Info, Operating Status, & Control Parameters

Data Item	Data Type	Limits	Default	Description
OpsControl				Operation Control Section
SleepInterval	Uin32	60 sec. to 7 days	60	Sleep interval
OpMode	Uin8	0 to 5	1	Mode 1=Report on every wakeup 2=Report after history count measurements. 3=Report all events since last report
TimeZone	Uin8		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	Uin16	5 to 300 seconds	45	Max radio attempt to connect wait time before sleep
InterMessageTO	Uin16	2 to 60 sec	5	Max inter-message time before sleep
ProvisioningTO	Uin16	60 to 600 sec	600	Max provisioning time
ReportCount	Uin8	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

12 Table 2 – Sensor Info, Operating Status, & Control Parameters

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 overflow 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.

12 Table 2 – Sensor Info, Operating Status, & Control Parameters

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

12 Table 2 – Sensor Info, Operating Status, & Control Parameters

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.

Revision History

<u>Revision</u>	<u>Date</u>	<u>Notes</u>
1.0	June 6, 2024	First release